Alternatives Analysis and Conceptual Design Report

Greenbank Beach and Boat Club, Inc. Drainage and Habitat Improvement Project

Prepared for:

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DRAFT

Executive Summary

This report documents the development of conceptual engineering options for improving drainage and natural habitat conditions at the Greenbank Beach and Boat Club, Inc.'s (GBBC) property at Holmes Harbor in Greenbank, Washington. GBBC officers identified four general goals for addressing ongoing drainage maintenance issues at the site:

1. Determine what responsibility GBBC may have for ongoing operation and maintenance (O&M) of the tidegate and associated infrastructure
2. Investigate the technical feasibility of discontinuing the O&M of the system
3. Maintain GBBC members' recreational access to the boat ramp and beach
4. Maintain or improve ecological conditions in the lagoon area.

Whidbey Island Conservation District (WICD) formulated specific technical objectives to use to identify and evaluate engineering options for addressing GBBC's Goals No. 2, 3 and 4. We believe that Goal No.1 is a legal issue that is outside the scope of the present study.

During September and October, 2013, WICD did field measurements and a review of public agency databases in order to develop a preliminary characterization of relevant site baseline conditions, including topography, existing drainage infrastructure, ecological and land use conditions, hydrology, tidal ranges, and coastal geomorphic conditions. Based on the preliminary data, WICD developed five conceptual-level options for achieving the specific technical objectives. The options represent a range of approaches from straight-forward modifications of the existing tidegate and drain outfall, to more aggressive reconfiguration of the drainage system that would allow partial or full restoration of tidal flow across the site, to arranging for the county to assume partial or full responsibility for drainage at the site. These options are:

- Option 1 Outfall Deflection Structure
- Option 2. Tidegate Replacement
- Option 3 Partial Restoration of Tidal Flow
- Option 4 Full Restoration of Tidal Flow
- Option 5 Divestment to Island County

Conceptual level engineering design drawings for Option Nos. 1 – 4 are presented in Appendix 1.

The report then evaluates each of the options using four basic screening criteria so that the relative advantages and disadvantages of each can be compared on a consistent basis. The evaluation criteria are: 1) effectiveness in meeting the specific objectives, 2) community acceptance, 3) regulatory permitting needs and 4) overall project cost. The following table summarizes the results of the evaluation:

Evaluation Summary

Option	Effectiveness	Community Acceptance	Permitting Requirements	Project Cost
1. Outfall Deflector	Low	Positive	Moderate	$28,000
2. Replace Tidegate	Low-moderate	Positive	Low	$37,000
Combined 1 and 2	Moderate	Positive	Moderate	$53,000
3. Partial Tidal Restoration	Moderate-high	Moderate-negative	Moderate-high	$426,000
4. Full Tidal Restoration	High	Negative	High	$523,000
5. Divestment to Island County	TBD*	TBD	TBD	TBD

*To be determined pending on whatever arrangement can be reached between GBBC and Island County.

At this stage, WICD did not recommend a preferred option. We would be happy to work with GBBC officers and Island County government officials to evaluate the various options in more detail, or to formulate different options that may be more effective in addressing GBBC's general interests at the project site.

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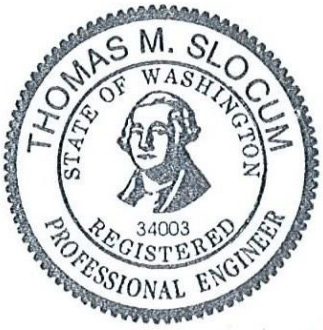

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1 Purpose

Whidbey Island Conservation District (WICD) asked the Washington Conservation District Northwest Region Engineering Program to provide engineering services related to developing and evaluating conceptual design options for maintaining drainage capacity and improving nearshore habitat conditions at the Greenbank Beach and Boat Club, Inc.'s (GBBC) beachfront property on Holmes Harbor in Greenbank, Washington. GBBC is the homeowner's association that represents the mutual interests of the residents of the Holmes Harbor Estate subdivision. Based on preliminary field observations completed in October 2013, correspondence with GBBC officers and Island County Department of Public Works staff, and previous experience in designing and permitting nearshore projects of this type, WICD is providing the following conceptual design recommendations for achieving GBBC's goals in a manner that will minimize the need for future maintenance and that will support Island County and State of Washington environmental protection and restoration policies.

2 Background

2.1 Description of the Project Area

GBBC owns an approximately 3.0-acre property consisting of three parcels[1] located on the shore of Holmes Harbor near the intersection of Shoreline Drive and North Bluff Road in Greenbank, Washington. The property is used by GBBC's members for recreation, and is developed with a gravel driveway and parking lot and a concrete boat ramp. Other site development includes an earthen berm, an earth and cobble dike, ditches, a tide gate and a drainage outfall pipe. These features reportedly were constructed by settlers in the early 1900s to convert the land from estuary and marsh to farm land. The drainage system now serves primarily to convey stormwater runoff from an approximately 480 acre drainage area surrounding the site. Details on the drainage system are provided in Section 2.3. Sheet 1 in the attached drawings shows the existing site features.

Privately-owned residential properties border the site on the north and south sides. A preliminary review of Island County property records indicates that the GBBC property abuts state-owned aquatic land (SOAL) on its east (shoreline) side. The precise boundary between the SOAL and GBBC's property was not determined for this preliminary study, but the county's internet-based records indicate that the property line runs approximately along the crest of the barrier beach, several feet inland from the mean higher high water (MHHW) on the beach. Island County's right of way for North Bluff Road forms the western boundary of the site. Approximate locations of the property boundaries are shown on Sheet 1. Figure 1 shows an aerial photograph of the project site.

[1] Parcel ID Nos. 263510, 263422 and 263431

Figure One: Aerial Photo of the Project Site
Photo credit Washington Department of Ecology

2.2 Land Use and Ecology

Land cover in the project area consists of open beach, dune, meadow, salt marsh, fresh water wetland and open water tidal lagoon. Vegetation varies with the elevation across the site approximately as follows:

Vegetation Community	Elevation Range (feet NAVD88)[2]	Comment
Open Beach	-2' to 10'	
Barrier beach dune grasses	10' to 13'	
High marsh/salt meadow	9' to 12'	Behind the barrier beach and parking lot fill
Low salt marsh	5.5' to 9'	Surrounding the lagoon, behind the cobble dike
Tidal lagoon	3.5' to 5.5'	
Freshwater emergent wetland	5.5' to 9'	West of North Bluff Road

The approximate elevations ranges are based on WICD's preliminary tidal research and elevation survey data (see discussion in Section 2.4). The vegetation communities represent distinct ecological zones at the site and appear to be remnants of the extensive tidal marsh that predominated in the area prior to

[2] NAVD88 refers to the "North American Vertical Datum of 1988", which is currently the most common vertical datum used for reporting elevations on the continent.

settlement in the late 19th Century. The approximate boundaries of the marsh are shown in Figure 2, which is an image from the 1888 U.S. Coast and Geodetic Survey "T Sheet." Figure 3 shows this shoreline overlaid onto a contemporary aerial photo.[3]

Figure 2: 1888 Shoreline Chart

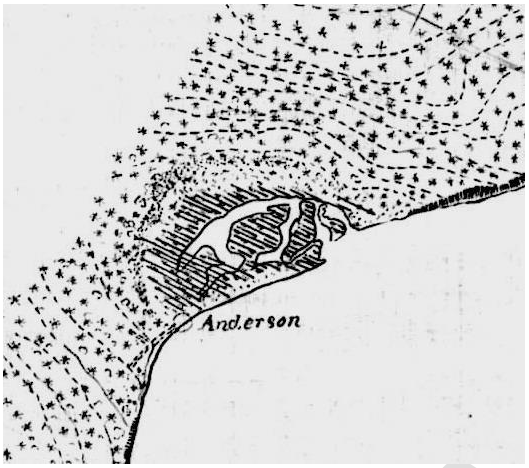


Figure 3: Historic Shoreline Overlay on Contemporary Conditions

The current salt water lagoon is impounded behind the dike and headwall system in the center of the site, as shown Figures 4 and 5, as well as in the Existing Site Plan (Sheet 1) in Appendix 1. At the estimated ordinary high water (OHW) elevation of approximately 7.0' NAVD88, this feature covers about 0.52 acres. The lagoon is connected to the larger fresh water "Greenbank Marsh" by a 30" diameter culvert running beneath North Bluff Road. Greenbank Marsh extends south and west to the Greenbank Farm property. WICD estimates that there are about 9.5 acres of open water in the marsh at the OHW elevation. The USDA soil survey characterizes 20.6 acres of land in the lagoon and marsh complex as wetland soils.[4]

Both wetland features would be characterized as "wetland" under the jurisdiction of the relevant Clean Water Act regulatory definitions (33 CFR 328.3).[5] Furthermore, it is likely that both wetlands would be categorized as Category 1 under the Washington Department of Ecology's (WDOE) functions and values assessment classification.

