Point Thomson Gas Cycling Project

Shoreline Erosion
Dock Design & Construction
Channel Dredging
Spoils Disposal

April 15, 2003

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Introduction

- Presentation designed to address EIS request-for-information (RFI) regarding shoreline erosion, dock design and construction, dredging, and spoils disposal.
- Shoreline Erosion related RFIs:
  - RFI-30: Shoreline erosion rates for a period of 30 years after anticipated construction start. Level of detail includes providing erosion rates along the coastline at each pad location and including North Staines River #1. Estimates of future erosion should consider the facility in place, including pads and the dock.
  - RFI-45: Results of dock-related shoreline erosion and alongshore transport study. Level of detail includes describing the methods and findings of the study.

Introduction

- Dock related RFIs:
  - RFI-42: Performance and maintenance history from armored and unarmored portions of West Dock, Endicott Causeway and islands, and Seal Island.
  - RFI-43: Detailed design of an armored dock. Level of detail includes engineering specifications and figures, paper and electronic, and criteria for selecting the type and degree of armoring. Estimated costs and comparison with unarmored dock, initial construction, and over the estimated facility life span.
  - RFI-60: Why is there a bend in the dock? Why not show it as a straight line?

Introduction

- Dredging and Disposal related RFI:
  - RFI-46: Provide a detailed description of the dredging method. Level of detail includes narrative description, including extraction and disposal methods (transport and dumping methods), vessel size, dredge type, dredge production rates, map of disposal locations, sediment character (information on type of dredge material), and operational period.

    Note: sediment character information to be provided at a later date.

Introduction

- Shoreline / Bluff Erosion Analysis
- Dock Design and Construction
- Dredging
- Spoils Disposal

Shoreline Erosion – Background

- The Pt. Thomson Gas Cycling Project proposes:
  - Locating the East, West, and Central Well Pads immediately south of the mainland shoreline. This also includes the east side of the Central Processing Facility pad.
  - A project life span of 30 years with pads designed to withstand the 100-year return period storm event.
- Concern raised that:
  - Coastal erosion rates are such that the proposed gravel pads will be compromised by shoreline encroachment during the 30-year project life.
  - Mitigation actions will be required to protect these pads in the event of shoreline encroachment.
  - Extreme erosion conditions could result in one or more of these pads effectively becoming islands within the lagoon.

Shoreline Erosion – Available Data

- Historical aerial photography:
  - 1955 1991
  - 1977 1997
  - 1982 2001

- Site-specific study for Pt. Thomson Unit:

  Point Thomson Coastal Processes and Sediment Dynamics Study, Beaufort Sea, *Alaska*
  (Tekmarine, Inc., 1983)

  - 67 coastal transects on mainland and barrier islands
  - Barrier islands: extremely dynamic
  - Mainland Shoreline: gradual erosion

Shoreline Erosion – Findings

- Oceanographic conditions
  - Barrier islands protect mainland shore in vicinity of proposed East and West Well Pads
  - Gap in barrier islands at Mary Sachs Entrance allows higher wave energy to reach mainland shore near Central Pad (CPF/CWP)

Shoreline Erosion – Findings

- Coastal processes
  - Littoral transport can be easterly or westerly, depending on wind and wave conditions
  - Net transport directed toward west, due to predominance of easterly winds and waves.

Shoreline Erosion – Findings

- The coast adjacent to all three pad sites is experiencing some measure of coastal erosion.

- The predominant cause of shoreline erosion is the high water levels (storm surge) and waves that accompany severe westerly storms.

Shoreline Erosion – West Well Pad

- Pad Set-Back from 2001 bluff is 170 to 190 feet
- Site-specific bluff erosion rates

	Annual Erosion Rates (feet/year)	
Time Period	**Average**	**Range**
Long-Term (1955 to 2001)	**-1.6 ft/yr**	**-0.3 to -2.3 ft/yr**
Recent Short-Term (1997 to 2001)	**-1.6 ft/yr**	**-0.3 to -4.5 ft/yr**

Note: negative sign (-) represents erosion

- **Conclusion**: Eroding coastal bluffs are not expected to encroach upon the West Well Pad during the 30-year project life, based on short-term site-specific bluff erosion rates (which are higher than the annual long-term rates).

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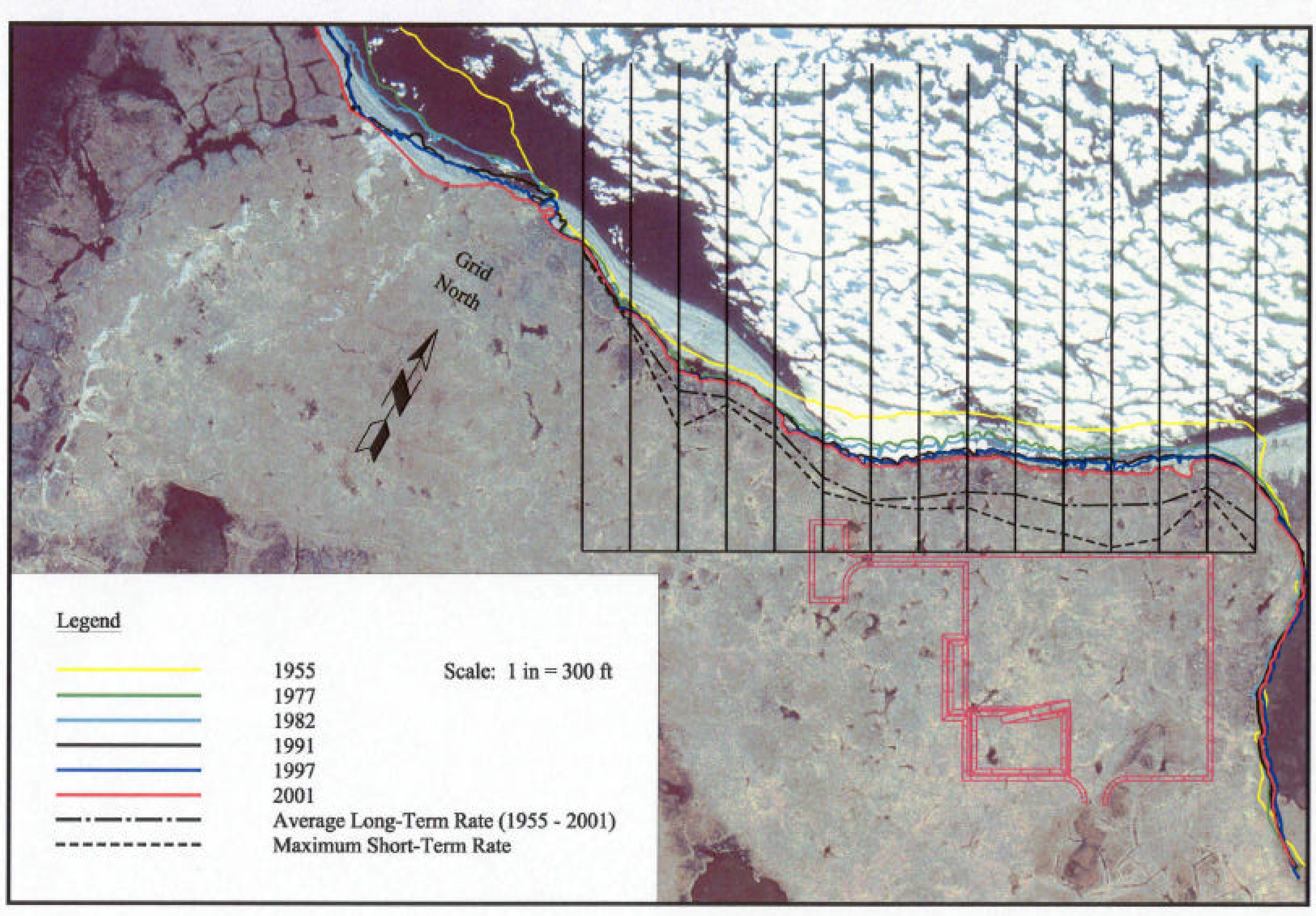
Shoreline Erosion – West Well Pad



Shoreline Erosion – Central Pad

- Pad Set-Back from 2001 shoreline is:
  - 330 feet on the north side; 150 to 340 feet on the east side
- North shoreline is relatively stable
- Site-specific shoreline erosion rates for east side

	Annual Erosion Rates (feet/year)	
Time Period	**Average**	**Range**
Long-Term (1955 to 2001)	**-0.9 ft/yr**	**+0.8 to -1.4 ft/yr**
Recent Short-Term (1997 to 2001)	**-2.6 ft/yr**	**+0.5 to -5.5 ft/yr**

Note: positive sign (+) represents accretion; negative sign (-) represents erosion

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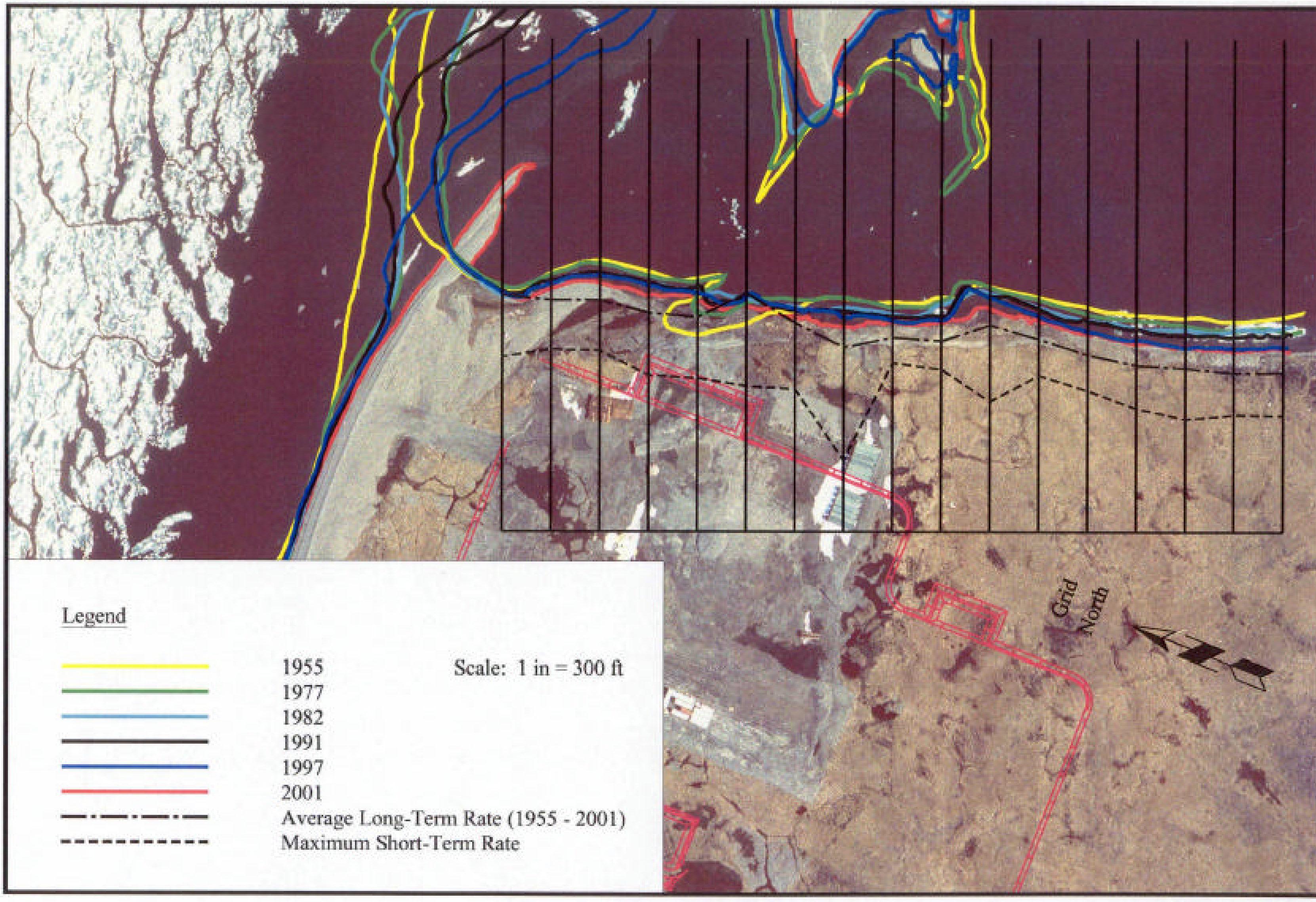
Shoreline Erosion – Central Pad

- **Conclusions**:
  - The Central Pad is situated in an area where the north-facing shoreline is relatively stable (no erosional encroachment during 30-year project life).
  - Recent short-term erosion rates along the east side of the pad are about 2½ times the average annual long-term rates. This increase appears to correlate with the natural degradation of a spit that formerly protected the site.
  - There is a possibility that erosion rates along the east side of the pad will remain high or increase further. Although this area is partially sheltered, erosion mitigation measures may become necessary during the project life.

