Maintaining Coastal Inlets and Navigation Infrastructure

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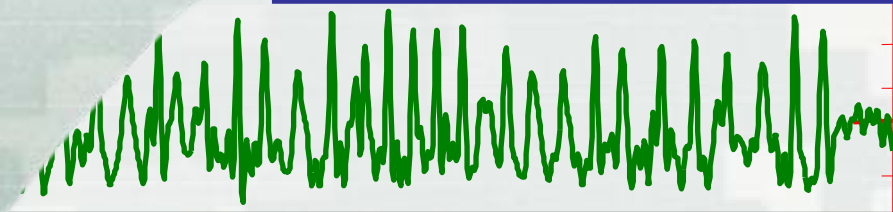
Portland District

1 December 2009



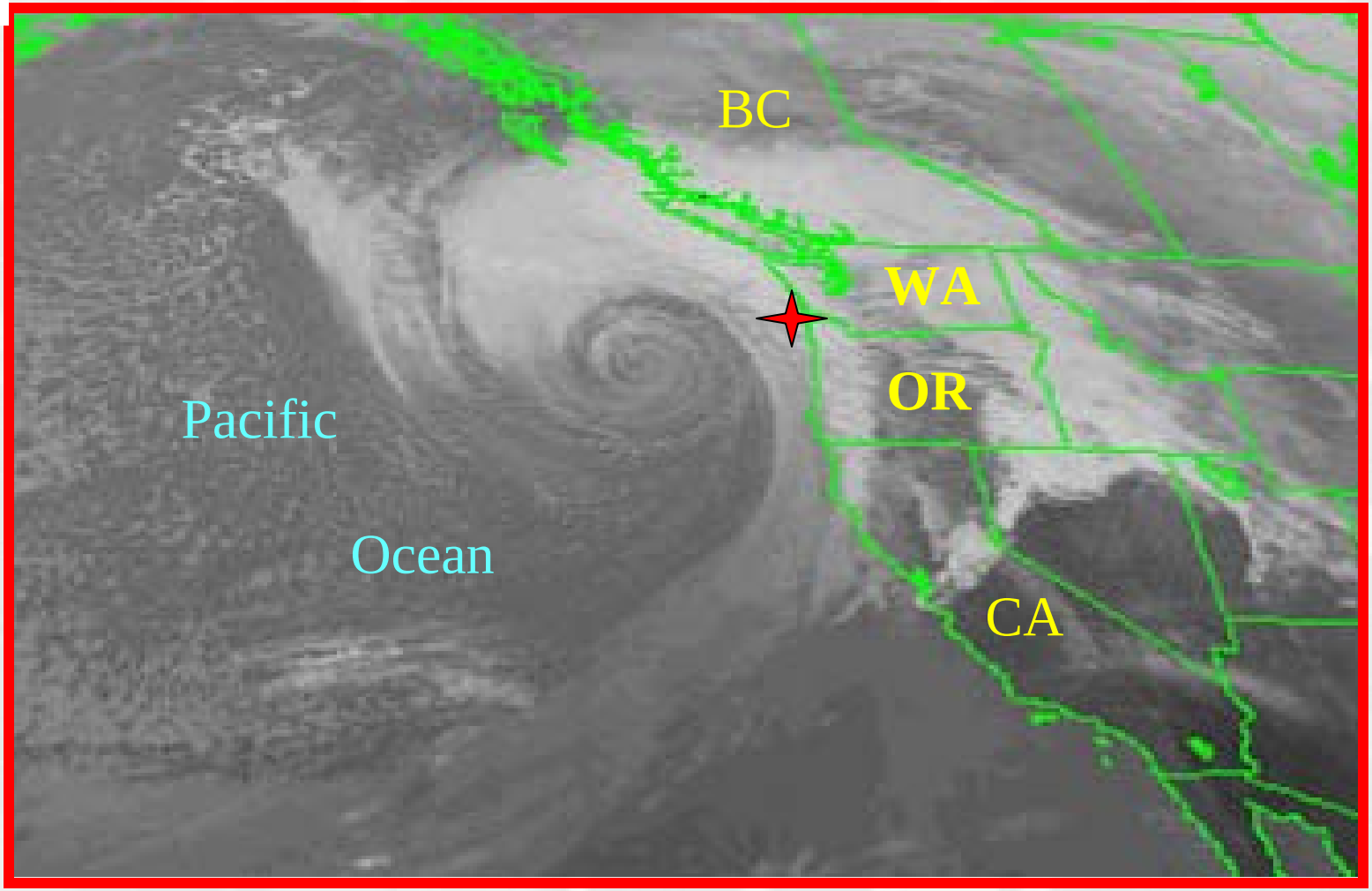
CIRP Tech-Transfer Workshop

US Army Corps of Engineers

BUILDING STRONG®

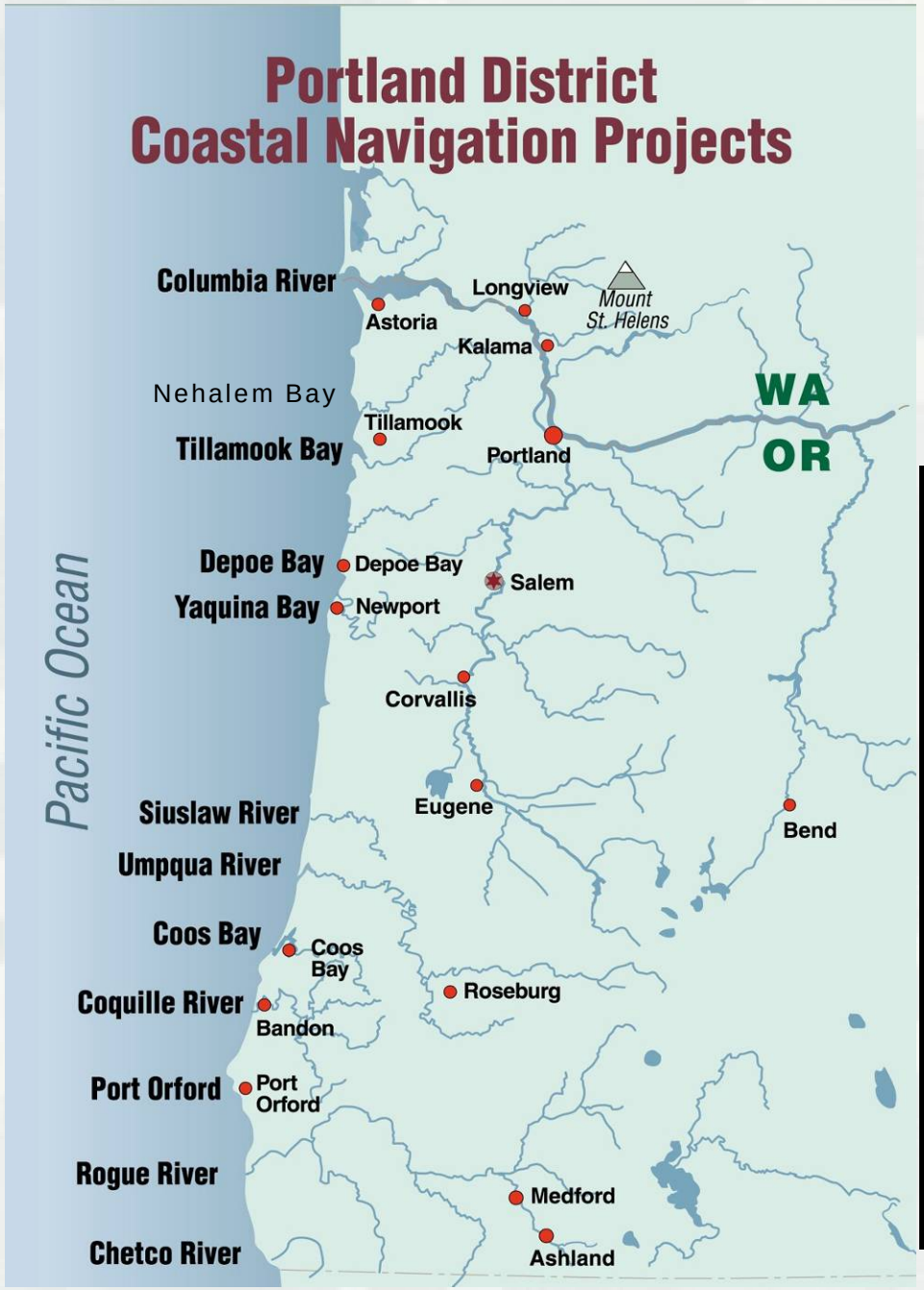
Presentation Themes

- Dredged Material Management
- Inlet Morphology Augmentation: Protect Infrastructure
- Forcing Environment: Wave-Centric with a Twist of Current
- Make The Right Moves – Do No Harm
- Data Fusion: Data Collection, Model Apps & Synthesis
- Many Engineered Inlets within Portland District
  - Aging Infrastructure



GOES-10 0000 UTC 3 MAR 1999

image courtesy of NOAA



11 Jettied Navigation Entrances

(Including Mouth of Columbia River)

30 Miles – Rubblemound

Construction / Repair - $2+ Billion

Armor Size – 10 to 50 ton

Maintenance Goal to <u>Avoid</u>:

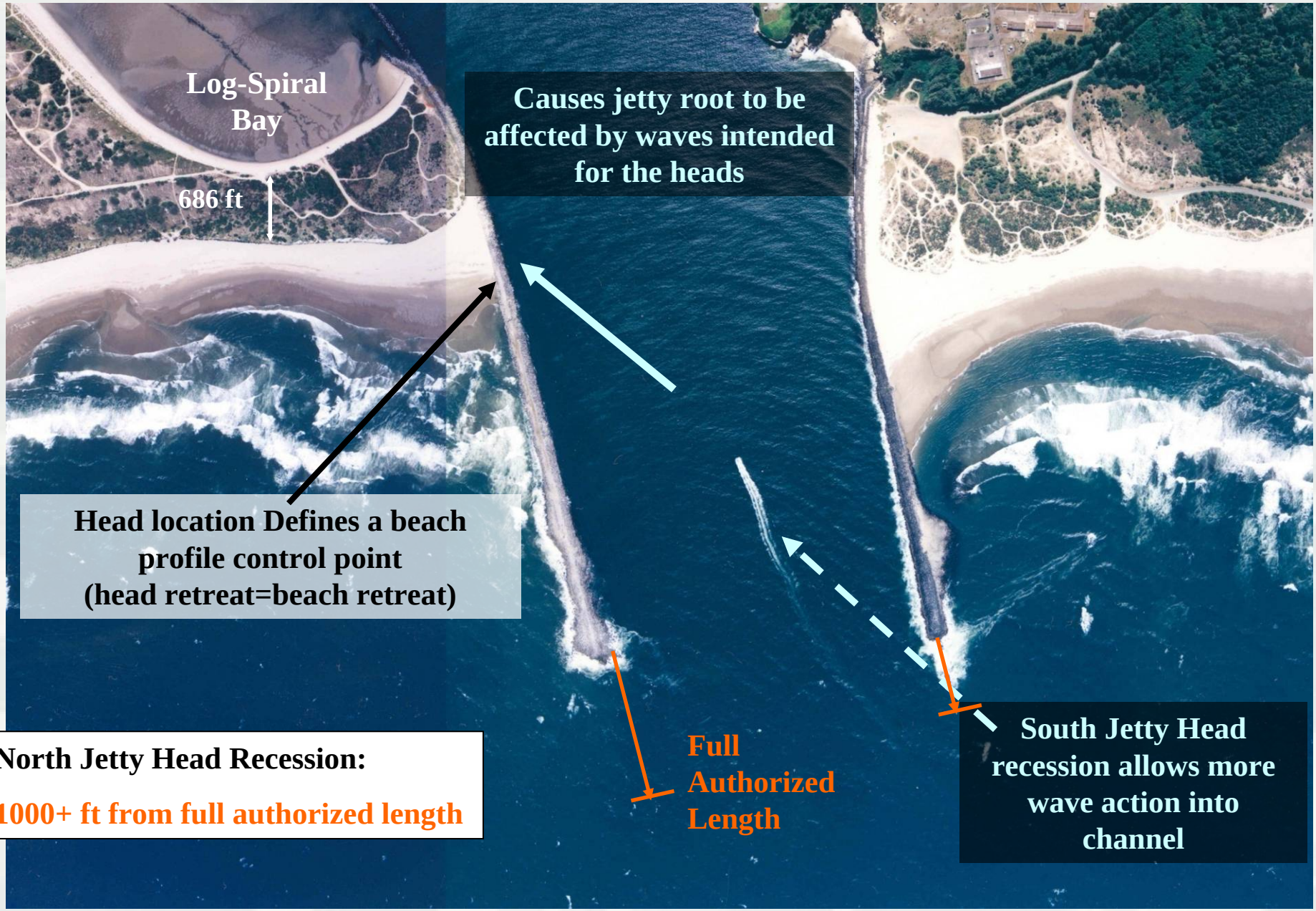
- **Loss of federal investment in infrastructure**
- **Increased project costs (dredging, emergency repair)**
- **Impacts to project function**
- **Environmental impacts (shoreline, shoal impacts)**
- **Loss of life**

Coastal Jetties

Secure Consistent and Safe Navigation Channel from Ocean to Inland Waters

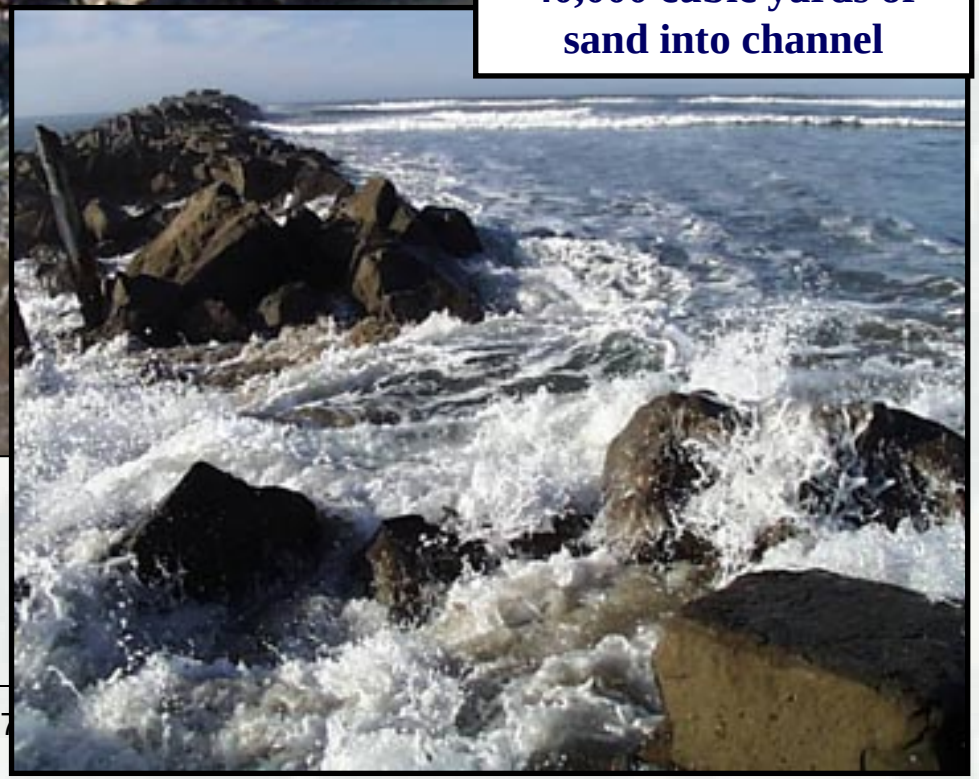
1) Constrict Flow through inlet – Stabilize Inlet and shoals
2) Use scour to promote the Authorized Channel Depth
3) Protect inlet from excessive Wave and Current action
4) Minimize Negative Consequences to estuary, adjacent shoreline, jetties

Vulnerability due to Jetty Head Recession



North Jetty Head Recession:

1000+ ft from full authorized length



High tide flow through jetty root transports ~ 40,000 cubic yards of sand into channel

Deepwater Wave Height Range:
2m average to 15 m extreme
"storm surge+transient" = 1.8 m + 1.8 m

