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memorandum

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to Renee LaCroix, City of Bellingham

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subject Padden Creek Estuary Habitat Enhancements Project No. EN-38 - Final Feasibility Analysis

Restoration of the Padden Creek estuary is a priority for the City of Bellingham and an important component of the Bellingham Bay and Puget Sound recovery strategies. The estuary is highly altered from its historical condition but still provides important habitat for fish and wildlife species. Urban and industrial development in the surrounding area has impaired the physical processes that properly functioning estuaries require: tidal exchange, tidal channel formation and maintenance, sediment deposition, detritus recruitment, and exchange of aquatic organisms. The City restored portions of the buffer on the west side of the estuary approximately 20 years ago; In 2011, the City engaged Environmental Science Associates (ESA) and Coastal Geologic Services (CGS) to evaluate the feasibility of additional enhancement / restoration actions that would enable the estuary to support a greater variety of ecosystem functions, species, and habitats, and serve as a more substantial amenity to the community.

The purpose of this memorandum is to describe and compare the feasibility of several possible restoration opportunities and assess the potential of each to achieve ecological uplift. Each opportunity is also evaluated in terms of associated engineering considerations and constraints, including constructability, site evolution in the face of projected sea level rise, sustainability over time, and other risk factors. The memorandum reviews the site’s historical condition, assesses past impacts, and describes the existing physical and biological site conditions including the current limiting factors for fish and wildlife. This memorandum addresses comments from the City and the Washington Department of Fish and Wildlife on the draft feasibility memo, which we submitted on March 5, 2011.

Site Description

Historic Conditions

The oldest documentation of conditions in the Fairhaven area was completed in 1888 by the U.S. Coast and Geodetic Survey (USC&GS) (Figure 1). At that time, the estuary area, inside the narrowest portion of the inlet and below MHW, was 3.3 acres. At its narrowest point, the estuary entrance was 74 feet across at MHW. A bridge had already been constructed across the center of the estuary, along the present-day McKenzie Avenue right-of-way. The original shoreline was in the general location of Harris Avenue, with a sand and gravel beach located in the southwest corner of the present estuary that extended into an eastward trending barrier spit.

The Padden Creek estuary has experience dramatic changes during multiple time periods since the late 1800s (Figure 2). Some of the most notable changes occurred as a result of the following actions:

- Construction of a shingle mill and a cannery on either side of the present estuary, constructed on pilings
- Construction of the great northern railroad through the shallow tidelands
- Filling of the historic back barrier estuary (south of Harris Avenue)
- Filling and redevelopment east of the estuary for boat/industrial use
- Filling of the area west of the estuary for industrial use
- Construction of the primarily solid fill causeway in the current railroad alignment
- Installation of a series of piers and docks waterward of the rail right-of-way
- Partial fill removal and native plant installation along the southeast and east estuary shores
- Reconstruction of armor along the east bank at several different periods up through the 1990s

The Padden estuary was formed when the nearshore was filled and various water-dependent uses were constructed, most notably wood processing where the estuary was used to both bring raw lumber in and for disposal of wood debris (Griffin 2007). Most changes to the estuary shoreline were in place by 1975. Minimal changes have occurred since the 1990s.

Pre-development and post-development conditions are depicted on the pair of maps in Figure 3, as reproduced from Brown et al. (2005). Their work used the 1888 USC&GS survey and 2004 orthophotography to digitize changes in nearshore habitat area (Table 1). Salt marsh area decreased form 13.1 to 1.0 acre, leaving only 7.6% of the original marsh area. Tide flat lost more acreage, with only 16.1% remaining. Brown et al (2005) identified Padden estuary as severely degraded with limited salmonid utilization (see subsequent discussion of fish and wildlife habitat for more detail). While no historic fish use data for Padden Creek were available, enhancement of the creek and estuary was identified as a priority for improving nearshore salmonid habitat in the vicinity of the Nooksack Delta.

Table 1. Historic and current habitat in the Padden Creek pocket estuary (Brown et al. 2005)

Location	Habitat Type	1888 (acres)	2004 (acres)	Area Remaining (%)
Padden Creek	Salt Marsh	13.1	1.0	7.6
	Tide Flat	18.6	3.0	16.1
	Scrub Shrub	0.0	1.4	0.0

Shoreform mapping completed by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) of both the current and historic conditions shows the Padden Creek estuary as Barrier Estuary based on the Shipman (2008) typology. The shoreline just outside the estuary was mapped as artificial, with Barrier Beach west of the opening and Bluff Backed Beach east of it. This is consistent with the 1888 mapping, which showed that a barrier estuary was present with natural beaches to either side of the creek mouth, although in a much more landward location.

Current Site Conditions

ESA and CGS examined recent aerial photographs obtained from the City and LiDAR data obtained from the U.S. Geological Survey (USGS) (Attachment A; Sheet C1.1–C1.3) to assess current site conditions. The LiDAR was flown at an approximate tidal elevation of +1 foot MLLW, and the 2006 creek channel was easily discernible through the estuary. The 2006 estuary was found to be slightly larger (3.9 acres) than the 1888 estuary (3.3 acres), below MHW. This area included a portion of Padden Creek upstream of the Harris Avenue culvert, as that area remains below MHW. The channel width was found to be smaller than in 1888, at 55 feet across at the narrowest portion inside the railroad bridge.

Field reconnaissance (in late 2011 and early 2012) supplemented the aerial photo and LiDAR review. Survey data were collected using a Leica TCR-1105 total station with direct rod measurements from existing City control points. Monument elevations were provided in NAVD88 datum, and converted to local MLLW datum prior to surveying using a conversion factor (obtained from the City) of 0.0 feet NAVD88 = +0.52 feet MLLW, which was further verified using NOAA's VDatum tool. Surveying was primarily profile-based in order to supplement the LiDAR data (Attachment A; Sheet C1.1).

Geomorphology

The majority of the study area is composed of intertidal mud flat. West of the Padden Creek channel the mudflat covers 2.4 acres, or 62% of the total estuary area. The elevation of the mudflat ranged from +4.4 feet MLLW in the south down to +3.0 feet MLLW to the north near the railroad causeway with a gradual slope throughout. One shallow drainage channel was seen extending from the southwest corner of the mudflat northward toward the railroad causeway where it parallels the rail line before flowing into the main creek channel.

Padden Creek enters the estuary via a concrete box culvert under Harris Avenue. The culvert is approximately 80 feet long and has an invert, or upstream, bottom elevation of +5.4 feet MLLW. The top of the culvert is underwater at high water levels as it only extends up to approximately +7 to 8 feet MLLW. The bottom of the box culvert is perched above low water levels with the outvert located at +4.4 feet MLLW.

As seen in the location of the channel thalweg (traced by Profile E, Sheet C1.2) Padden Creek has trended toward broader meanders since 2006. Where the stream exits the Harris Avenue culvert, the channel initially flows directly toward a wooden retaining wall, which is severely degraded. Further down-stream the channel has eroded portions of the western mudflat and deepened considerably where it flows directly into the riprap down-stream of the small boatyard dock. Lenses of wood waste and other debris are exposed on the cut banks of the mudflat.

Examination of Profile B (Sheet C1.2) shows the relatively rapid meander of the creek channel through the mudflat. The crest of the bank channel had migrated 7.2 feet westward in the 5.5 years between the LiDAR data and the 2012 survey, representing a rate of 1.3 ft/yr. Approximately 30 feet downstream of Profile B, at the outermost bend in the channel, the crest of the channel had migrated 15.6 feet in that same period, a rate of 2.8 ft/yr. Wood debris, primarily consisting of small, thin sheets, was seen exposed on the cut bank in January and February of 2012. Wood debris and fines were also seen accreting to the point bar of the meander.

The western shore of the estuary appears to be in a relatively naturalized condition. A gradual transition from mudflat through salt marsh into upland was seen during the site survey. The transition from salt marsh to mudflat was found to occur between +7.5 feet and +8.1 feet MLLW, or approximately 0.4 feet to 1.0 feet below MHHW. Salt marsh vegetation transitioned to upland grasses at approximately +8.7 feet MLLW, or 0.2 feet above MHHW.

A sloping rock revetment dominates the east shore of the estuary. The revetment stretches from 180 feet north of the Harris Avenue box culvert all the way out to the BNSF railroad bridge/causeway. The revetment was constructed at between1.5:1 (horizontal: vertical) to 2:1 slope. A very narrow (10 to 15 feet wide) vegetated band exists along the top of bank at the southern portion of this shore.

The northeastern-most portion of the estuary inside the railroad bridge contains a small pocket beach-like area. This rock revetment extends around the corner to this area, but transitions to concrete rubble on the east end where it abuts the railroad bridge. A significant amount of rock, concrete, and other debris is located over this beach. A rock groin crosses the intertidal from the northwest corner of the boat yard, along the east side of the intertidal creek channel and extending to under and north of the railroad bridge.

The railroad bridge crossing the mouth of the estuary was reconstructed in approximately 1995. This bridge is composed of seven prefabricated concrete spans that are supported by poured concrete piles and pile caps. This is a single track line in this area. The remainder of the north shore of the estuary consists of railroad causeway fill, which extends for approximately 360 feet. The upper portion of this causeway is armored with 2 to 4 foot angular riprap while the lower portion of the causeway consists of angular railroad ballast rock (generally 2-inch minus angular material).

A series of approximately 30 creosote treated wood piles is located in the area waterward of the Harris Avenue box culvert. These piles generally extend to approximately +10 feet MLLW. On the east edge of the pile field is a failing creosoted wood retaining wall that has lost some of its upper lagging over time. Various types of debris are located in this portion of the estuary including old chairs and metal.

The lower reach of the present day Padden Creek south of the Harris Avenue also receives tidal water and is therefore part of the estuary. This area was not assessed as it is outside of the defined study area. A 27-inch diameter culvert flows into the center portion of the Harris Avenue box culvert.

Hydrology (Tides, Freshwater Inflow)

The Padden Creek estuary is heavily tidally influenced through its connection to Bellingham Bay under the railroad bridge. Based on NOAA station #9449211 near the mouth of Whatcom Creek (approximately 1.5 miles to the north) the spring tidal range is 8.5 ft. However, this tidal amplitude is likely muted slightly by the restriction at the BNSF railroad causeway, which is about 20 feet narrower than the historic opening. Tides appear to influence streams levels at least 230 feet upstream of the Harris Avenue culvert, although this area is outside the defined study area.

Freshwater inflow to the estuary is typical of a semi-urbanized watershed. The watershed drains about 3,830 acres on the south end of Bellingham and includes the sub-basins of Lake Padden and Connelly Creek. The upper reaches, as high as 985 feet above sea level, flow through several unnamed streams into Padden Lake. This area includes dense, mixed-successional forest, a golf course, and residential developments. Lake Padden drains into Padden Creek where it flows through a forested ravine until reaching the moderately dense residential neighborhoods of Bellingham. Here Padden Creek has been largely channelized, and flows through an underground culvert for several hundred feet. Connelly Creek drains a small watershed into Padden Creek, as do many stormwater outfalls.

The inflow is mainly untreated storm water from a large portion of the Fairhaven, lower Happy Valley, and southern South Hill neighborhoods. One stormwater treatment system is in place at the head of Connelly Creek, which effectively treats nitrate and phosphorous loading from the Western Washington University campus. Details of the drainage system were not researched, as this was also understood to be outside of the primary scope of work. The City recently received grant funds to address the untreated stormwater discharges to the estuary at Harris Avenue. This project is anticipated to be built in 2014.

The City maintains a stream gauge on Padden Creek within Fairhaven Park, approximately 0.5 mile upstream of the Padden estuary. During 2010 the daily mean stream discharge varied considerably, from a minimum of 0.1 cfs in late summer to a maximum of 120 cfs in late fall (City of Bellingham 2011). Generally, the daily mean discharge varied from 5 to 50 cfs during the fall through spring months, and dropped off gradually to a trickle during the drier summer months. Flow patterns show sharp increases in discharge and gradual declines following storm events.

Fish and Wildlife Habitats and Species

The Padden Creek estuary has been greatly reduced in size due to dredging and filling activities associated with a cedar mill, cannery (Scherrer 2001), and other industrial uses, yet the estuary still supports a wide diversity of wildlife, including fish, birds, invertebrates, and mammals. Small estuaries areas have become increasingly valuable as the amount of intertidal area in Bellingham Bay has decreased. It is estimated that 282 acres of aquatic land have been lost in inner Bellingham Bay, with most of that lost acreage being intertidal estuarine habitat associated with streams (Pacific International Engineering and Anchor Environmental 1999).

Historically the salmonids within Padden Creek were distributed throughout much of the watershed. However, in 1892 almost one-half mile (2,300 feet) of Padden Creek between 22nd Street and Fairhaven Park was straightened and buried into a culvert (sometimes referred to as the “brick tunnel”) to allow for railroad construction. The watershed upstream of the culvert is considered acceptable spawning habitat, especially for chum salmon. The barrier severely limits upstream salmonid access, but many salmonids have been observed spawning and rearing just downstream of this barrier. The City has made substantial progress in daylighting the tunnel and is moving forward with construction in 2013. In addition, the box culvert under Harris Avenue is perched up to several feet at low tide and several other partial fish passage barriers, including several fish ladders, are located between the estuary and the old railroad culvert.

Urban stormwater runoff, septic tank leakage and fertilizer/pesticide runoff have degraded Padden Creek and Lake Padden water quality (Smith 2002). In the last decade there have been consistent high fecal coliform counts, turbidity and visible oil sheens in these waterbodies. Water quality in Lake Padden has improved with the extension of sewer service to parts of the surrounding watershed, but still suffers in late summer due to reduced flushing, increased urbanization and growing waterfowl populations. The lake has also experiences periodic episodes of high water temperature and low dissolved oxygen.

Current Habitat Conditions

The intertidal zone habitat within Padden Creek estuary is dominated by mudflat, which is a typically highly productive habitat supporting a high biomass. This system is the largest area of this habitat type within the City limits north of the Chuckanut Creek estuary. However, the estuary is surrounded by hard structures and developed surfaces (Harris Avenue, the railroad trestles, and industrial sites) and there is very little vegetated buffer, overhanging vegetation, or large woody debris within the confines of the Padden Creek estuary.

The existing buffer condition at the site is substantially degraded. On the northeastern potion of the site, a steep riprap bank confines any existing vegetation to a narrow band (2 to 5 feet wide) between the top of the riprap and the paved Port of Bellingham site. The vegetation consists primarily of reed canarygrass and Himalayan blackberry. On the southern portion of the eastern shoreline, the riprap is absent, and the bank is held in place by a retaining wall consisting of timber piles and planks. Here the vegetation width is slightly wider (5 to 15 feet), although invasive species still predominate. A few, small native trees are also scattered within this area.

The northern shoreline, along the railroad causeway, has no native shoreline vegetation, although a few scattered non-native herbaceous plants are located within the interstices of the higher elevation riprap fill within the railroad right-of-way.

The west shore of the estuary was the subject of the early 1990s enhancement project carried out by City of Bellingham 1992). This shore consists of a low-sloped mudflat with adjacent salt marsh fringe. Two rows of what appear to be creosoted piles are located in the upper intertidal in the lower edge of the salt marsh, along with several remaining bits of planking. West of the salt marsh is a broad backshore meadow and upland riparian vegetation band. The larger vegetation consists of shore pine and a variety of shrubs. A single intertidal channel was excavated into the northwest portion of the estuary to create a diversity of habitats as part of the early 1990s project.

The south shoreline is bounded by Harris Avenue and contains a moderately sloped vegetated area consisting of grass and herbaceous plants. The vegetated width ranges between 20 to 65 feet. Several clumps of apple and other trees are also present, while the remaining areas have impervious surface to the edge of the estuary. A very narrow salt marsh band is located here. A small area just east of the midway point of this shore contains excessive seepage in the upper intertidal and has several slumps. East of this location, the bank is steeper as the intertidal creek channel has caused scour.

The west shoreline has a buffer extending for between 80 to 105 feet, with the forested portion at the outside (adjacent to the Port parking lot) and with an average width of approximately 35 feet. The southeast corner of the estuary contains a small loop trail along with a wide variety of native plants such as Pacific madrone, hairy Manzanita and other species. Several large logs were placed in the upper intertidal as part of the 1990s enhancement project.

Fish Use in Padden Creek Estuary

Multiple species of salmonids migrate through the estuary before entering Padden Creek, including Chinook salmon, coho, and chum salmon, steelhead trout, as well as both resident and sea-run cutthroat trout (WDFW 2012).