Shoreline Erosion – Central Pad



Shoreline Erosion – East Well Pad

- Pad Set-Back from 2001 Bluff is 190 to 280 feet
- Site-specific bluff erosion rates

	Annual Erosion Rates (feet/year)	
Time Period	**Average**	**Range**
Long-Term (1955 to 2001)	**-3.3 ft/yr**	**-2.2 to -4.1 ft/yr**
Recent Short-Term (1997 to 2001)	**-4.8 ft/yr**	**-1.8 to -8.0 ft/yr**

Note: negative sign (-) represents erosion

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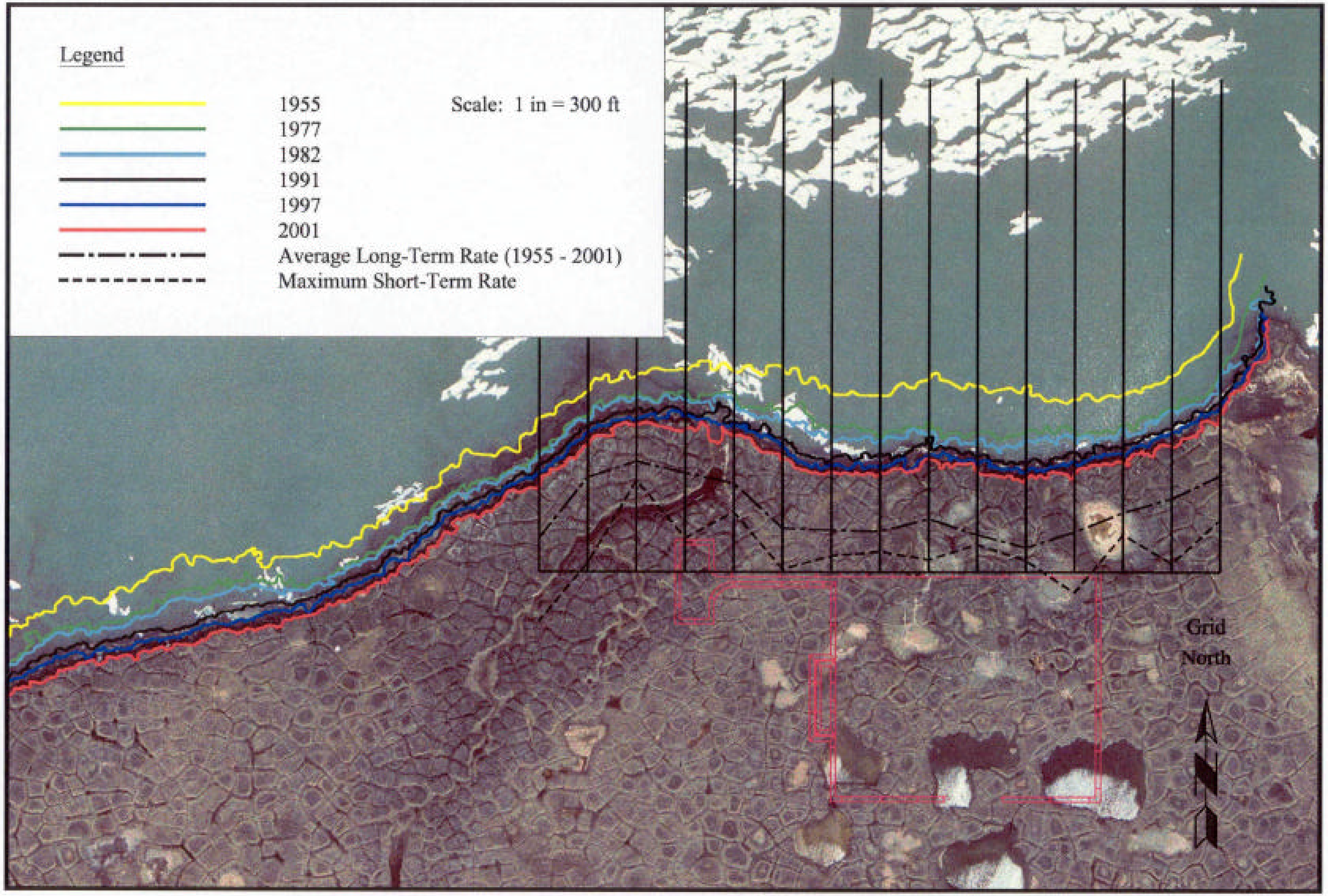
Shoreline Erosion – East Well Pad

- **Conclusions**:
  - The East Well Pad is set back sufficiently far from the coast to allow natural erosion processes to occur without significantly affecting the pad during the 30-year project life. This conclusion is based on the recent short-term erosion rates, which are higher than the average annual long-term rates.
  - This site has a higher erosion rate than the other two coastal pad locations due, in part, to its westerly exposure.

Shoreline Erosion – East Well Pad



Shoreline Erosion – North Staines River #1

- Existing Pad Set-Back from 2001 Bluff is 30 to 80 feet
- Site-specific bluff erosion rates

	Annual Erosion Rates (feet/year)	
Time Period	**Average**	**Range**
Long-Term (1955 to 2001)	**-1.4 ft/yr**	**-1.2 to -1.8 ft/yr**
Recent Short-Term (1997 to 2001)	**-3.0 ft/yr**	**-1.0 to -5.0 ft/yr**

Note: negative sign (-) represents erosion

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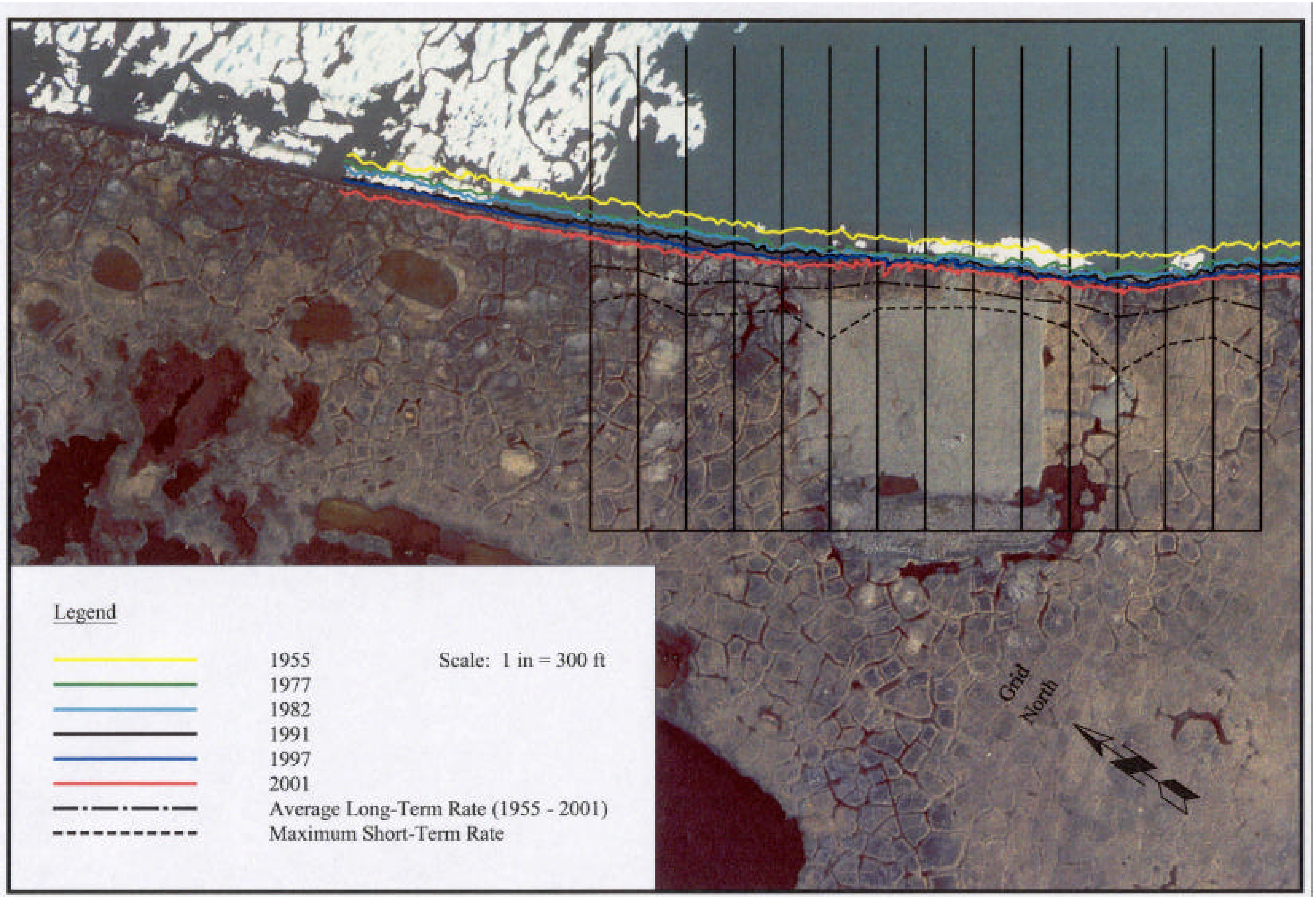
Shoreline Erosion – North Staines River #1

- **Conclusions**:
  - Bluff erosion rates at the North Staines River #1 Pad are lower than those at the East Well Pad site.
  - Recent short-term erosion rates are about 2 times the average annual long-term rates.
  - If the short-term erosion rates are applied over the 30-year project life, erosion will encroach up to 75 feet into the existing exploration pad.