Semidiurnal Tides:
Diurnal range = Approx. 2.5m

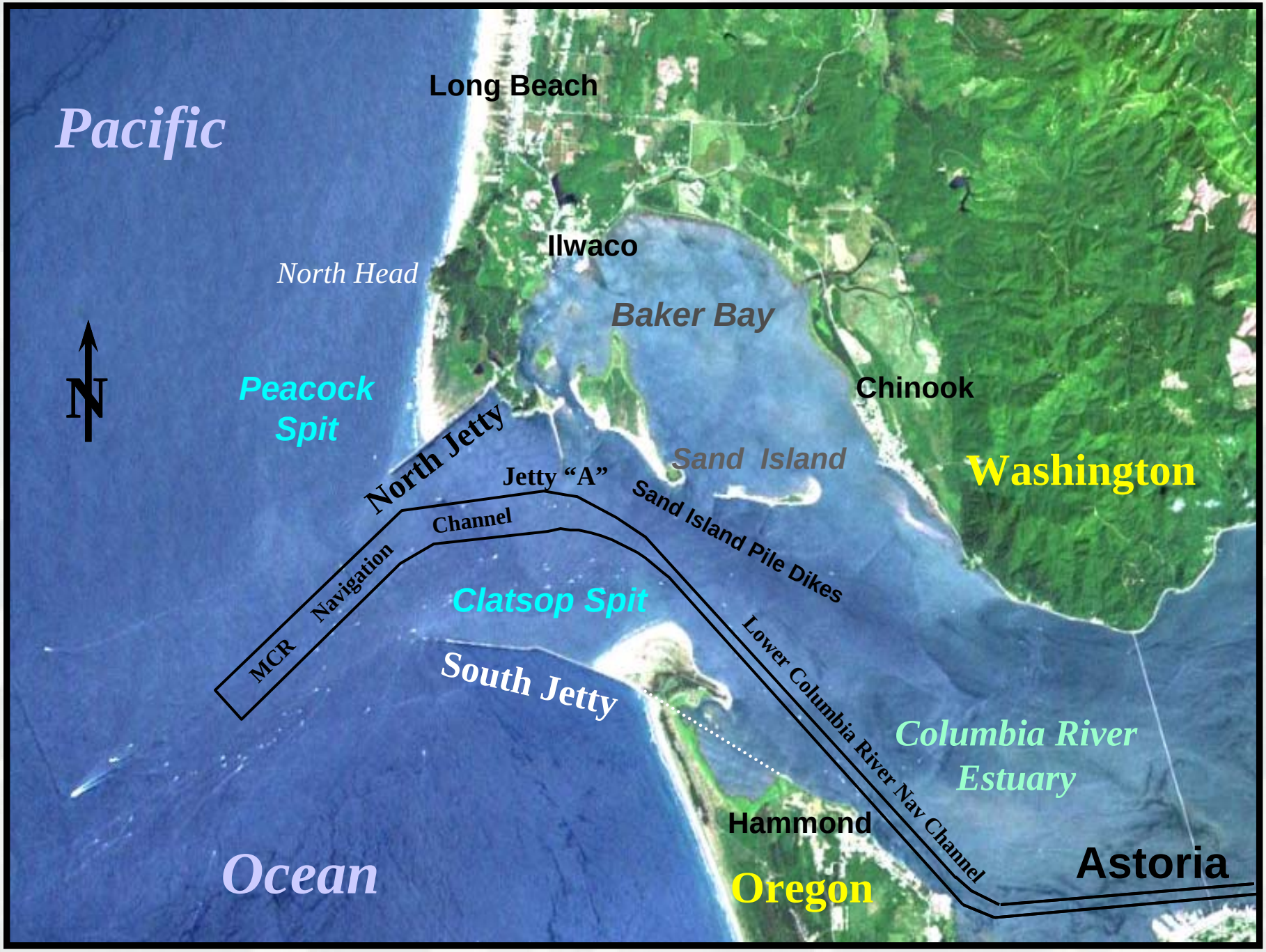
Water Depth at Projects:
6 to 25 m

Littoral Closure Depth:
20 m

Zone of Interest:
Backshore to 200m depth

Natural Inlet

Engineered Inlet

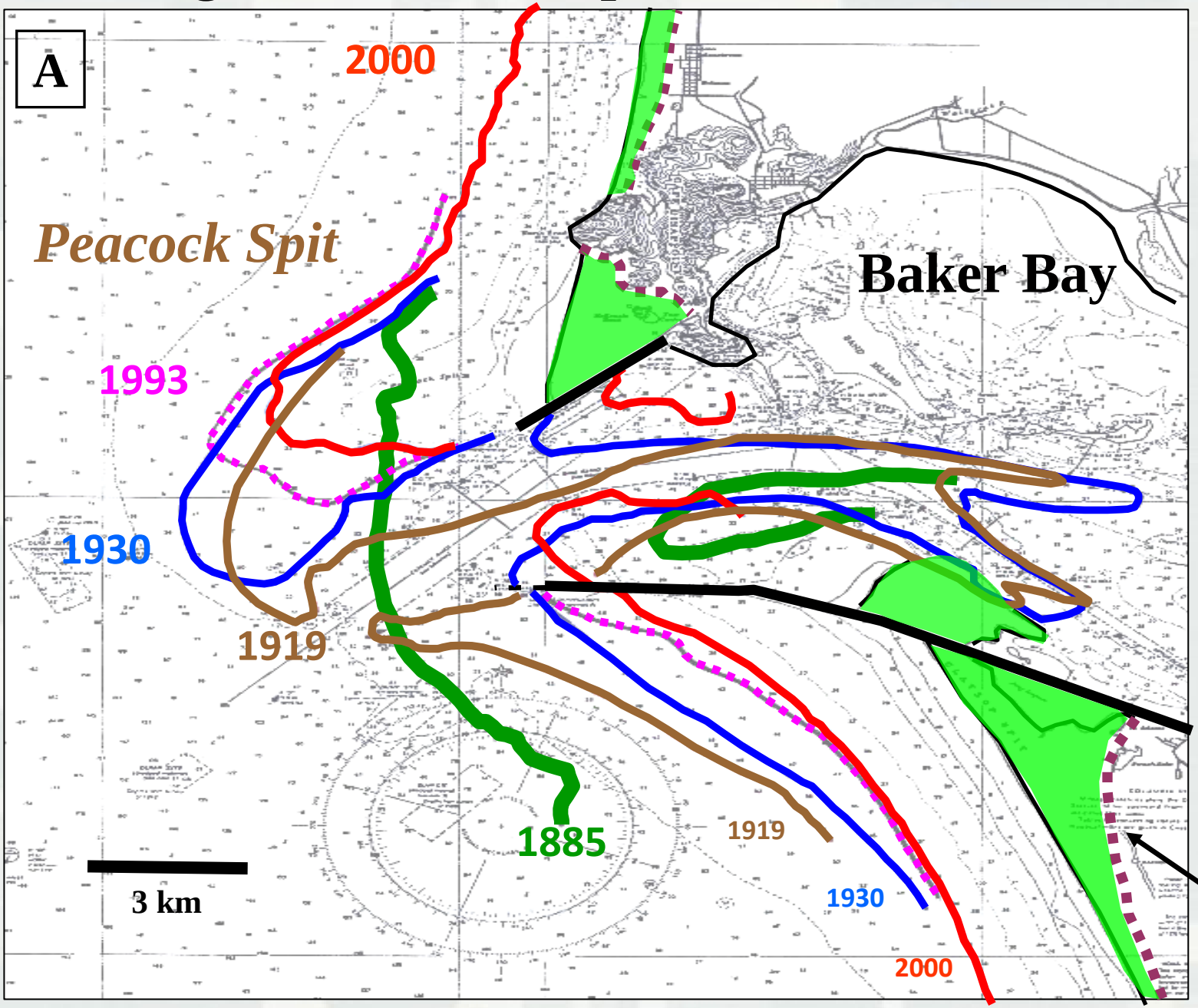

Pacific
Long Beach
Ilwaco
North Head
Baker Bay
N
Peacock Spit
Chinook
North Jetty
Jetty "A"
Sand Island
Washington
Sand Island Pile Dikes
Channel
Navigation
MCR
Clatsop Spit
South Jetty
Lower Columbia River Nav Channel
Columbia River Estuary
Hammond
Ocean
Oregon
Astoria

Hopper Dredges working at MCR

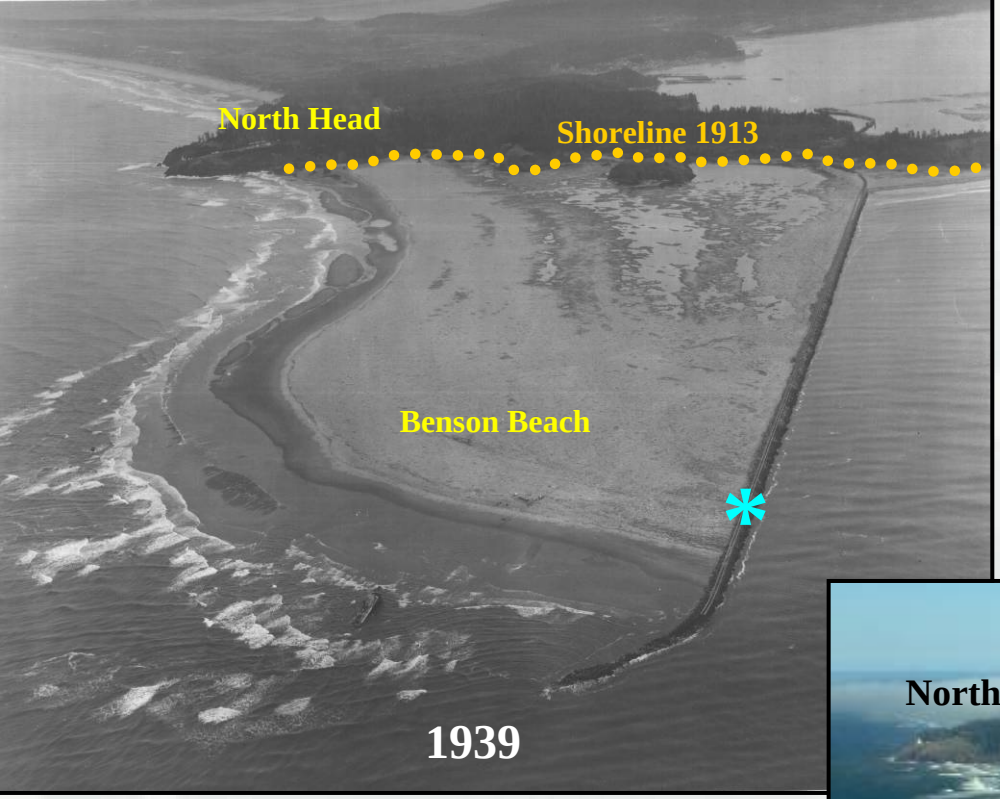
3-5 Million cy of Sand Dredged from MCR Each Year

MCR Maintenance Dredging is Performed during June-Sept

Change in the 40-ft depth Contour thru Time

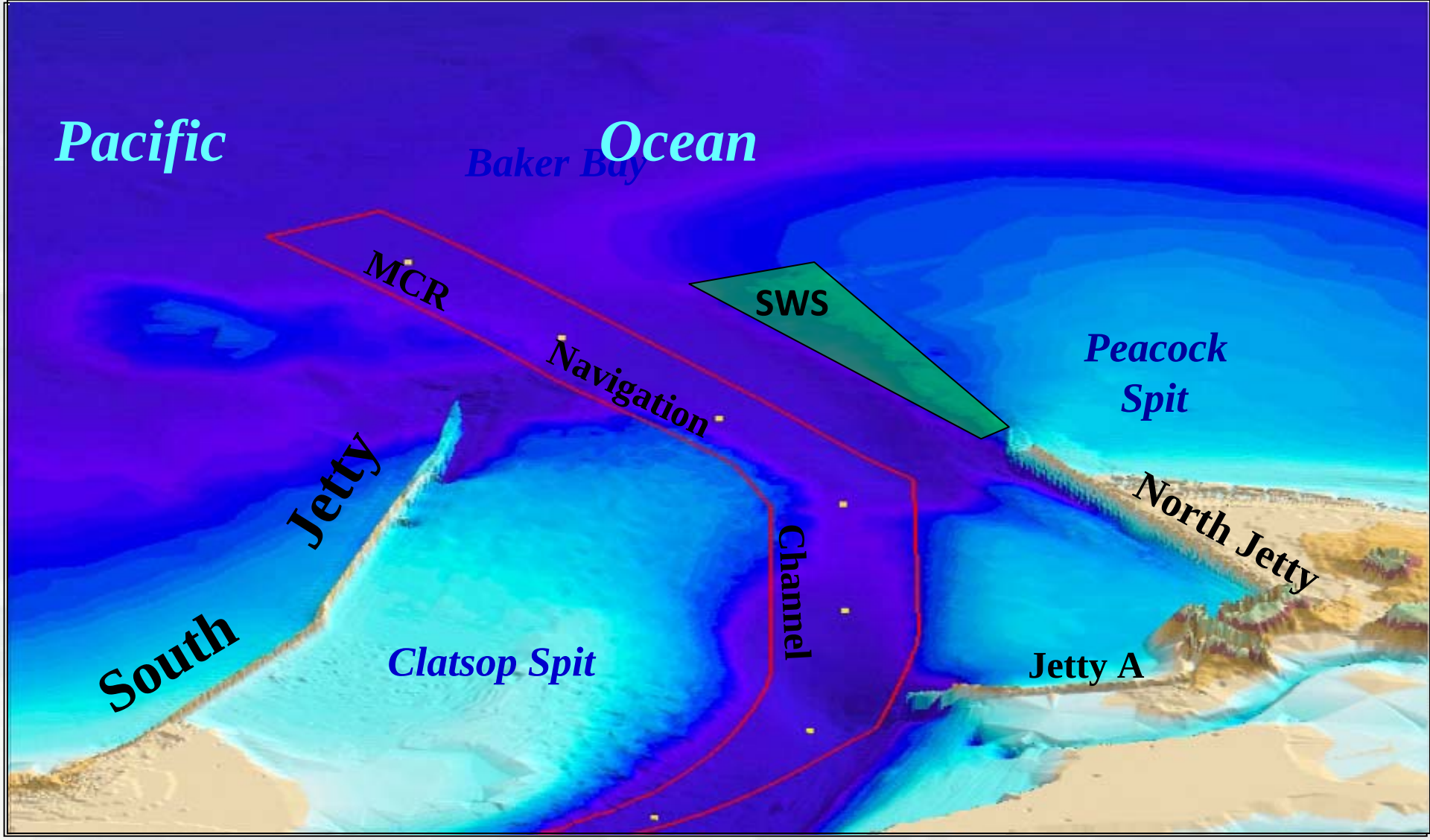


The underwater shoals at MCR are eroding, affecting the stability of the jetties and the inlet



As Shoals recede, jetties become vulnerable to foundation scour and wave attack

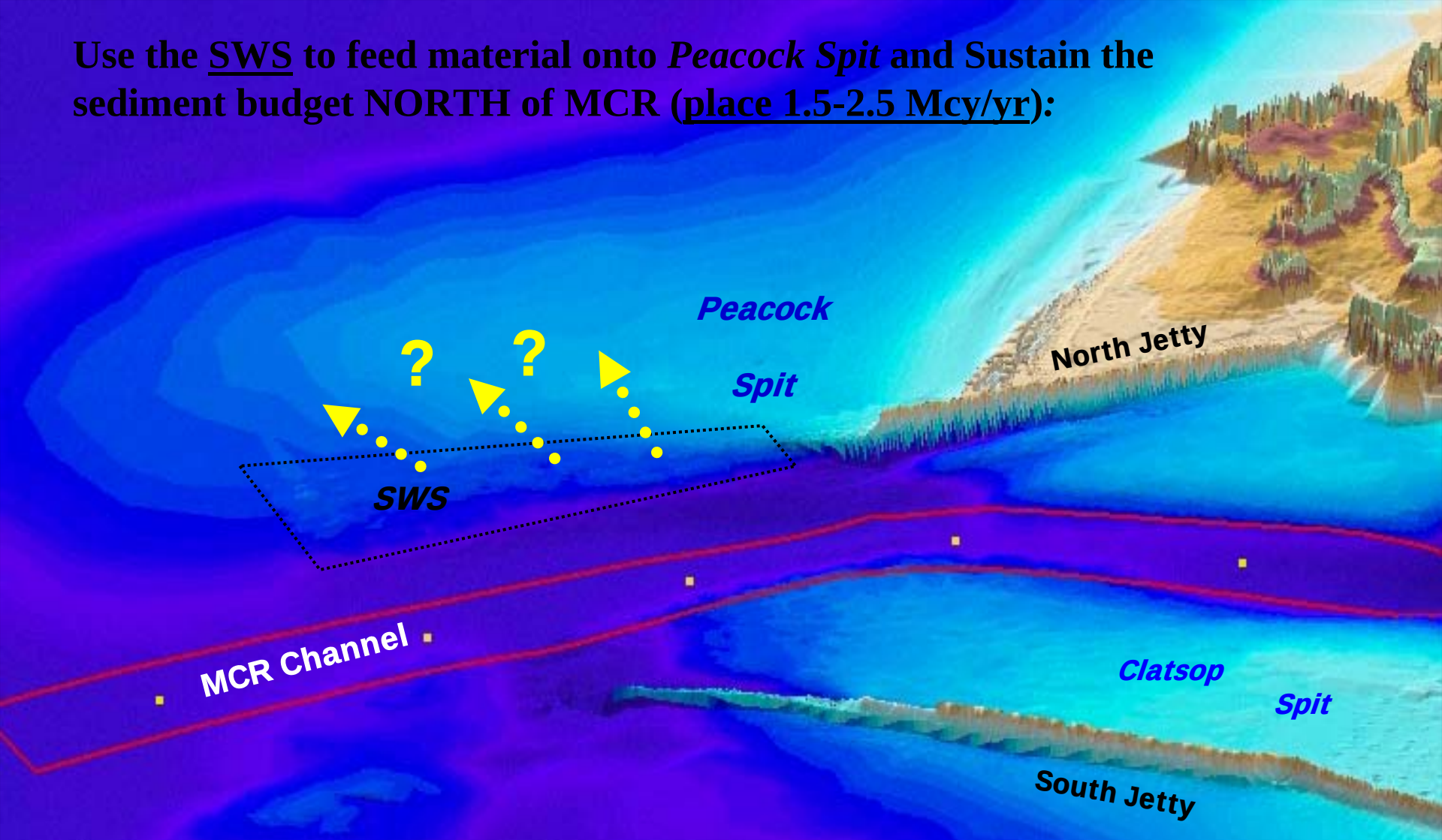
INTERVENTION IS NEEDED TO PREVENT LOSS OF JETTY FUNCTION & SUSTAIN RELIABLE NAVIGATION



Mouth of the Columbia River

3-D perspective, view to WEST- offshore

Use the <u>SWS</u> to feed material onto *Peacock Spit* and Sustain the sediment budget NORTH of MCR (<u>place 1.5-2.5 Mcy/yr</u>):



CAN WE ? :

