Hoonah Berthing Facility
Site Alternative Analysis Report

Prepared for:

City of Hoonah
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P N D

Project Description and Purpose

The Hoonah Berthing Facility project involves the construction of multi-use facility near Cannery Point north of Hoonah. The project is being funded by a grant from the State of Alaska.

As described in a letter from State Representative Bill Thomas to Mr. Scott Ruby, Director of the Division of Community and Regional Affairs:

> "The primary purpose of this grant is to fund the construction of a dock near Cannery Point which will be able to accommodate large cruise ships."

The letter also stated that:

> "The secondary purpose of the grant is to fund a design that will be able to accommodate year round ancillary uses such as barges, large yachts, the Alaska Marine Highways, and the US Coast Guard vessels. Maximizing the usage of this dock is important. When cruise ships are not using the dock, there is a perfect opportunity to explore other benefits that it might bring to the City of Hoonah."

Site Alternatives Analysis

In early August, 2011, the City of Hoonah retained PND Engineers Inc. (PND) to investigate three sites for the Hoonah Berthing Facility: One site northwest of Cannery Point, one adjacent to the Cannery and a third site near Shaman or Hoonah Point.

User Criteria

An initial meeting was held on August 23, 2011 at the City of Hoonah City Hall to discuss the site analysis. The meeting was attended by Ms. Marlene Duvall, City Administrator, Mr. Arlen Skaflestad, Harbormaster, Mr. Fred Knowles, project manager, and PND engineers Dick Somerville, P.E. and Chris Gianotti, P.E. The purpose of the meeting was to identify potential users of the proposed facility, to discuss known user criteria and to identify users and others that can provide additional input regarding user criteria.

Identified users of the facility include:

- Large cruise ships and their passengers
- Freight barge lines
- Light freight transfer operations
- Fishing industry
- Small tour ship and charter boat operations
- Alaska Marine Highway System
- US Coast Guard vessels

The following paragraphs summarize the use criteria for the above users.

Large Cruise Ship Vessels

Currently large cruise ship vessels are over 900 feet long. In the near future Celebrity Cruise Lines has indicated that they plan to have "Solstice" class ships in the Alaskan market. Some characteristics of a "Solstice" class ship include:

- 1,040 foot long
- 121 foot beam
- 3,136 maximum number of passengers
- 28 feet design draft
- 61,530 metric ton displacement
- 4,400 maximum persons on board

The Hoonah Berthing facility will need to have adequate water depth to allow for ship maneuvering, adequate energy absorption capacity in its fenders to accommodate the ship as the ship approaches and breasts against the dock, adequate mooring bollards to secure the ship, and structures that allow for adequate transfer of passengers.

The dock needs adequate routes of approach and departure and adequate draft. For an extreme minus tide of 5 feet below mean lower low water (MLLW), there should be water depths to accommodate the ship's draft and a clearance of 10 feet. The ships typically draft 30 feet so a mudline elevation of deeper than -45 feet MLLW is desired. In Hoonah the seafloor and surrounding land is rising approximately ½ inches per year it is prudent to set the pierhead line where the mudline is deeper than -50 feet MLLW to accommodate for future seafloor rising.

Discrete mooring and breasting dolphins are an economic method of providing structures for breasting and mooring. Mooring bollards should have the capacity to resist a 250,000 pound line load. Fenders need to accommodate 300,000 foot pounds of energy. A breasting dolphin should have an integral mooring bollard so that it can be used for securing ship's lines as well as to breast against. The discrete dolphins should be linked with catwalks to allow for easy access by longshoremen to efficiently secure the ship and quickly release moorage lines when disembarking.

Currently cruise lines prefer floating berths with deck heights that match the port doors. Port doors for the Solstice class ships are approximately 10 feet above the waterline. Typically the cruise ships want separate gangway access for passenger boarding and passenger disembarkation separated by several hundred feet. The floating berth is also used to transfer light freight, equipment, parts and supplies on and off the ships while they are in port. Cruise ships will likely not require the transfer of significant quantities of freight, equipment, parts, supplies or baggage while in Hoonah but there is often a need to have some small quantities. Using a floating berth allows easy transfer by using vehicles to deliver next to the ship and using hand carts to move onto or off of the ship.

A floating berth with a deck height close to the port level doors on the ship allows for near level gangways so that disabled passengers can easily leave and enter the ship. The float should be wide enough for vans or small buses to load disabled passengers and take them ashore. The floating berth needs to be wide enough to allow such small passenger and light freight vehicles to maneuver and turn around on the berth.

The floating berth will need to have floating camel fenders along the breasting pierhead. These are typically 6 to 8 feet in diameter. The floating berth should also have some mooring bollards building integral with it so that other users can tie up to the float (see other user criteria).

A transfer bridge is needed for connecting the floating berth to the shore. The bridge should be have capacity to handle service vans and possibly highway truck loads. It need not be a transfer bridge capable of supporting heavy forklifts as cargo transfer is not envisioned. The transfer bridge can also be used by passengers capable of walking. A covered portion of the transfer bridge can aid in keeping passengers dry as they transit. The transfer bridge should be long enough to result in reasonable grades from an elevation on shore above the highest water level (tide and storm surge wave) to the floating berth. A 140-foot long bridge should be used.

It should be noted that cruise-ship passengers should be within a short walk to their destination or vehicle shuttle service should be provided. A short walk is generally defines as a 5 minute walk of a distance about ¼ mile.

Freight Barge Lines

Currently Alaska Marine Lines (AML) serves Hoonah with weekly barge service in months from March to November. They currently use a ramp barge at gravel ramp near the Hoonah Warehouse near the Alaska Marine Highway System (AMHS) terminal on Gartina Highway. In other months of the year AML places containers on the AMHS ferries and do not ship by barge. They currently store shipping containers on chassis in a lot across the Gartina Highway from the barge landing. They have room to store approximately 6 containers at that site. AML uses a 276 foot long barge with a 76 foot beam and bow ramp.

Other companies and organizations transport construction equipment, materials and supplies to Hoonah using barges as needed. They currently use the other ramps available in the area. Other ramps include the gravel ramp near the Hoonah Warehouse, the boat launch ramp in the Hoonah Boar harbor and the gravel ramp at Long island. Gravel ramps need a significant amount of maintenance. The boat launch ramp in the harbor is difficult to get to and is usable only at higher tides. The ramp at Long Island is far from town.

AML can use a concrete ramp but the width of the ramp needs to be adequate so that the bow drop ramp, when lowered, is all supported on the concrete ramp. Guide piles or dolphins are needed for the barge to breast against. The barge draft is approximately 10 feet so the end of the ramp should be at -15 feet MLLW.

AML has indicated that a concrete ramp could be used with their ramp barge but in the long term they would prefer to load and unload barges over the side of the barge. AML keeps a fork lift on their barges and can transfer freight to and from a truck chassis. AML would like a facility that allows them to drive a truck chassis onto the barge.

AML's barges have a free-board of around 12 feet when loaded with a typical load when serving Hoonah. They could transfer freight using ramps from the AML Barge onto a floating berth if the ramp aligns with the transfer bridge serving the berth or have a separate transfer bridge to access their barge. If such a facility existed in Hoonah, they would likely use larger barges (up to 320 feet long by 90 feet wide) that serve Hawk Inlet on a weekly basis and no longer bring ramp barges into Hoonah.

Light Freight Transfer Operations

Another freight transfer company that serves Hoonah is Sea Level Transport, LLC that operates the motor vessel *Lite Weight*. The MV *Lite Weight* is a 45 foot long landing craft with a 17 foot beam. It has a cargo capacity of 130,000 pounds. Freight can be transferred on and off the vessel using the bow ramp with or without the use of the 6,000 pound capacity deck crane and a fork lift with telescoping boom.

The owner and operator of the MV *Lite Weight* indicates that he would like to have a concrete ramp to load and unload. A 15 to 17 percent grade works well with his vessel. A boarding float is preferred over simply a line of guide piles or dolphins as sometimes his freight overhangs the side of his vessel.

The MV *Poundstone* also serves Hoonah on a regular and seasonal basis. This is also a landing craft type vessel with a bow ramp.

Fishing Industry

The fishing industry has a need for additional facilities in Hoonah. These include:

- Floating berths accessed by transfer bridges where vessels can be easily loaded and unloaded. Crabbers would like better facilities to load and unload pots. They transport these by truck or truck with trailer. Sometimes fishing boats could transfer loads using their on board cranes but many would prefer a 10 ton knuckle-boom crane reaching up to 25 feet from the pierhead.
- A place where nets can be stretched out and worked on.
- Hydraulic cranes are needed to load and unload equipment and supplies.

The cruise ship floating berth can be used for fishing vessels where they could moor and transfer gear. Additional mooring bollards are likely needed for the relatively shorter fishing vessels. With 6 to 8 foot camel fenders along the face of the floating berth, some ramps or gangways may be needed for crew access. Small cranes near the pierhead may be desired to assist in loading or unloading gear. The float space could be an area where net work can occur.

Smaller Tourship or Charter Operations

Smaller tourship and charter fishing operators want to be close to large cruise-ship berths so that passengers can easily reach their vessels for day excursions. These are vessels smaller than 80 feet long with 20 to 30 foot beam. The catamaran tourships draft less than 5 feet. Charter fishing boats can have drafts up to 10 feet.

Currently Allen Marine operates whale-watching tours from the lightering float at Icy Strait Point. They have indicated that they would continue to do so unless there is another float with a 2 foot to 4 foot freeboard near the cruise ship berth.

Allen Marine has provided service to Hoonah in for AMHS when the vessels are out of commission or the ferry terminal marine facilities are under construction. In such cases Allen Marine indicates that they need an all-tide access float with a minimum width of about 8 feet and a freeboard between 2 and 4 feet. They need cleats to secure the vessels and a minimum water depth of about 10 feet or a mudline no shallower than -15 feet MLLW.

Criteria for fishing charter boats are similar although their vessel length is typically less than the Allen Marine tour boats. Fishing charter boats typically are limited to a crew and passenger count of 6 people although larger vessels can have up to 14 passengers.

Using the cruise ship floating berth for smaller tour boats and charter fishing is not ideal. A smaller float with a lower freeboard secured to the back side of the cruise ship floating berth would serve these users well. The smaller float should have 2 to 4 foot freeboard and be accessed from the higher float using small gangways.

Alaska Marine Highway System

The AMHS vessels range in length from the MV *Leconte's* 235 foot length to the MV *Columbia's* length of 418. Ship draft varies from 8.5 feet to 17.5 feet. The vehicle deck height on the AMHS vessels vary from the MV *Leconte's* 6 feet above waterline to 10 feet above waterline for the MV *Fairweather*.

Fendering, mooring bollards and pierhead depth for a cruise ship berth should be adequate for mooring AMHS Vessels. Additional mooring bollards along the floating berth may be needed to ensure that shorter vessels have adequate points to secure mooring lines. Transferring passengers from the vessels to a cruise ship floating berth with a freeboard of 6 to 8 feet likely can be accommodated with special ramps. The camel fenders on the face of the floating berth should aid in transferring as the ramps have additional length to accommodate a difference in elevation and not be too steep.

AMHS parks or lay-ups 3 or more vessels every winter due to a lower demand for service. Using a berth in Hoonah for a lay-up berth is possible if all the criteria that AMHS requires is met. Lay up berth criteria includes: power supply, water and sewer service (water shipped by tanker trucks and septic pumper/tanker trucks has been used), all hour crew access, security, adequate breasting and moorage structures and a fairly sheltered site. A lay-up berth is often near a ship yard if the ships are scheduled for major maintenance and renovation. The Hoonah Berthing Facility could likely be used as a lay-up berth should AMHS be interested.

US Coast Guard Vessels

The US Coast Guard currently operates 110 foot class and 225 foot long Juniper class ships in Southeast Alaska and plan to utilize the new 418 foot National Security Cutters in Alaska. The National Security Cutters have beams of 54 feet, drafts of 22.5 feet and full loaded displacement of 4,500 long tons. The Juniper Class ships have a beam of 46 feet, drafts of 13 feet and a displacement of 2000 long-tons.

Fendering and pierhead depth for a cruise ship berth should be adequate for mooring US Coast Guard vessels. Additional mooring bollards are needed along the floating berth to ensure that the shorter ship lines can be secured adequately. Crew should be able to be transferred with gangways which the Coat Guard use at other docks in Southeast Alaska.

Concept Designs and Cost Estimates

Concept plans and cost estimates for the Hoonah Berthing Facility were developed at three sites: Site 1 North of Cannery Point, Site 2 adjacent to and west of the Cannery, and Site 3 north of Shaman or Hoonah Point. At all these sites the primary criteria is to develop concepts for a cruise ship facility and then to develop additional facilities for that can be used for freight transfer and fisheries support. As noted above the cruise ship pier can also be used for AMHS and US Coast Guard vessels. In the future smaller floats could be added to the large float for small tour ships and charter fishing operations if there is enough demand for them.

The concept for freight transfer that is common to most users is a concrete barge ramp that is an all tide facility. It is to extend from -15 feet to +25 feet, sloped at a 15% grade. The ramp should be 60 feet wide and have guide piles or dolphins to breast against. If the wave environment allows an access float could be added along the guide piles.

In developing the concept designs a wind, wave and current analysis was performed. This study was necessary to determine the anticipated ocean climate at the sites. The complete report from that study is included in Appendix A of this report. The wave climate can influence what is practical at each site. While the facility needs to survive in a 50 or 100 year storm environment, they need to be operational in 5 year events.

All concept designs were based on availably bathymetry and no geotechnical information. Although the available bathymetry is reasonably accurate for this level of concept design development it is not suitable for final design, development of construction documents and construction. Significant changes may be required after suitable bathymetric surveys have been performed off shore and suitable topographic surveys have been performed at the uplands. More refined cost estimates for pile driving and anchoring will be possible after a geotechnical investigation is performed. The cost estimates developed in this effort include contingencies for rock anchoring piles.

Alternatives: Site 1 – Cannery Point

Site 1 is to the north of Cannery Point. The concept design has the following elements:

- A 400 foot by 50 foot float,
- A 40 foot by 50 foot bridge landing float,
- A 16 foot by 140 foot transfer bridge,
- A 20 foot by 300 foot access trestle,
- Four breasting dolphins with mooring bollards,
- Two mooring dolphins,
- 750 feet of catwalk and two 65 foot gangways to access dolphins,
- 1.5 acre upland staging area
- Concrete freight ramp with guide piles and dolphins,
- 10 foot by 250 foot concrete sidewalk to bus parking area,
- Approximately 3,750 foot long, 28 foot wide access road.

The predicted 50-year return period significant wave height at the site is approximately 12.5. With that wave environment an access float at the concrete freight ramp is not feasible. Maximum currents at the site are estimated to be 3.2 knots at peak flood tide, 4.1 knots at peak ebb tide and 1.1 knots during an average tide change.

The walking distance from the float pierhead to the Cannery Building is approximately 1800 feet. The distance from the freight staging area to City Hall in Hoonah is 2.1 miles.

The benefits of this site are as follows:

- Relatively close proximity to Cannery
- Adequate space for freight and bus staging

Deficiencies of this site include:

- Distance from town requires additional cost for access road.
- Extreme wave environment in winter months.
- High currents at peak tide changes and moderately high current at an average tide change.

The budget level construction cost estimate for this site is $ 25.2 million. Of that approximately $16.8 million is for marine construction, $5.1 million is for uplands development and the freight ramp facility, and $ 3.3 million for contingency. Total project costs are estimated to be $ 28.7 million. Construction costs include contractor mobilization, materials, labor and equipment necessary to build the facility, and a 15% contingency. Total project costs include costs for construction, design, bathymetric surveys, geotechnical investigation, permitting and environmental mitigation, construction administration and construction inspection.

An unknown cost at this time is the cost for anchoring piles loaded in tension. If the anticipated tension loads cannot be resisted by skin friction in sediments, that bedrock is shallow or if sediments are very soft, rock anchoring of piles is needed. The estimated construction cost contains costs for this unknown.

The cost estimate includes cost for a concrete pontoon in lieu of a steel pontoon for the floating berth. Using a steel pontoon will involve lower initial costs, likely $1.0 million less, but will require periodic maintenance. Over a 50 year life, a concrete pontoon is less expensive.

Alternatives: Site 2 – Cannery

The Cannery site is south of Cannery Point and to the west of the Cannery. The concept design for this site includes:

- A 400 foot by 50 foot float,
- A 40 foot by 50 foot bridge landing float,
- A 16 foot by 140 foot transfer bridge,
- A 20 foot by 160 foot access trestle,
- Four breasting dolphins with mooring bollards,
- Two mooring dolphins, and
- 750 feet of catwalk, two 65 foot gangways to access dolphins.

The site does not allow for a freight transfer facility or any bus staging.

The predicted 50-year return period significant wave height at the site is approximately 7.2 feet. Maximum currents at the site are estimated to be 1.5 knots at peak flood tide, 1.9 knots at peak ebb tide and 0.6 knots during an average tide change.

The walking distance from the float pierhead to the Cannery Building is approximately 850 feet. The distance from the end of the access trestle to City Hall in Hoonah is approximately 1.75 miles.

The benefits of this site are as follows:

- Close proximity to Cannery
- Reasonable currents

Deficiencies of this site include:

- No space for freight facility and bus staging.
- The proximity to the existing lightering float could be restrict use of that float.
- Use for the fishing industry will be difficult or not desired by the uplands owner.
- Moderately high wave environment at the float location.
- Vehicle transfer from AMHS is not very feasible.

The budget level construction cost estimate for this site is $ 18.7 million of which $16.3 million is for the marine facility and $2.4 million is for contingency. Total project costs are estimated to be $21.3 million. Construction costs include contractor mobilization, materials, labor and equipment necessary to build the facility, and a 15% contingency. Total project costs include costs for construction, design, bathymetric surveys, geotechnical investigation, permitting, construction administration and construction inspection.

An unknown cost at this time is the cost for anchoring piles loaded in tension. If the anticipated tension loads cannot be resisted by skin friction in sediments, that bedrock is shallow or if sediments are very soft, rock anchoring of piles is needed. The estimated construction cost contains costs for this unknown.

The cost estimate includes cost for a concrete pontoon in lieu of a steel pontoon for the floating berth. Using a steel pontoon will involve lower initial costs, likely $1.0 million less, but will require periodic maintenance. Over a 50 year life, a concrete pontoon is less expensive.

Alternatives: Site 3 – Shaman or Hoonah Point

Site 3 is between the Cannery and the AMHS Terminal at the nearest point to the Cannery, noted on nautical charts as Hoonah Point and locally referred to as Shaman Point. The concept plan includes:

- A 400 foot by 50 foot float,
- A 40 foot by 50 foot bridge landing float,
- A 16 foot by 140 foot transfer bridge,
- A 20 foot by 40 foot access trestle,
- Four breasting dolphins with mooring bollards,
- Two mooring dolphins,
- 750 feet of catwalk, two 65 foot gangways to access dolphins,
- 1.5 acre upland staging area
- Concrete freight ramp with guide piles and dolphins,
- A 650 foot long by 12 foot wide promenade with a 8 foot by 120 foot gangway for passenger pedestrian access to the Cannery. The promenade could be covered in the future. The 12 foot overall width will result in a 10 foot wide travelled way which is appropriate for the several thousand number of pedestrians attempting to disembark from the ship and to embark to the ship over a relatively short period of time.
- 10 foot by 170 foot concrete sidewalk to bus parking area,

The predicted 50-year return period significant wave height at the site is approximately 7.0 feet. Maximum currents at the site are estimated to be 1.0 knots at peak flood tide, 1.1 knots at peak ebb tide and 0.3 knots during an average tide change.

The walking distance from the float pierhead to the Cannery Building is approximately 1250 feet. The distance from the end of the access trestle to City Hall in Hoonah is approximately 1.3 miles.

The benefits of this site are as follows:

- Relatively close proximity to Cannery
- Low currents
- Closest of all facilities to City Hall.

Deficiencies of this site include:

- The experience of the passenger may be less desirable than at the other two sites.
- Moderately high wave environment at the site.
- The in water fill is more than other sites and will require more mitigation.

The budget level construction cost estimate for this site is $22.9 million. Of this approximately $17.1 million is for marine structures, $2.8 million is for the bus staging and freight ramp and $3.0 million is for contingency. Total project costs are estimated to be $26.3 million. Construction costs include contractor mobilization, materials, labor and equipment necessary to build the facility, and a 15% contingency. Total project costs include costs for construction, design, bathymetric surveys, geotechnical investigation, permitting, construction administration and construction inspection.

An unknown cost at this time is the cost for anchoring piles loaded in tension. If the anticipated tension loads cannot be resisted by skin friction in sediments, that bedrock is shallow or if sediments are very soft, rock anchoring of piles is needed. The estimated construction costs contains costs for this unknown.

The cost estimate includes cost for a concrete pontoon in lieu of a steel pontoon for the floating berth. Using a steel pontoon will involve lower initial costs, likely $1.0 million less, but will require periodic maintenance. Over a 50 year life, a concrete pontoon is less expensive.

Summary of Alternatives and Decision Matrix

Below is a summary of the characteristics of each site in matrix form that will assist in evaluating the sites and selecting a preferred site:

Characteristic	Site 1: Cannery Point	Site 2 Cannery	Site 3: Shaman Point
Large Cruise Ship Facility	**Y**	**Y**	**Y**
Uplands Staging for Busses	**Y**	**N**	**Y**
All Tide Freight Ramp	**Y(?)**	**N**	**Y**
Uplands Staging for Freight	**Y**	**N**	**Y**
Fishing Industry Off Season use	**Y**	**N**	**Y**
Potential for Future Small Tourship Floats	**N**	**Y**	**Y**
AMHS Vessel Moorage	**Y**	**N(?)**	**Y**
USCG Vessel Moorage	**Y**	**N(?)**	**Y**
Cruise Ship Passenger Positive Experience	**Y**	**Y**	**Y**
Significant 50-Year Wave Height, feet	12.5	7.2	7.0
Estimated Peak Flood Current, knots	3.2	1.5	1.0
Estimated Peak Ebb Current, knots	4.1	1.9	1.1
Average Tide Change Current, knots	1.1	0.6	0.3
Distance to Main Cannery Building, feet	1,800	850	1,250
Distance to City Hall, miles	2.0	1.75	1.3
Cruise Ship Facility Cost	$16.8 M	$16.3 M	$17.1 M
Uplands and Freight Ramp Costs	$5.1 M	---	$2.8 M
Total Construction Cost with Contingency	$25.2 M	$18.7 M	$22.9 M
Total Project Costs	28.7 M	$ 21.3 M	$26.0 M

Note: 1. **Y** - indicates user criteria is met.
2. **N** – indicates user criteria is not met.

Preferred Site Refined Concept Design and Cost Estimates

On September 27, 2011, after the Hoonah City Council selected Site 3, the City of Hoonah staff requested PND to refine the concept design for a facility at Site 3. Revisions were to accommodate the following: 1) move the facility so that the multi-use facility was all on City of Hoonah Tidelands, 2) Breakout the design into a Base Bid and Alternates.