Shoreline Erosion – North Staines River #1



750-foot Dock Design and Construction

Dock Requirements

Design Life

Design Storm Conditions

Dimensions and Characteristics

Oceanographic Conditions

Dock Road Elevation

Armoring Alternatives

Recommendations

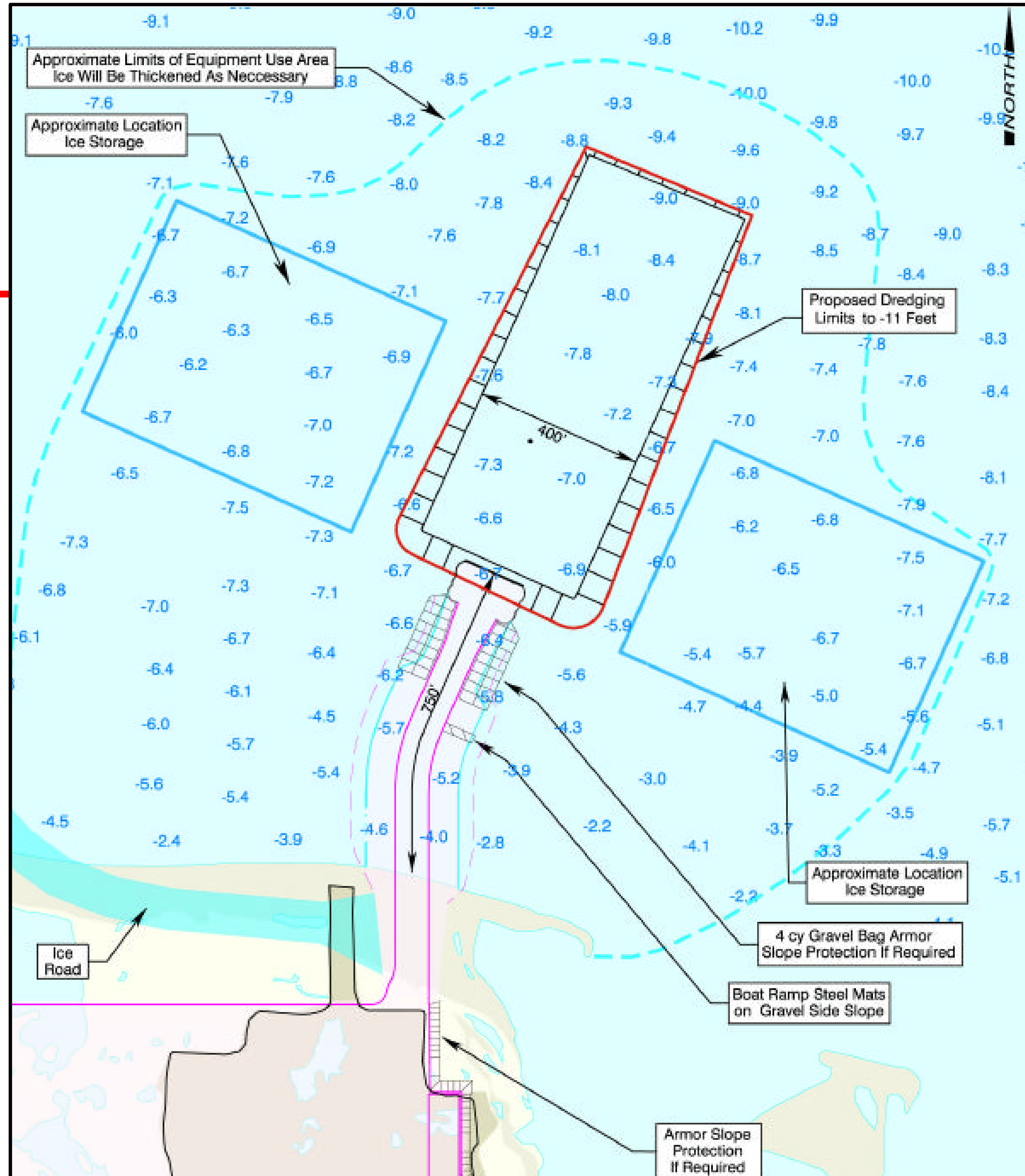
Construction

Dock Design and Construction

Design Requirements

- Location: Central Well Pad
- Min. Water Depth: 7 feet (750 feet offshore)
- Max. Module Weight: Approximately 6,000 tons
- Barge Types: Sea-Going & Coastal

750-foot Dock



Dock Design and Construction

Design Life

- 30 Years

Design Storm Conditions

- Dockhead: 75 Year Storm
- Dock Road: 50 Year Storm

Dock Design and Construction

Dimensions and Characteristics

- Dockhead
  - Cellular Sheetpile Construction (scour resistant)
  - Elevation: +7 feet MLLW (coastal barge access)
    +10½ feet MLLW (temporary sea-going barge access)
  - Width: 150 feet
- Dock Road
  - Width: 80 feet (to support module movements)
  - Grade: 2% maximum allowable
  - Transition to CPF Pad at Elevation +10 feet MLLW
- Alignment
  - Bend in dock achieves:
    - orients dockhead to be aligned such that the channel reaches the 9-foot isobath in the shortest distance, thus minimizing dredged spoil volumes
    - shortest distance to reach the 7-foot water depth

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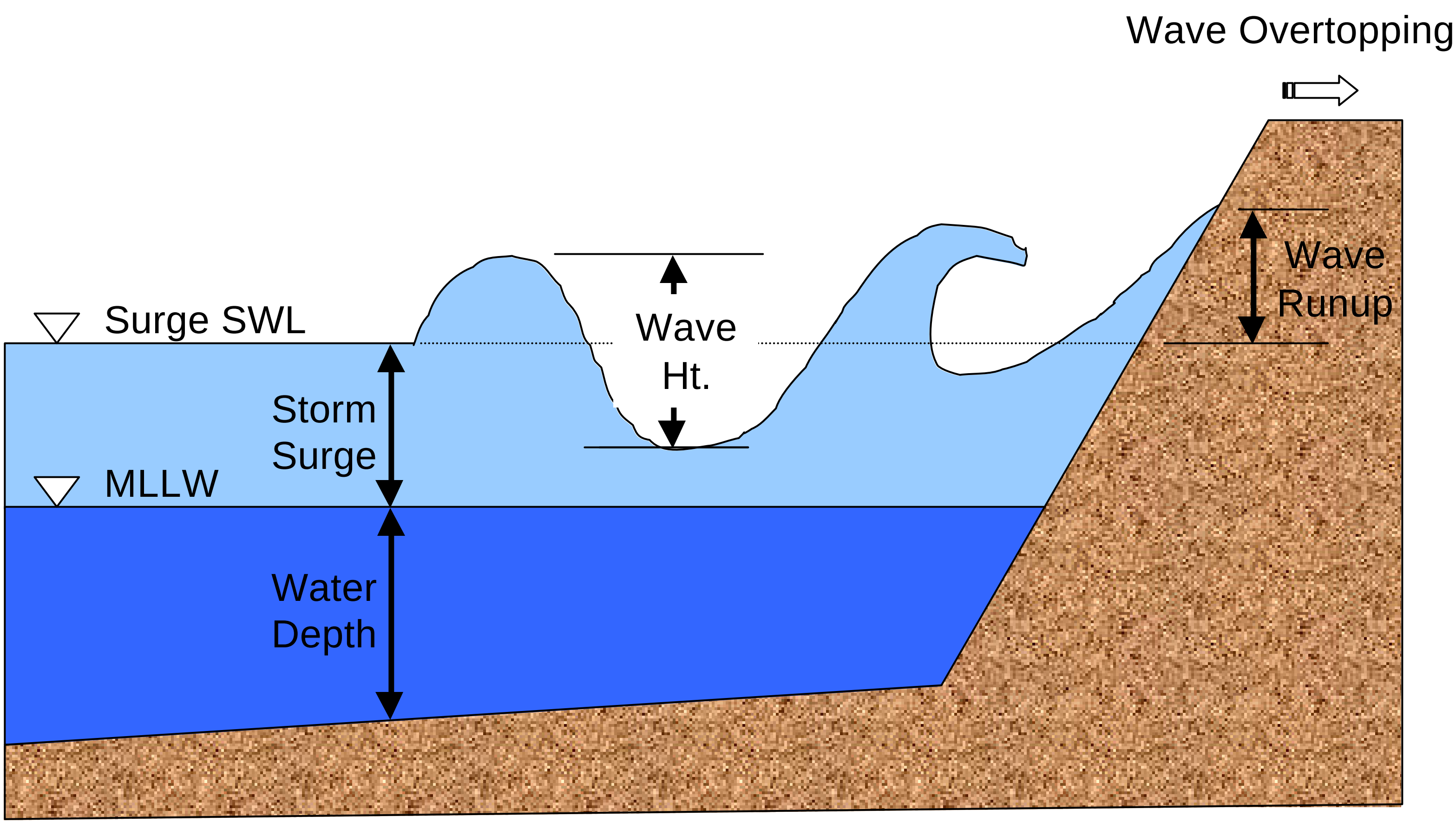
Dock Design and Construction