*** Reduce the rate of erosion affecting the north jetty?**

*** Reduce shoreline erosion along areas north of MCR?**

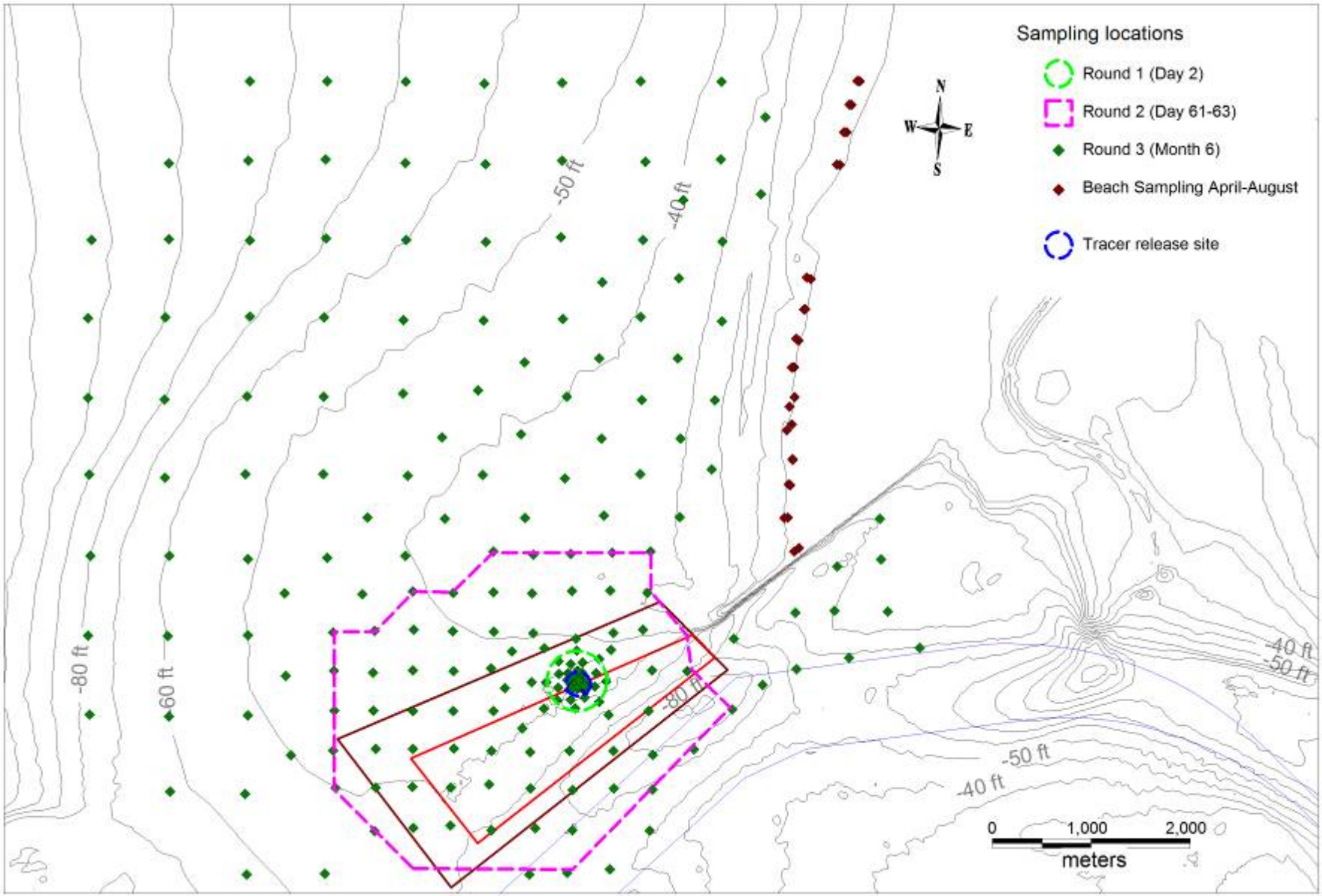
Dredged Material Placement within SWS

1997-2009: 29 Million cy has been placed ------

2.8 M cy remains within SWS

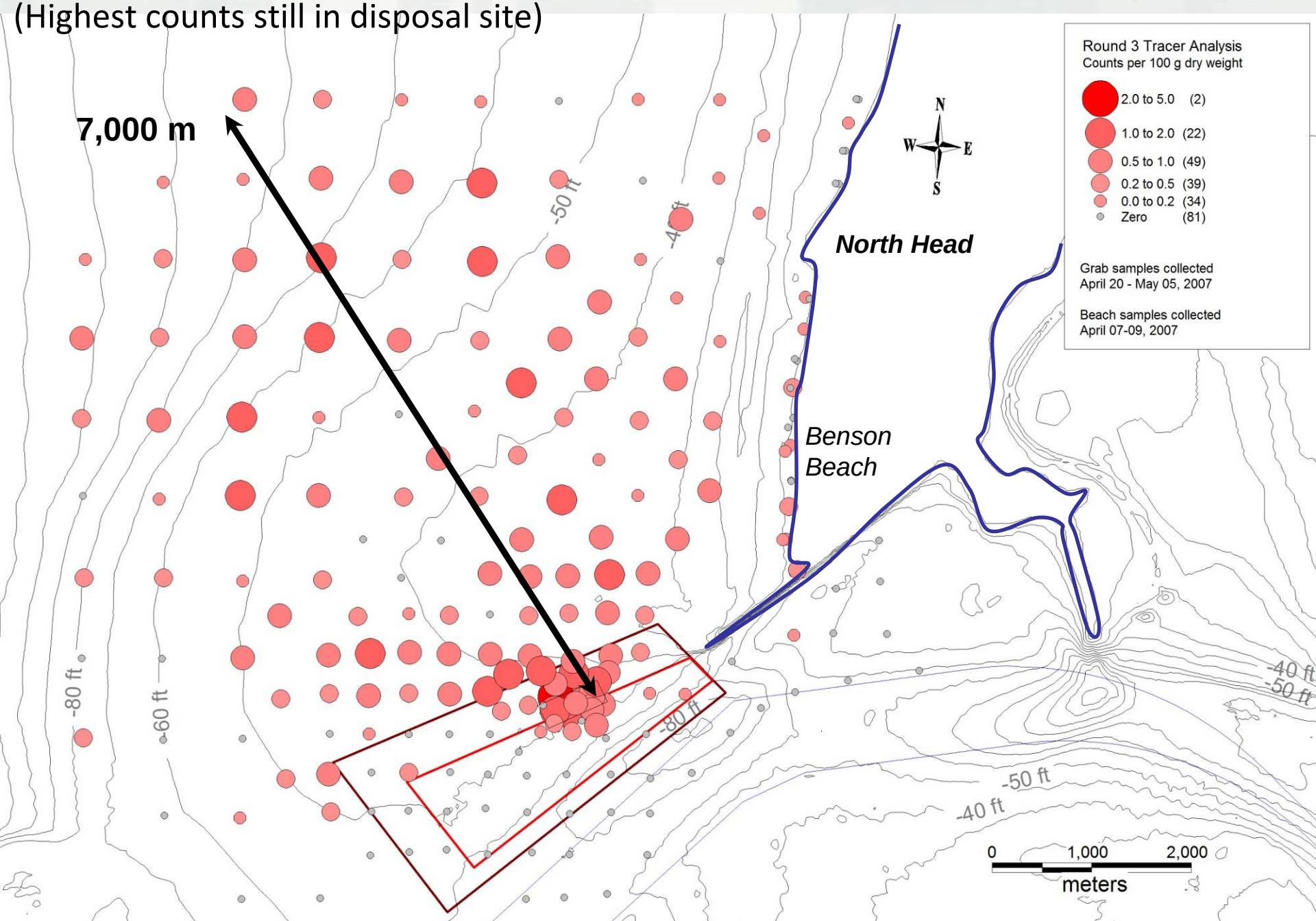
Seabed & beach sampling locations

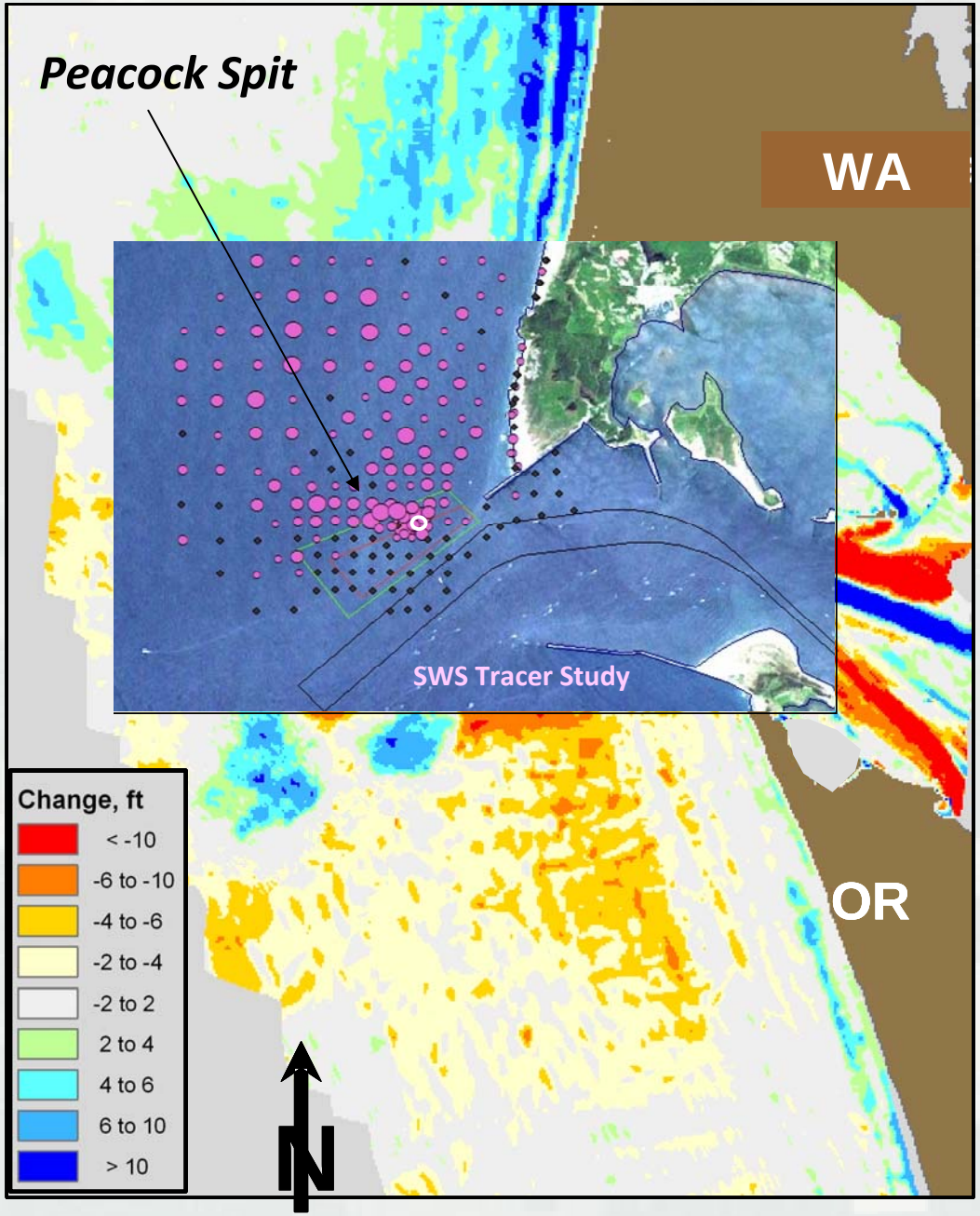
(Grabs: Day 2, Day 61-63 & Month 6. Beach: Dec 06 - Sept 07)



Month 6: Round 3 Sampling, Apr/May 2007

(Highest counts still in disposal site)





RED = Erosion

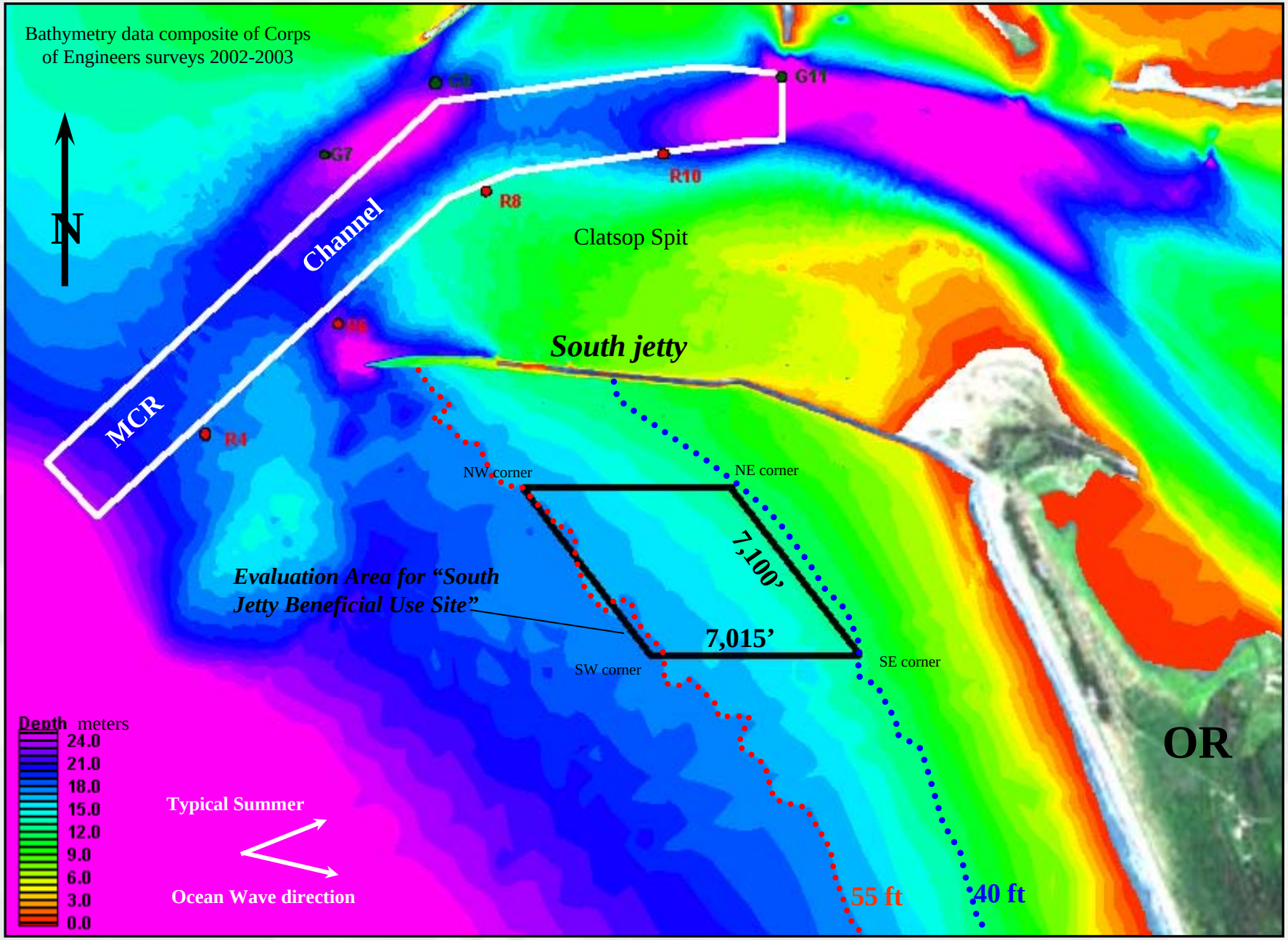
Blue = Deposition

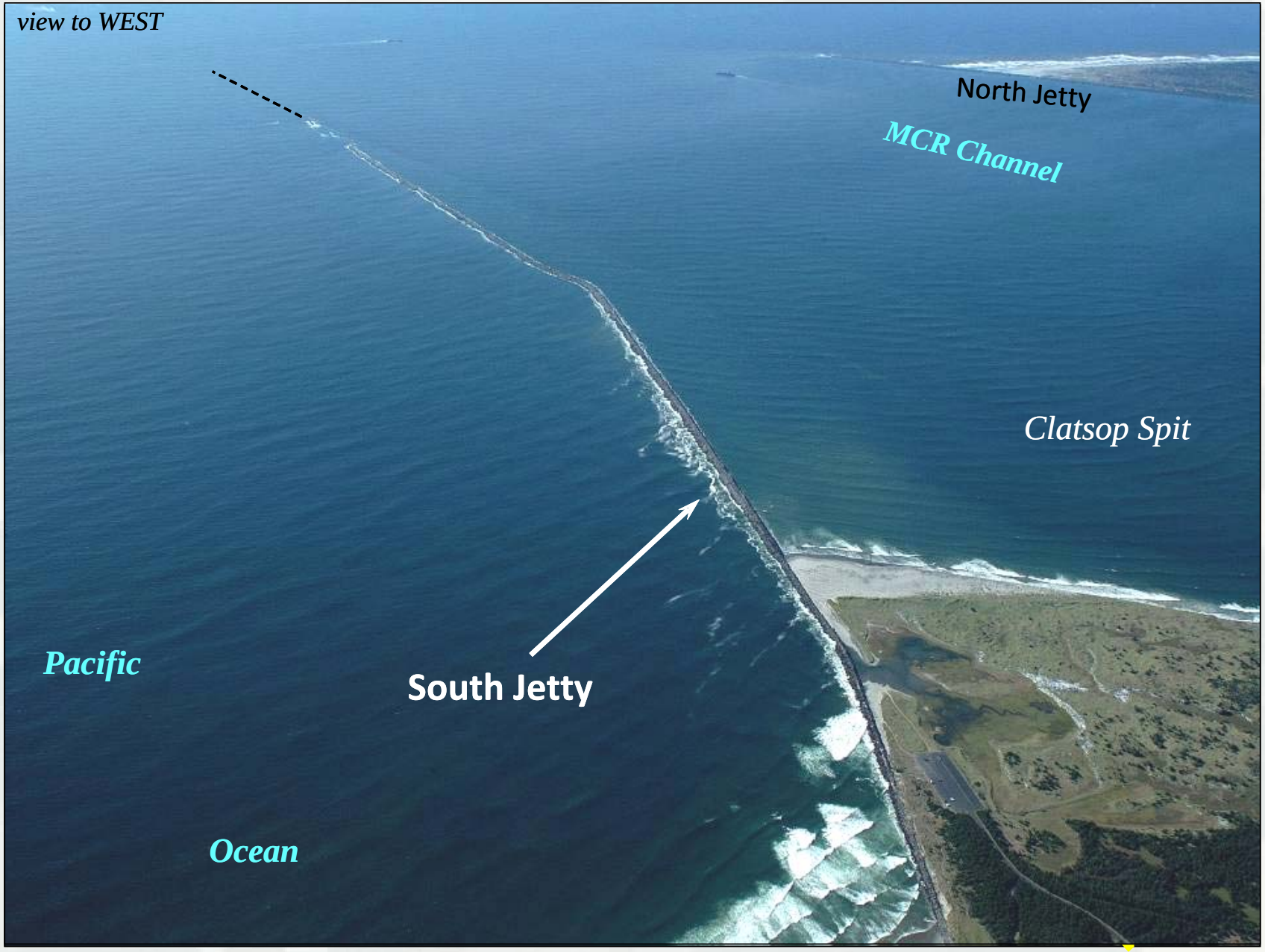
1958 to 2003 Bathymetric Change

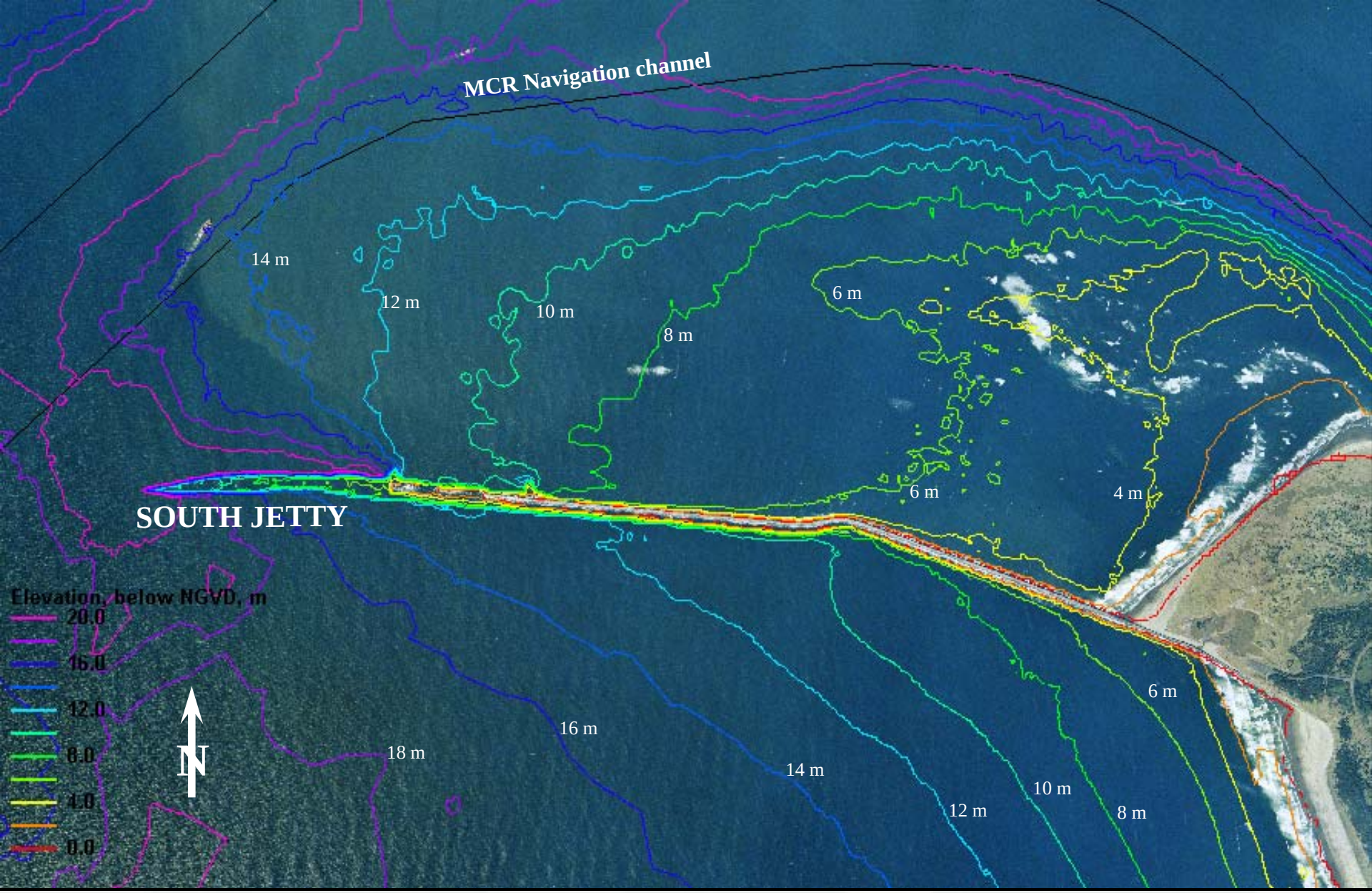
Use of the SWS has reduced the rate of recession affecting Peacock Spit.