The Base Bid portion of the facility is to include that to accommodate cruise ships with a steel pontoon and a minimal uplands facility.

Alternates are to include:

1) A removable float for fisherman, charter boats and small tour boats. This should include a 15 ton crane on the main pontoon, site lighting for fall, winter and early spring use.
2) A concrete pontoon in lieu of the steel pontoon.
3) A pile-supported promenade to the Icy Straight Point Complex.
4) A freight transfer facility that includes a bulkhead dock for barges.
5) An all-tide concrete ramp for ramp barges and landing craft.

The direct and overall costs for the base bid and additive alternates are as follows:

Project	Estimated Direct Construction Costs	Estimated Total Project Costs
Base Bid	$15,678,600	$18,131,600
Add Alternate 1: Fisherman's Float and Working Crane	$761,100	$898,100
Add Alternate 2: Concrete Pontoon	$2,546,100	$2,940,700
Add Alternate 3: Promenade	$3,750,800	$4,332,200
Add Alternate 4: Pass-Pass Freight Bulkhead	$4,558,100	$5,264,600
Add Alternate 5: Freight Ramp	$707,900	$817,600

Concept plans and detailed cost estimates for the base bid and additive alternates are included in Appendix D.

Appendix A: Coastal Engineering Assessment and Metocean Analysis

DRAFT

MEMORANDUM

PND Engineers, Inc.

To: Ms. Marlene Duvall, City of Hoonah

Date: September 19, 2011
Project No: 112051.01

From: Chris Gianotti, Ajay Sampath and Nels Sultan
PND Engineers, Inc.

Subject: Hoonah Berthing Facility - Coastal Engineering Assessment and Metocean Analysis

This memo presents the results of a coastal engineering assessment and metocean analysis for the Hoonah Berthing Facility project in, Juneau, Alaska. The purpose is to present environmental conditions for wind, waves, tides, water levels, and currents. This information is used for evaluating the best site for the berthing facility. The met-ocean criteria are used for calculating wave run-up, and establishing wind and wave loads on marine infrastructure.

INTRODUCTION

The three potential dock locations are at Hoonah, on the Chichagof Island in Alaska's southeast panhandle region. Figure 1 is an area map and Figure 2 shows three sites for dock locations that are analyzed in this report. Figure 3 is a nautical chart showing Port Frederick and Hoonah near the entrance to the bay. Figure 4 and Figure 5 two of the site alternatives. Site one (Cannery Point) is located on the north side of Cannery Point. Site two (Cannery) is located west of the existing dock in Hoonah. The third site is further south near Shaman Point, which is labeled Hoonah Point on the nautical chart.

The maritime climate is characterized by cool summers and mild winters. The primary factor influencing the climate is the Aleutian low-pressure area, which is semi-permanent in the fall and winter but tends to migrate or dissipate in the spring and summer. Summer temperatures average 52 to 63 ^{o}F and winter temperatures average 26 to 39 ^{o}F. Temperature extremes have been recorded from -25 to 87^{o} F at Hoonah. Precipitation averages 100 inches annually, with 71 inches of snowfall.

Bedrock in this region is composed of sedimentary rock. Glacial-marine deposits and alluvium characterize the geology and is typical of the Southeast Alaska areas. PND site observations during a low tide in 2011 revealed 6" cobble size rock, and large boulders with little gravel and no sand at Hoonah Point. Bedrock is likely close to the surface. On the north side of Cannery Point, the conditions are similar to that of Hoonah Point. Gravelly sand is present in front of Cannery Point. The shoreline appears stable, neither eroding nor accreting. Sediment transport is likely not a major factor for design and site selection.

Metocean data is limited, with no direct measurements of tide, waves or currents available. Reports by local residents indicate that Hoonah Point is well protected from the northwesterly to northeasterly winds. Hoonah means "place protected from the North Wind" in the Tlingit language. The harbormaster reports that southwesterly winds are reported to cause 4 to 5 foot waves. Also that waves with significant wave height of 2 to 2.5 feet are possible at 15 to 20 miles per hour windspeeds. Four foot seas can be seen during 30 knot winds. Northerly winds with a 40 knots windspeed can lead to 6 to 8 foot seas near Cannery Point. Taku winds (local name for extreme winds) are predominant in Icy Strait.

Hoonah is exposed to tsunamis and storm driven sea surges that can result in severe coastal flooding, based on information in the Hoonah Coastal Management Plan (City of Hoonah, 2006). Hoonah is occasionally alerted to possible tsunamis originating in the Pacific Ocean. There have been no major tsunami impacts reported at Hoonah in recent years based on the report.

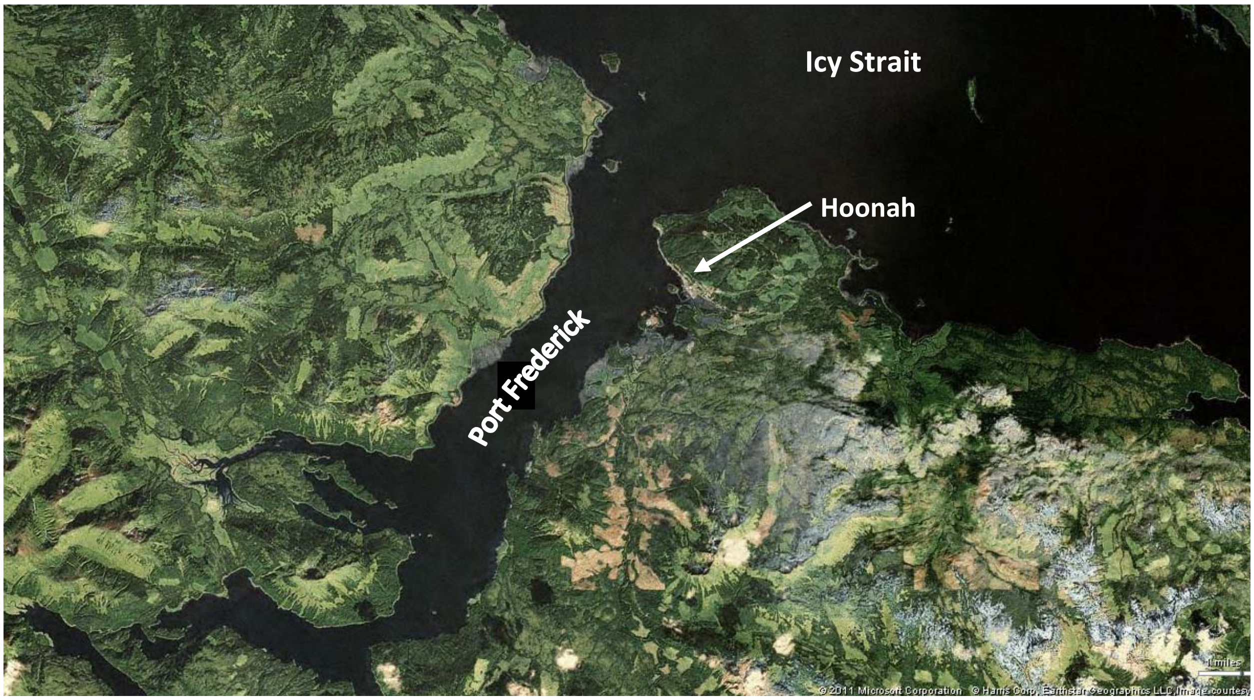

Figure 1. Area Map - Satellite Photo (Bing Image, 2011)

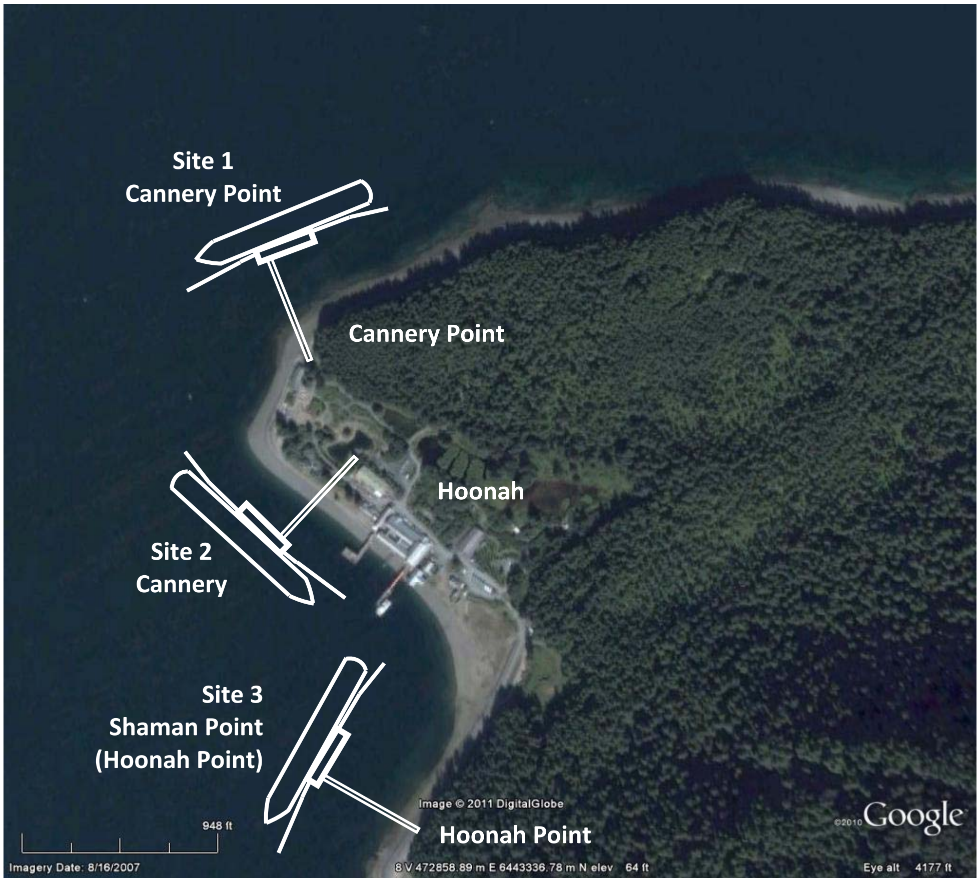

Figure 2. Alternative Dock Locations (Google Image, 2007)

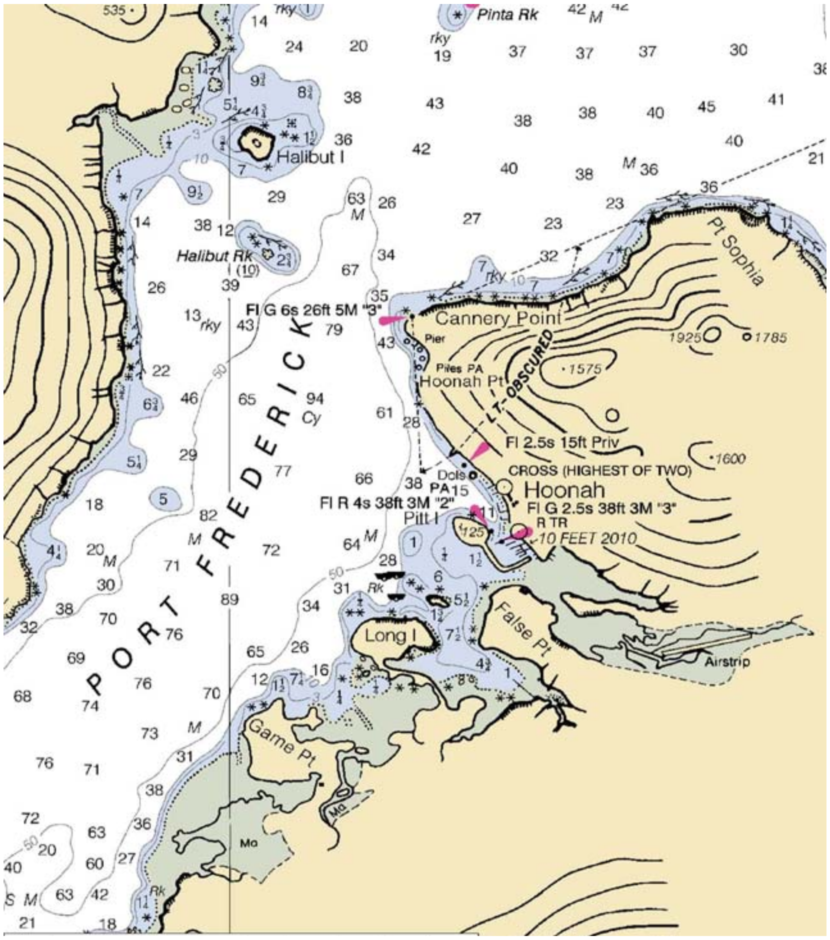

Figure 3. Port Frederick - Nautical Chart 17302 (Depths in Fathoms)

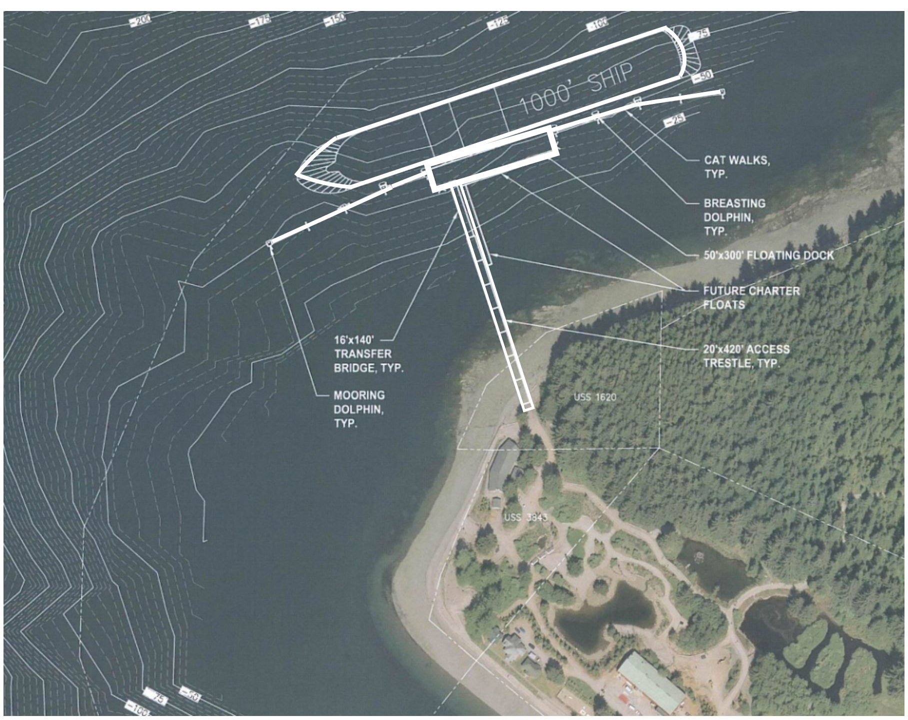

Figure 4. Dock Location - Site 1 – Cannery Point

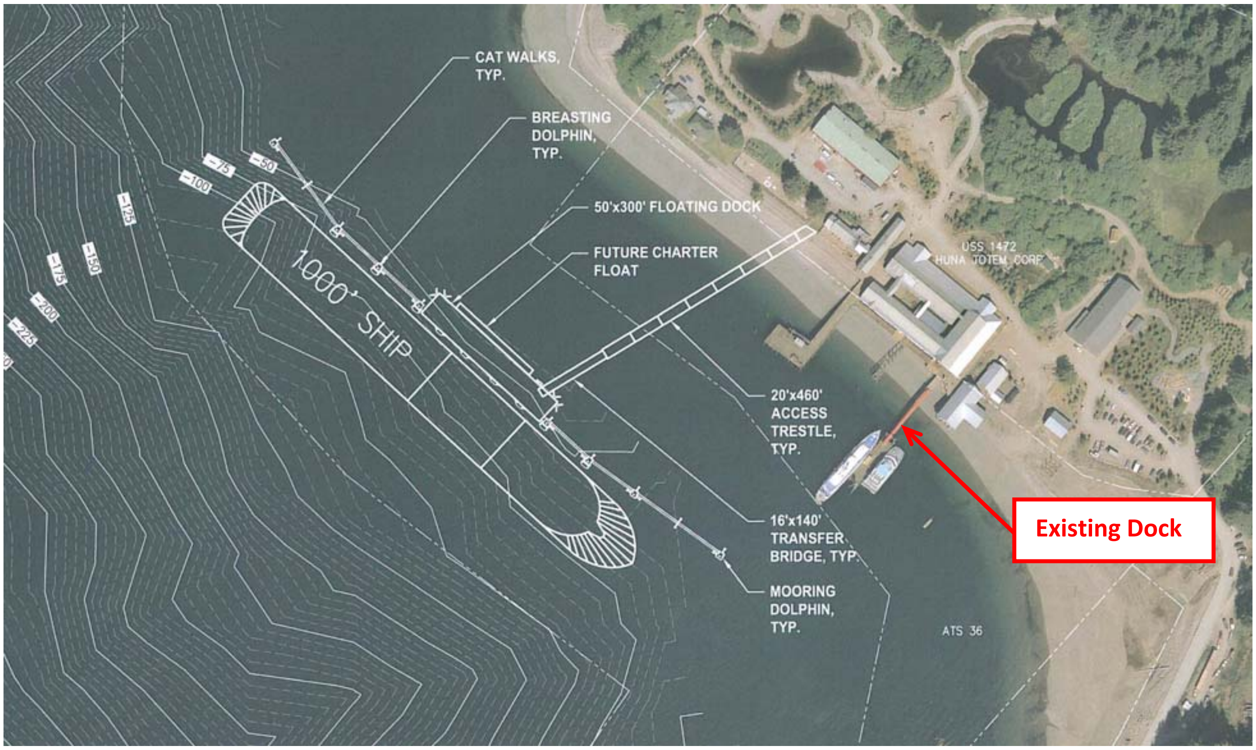

Figure 5. Dock Location - Site 2 – Cannery

SURVEY DATA, WATER LEVEL AND DATUMS

Bathymetry data was obtained from the NOAA National Geophysical Data Center in x-y-z digital format and is shown in Figure 7. The bathymetry is shown on NOAA chart 17302 (Figure 3). Horizontal datum is UTM NAD 27. Vertical datum is Mean Lower Low Water (MLLW), feet. Water depths offshore are relatively deep close to shore, with a maximum depth of 564 feet off of Cannery Point.

Tide elevations listed in Table 1 are based on data included on Nautical Chart 17302. Limited water level measurements at Hoonah from October-December 2009 are available in the NOAA Tides and Currents website and were used to develop local tide predictions, plotted Figure 6. Hoonah is an area experiencing relative sea level fall, likely due to glacial rebound. At Juneau the rate is about 0.5 inch per year, based on tide gage measurements (NOAA, 2011). The marine facilities should be sited to anticipate continued sea level changes.

A two-layer estuarine circulation system likely occurs seasonally beginning with an increased freshwater discharge accompanying the spring thaw in April and May and continues through October. These systems occur in the most protected bays and passages along the outer coast (City of Hoonah, 2006).

Table 1. Tide Information – Hoonah Harbor – Nautical Chart 17302

Description	Elevation (feet, MLLW)
Mean Higher High Water, MHHW	14.8
Mean High Water, MHW	13.4
Mean Low Water, MLW	1.5
Mean Lower Low Water	0.0

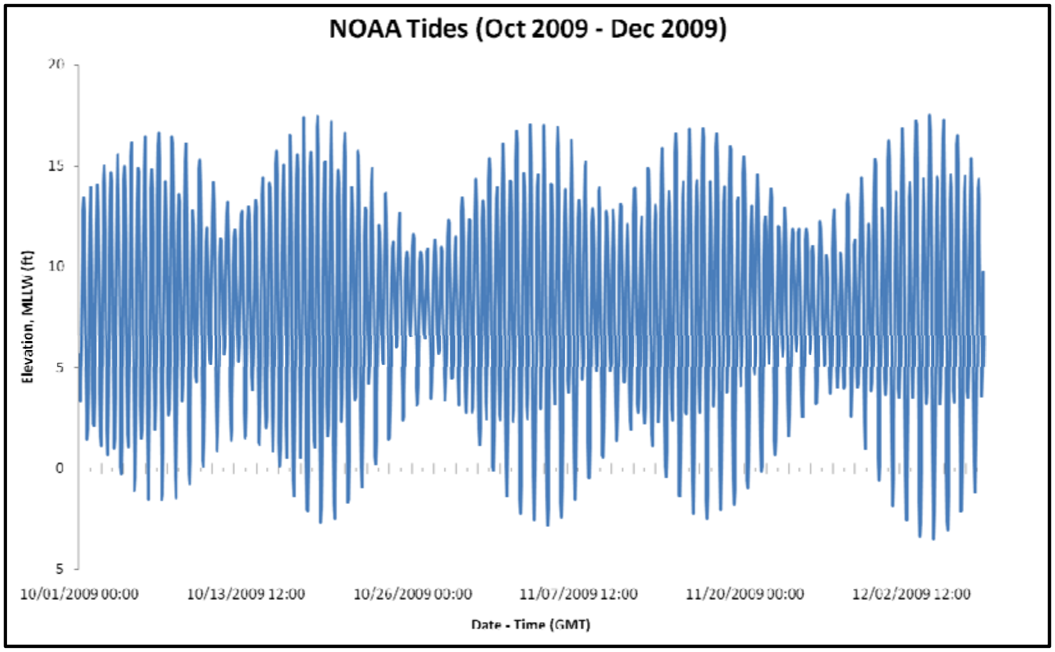

Figure 6. NOAA Predicted Water Levels October to December 2009.