[3] Source: WDOE "Washington State Coastal Atlas", 2013. URL https://fortress.wa.gov/ecy/coastalatlas/

[4] USDA NRCS Web Soil Survey, URL http://websoilsurvey.sc.egov.usda.gov

[5] This assessment is based on WICD's preliminary field observations of vegetation, soils and hydrology.

Figure 4: Lagoon and Headwall

Figure 5: Earth and Cobble Dike

Salmon Recovery Context

Island County's salmon recovery plan identifies various geographic areas and land forms in the county as being of special interest for supporting its goal of recovering stocks of wild salmon that are listed as threatened or endangered under the Federal Endangered Species Act (ESA). The shoreline of Saratoga Passage, including Holmes Harbor and the vicinity of the project site, is classified as the second tier geographic priority area for supporting recovery of ESA-listed Puget Sound Chinook salmon stocks. Within this area, marshes and "pocket estuaries" are the highest priority habitat areas because of their value in providing rearing habitat for juvenile salmon migrating out of the Skagit, Stillaguamish and Snohomish rivers.[6] Within this context, the small lagoon and salt marsh on GBBC's property, as well as the larger Greenbank Marsh across North Bluff Road, have potential to provide substantial benefit to supporting the county's salmon recovery goals, provided that the their tidal connection with the open water in Holmes Harbor can be improved.

2.3 Hydrology and Drainage Issues

Hydrology Modeling

The project site lies at the base of an approximately 480-acre catchment area. Runoff from the hills to the south, west and north drains through various field ditches, road culverts and overland flow into the Greenbank Marsh, then through the culvert under North Bluff Road to the tidal lagoon, and then into GBBC's outfall pipe to discharge into Holmes Harbor. The lagoon also receives runoff directly from the system of culverts and open ditch line along the east side of North Bluff Road.

WICD estimated peak runoff volumes from the watershed under various precipitation event recurrence intervals. Using soils data, topography and land cover characteristics from available public on-line sources, WICD compared the outputs of preliminary runs of the following hydrology models:

[6] *WRIA 6 Multi-Species Salmon Recovery Plan*. Island County Water Resources Advisory Committee, May 2005.

- USDA Natural Resources Conservation Service "Win TR-55" model
- Washington Department of Ecology "Western Washington Hydrology Model 4.0"
- U.S. Geological Survey "Streamstats" model

Peak runoff estimates from the various models are as follows.

Model	Precipitation Event Recurrence Interval				
	2 year	10 year	25 year	50 year	100 year
Win TR-55	3.2 cfs*	7.7 cfs	19.9 cfs	49.2 cfs	83.7 cfs
WWHM 4.0	8.0 cfs	19.2 cfs	27.8 cfs	36.0 cfs	45.8 cfs
Streamstats	7.9 cfs ±56%	13.7 cfs ±53%	16.8 cfs ±53%	19.5 cfs ±53%	28.3 cfs ±54%

*Cubic feet per second

The low permeability of the glacial till soils and fairly steep terrain that characterize the catchment area account for the relatively high runoff. The USDA soil survey classifies the majority of the soils as Group D, indicating slow infiltration and high runoff potential. At the present time, insufficient field data is available to verify the soil and land cover and to calibrate the modeling assumptions, so these runoff estimates are considered provisional.

Drainage Infrastructure Capacity

WICD compared the provisional peak flow estimates with the conveyance capacity of the stormwater outfall at GBBC's project site. We measured a slope of approximately 0.011 feet/foot (1.1 percent) on the 24-inch diameter ceramic pipe. Under ideal conditions, this pipe would have capacity to convey a maximum of about 21.0 cfs, suggesting that it could handle peak runoff from a 25-year runoff event[7], more or less. Several factors reduce the actual capacity of the pipe, including backwatering of the outfall by the tide, increased roughness on the pipe walls by marine growth, and especially the quantity of gravel filling the outfall. Figure 6 shows the outfall during a site visit in April 2013, when gravel filled about 85 percent of the pipe's cross section area. Under these conditions, the maximum flow capacity of the outfall was estimated to be only 2.0 cfs, and was probably actually substantially less.

The existing tidegate at the project site also significantly impacts the capacity of the site's drainage system. The tidegate is a Tideflex Technologies/Red Valve Company "duck bill" bladder-type structure that was reportedly installed in 1998. This tidegate is shown in Figure 7. The 24-inch diameter aperture onto which the tidegate is installed was fitted onto a steel plate that blocks the outlet of the rectangular-shaped, concrete outlet culvert from the lagoon. Both the tidegate and the steel plate are presently in poor condition. The tidegate material has become rigid and encrusted with barnacles so that it can open only a fraction of its design width, and corrosion around the seal of the steel mounting

[7] A "25-year" recurrence event refers to a runoff event that has a 4% statistical probability of occurring in any given year. A 2-year event and a 100-year event have a 50% and 1% probability, respectively, of occurring in any year.

plate and concrete headwall allows substantial leakage. No attempt was made to estimate the actual flow capacity of the tidegate, but it is assumed to be no greater than that of the gravel-clogged outfall.

Figure 6: Drainage Outfall, April 2013

Figure 7: Tidegate, October 2013

<u>Ownership and Maintenance of the Drainage Infrastructure</u>

During a site meeting on August 20, 2013 GBBC officers and Island County DPW's surface water manager Mr. Phil Cohen discussed the issue of the roles and responsibilities between GBBC and the county for maintaining the site's existing drainage infrastructure. GBBC did not construct the drain outfall and tidegate system, but took control of it when it purchased the property. GBBC members reported that they are under the impression that the system was built in the early 1900s for the purpose of draining the surrounding marsh to allow for cattle grazing.[8] Members currently maintain the system on an as-needed basis, particularly clearing accumulated gravel from the outfall pipe outlet after storms.

Island County for its part installed and owns the culvert under North Bluff Road, which routes water to the tidegate and outfall. The county also reportedly paid for half of the cost of installing the current tidegate in 1998,[9] but has not identified having any formal drainage easement to the site. Mr. Cohen reported that Island County is willing to consider negotiating a formal cost-sharing arrangement with GBBC to maintain the drainage system, but at present no details of this arrangement have been discussed.

Likewise, no records of drainage easements have been identified between GBCC and the owners of the private properties along the east side of North Bluff Road, whose system of private ditches and culverts feeds storm runoff into GBBC's drainage system. GBBC officers stated to WICD that they do not believe that GBBC has an affirmative duty to provide drainage either for these private parcels or for other land in the catchment area lying outside of the Holmes Harbor Estates subdivision. A detailed analysis of

[8] Personal communication with Ms. Judi Moore, August 2013
[9] Ibid.

GBBC's and Island County's legal rights, responsibilities and liabilities regarding the drainage situation is beyond the scope of the present study.

2.4 Tidal Datum and Coastal Morphology

Tidal Datum

WICD reviewed available on-line information from the National Oceanic and Atmospheric Administration (NOAA) to estimate the tidal range at the project site. The following estimated elevation range, which is based on an interpolation between the published data for NOAA's Sandy Point and Crescent Harbor tidal stations[10], is believed to be a reasonable preliminary approximation for the site. A more precise identification of the actual tidal range at the site would be needed for completing any detailed design of drainage or habitat improvements.