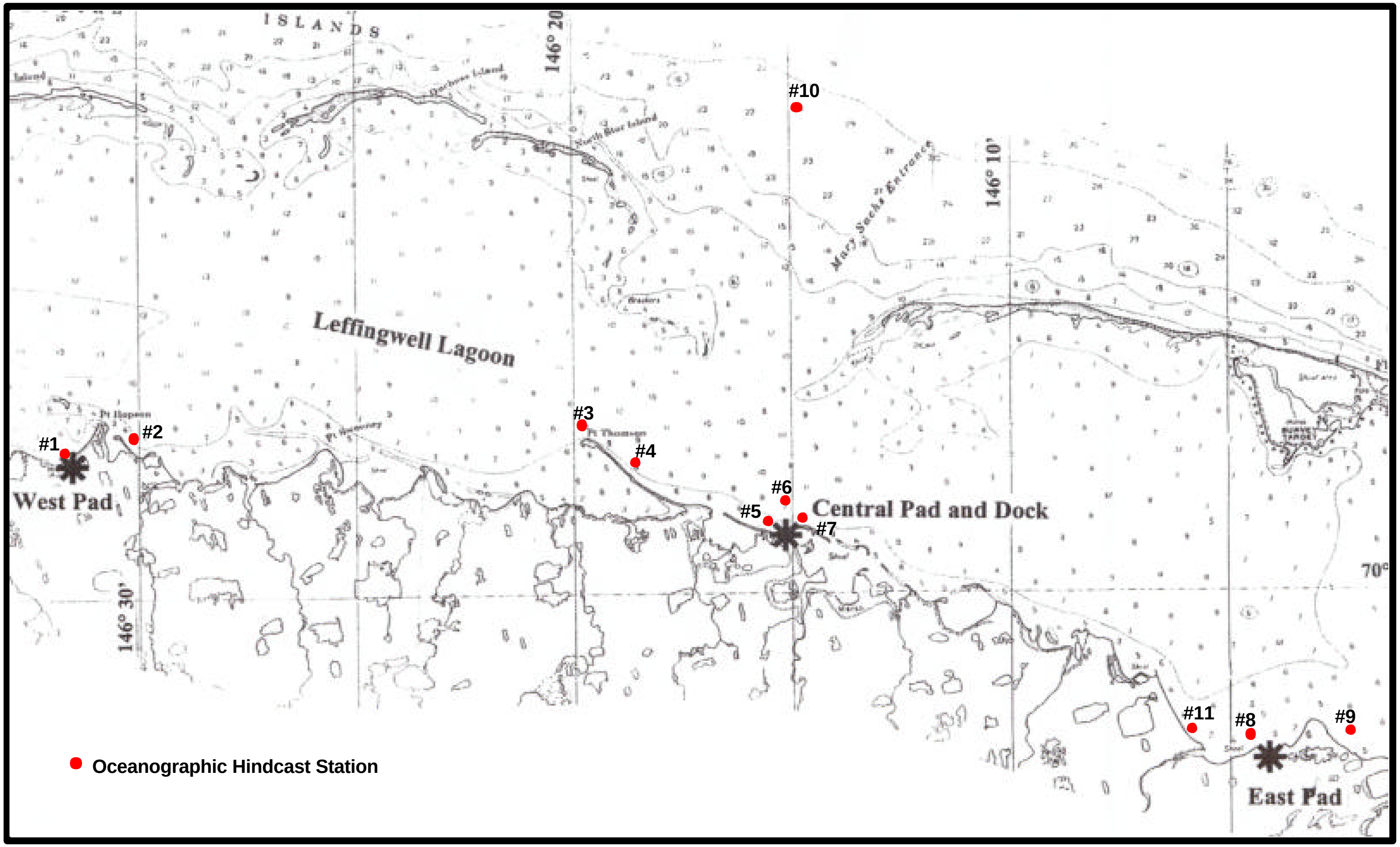
Definitions

Dock Design and Construction

Oceanographic Conditions: Methods

- Hindcast Analysis
  - Large Scale Beaufort Sea Hindcast Study (1982)
  - Dr. Donald T. Resio
- Objective
  - Design Storm Surge & Wave Conditions at 11 Sites
- Approach
  - 8 Easterly and 8 Westerly Storms (1949-79)
  - Surge & Wave Models on 760-ft Grid
  - Extremal Analysis for Return Periods of 1 – 150 years
- Predictions
  - Storm Surge (Westerlies) & Setdown (Easterlies)
  - Significant and Maximum Wave Conditions

Dock Design and Construction



Oceanographic Hindcast Stations

Dock Design and Construction

Oceanographic Conditions: Results

- Storm Surge (Westerly Storms)
  - 100-Year Surge: +6.0 to +7.1 ft (MLLW)
  - Highest Surges: West-Facing Sites
- Wave Conditions (Westerly Storms)
  - 100-Year H_s: 3.2 to 8.2 ft (Lagoon); 18.5 ft (Offshore)
  - 100-Year T_p: 6.4 to 12.6 sec
  - Wave Generation: Local (Lagoon) and Offshore
  - Wave Exposure: Greatest near Mary Sachs Entrance
- Easterly Storms
  - Setdown Rather than Surge
  - Wave Conditions Comparable to or less than Westerlies

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Dock Design and Construction

Design Oceanographic Conditions (50-year Storm)

Storm Direction	Hindcast Station	Surge SWL (MLLW)	Significant Wave Height	Spectral Peak Period	Max. Individual Wave Height	Max. Individual Wave Period
West	5	5.9 ft	7.0 ft	11.8 sec	9.8 ft	14.6 sec
East	7	0.8 ft	4.9 ft	11.1 sec	5.8 ft	14.3 sec

Dock Design and Construction

Dock Road Elevation

- Storm Surge
- Wave Runup
  - Large Scale Model Test Data from Lisburne (Tekmarine, 1984)
  - Method of Stoa (1978)
- Wave Overtopping
  - Method of Weggel (1976)
- Elevation Adjustment
  - Endicott Criterion of 0.2 cfs/ft (Tekmarine, 1985)

Dock Design and Construction

Dock Road Armor Alternatives

- Gravel Beach (Badami analog)
- Gravel Beach with +14½ foot elevation
- Gravel Bag Armor
- Linked Concrete Mat Armor
- Linked Concrete Mat Armor / Gravel Bag Berm
- Linked Concrete Mat Armor / Armored Road Surface
- Mat-Bag Hybrid (Endicott analog)

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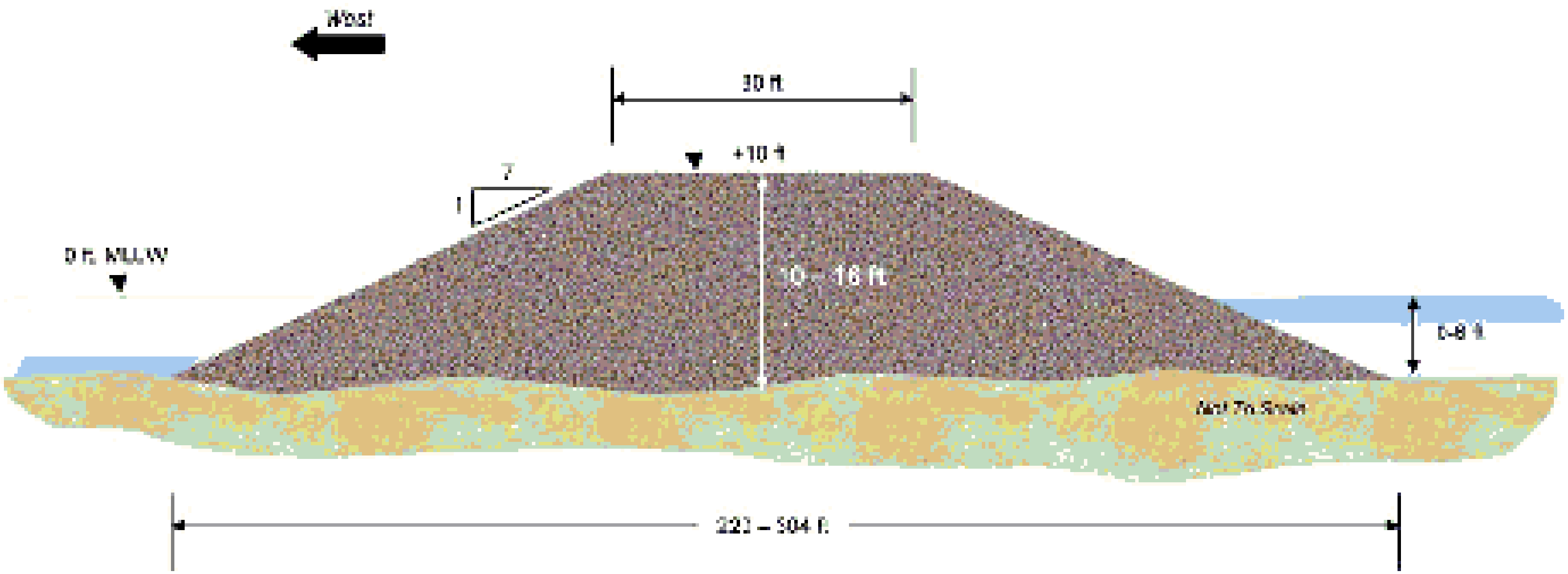
Dock Design and Construction

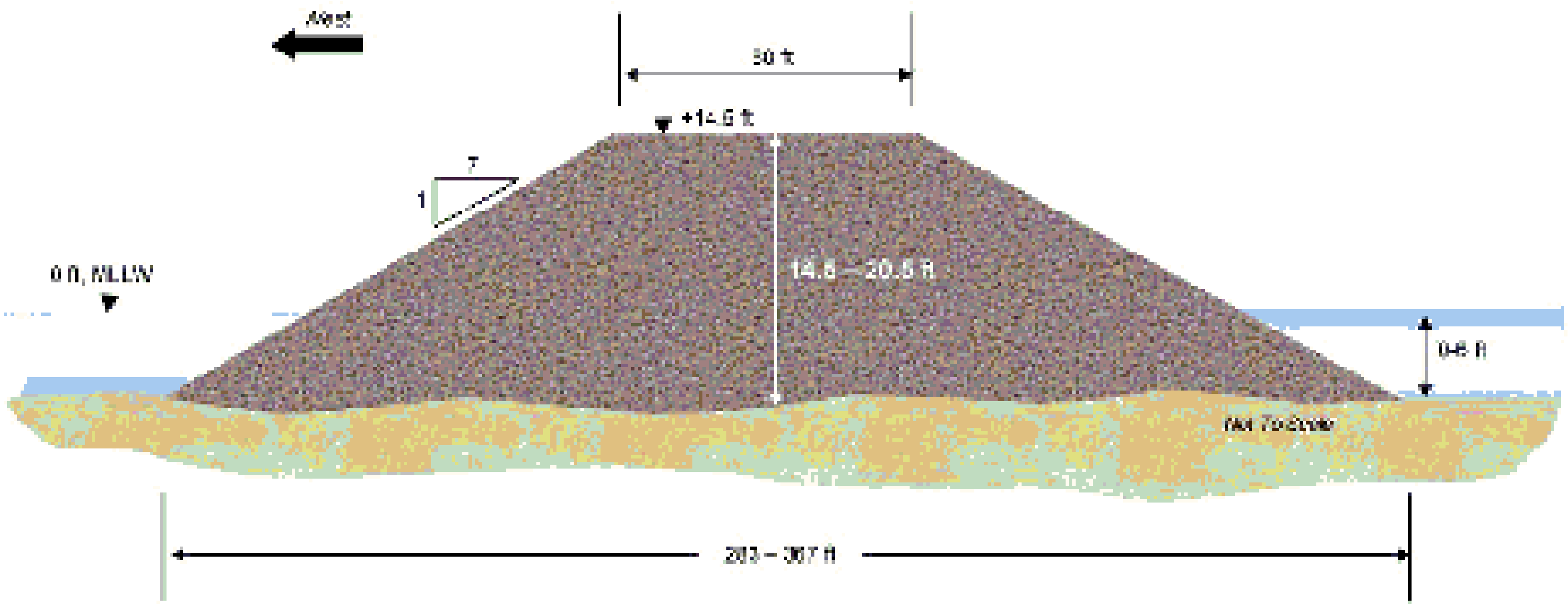
Gravel beach (Badami analog)



Gravel beach with +10.0 foot road surface per Badami Dock design.