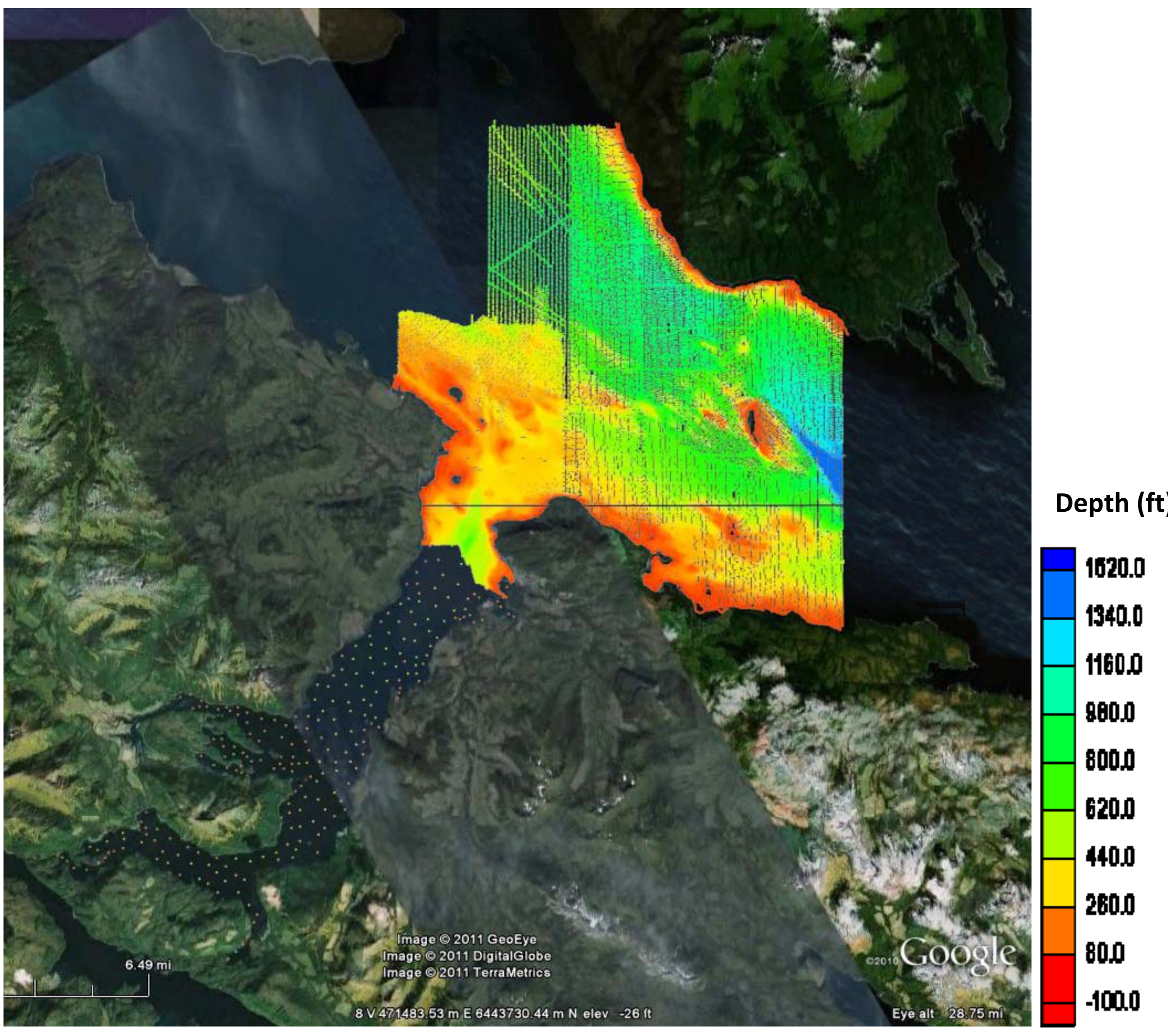

Figure 7. Bathymetry Data (NOAA National Geophysical Data Center)

WIND

Measured wave data is not known to exist in the Port Frederick area. Therefore, standard wave prediction methods, based on the measured wind data have been applied to estimate hindcast waves at the project site. In addition, wave numerical models have been applied to estimate wave conditions at the alternative site locations.

The nearest source of wind data is from the Hoonah Seaplane Base (Figure 9) and Sisters Island (Figure 8). The Hoonah Seaplane Base station is located near the site but is strongly influenced by the local topography. It is therefore is not representative of the wind conditions that generate offshore waves that reach the project sites. Wind speed and direction from Sisters Island has been applied for wave calculations, and was analyzed for the years 1978-1984 and 2007-2011. The data is measured hourly, and is equivalent to a two-minute average (NOAA, 2011).

The measured data at Sisters Island indicates that the winds are predominantly from the east. The longest fetch distance of 19 nautical miles is from the east, but this direction does not generate large waves that reach the project site directly. Figure 8 includes a wind rose, based on the Sisters Island wind data in Table 2. The wind rose and table shows the wind frequency by speed and direction. Wind direction is defined as the direction winds are travelling from. Figure 9 shows a wind rose for data from the Hoonah Seaplane base.

The wind data extremes (directional) were analyzed to determine the wind speed associated with a given return period. Table 3 lists the largest windspeeds measured for different directions (northwest, southwest and northeast). Table 4 and Figure 11 show the results of the extremal analysis for all data from all directions. 90% confidence limits on the predictions are included. The 50 year return period windspeed is approximately 85 knots. A similar analysis was done for winds from each of the three fetch directions shown in Figure 10, which results in smaller return period windspeeds because winds from the east are not included (Table 5). Wind speeds were used to calculate hindcast wave heights in the following section.

Given the length of record (17 years), return period predictions for the design project life of about 50 years are reasonable for the Sisters Island data. As a general rule, data can be extrapolated to return periods up to 3 times the length of record (USACE Automated Coastal Engineering Systems Technical reference, 1992), although longer lengths of record provide more reliable estimates.

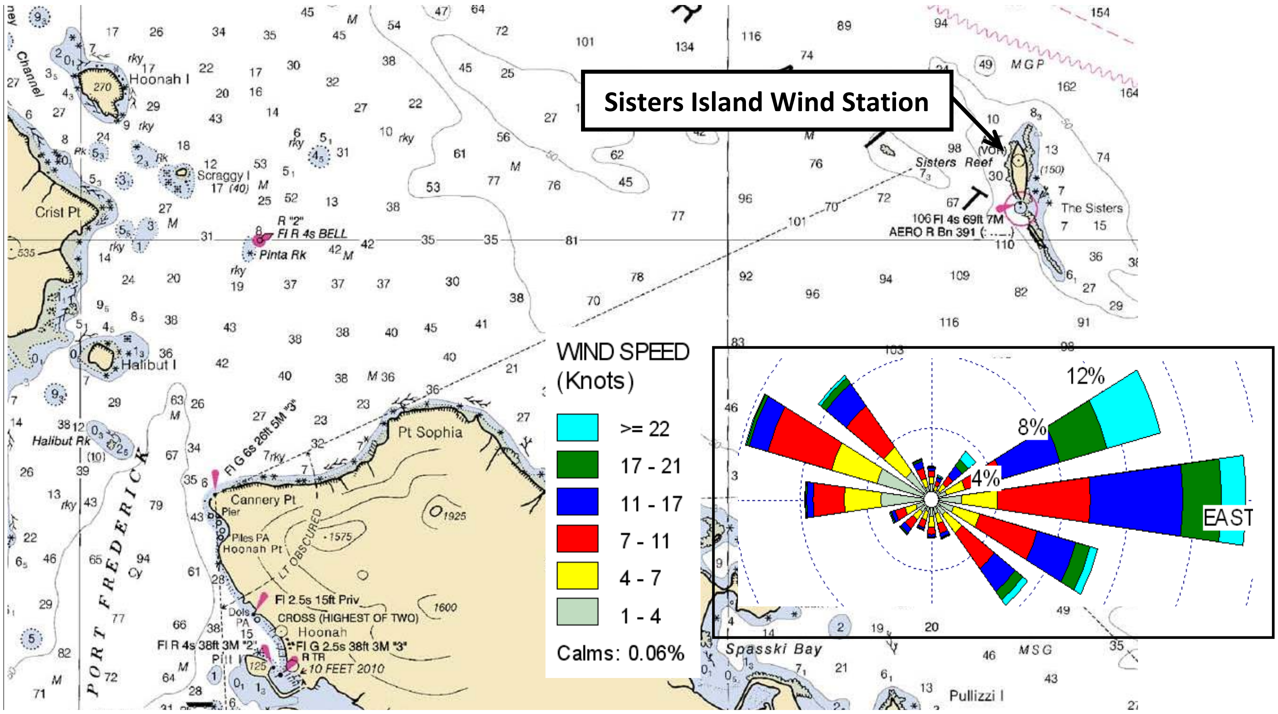

Figure 8. Sisters Island Wind Rose – All Months – 1973-2011

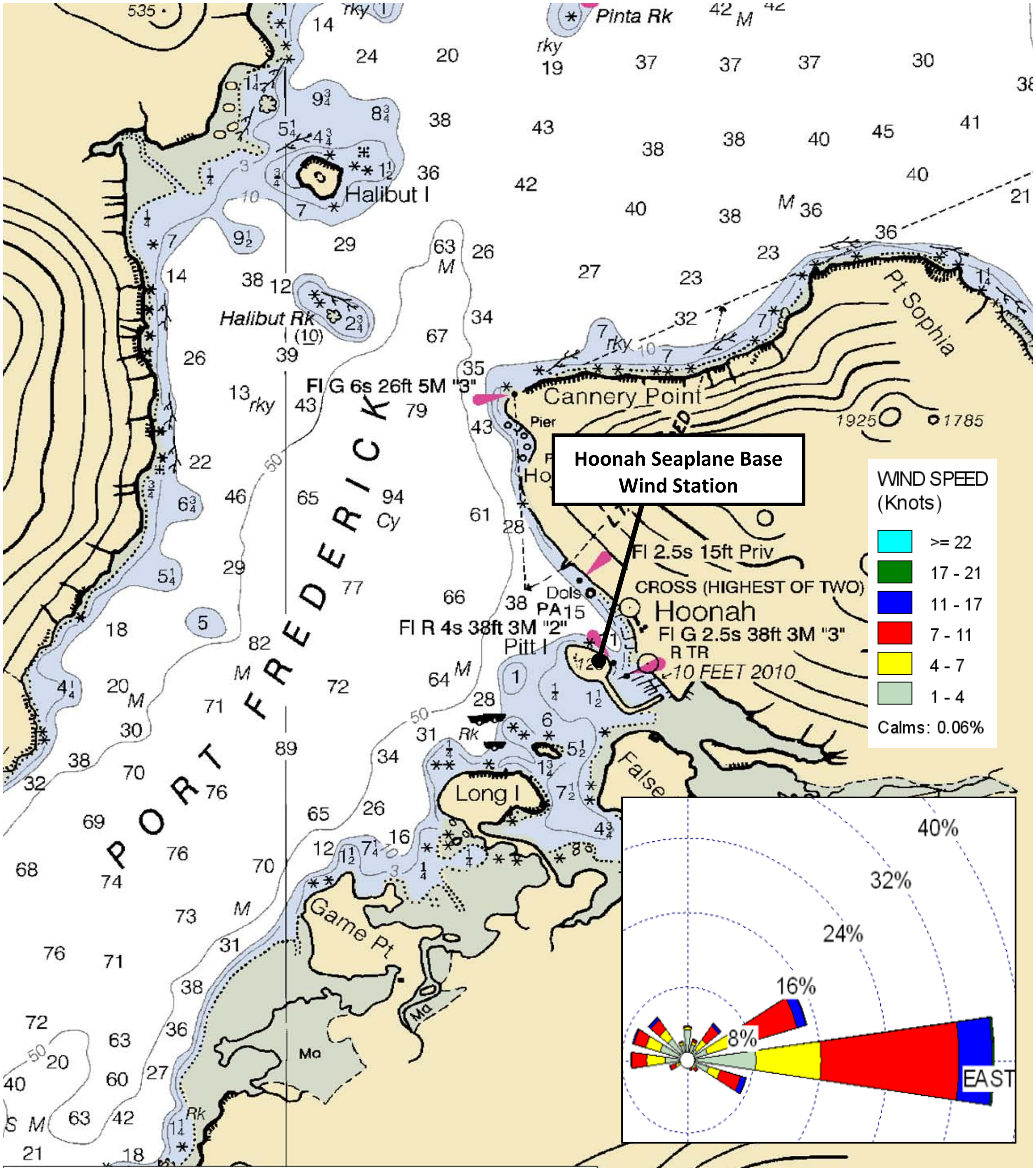

Figure 9. Hoonah Seaplane Base - Wind Rose – All Months – 1978-2011

Table 2. Sisters Island Wind Speed and Direction – All Months 1973-2011 (No. Days)

Direction	Wind Speed (knots)						Total
	1 - 4	4 - 7	7 - 11	11 - 17	17 - 21	>=22	
348.75-11.25	537	226	210	99	26	16	**1114**
11.25-33.75	334	165	158	121	35	47	**860**
33.75-56.25	415	265	337	405	271	342	**2035**
56.25-78.75	590	693	1374	2130	1745	1977	**8509**
78.75-101.25	1129	1276	3316	3305	1383	875	**11284**
101.25-123.75	866	974	2117	1427	528	287	**6199**
123.75-146.25	678	739	1454	937	342	227	**4377**
146.25-168.75	519	337	338	121	35	17	**1367**
168.75-191.25	575	350	251	69	14	19	**1278**
191.25-213.75	437	293	256	62	21	17	**1086**
213.75-236.25	538	338	365	168	50	29	**1488**
236.25-258.75	611	408	367	127	45	32	**1590**
258.75-281.25	1833	1320	1115	229	47	25	**4569**
281.25-303.75	2040	1690	2352	697	107	37	**6923**
303.75-326.25	1176	1001	1705	904	238	103	**5127**
326.25-348.75	465	286	357	218	62	28	**1416**
Total	**12743**	**10361**	**16072**	**11019**	**4949**	**4078**	**59222**

Table 3. Sisters Island - Largest Recorded Windspeeds 1973 - 2011

No.	Date	U (knots)	Dir (Az)		Date	U (knots)	Dir (Az)		Date	U (knots)	Dir (Az)
Northwest (280°-340°)					Southwest (210°-250°)				Northeast (40°-80°)		
1	1/10/1983	50	310		12/27/1978	47	220		1/30/2008	60	70
2	10/26/1973	42	300		4/16/2007	33	210		2/8/1979	60	60
3	7/9/1982	40	310		10/12/2010	33	230		11/16/2007	49	70
4	2/24/1981	37	290		3/11/2011	33	210		10/12/2010	47	70
5	2/8/2008	34	330		2/7/2008	32	240		12/4/1975	45	60
6	6/23/1978	32	330		7/12/1974	30	220		2/28/2011	45	50
7	3/29/2007	31	300		2/23/1978	30	240		11/14/2009	41	80
8	4/4/2009	31	290		3/7/1979	30	240		1/5/1976	40	50
9	3/6/2010	31	320		4/4/2009	29	250		10/21/1977	40	80
10	6/19/1975	30	300		12/4/1980	28	240		12/21/1978	40	60

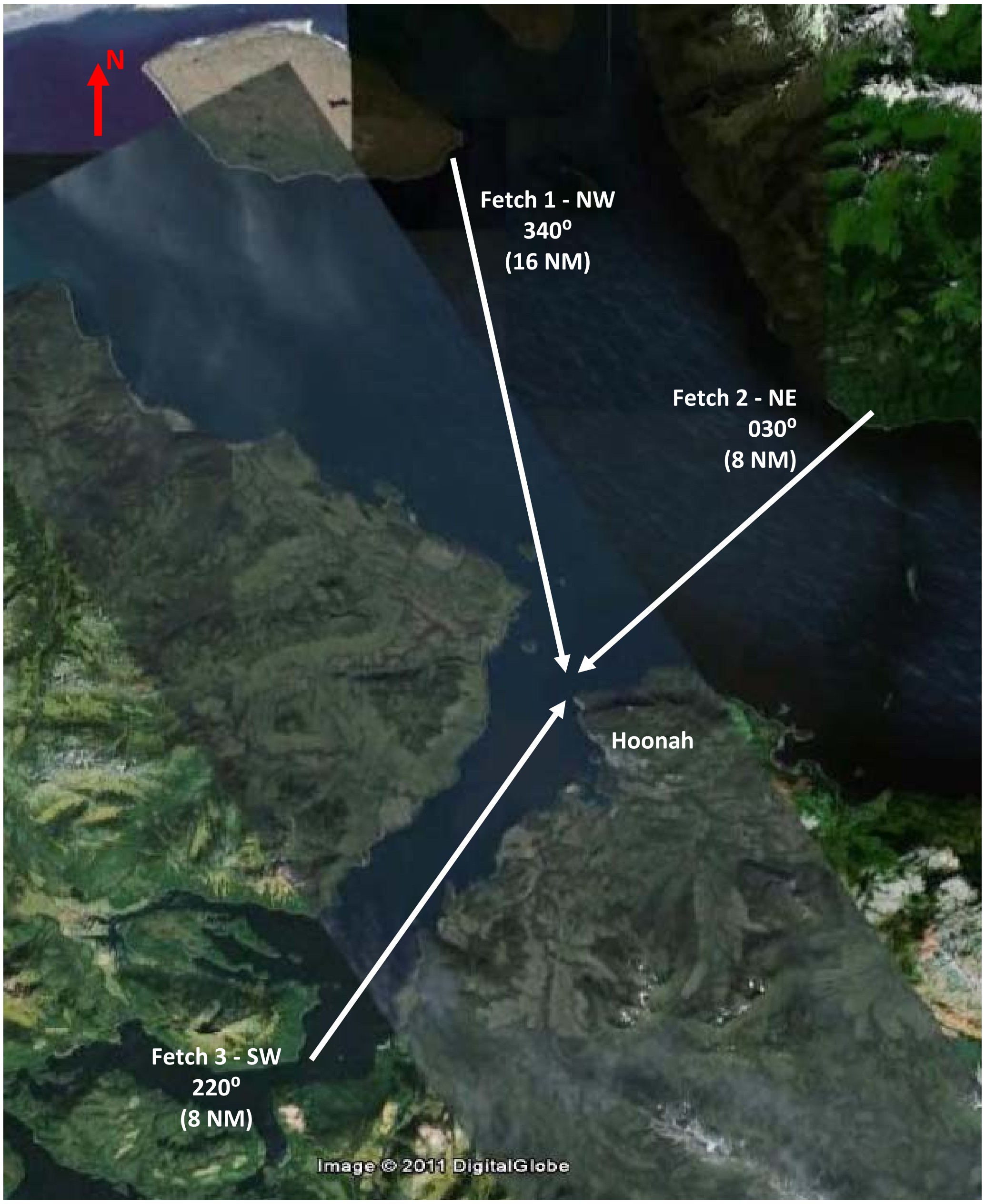

Figure 10. Hindcast Waves - Fetch Distance and Direction

Table 4. Sisters Island- Return Period Wind Speed (knots) - All Directions-All Months - 1973-2011

N= 17; Nu= 1.0 NT= 17; K= 17 Lambda=1.0	FT-I	Weibull k= 0.75	Weibull k= 1.00	Weibull k= 1.40	Weibull k= 2.00
Correlation Coefficient	0.9487	0.9885	0.9798	0.9556	0.9233
Return Period (years)					
2	47.2	44.4	45.2	46.4	47.6
5	57.6	54.6	56.5	57.8	58.3
10	64.5	63.9	65.1	65.1	64.3
25	73.2	77.8	76.4	73.9	71.1
50	79.7	89.1	85.0	80.0	75.5
100	86.1	101.2	93.6	85.9	79.6
90% Confidence Interval : Return Period (years)					
5	49.8-65.5	40.7-68.6	45.6-67.4	48.7-66.9	50.4-66.1
10	53.9-75.1	42.2-85.6	49.3-80.9	53.2-77.1	54.8-73.8
25	59.0-87.5	44.3-111.2	54.0-98.9	58.3-89.4	59.6-82.6
50	62.6-96.8	45.9-132.3	57.5-112.6	61.9-98.1	62.7-88.4
100	66.2-106.0	47.6-154.8	60.9-126.3	65.3-106.4	65.5-93.8

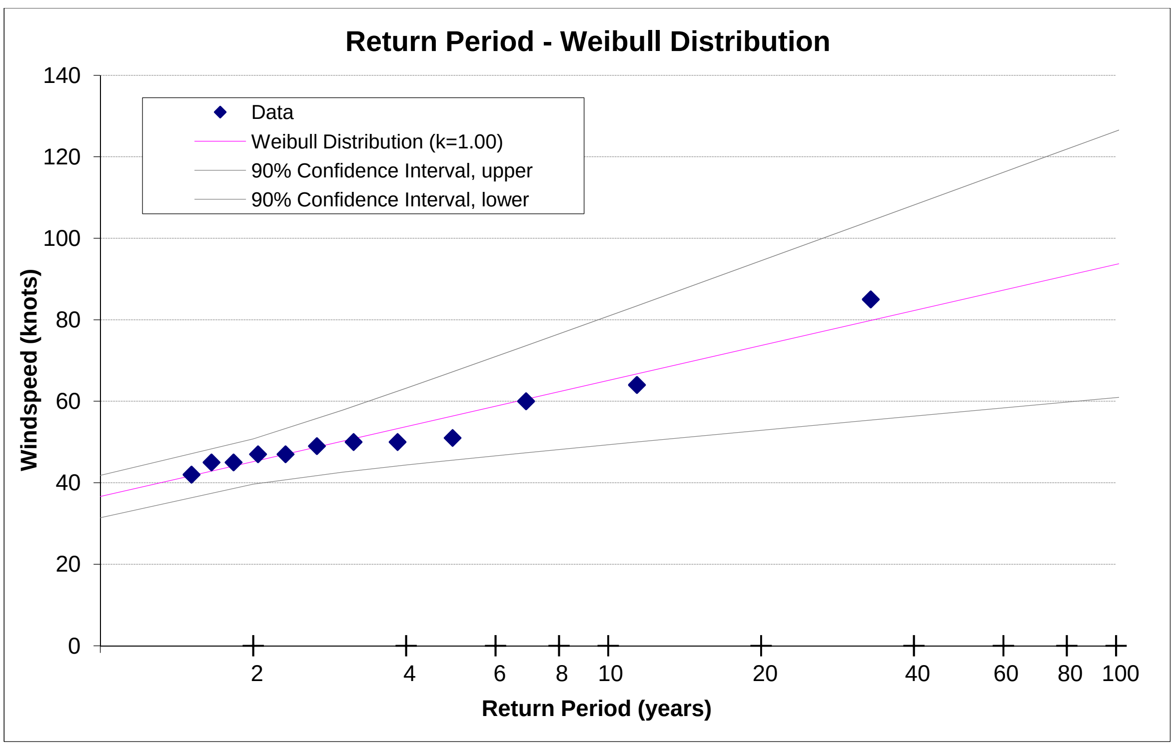

Figure 11. Sisters Island Return Period - Wind Speeds from All Directions-1973-2011

WAVE

The wave conditions at the project site alternatives were calculated using standard hindcast equations and by applying the wave numerical model Delft3D. Observations and reports by local residents have also been considered in developing the recommended design environmental conditions.

HINDCAST WIND WAVES

Fetch limited wave calculation methods were applied to estimate the wave height and period associated with 50 year return period wind speed and fetch length. The hindcast significant wave height, peak period, and maximum wave height were calculated using standard wave prediction formulae in the US Army Corps of Engineers Coastal Engineering Manual. The results are listed in Table 5. The wave heights listed are for a point offshore of Cannery Point, in “deepwater” meaning in a depth offshore before they can feel the bottom and shoal or refract. The desktop calculations assume waves are generated and move along a straight line fetch, without the effects of wave refraction, shoaling, dissipation and other transformations. The significant wave height (Hs) is the average wave height of the one-third largest waves. The maximum wave height is the largest single wave during a storm event and is assumed equal to 1.7 times the significant wave height.