Estimated Tidal Elevations

Tide Stage	Station Data		
	Sandy Point	Crescent Harbor	GBBC Site Estimate
MLLW	-1.87 ft.	-2.21 ft.	-2.0 ft.
NAVD88	0.00 ft.	0.00 ft.	0.00 ft.
MHHW	9.39 ft.	9.45 ft.	9.4 ft.
Extreme High Water[11]			12.5'±0.5'

The available LiDAR and survey monument data that were used in the conceptual design options are referenced to the NAVD88 elevation datum, so this datum is used consistently throughout the study. The conversion between conventional tide table predictions, which are referenced to mean lower low water (MLLW) = 0.0' and the NAVD88 datum is approximately +2.0 feet. For example, a tide prediction reported as 10.0' MLLW in the tide tables is equivalent to 8.0' NAVD88. The estimated MLLW and mean higher high water (MHHW) lines are shown in Sheet 1.

Site Elevations

WICD measured the elevations of key site features by surveying transects across the site from the MLLW line to the wetland west of North Bluff Road. We calibrated these measurements by surveying a level line transect from WSDOT's elevation control benchmark No. GP15525—28, located near the intersection of North Bluff Road and SR 525, using a laser level and rod technique. The elevation of this benchmark is reported as 121.424' NAVD88. We then established a provisional elevation benchmark on the concrete headwall near the tidegate vault, which we estimate to be at elevation 11.82' NAVD88. WICD field checked our surveyed site elevations against the reported LiDAR data and observed tidal conditions at the site and concluded that the estimates are reasonably accurate for the purposes of this

[10] NOAA COOPS,1983-2001 epoch. URL = http://www.co-ops.nos.noaa.gov/datums.html?id=9447856

[11] US Army Corps of Engineers Seattle District tidal datum for Crescent Harbor station. . URL = http://www.nws.usace.army.mil/About/Offices/Engineering/HydraulicsandHydrology/HistoricalDatumRegions/WhidbeyIsland.aspx This estimate is provided as a reference only and is not intended to represent the actual condition at the project site.

conceptual design report. However, it is important to note that this work was not done by a licensed surveyor and the accuracy is limited by the limitations of our equipment and technique. For any subsequent detailed design work, elevation control must be established on site by a licensed surveyor.

Sediment Transport Patterns

Sediment transport along the shoreline of Holmes Harbor is a key physical factor that affects the function of the existing drainage outfall as well as the design of drainage and habitat improvement options for the site. A 2005 county-wide survey of shoreline sediment transport patterns concluded that sediment moves from the south to the north (left to right as facing the shoreline from the water) along the Greenbank shore.[12] Field observations at the site show that particle sizes up to approximately 2-inch diameter coarse gravel are routinely transported along the shore. Among other implications, the constant movement of sand and gravel tends to bury much of the length of the concrete boat ramp and fill most of the outlet of the outfall pipe. The combined effect of the boat ramp and the outflow of the pipe tend to obstruct sediment drift along the shore slightly, and as a result have formed a subtle alluvial fan-like feature rising a few inches above the surrounding beach grade at that location.

Tidal Connection to the Lagoon

As discussed in Section 2.3, corrosion around the edges of the tidegate mounting plate in the tidegate vault allows a portion of the flow from the lagoon to bypass the tidegate. It also allows sea water to flow back into the lagoon when the tide level is above the invert of the lagoon outlet pipe. WICD estimates that sea water back-flows into the lagoon when the tide reaches an elevation of about 3.3' NAVD88 (about 5.3' above MLLW). This backflow through the vault is important for maintaining the ecological conditions in the lagoon and surrounding salt marsh.

3 Goals and Specific Objectives

During meetings with WICD on April 23, 2013 and August 20, 2103, GBBC officers identified the following general goals for addressing ongoing drainage maintenance issues at the project site.

1. Determine what responsibility GBBC may have for ongoing operation and maintenance (O&M) of the tidegate and associated infrastructure,
2. Investigate the technical feasibility of discontinuing O&M of the system,
3. Maintain GBBC members' recreational access to the boat ramp and beach, and
4. Maintain or improve ecological conditions in the lagoon area.

WICD has developed the following specific technical objectives to use to identify and evaluate engineering options for addressing GBBC's goals.

1. Maintain or improve the capacity to route stormwater runoff from the lagoon to Holmes Harbor, compared with current conditions. Do not impair drainage or otherwise cause impacts on adjacent properties or the county road right of way

[12] Johannessen, Jim. "Island County Feeder Bluff and Accretion Shoreform Mapping: Final Report." Prepared for Island County Marine Resources Committee, Nov. 30, 2005

2. Reduce or eliminate the effort and cost required for maintaining drainage capacity, compared with current conditions.
3. Maintain safe and convenient motor vehicle access for boat launching and parking at the existing or better level of service. Maintain safe and convenient walking access to the beach at the existing level or better.
4. Maintain or improve the ecological function and value of the lagoon and salt marsh, as well as the freshwater wetland located west of North Bluff Road, compared with the existing condition.

Addressing goal #1, a determination of GBBC's legal responsibility for ongoing operation or the drainage infrastructure, is a legal evaluation that is outside the scope of WICD's present study.

4 Conceptual Options for Achieving the Objectives

Based on our study of the site baseline conditions and our understanding of GBBC's general goals, WICD identified five conceptual options for achieving the specific objectives. The options represent a range of approaches that we believe would be feasible and, to varying degrees, effective in achieving the objectives. These options are not intended to be exclusive, as several other, different approaches might also be feasible. Each of the options is summarized in the following sections. A conceptual-level engineering design for each option is included in the plan sets in Appendix 1.

4.1 Option 1: Outfall Deflector Structure

Sheet 3 of the plan set shows a sample conceptual design for a simple deflector structure that could be constructed around the existing drain outfall to reduce the accumulation of gravel that currently blocks the pipe outlet. Key design features of this structure include:

- It is angled oblique to the typical direction of waves hitting the beach and to the direction of along-shore sediment transport, in order to deflect some of the force that currently pushes gravel into the pipe outlet.
- The walls extend a short distance above the surrounding beach grade to serve as a partial barrier to sand and gravel moving northward along the beach
- The interior walls are sloped to roughly form a "V" shape, which serves to constrict the outflow of water from the pipe, and in that way concentrate the shear force of the flowing water into the bottom of the structure, where it will more effectively sweep out accumulated sediment.
- The interior floor of the structure is designed to accommodate the width of a typical shovel, to allow for convenient removal of accumulated sediment by hand.

WICD has no record of a structure of this design being used for this purpose, but we have seen some of the design elements employed to varying degrees of success on other beach outfalls on Whidbey Island. Figure 8 shows an example of curbing constructed around the outfall of the Admirals Cove lagoon to reduce sediment entrainment. Figure 9 shows the outfall of the Maxwelton lagoon oriented oblique to the general direction of waves and along shore drift.

Figure 8: Curbing at Admirals Cove Outfall

Figure 9: Oblique Orientation of Maxwelton Outfall

4.2 Option 2: Tidegate Replacement

Sheet 3 of the plan set shows a conceptual design for replacing the existing Tideflex tidegate with an aluminum, side-hinged tidegate that will not restrict drainage from the lagoon, as is currently the case with the existing tidegate. It takes very little flow from the upstream side to open a well-balanced, side hinged tidegate, and the gate will stay open until the water surface elevation on the downstream side rises above that of the upstream side. Installing a new gate would involve removing the existing gate and mounting plate and installing a new aluminum mounting plate and the tidegate as a single unit. The corroded concrete around the existing mounting plate would be patched with hydraulic cement.

WICD worked with a tidegate vendor to retrofit Whidbey Island Dike District No. 2's tidegate vault at the mouth of Maxwelton Creek with this kind of a side-hinged gate. The new gate system has operated well since 2006. Figures 10 and 11 show photos of this installation.

Figure 10: Side-hinged Tidegate at Maxwelton

Figure 11: Installation of Side-Hinged Gate

In order to meet the specific objective of maintaining or improving the ecological function of the lagoon, this design option should include a way to allow a small flow of tidal water to enter the lagoon, as currently occurs through the leaks in the vault. The conceptual design on Sheet 3 includes a 6" diameter aperture through the mounting plate. The final design would determine the precise sizing and location of the aperture by balancing the quantity of saltwater backflow needed to maintain healthy ecological conditions in the lagoon against the quantity of out flow needed to open the tidegate.