Sustain the Spits/shoals and they will protect the jetties and inlet.

Initial Evaluation Area for "South Jetty Beneficial Use Site"




view to WEST
North Jetty
MCR Channel
Clatsop Spit
Pacific
South Jetty
Ocean



1425 m
scale

Figure 6 . South side of Mouth of the Columbia River. South jetty shown with Bathymetry, elevation is in meters below NGVD.

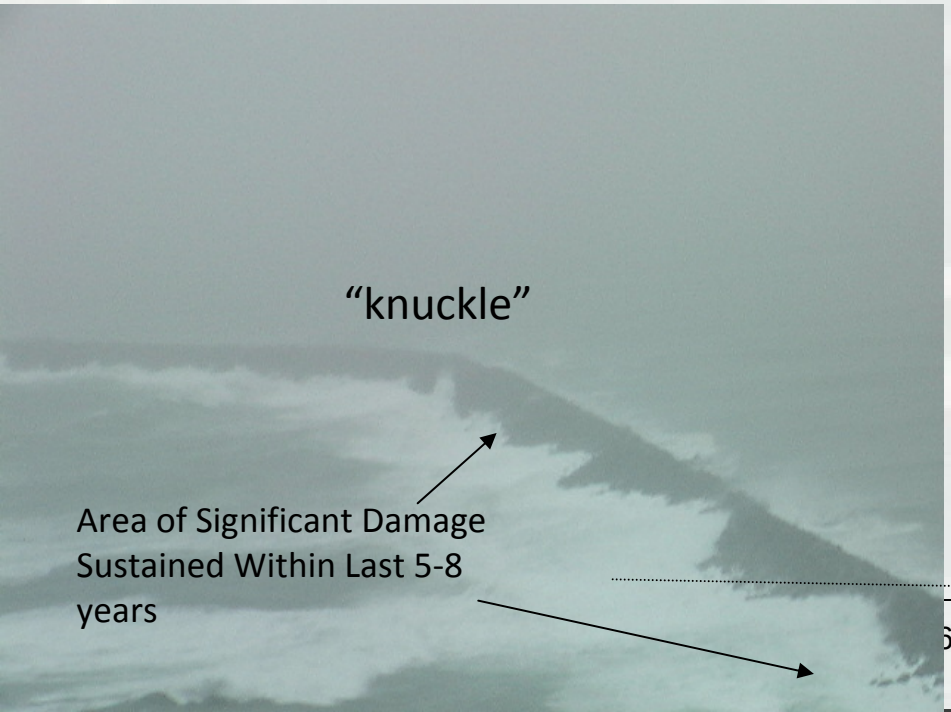
South Jetty - 31 Jan 2006

The Sustainability of South Jetty is threatened by Longterm EROSION of the nearshore Seabed:

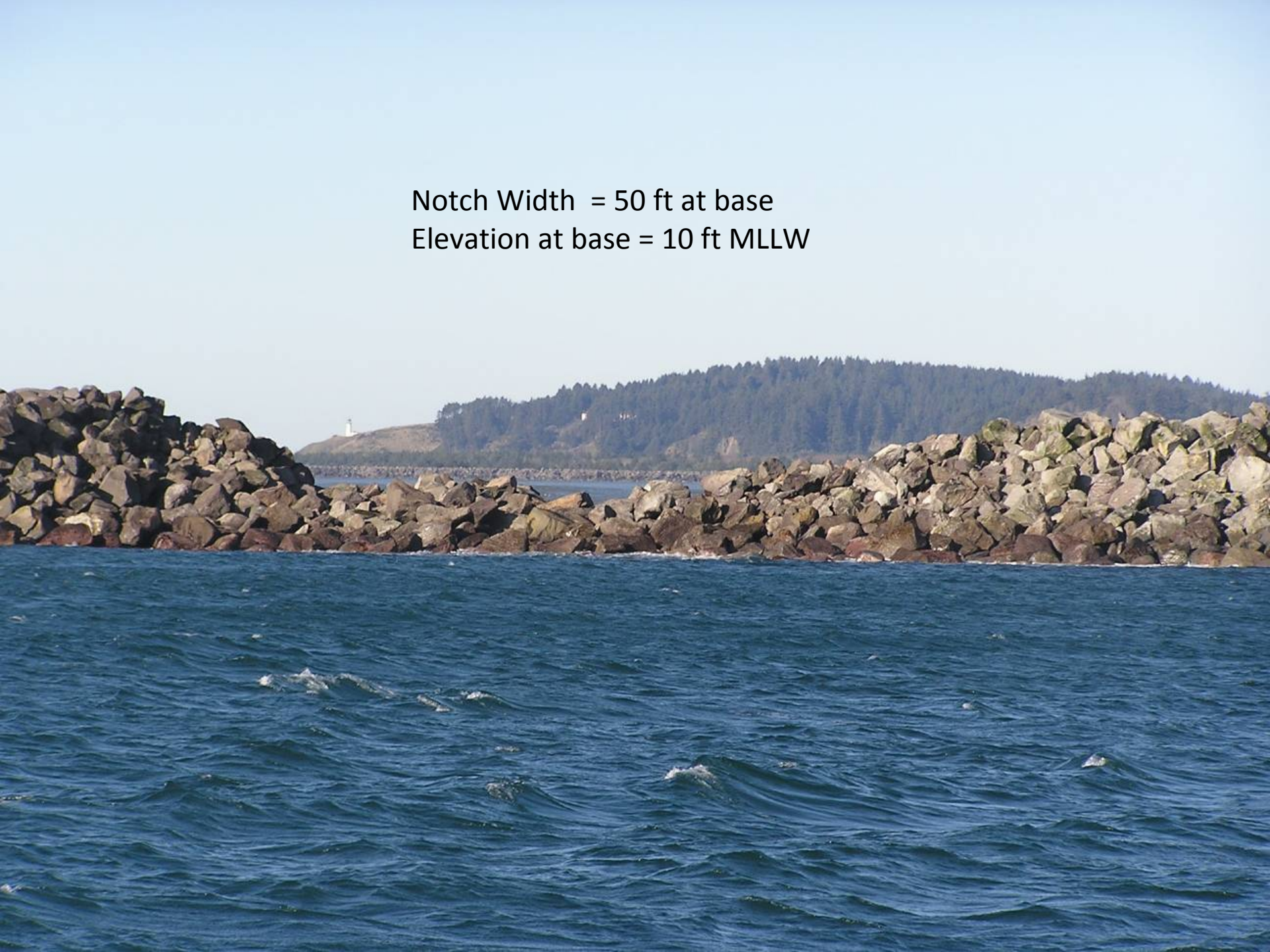
As the nearshore area continues to erode (deepen), the MCR South Jetty is subjected to foundation scour and increased wave attack = Loss of Jetty

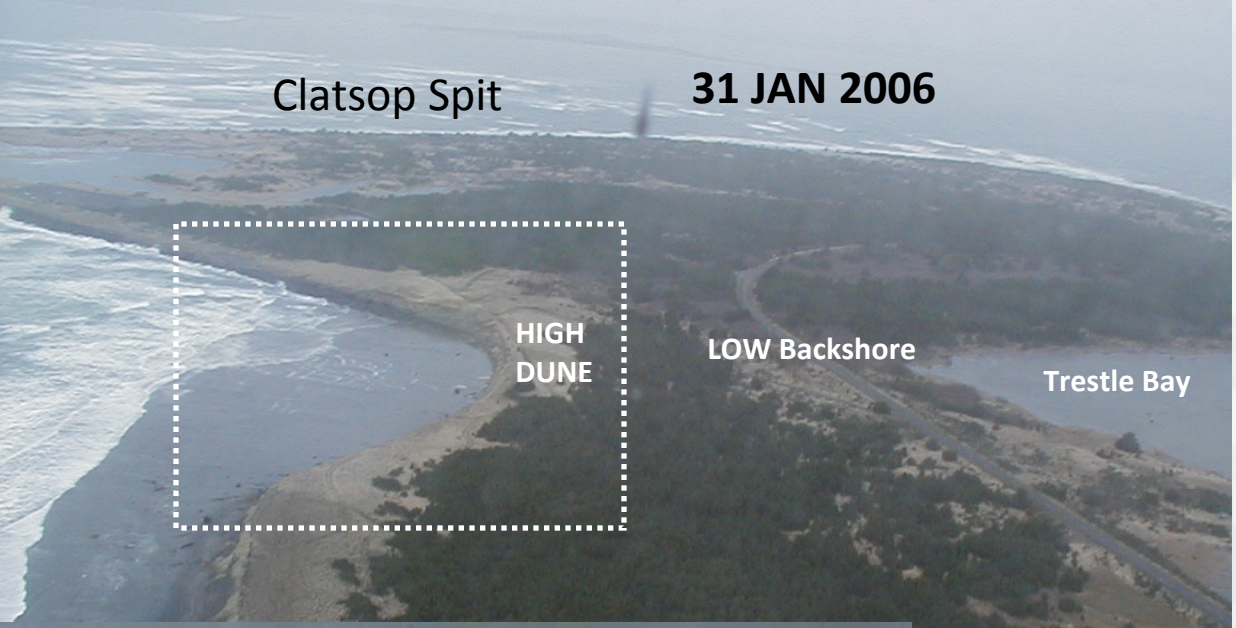
South Jetty

12 Jan 1300 – Coast Guard Photos
Wave height 16 ft and building
Wind south at 30-40 kts

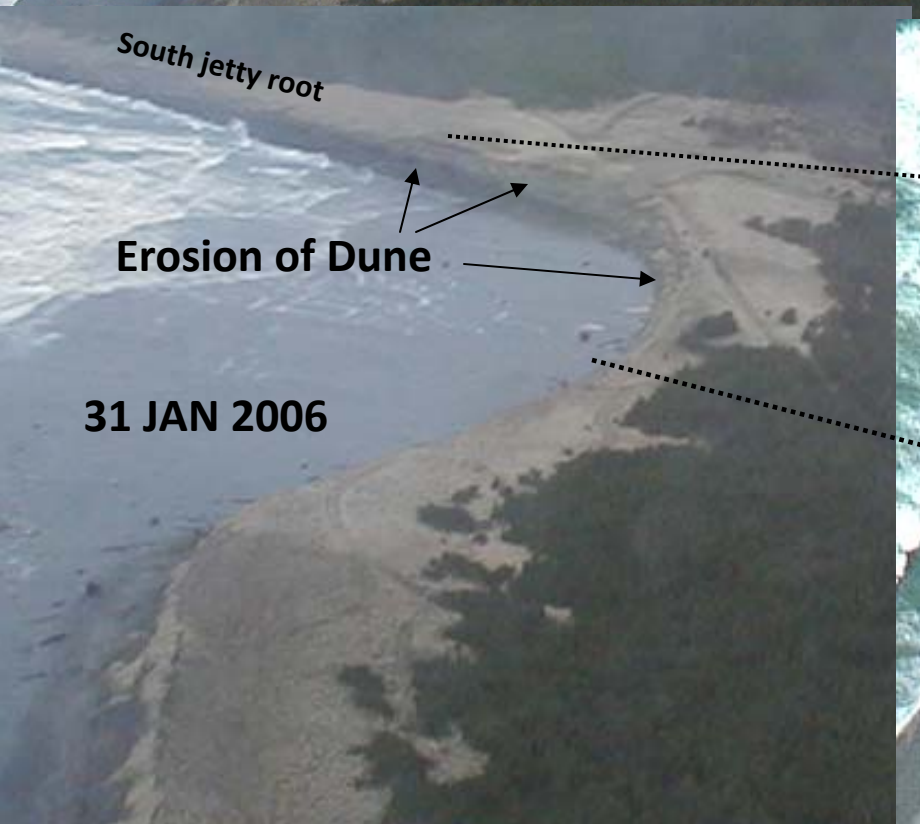


Notch Width = 50 ft at base
Elevation at base = 10 ft MLLW





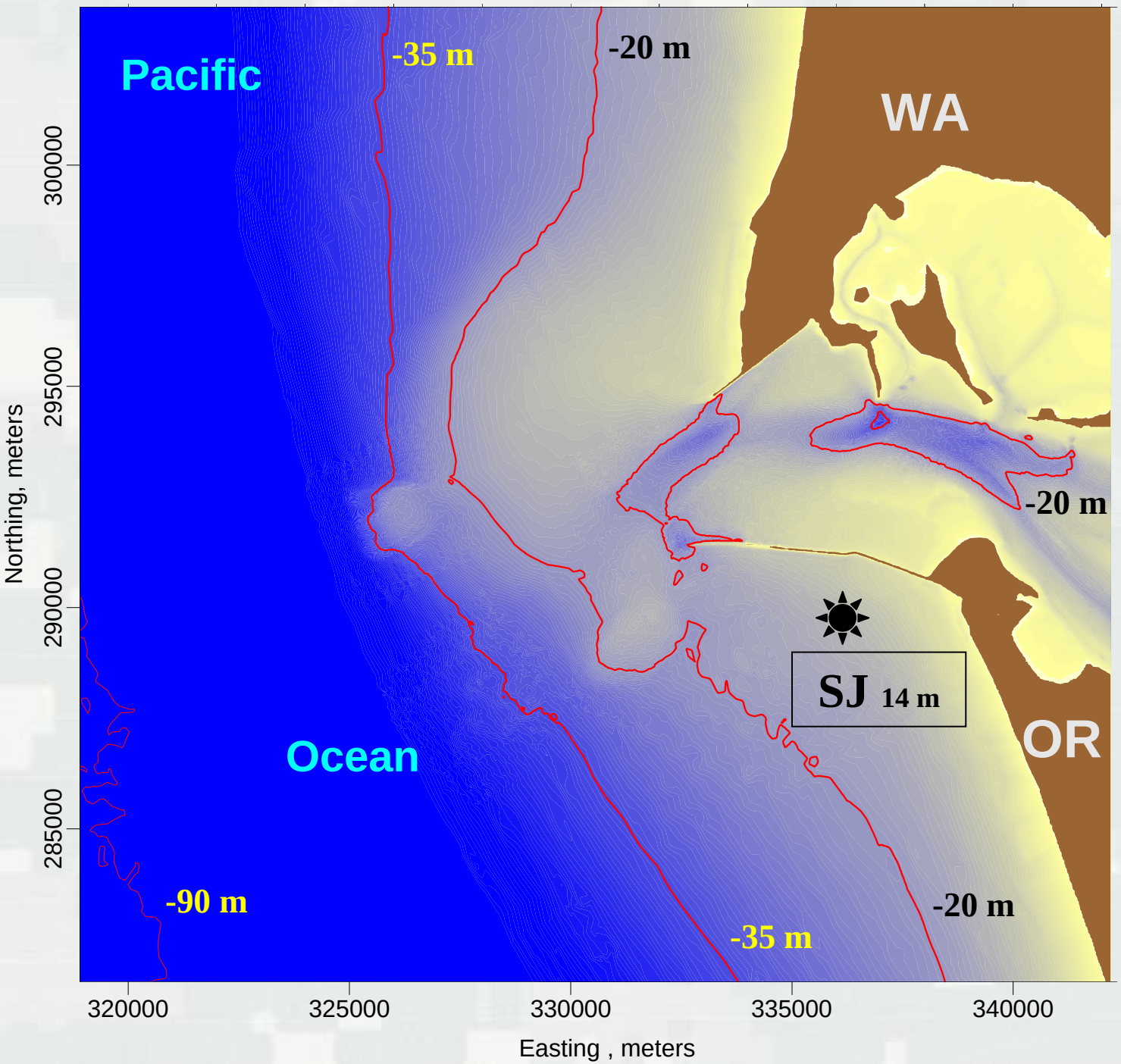
Root of MCR South Jetty is threatened by receding morphology at MCR inlet