The windspeed analysis was directional, meaning the return period winds aligned with the associated fetch direction (as shown in Table 5) were used to calculate the return period windspeed.

The wave heights and periods were calculated for different conditions as shown in Table 5. The wave model Delft3D, (which applies the SWAN numerical code), was used with wind only input, as a check for the wave hindcast calculations, and to incorporate the effect of local wave transformations. The results were similar to the desktop calculations.

The largest significant wave height is 9.4 feet from the northwest for a 50 year return period windspeed of 56 knots. The winds from the southwest and northeast, over a shorter fetch distance, generate waves with relatively smaller wave heights compared to waves generated by winds from the northeast. The significant wave height is 8.6 feet for winds from the northeast and 6.1 feet for winds from the southwest.

Site 3 (Hoonah Point) is relatively protected from waves from the northeast and the northwest compared to Site 1 (Cannery Point) and Site 2 (Cannery). Waves with a significant wave height of 6.1 feet are possible at Site 3. Site 1 is the most exposed, and is under direct attack from waves from the northeast and northwest. Very large waves with significant wave height up to 9.4 feet are possible at this site. The expected wave conditions at the project site alternatives are discussed in detail in the next section.

Table 5. Wave Hindcast– 50 Year Return Period

No.	Direction – Fetch [1]	50-yr Return Period Wind Speed (knots)	Hs (ft)	Hmax [2] (ft)	Tp (s)
1	Northwest (300° - 350°)– 16 NM	56	9.4	16.0	4.8
2	Northeast (20° - 80°) – 8 NM	66	8.6	14.6	4.1
3	Southwest (200° - 250°)– 8 NM	50	6.1	10.4	3.7

[1] The fetch distance and directions are shown in Figure 10
[2] Hmax = 1.7x(Hs)

DELFT3D WAVE NUMERICAL MODEL

In addition to desktop calculations using hindcast wind-wave equations, the Delft3D wave numerical model was applied to simulate wind-generated waves in coastal waters. The model computes the non-steady propagation of short-crested waves over an uneven bottom. The input forcing is the wind acting over the model domain. Wave transformations include, energy dissipation due to bottom friction, wave breaking, refraction (due to bottom topography, diffraction, shoaling and directional spreading. The Delft3D program is based on the spectral model SWAN, developed at Delft University of Technology.

Bathymetry data was obtained from NOAA's National Geophysical Data Center (NGDC). The bathymetry data limits are shown in Figure 7. The data was used to develop the model grids for the project site. The model domain covers the entire Port Frederick area and a portion of Icy Strait as shown in Figure 12. Two smaller, nested grids are inside the larger grid. The nested grids are more refined, with closer spacing of the grid nodes. The nested grid limits are shown in Figure 13. The domain limits (wet points) and the location of the observation stations for the model simulations are shown in Figure 14. The land boundary was defined at points that are above the expected maximum water elevation.

The significant wave height and period are calculated at every grid point. Output was analyzed at the following grid points; OBS 1 (Site 1), OBS 2 (Site 2) and OBS 3 (Site 3). The output points are in a water depth of 50 feet, approximately the same water depth as the dock locations. Three model simulation runs (R1, R2 and R3) were applied, each corresponding to 50 year return wind speeds from the three principal fetch directions. The model output includes the color map plots in Appendix A showing the distribution of wave heights in Port Frederick.

Table 6 lists the input used for the Delft3D model simulations and the output obtained at the observation stations. The largest wave height, 9.2 feet is observed near Site 1 for winds from the northwest direction along a relatively long fetch of 16 nautical miles. Site 1 is more exposed to the wind generated waves from the northeast and northwest compared to Site 2 and Site 3.The observed wave heights at Site 2 are smaller (6.0 feet) compared to Site 1. Site 3 is well protected from waves generated by the winds from the northwest and northeast. The 50 year return period significant wave height at Site 3 is 5.9 feet, generated by winds from the southwest. Site 3 is the best location for the project site in terms of wave exposure.

The waves do not appear to be focused by the bathymetry at any of the project sites. The bathymetry is generally deep close to shore, and the waves are in a water depth of 50 feet at the model output points. Hence the waves do not experience significant shoaling or diffraction effects before reaching the project sites. The wave model results do not show any unexpected results.

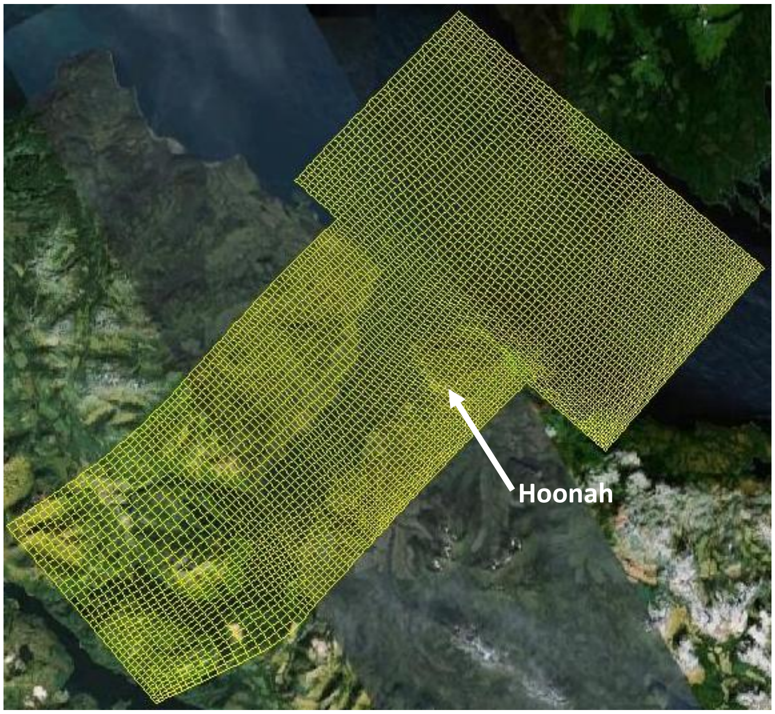

Figure 12. Delft3D Wave Model Domain

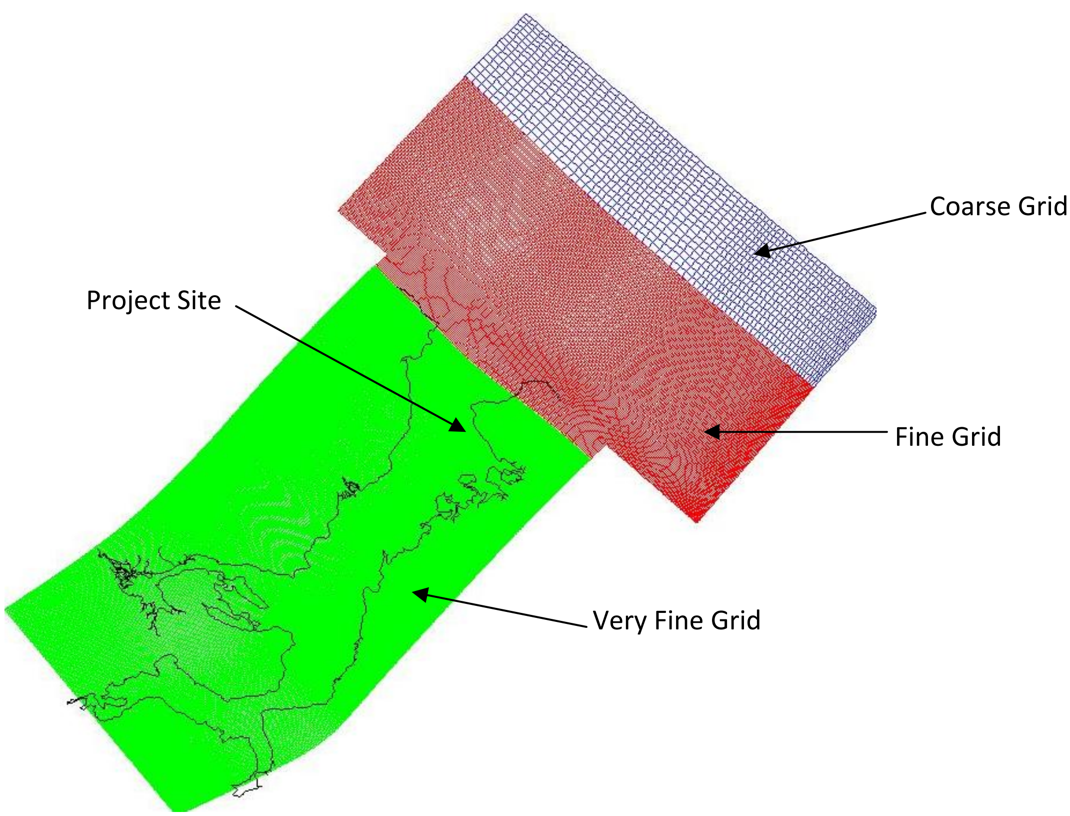

Figure 13. Delft3D Wave Model – Nested Grids

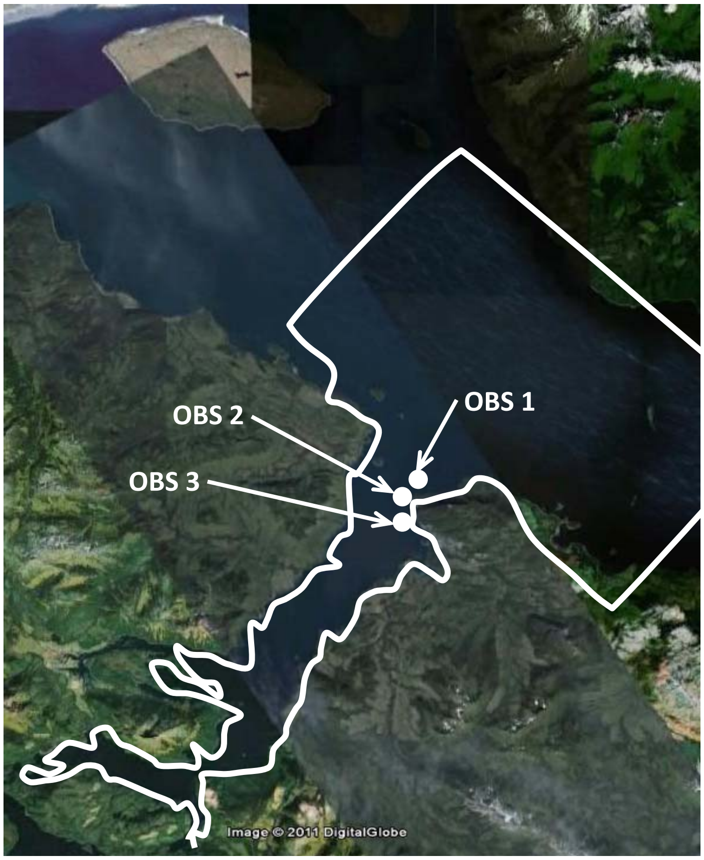

Figure 14. Model Domain (wet points) and Observation Points 1, 2 and 3

Table 6. Delft3D Wave Model – Input and Output

Run No.	Wind Input		Wave Input			Wave Output								
						OBS 1 (Cannery Pt)			OBS 2 (Cannery)			OBS 3 (Shaman Pt)		
	Spd (kts)	Dir. (deg)	Hs (ft)	Tp (s)	Dir. (deg)	Hs (ft)	Tp (s)	Dir. (deg)	Hs (ft)	Tp (s)	Dir. (deg)	Hs (ft)	Tp (s)	Dir. (deg)
R1	56	340°	9.4	4.8	340°	9.2	4.3	004°	5.3	3.5	320°	3.6	2.6	300°
R2	66	30°	8.6	4.1	030°	8.5	5.4	012°	5.5	4.2	328°	3.0	2.5	322°
R3	50	220°	6.1	3.7	220°	5.4	3.4	236°	6.0	3.7	221°	5.9	3.6	226°

[1] wave-wave interactions may lead to a small increase in the output wave height.
[2] Note that the output wave are strictly wind generated

CURRENTS

Currents can be significant in Port Frederick because of the large tidal range. The Coastal Pilot published by NOAA mentions strong currents south of Pitt Island, near the Small Boat Harbor. Also, local residents report large currents near the entrance to Port Frederick, based on observations from shore of the movement of water during ebb and flood. However, there is a lack of direct measurements of the currents. PND did limited currents measurements in 1994-95 at the end of the L-shaped dock, shown in Figure 16. The tidal current was measured with a mechanical gage. The current meter was raised and lowered in the water column from the end of the dock during an extreme tide range. The measured currents were "significant", approximately 2 knots, based on the recollection of the persons with PND who did the measurements. The PND measurements were for a confidential client and no written record of the data and report are available.

PND analyzed currents at the proposed dock locations for this study using the numerical model Delft3D Flow, as described in the following section. However, numerical models are just one source of information and ideally their results should be verified by field measurements. Additional investigation of the currents is recommended before final design, including collection of field data. Simple estimates of current speed from land, based on observation of objects floating on the surface the proposed dock locations are also recommended.

DELFT3D FLOW NUMERICAL MODEL

The Delft3D-Flow numerical model is part of a suite of numerical routines developed by Delft Hydraulics in the Netherlands to simulate waves, currents, and sediment transport, based on input from tide, wind and other metocean conditions. The Delft3D flow module can be applied to model tide and wind driven flows, wave driven flow, river discharges into bays and river flow simulations. It incorporates the effects of tides, winds, air pressure, density differences, wave turbulence and drying and flooding. Flow is a standard component that covers both curvilinear and rectilinear grids and can be easily coupled with other modules such as wave and sediment transport. Some of the special features also include different options for coordinate systems (spherical), wave induced stresses and mass fluxes. Additional details and limits of the model are described in the User Manual (Deltares, 2010).

The model applied for this study assumes a fixed seabed, and depth averaged currents. The model solves the fundamental equations of fluid motion at points on a finite-difference grid. The model was applied for this project to simulate tide circulation and estimate current speed and direction at the alternative site locations. The model was forced using the water level data measured by NOAA during October-December 2009, applied at the open ocean boundary. Wind and wave forcing were not included to simplify the interpretation of the model.

The main purpose of the flow model study is to help assess the feasibility of the project site locations for berthing facilities based on the current environment. Bathymetry data from NOAA NGDC (Figure 7) was used to create the model grid for Port Frederick inlet and a portion of Icy Strait. Figure 15 shows the model grid used for the flow model simulations. The model grid and observation points for the flow model are different from the grid and points used for the wave model.

The land boundary is defined at points that are above the expected maximum water elevation. This allows flooding and drying of inter-tidal areas. Elements inside the domain were allowed to flood and dry according to the change in water elevation. The sea boundary was set outside the harbor in Icy Strait. The model output locations are shown in Figure 16. Wind, wave and stream flow were not included in the model. The model only simulates flow due to tidal circulation, which is the primary driver of water flow in Port Frederick. The output was obtained at four different locations as shown in Figure 16. The locations are approximately at the dock locations for Site 1 (P1), Site 2 (P2) and Site 3 (P3). Monitoring station P4 is at the same location as the PND current measurement in 1994-95. The model was run for three different cases- peak flood (12/3/2009), peak ebb (12/4/2009) and average tide (10/26/2009).

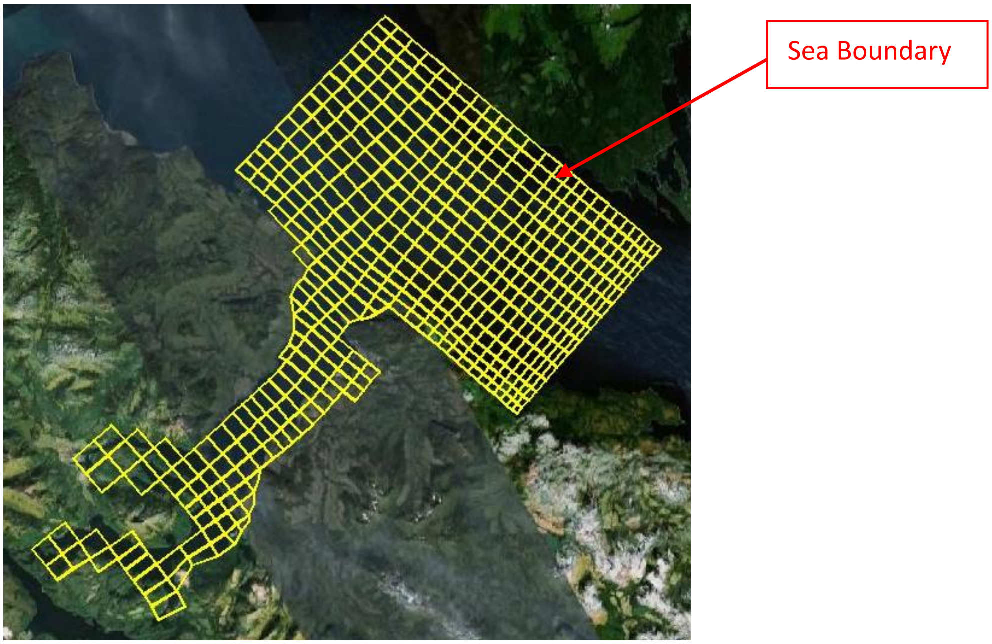

Figure 15. Delft3D Flow Model Grid

Model output was obtained as depth averaged velocities at each point on the grid, plotted every hour. The output can be viewed as vectors in a digital avi animation file, and as still images from the animations in figures in Appendix A. The current speed and direction changes during the tide cycle. The current vectors point in the direction of propagation.

The model output was compared with data from the PND current measurements from 1994-95. Output from the numerical model was obtained at a point P4 near the L-Shaped dock. The maximum modeled current modeled at point P4 was 1.2 knots. This compares with a recollection of a maximum measured current speed of about 2 knots in 1994-95.

Table 7 lists the numerical model output current speed (magnitude) and direction for the three runs. The largest current observation is at P4, 1.23 knots, which is lower than the PND current measurement in 1994-95. The observation points P2 and P4 are located in the same grid cell of the model domain. Hence, the results at P4 are representative of the results at Point 2. The model results should be interpreted primarily as an indication of relative current velocity between site alternatives.

The current velocities and flow patterns are similar at the three output stations. The flow velocity is slightly higher at Site 3 (Hoonah Point) during the peak flood tide cycle. The model also shows that the flood currents are higher than the ebb currents. Currents during a normal day, average tide cycle, are approximately 0.4 knots at all three sites. The flow patterns are as expected without any large eddies or turbulence noted, although a finer mesh grid may reveal these details. Depth averaged velocity and direction plots for all three sites and for all three model runs are included in Appendix A. The model results should be further analyzed during final design with different grid resolutions and boundary conditions, and with comparison to measured data if available.

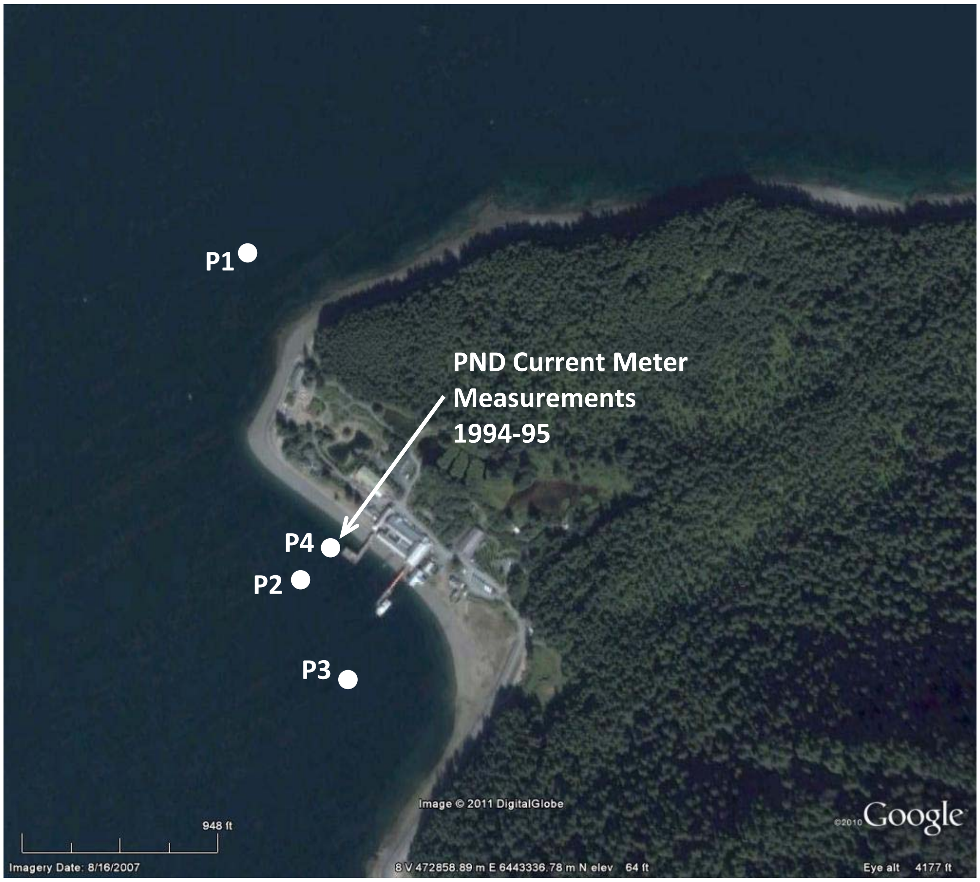

Figure 16. Current Model Output Points P1-P4

Table 7 Current Model Summary (Depth Average Speed and Direction)

Run	Description	Date	Tide Range (feet)	P1 (Cannery Point) Model Output (knots, direction)	P2 (Cannery) Model Output (knots, direction)	P3 (Hoonah Point) Model Output (knots, direction)
R1	Peak Flood	12/3/2009	20.9	1.2, 057^o	1.2, 037^o	1.3, 033^o
R2	Peak Ebb	12/4/2009	20.7	1.0, 056^o	1.1, 037^o	1.1, 033^o
R3	Average Tide	10/26/2009	8.5	0.4, 051^o	0.4, 037^o	0.4, 034^o

FINDINGS AND CONCLUSIONS

The environmental conditions for the project site alternatives have been evaluated. The preferred site for the berthing facilities based on protection from waves and currents is Site 3 (Shaman Point). The recommended Design Environmental Conditions (DEC) for Site 3 are listed in Table 8. The DEC the specific combination of tide, wind, waves and currents for which the marine facilities should be designed. The DEC should be further evaluated during final design and if additional information becomes available, such as field measurements.

Current speeds may control the structural design of the docks and additional investigation is recommended. Simple observations from land during a large tide range, recorded with a video camera, can yield valuable insights. Measurements with a bottom mounted wave and current meter would allow verification and calibration of the models.

The analysis show that winds are predominantly from the east along a relatively long fetch distance of 19 nautical miles. However, the three sites evaluated are not exposed directly to easterly winds. Northwest winds along a 16 nautical mile fetch can generate waves with significant height of 9 feet at Cannery Point. Hoonah Point is well protected from northwesterly and northeasterly winds. Southwest winds can generate waves with significant height of 6 feet at Hoonah Point.