4.3 Option 3: Partial Restoration of Tidal Flow

Option 3 takes a more aggressive approach for achieving the project objectives by removing the existing tidegate and outfall pipe and replacing it with an open channel and a new "muted tidal regulated" tidegate system. Sheet 4 in Appendix 1 shows a conceptual design of this option. This option includes the following basic features:

- An approximately 120-foot long open channel starting on the beach near the end of the existing boat ramp and extending to the edge of the parking lot. The channel's sides would be armored with riprap to protect the boat ramp and to reduce sediment entrainment from shoreline drift. The cross section area of the channel would be sized to concentrate the flow of water, so that the shear force of flowing water would help sweep entrained sediment out to Holmes Harbor.
- A 20' long x 10' wide x 8' deep concrete box culvert beneath the parking lot, which houses a muted tidal regulated (MTR) tidegate. This tidegate design has a float mechanism that closes it at a predetermined tidal height, so that it will allow a portion of the daily tidal prism to flow into the lagoon, but then close when the water level in the lagoon reaches the desired level. For example, the tidegate could be set to close when the water surface in the lagoon reaches the existing "ordinary high water" level of about 7.0' NAVD88[13]. This level is 2.4 feet below the MHHW level, so the tidal prism would substantially "muted," compared to the natural tide range. The top of the box culvert would be covered with a heavy grating to allow vehicles to drive over it and concrete barriers would be placed to separate the channel from parking areas.
- About 280 lineal feet of open channel from the tidegate back to the existing lagoon outlet. The sides of this channel would not be armored, but would have the appearance of a natural, meandering marsh channel. The existing tidegate vault would be removed, but the concrete headwalls and dike would remain in place.
- Planting of native salt marsh vegetation in the marsh and a hedge of Nootka rose or other dense shrub along the channel banks.
- A simple flap gate would be installed on the outlet of the culvert in the road side ditch at the adjoining property to the south, so that salt water will not back up into the ditch. The ditch water would drain as usual when the water level in the lagoon falls on each ebb tide.

[13] At the OHW level of 7.0', the lagoon is about 3.6' deep at its deepest point.

4.4 Option 4: Full Restoration of Tidal Flow

Option 4 allows for a full restoration of tidal flow between Holmes Harbor and the lagoon/salt marsh on the GBBC property as well as the large wetland west of North Bluff Road. Sheet 5 in Appendix 1 shows a conceptual design of this option. This design option includes the following basic features:

- About 500 lineal feet of meandering channel running from the lagoon, through the beach crest, to the beach about 50 feet south of the boat ramp. The channel alignment follows the lowest-lying points of the existing ground surface, which corresponds roughly with the alignment of a historical tidal channel depicted in the 1888 USCGS chart. The channel would be wider than the one proposed in Option 3, reflecting the typical width of natural marsh channels found at reference sites in Island and San Juan counties. The channel seaward of the beach crest would be armored with rock to prevent it from migrating towards the boat ramp; landward of the beach crest the channel design would match natural reference conditions.
- The existing outfall pipe, tidegate vault and concrete headwalls would be removed. The existing soil berm and the soil and cobble dike would be removed. The footprints of the berm and the dike would be planted with native marsh vegetation.
- A new dike would be constructed along the south property boundary to prevent tidal water from impacting properties to the south. This dike would be constructed to approximate elevation 12.0' NAVD88.[14] This elevation is equivalent to the "extreme high water" level prediction used by US Army Corps of Engineers planning. By comparison, WICD's preliminary survey measured the lowest point in the existing cobble dike at about 11.8' NAVD88, and the lowest point in the existing beach crest at about 10.3'. At the MHHW elevation of roughly 9.4', there would be 2.6 feet of freeboard between the water surface and dike top. The new dike would connect to the shoulder of North Bluff Road at the south west corner of the property, where the edge of pavement is at elevation 11.0'. The dike would then curve north, parallel to the road, so as to raise the road shoulder to elevation 12.0'. A new culvert and flap gate would be run under the dike, along the existing ditch line, to allow the road ditch to drain out on ebb tides.
- Additional soil fill would be placed on the parking lot and the last 300 or so lineal feet of the driveway to raise their grade to 12.0' NAVD88 as well. Not only would this keep the parking lot and driveway from flooding at high tides, but it also would serve as a dike to protect the adjacent, low-lying private property to the north of GBBC's property.

It is assumed that the tidal prism would be allowed to flow freely into Greenbank Marsh once the water surface in the lagoon rose above the invert elevation of the county's culvert (about 5.7' NAVD88). At the MHHW level, the water depth in the deepest point in the marsh would be about 3.7 feet deep. If subsequent detailed design studies were to show that this would create drainage problems or otherwise impact property, a tidegate could be installed on the county's culvert to block tidal flow into the marsh.

[14] This dike elevation could be increased to provide additional flood protection, but flooding of North Bluff Road to the south of the project site would occur regardless by tidal flow over the natural beach crest .

4.5 Option 5: Divestment to Island County

Option 5 involves negotiating an agreement between GBBC and Island County government by which the county would either share or assume sole responsibility for maintenance and improvement of the drainage system at the GBBC property. The county reportedly paid half the cost of installing the existing tidegate in 1998, and Mr. Phil Cohen stated that the Department of Public Works would consider similar cost-sharing arrangements in the future.[15] If GBBC wished to completely divest itself of responsibility for maintaining the drainage system, Mr. Cohen speculated that the county might be in a position to take on this responsibility, on condition that it could exercise control over public access to the site and carry-out natural habitat restoration activities, such as increasing tidal connection with the lagoon.[16]

5 Evaluation of Options

WICD evaluated each of the options using four basic screening criteria so that the relative advantages and disadvantages of each could be compared on a consistent basis. Each criterion is crucial to consider when deciding on a course of action for meeting GBBC's drainage and habitat improvement goals.

- effectiveness in meeting the specific objectives
- community acceptance
- regulatory permitting needs
- overall project cost

A summary of the evaluation is presented below.

5.1 Effectiveness in Meeting the Specific Objectives

As described in Section 3, the specific technical objectives for addressing GBBC's goals at the site are:

1. Maintain or improve the capacity to route stormwater runoff from the lagoon to Holmes Harbor, compared with current conditions. Do not impair drainage or otherwise cause impacts on adjacent properties or the county road right of way.
2. Reduce or eliminate the effort and cost required for maintaining drainage capacity, compared with current conditions.
3. Maintain safe and convenient motor vehicle access for boat launching and parking at the existing or better level of service. Maintain safe and convenient walking access to the beach at the existing level or better.
4. Maintain or improve the ecological function and value of the on-site lagoon and salt marsh, as well as the large freshwater wetland located west of North Bluff Road, compared with the existing condition.

A discussion of how well each option meets these objectives follows.

[15] Personal communication with Phil Cohen, November 18, 2013.
[16] Ibid.

Option 1

Option 1 would be expected to somewhat improve the conveyance capacity of the existing outfall pipe, compared with the existing condition, but the drainage capacity would still be severely constrained by the existing Tideflex tidegate. This option would not be expected to have any negative impacts on adjacent properties or on GBBC's existing level of recreational use of the site. The maintenance needs would be lower compared to the existing condition, although gravel would still have to be shoveled out of the outlet structure on a regular basis. It would not be expected to have a significant positive or negative effect on the ecological function of the lagoon or marsh.

Option 2

Option 2 would greatly improve the drainage capacity at the lagoon outlet, but flow through the outfall pipe would still be constrained by gravel obstructing the pipe outlet. Combining Option 1 with Option 2 would have a much greater effect on drainage capacity, since they would remove the obstructions of both the non-functioning duck bill tidegate and the gravel blockage at the pipe outlet. WICD estimates that if these two obstructions can be removed, the existing drainage system would be able to handle typical peak runoff flows from the entire catchment area[17]

Option 2 would have a positive impact on maintaining/improving ecological function in the lagoon and salt marsh if the small aperture is included in the tidegate mounting plate to allow for a small backflow of tidal water into the lagoon. If the aperture were not included, then Option 2 would negatively impact the lagoon ecology, because the current leakage of salt water through the corroded mounting plate would be eliminated. Maintenance costs for Option 2 would be equivalent to the cost of maintaining the current tidegate. Option 2 would not impact use of the boat ramp or parking lot.