Dock Design and Construction

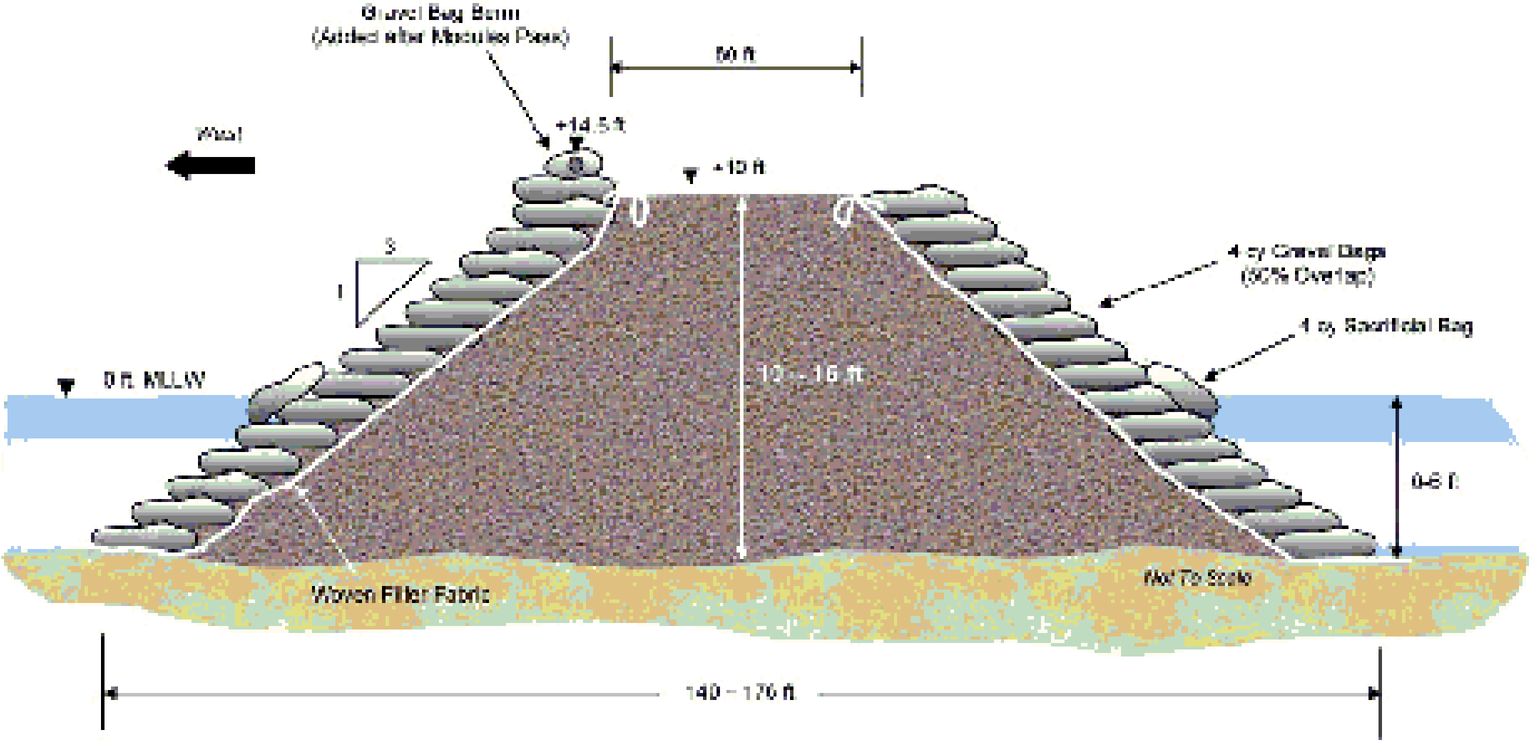
Gravel beach with +14½ foot elevation



Gravel beach with +14½ foot road surface.

Dock Design and Construction

Gravel bag armor



Gravel bag armor with +10.0 foot road surface.

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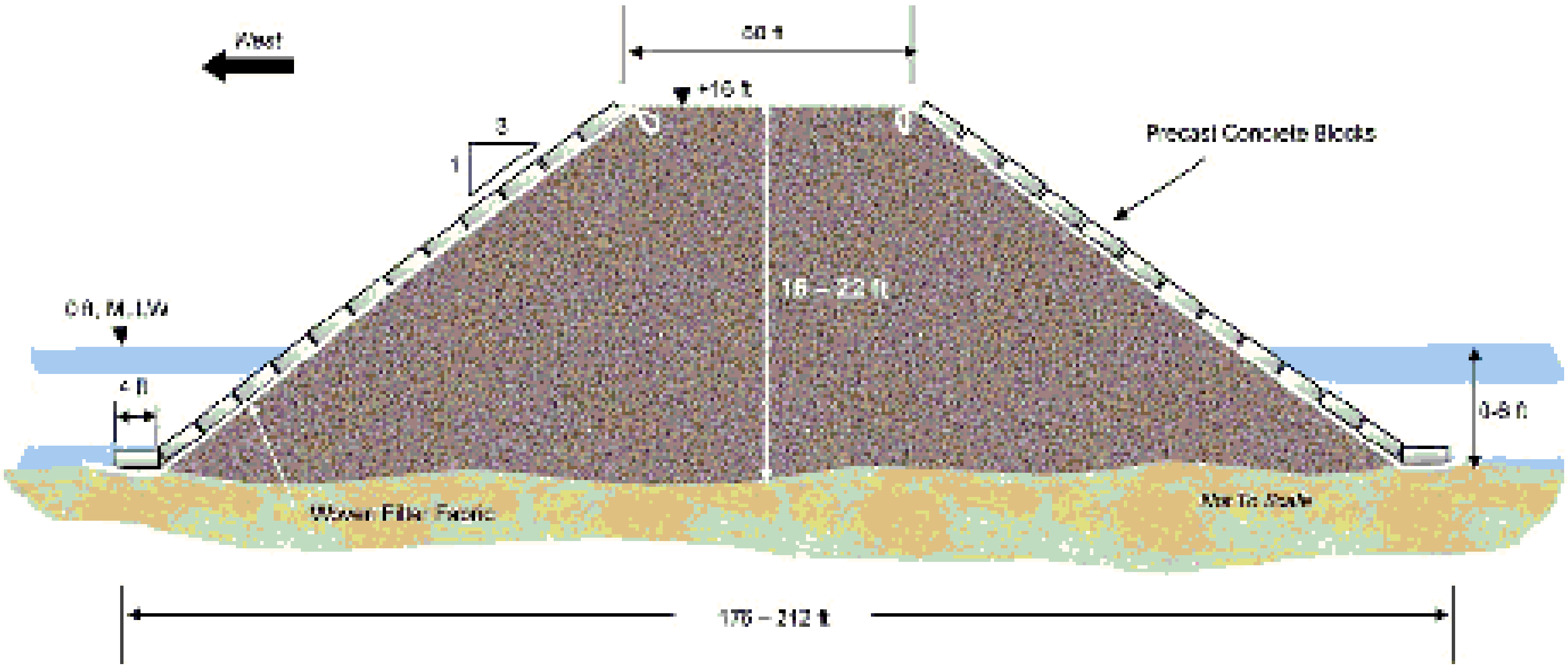
Dock Design and Construction

Linked concrete mat armor



Linked concrete mat armor with +16.0 foot road surface.

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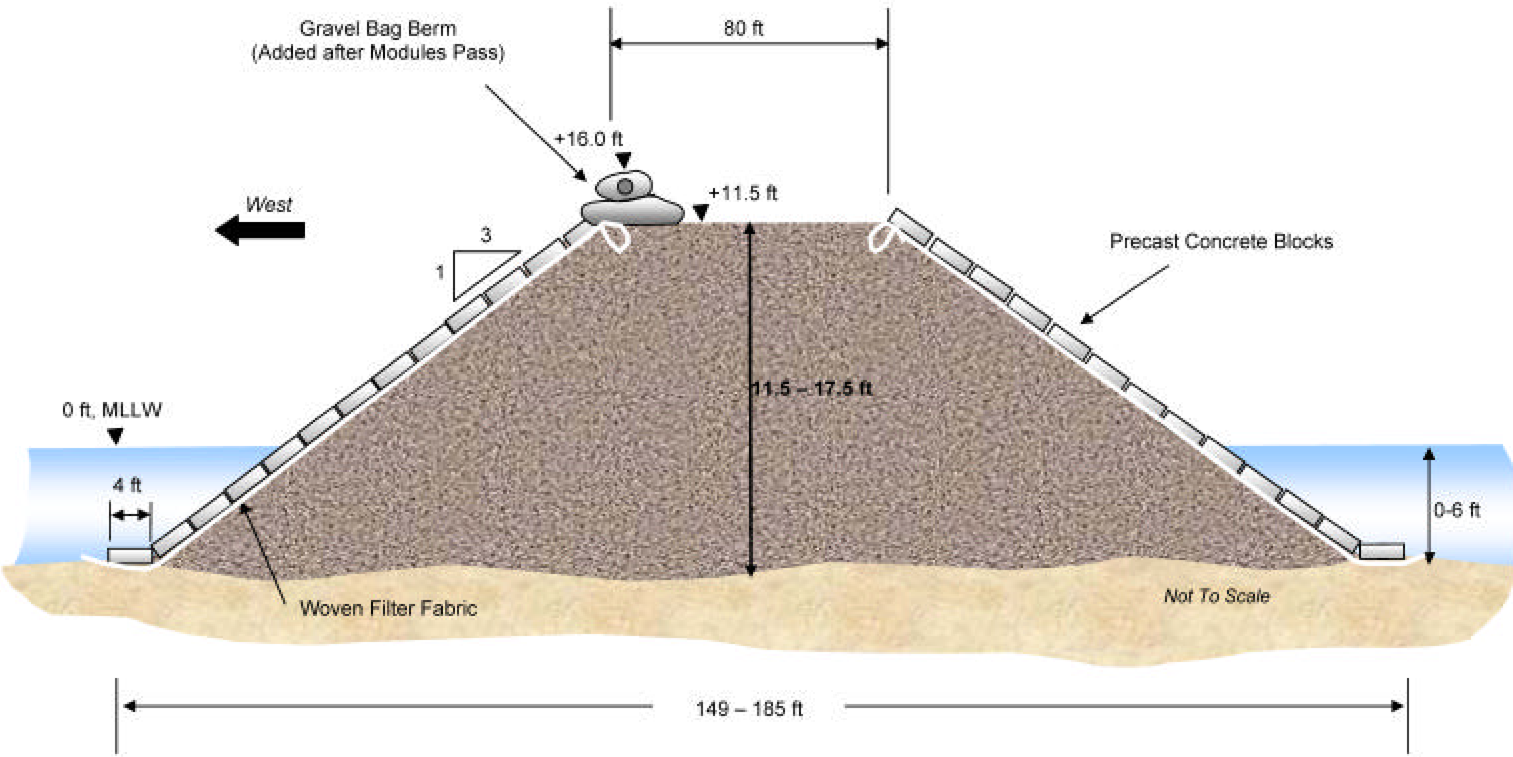
Dock Design and Construction