Table 8. Hoonah Berthing Facilities – Design Environmental Conditions – Site 3 (Shaman Point)

Case	Tide Elevation (feet, MLLW)	Wind		Wave [2]			Current [3]	
		U (knots)	Direction (azimuth)	Hs (feet)	Tp (sec)	Direction (degrees)	U (knots)	Direction (Azimuth)
1	14.5	56	340°	3.6	2.6	300°	0.6	040°, 150°
2	14.5	66	030°	3.0	2.5	322°	0.6	040°, 150°
3	14.5	50	220°	5.9	3.6	226°	0.6	040°, 150°
4	14.5	--	--	--	--	--	2.0	040°, 150°

[2] Wave Height and period are offshore in a water depth of 50 feet
[3] Maximum current observed at maximum flood from the Delft3D flow model simulation

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Hoonah Coastal Management Plan, City of Hoonah, March 2006.

APPENDIX A
DELFT3D NUMERICAL MODEL – FIGURES

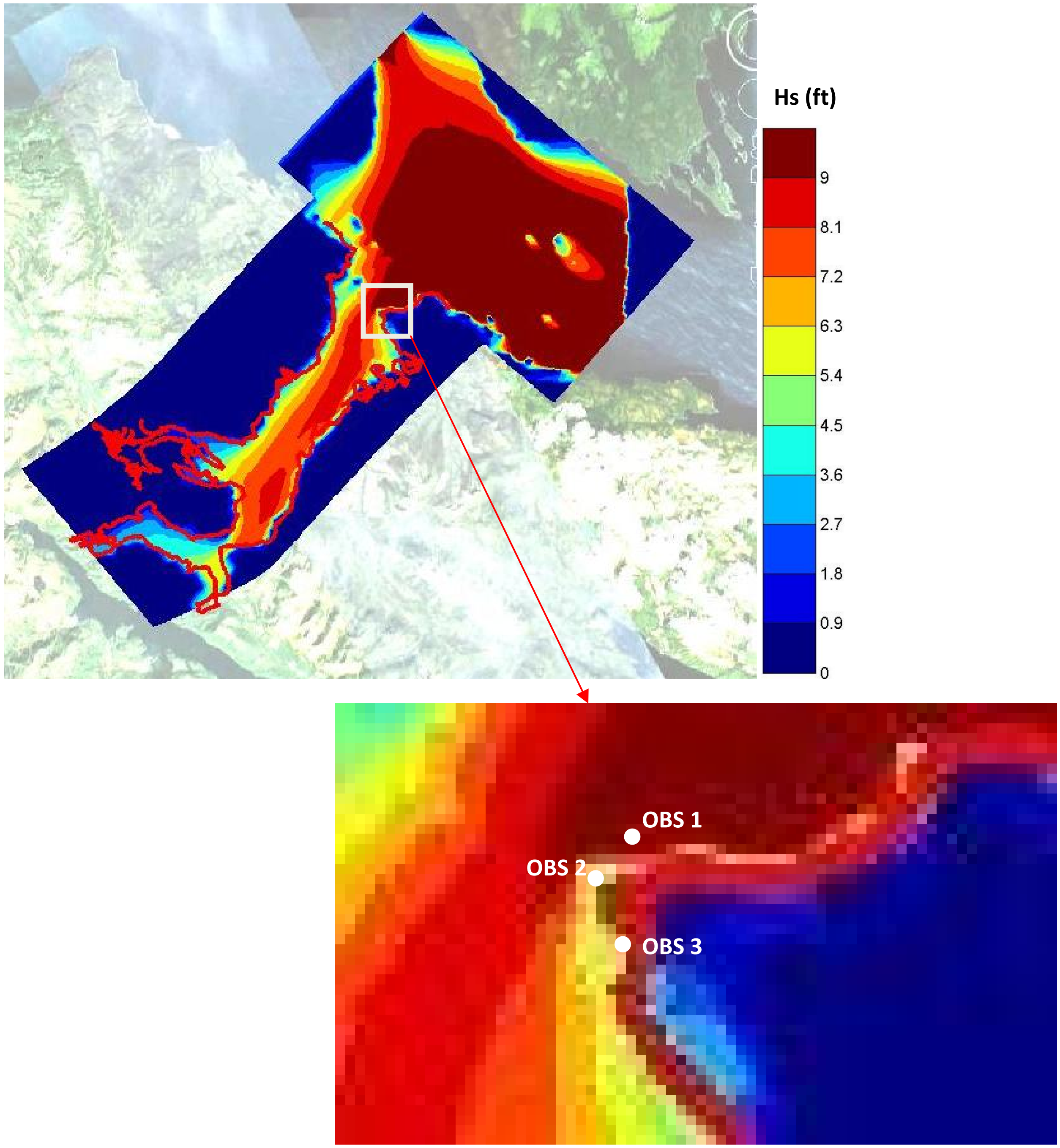


Figure A1. **Delft3D Wave model output for Run R1. Wind Input: speed - 56 knots, direction – azimuth 340°**

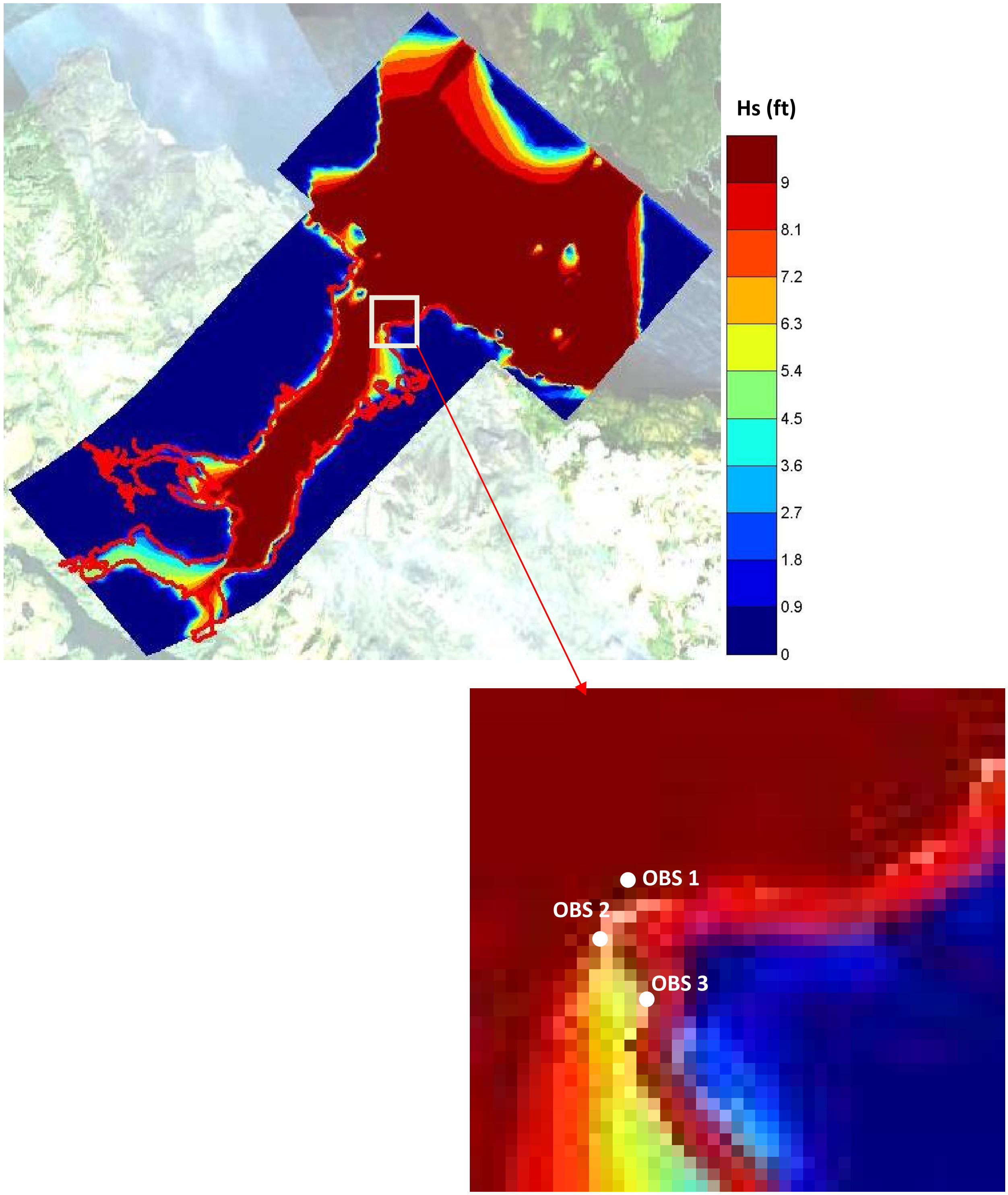


Figure A2. Delft3D Wave model output for Run R2. Wind Input: speed - 66 knots, direction – azimuth 30^{o}

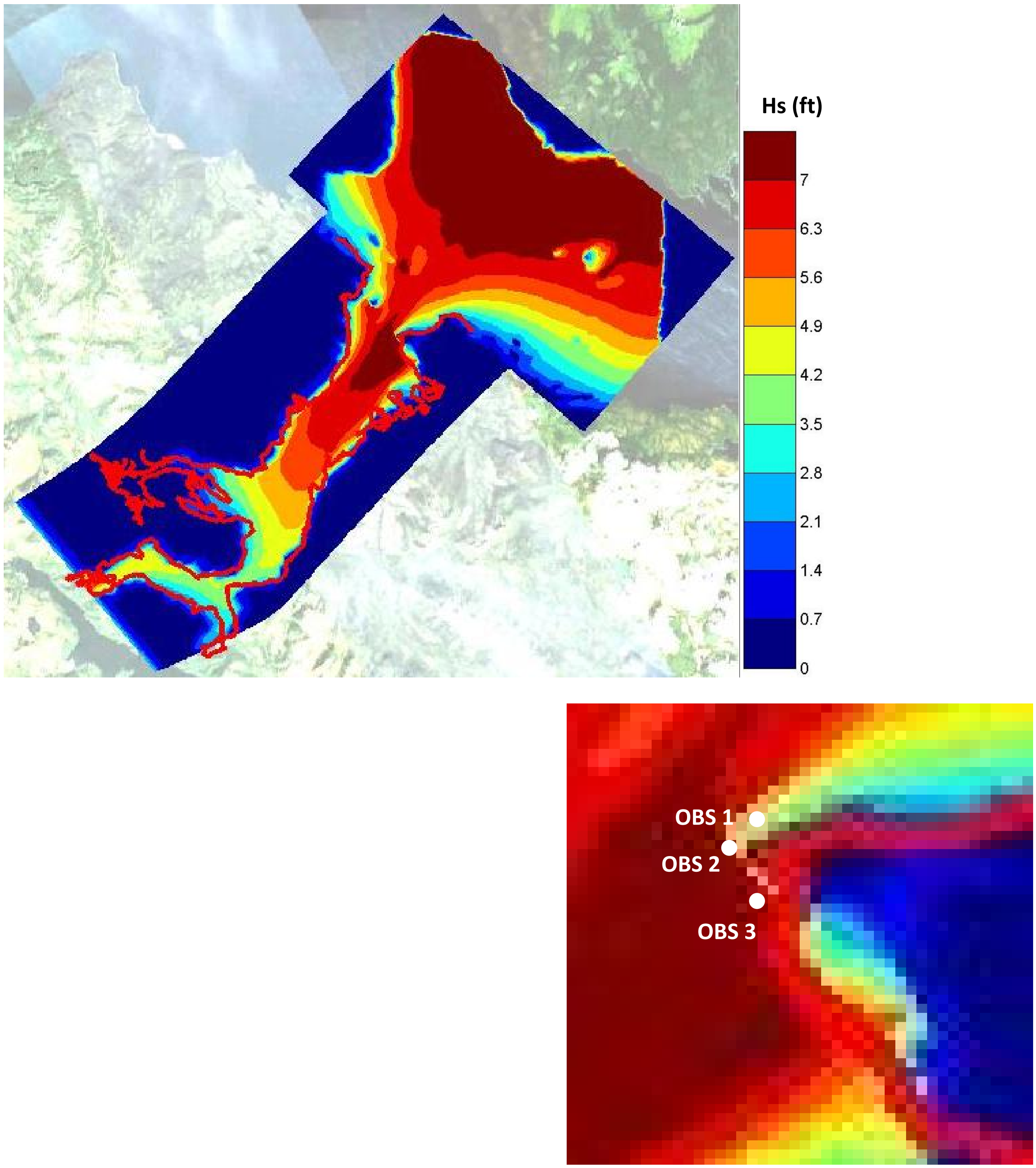


Figure A3. Delft3D Wave model output for Run R3. Wind Input: speed - 50 knots, direction – azimuth 220°

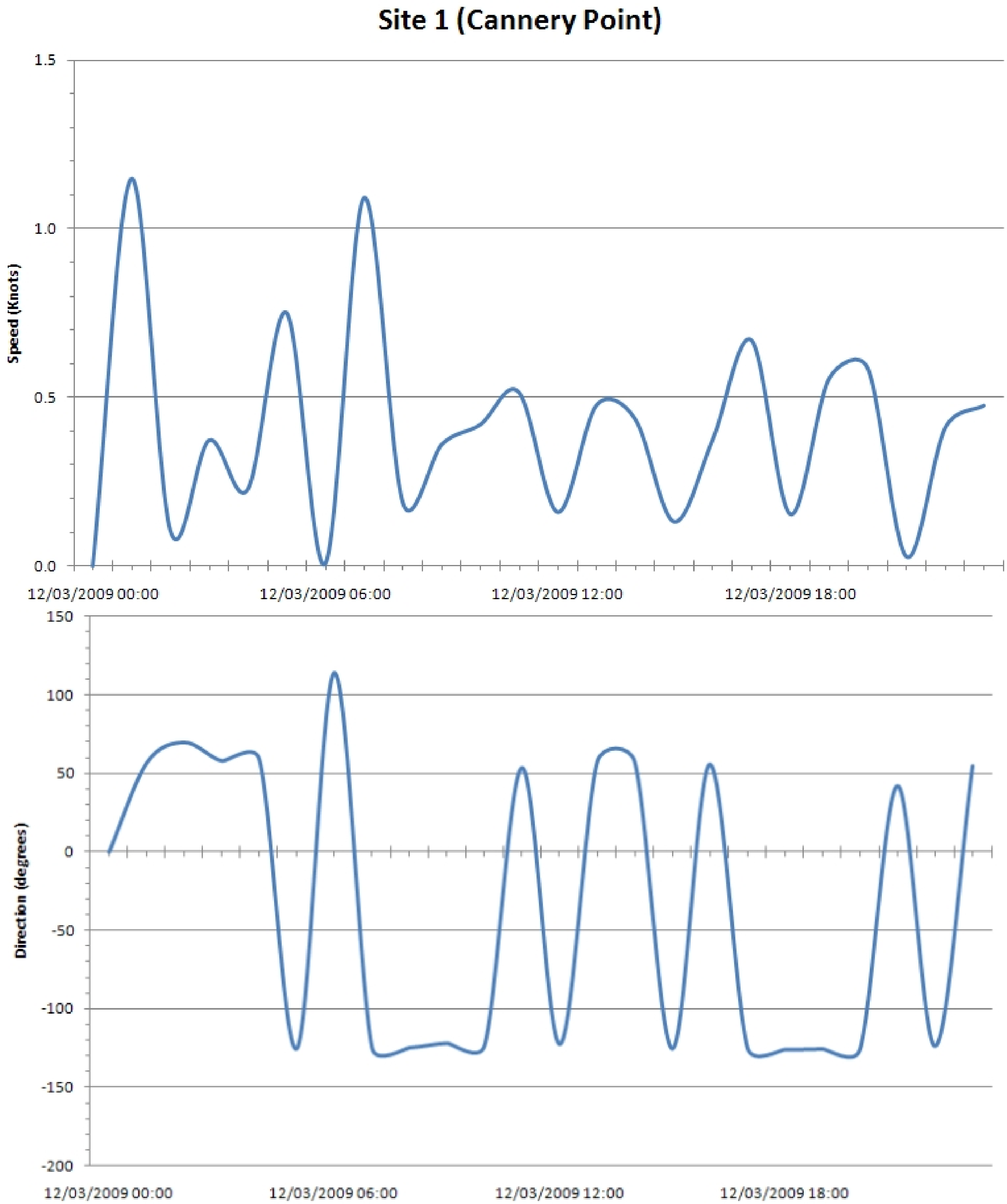


Figure A4. Delft3D Current Model - R1 – Peak Flood – Site 1 – Current Magnitude and Direction.

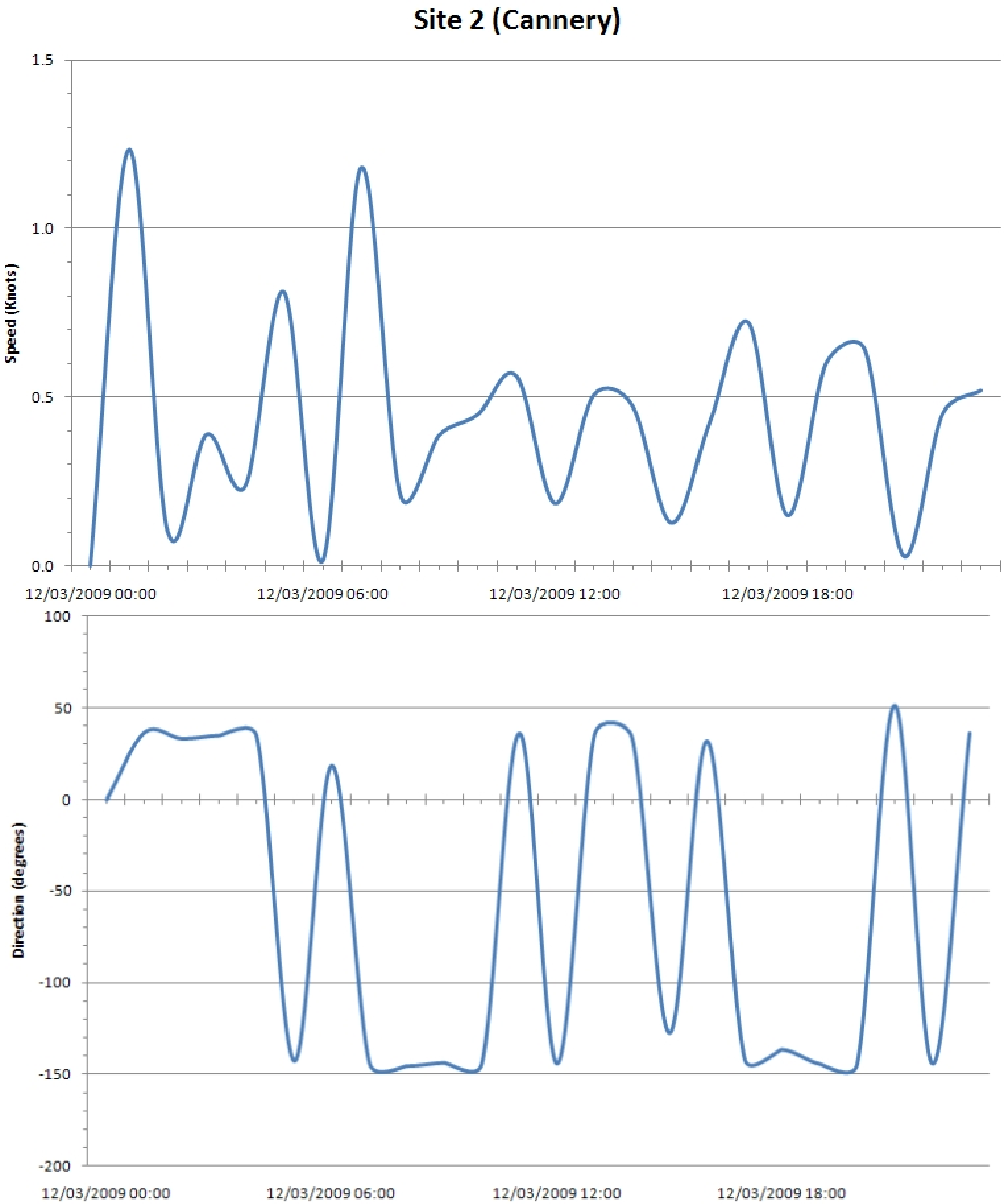


Figure A5. Delft3D Current Model - R1 – Peak Flood – Site 2 – Current Magnitude and Direction.

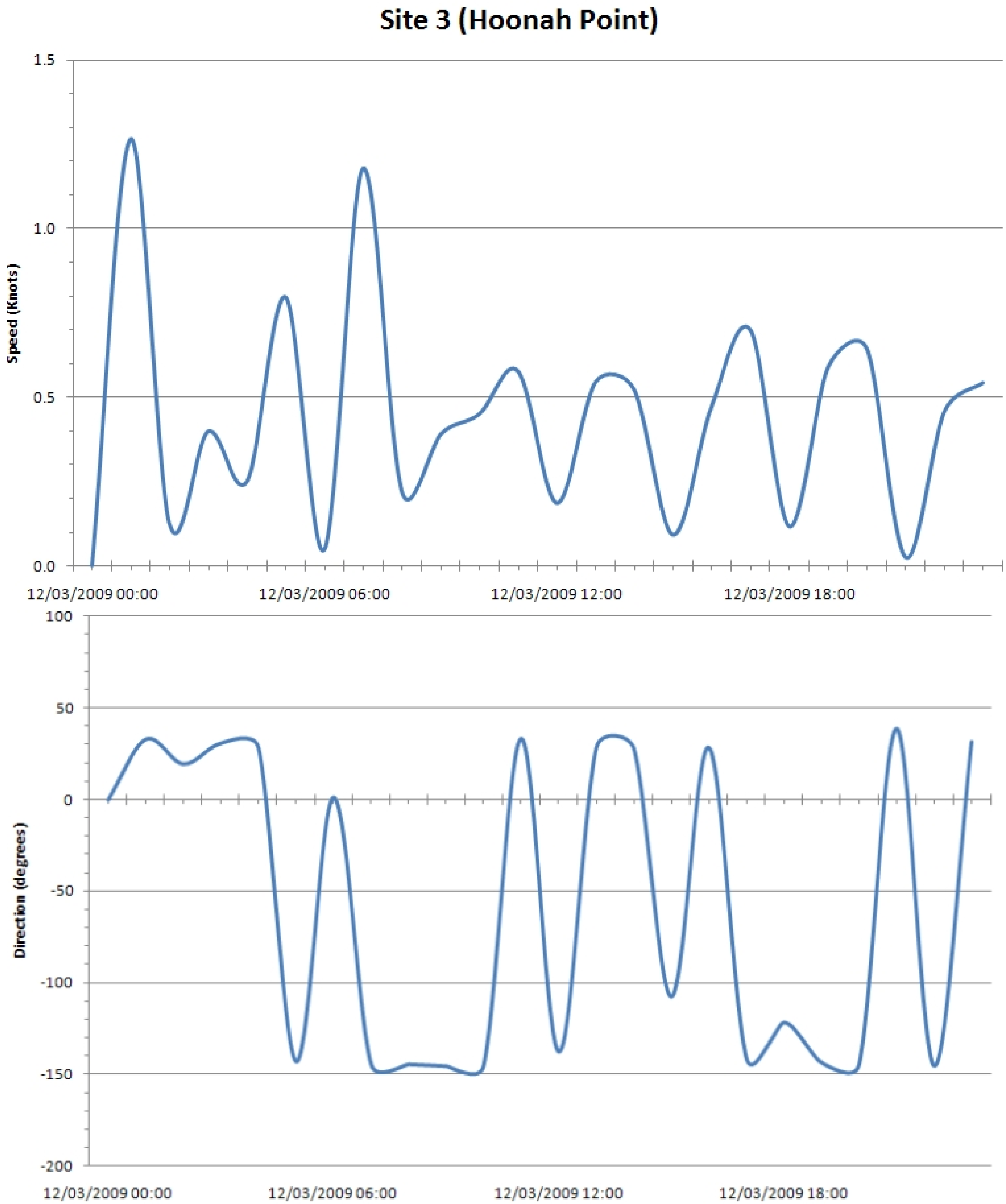


Figure A6. Delft3D Current Model - R1 – Peak Flood – Site 3 – Current Magnitude and Direction.