Option 3

Option 3 would greatly increase the site's capacity to drain stormwater from the surrounding watershed. When the tide falls below the water level in the lagoon, the new MTR tidegate would open wide and allow standing water in the lagoon and marsh to drain out quickly. The channel would be designed to be self-cleaning, with the ebb of the tide from the lagoon sweeping out accumulated sediment, so ideally the channel would be maintenance free. The tidegate closure setting would be designed so as not to cause impacts to the surrounding properties or public roads. The tidegate would require occasional maintenance, equivalent to the maintenance costs for the existing tidegate.

Vehicle access to the boat ramp would be maintained, but the new channel would take up a portion of the parking lot. The channel would obstruct foot access along the upper beach, but this could be mitigated by including stepping stones or a similar method for helping people cross the channel. Ecological function of the lagoon, salt marsh, and fresh water marsh across North Bluff Road would be substantially improved by greatly increasing the degree of salt water exchange, compared with the existing condition. The MTR tidegate would also allow for limited fish passage into the lagoon and marsh, which would support Island County's salmon recovery goals.

[17] Refer to the discussion in Section 2.3.

Option 4

Option 4 would be expected to have both greater disadvantages and greater advantages compared with Option 3. The drainage capacity of the outlet channel would be able to handle any anticipated runoff from the watershed, and would be naturally self-maintaining. Special consideration would be needed to assure that the elevated water level in the lagoon at high tide did not impact septic systems at adjacent properties. Foot access would be more difficult where the channel crosses the beach, and a larger portion of the parking lot would be lost to the new channel. Raising the parking lot to the level of the extreme high water tide prediction level would keep it from being flooded at high tides. This option would have the highest benefits for improving ecological functions and values in the lagoon, salt marsh and freshwater marsh. With unrestricted tidal exchange, these features would likely quickly evolve into highly productive natural habitat for Juvenile salmon and other marine animals.

Option 5

The potential effectiveness of Option 5 depends on the detailed arrangements that would be the outcome of negotiations between GBBC and Island County.

5.2 Community Acceptance

Over the years WICD has worked with many community groups on conservation projects involving drainage, habitat restoration, and other natural resource management issues on Whidbey Island. Although each member of the community has his or her own individual opinions and preferences, we have found some common trends among Whidbey Islanders' reactions to conservation projects in shoreline areas. People commonly favor the general idea of improving the ecological function and values of lagoons, marshes and other nearshore habitats, provided that it does not substantially affect their customary use of the site or have a negative impact on their own private property. When planning work such as at the GBBC property, it is essential to actively solicit input from all stakeholders and to include their opinions in the decision making process.

Options 1 and 2

Options 1 and 2 have negligible impact on GBBC members' use of the site and would not be expected to have a negative impact on other private property. The outfall diversion structure would detract somewhat from the current view of the beach. The improved drainage situation would actually benefit adjacent private properties. Weighing the pros and the cons, it is likely that Options 1 and 2 would have fairly positive community acceptance.

Option 3

It is likely that many people would object to the channel across the beach and the loss of a few parking spaces that would result from Option 3. These objections could be mitigated somewhat by building some manner of a crossing structure across the channel and by expanding the parking lot to compensate for the area lost to the new channel. While the substantially improved drainage capacity would generally benefit other private properties, neighbors would object if the water level in the lagoon at high tides were to impact their septic drain fields. The potential impacts would need to be evaluated and addressed in the detailed project design. Weighing the pros and the cons, it is likely that Option 3 would have a moderately negative community acceptance, at least initially.

Option 4

Option 4 would substantially change the way GBBC members used the beach and parking area, and these impacts would need to be compensated for in the project design. Likewise, potential impacts on nearby drain fields caused by the daily tidal flow into the lagoon and Greenbank Marsh (if any) would need to be mitigated in the project design. While many community members would approve of the substantial ecological benefit of restoring tidal exchange to Greenbank Marsh, it is likely that the more typical community reactions to such drastic changes would range from wary to strongly negative.

Option 5

No attempt is made to gauge the community acceptance of divesting maintenance of the drainage system to Island County government because it will likely depend on whatever conditions are agreed to between GBBC and the county.

5.3 Regulatory Permitting Needs

The primary regulatory permitting requirements that affect the implementation of the various project options are the shoreline and wetland protection requirements under Section 404 of the federal Clean Water Act and development restrictions under Washington's Shoreline Management Act (SMA) and Growth Management Act (GMA). Other permitting requirements, such as the Washington Department of Fish and Wildlife's "Hydraulic Project Approval" and Washington State SEPA review, are relatively straight-forward.

Options 1 and 2

The work proposed in Options 1 and 2 is consistent with the SMA and GMA, involving primarily the replacement or upgrade of existing structures. Building the outfall diversion structure will require an "individual" Section 404 permit from the U.S. Army Corps of Engineers, which will likely entail independent review by the Washington Department of Ecology under its Section 401 water quality certification authority. In view of this, the permitting requirements for Option 2 can be considered to be "low," while the requirements for Option 1 can be considered to be "moderate."

Option 3

The work proposed in Option 3 would be considered to be a "substantial shoreline development" under the SMA and would require extensive review and public comment by Island County. The construction of the new channel will require extensive review by the county under the "critical areas ordinance" provisions of the GMA. Because much of the intent of Option 3 is to improve the ecological function of the lagoon, the project may qualify for a programmatic "nationwide" Section 404 permit,[18] which involves reduced permitting requirements compared to the "individual" permit that would likely be required for Option 1. Overall, the permitting requirements for Option 3 can be considered to be "moderate to high."

Option 4

Construction the channel and dikes in Option 4 will require extensive shorelines and critical areas review by Island County. Even though the work will restore aquatic habitat, the scale of the project might make

[18] U.S. Army Corps of Engineers Nationwide Permit No. 27 for aquatic habitat restoration or enhancement.

it ineligible for a Nationwide Permit 27, so an individual U.S. Army Corps of Engineers Section 404 may be required. Overall, the permitting requirements for Option 4 will likely be "high."

Option 5
No permitting will be required for Option 5.

5.4 Overall Project Cost

WICD developed preliminary, conceptual level costs for designing, permitting and constructing each of the options. The costs are summarized in the following table.

Conceptual Level Project Cost Summary

Option	Design and Project Management	Permitting	Construction	Total Project Cost
1. Outfall Deflector	$11,000	$10,000	$7,000	$28,000
2. Replace Tidegate	$9,000	$5,000	$23,000	$37,000
1. and 2. combined	$13,000	$10,000	$30,000	$53,000
3. Partial Tidal Restoration	$100,000	$15,000	$311,000	$426,000
4. Full Tidal Restoration	$170,000	$25,000	$328,000	$523,000
5. Divestment to Island County	TBD[19]	TBD	TBD	TBD

Project management, engineering and permitting constitute a large part of the overall project cost of Options 1 and 2. For this cost estimate, WICD assumed a rate of $100/hour, which corresponds to a typical average hourly fee for local private consulting firms. This cost could be reduced if the work were done by public agency staff, such as staff of WICD. WICD based its construction cost estimates on cost estimates and construction bids for similar projects that it has designed in the past. The estimates include a 15 percent "contingency" to account for unanticipated issues that may arise.

Because of its high benefit for supporting Island County's ESA-listed salmon recovery goals, it is likely that State of Washington grant funding would be awarded for construction of Option 4. To a lesser degree, Option 3 would also benefit the county's salmon recovery goals, and may also be eligible for at least partial grant funding from the state.

[19] To be determined. The specific costs and outcomes depend on whatever arrangement can be reached between GBBC and Island County.

5.5 Summary

A summary of the evaluation is presented in the following table.