Estuary and nearshore habitat have been recorded to be important for refuge and rearing habitat for juvenile forage fish (e.g., surf smelt, herring, sand lance) and groundfish (e.g., flatfish, rockfish) (Williams and Thom 2001). These habitats provide for adult spawning, residence and migration of juvenile and adults, and juvenile rearing for Pacific herring, surf smelt, longfin smelt, and sand lance. Forage fish, which are a critical food source for young salmon, exist within Bellingham Bay. Surf smelt and sand lance, for example, are known to spawn on beaches several hundred feet to the north of the outlet to the estuary (Ecology 2012a), although there is no documentation of spawning within the Padden Creek estuary. Based on visual observations, suitable forage fish spawning habitat may be present at the pocket beach located immediately south of the railroad trestle. Features that make pocket estuaries most functional for forage fish and groundfish are similar those discussed for salmonids below.

Although estuary habitat tends to be more significant for forage fish species than groundfish species, at high tides, the Padden Creek estuary likely receives some use from Pacific groundfish including flatfish (e.g., Starry flounder), rockfish (e.g., sculpin), as well as surfperch and stickleback species. Mudflats also support multiple species of algae, phytoplankton, and invertebrates that serve as food sources for fish and wildlife species. These include diatoms, and green and blue green algae. Burrowing animals commonly found within mudflats include clams, poychaete worms, and crustaceans. Within estuaries, zooplankton are also important prey for estuarine and nearshore fish, especially juvenile Chinook and chum salmonids (Simenstad et al. 1982; Healey 1980; Argue et al. 1985; Brennen et al. 2004).

Wildlife Use of Padden Creek Estuary

Estuaries provide habitat for a variety of wildlife species. A study from King County (2001) lists 205 species that are associated with estuaries or nearshore habitats at some point during their lifespan. Although no known study specifically examined wildlife usage of pocket estuaries, pocket estuaries are believed to be similar to general estuary and nearshore areas in terms of wildlife habitat.

Pocket estuaries in the Bellingham Bay area are known to support concentrations of wintering waterfowl (e.g., bufflehead, goldeneye, merganser, grebes, etc.), winter concentrations of dabbling duck and rocky shorebird species, important stopover foraging areas for migrating shorebirds, foraging great blue herons, and foraging bald eagles (Northwest Ecological Services, LLC. 2006). Buchanan (2006) documented relatively large seasonal populations of surf scoter, dunlin, and black oystercatcher within Bellingham Bay.

Commonly observed non-avian species observed at the estuary include mustilid mammals (e.g., mink, river otter, weasel), and garter snake (City of Bellingham 1990, Northwest Ecological Services, LLC. 2006). Over 60 species of birds have been documented onsite, including terns, swifts, flickers, swallows, mergansers, loons, greebs, cormorants, herons, ducks, teals, falcons, plovers, sandpipers, gulls, crows, wrens, starlings, sparrows, blackbirds, and finches (City of Bellingham 1990).

The level of wildlife use of pocket estuaries is dependent not only on the characteristics of the aquatic habitats, but on the condition and connectivity of the surrounding upland buffer. As compared to some other pocket estuaries within Bellingham Bay (e.g., Chuckanut Creek), the Padden Creek estuary is generally more isolated from surrounding terrestrial habitat and lacks a well connected forested corridor to other systems, with a somewhat fragmented aquatic and shoreline habitat corridor. However, some continuity with the upstream corridor is still present and the existing wildlife functions are important, as pocket estuary habitat is rare within Bellingham Bay.

Importance of Estuary Habitats to Juvenile Salmon

Habitat for juvenile and adult salmonids is likely the most significant habitat in the Padden Creek estuary. Research on the importance of estuary habitat to salmonids is well documented. The literature indicates that general estuary and nearshore habitat provide a range of important functions for all life phases of salmonids. Specific research on value of pocket estuaries is more limited.

Functions provided by estuaries and nearshore habitat include: migration of juvenile fish from freshwater to marine system; nursery habitat (particularly for chum and Chinook salmon juveniles); juvenile food production and feeding; adult food production; residence or refuge habitat for juveniles including avoidance of predators; and areas suitable for the physiological transition from freshwater to marine habitat (Simenstad et al. 1982; Simenstad and Cordell 2000; Williams and Thom 2001). Within Bellingham Bay, pocket estuaries are important habitat links in a fractured aquatic habitat for out migrating juvenile salmon (Simenstad *in* City of Bellingham Parks and Recreation 1990).

Pocket estuary habitat appears to be particularly important to Chinook and chum salmon juveniles as they are the most estuarine-dependent salmon species. These species feed and rear in these habitats for extended periods (days to several months) before moving to deeper water habitats (Williams and Thom 2001). Studies performed by the Skagit River Cooperative have demonstrated the significance of this habitat type to both Chinook and chum salmon populations (Beamer et al. 2003; Beamer and LaRock 1998; Beamer et al. 2005; Beamer et al. 2006; Beamer et al. 2007; Beamer et al. 2011).

Ideally, a diverse mosaic of accessible habitat types is present in an estuary, including intertidal, shallow sub-tidal, blind channel, and distributary channel habitats. These estuarine features provide juvenile salmonids with access corridors to estuary habitats producing preferred prey species (Shreffler and Thom 1993) as well as a delivery system that transports preferred prey species from estuary habitats that are not accessible by juvenile salmonids.

Intertidal and shallow subtidal habitat provide juvenile salmonids protection and refuge from avian and fish predators, while blind channel and side-channel estuary habitats serve as refuge from high water discharge events. Distributary channels provide critical migration and movement routes between habitats. Estuaries provide a complex mosaic of shallow water habitats and distributary channels that serve as migration corridors for juvenile salmonids, while deeper water distributary channels serve as migration corridors for adults (Shreffler and Thom 1993).

Vegetative biomass produced in the estuaries is exported as detritus and is the primary fuel source for the estuary and nearshore marine detritus-based food webs upon which juvenile salmonids depend. The complex mosaic of estuary habitats supports salmonid survival by providing a wide variety of rearing and refuge opportunities to accommodate different juvenile out-migration strategies.

Limiting Fish and Wildlife Habitat Factors

A primary goal of the Padden Creek enhancement project is to improve habitat conditions and ecological functions that support native fish and wildlife species. In order to assess the feasibility of achieving this goal, it is crucial that the factors currently limiting fish and wildlife in the system are understood. Elevation is a primary factor limiting greater salmonid utilization of the estuary. The mudflat is relatively high-- generally draining completely at most low tides-- resulting in minimal refuge and forage functions except during higher tides. In addition, altered tidal dynamics and the constraints placed on the site by the fill around the perimeter, have lowered habitat diversity and eliminated key features such as braided or distributary channels. The current site configuration also severely limits the development of salt marsh at the estuary margins. The steep rip-rapped banks and surrounding land uses have displaced natural buffer areas leaving narrow zones of vegetation, a general lack of vegetative biodiversity, and a system which provides minimal cover in the form of overhanging vegetation or large woody debris.

In addition to limited fish passage, discussed above, other factors limiting salmonids in the system originate from upstream. Padden Creek has somewhat poor water quality associated with increasing development and stormwater runoff in the basin (Smith 2002). Padden Creek is on the 2008 303(d) list (Ecology 2012b) for high levels of fecal coliform. In addition, elevated stream temperatures and turbidity, low dissolved oxygen levels, and the presence of elevated levels of mercury, lead, zinc, and copper have been occasionally documented in Padden Creek (Smith 2002).

Limiting factors for wildlife species are also related to the constraints of the site including habitat fragmentation and lack of a well developed forested corridor, the lack of vegetative diversity, including mature trees and snags, and lack of clean woody debris. While the mudflats provide feeding grounds for birds, particularly for migratory species that use them for staging stops between their breeding and wintering grounds, the lack of aquatic vegetation, habitat complexity, and a well-developed salt marsh, likely limits the productivity of this site for most wildlife species. In addition, detritral production is likely limited in the estuary, based on limited input from the narrow vegetated buffer of both the estuary and Padden Creek.

Potential Contamination Issues

A Phase I Environmental Site Assessment was conducted for the project (Attachment B). The report identifies eight offsite contamination sources that pose potential risk of contamination to the subject property. Of these sites, Bellingham Iron Works, Tolly Craft Yacht Corp., Ex-Murray Chris-Craft Boat Yard/Aqustar USA Corp, and Uniflite Inc. have or had the greatest risk of contamination to sediments and soil of the estuary.

The Phase I assessment concluded that both previous uses of the subject property and contamination and hazardous waste generated from adjacent, offsite facility operations may have impacted surface water, soil, groundwater, and sediment. Potential contaminants from past operations on the property include metals, tributyltin, petroleum hydrocarbons, PAHs, and phenolic compounds including pentachlorophenol. In addition, stormwater runoff / discharges (non-point source) has the potential to contaminate surface water, sediment, and soil on the property.

The assessment also recommends further site investigation in support of the design options for the project. A Phase II investigation would include soil and sediment sample collection and testing to evaluate the extent and magnitude of contamination on the property. The information resulting from a Phase II investigation would help determine the appropriate enhancement / restoration alternative(s) for the estuary.

Restoration and Enhancement Approach

Successful restoration and enhancement require explicit consideration of the overall project goals and objectives. At Padden Creek estuary the selection of a preferred action or actions should be based on an analysis of the potential habitat benefits that will be achieved as compared to cost and other considerations. The feasibility of achieving project goals must be considered in the context of known constraints.

Project Goals and Objectives

The primary project goals, as defined by the City, are:

1. Implement onsite restoration actions that will result in a estuary system that supports a greater number and magnitude of ecosystem functions, resulting in greater species use and habitat value, and

2. Create a site that will serve as a more substantial amenity to the community.

A successful restoration/enhancement project is also dependent on the establishment of project objectives, which if achieved, will help ensure the project goals are met. The project objectives should have a proven scientific or engineering relationship to the established goals, while also being achievable and measurable. In addition to serving as a primary basis for evaluating different potential restoration actions, the project objectives will ideally serve as the foundation for project success monitoring and the formulation of an appropriate adaptive management plan.

Project objectives associated with improvement of ecosystem functions include:

- Increase estuary residence time of juvenile salmonids.
- Increase the quality and quantity of salmonid forage species.
- Increase habitat complexity within the Padden Creek estuary.
- Improve water quality within the Padden Creek estuary.
- Increase bird use of the Padden Creek estuary.

Project objectives associated with developing a more substantial amenity to the community include:

- Increase bird and wildlife usage, providing increased opportunities for public viewing/bird-watching.
- Incorporate onsite public education/outreach materials to enhance public enjoyment of Padden Creek estuary and inform public on restoration efforts.

Site and Project Constraints

Restoration and enhancement opportunities at Padden Creek estuary are somewhat fixed given the following project and site constraints:

- The actions cannot encroach onto Port property to the east and west, nor threaten the structural integrity of the industrial property above the east bank.
- The actions cannot alter the estuary mouth (railroad trestle and adjacent Port property).
- The actions cannot impact the integrity of the rail causeway or substantially interfere with rail operations.
- The actions cannot alter the existing Harris Avenue box culvert or roadway.
- The actions must limit the risk of increasing release of contaminants that may be present in site soils.

Restoration and Enhancement Opportunities

Based on the project goals, site history, and the assessment of existing site conditions and constraints, multiple potential restoration opportunities were identified.

- Create additional sub-tidal habitat through excavation, to increase estuary residence time of juvenile salmonids.
- Alter site elevations on the mudflat through excavation and the placement of fill to increase fish and wildlife habitat complexity.
- Improve the quality and quantity of salt-marsh fringe vegetation, including overhanging vegetation, through creation of new salt-marsh and vegetation planting and enhancement.
- Remove existing sources of contaminants within the estuary, such as creosote treated piles, to improve water quality within the estuary.
- Create or enhance beaches to serve as forage fish spawning sites to provide food sources for juvenile salmonid.

Proposed Near-term Restoration/Enhancement Actions

The restoration and enhancement opportunities listed above were evaluated for suitability within the study area to formulate a suite of specific restoration actions that would achieve the City's goals. This section describes concepts for a number of relatively small-scale actions along with three larger scale actions for the immediate study area. Specific actions are identified by type and location on the accompanying habitat enhancement concepts map (Figure 4) using the key described below. Additionally there are several other larger actions that could provide substantial habitat enhancement value in the future if implemented (see Figure 4 for reference). These are potential long-range opportunities that extend beyond the immediate project area boundaries and are outside the scope of this effort.

Contaminant Removal (CR) Concepts

CR-1: A cluster of approximately 25 creosoted wood piles would be removed in the area immediately north of the Harris Avenue box culvert. These piles are fairly deteriorated and are serving no useful purpose. Several of the piles trend towards the west from the largest group. Some of these piles could be vibrated out to remove the full length of pile. However, several of these are quite rotten and may brake; in which case the pile should be cut and fully removed above the mudline. This action is not a complicated or involved effort, as at least most of the piles can likely be reached from the adjacent uplands.

CR-2: The creosoted timber retaining wall and approximately 15 creosoted wood piles located along the southeast bank of the estuary would be removed. This action would require installing a new retaining wall (such as a vinyl sheet pile wall) in order to maintain the structural integrity of the adjacent filled uplands owned by the Port of Bellingham. Otherwise the bank would need to be pulled back slightly and allowed to erode, which does not appear to be a viable option given the ownership and the fact that this is potentially a contaminated soil area. Regardless of the precise treatment, modification of the retaining wall would require additional soil investigation and testing to determine the nature and extent of any contamination. Access to this part of the site is quite good (there as a paved driveway is immediately adjacent) so constructability is not a significant concern.

CR-3: Two and a half lines of approximately 50 creosoted wood piles along the west shore of the estuary would be removed. These piles extend southward from the railroad causeway, with only several feet or pile exposed above the ground surface. Access is poor here as the piles are surrounded by salt marsh and adjacent vegetation on the west side and by mud flat on the east side. Once access was established, possibly from the adjacent parking area by using a set of large steel plates to minimize damage to the vegetation, these piles could likely be vibrated out to remove the full length of pile. Again, as this is in a potentially contaminated soil area. Therefore additional information on the nature of the soils may be required, as discussed above.

Debris Removal (DR) Concepts

DR-1: Miscellaneous small pieces of debris (some of which are old office chairs) have entered the southern portion of the intertidal Creek channel, which would be removed.

DR-2: Concrete slabs, rock, decommissioned utility lines, and other debris are located in the intertidal in the far northeast corner of the estuary near the railroad bridge. These would be removed. Access is good from the adjacent uplands of the boat yard, after the removal of several sections of the old chain link fence. This is also associated with BE-1 (see below).

DR-3: Concrete slabs, rock, decommissioned utility lines, and other debris are located in the intertidal near both sides of the railroad bridge. These would be removed. Access is also good from the lift access route from the boat yard, after the removal of several sections of the old chain link fence.

Removal of the small boat launch ramp on the east bank (accessed from the Port property) would be desirable from an ecological point of view but may have adverse implications in terms of public access and recreational use. Removing the ramp could run counter to the City's shoreline master program, which supports and promotes public access and recreation.

Riparian Vegetation (RV) Enhancement Concepts

RV-1: Exotic species such as Himalayan blackberry would be removed and beneficial native species would be installed in the narrow vegetated buffer along the east shore of the estuary, south of the rock revetment. This area abuts the paved access drive such that tall tree species are likely not suitable.

RV-2: Select fill would be placed along a portion of the rock revetment on the east shore of the estuary south of the rock revetment and beneficial native species would be installed.

RV-3: Several clusters of beneficial native riparian vegetation would be installed approximately 160 to 250 feet north of Harris Avenue, immediately east of the existing trees, to both provide beneficial habitats and limit the use of what has now developed into a foot trail in this area.

RV-4: Several clusters of beneficial native riparian plants would be installed approximately 340 to 410 feet north of Harris Avenue, east of the existing trees to both provide beneficial habitats and be placed strategically to strictly limit the use of what has now developed into a foot trail in this area.

Salt Marsh (SM) Enhancement Concepts

SM-1: Salt marsh vegetation would be installed on select fill associated with concept RV-1 (see above) to increase the salt marsh cover.

SM-2: Salt marsh vegetation would be installed on select fill associated with concept RV-2 (see above) to increase the salt marsh cover.

SM-3: Select fill would be placed and salt marsh vegetation would be installed on the southern side of a portion of the railroad causeway to enhance the angular rock shore and increase the salt marsh area cover.

Beach Enhancement (BE) Concept

BE-1: Limited volume of beach nourishment sediment suitable for forage fish spawning would be placed in the intertidal zone in the far northeast corner of the estuary south of the railroad bridge following debris removal concept DR-2 (see above).

Log Jam (LJ) Concepts

LJ-1: A log jam structure would be anchored to divert intertidal creek channel flow and scour away from the southern portion of the east bank of the estuary. This could also help protect sediment and vegetation placed at SM-1.

LJ-2: A log jam structure would be anchored to divert intertidal creek channel flow and scour away from the rock revetment along a portion of the east bank of the estuary adjacent to the boatyard, where the channel is scouring out a deep area. This would also help protect sediment and vegetation placed at SM-2 (see above).