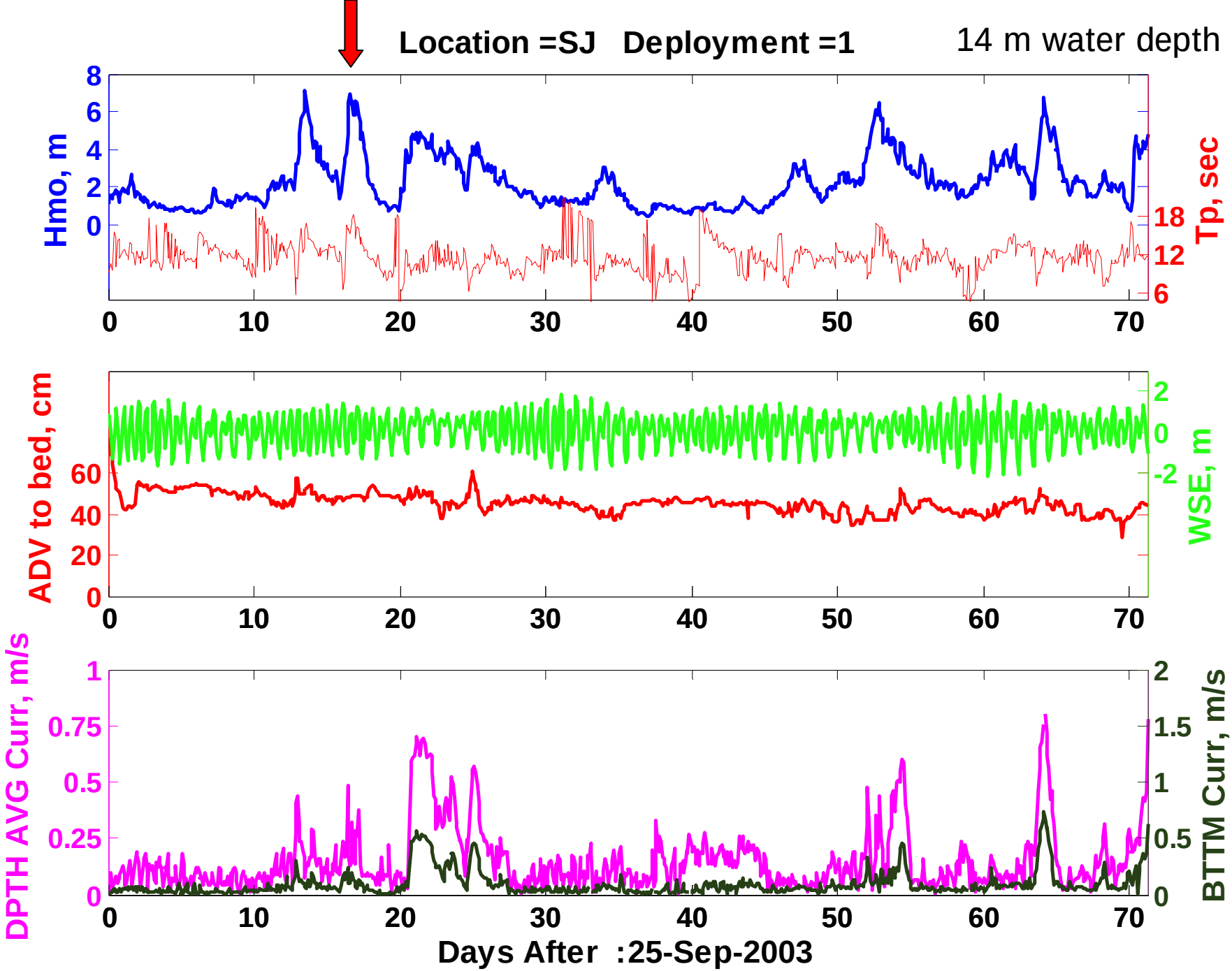
Wave-induced Erosion of primary Dune protecting un-secured jetty root and low elevation backshore (east, behind dune)

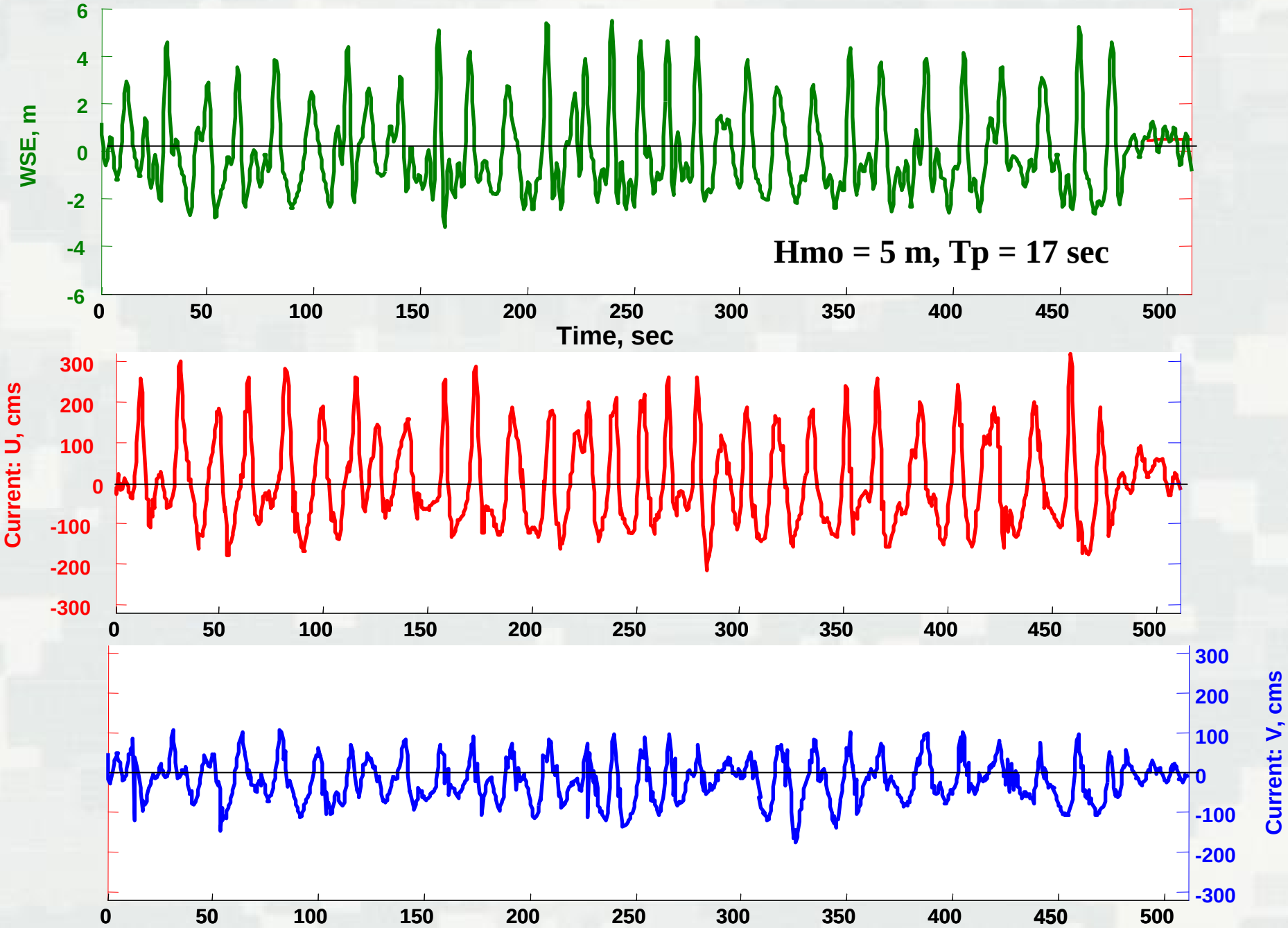
2/04/06

View to east along south jetty root

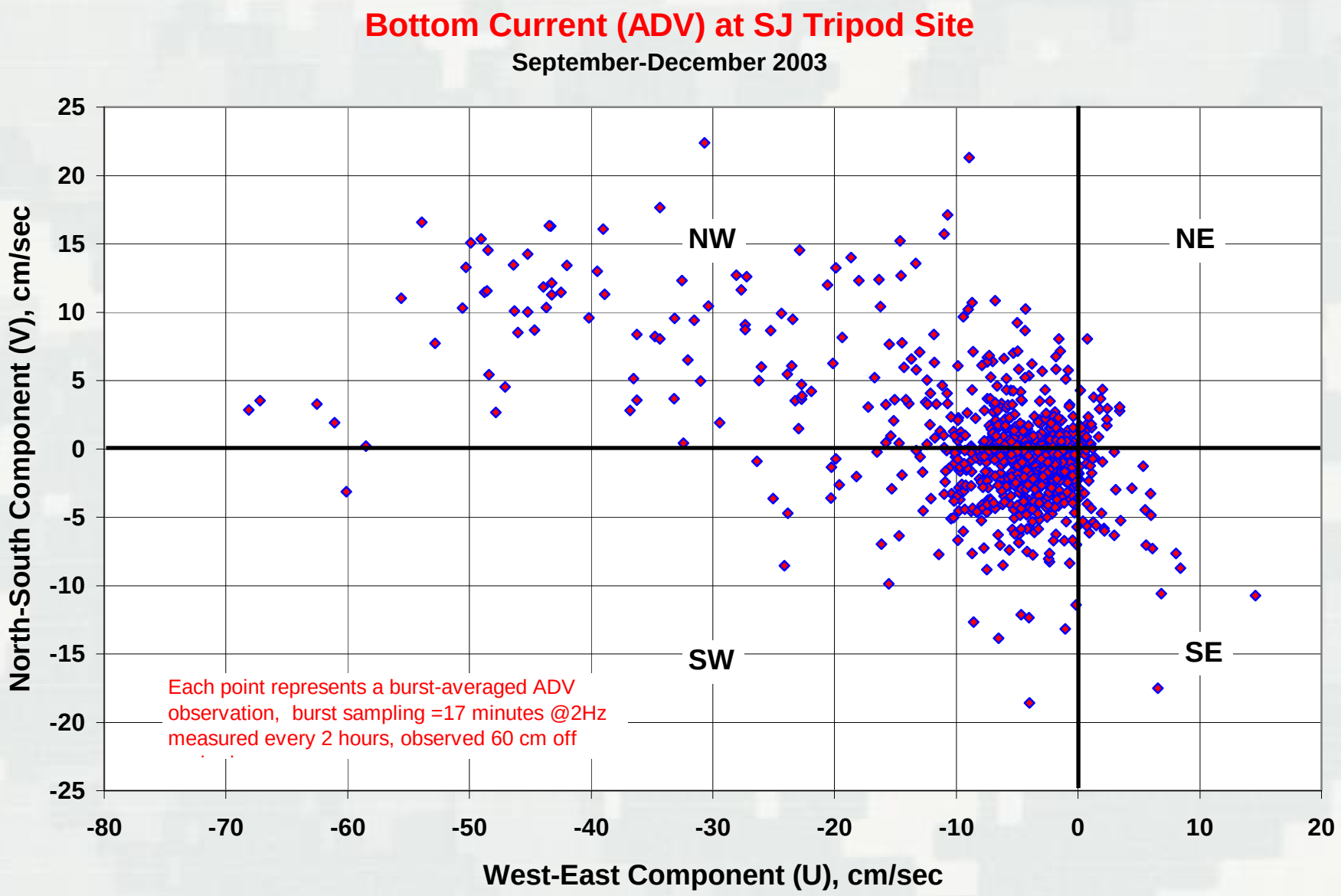


Mouth of the Columbia River


Location =SJ Deployment =1
14 m water depth
Hmo, m
Tp, sec
ADV to bed, cm
WSE, m
DPTH AVG Curr, m/s
BTTM Curr, m/s
Days After :25-Sep-2003


WSE, m
Hmo = 5 m, Tp = 17 sec
Time, sec
Current: U, cms
Current: V, cms

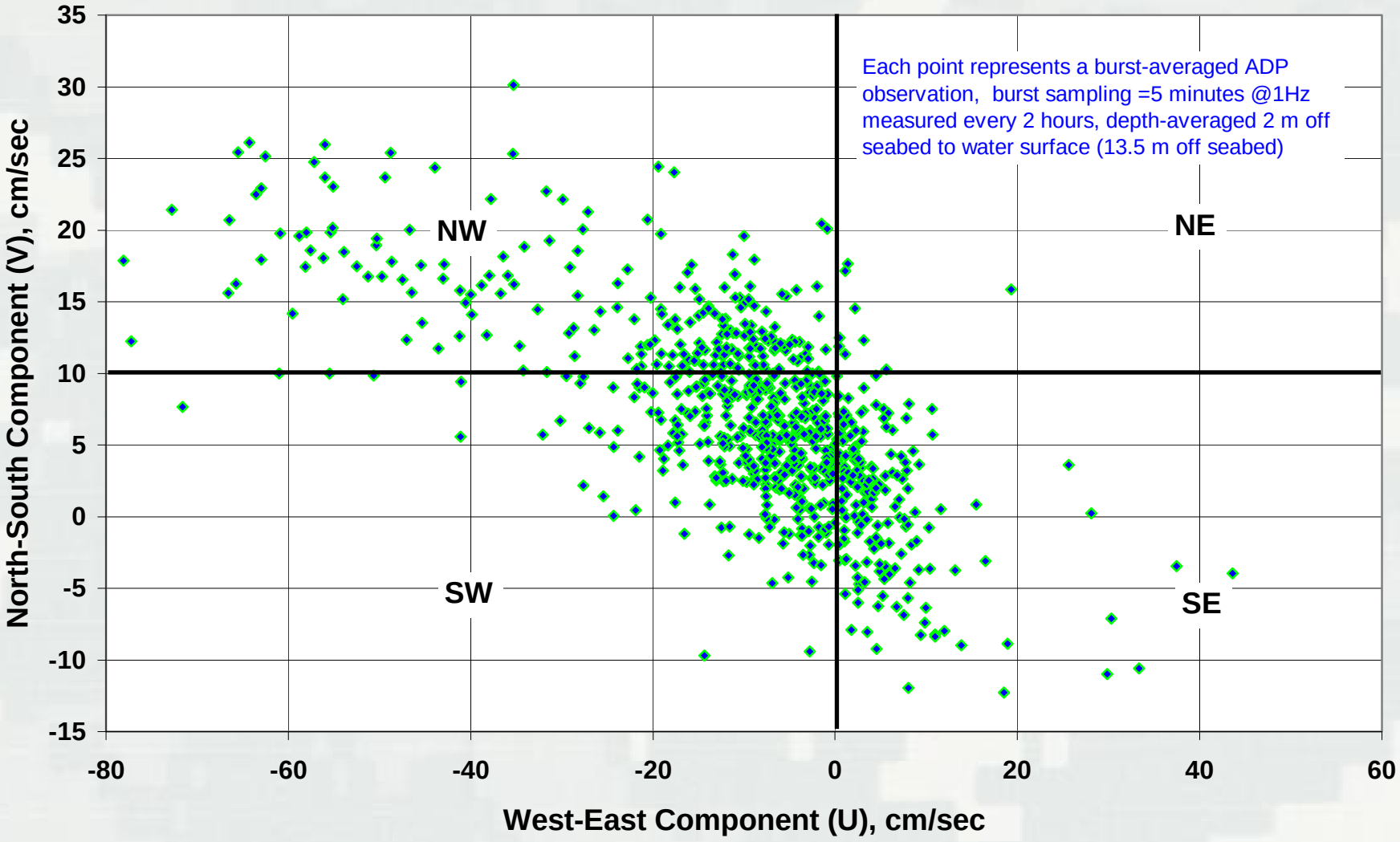
BURST-AVERAGED



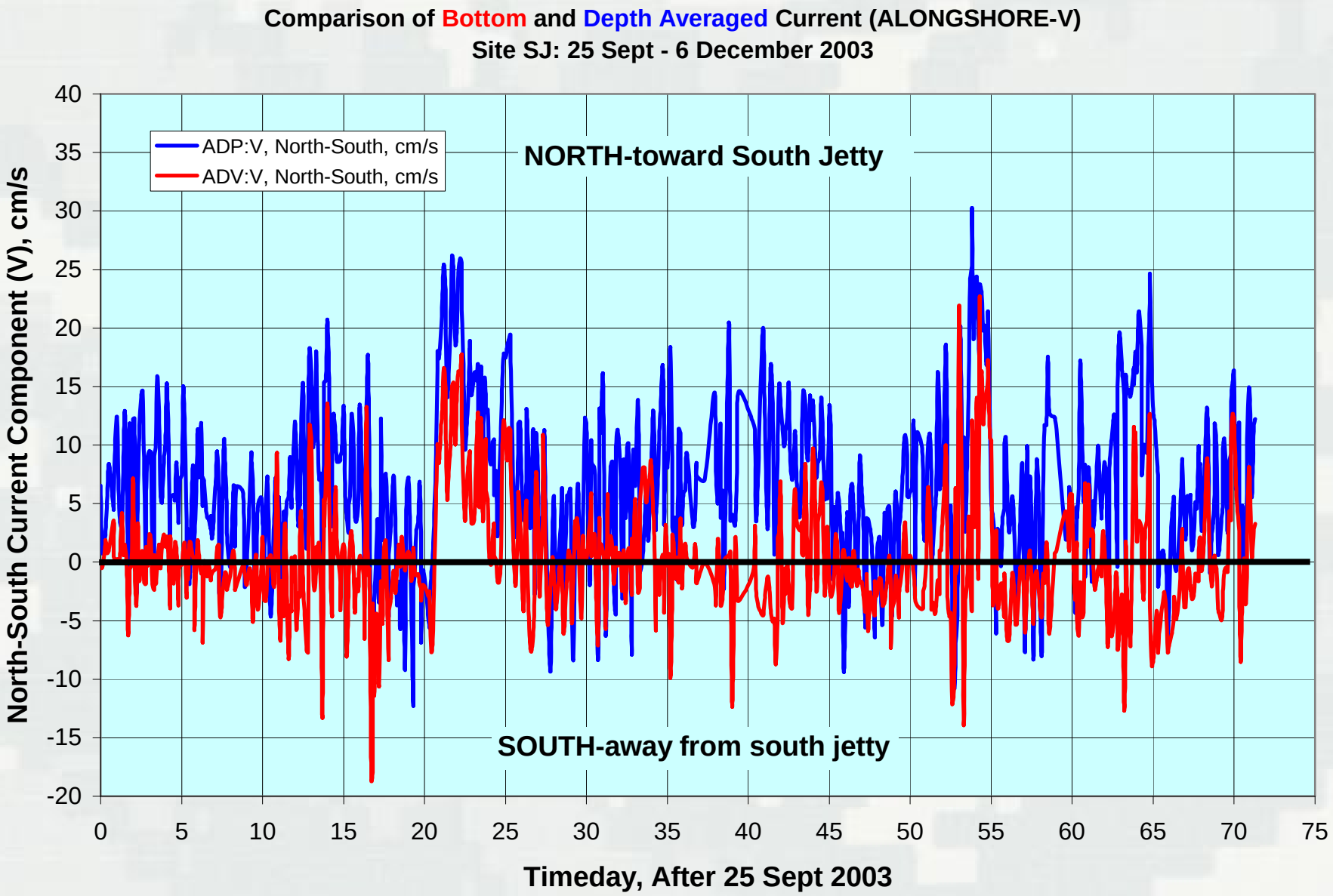
BURST-AVERAGED

Depth-Averaged Current (ADP) at SJ Tripod Site

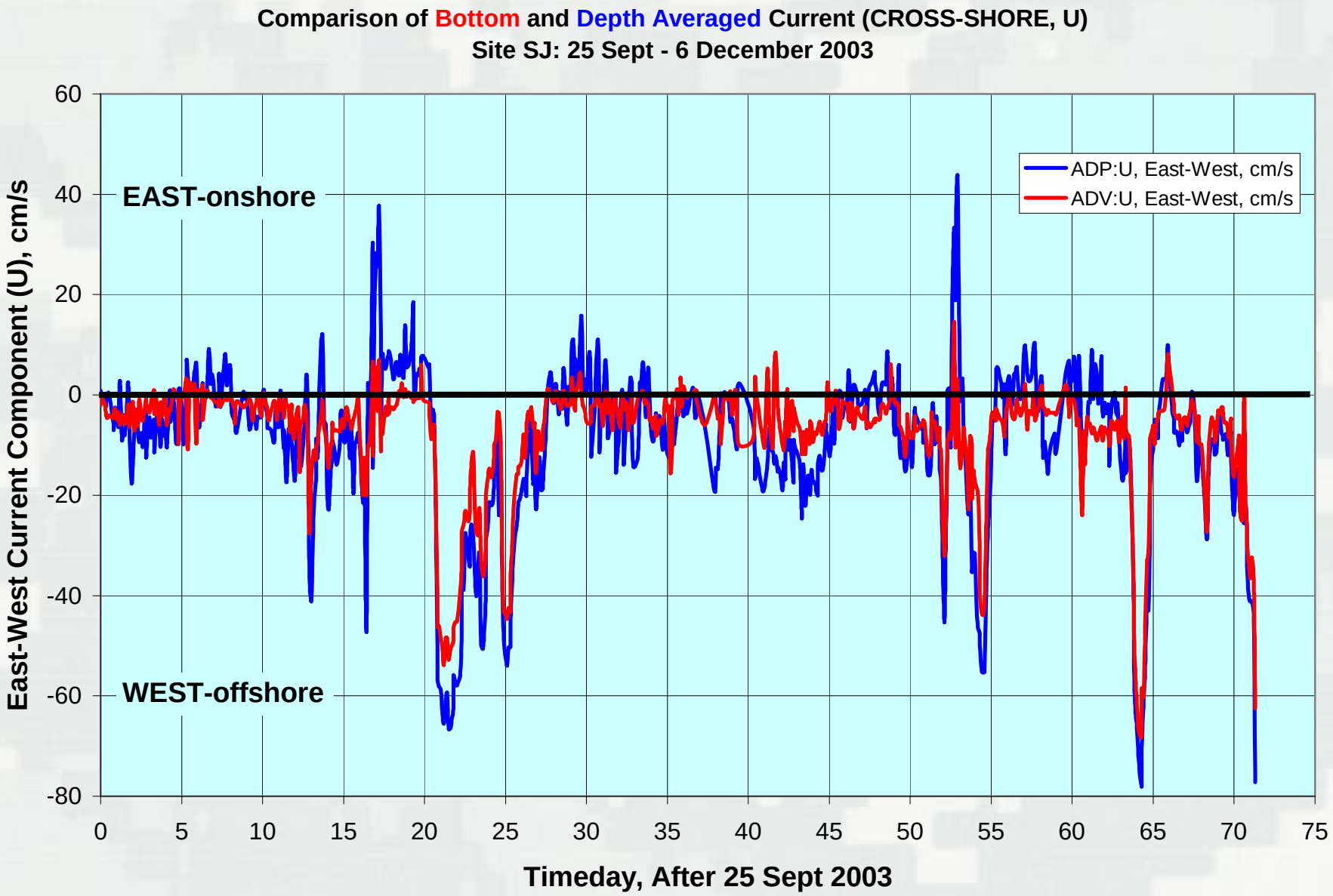
September-December 2003



BURST-AVERAGED



BURST-AVERAGED



Mouth of the Columbia River - Bathymetry and 2005 Dredged Material Placement Sites