Evaluation Summary

Option	Effectiveness	Community Acceptance	Permitting Requirements	Project Cost
1. Outfall Deflector	Low	Positive	Moderate	$28,000
2. Replace Tidegate	Low-moderate	Positive	Low	$37,000
Combined 1 and 2	Moderate	Positive	Moderate	$53,000
3. Partial Tidal Restoration	Moderate-high	Moderate-negative	Moderate-high	$426,000
4. Full Tidal Restoration	High	Negative	High	$523,000
5. Divestment to Island County	TBD	TBD	TBD	TBD

6 Preferred Alternative

WICD has not attempted to identify a preferred alternative at this point. We would be happy to work with GBBC officers and Island County government officials to evaluate the various options in more detail, or to formulate different options that may be more effective in addressing GBBC's general interests at the project site.

7 Disclaimers

The evaluations and conclusions in this report are based on WICD's preliminary field observations, review of available public information sources, and our experience with designing, permitting and constructing similar projects on Whidbey Island. It is our experience that planning and construction of hydraulic projects in shoreline areas is technically complex and controversial. Many factors can have large influence on the decision making and cost, including geotechnical and soil conditions, shoreline hydraulics, groundwater and water table conditions, unforeseen buried utility lines, property title and easements, community acceptance, and other issues. WICD has not evaluated any of these issues in detail at this point, and does not make any representations as to how they may or may not affect GBBC's choice of which option(s) to pursue, or the final design of the selected option.

All photographs used in this report are ©Tom Slocum unless noted otherwise. Please reference when using them.

APPENDIX ONE

CONCEPTUAL DESIGN DRAWINGS

THOMAS M. SLOCUM
STATE OF WASHINGTON
34003
REGISTERED PROFESSIONAL ENGINEER

Revisions

Greenbank Beach & Boat Club Drainage Evaluation Existing Site Plan

Prepared for:

Greenbank Beach & Boat Club, Inc.
PO Box 75
Greenbank, WA 98253

Prepared by:

WHIDBEY ISLAND CONSERVATION DISTRICT

PO Box 490
Coupeville, WA 98239
(360) 678-4708

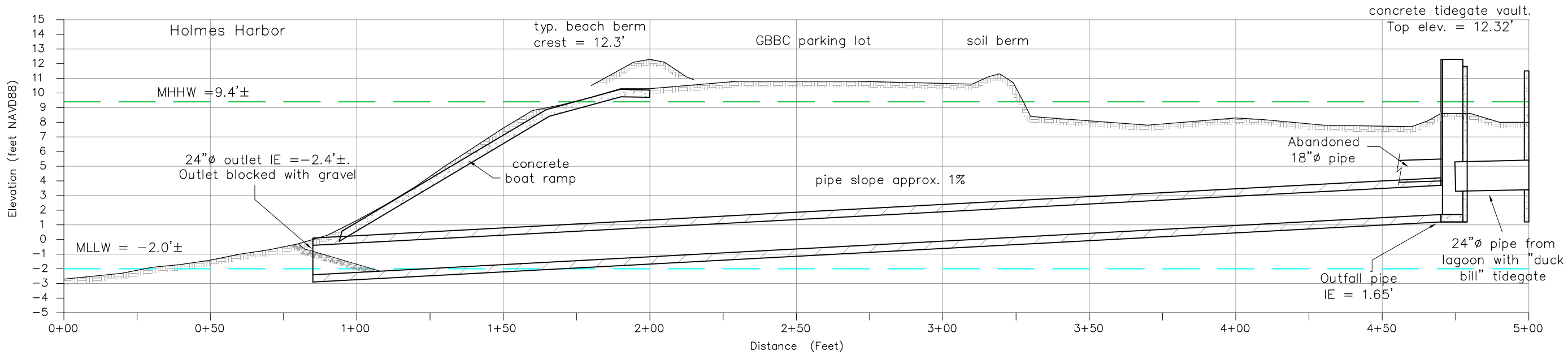
Date: 11-22-13

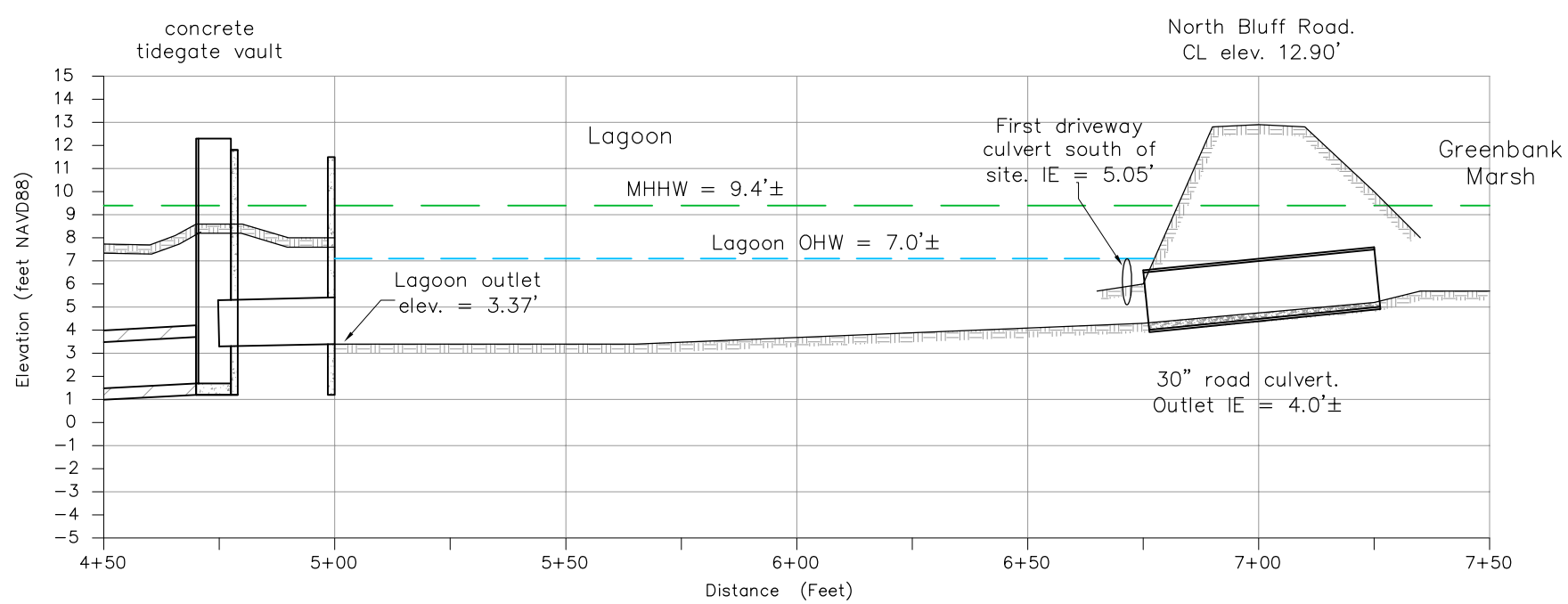
Scale: 1" = 60'

Sheet # 1 of 5

Preliminary Design
Not For Construction

Section A–A1: MLLW to the Tidegate – Scale 1'V = 5'H





Section A–A1: Tidegate to the Greenbank Marsh – Scale 1'V = 5'H

Revisions

Greenbank Beach & Boat Club
Drainage Evaluation
Existing Site Profile A–A1

Prepared for:

Greenbank Beach &
Boat Club, Inc.
PO Box 75
Greenbank, WA 98253

Prepared by:

WHIDBEY ISLAND CONSERVATION DISTRICT
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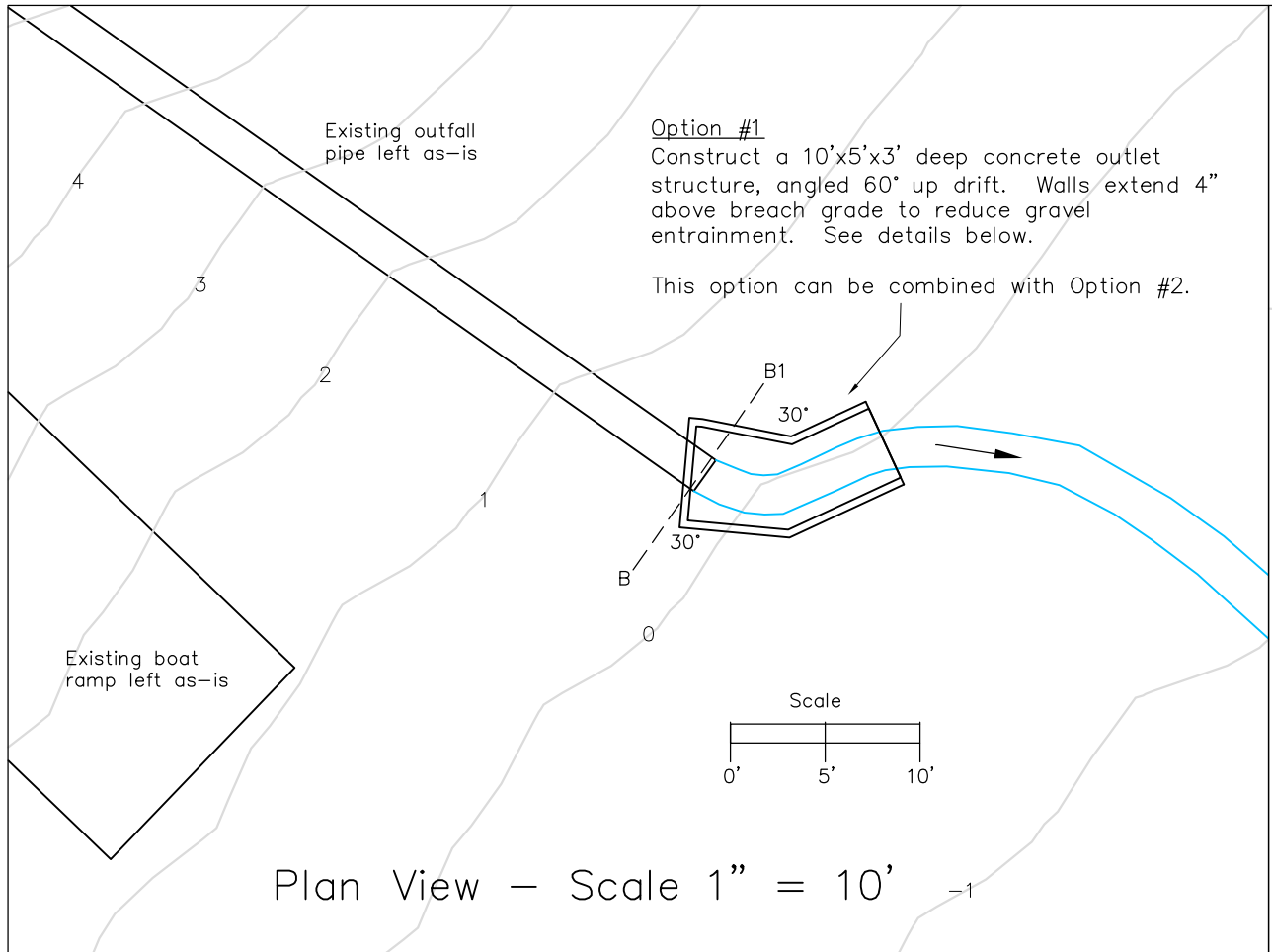
Coupeville, WA 98239
(360) 678–4708