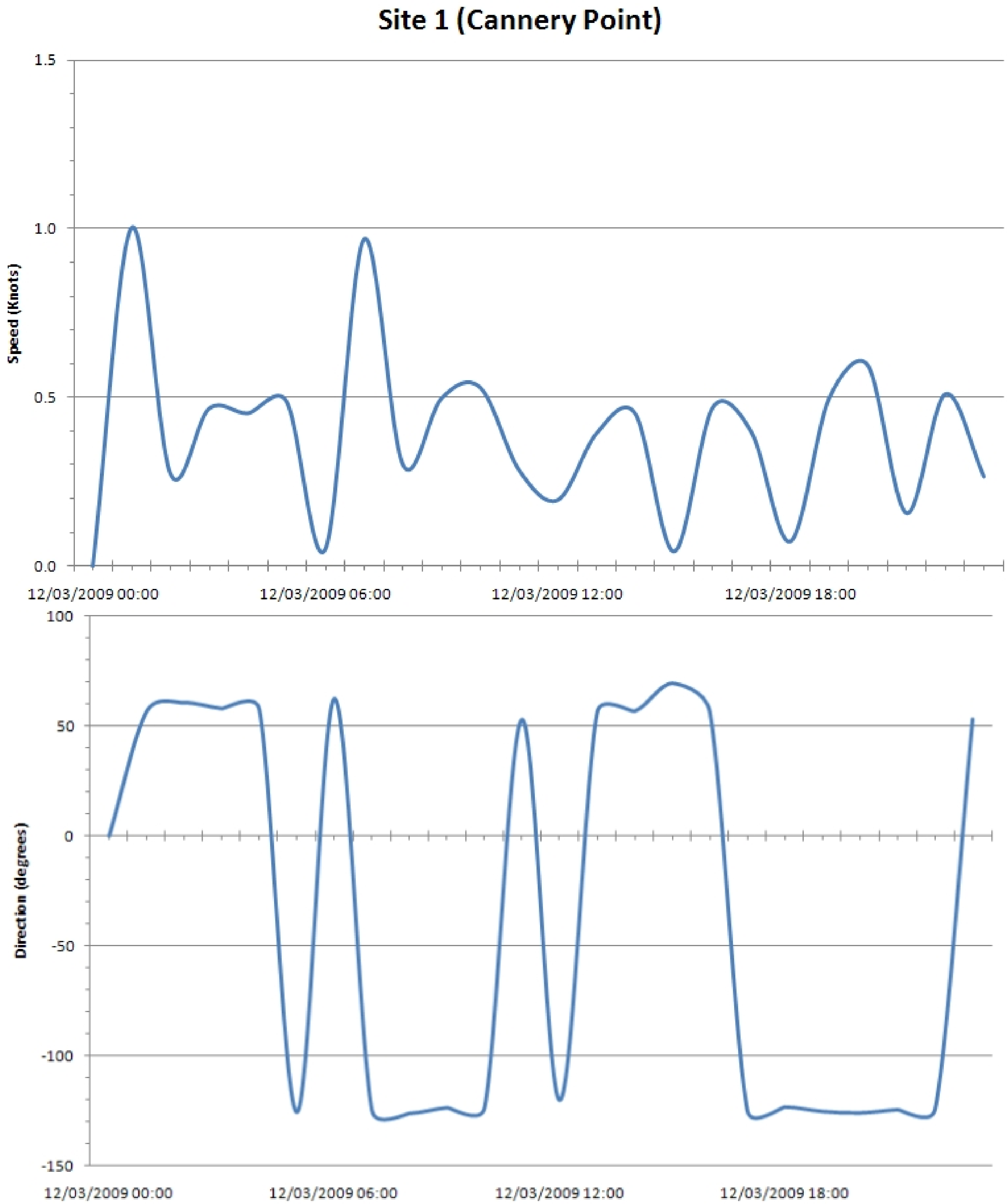


Figure A7. Delft3D Current Model – R2 – Peak Ebb – Site 1 – Current Magnitude and Direction.

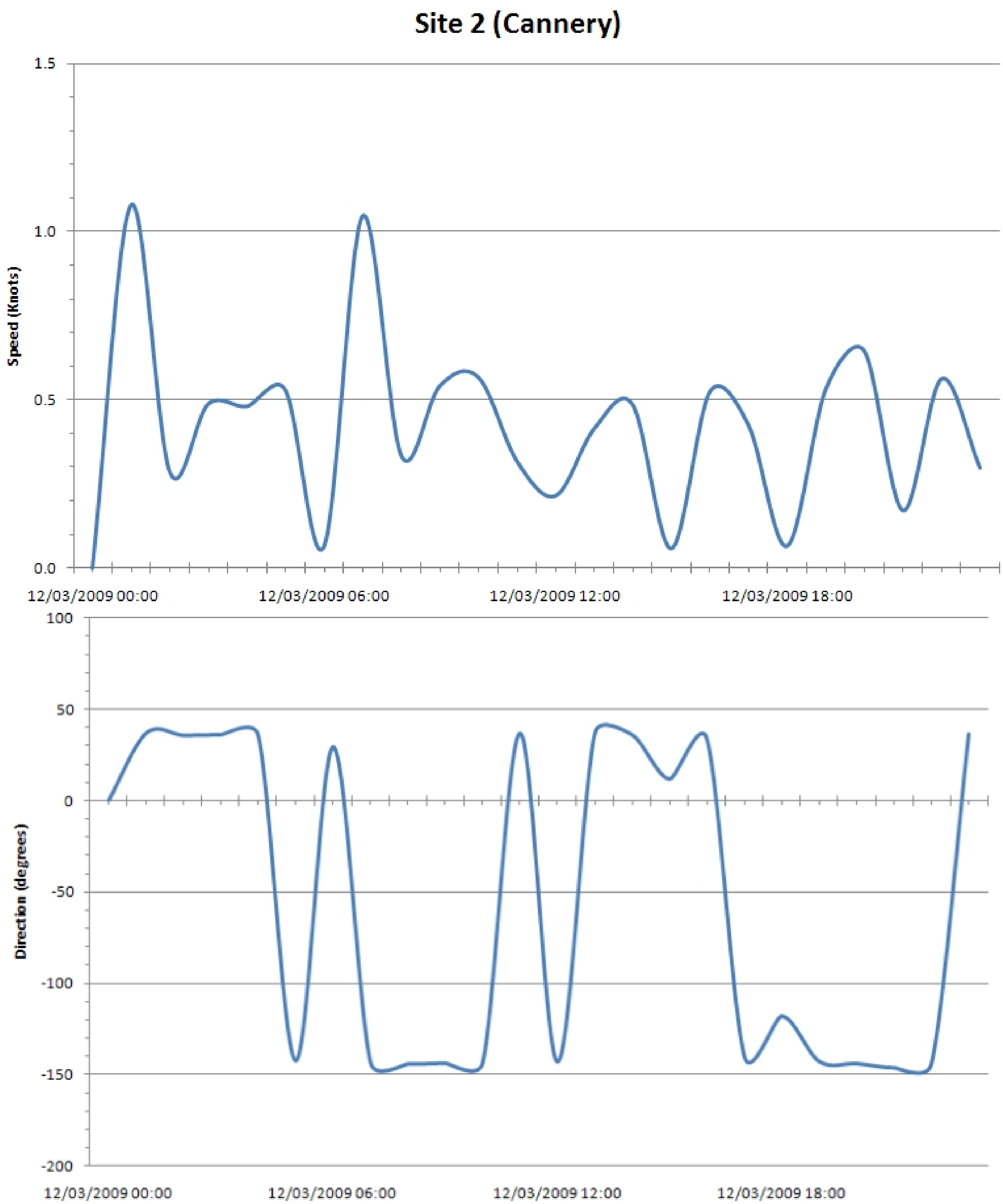


Figure A8. Delft3D Current Model – R2 – Peak Ebb – Site 2 – Current Magnitude and Direction.

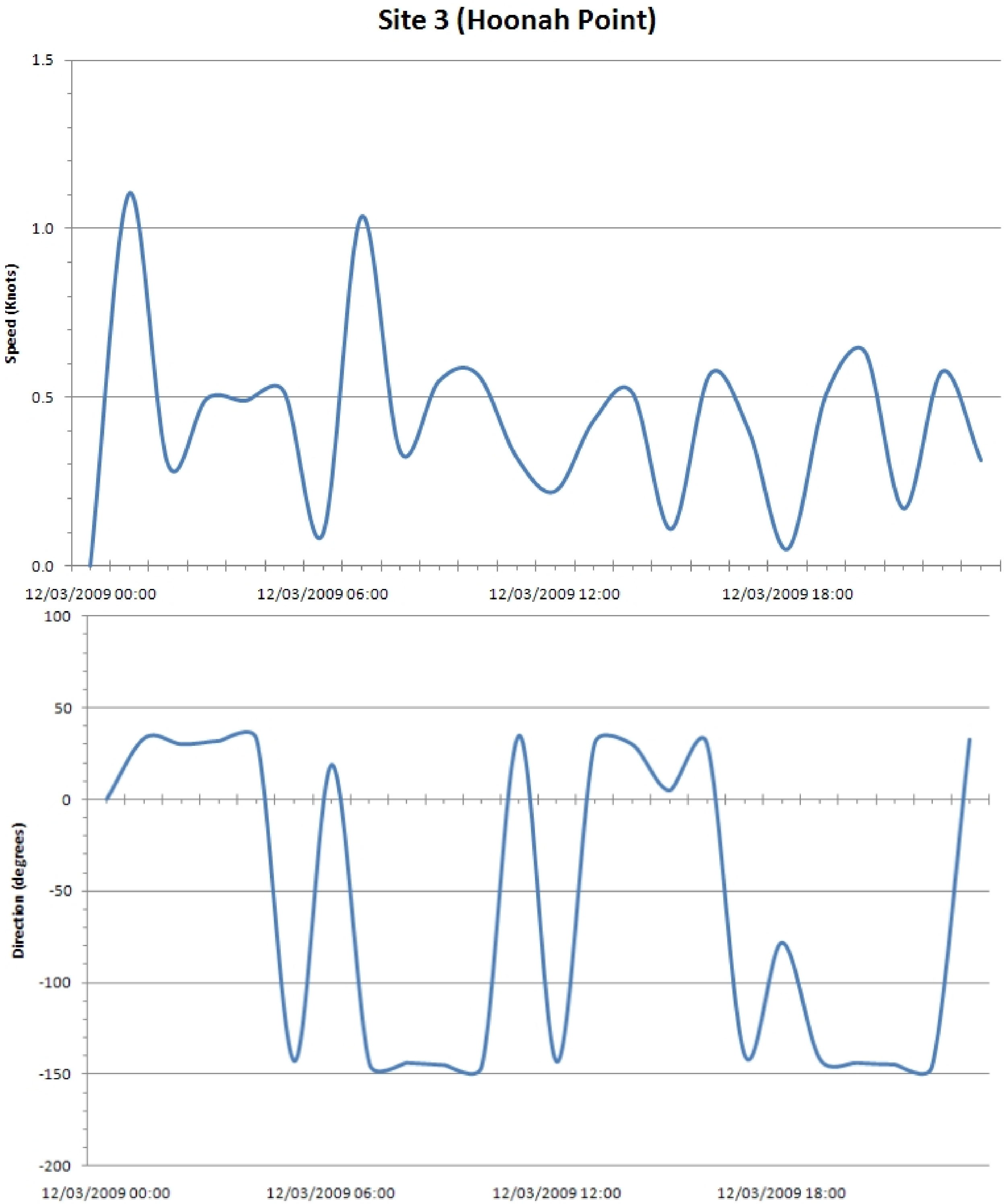


Figure A9. Delft3D Current Model – R2 – Peak Ebb – Site 3 – Current Magnitude and Direction.

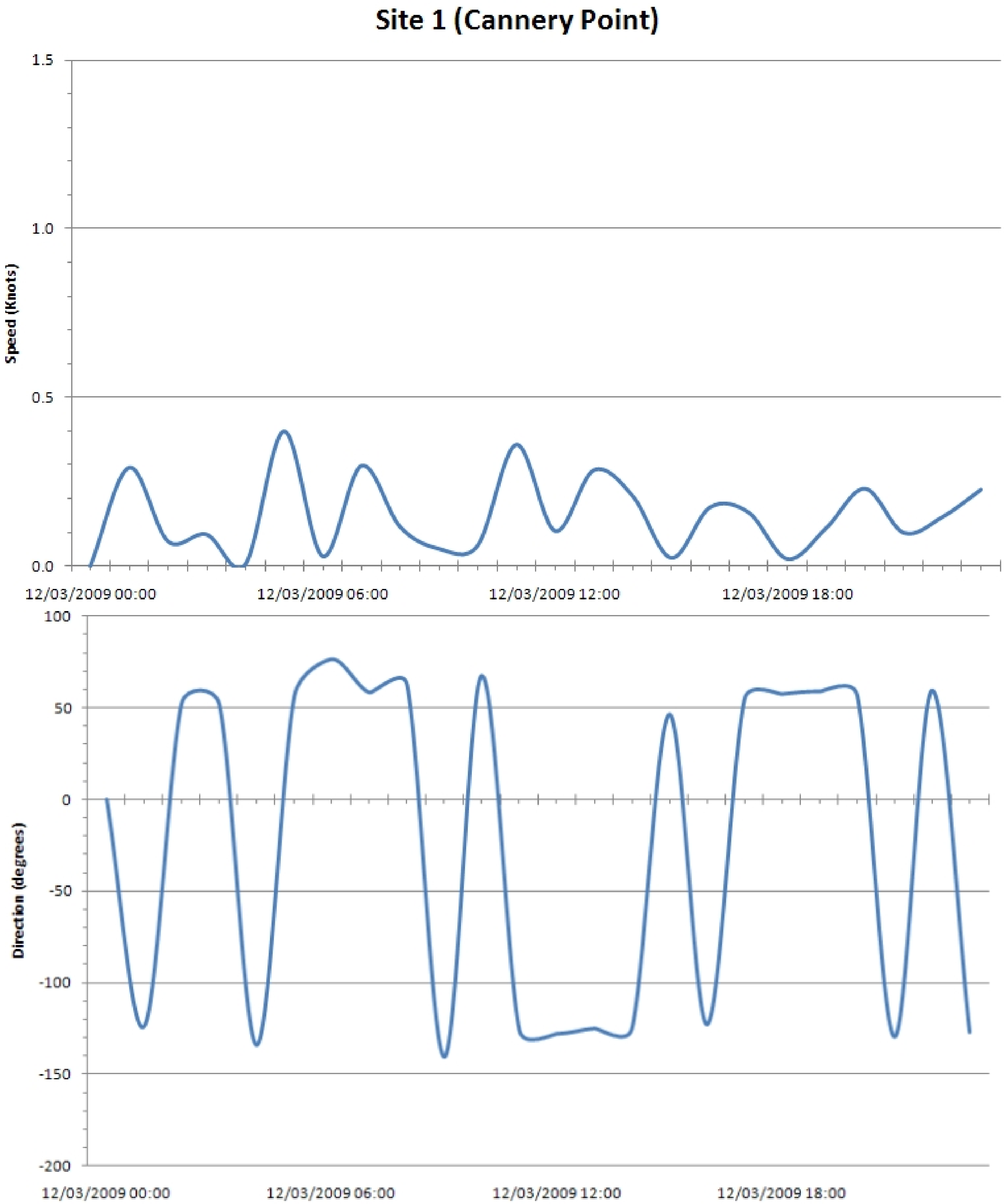


Figure A10. Delft3D Current Model – R3 – Average Tide – Site 1 – Current Magnitude and Direction.

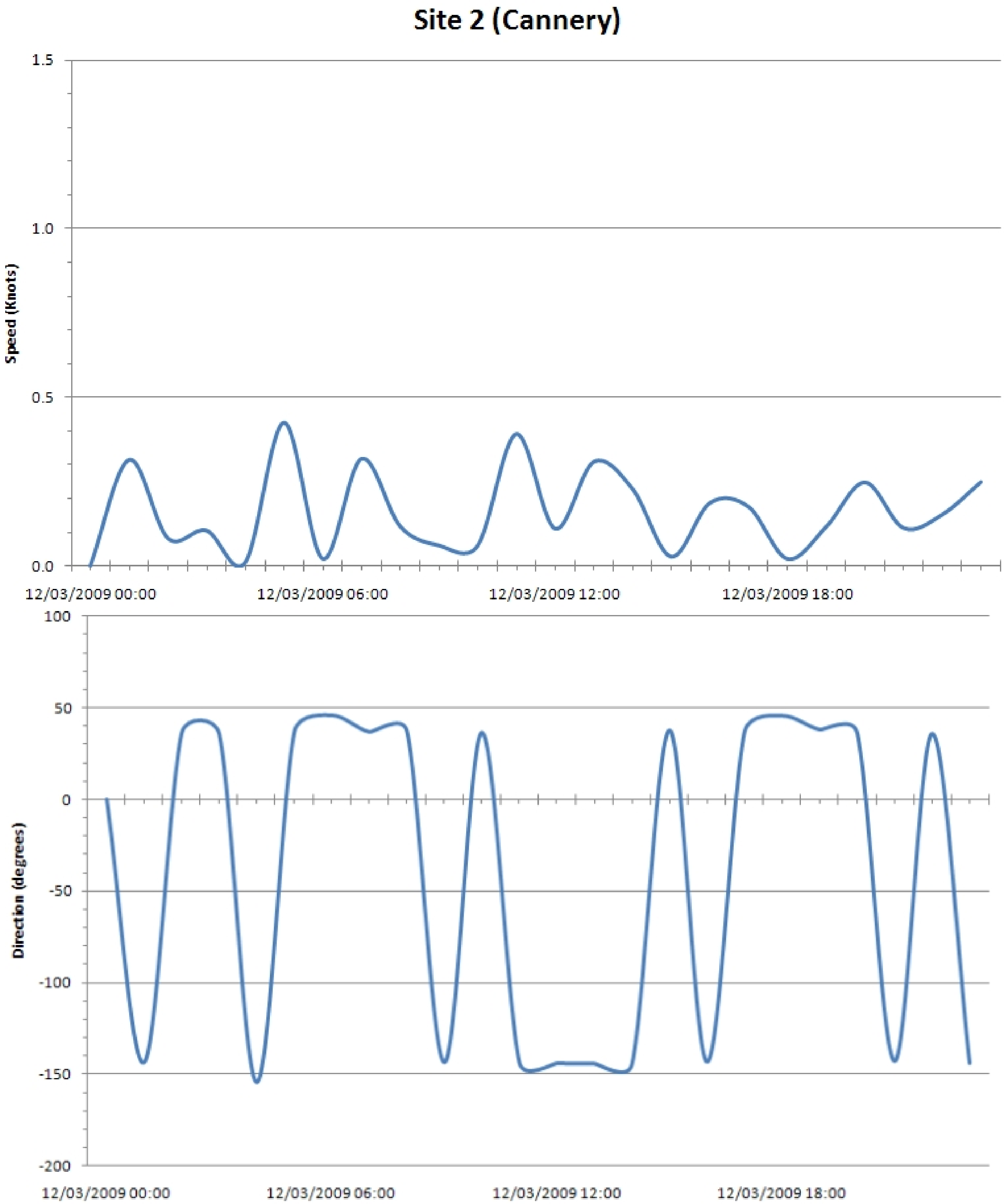


Figure A11. Delft3D Current Model – R3 – Average Tide – Site 2 – Current Magnitude and Direction.