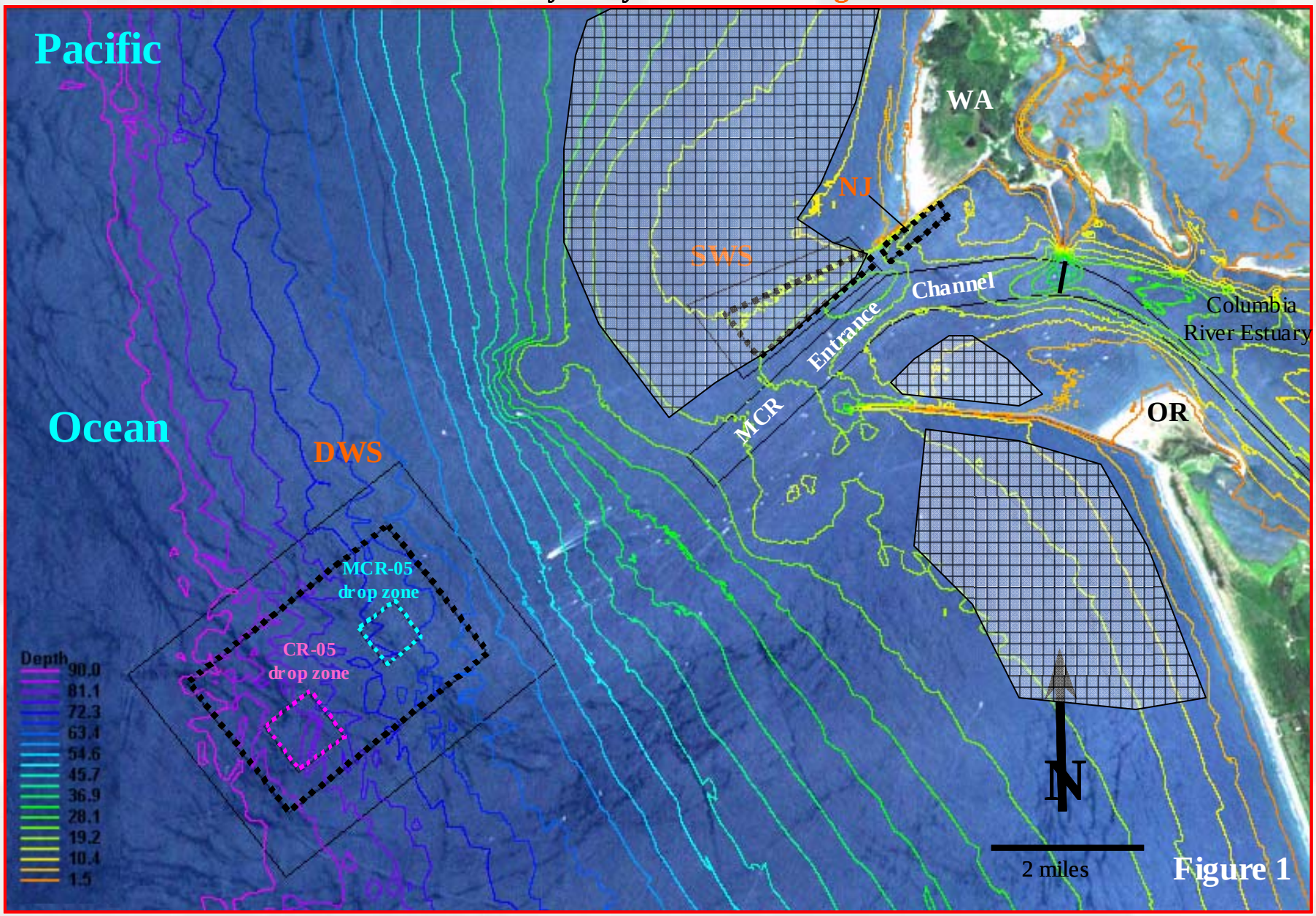


Figure 1

DWS= Deep Water Site, 102 MPRSA NJ Site = North Jetty disposal site, 404 CWA

SWS= Shallow Water Site, 102 MPRSA (formally Site E, 103 MPRSA)

-----Opportunity for Intervention-----

Strategically Place Dredged Material within Nearshore

DO NO HARM

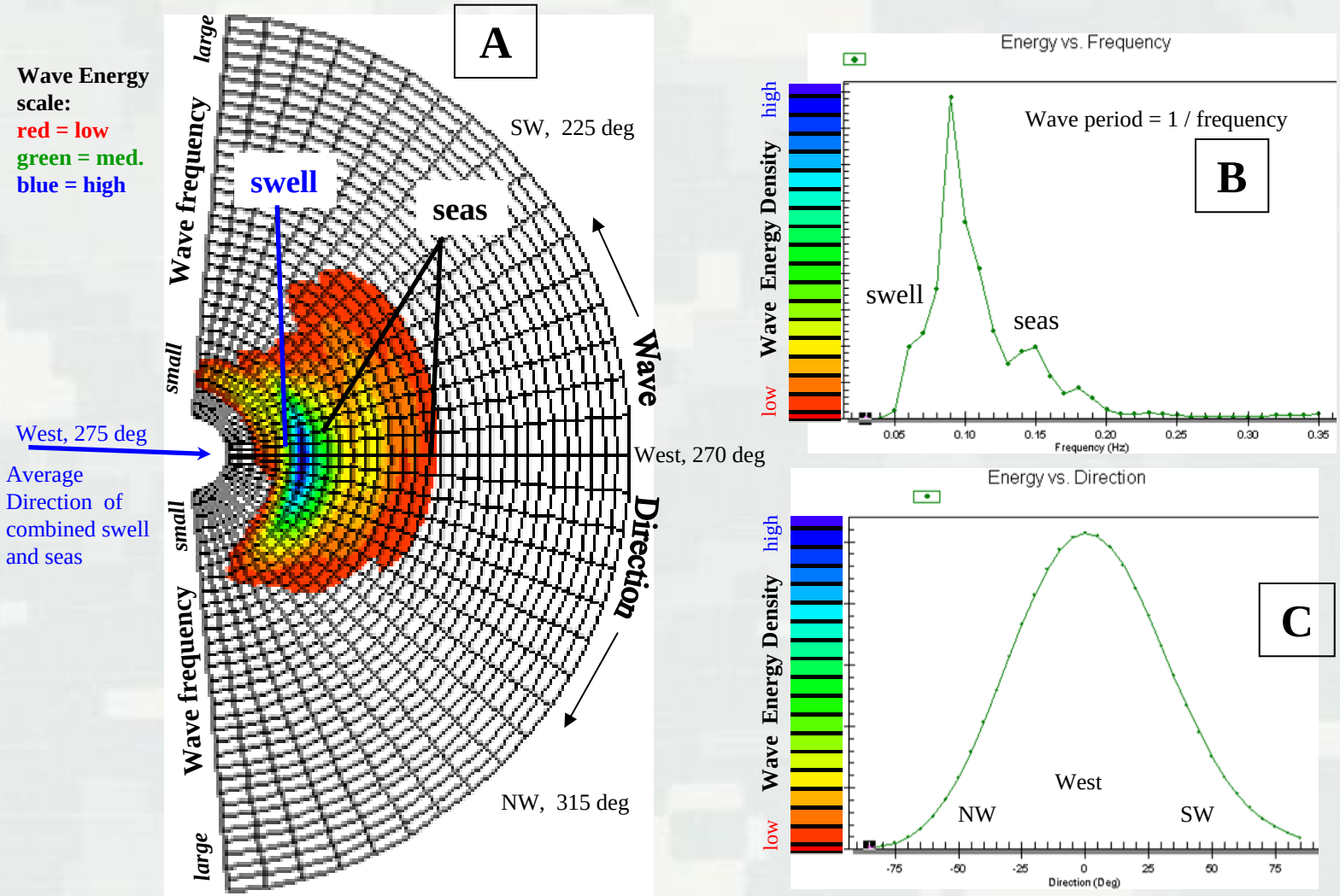
- **Benefits-** Sustain sediment budget at the Inlet; Reduce erosion of the inlet's morphology.

  Protect Navigation Infrastructure from waves and scour: Defer costly jetty repair

- **Risks -** Dredged material may not "behave" as intended when placed in Nearshore = Unintended consequences

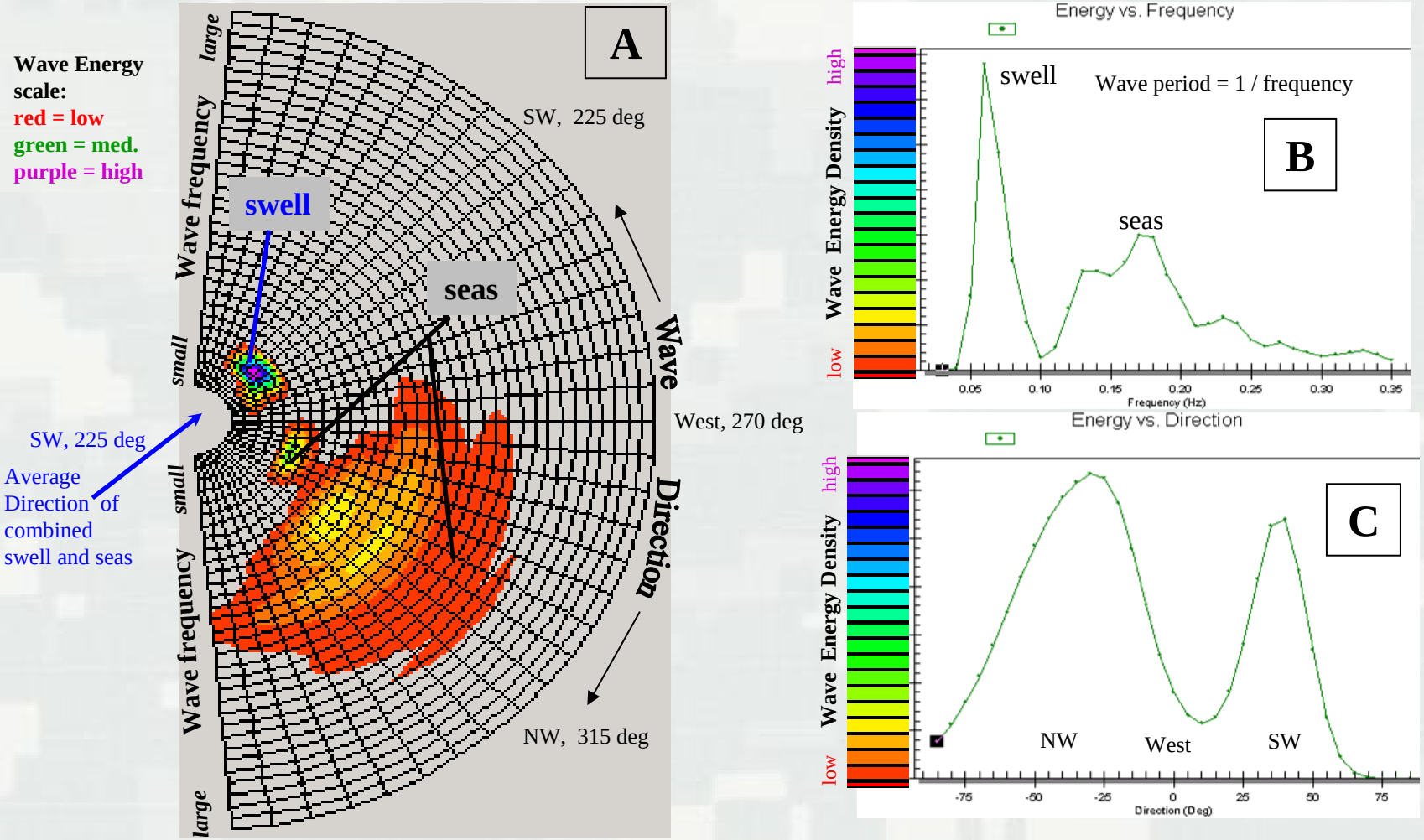
  * Mounding creates hazardous waves/currents
  * Moves back into Channel

  Living Resources are Adversely Affected by Placement



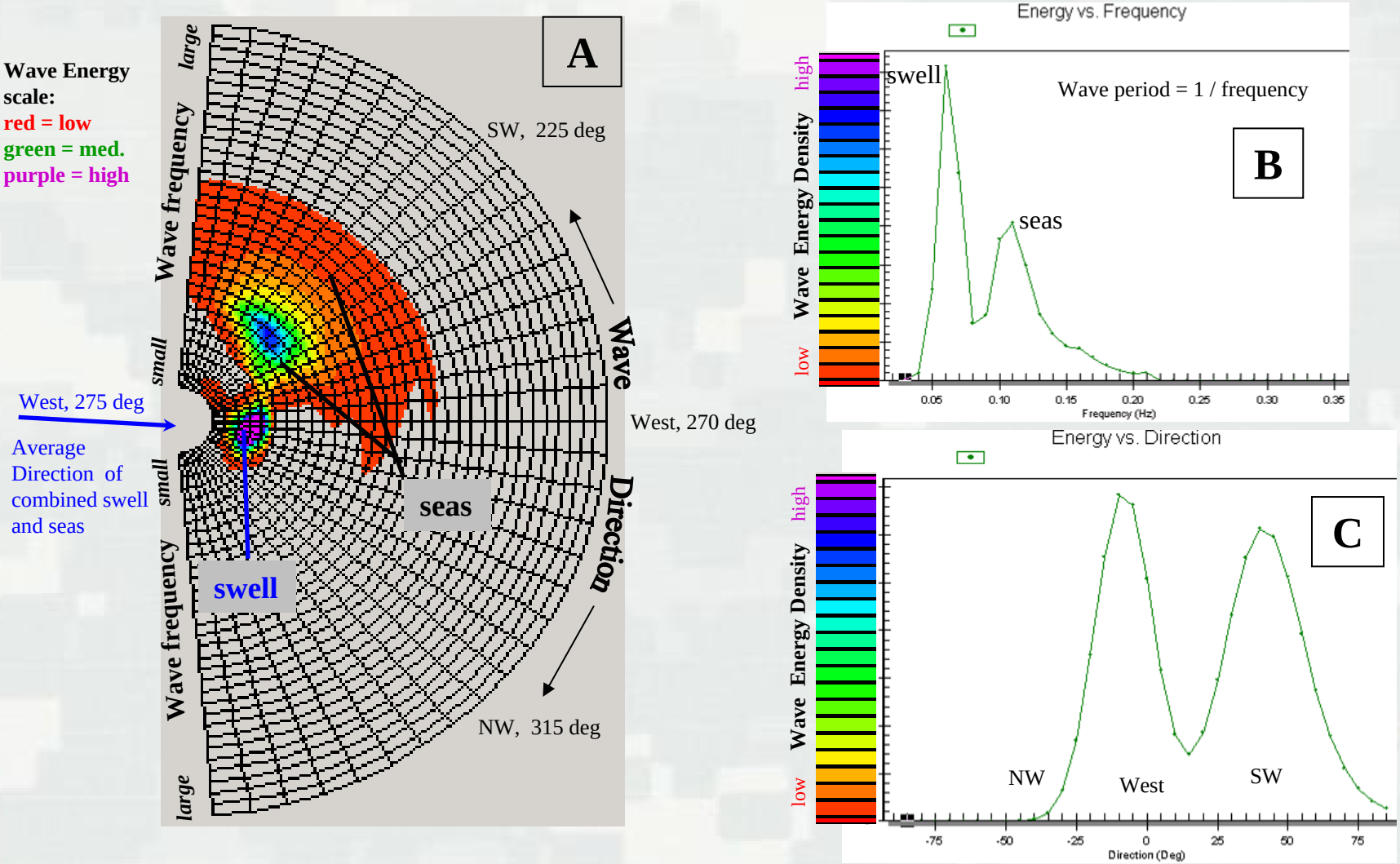
Summer Swell: Avg. wave height = 1.79 m, Peak wave period =11.0 sec, Avg. wave direction = W (275 deg), Wind=5.9 m/s @ NW (329 deg)

Figure S6. Energy spectrum for waves composed of local seas (chop) and some swell. Graphic (A) shows the wave energy distribution in terms of wave direction and frequency. Graphic (B) is a x-section thru the areas of maximum energy, along the frequency axis in (A), to show where the most energy is in terms of frequency . Graphic (C) is a x-section thru the areas of maximum energy, along the direction axis in (A), to show where the most energy is in terms of wave direction. Note that swell is approaching from west and seas include a wide range of direction and period; the wave field is a mix of swell and seas.