Linked concrete mat armor / gravel bag berm



Linked concrete mat armor with gravel bag berm and +11.5 foot road surface

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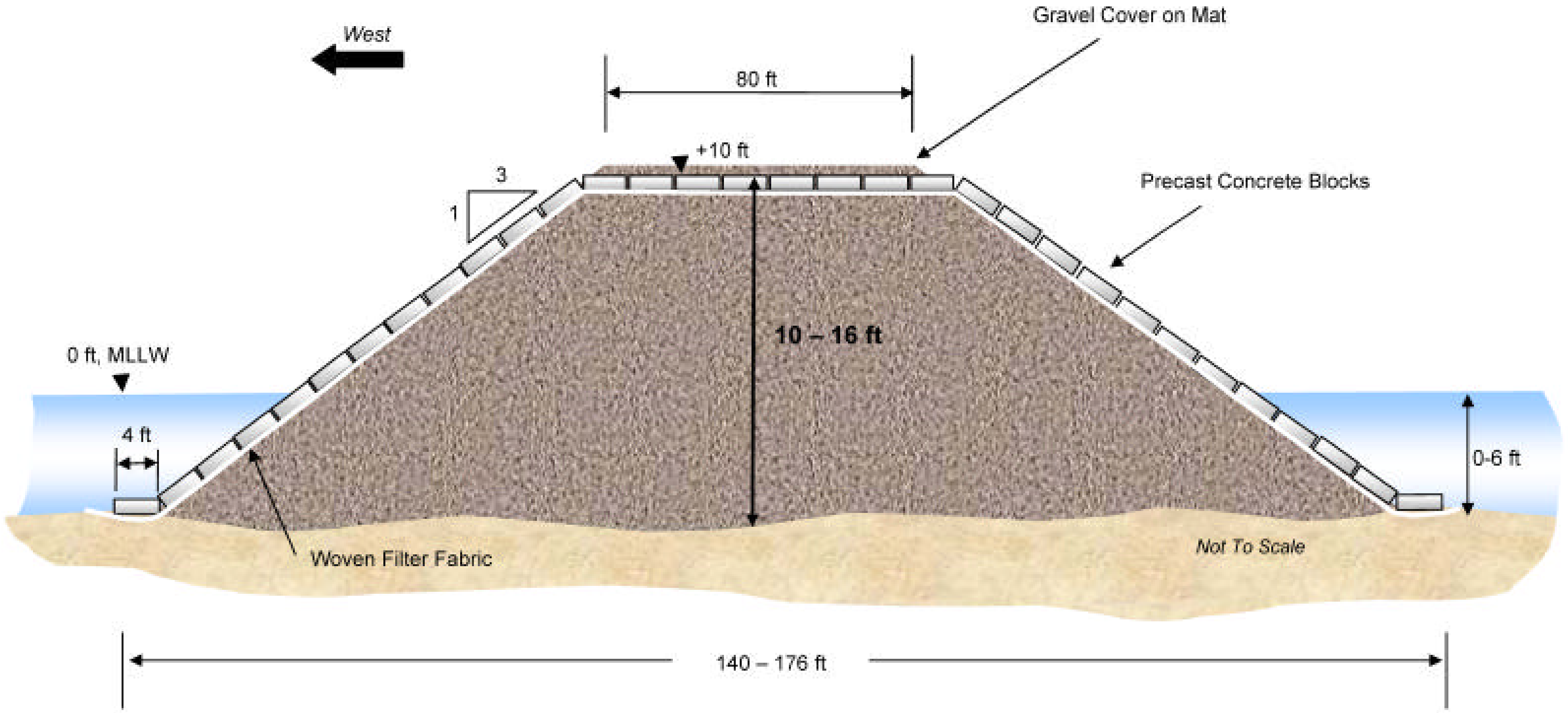
Dock Design and Construction

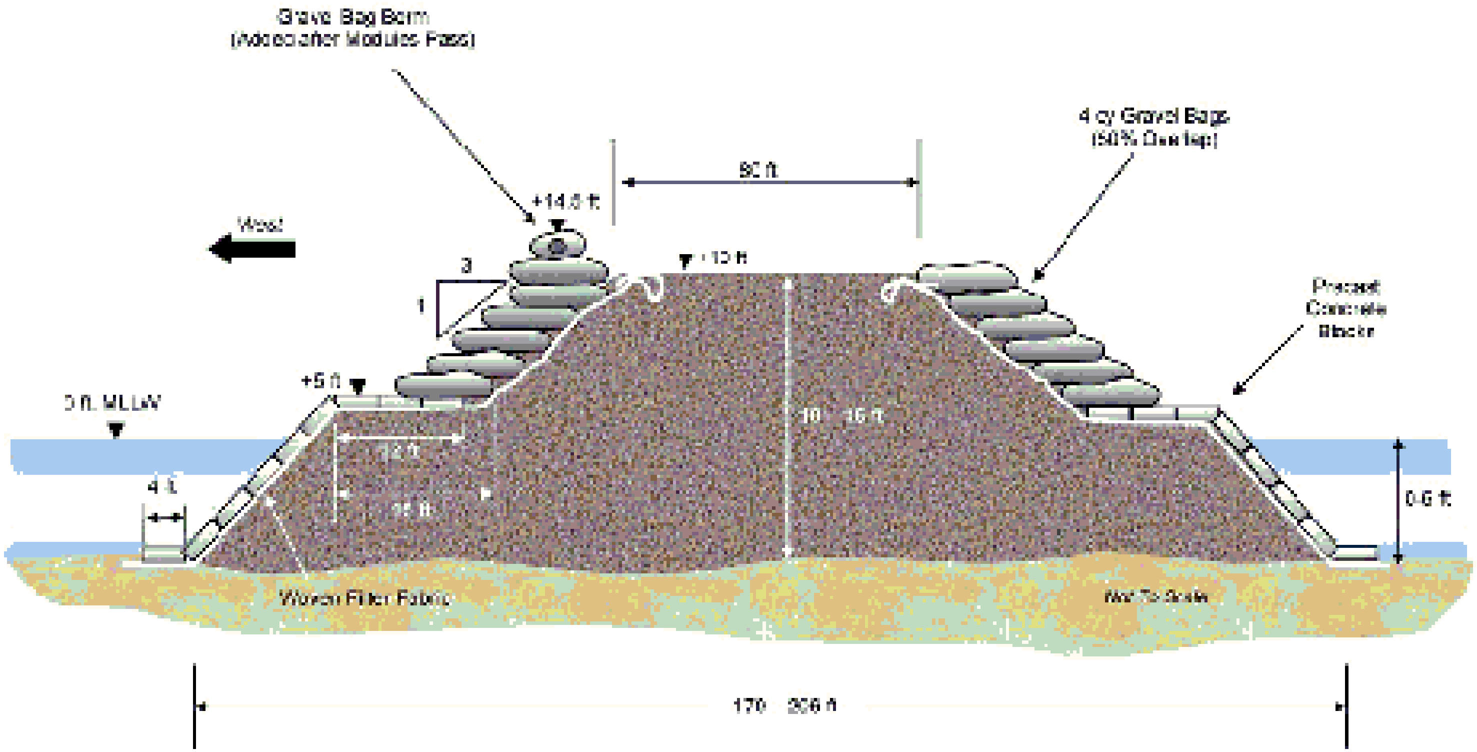
Linked concrete mat armor / armored road surface



Linked concrete mat armor with +10 foot armored road surface

Dock Design and Construction

Mat-Bag hybrid (Endicott analog)



Mat-bag hybrid armor with +10.0 foot road surface.

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Dock Design and Construction

Alternative	Surface Elevation	Engineering Acceptability	Cost	
			Capital	Annual O & M
Gravel Beach (Badami analog)	10 feet	**Not Acceptable**: Failure under 50-yr design event	Not Applicable (N/A)	N/A
Gravel Beach with a +14.5 foot elevation	14½ feet	**Not Acceptable**: Not functional due to elevation	N/A	N/A
Gravel Bag Armor[1]	+10 feet	**Acceptable**	$10.8 million	$17,800
Linked Concrete Mat Armor	+16 feet	**Not Acceptable**: Not functional due to elevation	N/A	N/A
Linked Concrete Mat Armor w/ Gravel Bag Berm	+11½ feet	**Acceptable**	$13.5 million	$0
Linked Concrete Mat Armor w/ Armored Road Surface	+10 feet	**Acceptable**	$16.8 million	$0
Mat-Bag Hybrid (Endicott analog)	+10 feet	**Acceptable**	$13.5 million	$1,600

1 Recommended alternative

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Dock Design and Construction

Recommended Alternative: Gravel Bag Armor

- Lowest Life-Cycle Cost
- Non-Catastrophic Mode of Failure
- Minimal Maintenance
  - Polyester (Endicott) Bags rather than Polypropylene
  - Sheltered Ice Environment

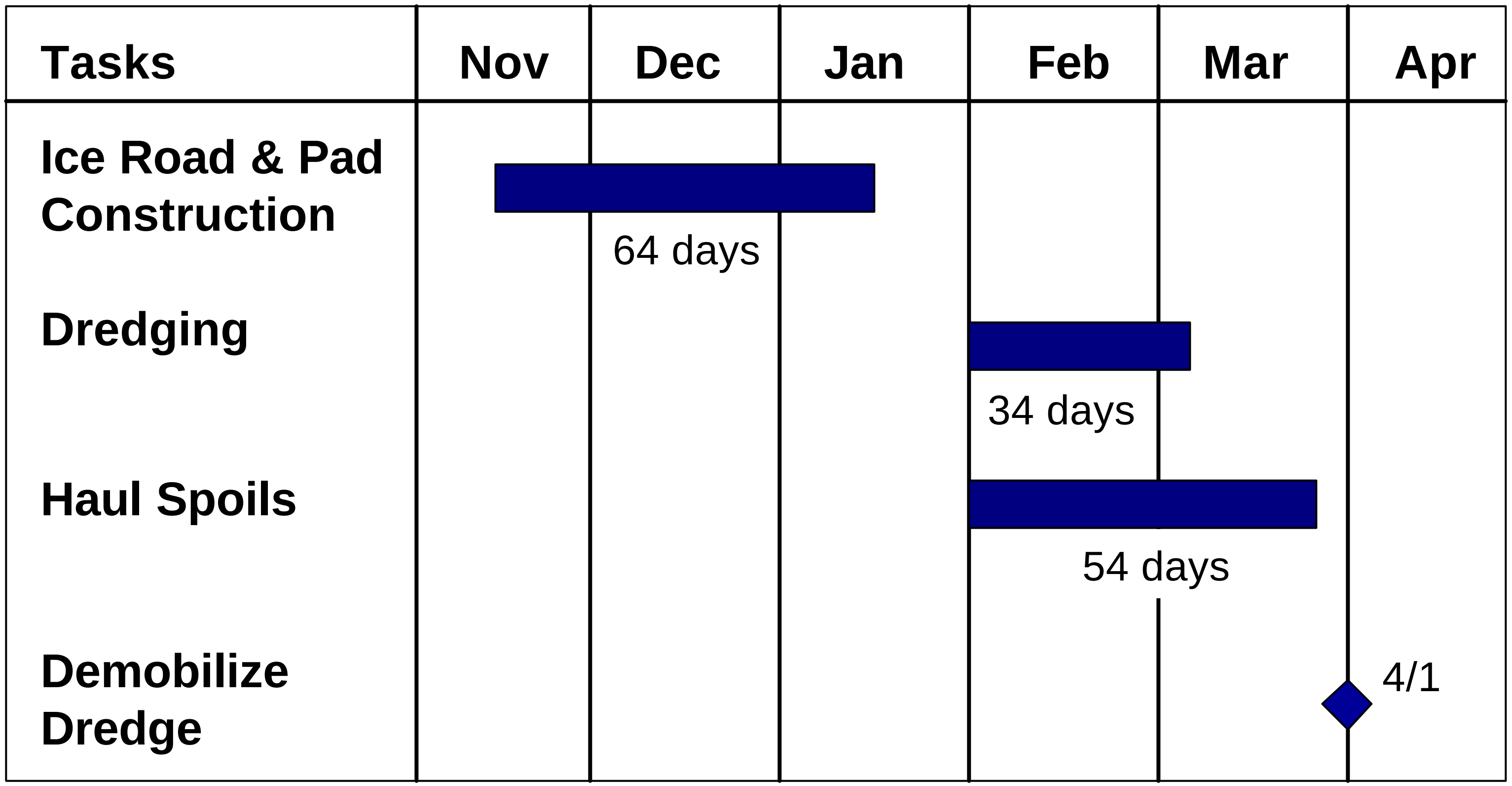
Dock Construction

- Construction will begin during the first winter construction season.
- Surrounding sea ice will be flooded as necessary to ground the sea ice. Sea ice within the footprint of the dock will be removed and disposed of at a suitable location.
- Gravel will be dumped onto the exposed seabed to form the bulk of the dock structure.
- Final dock construction, including installation of the dock sheetpile, gravel compaction, bag placement, and shaping for all areas, will continue until the dock is operational.