Date: 11–22–13

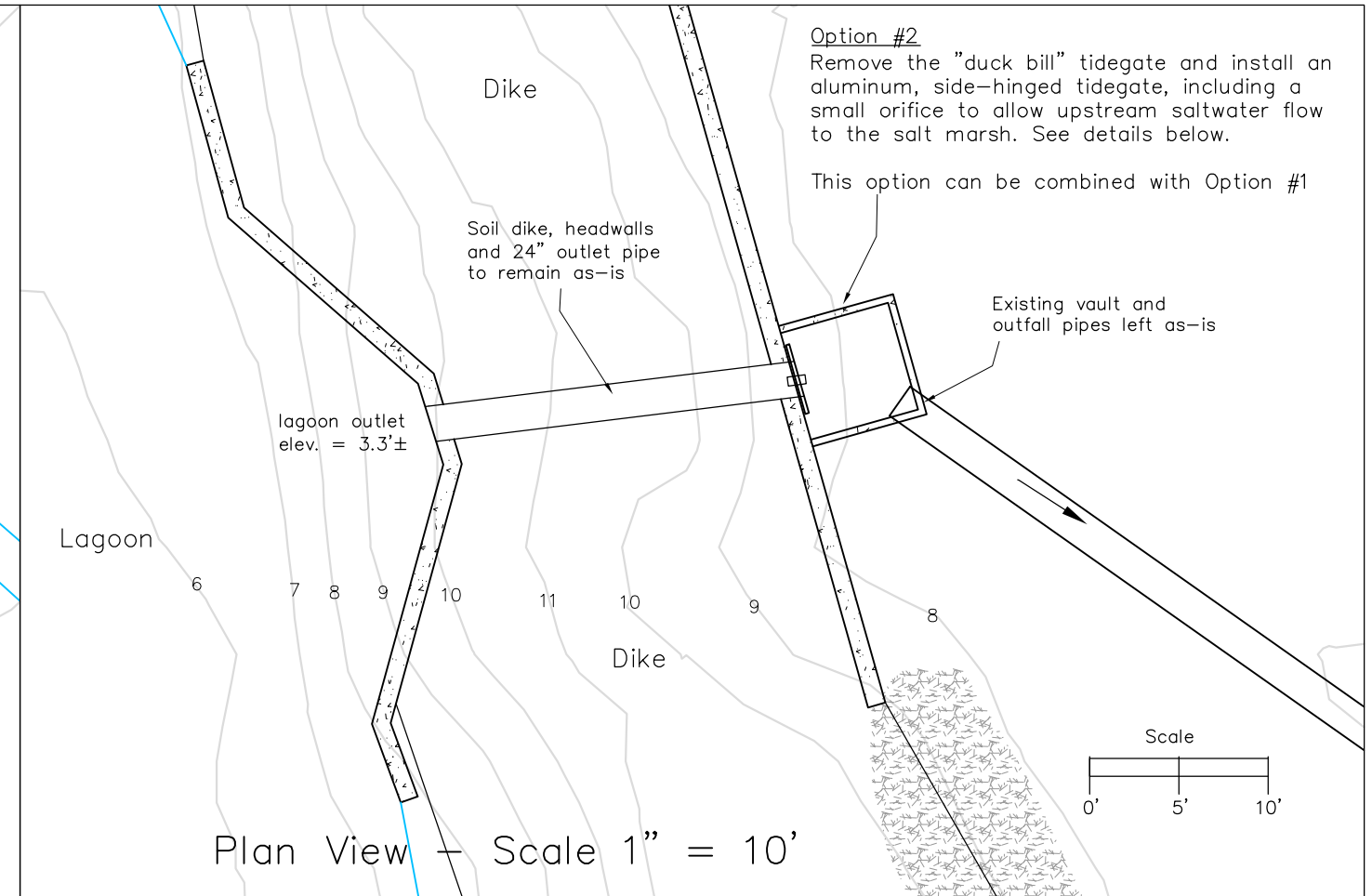
Scale: as noted

Sheet # 2 of 5

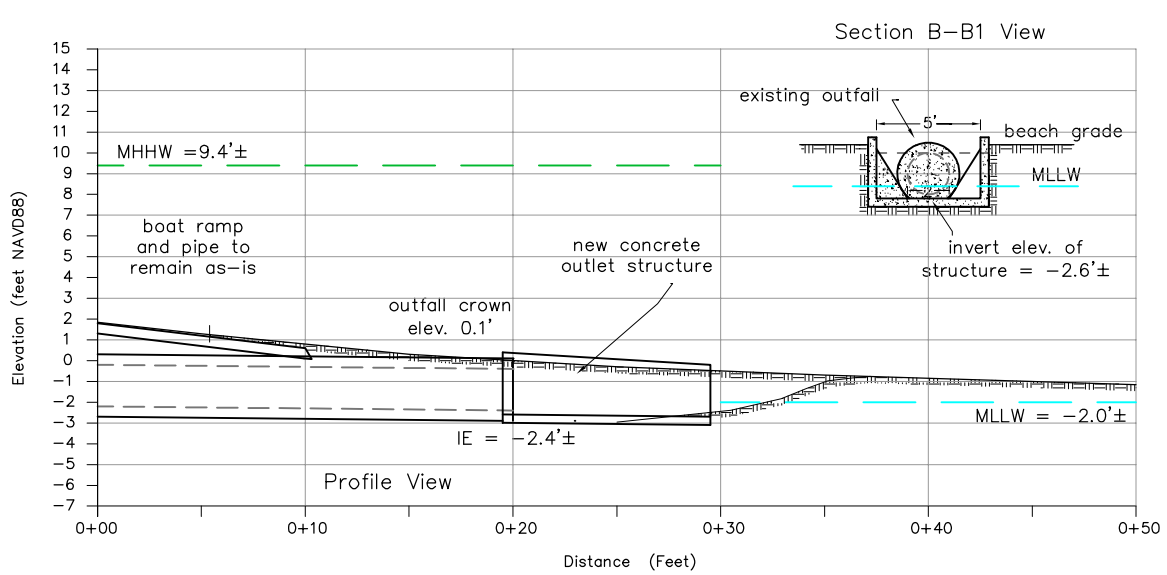
Option 1: New Outlet Structure



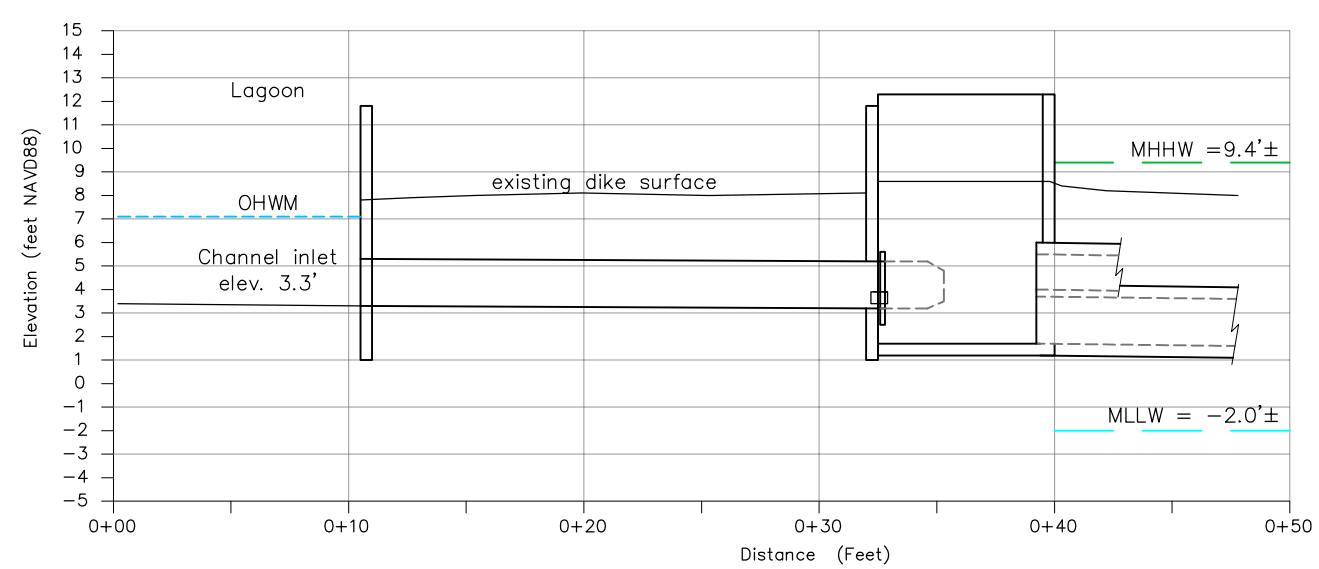
Option 2: New Side–Hinged Tide Gate



Section and Profile Views of New Outlet Structure



Profile Views of New Side–Hinged Tidegate



THOMAS M. SLOCUM
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Revisions

Greenbank Beach & Boat Club Drainage Evaluation Options 1 & 2 Conceptual Designs

Prepared for:

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Date: 11–22–13

Scale: 1" = 10'

Sheet # 3 of 5

Revisions

Greenbank Beach & Boat Club Drainage Evaluation Option 3 Conceptual Site Plan

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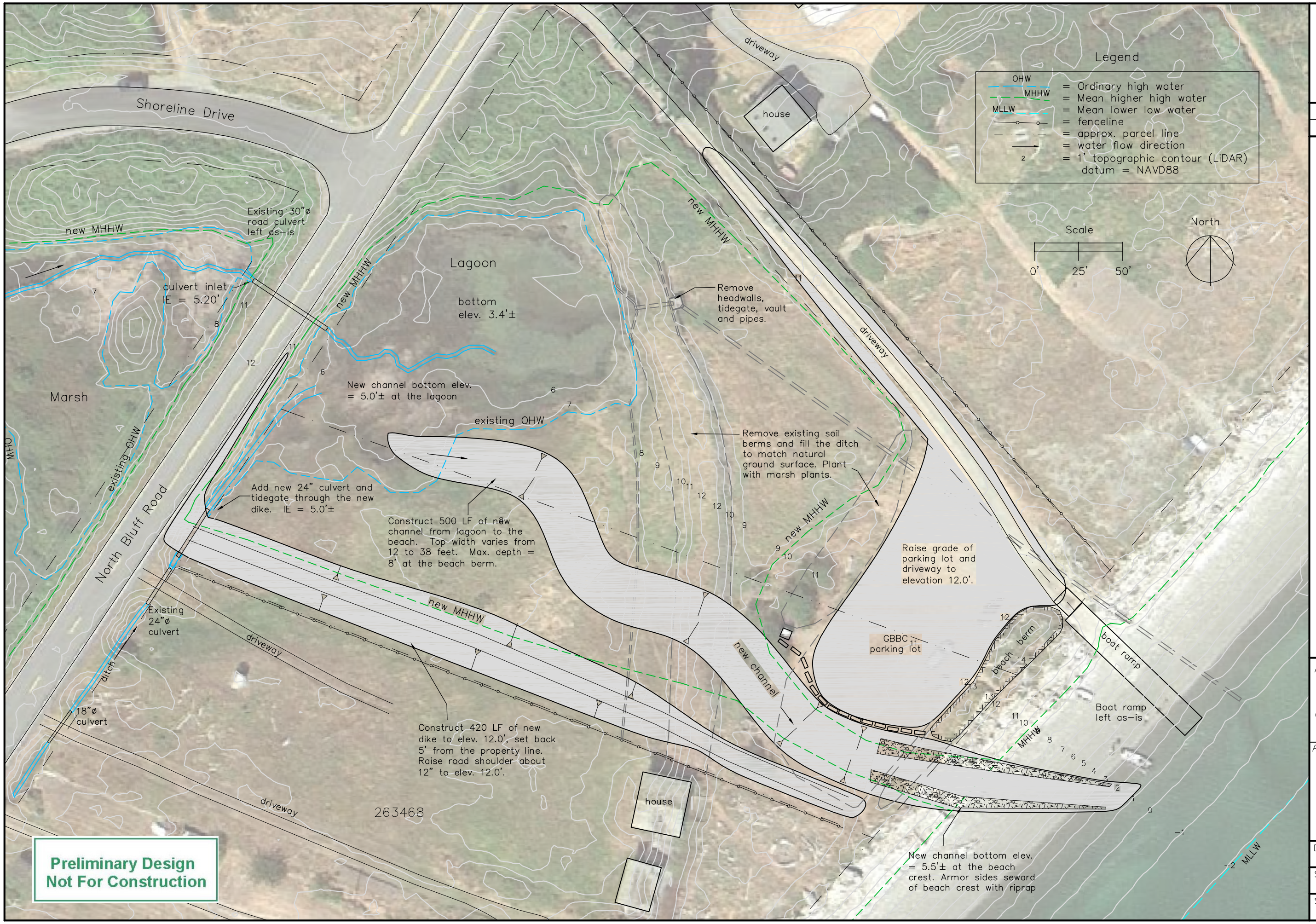
Date: 11-22-13

Scale: 1" = 30'

Sheet # 4 of 5



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Revisions

Greenbank Beach & Boat Club Drainage Evaluation Option 4 Conceptual Site Plan

Prepared for:

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Scale: 1" = 50'

Sheet # 5 of 5