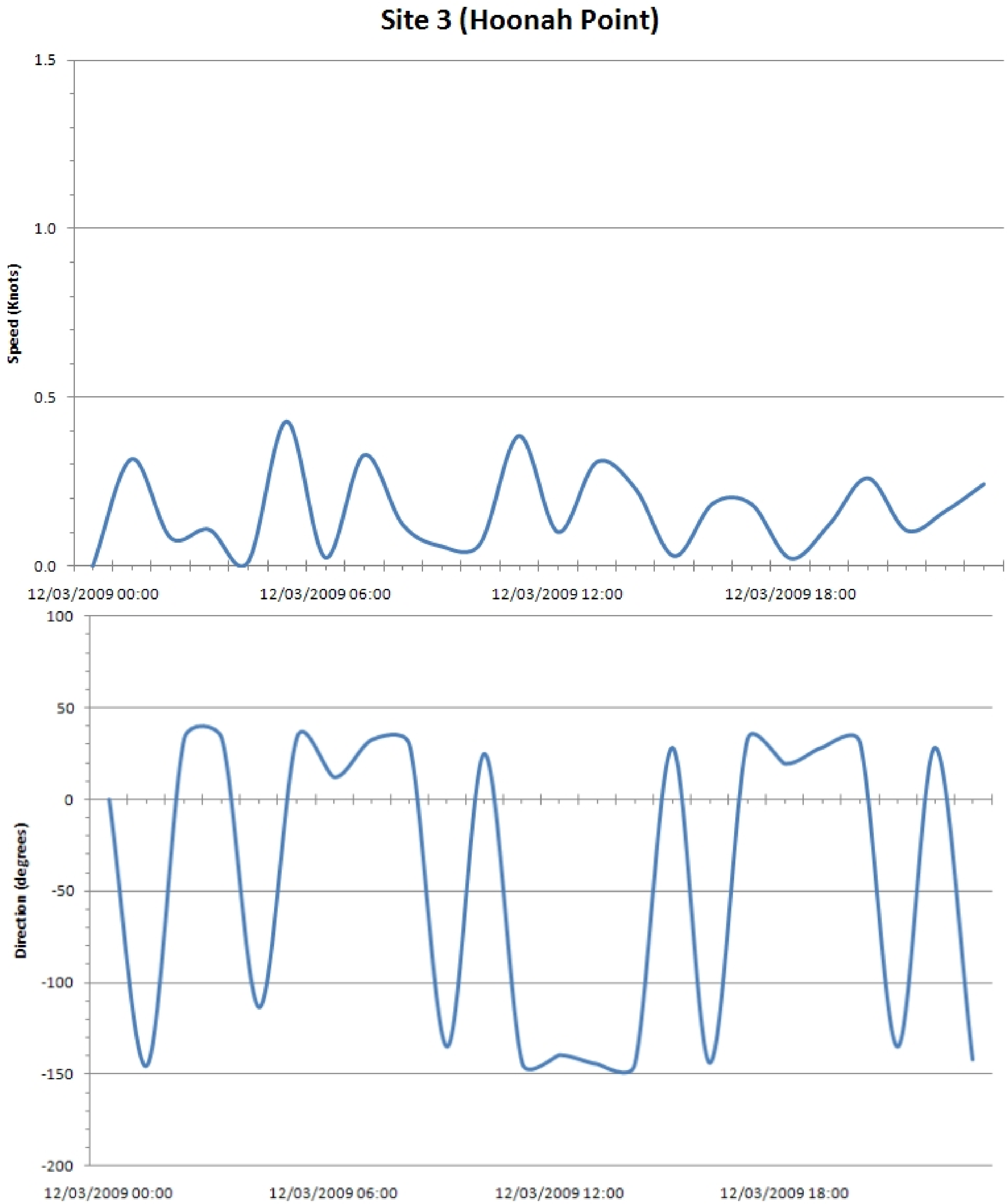


Figure A12. Delft3D Current Model – R3 – Average Tide – Site 2 – Current Magnitude and Direction.

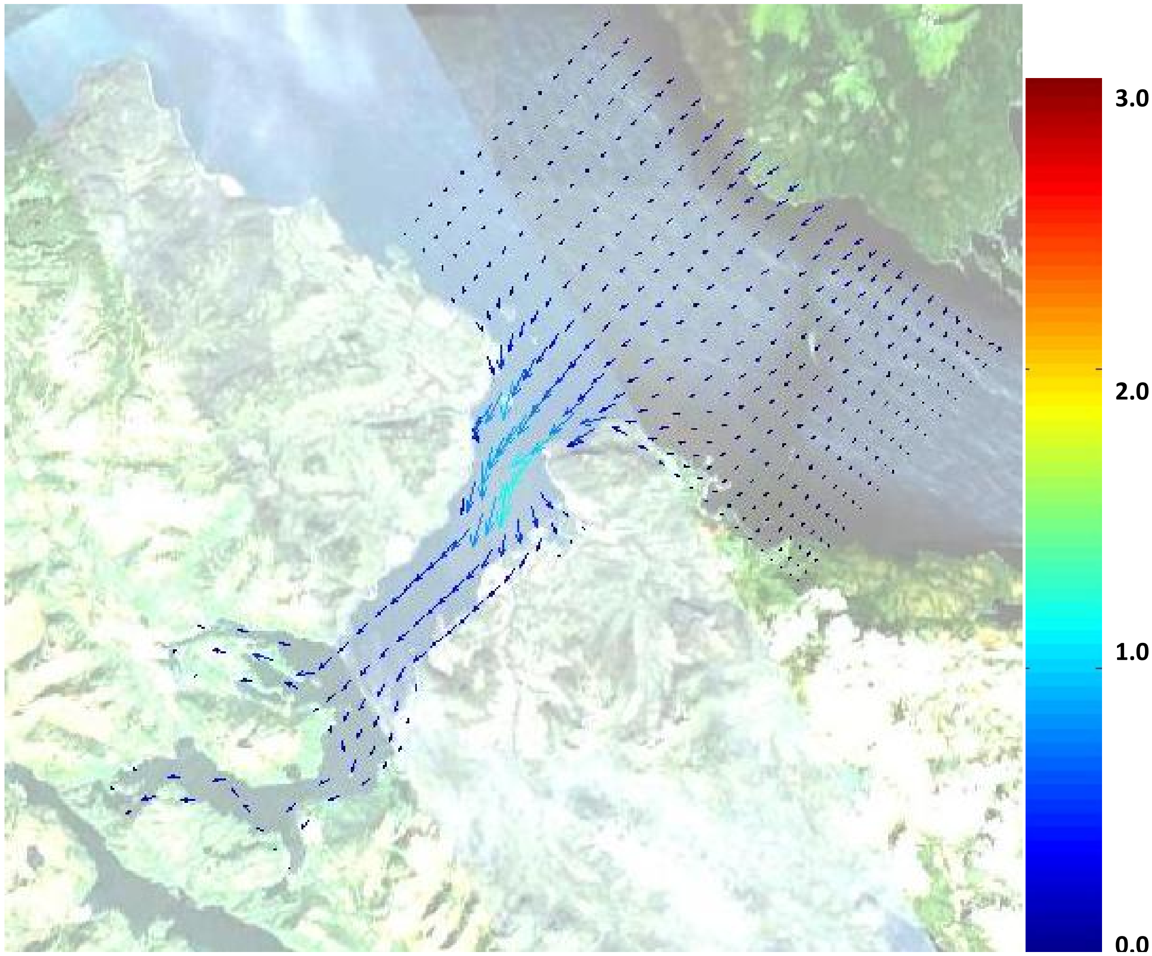


Figure A13. Delft3D Flow Model – R1 – Depth averaged velocity (knots) - 12/3/2009 19:00

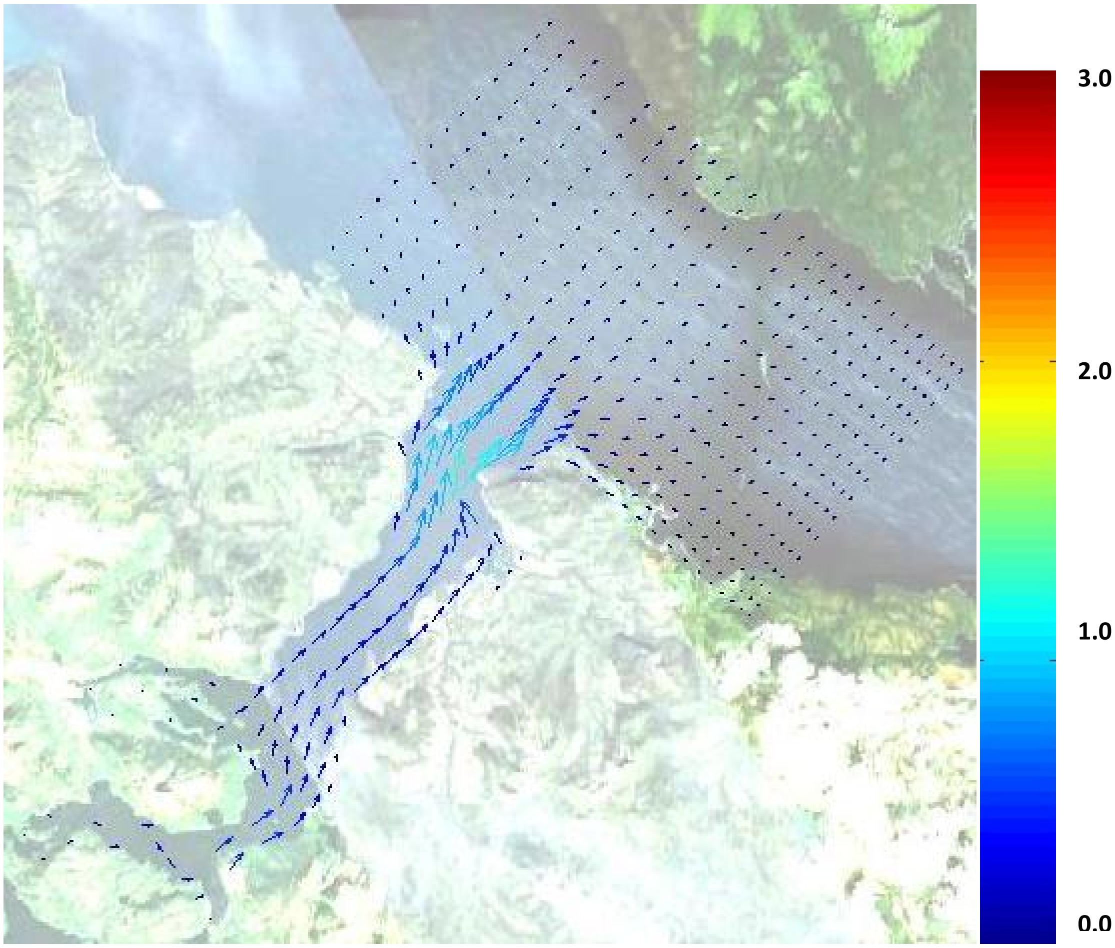
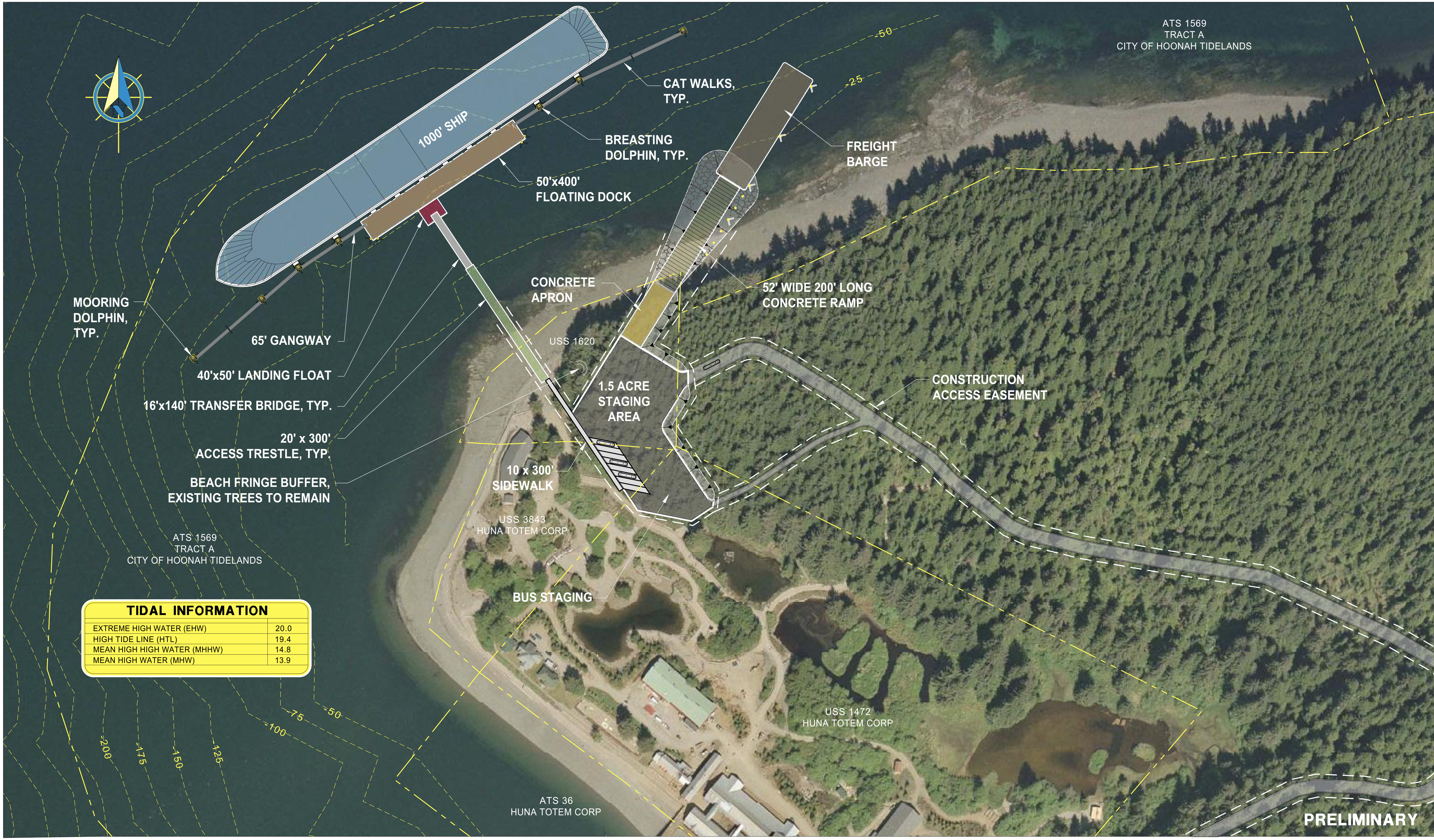


Figure A14. Delft3D Flow Model – R2 – Depth averaged velocity (knots) - 12/4/2009 1:00

Appendix B: Concept Designs for Site Analysis Comparison



TIDAL INFORMATION

EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.4
MEAN HIGH HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

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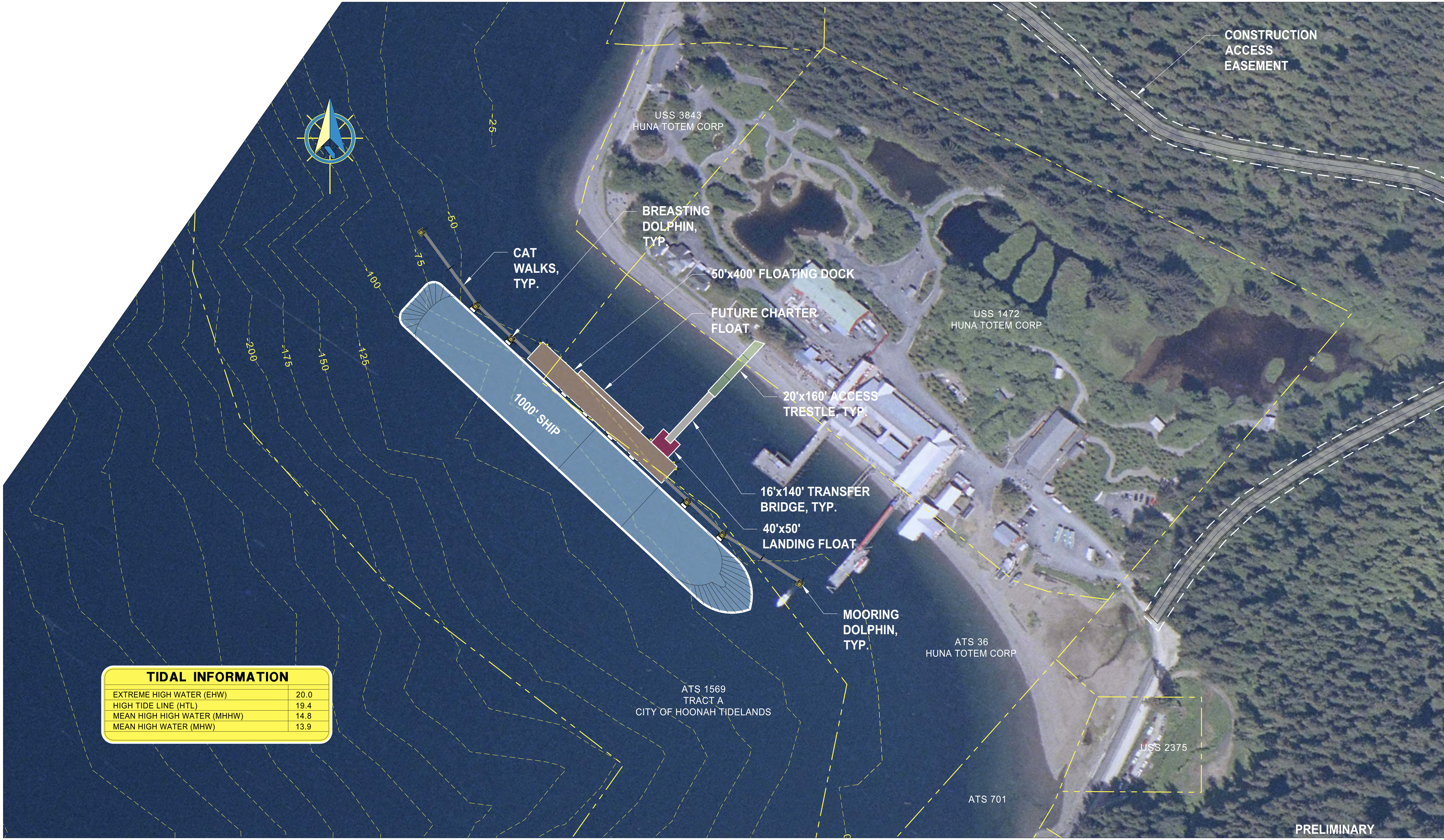
HOONAH BERTHING FACILITY

SHEET TITLE: SITE NO. 1 PLAN CANNERY POINT

PN&D PROJECT NO.: 112051 DWG. FILE:

SHEET 1
1 OF 3



TIDAL INFORMATION	
EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.4
MEAN HIGH HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

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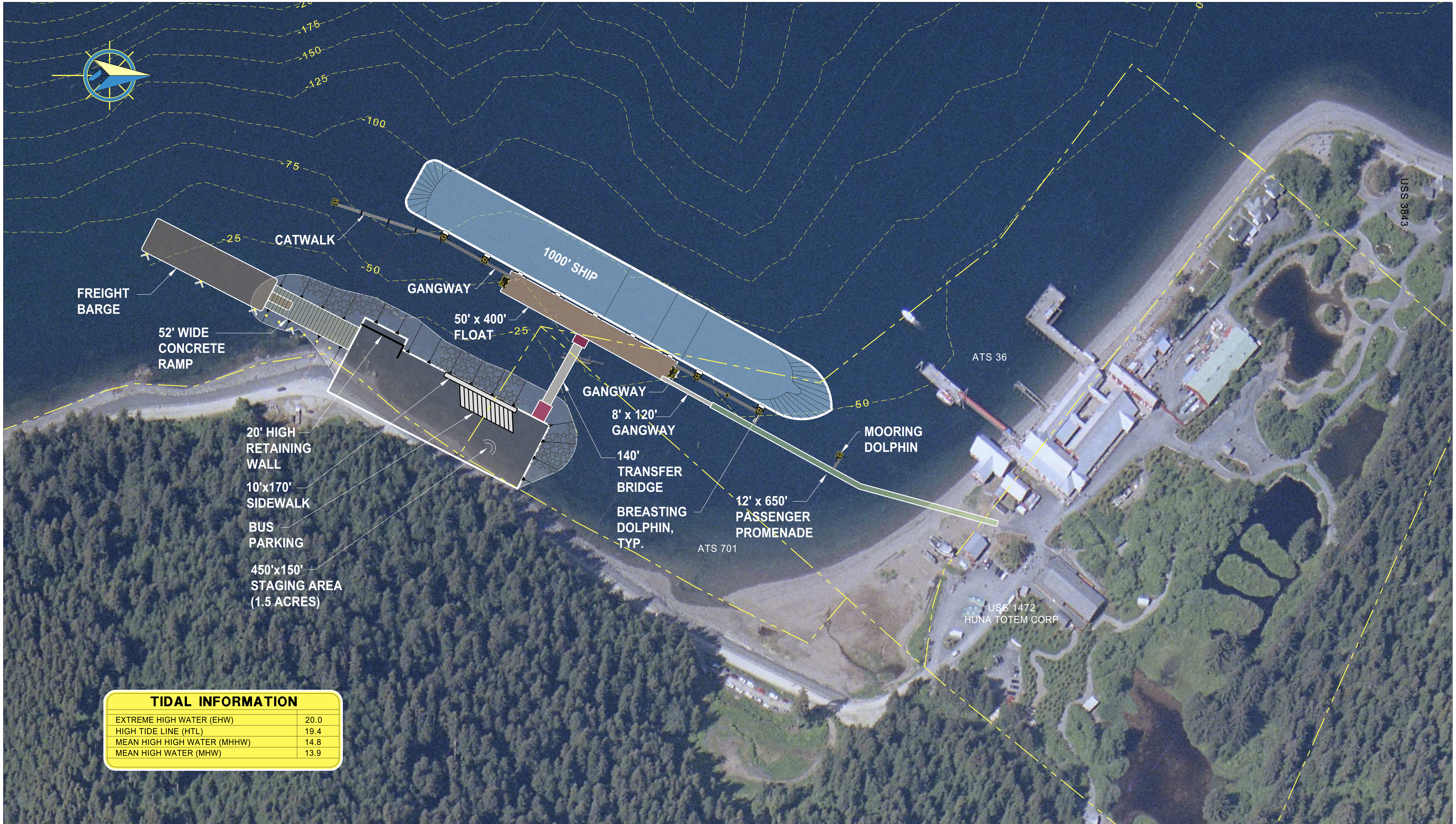
HOONAH BERTHING FACILITY

SHEET TITLE: SITE NO. 2 PLAN

PN&D PROJECT NO.: 112051
DWG. FILE:

SHEET 2 OF 3



TIDAL INFORMATION

EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.4
MEAN HIGH HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

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CITY OF HOONAH
HOONAH BERTHING FACILITY

SHEET TITLE: SITE 3 PLAN SHAMAN (HOONAH) POINT

PN&D PROJECT NO.: 112051 DWG. FILE:

Appendix C: Budget Level Cost Estimates

Site 1 - Cannery Point
Concept Design
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost	Component Cost
Mobilization (8 percent of all other construction items)	1	LS	$1,622,400	$1,622,400	
Mooring Dolphins	2	EA	$450,000	$900,000	
Breasting Dolphins	4	EA	$575,000	$2,300,000	
Floating Dock Pile Restraints	2	EA	$1,000,000	$2,000,000	
Catwalks	700	LF	$575	$402,500	
Gangways to Dolphins and Catwalks	2	EA	$75,000	$150,000	
Float - 400' x 50'	20,000	SF	$290	$5,800,000	
Floating Dock Marine Fenders	6	EA	$40,000	$240,000	
Transfer Bridge with Support Float and Abutment	1	LS	$1,350,000	$1,350,000	
Access Trestle	6,000	SF	$225	$1,350,000	
Rock Anchor Contingency	55	EA	$20,000	$1,100,000	$16,839,900
Uplands Staging Area	1.5	Acres	$250,000	$375,000	
Sidewalk to Bus Staging	50	CY	$750	$37,500	
Freight Ramp with Concrete Planks, Dolphins, Guide Piles	1	LS	$1,800,000	$1,800,000	
Site Lighting (excluding Utility Co. Service to Site)	1	LS	$250,000	$250,000	
Access Road (2 Lane, 24 feet Wide)	1	LS	$2,225,000	$2,225,000	$5,062,500
Construction Subtotal				$21,902,400	$21,902,400
Contingency	15.0%				$3,285,400
Total Estimated Construction					$25,187,800
Permitting & Mitigation					$250,000
Bathymetry and Uplands Surveying					$75,000
Geotechnical Investigation (Marine & Uplands)					$400,000
Final Design	5.5%				$1,385,300
Contract Administration and Construction Inspection	5.5%				$1,385,300
Total Estimated Project Costs					$28,683,400

Note: Due to environmental wind and wave conditions at Site 1, an alternative pile supported dock may be required in lieu of a floating structure. Further analysis is recommneded during final design.