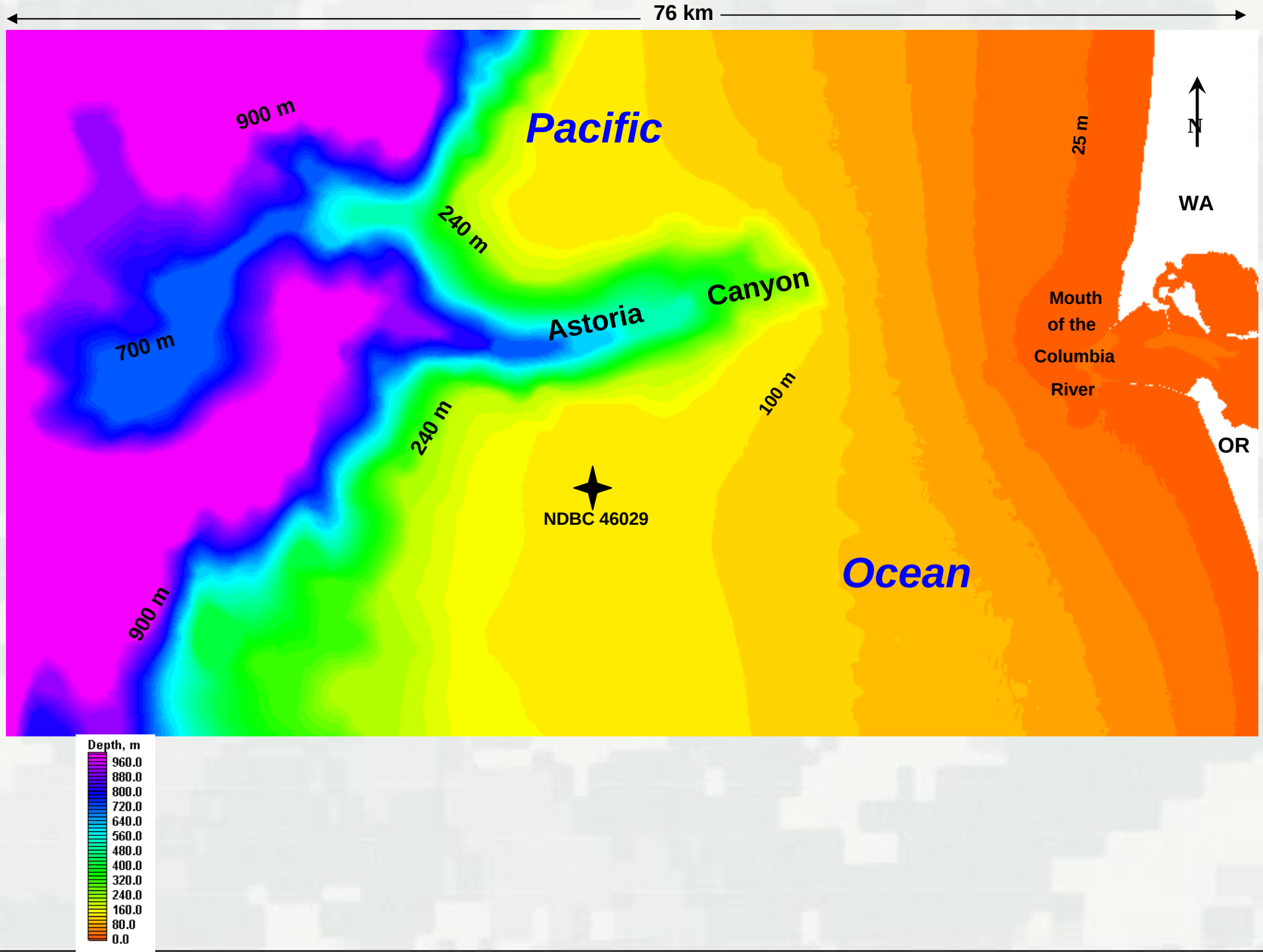
Summer Swell: Avg. wave height = 1.29 m, peak wave period=16.7 sec, Avg. Wave direction =SW (225 deg), Wind=5.4 m/s @ NW (316 deg)

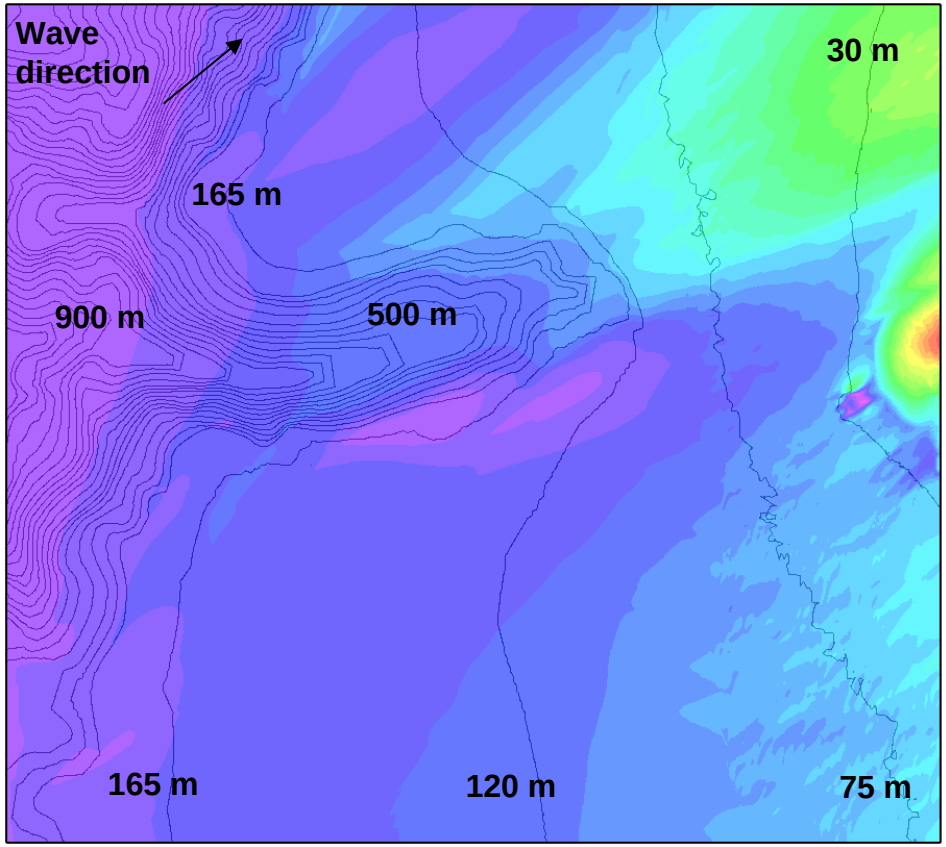
Figure S8. Energy spectrum for waves composed of swell and seas. Graphic (A) shows the wave energy distribution in terms of wave direction and frequency. Graphic (B) is a x-section thru the areas of maximum energy, along the frequency axis in (A), to show where the most energy is in terms of frequency . Graphic (C) is a x-section thru the areas of maximum energy, along the direction axis in (A), to show where the most energy is in terms of wave direction. The swell has a long period, is from one direction (SW), and distinctive from the seas; the seas include a wide range of frequency and direction; the wave field is a bi-modal combination of swell (distant source) and seas (local source).

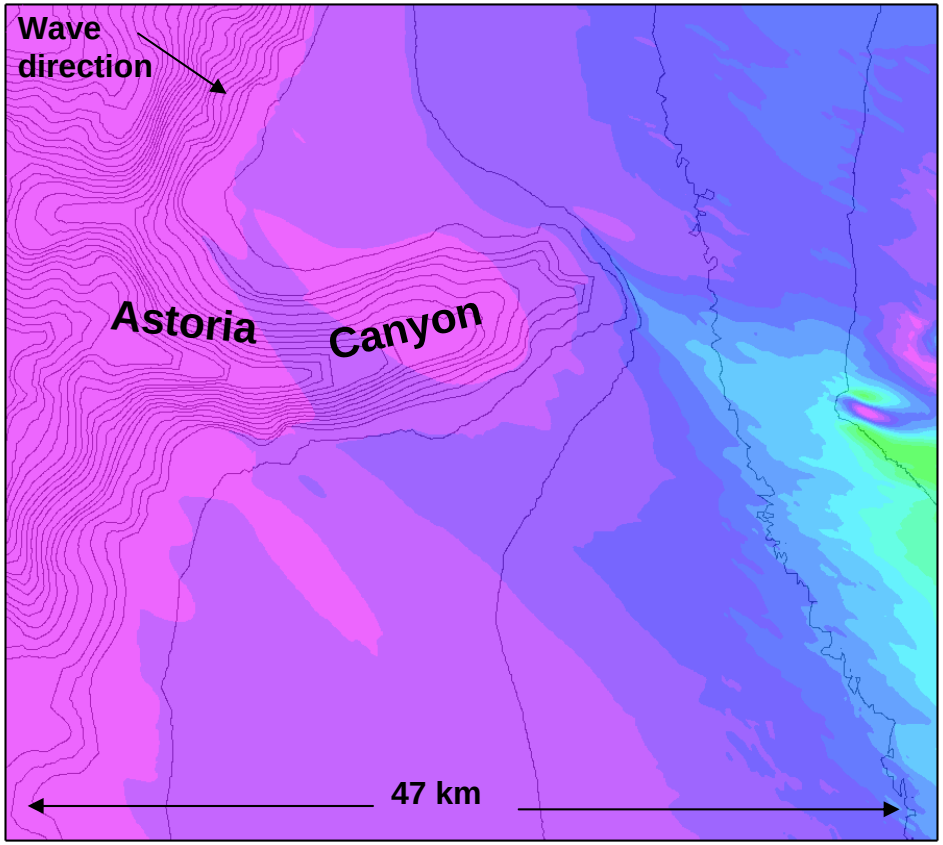


Winter Swell: Avg. wave height= 3.75 m, peak wave period =16.7 sec, Avg. wave direction =W (275 deg), Wind=6.9 m/s @ E (108 deg)

Figure S9. Energy spectrum for waves composed of swell and seas. Graphic (A) shows the wave energy distribution in terms of wave direction and frequency. Graphic (B) is a x-section thru the areas of maximum energy, along the frequency axis in (A), to show where the most energy is in terms of frequency . Graphic (C) is a x-section thru the areas of maximum energy, along the direction axis in (A), to show where the most energy is in terms of wave direction. The swell has a long period, is from one direction (W), and distinctive from the seas; the seas include a wide range of frequency and direction,with the peak energy from SW; the wave field is a bi-modal combination of swell (distant source) and seas (local source).

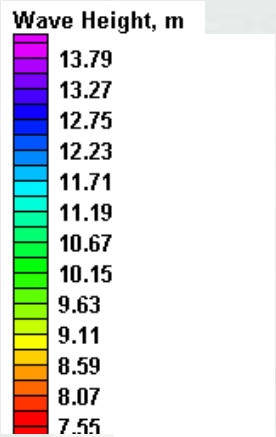

76 km
Pacific
Ocean
Astoria
Canyon
900 m
700 m
240 m
240 m
100 m
25 m
900 m
NDBC 46029
Mouth
of the
Columbia
River
WA
OR
N
Depth, m
960.0
880.0
800.0
720.0
640.0
560.0
480.0
400.0
320.0
240.0
160.0
80.0
0.0