Channel Dredging

- Schedule
- Recent Bathymetric Map
- Dredging Volumes
- Dredging Activity Map
- Dredging Methods

Channel Dredging Schedule



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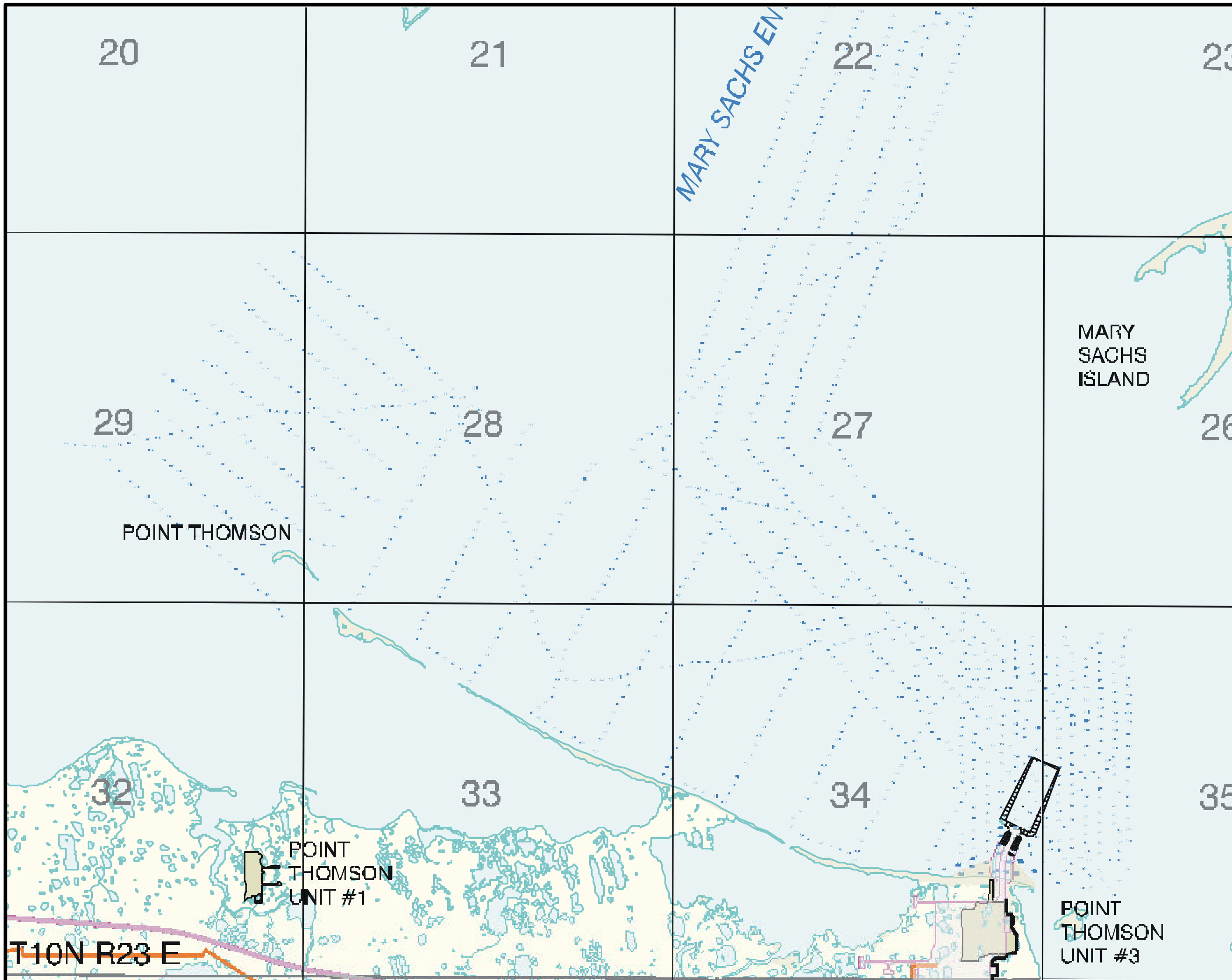
Channel Dredging Schedule

- Winter dredging was selected due to:
  - Anticipated 34-day duration
  - Proven construction methods and equipment already modified to work in arctic winter conditions
- Summer dredging of the main channel was removed from further consideration due to:
  - limited open-water season
  - dredging down time as a result of storms
  - sea-going barges could be stranded the following winter due to a late offloading
  - inability to offload sea-going barges and thus project delay of one year
  - During dredging, prevents local coastal barge access to dock

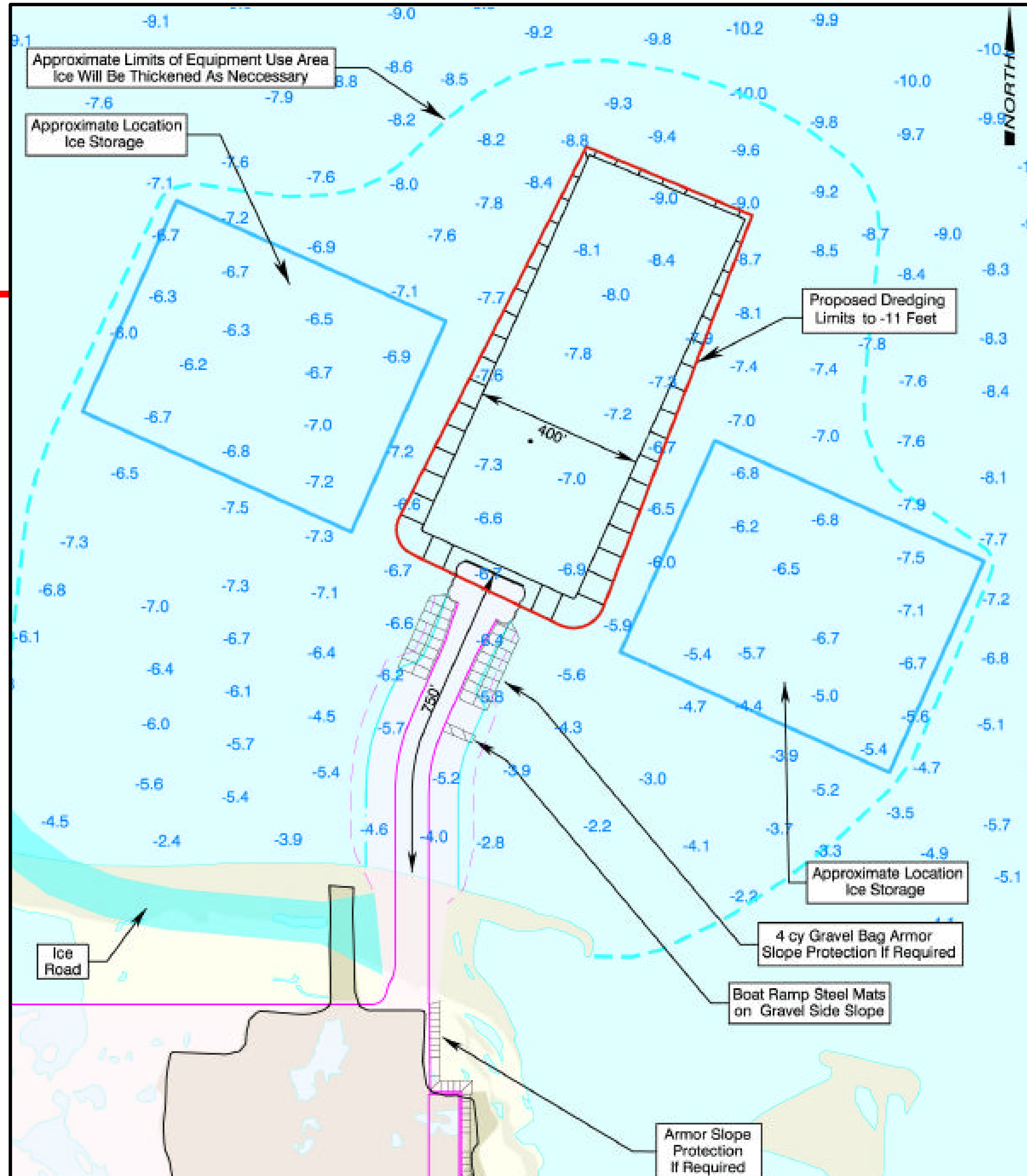
Site Bathymetry Survey Coverage



Dredging Volumes

- To assure that sea-going barges reach the dock, the channel will be dredged to the -11 foot isobath. This dredged amount is expected to provide sufficient draft in the event that sediment drifts into channel due to a summer storm event.
- The amount (volume) of dredged material anticipated to be removed in front of the dock is approximately:
  - 70,000 cubic yards (neat) based on a 1,000 x 400 foot excavation
  - 100,000 cubic yards including entrained water volume

Dredging Activity Map



Dredging Methods

- As necessary, thicken sea ice in the immediate vicinity of the channel excavation.
- Initially, cut an east/west oriented slot in the sea ice at the far north end of the channel.
- Excavate channel to -11 foot MLLW elevation with backhoes equipped with buckets and/or clamshells *(similar to the Northstar pipeline excavation)*
- Spoils will be loaded directly into dump trucks from the backhoe or temporarily stored immediately adjacent to excavation. Heavy equipment will be used to load temporarily stored spoils into dump trucks at a later time.
- Continue to cut sea ice and move excavation activities south to the dockhead.