Log jam installations will need to be evaluated further to ensure they do not result in scour of the right (east) bank, thereby affecting the adjacent property and/or and mobilizing contaminated materials (if present). The log structures would b need to be solidly connected to the bank to mitigate this concern.

Blind Channel (BC) Concept

A blind channel concept was developed to investigate the possibility of adding habitat complexity and allowing more dynamic channel and floodplain forming processes to occur within the existing mudflat. In the current state, the mudflat includes areas that range from +3 to +5 MLLW; lower areas only exist within the active channel. A tidal drainage pattern has started to develop on the western half of the mudflat, flowing north then east along the toe of the railroad berm.

The blind channel concept would include the excavation of a swale within the existing mudflat that connects to the main channel on its downstream end. Excavated sediment would be placed near the new channel to form a series of disconnected mounds. The mounds would have flat slopes (e.g., 1H: 5V or flatter, reaching an elevation within the range MHHW. These actions would replicate tidal marsh characteristics and accelerate evolution of the mudflats to vegetated marsh.

The design is consistent with the typical morphology of a tidal wetland floodplain tributary to a freshwater creek. Conceptually, the primary sediment supply to this area is from the watershed via Padden Creek, which results in formation of a slight berm (e.g., fluvial levee) along the channel bank. Floodplain drainage is consolidate into one channel with sufficient flow to maintain its connection by transporting sediment from the creek and into the flats, and scouring sediment back into the creek. Over time, depending on sediment supply rates and vertical land motion, the site should aggrade toward higher tidal elevations and become more vegetated.

The tidal channel network would provide a natural tidal hydrology to the sediment flat, as well as shallow submerged habitat and an enhanced sediment pathway from Padden Creek to the flats. The channel(s) would provide more complex off-channel habitat for juvenile salmon, with lower velocities and (eventually) overhanging vegetative cover. This would enhance residence time, and may provide greater refugia for fish, as well as supporting rearing, feeding, and physiological adaption functions. The mounds would provide elevations and inundation frequencies consistent with salt marsh vegetation, and would be expected to colonize (or could be planted) with native wetland plants. The mounds would also provide habitat for birds and terrestrial animals during higher tides when the site is presently inundated.

Conceptual Channel and Mound Geometry

To develop channel geometry for this alternative, the tidal prism (volume within the site between MHHW and MLLW) and potential drainage areas were calculated using the LiDAR topography. This approach to channel sizing relies on empirical data that relate both tidal drainage area and tidal prism to channel geometry (see for example Williams et al., 2002 for an example from the San Francisco Bay). Using the LiDAR suggests a tidal drainage area below MHHW is approximately 2.3 acres, and represents 19,185 CY (14,668 m^3) of tidal prism.

A generalized relationship between tidal drainage area and channel geometry has been developed as part of the PSNERP *Conceptual Design Report* (ESA 2010). Table 2 shows the channel geometry using this relationship for the NOS gauge on Bellingham Bay.

Table 2. Conceptual Tidal Channel Geometry Based on Marsh Area

Channel Characteristic	**Size**
Top Width (at MHHW)	10 feet
Depth (below MHHW)	3 feet (elevation of 5.5 feet MLLW)
Cross-Sectional Area	22 square feet

This geometry is based on the assumption that sedimentation will occur on the mudflats over time. Since the overall site elevation is low now, some initial channel scour is likely. The preliminary channel geometry proposed here consists of:

1. Channel top width of 10 feet.

2. Channel bottom elevation at +2 MLLW. This elevation was set lower than the regressions would suggest to allow greater initial channel depth, generate more material for berm creation, and anticipate some initial scour.

3. Channel bottom width of 2 feet with 2H:1V sideslopes.

4. Mounds along approximately 25% of overall channel length with a 6 foot wide crest, 3H:1V side slope, between 3 and 4 feet tall to extend into the salt marsh elevation range.

The plan form of the channel is simple to facilitate implementation. The orientation of the channel is to connect to the main channel as far upstream as possible to maximize the potential to interact with sediments delivered by the watershed. This orientation would also increase the likelihood that the main channel would be more dynamic through the existing mudflat; this is viewed as a benefit to the system, as it would result in more heterogeneous landforms and habitat within the site. The channel would be over-excavated (deepened) somewhat to limit the risk of the channel connection becoming blocked. Overall sediment input appears to be relatively low since the site has not aggraded substantially, but this is based on visual inspection and not detailed sediment analysis. If the watershed delivered a “slug” of gravel/coarse sediment the blind channel could become blocked, potentially creating a fish trap at low tides. If the sediment input consists mainly of finer materials, the blind channel would fill in more uniformly with less risk of fish stranding. The rate and type of sediment input could also influence the location of the blind channel:

- if the sediment yield is greater than estimated, a channel connection at the downstream is preferable (if the sediment yield is low then this arrangement may enhance sediment export); or

- if the sediment yield is lower than estimated the southern, the upstream connection is preferable.

The idea of filling the bank and using biotechnical measures (LJs) to block / divert flow to the west and digging a channel to convey sediment to the west and into the flats appears to be a sound, integrated approach. A variant is to shift the channel to the west by connecting it all the way to the north, downstream, allowing the existing channel to become the blind channel. These options need further study during the conceptual design.

Construction Considerations

Construction of the tidal channel could potentially be accomplished with an amphibious excavator. Floating equipment could be used at higher tides, and land-based equipment with low-ground pressure wheels / tracks could be used with an earth, timber mat, rock or structural causeway removed after construction. However, the amphibious equipment, if available, would be cheaper and have less impact.

The potential to encounter contaminated sediments during excavation within the mudflat is a substantial unknown for the blind channel alternative. If the soils in this part of the estuary are found to be contaminated, more substantial sediment removal may be required and the excavated material would likely need to be transported off site for proper handling/disposal. New, clean material would need to be imported to construct the salt marsh benches. This approach may be imprudent and/or cost prohibitive, especially when compared to the potential benefits.

Potential Long-Range (LR) Concepts

Although not proposed for implementation as part of this project, three long-range concepts are included here for purposes of comparing the ecological / habitat benefits and engineering considerations of larger-scale future restoration of the Padden Creek estuary.

LR-1: Replace the undersized and perched boxed culvert beneath Harris Avenue with a bridge. This would remove the downstream partial fish barrier and improve access to upstream reaches (as upstream barriers are removed).

LR-2: Remove the untreated storm water input from a 27-inch diameter culvert entering the center portion of the Harris Avenue box culvert. The water should instead be treated before it enters the creek or the estuary to substantially improve water quality in the estuary (we understand the City is actively pursuing stormwater retrofits for this area).

LR-3: Remove armor and re-create the east shore of the estuary to allow more room for the intertidal creek channel to migrate an enable installation of salt marsh and native riparian vegetation. This action may require more extensive clean-up actions to address contaminated material.

Summary and Comparison of Benefits

The Padden Creek estuary represents a highly altered system when compared to the 1888 mapping shown in Figure 1. The restoration potential of the site has been limited by the magnitude of changes that have occurred to isolate this piece of the nearshore from its contributing area and from Bellingham Bay.

The restoration approaches described above are generally modest in terms of cost, effort, and potential benefit. The contaminant removal, debris removal, riparian vegetation enhancement, and beach enhancement concepts all appear to be feasible, would have relatively low design and implementation costs, and appear to present limited regulatory approvals. The salt marsh enhancement concept is similar, but has the potential for a more involved regulatory process, as it would include filling of existing mudflats, though the fill would not reduce the overall jurisdictional area within the site. All of these elements could be accomplished without substantial disturbance of existing sediments, and would not preclude larger restoration actions in the future.

The log jam structures represent a more invasive restoration action that could address an existing bank erosion issue downstream of the Harris Street culvert. This is one of many possible structural repairs, but it is one that would provide habitat benefits in terms of using natural materials and providing additional streamside cover. Installation of these features would involve potentially significant excavation to install timber piles and build the base of the structure. This excavation is in an area with the potential for contamination, so this action would likely trigger a site-specific sampling effort. Installing log jams to and below the scour depths evident at the Harris Street culvert will require substantial materials, and will likely be the most expensive measure proposed here. The addition of log jams also has greater uncertainty of outcome, where scour at the log structure could continue, or even be enhanced on the adjacent banks.

The blind channel excavation (BC-1) represents the potential to both: (1) increase the volume within the site at the lower end of the tide range, and (2) engage dynamic fluvial sedimentation processes within the mudflat. This alternative is the most invasive to the site, and also the most potential to allow for greater creation of habitats in the lower end of the tide range. Engaging dynamic processes has a less-certain endpoint, which will need to be communicated to stakeholders to properly set expectations for what the site could look like. Site specific sampling will be required to determine if excavation is feasible in the context of past site activities. This will likely include a Phase 2 site assessment. This alternative will have other implementation challenges, but the overall volumes of excavation are not particularly large – as shown, the channel excavation is less than 200 cubic yards.

Although all of the near-term options would improve fish and wildlife habitat conditions, the magnitude of improvement and potential affect on the primary salmonid limiting factors is slight to modest due to the various site and project constraints (Table 3). The various edge treatments would result in nominal change to residence time of juvenile salmonids and only slight increases in estuary-wide habitat quality. These options, although prudent, are by themselves unlikely to substantially increase existing salmonid use of the estuary.

The blind channel concept (BC-1) would result in 426 new linear feet of channel and at least 90 linear feet of berms which will alter 6,690 square feet of the existing mudflat (about 6.7 percent of the existing tidal basin within the mudflat). This would allow for areas that will be inundated by tidal waters for longer durations during the tide cycle, but will still empty almost completely at typical low tides. This alternative would also allow for additional salt marsh establishment on the sidecast mounds.

The blind channel concept represents an increase in salmonid-accessible estuary during the lower portion of the tidal cycle, adding volume below +4 MLLW that currently only exists in the fluvially dominated channel. Excavating the channel also has the potential to engage more dynamic fluvial processes within the mudflat, changing sedimentation patterns to resulting in greater site complexity. Of all proposed individual options, Option BC-1 has the greatest probability in increasing the residence time of juvenile salmonids and increasing site diversity.

The log jam concepts provide one possible structural solution to ongoing and potentially significant slope stability issues on the perimeter of the site. Installing engineered log jams is one way to achieve the structural objectives while providing some level of habitat enhancement.

In comparison to the proposed options, the three listed long range concepts would likely be significantly more complex and costly, however the expected ecological benefits would be commensurate and if all three concepts were eventually implemented, the result would be substantial increases in the habitat function of nearly all identified limiting factors for fish and wildlife species in the estuary.

The path forward to determine a preferred alternative lies primarily on the City’s interest in further investigating potential contamination within the site. If this type of investigation is outside the scope of proposed actions here, then the contaminant and debris removal, riparian and salt marsh enhancements represent a reasonable way to achieve slight improvements in ecological functioning. If further investigations are possible, the blind channel option represents a way forward to developing a more-functional estuary without substantial initial modifications. We welcome discussion with the City regarding these potential approaches to find a path that achieves your goals, and net improvement of the Padden Creek estuary.

Table 3. Comparison of Ecological and Engineering Considerations of Padden Creek Estuary Habitat Enhancement Concepts

Ecological Considerations

Habitat Enhancement Concepts	Salmonid Limiting Factors					Wildlife Habitat		Ecological Risk
	Estuary Residence Time	Cover and Refugia	Nutrients and Feeding Opportunities	Water Quality	Fish Passage	Bird Habitat	Mammal Habitat	
Enhancement Component								Low
Riparian Vegetation Enhancement (RV-1 through RV-4)		Slight	Slight			Slight	Slight	Low
Salt Marsh Enhancement (SM-1 and SM-2)		Slight	Slight			Slight	Slight	Low
Beach Enhancement (BE-1)			Slight					Low
Debris Removal (DR-1 and DR-2)					Slight			Low
Contaminant Removal (CR-1 and CR-2)				Slight				
Log Jam (LR-1 and LR-2)		Slight						Low to High*
Blind Channel Construction with Adjacent Habitat Islands (BC -1)	Moderate	Slight to Moderate	Moderate			Slight	Slight	Low to High*
Long Range Concepts								
Replace Harris Avenue Culvert with Bridge (LR-1)	Slight				Substantial		Slight	Low to High*
Stormwater Treatment for Discharge from Fairhaven (LR-2)				Substantial				Low
Recreate Natural Shoreline Features on East Shore (LR-3)			Moderate			Slight	Slight	Low to High*

Engineering Considerations

Habitat Enhancement Concepts	Construction Complexity	SLR Ready	Contaminants Risk	Approximate Risk	Approximate Cost***
Enhancement Component					
Riparian Vegetation Enhancement (RV-1 through RV-4)	Low	Moderate	Low	Low	Low
Salt Marsh Enhancement (SM-1 and SM-2)	Low	Moderate	Low	Low	Low
Beach Enhancement (BE-1)	Moderate	Low	Low	Low	Low
Debris Removal (DR-1 and DR-2)	Very Low	High	Very Low	Very Low	Low
Contaminant Removal (CR-1)	Low	High	High	Low	Moderate
Contaminant Removal (CR-2)	High	Low*	Low-Moderate	Moderate-High	Moderate
Log Jam (LR-1 and LR-2)	Moderate	Low	Moderate	Moderate	High

	Habitat Enhancement Concepts	Construction Complexity	SLR Ready	Contaminants Risk	Approximate Risk	Approximate Cost***
	Blind Channel Construction with Adjacent Habitat Islands (BC-1)	High	High	Moderate-High	Moderate	High
	Long Range Concepts					
	Replace Harris Avenue Culvert with Bridge (LR-1)	Moderate	Moderate**	Moderate**	Moderate	High
	Stormwater Treatment for Discharge from Fairhaven (LR-2)	High	N/A	Low	Moderate	High
	Recreate Natural Shoreline Features on East Shore (LR-3)	Moderate	Moderate**	High	Moderate	High

NOTES: *Depending on presence of contaminated sediments

** Project engineering specific issues apply that cannot be determined with existing information.

*** Low = < $50,000; Moderate = $50,000-100,000;High = > $100,000

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Figure List

Figure 1: 1888 Mapping of Padden Creek Estuary

Figure 2: Historic Aerial Images of Padden Creek Estuary

Figure 3: Habitats of the Padden Estuary Vicinity in 1888 and 2005

Figure 4: Habitat Enhancement Concepts

Figure 5: Blind Channel Conceptual Layout

Attachments

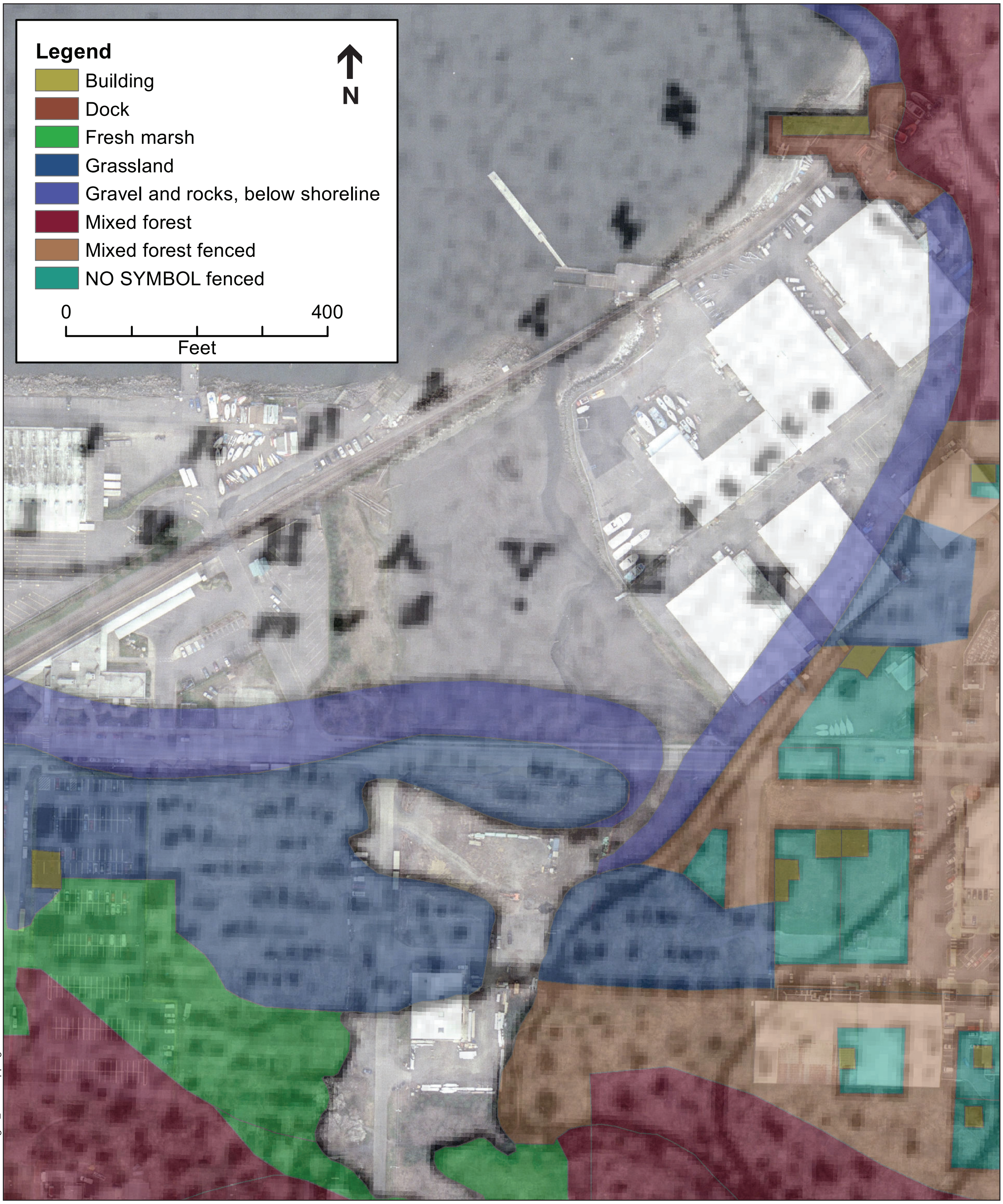
Attachment 1 – LiDAR and Survey Sheets

Sheet C1.1: LiDAR Site Plan

Sheet C1.2: LiDAR and Survey Cross Sections

Sheet C1.3: LiDAR and Survey Cross Sections

Attachment 2 – Final Phase I Environmental Site Assessment - Padden Creek Estuary Habitat Enhancements Project



FILE NAME: Fig01_1888Mapping.ai / CREATED BY: JAB / DATE LAST UPDATED: 03/01/12

SOURCE: CGS, 2012.