Site 2 - Cannery
Concept Design
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost	Component Cost
Mobilization (8 percent of all other construction items)	1	LS	$1,204,500	$1,204,500	
Mooring Dolphins	2	EA	$450,000	$900,000	
Breasting Dolphins	4	EA	$575,000	$2,300,000	
Floating Dock Pile Restraints	2	EA	$1,000,000	$2,000,000	
Catwalks	655	LF	$575	$376,625	
Gangways to Dolphins and Catwalks	2	EA	$75,000	$150,000	
Float - 400' x 50'	20,000	SF	$290	$5,800,000	
Floating Dock Marine Fenders	6	EA	$40,000	$240,000	
Transfer Bridge with Float and Abutment	1	LS	$1,350,000	$1,350,000	
Access Trestle	3200	SF	$225	$720,000	
Rock Anchor Contingency	51	EA	$20,000	$1,020,000	
Site Lighting (excluding Utility Co. Service to Site)	1	LS	$200,000	$200,000	$16,261,155
Construction Subtotal				$16,261,125	$16,261,155
Contingency	15.0%				$2,439,200
Total Estimated Construction					$18,700,355
Permitting & Mitigation					$100,000
Bathymetry and Uplands Surveying					$50,000
Geotechnical Investigation (Marine)					$350,000
Final Design	5.5%				$1,028,500
Contract Administration and Construction Inspection	5.5%				$1,028,500
Total Estimated Project Costs					$21,257,355

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Site 3 - Shaman (Hoonah) Point Point
Concept Design
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost	Component Cost
Mobilization (8 percent of all other construction items)	1	LS	$1,472,600	$1,472,600	
Mooring Dolphins	2	EA	$450,000	$900,000	
Breasting Dolphins	4	EA	$575,000	$2,300,000	
Floating Dock Pile Restraints	2	EA	$1,000,000	$2,000,000	
Catwalks	500	LF	$575	$287,500	
Gangways to Dolphins and Catwalks	2	EA	$75,000	$150,000	
Float - 400' x 50'	20,000	SF	$290	$5,800,000	
Floating Dock Marine Fenders	6	EA	$40,000	$240,000	
Transfer Bridge with Float and Abutment	1	LS	$1,350,000	$1,350,000	
Access Trestle	800	SF	$225	$180,000	
Promenade with Gangway	1	LS	$1,685,000	$1,685,000	
Rock Anchor Contingency	47	EA	$20,000	$940,000	$17,099,100
Uplands Staging Area	1.5	Acres	$350,000	$525,000	
Freight Ramp with Concrete Planks, Dolphins, Guide Piles	1	LS	$1,800,000	$1,800,000	
Site Lighting (excluding Utility Co. Service to Site)	1	LS	$250,000	$250,000	$2,781,000
Construction Subtotal				$19,880,100	$19,880,100
Construction Contingency	15.0%				$2,982,000
Total Estimated Construction					$22,862,100
Permitting & Mitigation					$250,000
Bathymetry and Uplands Surveying					$50,000
Geotechnical Investigation (Marine)					$350,000
Final Design	5.5%				$1,257,400
Contract Administration and Construction Inspection	5.5%				$1,257,400
Total Estimated Project Costs					$26,026,900

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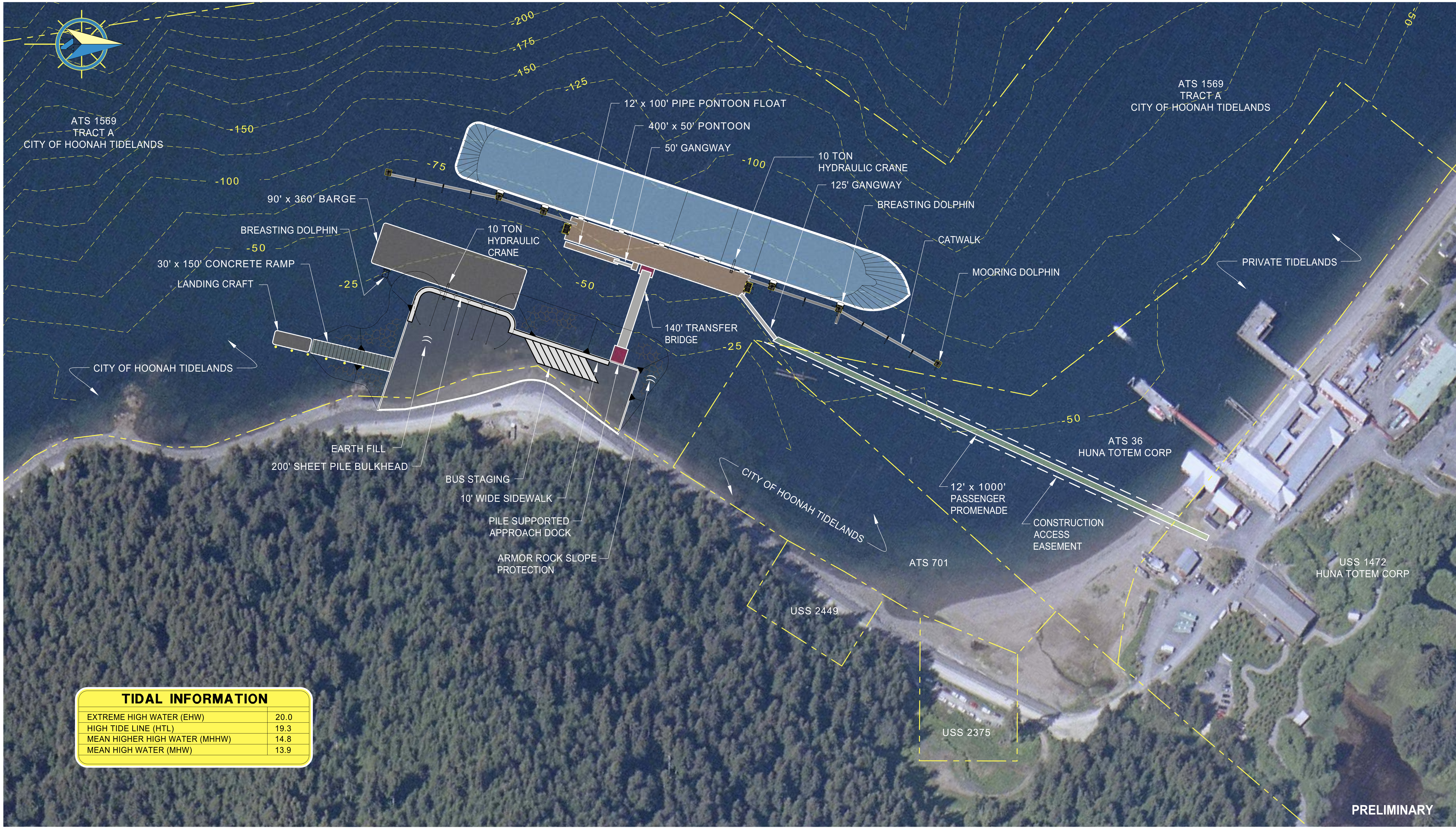
Appendix D: Refined Concept Plan for Preferred Site and Budget Level Cost Estimates



TIDAL INFORMATION

EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.3
MEAN HIGHER HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

NOTE: BATHYMETRIC CONTOURS FROM NOAA AND THE CITY OF HOONAH.

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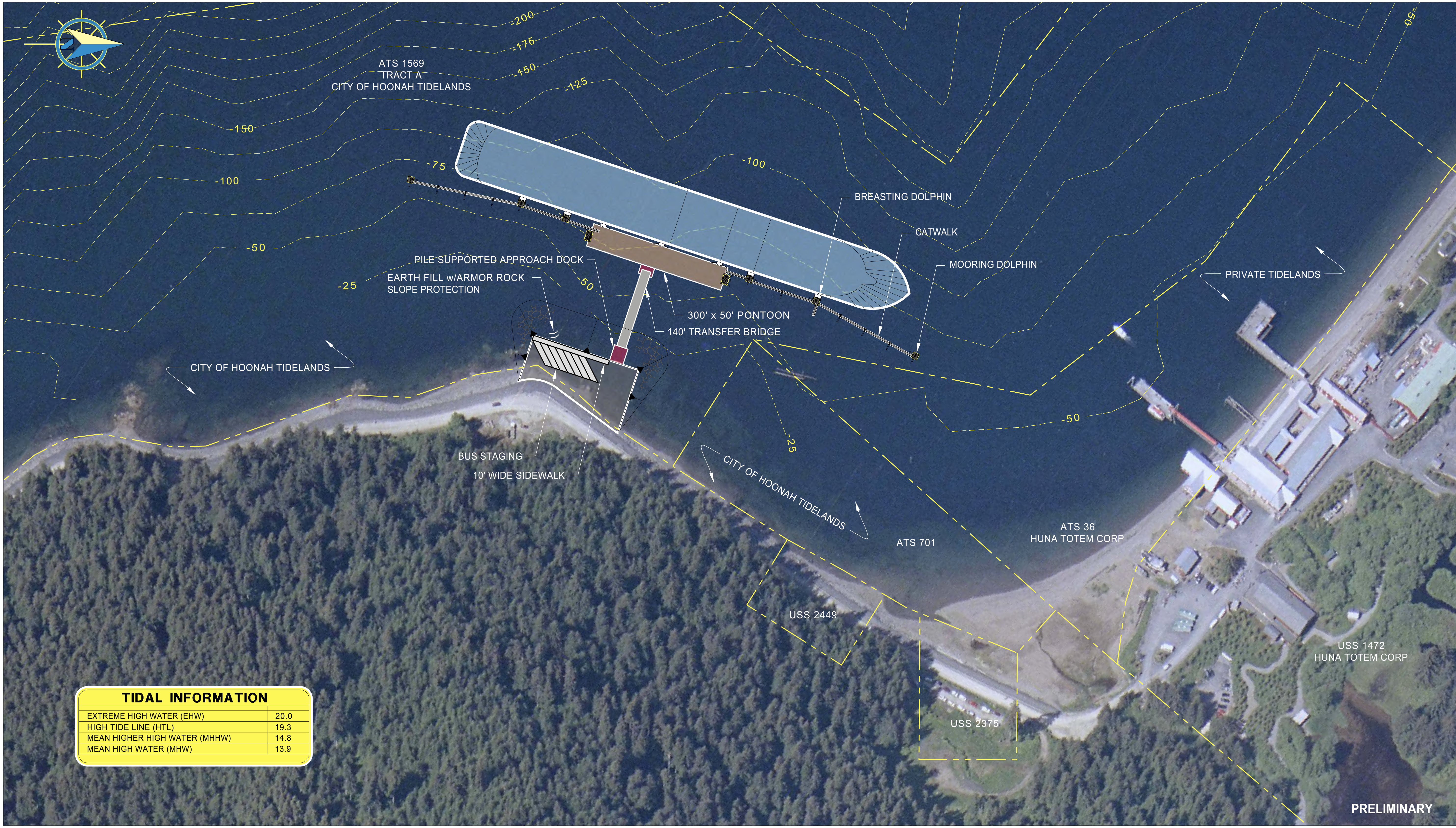
SHEET TITLE: SITE 3 PLAN (BASE BID w/ ALTERNATIVES) SHAMAN (HOONAH) POINT

PN&D PROJECT NO.: 112051 DWG. FILE:

SHEET 1 — 1 OF 3



TIDAL INFORMATION

EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.3
MEAN HIGHER HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

NOTE: BATHYMETRIC CONTOURS FROM NOAA AND THE CITY OF HOONAH.

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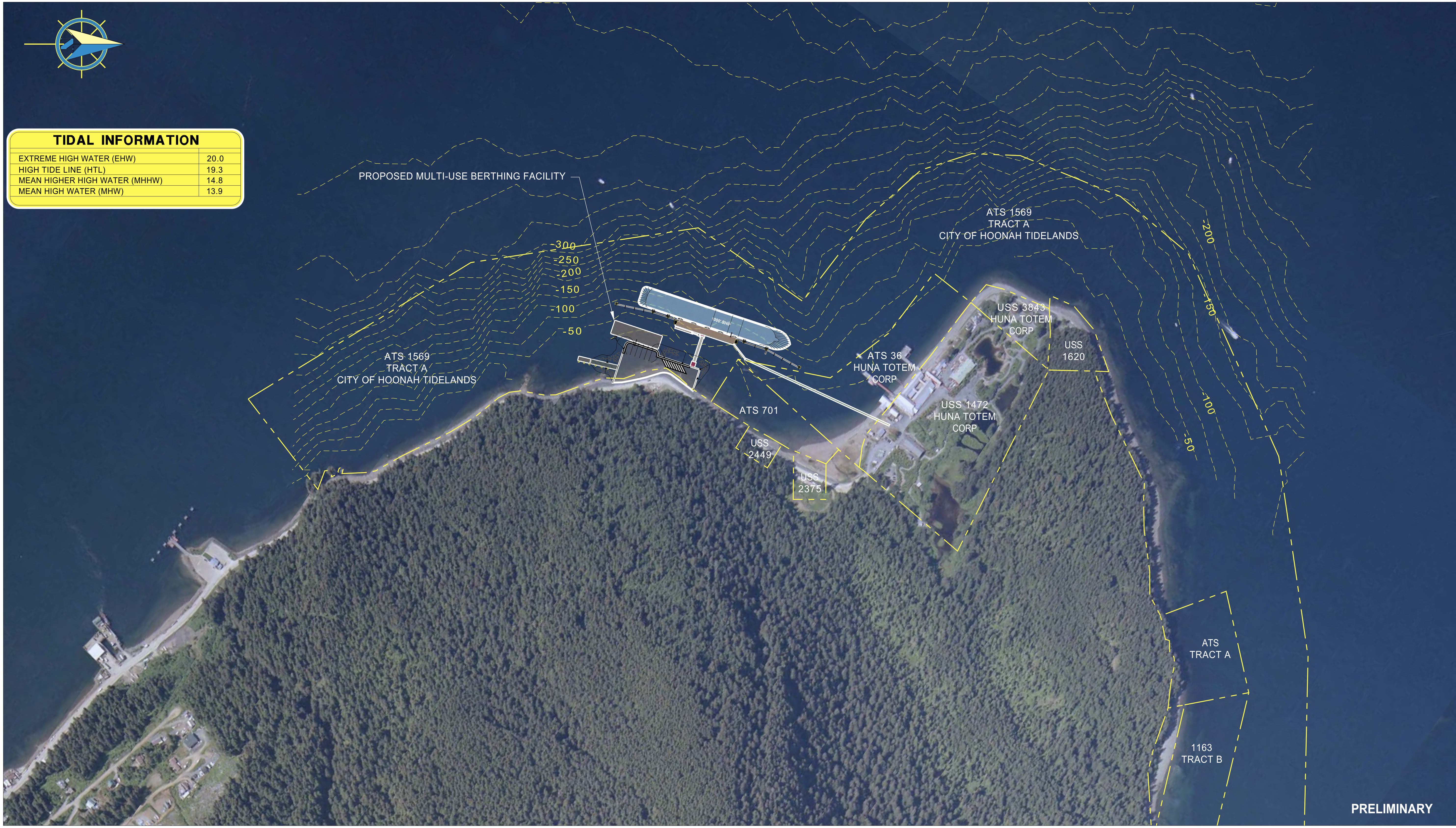
HOONAH BERTHING FACILITY

SHEET TITLE: SITE 3 PLAN (BASE BID)
SHAMAN (HOONAH) POINT

PN&D PROJECT NO.: 112051 DWG. FILE:

SHEET 2 OF 3



TIDAL INFORMATION

EXTREME HIGH WATER (EHW)	20.0
HIGH TIDE LINE (HTL)	19.3
MEAN HIGHER HIGH WATER (MHHW)	14.8
MEAN HIGH WATER (MHW)	13.9

NOTE: BATHYMETRIC CONTOURS FROM NOAA AND THE CITY OF HOONAH.

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SHEET TITLE:
SITE 3 PLAN (BASE BID w/ ALTERNATIVES)
SHAMAN (HOONAH) POINT - VICINITY PLAN

PN&D PROJECT NO.: 112051 DWG. FILE:

SHEET 3 OF 3

Site 3 - Shaman (Hoonah) Point Point
Concept Design - Base Bid
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost	Component Cost
Mobilization (8 percent of all other construction items)	1	LS	$1,055,800	$1,055,800	
Mooring Dolphins	2	EA	$500,000	$1,000,000	
Breasting Dolphins	4	EA	$625,000	$2,500,000	
Floating Dock Pile Restraints	2	EA	$1,000,000	$2,000,000	
Catwalks	500	LF	$575	$287,500	
Gangways to Dolphins and Catwalks	2	EA	$75,000	$150,000	
Float - 300' x 50'	15,000	SF	$250	$3,750,000	
Floating Dock Marine Fenders	6	EA	$40,000	$240,000	
Transfer Bridge with Float and Abutment	1	LS	$1,350,000	$1,350,000	
Access Trestle	800	SF	$225	$180,000	
Rock Anchor Contingency	27	EA	$20,000	$540,000	$13,053,300
Uplands Staging Area	0.6	Acres	$2,000,000	$1,200,000	$1,200,000
Construction Subtotal				$14,253,300	$14,253,300
Construction Contingency	10.0%				$1,425,300
Total Estimated Construction					$15,678,600
Permitting & Mitigation					$250,000
Bathymetry and Uplands Surveying					$50,000
Geotechnical Investigation (Marine)					$350,000
Final Design	5.5%				$862,300
Contract Administration and Construction Inspection	6.0%				$940,700
Total Estimated Project Costs					$18,131,600

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Site 3 - Shaman (Hoonah) Point Point
Concept Design Add Alt 1 - Fisherman's Float And Working Crane on Main Float
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$26,800	$26,800		
Removable Float Connection to Pontoon	1	LS	$25,000	$25,000		
12' x 100' Float	1200	SF	$200	$240,000		
50 foot Gangway	1	LS	$50,000	$50,000		
Access Platform	100	SF	$200	$20,000		
10 Ton Hydraulic Crane on Main Pontoon	1	EA	$150,000	$150,000		
Site Lighting and Power	1	LS	$150,000	$150,000		
Construction Subtotal				$661,800	$661,800	
Construction Contingency	15.0%				$99,300	
Total Estimated Construction					$761,100	$761,100
Final Design	8.0%					$60,900
Contract Administration and Construction Inspection	10.0%					$76,100
Total Estimated Project Costs						$898,100

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Site 3 - Shaman (Hoonah) Point Point
Concept Design Add Alt 2 Concrete Float
Budget Level Cost Estimate

Alternate 2A: 50'x400' Concrete Pontoon

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$164,000	$164,000		
Deduct Steel Pontoon	1	LS	-$3,750,000	-$3,750,000		
50'x 400 Foot Concrete Pontoon	20,000	SF	$290	$5,800,000		
Construction Subtotal				$2,214,000	$2,214,000	
Construction Contingency	15.0%				$332,100	
Total Estimated Construction					$2,546,100	$2,546,100
Final Design	5.5%					$140,000
Contract Administration and Construction Inspection	10.0%					$254,600
Total Estimated Project Costs						$2,940,700

Alternate 2B: 50'x300' Concrete Pontoon

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$48,000	$48,000		
Deduct Steel Pontoon	1	LS	-$3,750,000	-$3,750,000		
50'x 300 Foot Concrete Pontoon	15,000	SF	$290	$4,350,000		
Construction Subtotal				$648,000	$648,000	
Construction Contingency	15.0%				$332,100	
Total Estimated Construction					$980,100	$980,100
Final Design	5.5%					$140,000
Contract Administration and Construction Inspection	10.0%					$254,600
Total Estimated Project Costs						$1,374,700

Site 3 - Shaman (Hoonah) Point Point
Concept Design Add Alt 3 Promenade
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$241,600	$241,600		
Vertical Support Piles	36	EA	$15,000	$540,000		
Batter Piles	14	EA	$15,000	$210,000		
Promenade Superstructure	12,000	SF	$175	$2,100,000		
Gangway to Promenade	1	LS	$120,000	$120,000		
Promenade Lighting	1	LS	$50,000	$50,000		
Construction Subtotal				$3,261,600	$3,261,600	
Construction Contingency	15.0%				$489,200	
Total Estimated Construction					$3,750,800	$3,750,800
Final Design	5.5%					$206,300
Contract Administration and Construction Inspection	10.0%					$375,100
Total Estimated Project Costs						$4,332,200

Note: No Roof on Promenade

Site 3 - Shaman (Hoonah) Point Point
Concept Design: Add Alt 4 -Pass Pass Freight Facility
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$293,600	$293,600		
Bulkhead Steel Sheet Piling, Provide	600	Tons	$2,300	$1,380,000		
Install Sheet Piles	600	Tons	$900	$540,000		
Bulkhead Anodes	1	LS	$75,000	$75,000		
Gravel Fill	45,000	CY	$25	$1,125,000		
Armor Rock	2000	CY	$50	$100,000		
Fender piles with Mooring Bit	5	EA	$20,000	$100,000		
Breasting Dolphin Piles	3	EA	$30,000	$90,000		
Breasting Dolphin Piles Rock Anchors	3	EA	$20,000	$60,000		
Breasting Dolphin Mooring Dolphin Cap and Bollard	1	LS	$50,000	$50,000		
Hydraulic Crane	1	LS	$100,000	$100,000		
Site Lighting	1	LS	$50,000	$50,000		
Construction Subtotal				$3,963,600	$3,963,600	
Construction Contingency	15.0%				$594,500	
Total Estimated Construction					$4,558,100	$4,558,100
Final Design	5.5%					$250,700
Contract Administration and Construction Inspection	10.0%					$455,800
Total Estimated Project Costs						$5,264,600

Site 3 - Shaman (Hoonah) Point Point
Concept Design: Add Alt 5 - Freight Ramp
Budget Level Cost Estimate

Item	Quantity	Units	Unit Cost	Cost		
Mobilization (10 percent of all other construction items)	1	LS	$45,600	$45,600		
Earth Fill	5000	CY	$25	$125,000		
Armor Rock	1500	CY	$50	$75,000		
Concrete Ramp	200	CY	$1,250	$250,000		
Breasting Piles	6	EA	$20,000	$120,000		
Construction Subtotal				$615,600	$615,600	
Construction Contingency	15.0%				$92,300	
Total Estimated Construction					$707,900	$707,900
Final Design	5.5%					$38,900
Contract Administration and Construction Inspection	10.0%					$70,800
Total Estimated Project Costs						$817,600