Spoils Disposal

Disposal Sites and Capacity

Disposal Methods

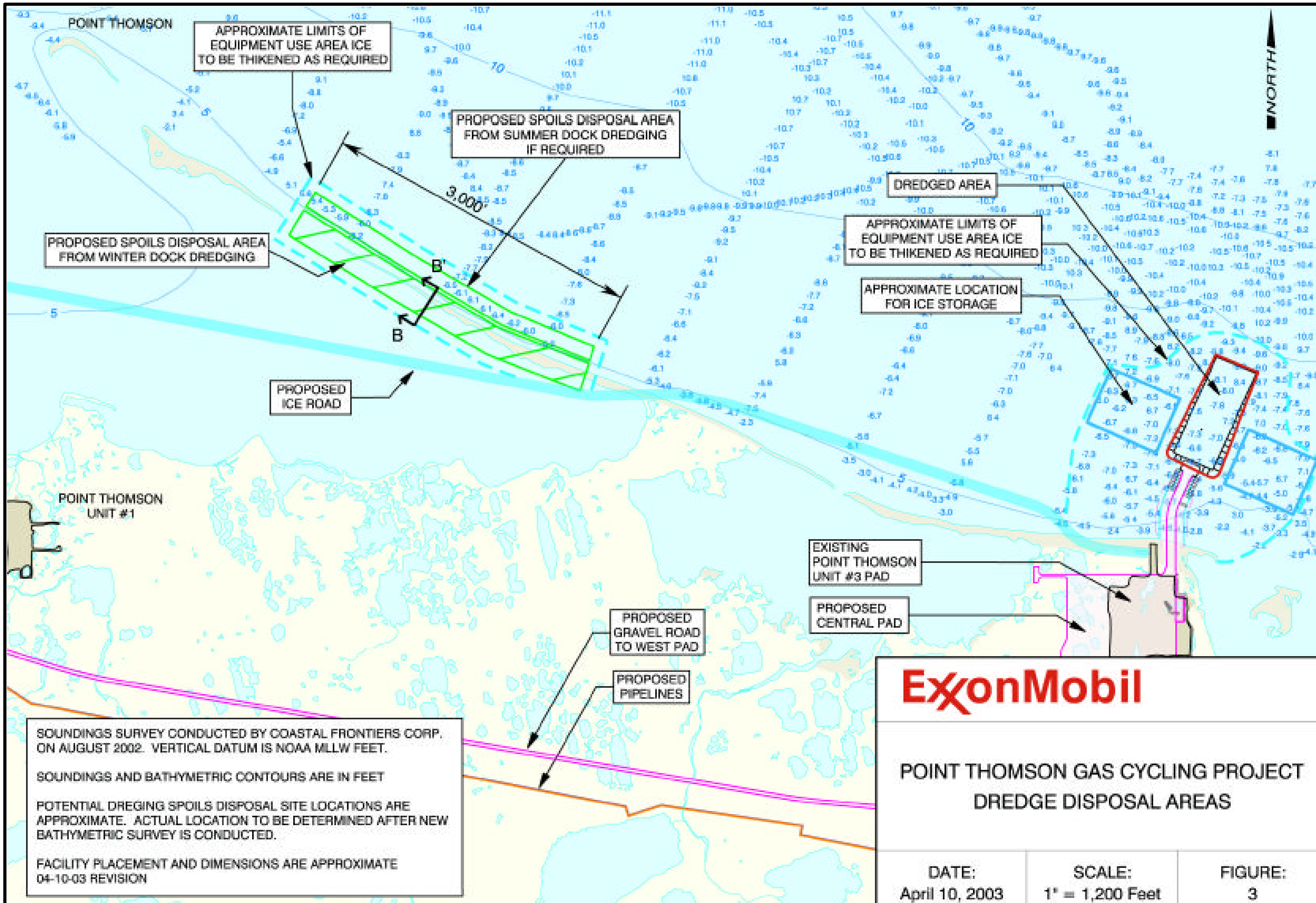
Barge Access Dredging & Screeding

Summer Contingency Dumping Site

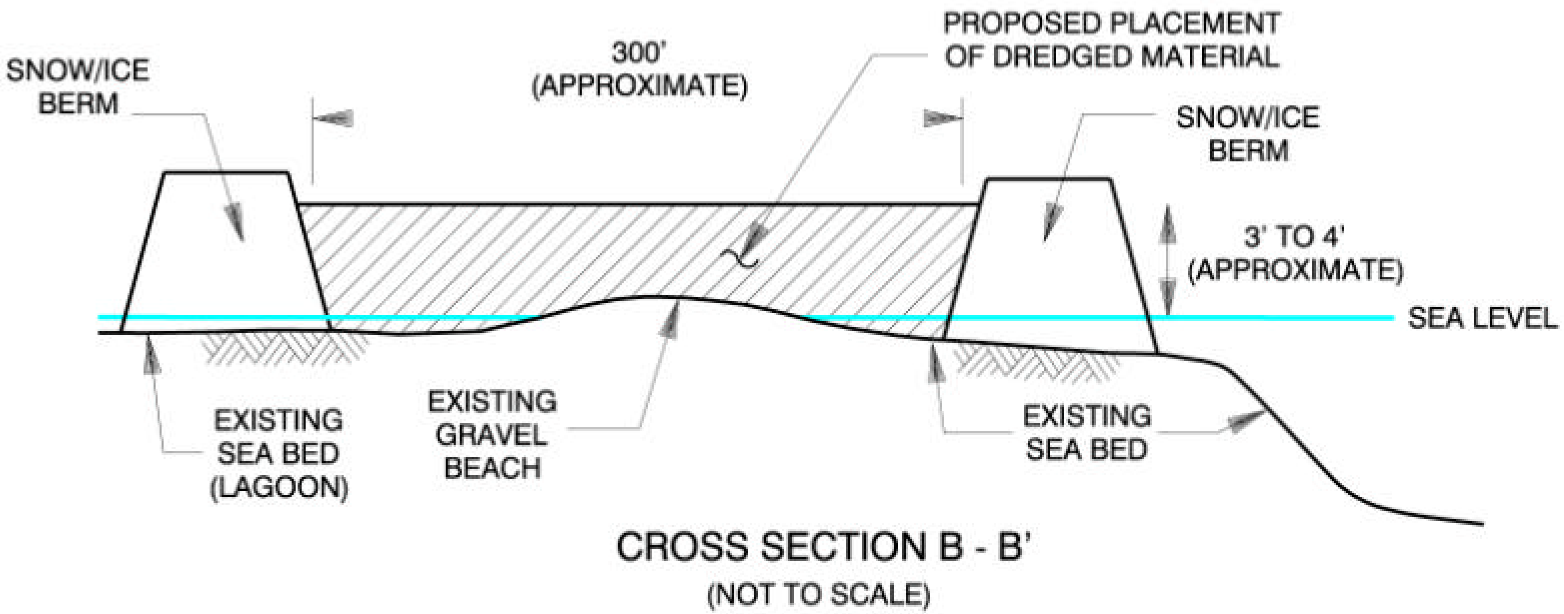
Disposal Sites and Capacity

- Primary disposal site along axis of the Point Thomson Spit.
  - Volume: 100,000 cubic yards
  - Approximate dimensions: 300 (W) x 3,000 (L) x 3 (H) feet
  - Purpose:
    - Mimic natural spit in dispersing sediment primarily during periods of high waves (when natural turbidity is high)

Spit Disposal Site



Spit Disposal Site Cross-Section



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Winter Disposal Methods

- Spoils will be loaded directly into dump trucks from the backhoe or temporarily stored immediately adjacent to excavation. Heavy equipment will be used to load temporarily stored spoils into dump trucks at a later time.
- Dump trucks will transport the spoils to the spit disposal site. Due to safety considerations, these haul roads will be situated on grounded sea-ice.
- Spoils will be dumped into the disposal sites.
- Final grading will be completed prior to the closure of the sea ice roads.

Barge Access Dredging & Screeding

- This proposed barge access dredging and screeding program is based on 1998 and 2002 bathymetry surveys.
- There is a potential that limited dredging and/or screeding will need to be completed prior to the arrival of the sea-going barges due to shallow water areas within Mary Sachs Entrance and/or the lagoon.
- This activity would be completed in the summer open-water season immediately prior to the sea-lift arrival.
- Additional bathymetry survey will be conducted to refine barge access routes, and if necessary, delineate screeding/dredging areas.
- Hard areas may require excavation with a backhoe or clamshell on a barge.
- Possible barge access dredging volumes:
  - Mary Sachs Entrance: 13,000 cubic yards
  - Challenge Entrance (lagoon): 10,000 cubic yards

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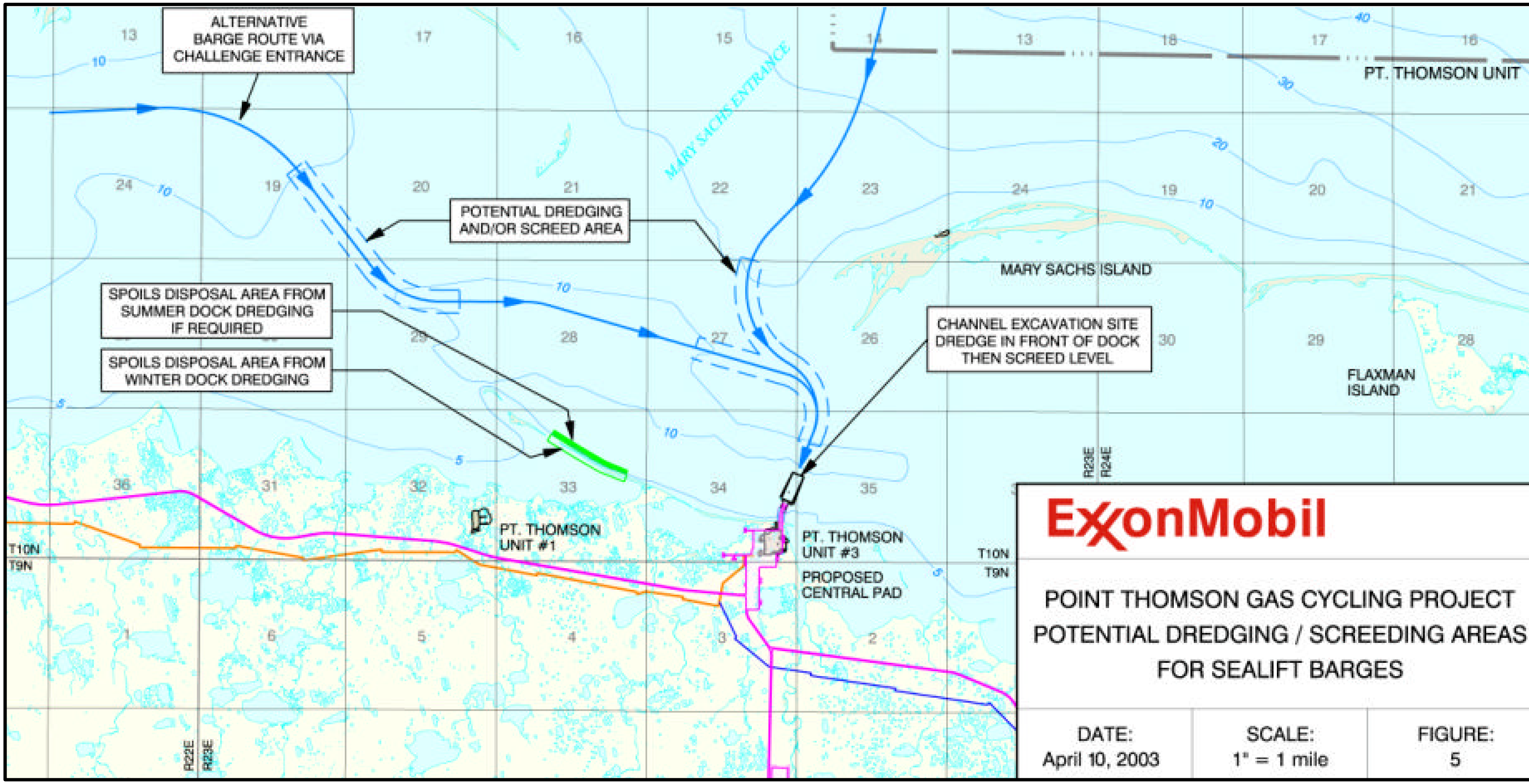
Barge Access Dredging & Screeding Sites



Summer Contingency Dredging

- There is a potential for summer contingency dredging in the rare event that large amounts of sediment moves into the channel established during the prior winter such it forms navigational hazards.
- Anticipated worst-case volume is 30,000 cubic yards (neat) to be removed from the channel.
- Spoils would be disposed in the summer spit dump site with a barge and loader.

Summer Contingency Dumping Site