Padden Creek Estuary . 211465

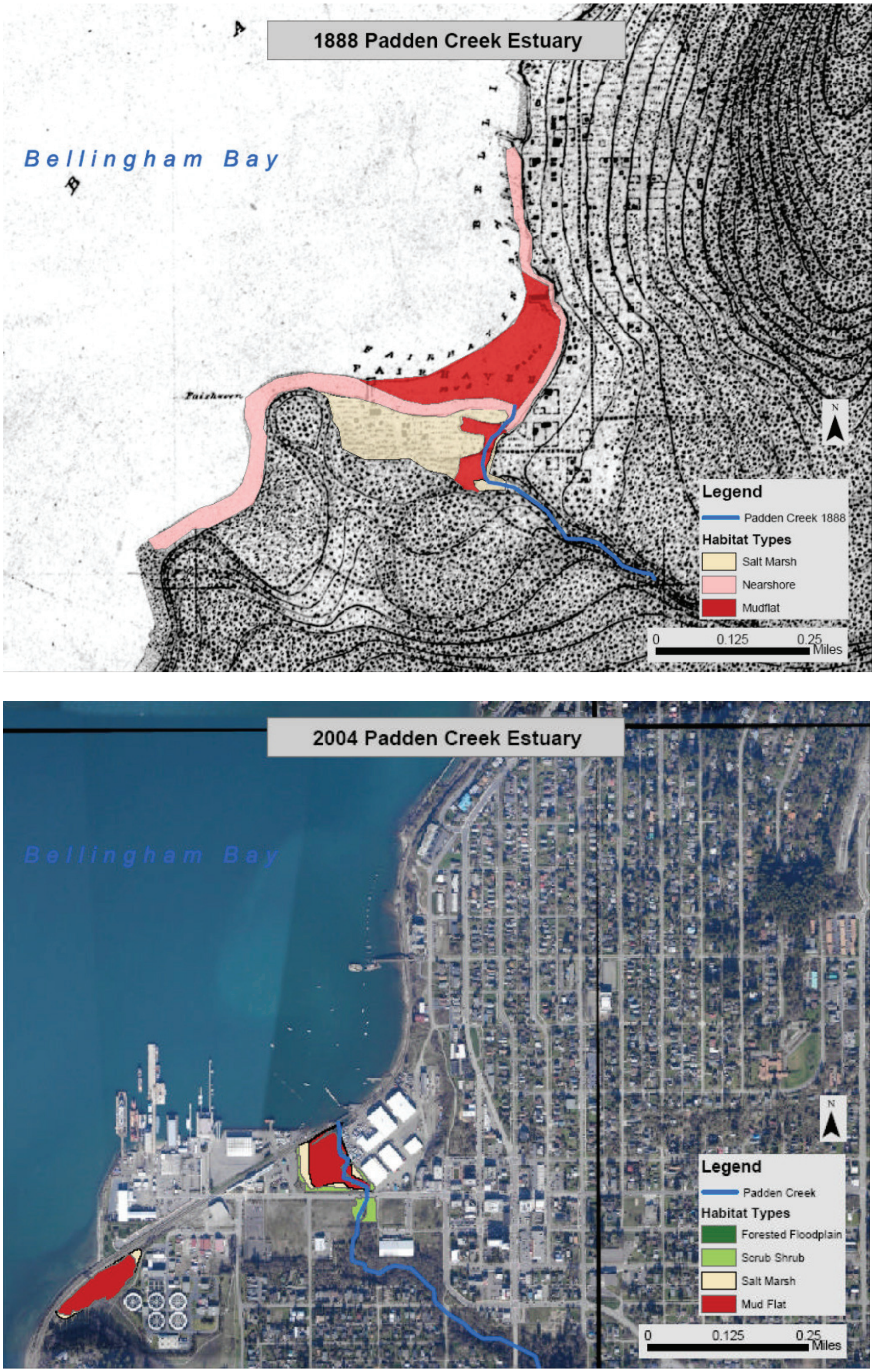
Figure 1
1888 Mapping of Padden Creek Estuary
Bellingham, Washington

FILE NAME: Fig02_HistoricAerials.ai / CREATED BY: JAB / DATE LAST UPDATED: 03/01/12

SOURCE: CGS, 2012.

Padden Creek Estuary . 211465

Figure 2
Historic Aerial Images of Padden Creek Estuary
Bellingham, Washington

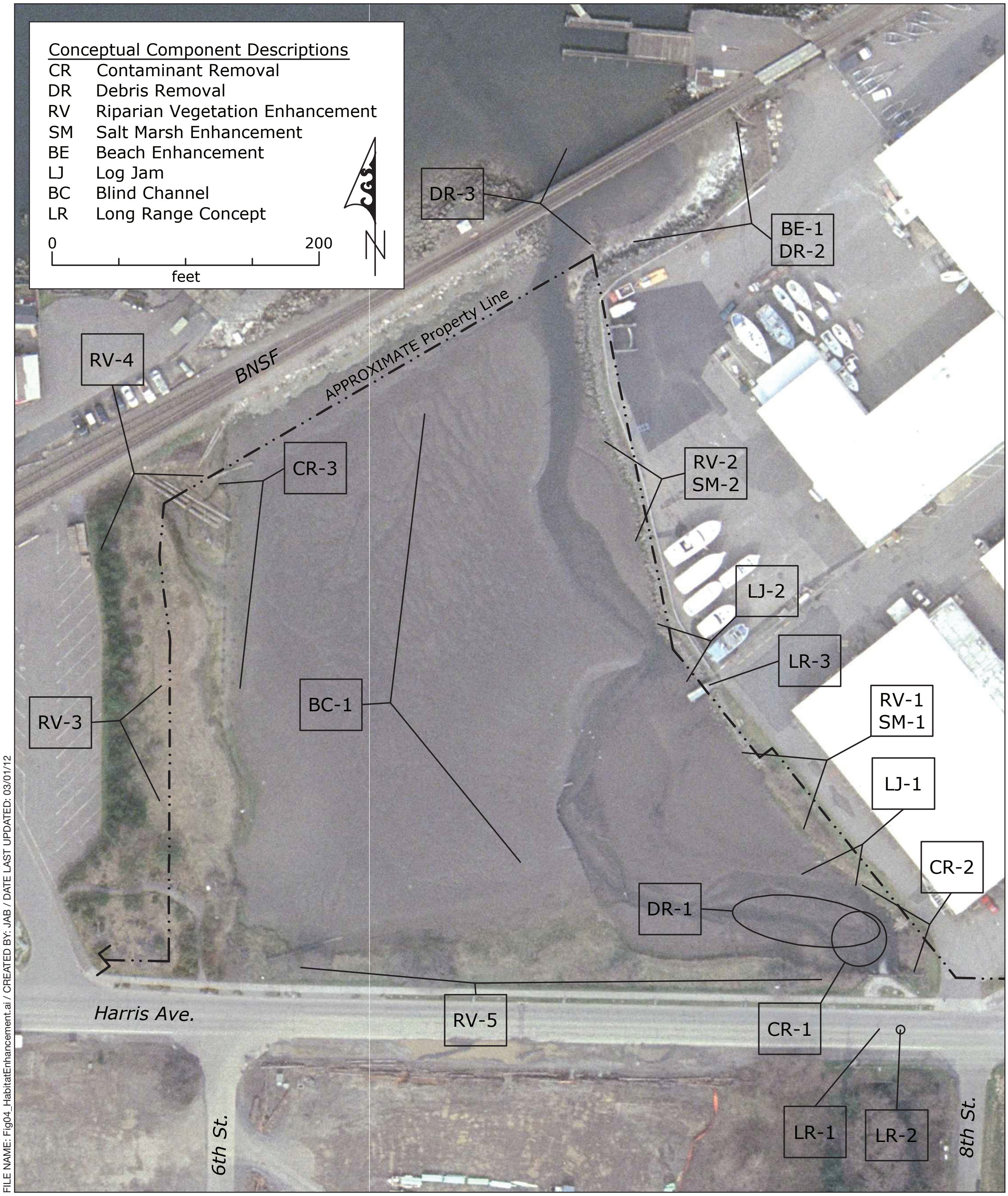


FILE NAME: Fig03_Habitats-PaddenLagoon.ai / CREATED BY: JAB / DATE LAST UPDATED: 03/01/12

SOURCE: Reprinted from LNR 2005, Figure 71.

Padden Creek Estuary . 211465

Figure 3
Habitats of the Padden Lagoon Vicinity in 1888 and 2005
Bellingham, Washington



SOURCE: CGS, 2012.

Padden Creek Estuary . 211465

Figure 4
Habitat Enhancement Concepts
Bellingham, Washington

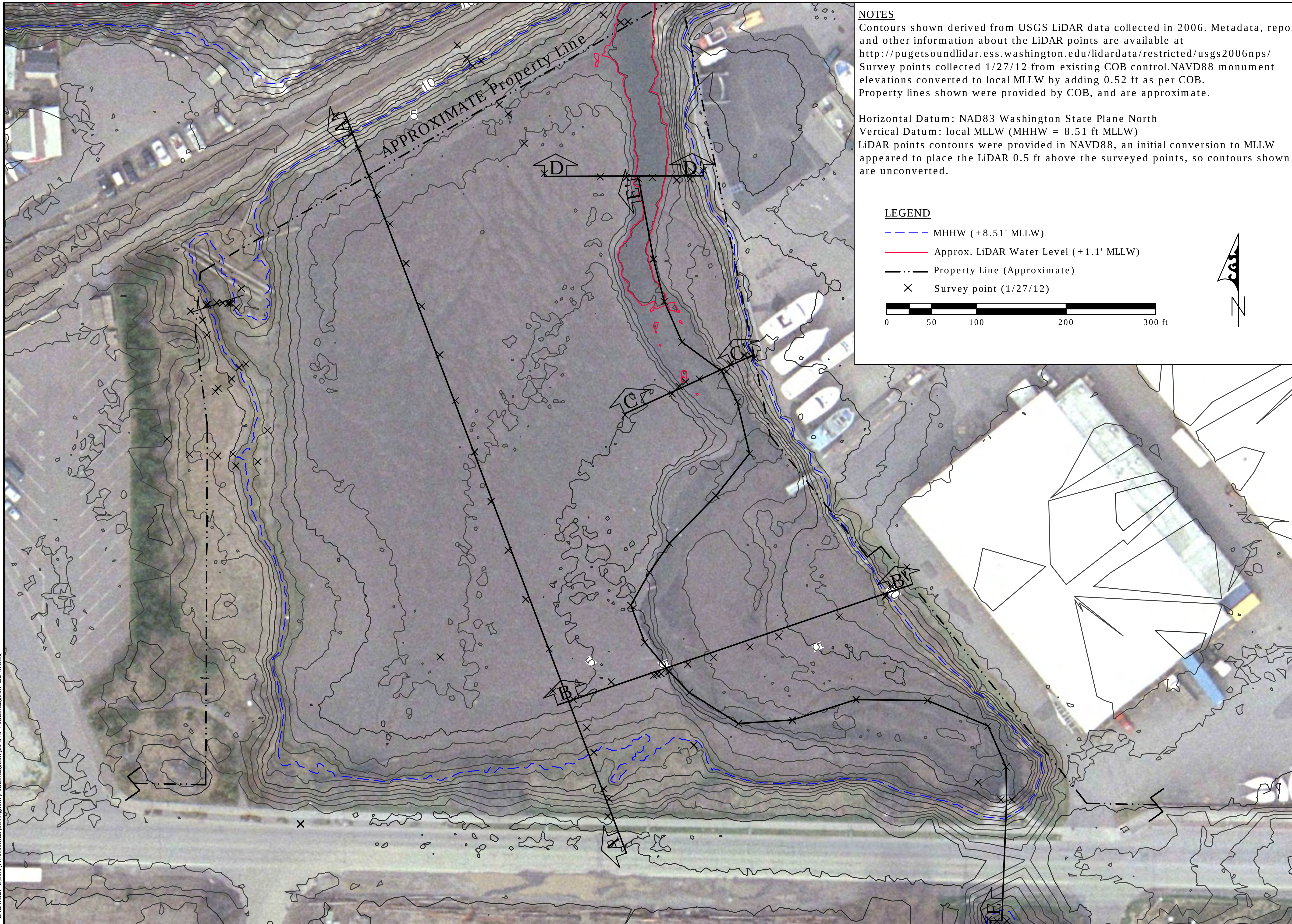
SOURCE: ERSI online aerial photot

Padden Creek Estuary. 211465

Figure 5.

Blind Channel Conceptual Layout

Bellingham, Washington



NOTES

Contours shown derived from USGS LiDAR data collected in 2006. Metadata, report, and other information about the LiDAR points are available at http://pugetsoundlidar.ess.washington.edu/lidardata/restricted/usgs2006nps/
Survey points collected 1/27/12 from existing COB control.NAVD88 monument elevations converted to local MLLW by adding 0.52 ft as per COB.
Property lines shown were provided by COB, and are approximate.

Horizontal Datum: NAD83 Washington State Plane North
Vertical Datum: local MLLW (MHHW = 8.51 ft MLLW)
LiDAR points contours were provided in NAVD88, an initial conversion to MLLW appeared to place the LiDAR 0.5 ft above the surveyed points, so contours shown are unconverted.

LEGEND

- MHHW (+8.51' MLLW)
- Approx. LiDAR Water Level (+1.1' MLLW)
- Property Line (Approximate)
- × Survey point (1/27/12)

0 50 100 200 300 ft

COASTAL GEOLOGIC SERVICES
1711 Ellis St, suite 103
Bellingham, WA 98225
360-647-1845 - coastalgeo.com

REVISIONS

DRAWN BY: JFW
DESIGNED BY:
CHECKED BY:
DATE SURVEYED: 1/27/12

Padden Lagoon Conceptual Design

Profile View
LiDAR and Site Survey

DRAFT

MLLW=0.0'

SCALE: AS NOTED
DATE: 2/16/2012
SHEET: 1
C1.1
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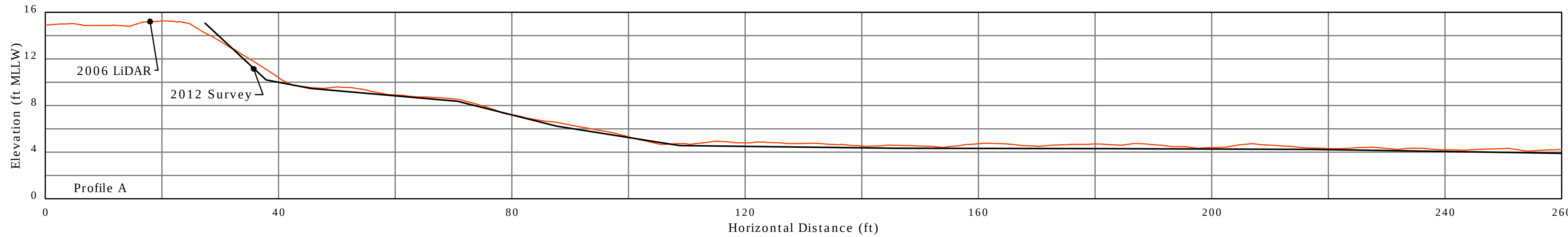

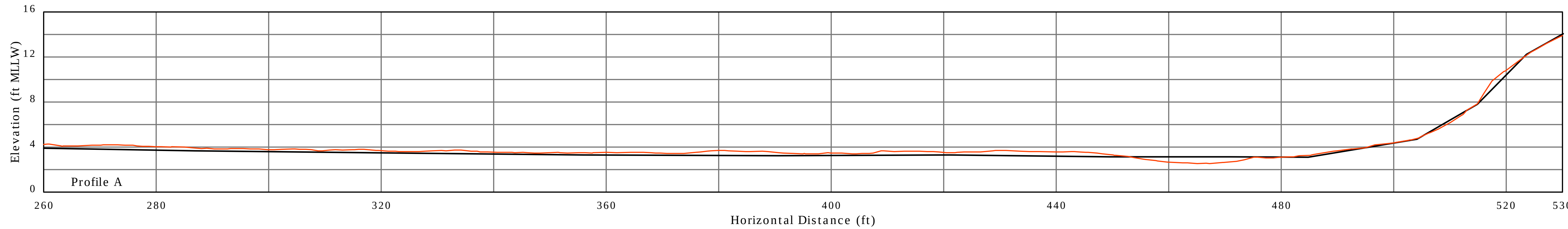

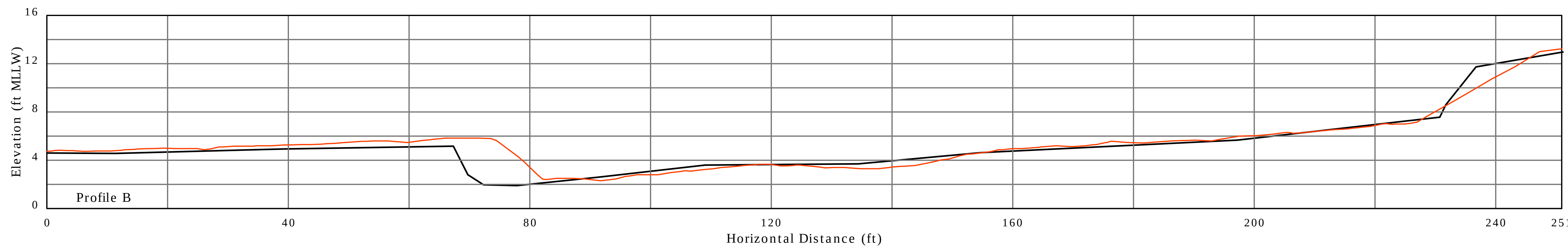

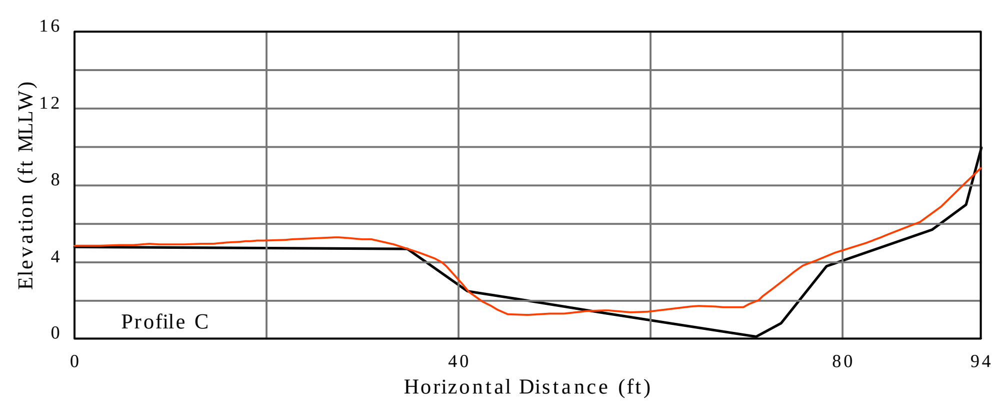

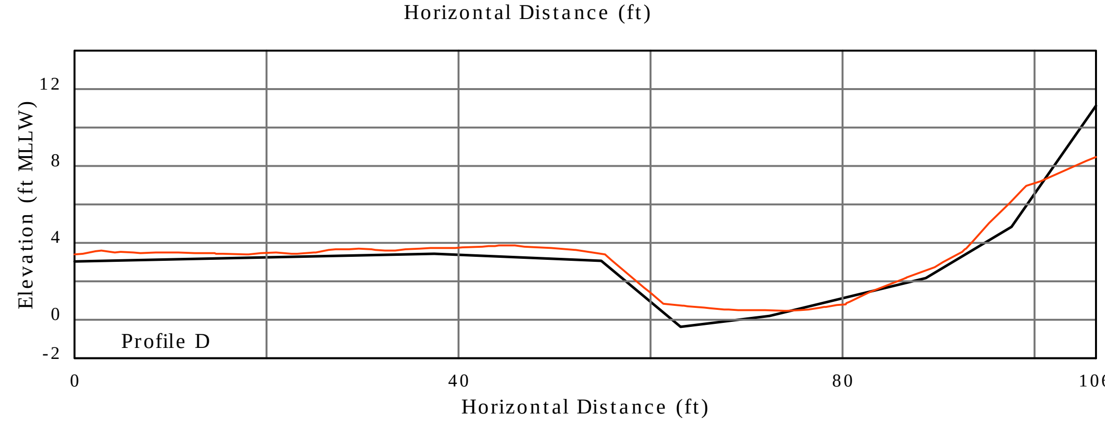

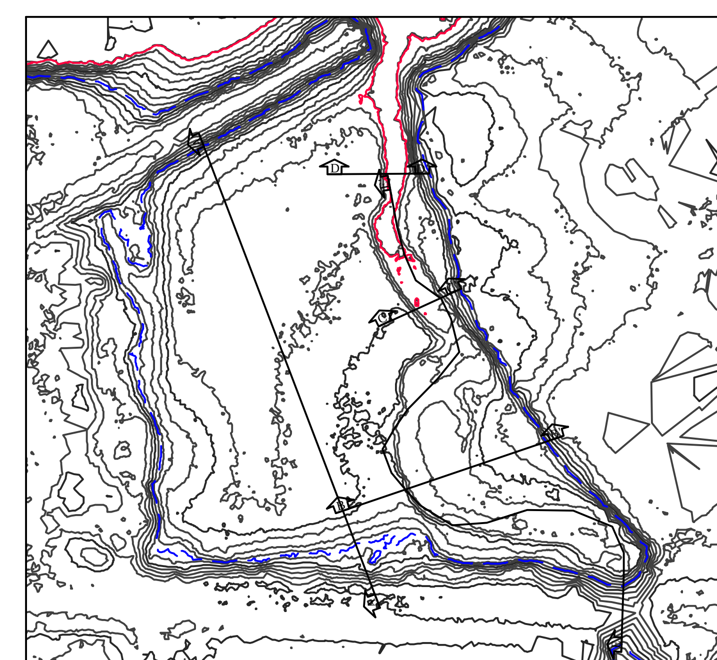

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COASTAL GEOLOGIC SERVICES
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360-647-1845 - coastalgeo.com

REVISIONS

DRAWN BY: JFW
DESIGNED BY:
CHECKED BY:
DATE SURVEYED:
1/27/12

Padden Lagoon Conceptual Design

Profile View
LiDAR and Site Survey

DRAFT

MLLW=0.0'

SCALE: AS NOTED

DATE:
2/16/12

SHEET: 2

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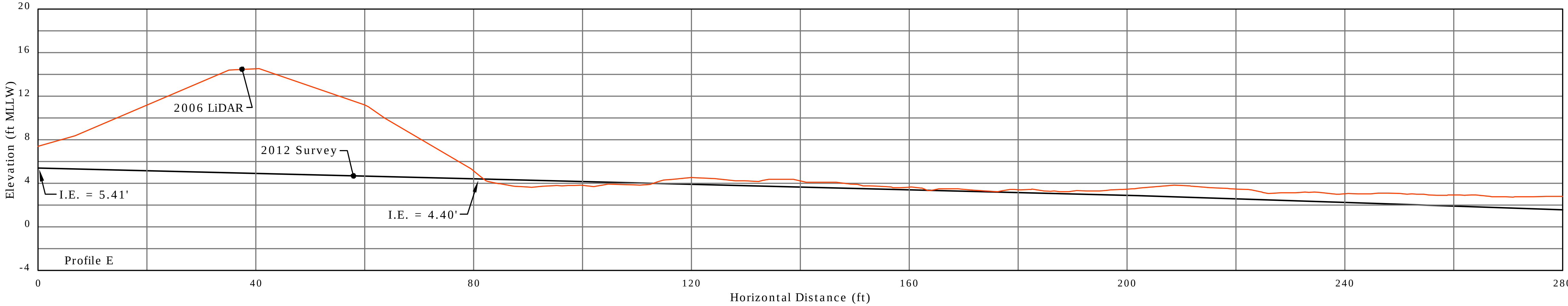

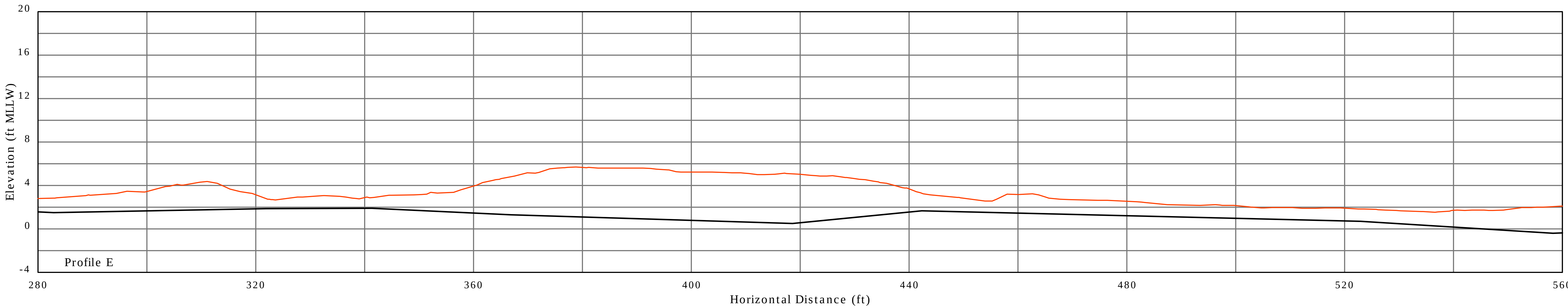

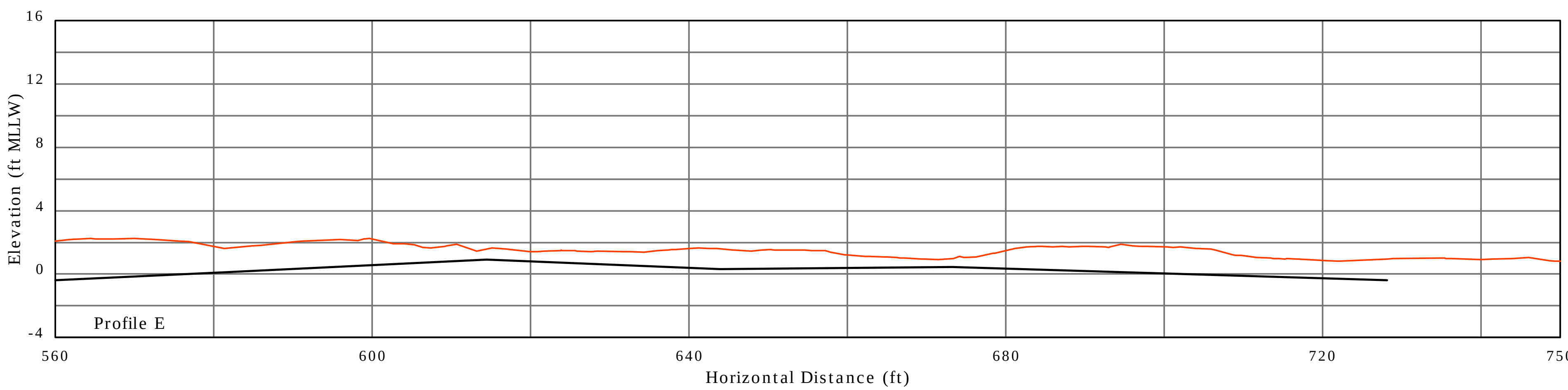

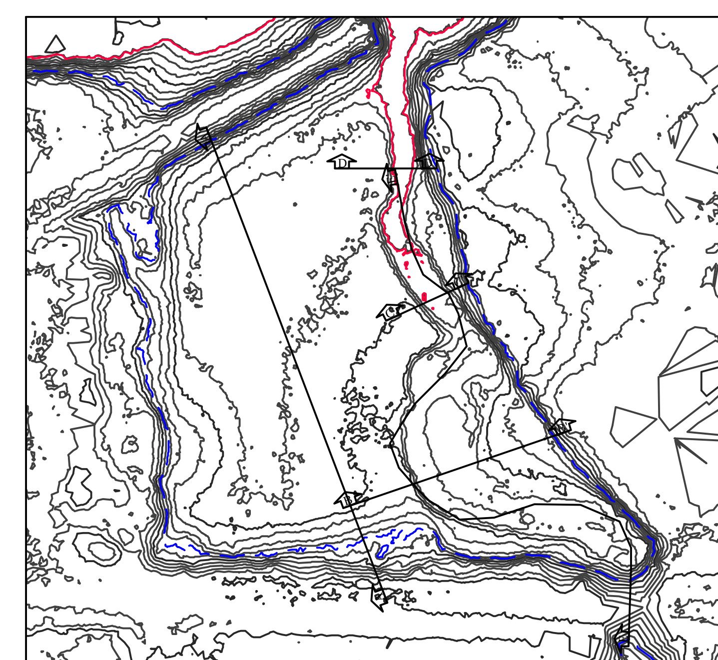

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LiDAR and Site Survey

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DATE: 2/16/2012
SHEET: 3

C1.3

OF: 3

PHASE I
ENVIRONMENTAL SITE ASSESSMENT

Padden Creek Estuary Habitat Enhancements Project
(Project No. EN-38)

Prepared for

ESA
5309 Shilshole Avenue NW, Suite 200
Seattle, WA 98107

and

City of Bellingham
Public Works Department
210 Lottie Street
Bellingham, WA 98225

Prepared by

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May 2, 2012

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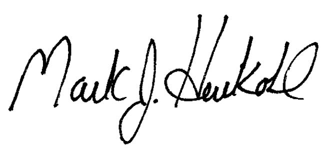
ACRONYMS AND ABBREVIATIONS

AC	Awaiting Cleanup
ASTM	American Society for Testing and Materials
BNSF	Burlington Northern Santa Fe
City	City of Bellingham
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
County	Whatcom County
CS	Cleanup Started
CSCS	Confirmed and Suspected Contaminated Sites
LUST	Leaking Underground Storage Tank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERNS	Emergency Response Notification System
ESA	Environmental Science Associates Adolfson
Herrenkohl Consulting	Herrenkohl Consulting LLC
HWG	Hazardous Waste Generator
MLL	mean lower low water
NFRAP	De-listed CERCLIS
NPL	National Priorities List
NRC	National Response Center
PCB	polychlorinated biphenyls
PAH	polycyclic aromatic hydrocarbons
Phase I	Phase I Environmental Site Assessment
Port	Port of Bellingham
RCU	Reportedly Cleaned Up
RCRA	Resource Conservation and Recovery Act
RCRA TSD	Resource Conservation and Recovery Act Transfer, Storage, and/or Disposal Facility
SW	Solid Waste Landfill Sites
UST	Underground Storage Tank

CERTIFICATION

I, Mark J. Herrenkohl, a professional engineering geologist in the State of Washington, certify that I have reviewed the geosciences portions of this document.



Signature and Name of Geologist: <u>Mark J. Herrenkohl, LEG</u> Date: <u>May 2, 2012</u>

1 INTRODUCTION

This document presents the results of a Phase I Environmental Site Assessment (Phase I) for the Padden Creek Estuary property located at 600 Harris Avenue, Bellingham, Washington (Figure 1). Herrenkohl Consulting LLC (Herrenkohl Consulting) is conducting this work in association with Environmental Science Associates Adolfson (ESA) under contract with the City of Bellingham Public Works Department (City), the property owner. Herrenkohl Consulting conducted site visits in support of the Phase I on January 27 and February 3 2012.

The subject property is comprised of one tax parcel (Whatcom County tax parcel No. 37020255115) with an area of approximately 162,000 ft^2 (3.7 acres). The property is currently a marine tidal mud flat with undeveloped forest and grass land.

1.1 PURPOSE AND SCOPE

The purpose of this Phase I investigation is to identify, to the extent feasible, recognized environmental conditions in connection with the subject property pursuant to the processes prescribed within the U.S. Environmental Protection Agency (EPA) Federal Standards and Practices for All Appropriate Inquiries (40 CFR Part 312) and American Society for Testing and Materials (ASTM) Standard Practice E 1527-05. A recognized environmental condition is defined in the ASTM Standard Practice E 1527-05 as, “the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property, even under conditions in compliance with existing laws." The standard is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies.

The scope of our services for the Phase I included:

- Inspection of the subject property and adjacent properties for indication of hazardous substances, petroleum products, stained soil, stressed vegetation, or careless manufacturing or industrial practices which may be present. Document the storage and waste management practices and the condition of the materials, if present.

- Review of federal, state, and local records as to locations of nearby hazardous waste sites, leaking underground storage tanks, and landfills.

- Review of historic aerial photographs, historic maps (e.g., Sanborn insurance maps), and other available public records to determine past usage of the property and surrounding areas.

- Interview the property manager or representatives, City of Bellingham.

- Review of the physical setting, geology, and hydrogeology of the site.
- Preparation of this report describing the conditions encountered and recommendations for further study, if necessary.

Herrenkohl Consulting understands the results of the Phase I investigation will support a feasibility study to evaluate enhancement/restoration alternatives for the Padden Creek Estuary.

1.2 SIGNIFICANT ASSUMPTIONS AND CONDITIONS

Herrenkohl Consulting has prepared this report using reasonable efforts in each phase of its work to estimate the liabilities associated with recognized environmental conditions on the subject property and in the vicinity of the subject property. No assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions in connection with a property. This report is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with the subject property, in recognition of reasonable limits of time and cost.

Herrenkohl Consulting assumes that the records and public information assembled in support of this Phase I investigation are accurate and current. This report is not definitive and should not be considered a complete or specific definition of all conditions above or below grade at the property.

2 SITE CHARACTERIZATION

2.1 LOCATION AND LEGAL DESCRIPTION

The site is located at 600 Harris Avenue, north of Harris Ave between 6th and 8th Streets, Bellingham, Washington. The property is in the southeast quarter of Section 23, Township 37 North, Range 2 East of the Willamette Meridian (Figure 1).

The legal description of for the subject property as per the Whatcom County Assessor's website is the following:

> "Fairhaven Tidelands that PTN of lots 62-65-67-132-VAC Sixth ST ABTG LY Within TR DAF-BEG at Inters of C/L of Harris Ave WI C/L of Sixth ST- TH N 01 DEG 15'04" E ALG PROJ of C/L of SIXTH ST 40 ft to N LI of Harris Ave-POB-TH N 88 Deg 46'59" W ALG SD N LI 45.52 ft-th 00 DEG 14'45" E 240.29 FT-TH N 07 DEG 12'02" W 63.47 FT-TH N 04 DE 57'58" E 39.10 FT to SELY LI of Burlington Northern RR R/W-TH N 59 DEG 58'31" E ALG SD SELY LI 371.04 FT to WLY LI of TR DESC IN Modified Lease Granted Uniflite by Port of Bellingham Under AF 1475047-th S 11 DEG 30'35" E ALG SD WLY LI 300.86 FT-TH S 38 DEG 39'35" E ALG SD WLY LI 104 FT-TH N 51 DEG 20'30" E ALG SD WLY LI 11.67 FT-TH S 38 DEG 39'35" E ALG SD WLY LI 219.78 FT to N LI of Harris Ave-th N 88 DEG 47'13" W ALG SD N LI 543.73 FT to POB."

2.2 SITE AND VICINITY GENERAL CHARACTERISTICS

The subject property is owned by the City and is located along an industrially developed roadway in an area of mixed commercial and industrial land use in the Fairhaven area of Bellingham. The subject property consists of one tax parcel, approximately 162,000 ft^2 (3.7 acres) in area. The majority of the property is occupied by a marine estuary with a small upland forest and meadow areas.

The site is hydrologically connected to Bellingham Bay and has an elevation ranging from approximately 0 to +15 feet mean lower low water (MLLW). Padden Creek enters the estuary from the southeastern corner of the property.

An aerial photograph of the site is provided in Figure 1 and photographs of the site are shown in Figures 3, 14, and 15.

2.2.1 Geologic Summary

Northwestern Washington has been occupied by continental glaciers at least four times during the Pleistocene Epoch (1.6 million to 10,000 years ago). During these glacial (stades) and accompanying interglacial periods (interstades), the underlying bedrock was eroded and glacial related sediments of varying thickness were deposited over the bedrock.

The surficial deposits on the subject property and in the vicinity of the subject property were interpreted from the Geologic Map of the Bellingham 1:62,500 Folio of Whatcom County, Washington, MAP I-854-B (Easterbrook, 1976). The subject property is underlain by the Chuckanut Formation (TKc), deposited during the Paleocene to Upper Cretaceous. The Chuckanut Formation consists of sandstone, conglomerate, shale, and bituminous to subbituminous coal. The surface of the subject property and above the Chuckanut Formation is Holocene marine sedimentary deposits and anthropogenic fill.

The Soil Survey of Whatcom County, Washington (USDA, 1992) describes the soils on the subject property as Urban land complex with 0 to 3 percent slopes. The unit is approximately 85% Urban Land and about 2% minor components (Labounty, Whatcom, Whitehorn, Birchbay, Everett, and Squalicum soils). This mapped unit is largely covered by streets, buildings, parking lots, and other structures that obscure the soils, so that identification of the soil series is not feasible (USDA 1992).

2.2.2 Hydrogeologic Summary

The groundwater on the property generally follows the topography of the area and flows toward the northeast corner of the property and Bellingham Bay (Figure 4). The site's hydrology is dominated by the tidal cycle and discharge from Padden Creek. Approximately 90% of the property is considered tidal flats and experiences inundation from salt water twice per day. Groundwater flow and stormwater/surface water drain into the estuary from the properties immediately adjacent to the subject property. In addition, the majority of stormwater generated from the Fairhaven downtown area discharges into Padden Creek and then into the estuary.

2.3 SITE DESCRIPTION

Representatives of Herrenkohl Consulting visited the subject property on January 27 and again on February 3, 2012. The subject property is occupied by a large marine tidal flat and estuary occupying the center, north and east sides, with some forested and grassy lands on the west and south sides.

An aerial photograph of the site and vicinity is provided in Figure 1. A detailed image of the site is provided in Figure 2. Site photographs are provided in Figures 3, 14 and 15.

2.3.1 Public Utilities

The property is not served by any utilities, however utilities are located along the southern property line under Harris Avenue and an electrical line appears to cross the mouth of the estuary to a Burlington Northern Santa Fe (BNSF) railroad switch, based on observations during our site visit.

2.3.2 Building Conditions

No buildings currently occupy the site. However historical buildings, wharfs, and railroads did occupy portions of the subject property (refer to historical review in Section 2.5).

As required by ASTM Standard Practice E 1527-05, interior observations during our site visit on January 27 are presented in Table 1.

Table 1. Interior Observations Checklist

ASTM Observation	Yes/No	Comments
Heating	No	No Building
Stains/Corrosion	No	No Building
Drains/Sumps	No	No Building
Asbestos	No	No Building
PCBs	No	No Building
Hazardous Containers	No	No Building
Odors	No	No Building

2.3.3 Surface Conditions

Ninety percent of the property is occupied by marine tidal mud flats. These mud flats had creosote pilings visible in several locations along the western shore and near the mouth of Padden Creek in the southeast corner. Wood shingles were visible in the center of the estuary, exposed through erosional action caused by down-cutting of Padden Creek through the mud, as well as some dumped chairs and urban trash (Figure 14 and 15). The upland portion of the property is located on the west and south sides and covered by undeveloped forest and grassland. Cresote pilings are located on the edge of the western shoreline on the subject property. The land north of the estuary is occupied by a BNSF rail line and there is rip-rap lining portions of the property boundary. The surface on the east side of the estuary is also rip-rapped with creosote pilings and bulkhead, and borders a paved industrial area primarily used for boat building, repair, maintenance, and storage.

Also on January 27, we conducted exterior observations as required by ASTM Standard Practice E 1527-05 (Table 2).

Table 2. Exterior Observations Checklist

ASTM Observation	Yes/No	Comments
Hazardous Containers	No	--
Storage Tanks	No	--
Solid Waste Disposal	Yes	Wood debris and urban dumping of waste.
Odors	No	--
PCBs	No	--
Pits, Ponds, Lagoons	Yes	Property is occupied by a large tidal estuary.
Stained Soil	No	--
Stressed Vegetation	No	--
Waste Water	Yes	Stormwater from adjacent properties and downtown Fairhaven drain onto and through the subject property.

2.4 HISTORIC USE OF PROPERTY

Since the late 1800's, the historic uses of the subject property have included an estuary, log pond, multiple saw mills and lumber companies, a lumber and shingle company, railroad crossings, boarding houses, barns, and a pattern shop. The past use of the property and adjacent properties was evaluated from historic aerial photographs, assessor records, and Sanborn fire insurance maps.

In 1890, a portion of the estuary was occupied by the H.P Hercock Saw Mill, as well as, railroad trellises and open water (Sanborn 1890). In 1891 the mill changed names to the Pacific Coast Trade Company Saw Mill (Sanborn 1891). In 1897 the Pacific Coast Mill Company Saw & Shingle Mill was located on the subject property (Sanborn 1897). By 1913 a portion of the estuary had been filled and the Puget Sound Mill & Timber Company, barn, garage, and boarding houses were located onsite (Sanborn 1913). The Bellingham Plywood Corporation occupied portions of the property in 1941 and filling had continued on the east side (Sanborn 1941). By the 1950's no overwater structures were visible in the aerial photographs but filling continued until around 1975, at which point the estuary looks as it does today. Copies of the historic aerial photographs of the subject property and vicinity from 1950, 1963, 1975, 1988, 2002, and 2008 are provided in Figures 6 through 13. No reference to the source or type of fill materials was discovered during our historical review.

2.5 ADJOINING PROPERTIES

2.5.1 Current Use of Adjoining Properties

The subject property is bound by Harris Avenue to the south and a BNSF rail line to the north. A vacant lot and unpaved parking area are located across Harris Avenue. Bellingham Bay is located across the railroad tracks to the north. The Port of Bellingham (Port) owns the property to the east and leases the buildings for industrial uses. The industrial park currently has eight buildings which are either vacant or being leased by Unicraft Marine Products Inc., LFS Trawl (LFS Inc.), NuCanoe, Northstar Yachts, and Seaview Yacht Service Fairhaven. A parking lot and bathroom operated by the Port is located to the west of the subject property. The adjoining properties can be seen in relation to the subject property on Figure 2.

2.5.2 Past Use of Adjoining Properties

Historic aerial photographs, assessor records, and Sanborn maps were used for gathering information regarding the past use of the adjoining properties (Figures 6 through 13). The property adjoining the subject property to the north has been a railroad since before 1890. The property adjoining the subject property to the east has been slowly filled and occupied by a series of saw mills or plywood factories until after 1941. From at least 1941 until the present time, the area east of the property was developed with marine industrial uses, including boat manufacturing, repair, storage, retail, plastic fabrication, and other uses. The Uniflite Inc. factory located in the same location currently occupied by Seaview Yacht Service Fairhaven, succumbed to fire on April 8, 1980 (Figure 8). Harris Ave has been directly south of the subject property since 1890, but a building across from Harris Ave was occupied by the Burpee & Letson LTD Machine Shop and Foundry (1904-1913), Bellingham Iron Works and Machine Shop in 1933. In 1941, the building was vacant but was again in use by the Hardwood Fuel Company and an aluminum foundry by 1950 (Figure 6). The building was removed by 1975 and the lot has since been vacant. The properties adjoining the subject property to the west were occupied by a boarding house in 1913. By 1933, a pattern shop was added to the structures. From 1941 to 1997, the property was a vacant grass and dirt lot but by 1997, the Port had added a parking lot and a restroom building, which is still present today.

2.6 INTERVIEWS

Herrenkohl Consulting contacted the Whatcom County Health Department regarding any potential environmental concerns on the subject property. The Health Department did not have any complaints regarding the subject property or the immediate vicinity in their files as of February 10.

Renee LaCroix, the authorized representative for the City, met with project representatives at the property on January 27. She provided information on the history and proposed future uses of the site and answered questions about the site.

Tim Wahl, with the City Parks and Recreation Department, was interviewed on February 15 about his observations during a restoration project conducted on the west side of the subject property in the 1990's. Mr. Wahl stated that he did not observe any hazardous material during the excavation and that the soil appeared to be mostly mineral soil without fill materials.

3 RECORDS REVIEW

3.1 SITE DOCUMENTS

No significant environmental documents were found regarding the subject property. The Port's Fairhaven Comprehensive Scheme of Harbor Improvements report (Reid Middleton 2008) for the subject property and surrounding area was reviewed for this report.

The Harbor Improvements report was intended to assist the Port with planning for future port development and restoration within the Fairhaven area. Although this report did not include specific information about the subject property, the report was primarily used as an additional source for current and past land uses and companies that have utilized the properties east and west of the subject parcel.

3.2 STANDARD ASTM ENVIRONMENTAL RECORD SOURCES

The subject property was investigated using records available from the EPA, Washington State Department of Ecology (Ecology), and local health department. The investigation was intended to identify offsite contamination sources on or near the subject property, which have the potential to impact the soil, ground water, or surface water of the subject property.

Public records search was completed through internet research. Each database is searched by city, county, zip code or through mapping programs. The following public records were searched:

- Federal National Priorities List (NPL), active and de-listed sites
- Federal Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), active and de-listed sites
- Federal Resource Conservation and Recovery Act hazardous waste generator or waste handler records or permits (RCRA)
- Federal Resource Conservation and Recovery Act, Treatment, Storage, and Disposal List (RCRA TSD)
- Federal Resource Conservation and Recovery Act sites under corrective action (CORRACT sites)
- Federal Emergency Response Notification System (ERNS), also known as National Response Center (NRC) sites
- Ecology Confirmed and Suspected Contaminated Sites (CSCS) Report
- Ecology Leaking Underground Storage Tank List (LUST)
- Ecology Underground Storage Tank List (UST)
- Washington State Brownsfield List
- Washington State Environmental Registry
- Whatcom County Health Department Solid Waste Disposal and Landfill List

Seventeen potential offsite contamination sources were identified within the ASTM search radius (Table 3). Seven of the sites are listed on more than one database and therefore twenty-four listings of sites are identified within the search radius. The subject property was listed with the NRC due to the sinking of a pleasure boat and an associated petroleum release. The approximate locations of on- and offsite contamination sources in relation to the subject property are shown on Figure 5. The results of the public records search are reported in Table 3.

Table 3. Results for environmental records review of offsite contamination sources near the subject property.

Agency	Document	Search Radius (miles)	# of Sites Identified
Federal	NPL or SUPERFUND	1	0
	De-Listed NPL Site	1/2	0
	RCRA TSD	1	0
	RCRA Hazardous Waste Handler or Generator records and permits	Adjacent Properties	9
	CERCLIS (Active) and De-Listed CERCLIS Sites (NFRAP)	1/2	1
	NRC/ ERNS	Subject Property	1
	RCRA CORRACTS TSD (corrective action underway)	1	0
Washington State	CSCS	1	7
	LUST	1/2	4
	UST	Adjacent Properties	1
	State Brownfield Site	1/2	1
	Institutional or Engineering Control Registry	Subject Property	0
Whatcom County	Solid Waste Landfill Sites (SW)	1/2	0

3.3 POTENTIAL ONSITE SOURCES

As mentioned in previous sections, Herrenkohl Consulting personnel visited the subject property on January 27 and February 3. The purpose of the site visit was to identify, to the extent feasible pursuant to the processes prescribed within the ASTM Standard Practice E 1527, recognized environmental conditions in connection with the subject property.

The Padden Creek estuary was historically a larger estuary, with a log pond by multiple saw mills and lumber companies, a lumber and shingle company, railroad crossings, boarding houses with miscellaneous support structures, and a pattern shop. Possible sources of contamination from these activities include but are not limited to cresote pilings, discarded treated wood waste, and stormwater runoff from factories, waste oil spills, and potential contaminated fill. The pilings located on the eastside and edge of the western shoreline were determined to be treated with creosote, based on field observations (i.e., creosote-like odor after breaking a small portion of a piling).

No hazardous or obviously contaminated materials were noted in the debris during an excavation on the western side of the estuary during a restoration project in 1990’s (per com. Tim Wahl).

The NRC showed that a pleasure vessel was reported to have sunk on the property on January 11, 2007. The report stated that it was unknown if fuels or other materials were released during the sink (Table 4).

No other environmental conditions were identified for the site.

3.4 POSSIBLE OFFSITE SOURCES

The sites found within the ASTM search radius were evaluated to determine their potential effect on the subject property. Factors such as location, topographic barriers, groundwater flow direction, type of contamination, and the actions taken to remove the contamination were evaluated to determine the potential impact of each offsite contamination source to the subject property.

Seventeen properties were identified in the public databases that are located within the ASTM search radius of the subject property. Of the 17 possible properties, 8 were identified as possible sources of contamination with two additional sources (pleasure boat sinking and stormwater drainage from Fairhaven).

The names of the contaminated sites, their addresses, type of contamination present on each site, status of the site, site hazard ranking, and whether the sites are located potentially upgradient of the subject property are presented in Table 4. The sites were determined to be located upgradient based upon our interpretation of the surficial topography of the area and the elevations of the sites (Figures 4 and 5). The sites located upgradient that may have impacted the subject property are shown in bold type.

Table 4. Information for potential onsite and offsite contamination sources

Site Name	Site Address	Site Types	Contamination	Contamination Media	Status	Up gradient
Alaska Marine Highway System	365 Harris Ave	HWG	None reported	--	Inactive	No
Arrowax Fisheries Inc.	207 Harris Ave	HWG	None reported	--	Inactive	No
Port of Bellingham	355 Harris Ave	HWG	None reported	--	Inactive	No
Padden Creek Marine Inc.	**809 Harris Ave Bldgs 4/5**	**HWG**	**None reported**	**--**	**Active**	**Yes**
Tollycraft Yachts Corp	**9th and Harris Ave**	**HWD* CSCS**	**Acetone, Styrene* Halogenated - Organics Non-Halogenated - Solvents Petroleum Products-Unspecified Phenolic Compounds**	**Air* Groundwater Surface Water Soil Air**	**Inactive* AC Ranked 2**	**Yes**
Unicraft Marine Products Inc.	**801 Harris Ave Bldg 2**	**HWG**	**None reported**	**--**	**Active**	**Yes**
South State St. Manufactured Gas Plant	S State ST and Bayview ST	CSCS	Metals – Priority Pollutants Petroleum Products-Unspecified PAHs	Groundwater Surface Water Soil	CS Ranked 1	No
Pleasure Vessel Sinking	600 Harris Ave	NRC	Unknown	Water	--	Onsite
West Bay Sonship Yachts Corp	**895 Harris Ave Bldg 7**	**HWG**	**None reported**	**--**	**Inactive**	**Yes**
Ex-Murray Chris Craft Boat Yard/ Aqustar USA Corp*	**809 Harris Ave**	**LUST UST/ HWG***	**Petroleum-Diesel**	Groundwater Soil	**CS/ Inactive***	**Yes**
Muljat Property	1601 12th ST	LUST CSCS	Benzene Petroleum-Gasoline Petroleum-Other	Soil	CS RCU	Yes
Starvin Sams 16	1602 12th ST	LUST CSCS	Benzene Petroleum-Gasoline Petroleum-Other	Soil	CS RCU AC	Yes

Table 4. Information for potential onsite and offsite contamination sources

Site Name	Site Address	Site Types	Contamination	Contamination Media	Status	Up gradient
Yorky's Mini Mart	1501 12th ST	LUST CSCS	Benzene Petroleum-Gasoline Petroleum-Other	Soil	CS RCU	Yes
Unicraft Plastics Inc.	**801 Harris Ave Bld 10**	**HWG**	**None reported**	**--**	**Inactive**	**Yes**
210 McKenzie Ave	210 McKenzie Ave	Brown-field CSCS	Metals - Other Metals – Priority Pollutants Non-Halogenated - Solvents Petroleum Products- Unspecified PCBs PAHs	Soil Groundwater	CS	No
Bellingham Iron Works	**600 Block Harris Ave**	--	**Unknown**	**Soil Groundwater**	--	**Yes**
Uniflite Inc.	**9th and Harris Ave**	**NFRAP**	**None reported**	**--**	**--**	**Yes**
Bellingham Port Harris Ave Shipyard	201 Harris Ave	CSCS	Arsenic Base/Neutral/Acid - Organics Metals - Other Metals – Priority Pollutants Phenolic Compounds PCBs PAHs	Soils Groundwater Sediment Air	CS Ranked 2	No

Table Notes: (CS)=cleanup started, (RCU)=reportedly cleaned up, (AC)=Awaiting Cleanup(HWG)=RCRA Hazardous Waste Generator, (NRC)=National Response Center, (NFRAP)=De-listed CERCLIS Sites. Sites in **bold** indicate upgradient sites may have impacted estuary.

Historical records show that an iron works, foundry, and aluminum foundry existed across Harris Ave. from the subject property (Bellingham Iron Works) (Figure 6). Also, untreated stormwater runoff from downtown Fairhaven has been identified as an additional source of offsite contamination for the site. Surface water and stormwater flows off the streets and developed area of Fairhaven, enters Padden Creek, and then discharges through the subject property as it drains to Bellingham Bay.

Based upon the distance separating the potential offsite contamination sources from the subject property, the direction of groundwater flow and stormwater runoff in relationship to the source and subject property, and the type of contamination and the media affected by the contamination, it is our opinion that 8 offsite sources pose potential risk of contamination to the subject property (sites highlighted in bold, Table 4). Of the 8 sites, Bellingham Iron Works, Tolly Craft Yacht Corp., Ex-Murray Chris-Craft Boat Yard/Aqustar USA Corp, and Uniflite Inc. (including the fire) have/had the greatest risk of contamination to sediments and soil of the estuary. The Bellingham Iron Works site was directly upgradient from the subject property and may have conducted similar activities as the iron works that was located at 210 McKenzie. The Tolly Craft Yacht Corp. was adjacent and potentially upgradient to the subject property and is listed as a CSCS with an Ecology Site Hazard Assessment Rank of 2. The Ex-Murray Chris-Craft Boat Yard/Aqustar USA Corp. is listed as a LUST site with known petroleum-diesel contamination. Although the Uniflite Inc. site is only listed as an NFRAP site, the fire that destroyed the building reportedly engulfed the entire building with the potential for hazardous materials (e.g., solvents, resins, plasticizers) to have drained into the estuary during firefighting efforts.

Padden Creek Marine Inc. (currently Seaview Yacht Service Fairhaven) is listed as a RCRA Hazardous Waste Handler and poses a potential risk for contamination due to the fact that a portion of the facility floods during high tide and stormwater runoff drains directly into the estuary. Any spills or releases on the paved area around the facility could have the potential to contaminate the subject property.

The untreated stormwater runoff from the downtown area has the potential to transport pesticides, metals, petroleum products, and other auto fluids into the estuary. A stormwater pipe empties into Padden Creek underneath the Harris Avenue culvert and then flows directly into the estuary. This drainage may pose a risk of contamination to the subject property.

Three of the sites including Unicraft Marine Products Inc., Unicraft Plastic Inc., and West Bay Sonship Yacht Corp. are listed as active or inactive RCRA Hazardous Waste Handler sites; however, no contamination has been reported from their activities. These sites are unlikely to pose a significant risk of contamination to the subject property.

The remaining sites were determined to pose a low risk of contamination to the subject property because of location and distance from the estuary.

4 DATA GAPS

The following data gaps indicate areas where information was unavailable or inaccessible during this Phase I investigation, as required by the all appropriate inquiries, despite good faith efforts.

1) The title history for the subject property was not available for review.

2) The type of contamination associated with Padden Creek Marine Inc. (currently Seaview Yacht Service Fairhaven) current and past activities is unknown.

3) The type of contamination associated with Bellingham Iron Works past activities is unknown.

4) The relationship between the purchase price and the value of the property in relation to the presence or absence of contamination was not reviewed.

5) The agency files associated with the each potential contamination sources identified during within the ASTM search radius was not reviewed.

6) The record search did not contain detailed information regarding the Uniflite Inc. NFRAP site or the fire that destroyed it, and agency files for it were not reviewed. The type and amount of contamination released during the Uniflite Inc. fire is unknown.

The above mentioned data gaps do not significantly alter our evaluation of the environmental conditions on the subject property. No other data gaps or limiting conditions were encountered during the conduct of this Phase I work.

5 CONCLUSIONS

Herrenkohl Consulting has performed this Phase I investigation for the subject property in general conformance with the scope and limitations of ASTM Practice E 1527. Our site visit, historical research, and review of available environmental documentation for the site have identified three recognized environmental concerns at the site:

1. Previous uses of the property may have impacted surface water, soil, groundwater, and sediment. Potential contaminants from past operations on the property include metals, tributyltin, petroleum hydrocarbons, PAHs, and phenolic compounds including pentachlorophenol. The sources of these contaminants include but are not limited to creosote pilings, discarded treated wood waste, and stormwater runoff from factories and local area streets, spills, and potential contaminated fill materials.

2. Contamination and hazardous waste generated from adjacent, offsite facility operations may have impacted surface water, soil, groundwater, and sediment on the property. Potential contaminants generated from past and current operations of offsite properties include metals, trybutyltin, non-halogenated solvents, petroleum products, PCBs, PAHs, halogenated organics, and phenolic compounds including pentachlorophenol.

3. Stormwater runoff and discharges (non-point source) has the potential to contaminate surface water, sediment, and soil on the property. Potential contaminants discharged from stormwater may include metals, petroleum hydrocarbons, pesticides, and PAHs.

It is our opinion that further investigation is warranted on the site in support of the feasibility study for the Padden Creek Estuary Enhancements Project. The Phase 2 investigation would include soil and sediment sample collection and testing to evaluate the extent and magnitude of contamination on the property in support of determining a preferred enhancement/restoration alternative(s) for the estuary.

6 REFERENCES AND SOURCES

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Figure 1. Subject property's location in Bellingham, Washington.

Figure 2. Detail aerial photograph of the subject property and the vicinity.

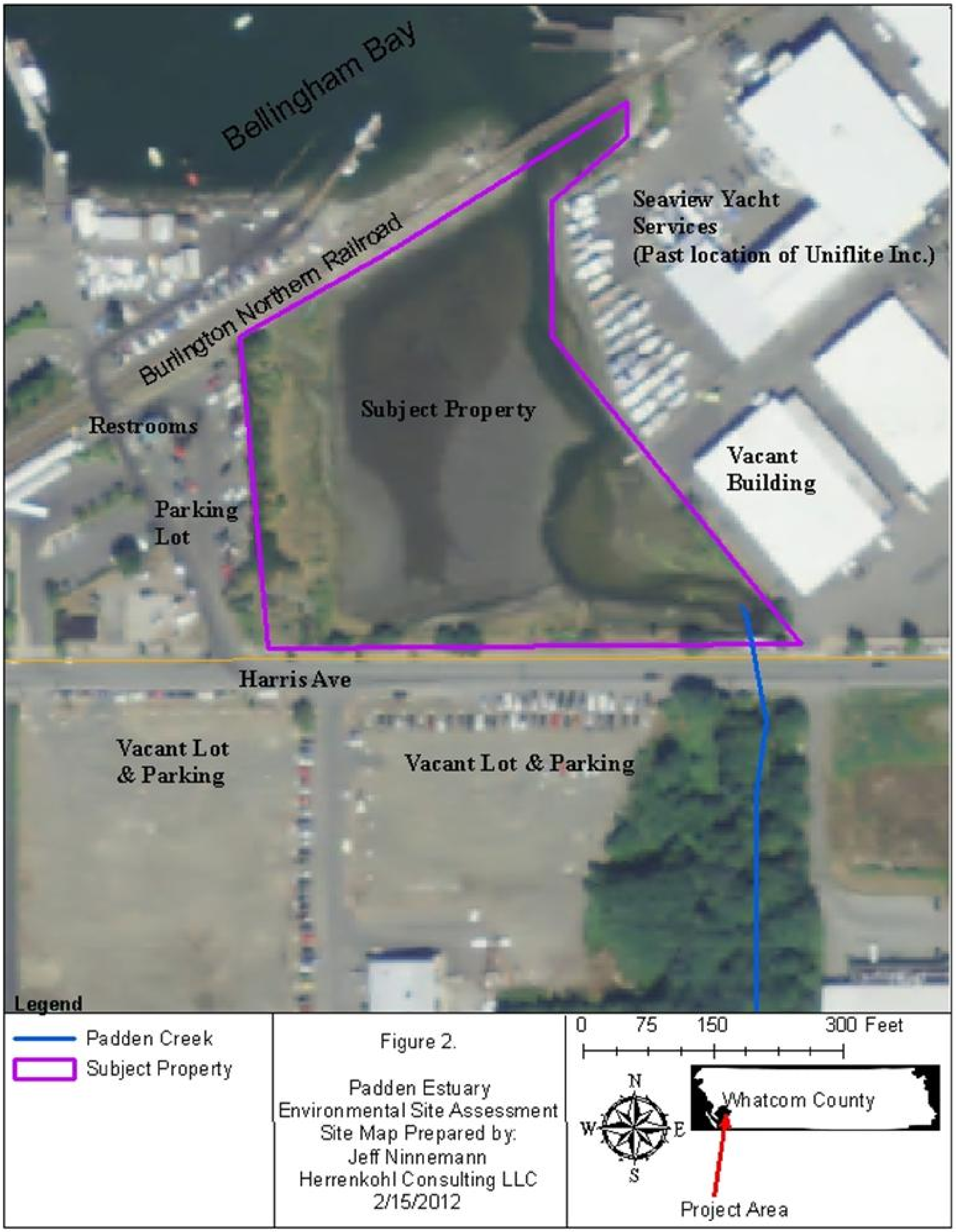

Figure 3. Photos of the subject property looking southeast (above) and northwest (below).

Figure 4. Topographic map showing the likely hydrologic flow direction.

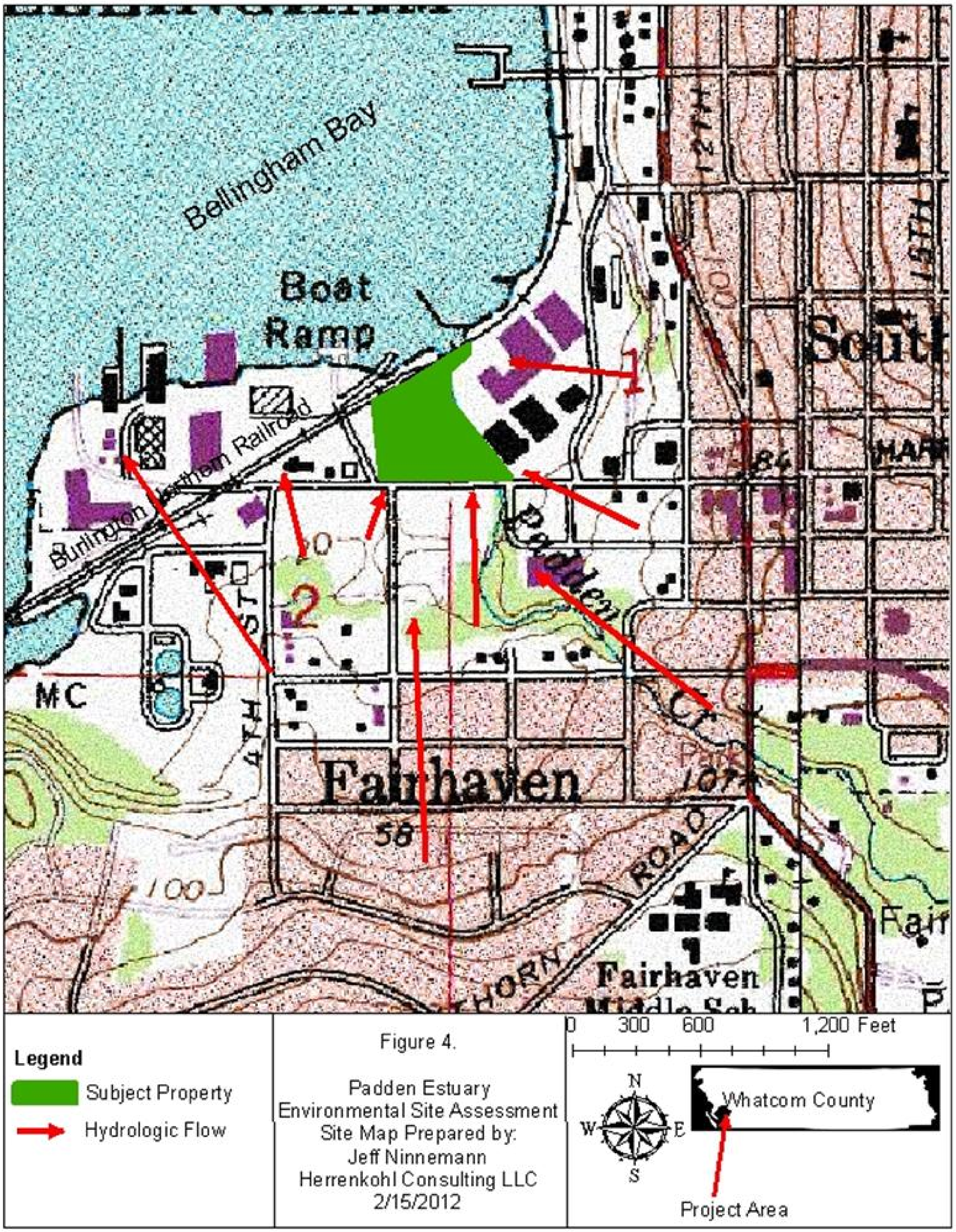

Figure 5. Locations of potential onsite and offsite contamination sources.

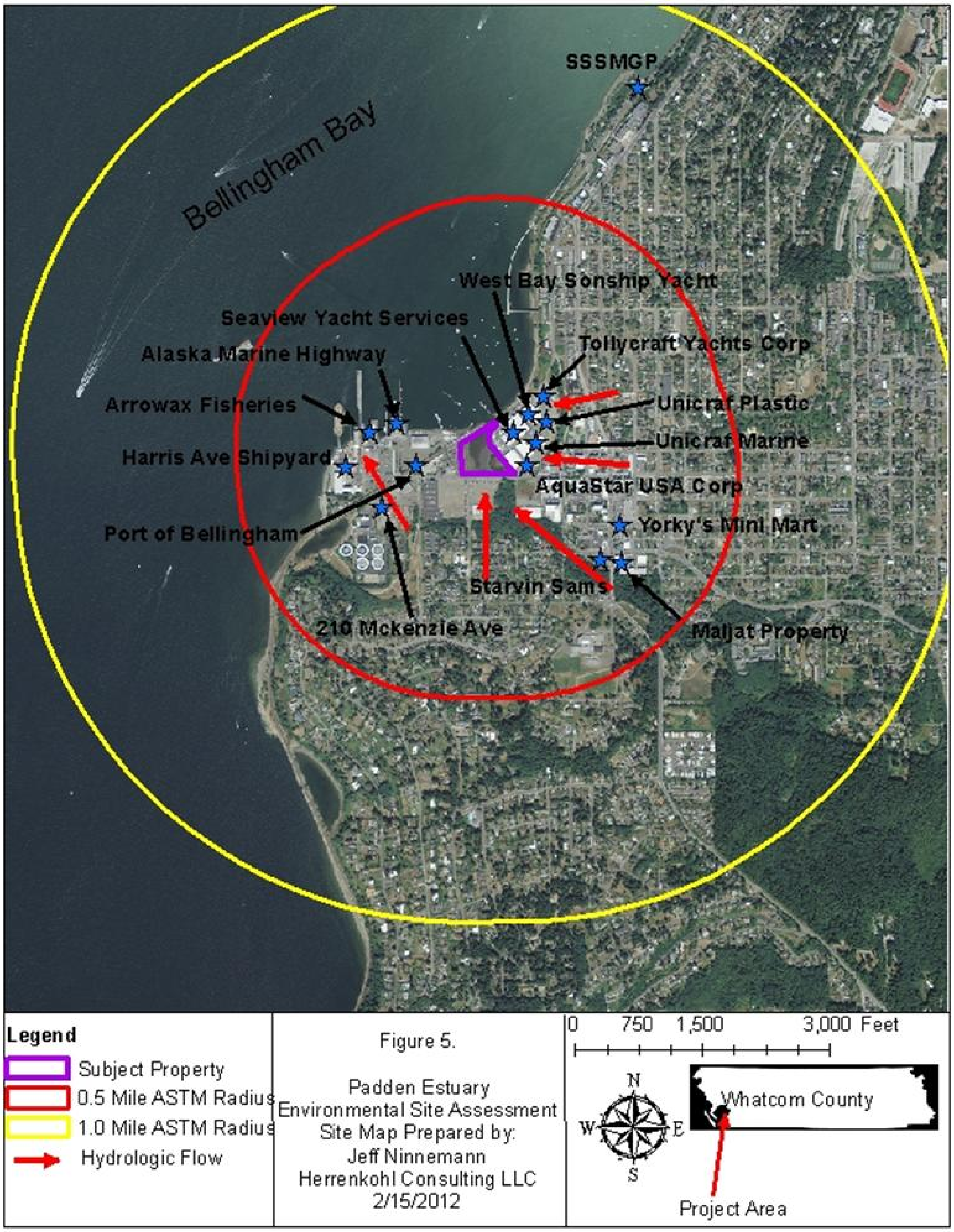

Figure 6. Aerial photograph of the subject property in 1950.

Figure 7. Aerial photograph of the subject property in 1963.

Figure 8. Aerial photograph of the east side of the subject property in 1975.

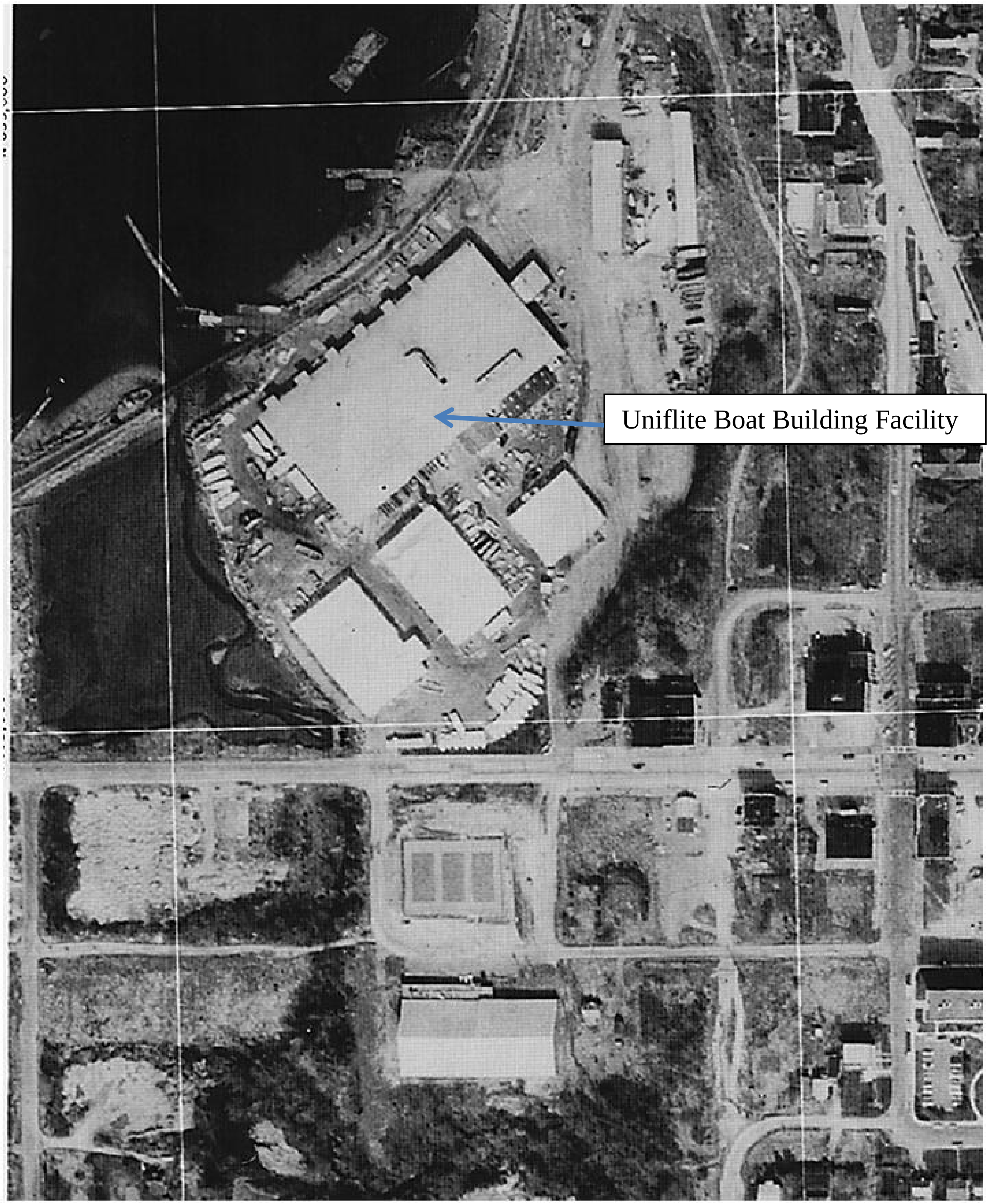

Figure 9. Aerial photograph of the west side of the subject property in 1975.

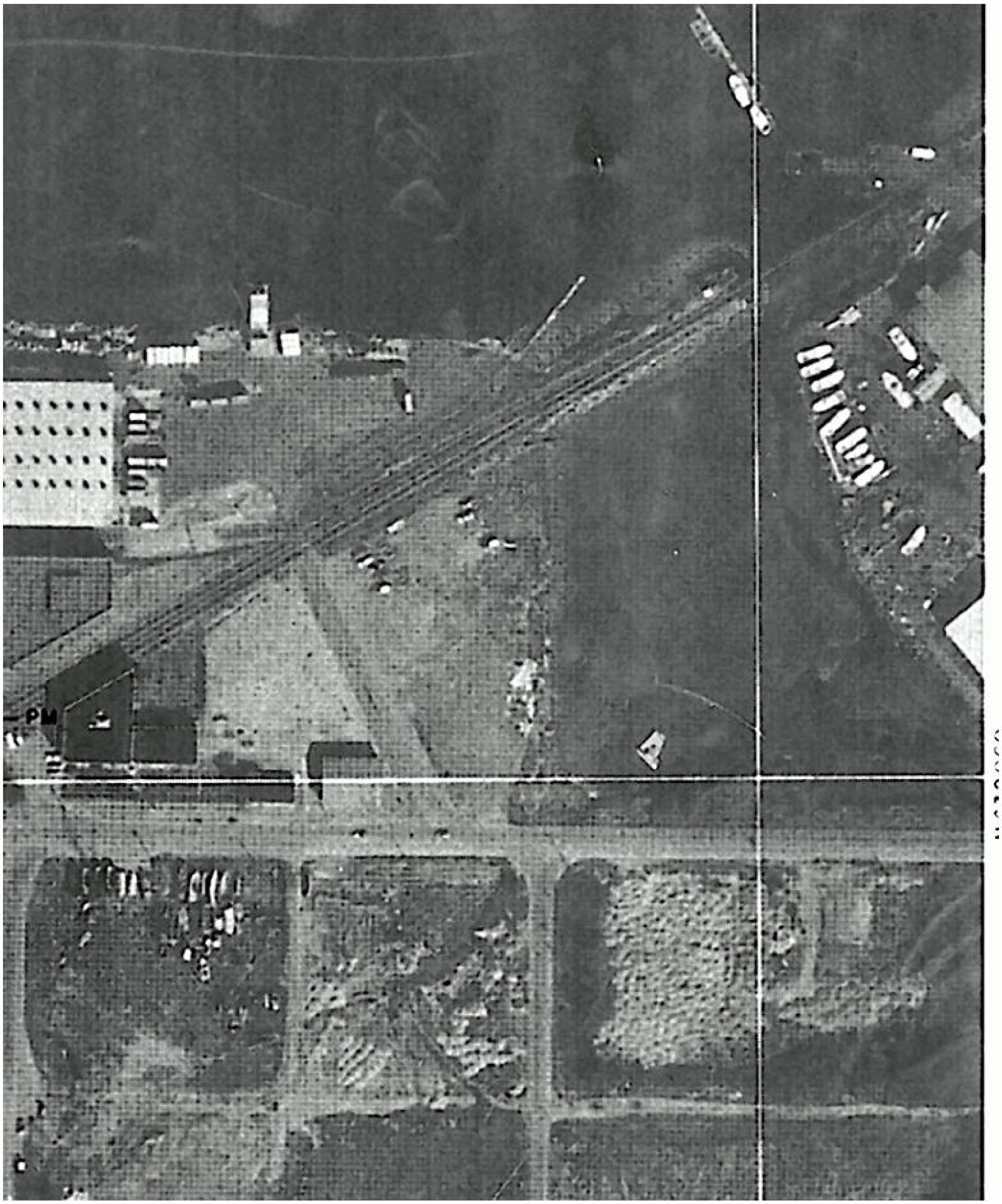

Figure 10. Aerial photograph of the east side of the subject property in 1988.

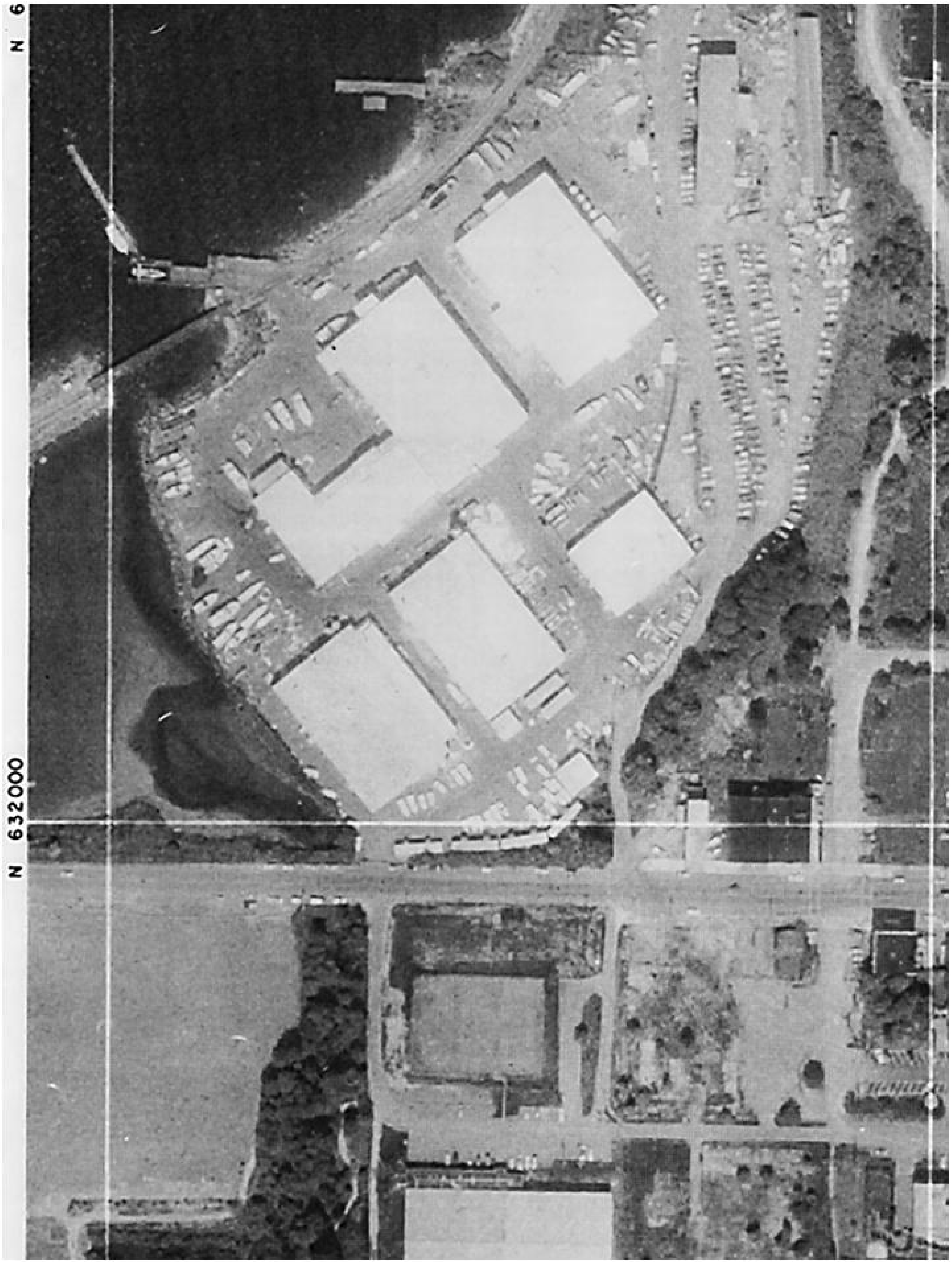

Figure 11. Aerial photograph of the east side of the subject property in 2002.

Figure 12. Aerial photograph of the west side of the subject property in 2002.

Figure 13. Aerial photograph of the subject property in 2008.

Figure 14. Photo of the shingles layer in sediments on the subject property.

Figure 15. Photo of bulkhead and pilings in the southeast corner of the subject property (above) and urban trash in middle of estuary (below).