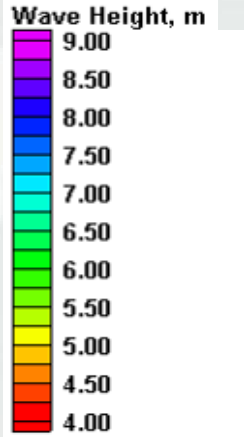
4 FEB 06

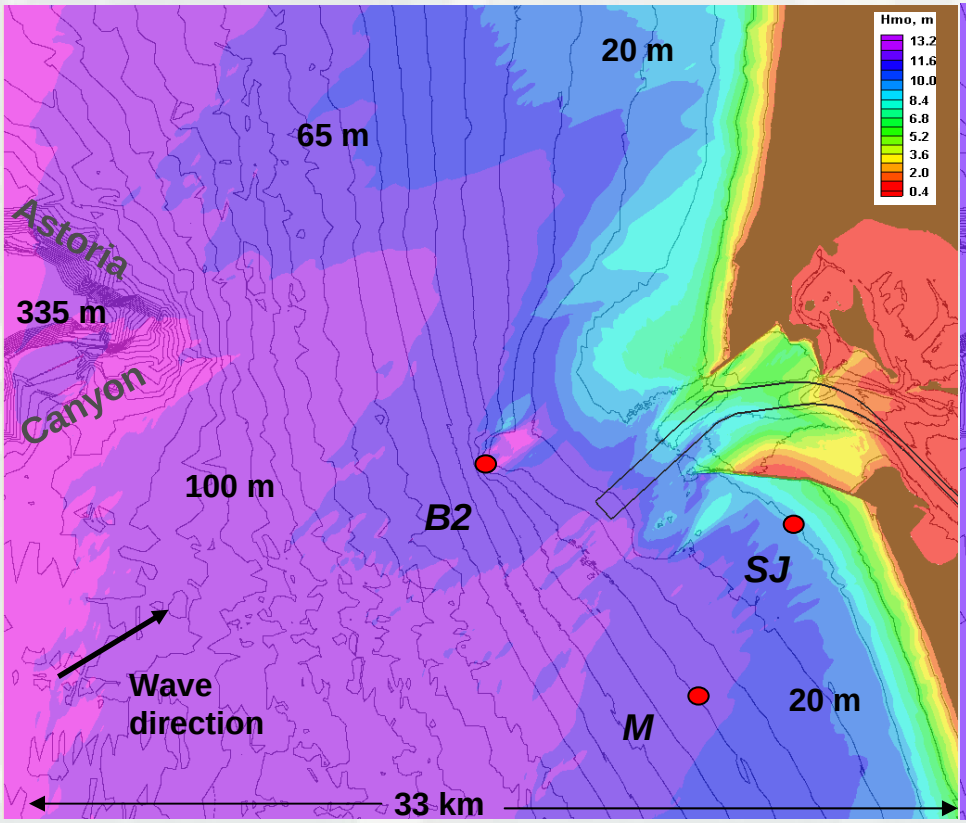
Hmo=13.8 m, Tp = 16.7 sec, Dp=230º

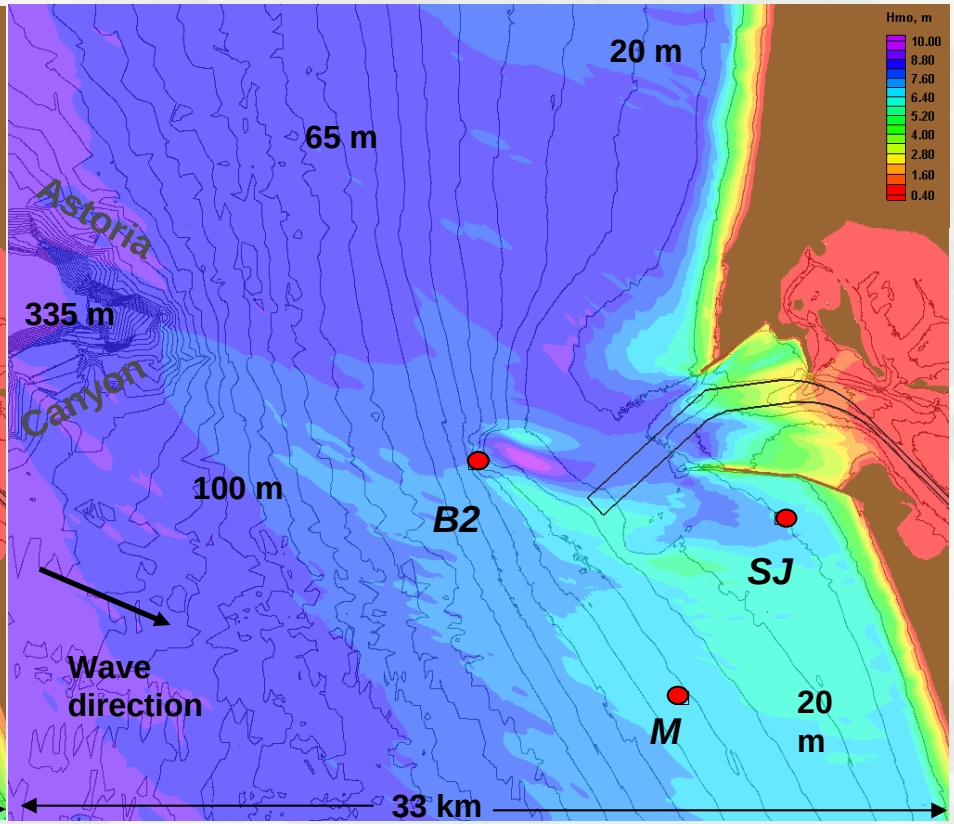


17 NOV03

Hmo=9.3 m, Tp = 16.7 sec, Dp=312º



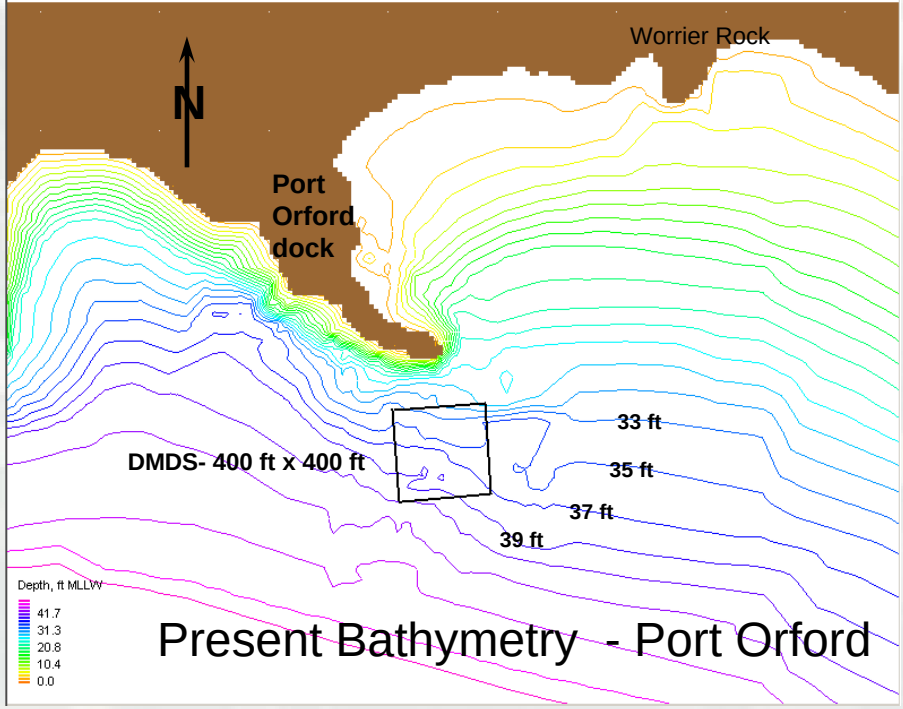


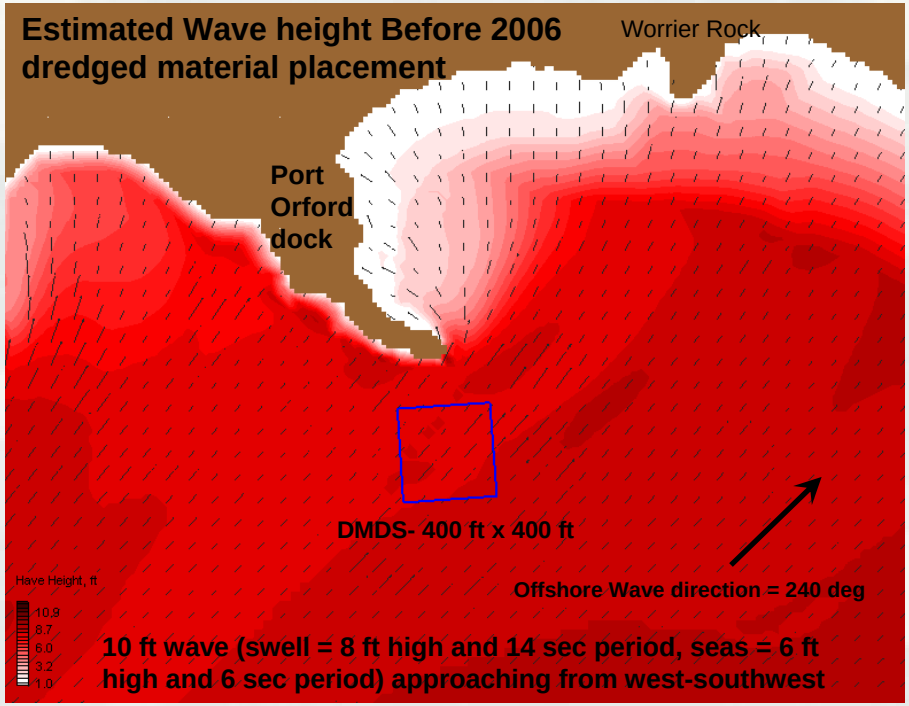


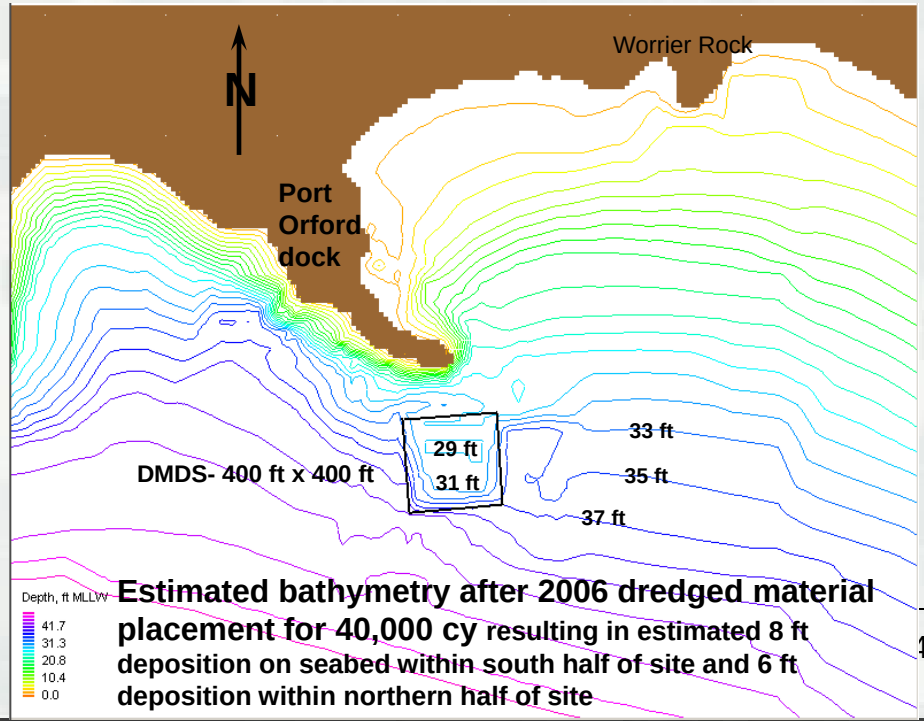
4 FEB 06
Hmo=13.8 m, Tp = 16.7 sec, Dp=230º

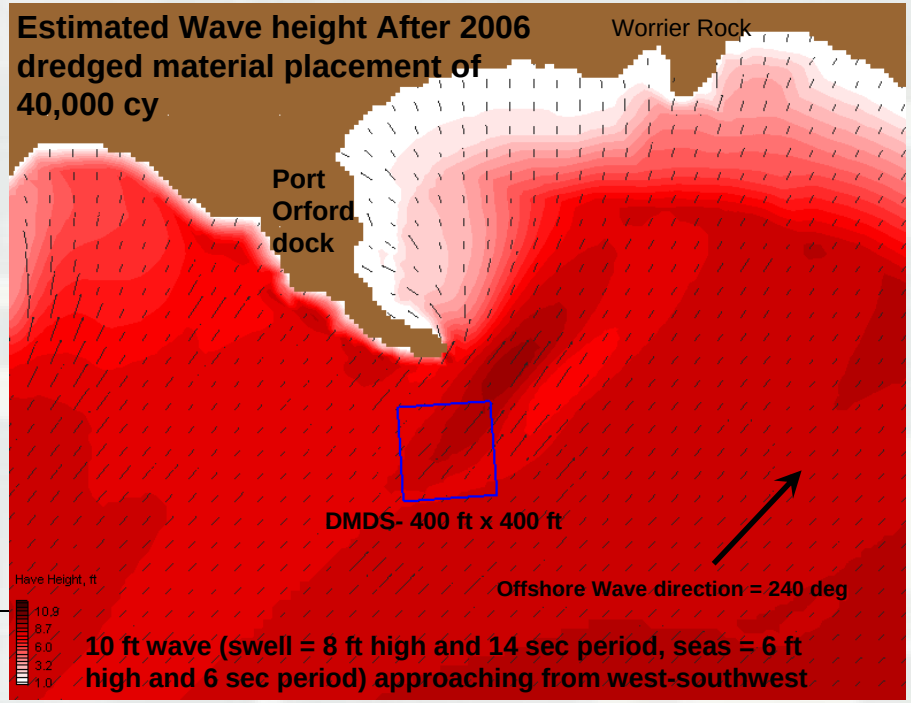
17 NOV03
Hmo=9.3 m, Tp = 16.7 sec, Dp=312º

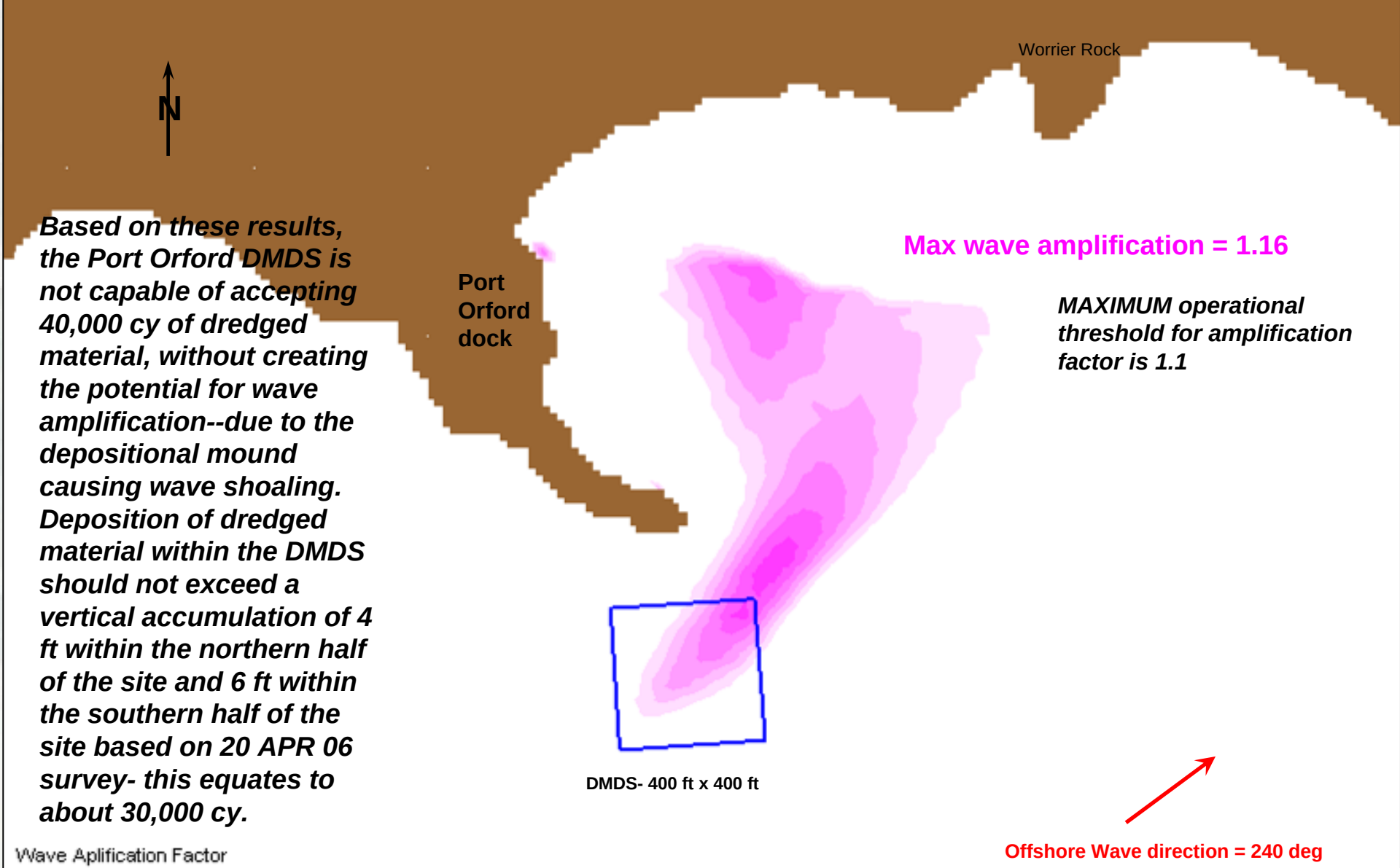
ASTORIA CANYONN AFFECTS WAVES HAVING PERIOD > 14 SEC


Worrier Rock
N
Port
Orford
dock
DMDS- 400 ft x 400 ft
33 ft
35 ft
37 ft
39 ft
Depth, ft MLLW
41.7
31.3
20.8
10.4
0.0
Present Bathymetry - Port Orford


Estimated Wave height Before 2006 dredged material placement
Worrier Rock
Port
Orford
dock
DMDS- 400 ft x 400 ft
Offshore Wave direction = 240 deg
Have Height, ft
10.9
8.7
6.0
3.2
1.0
10 ft wave (swell = 8 ft high and 14 sec period, seas = 6 ft high and 6 sec period) approaching from west-southwest

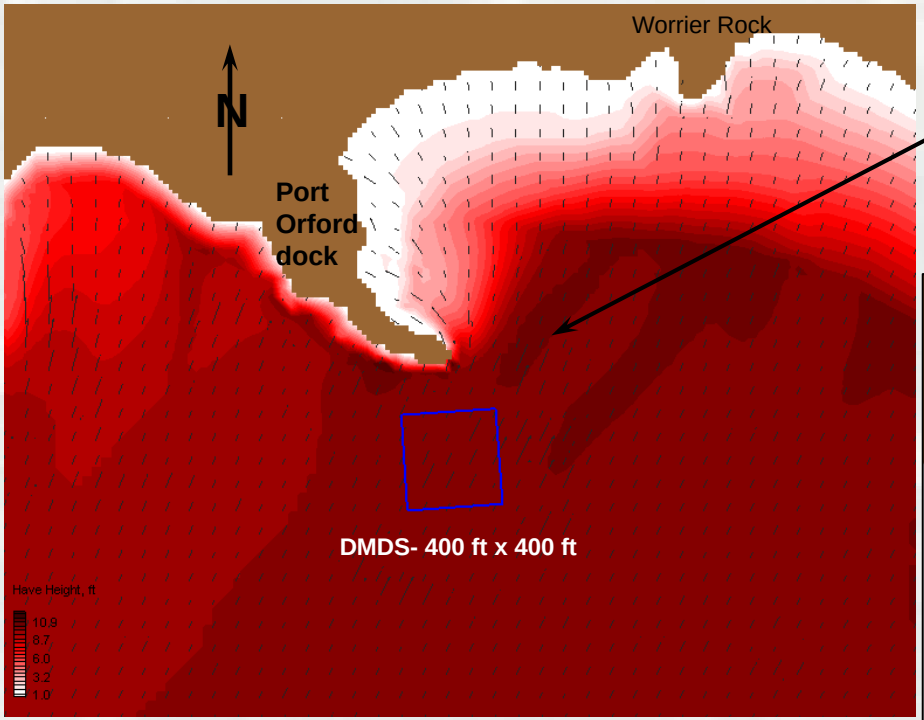

Worrier Rock
N
Port
Orford
dock
DMDS- 400 ft x 400 ft
29 ft
31 ft
33 ft
35 ft
37 ft
Depth, ft MLLW
41.7
31.3
20.8
10.4
0.0
Estimated bathymetry after 2006 dredged material placement for 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site


Estimated Wave height After 2006 dredged material placement of 40,000 cy
Worrier Rock
Port
Orford
dock
DMDS- 400 ft x 400 ft
Offshore Wave direction = 240 deg
Have Height, ft
10.9
8.7
6.0
3.2
1.0
10 ft wave (swell = 8 ft high and 14 sec period, seas = 6 ft high and 6 sec period) approaching from west-southwest

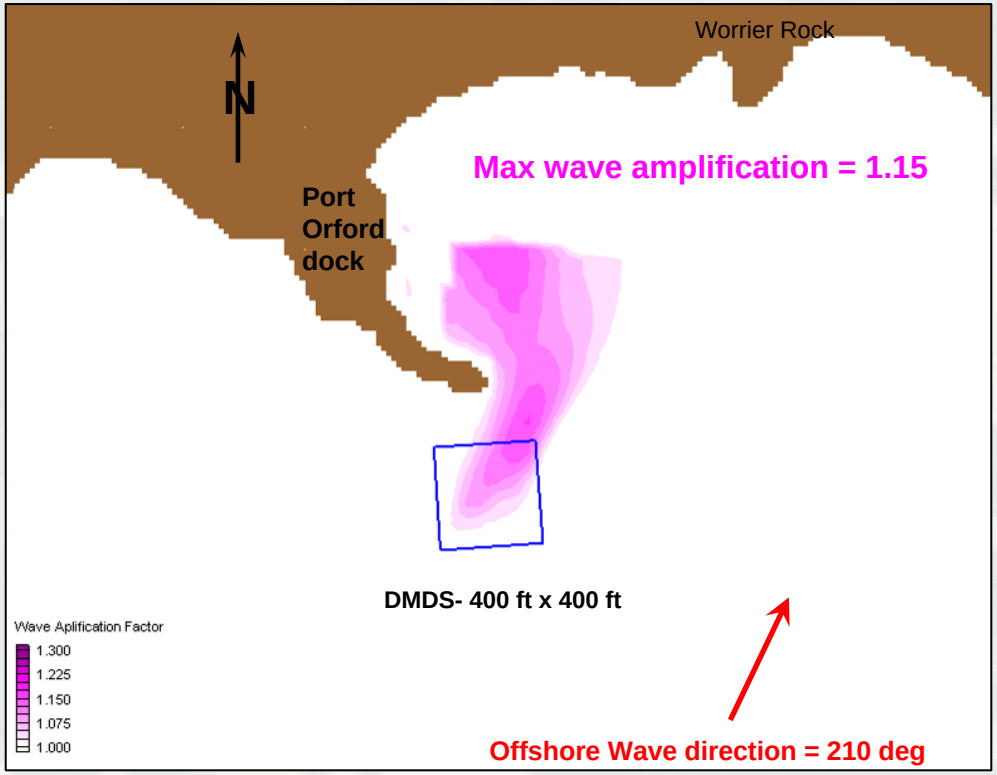


Based on these results, the Port Orford DMDS is not capable of accepting 40,000 cy of dredged material, without creating the potential for wave amplification--due to the depositional mound causing wave shoaling. Deposition of dredged material within the DMDS should not exceed a vertical accumulation of 4 ft within the northern half of the site and 6 ft within the southern half of the site based on 20 APR 06 survey- this equates to about 30,000 cy.

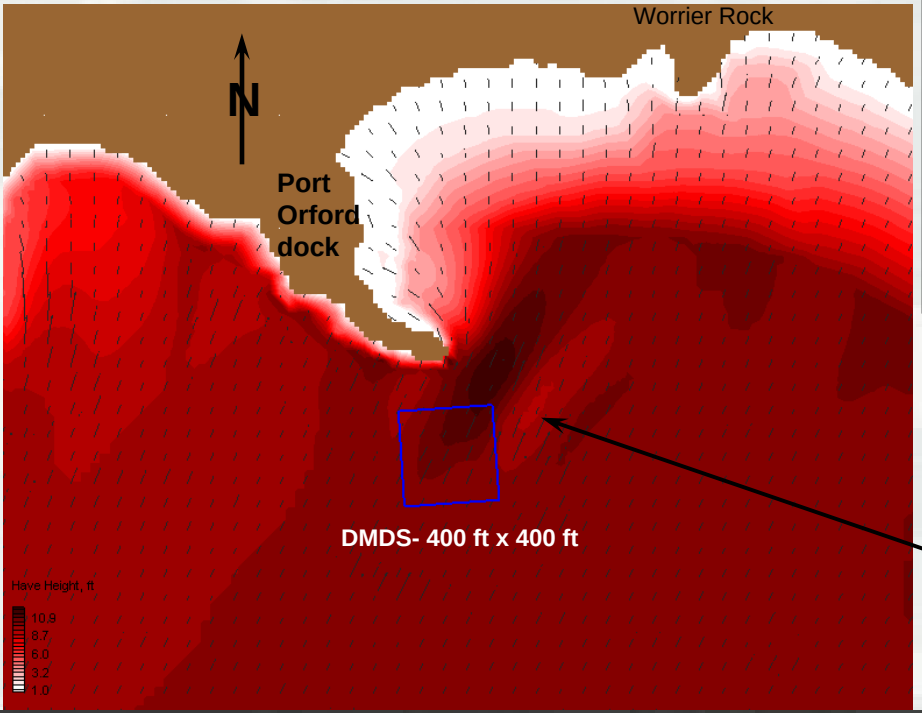
Estimated wave amplification due to bathymetry change within DMDS – for: 10 ft wave (swell = 8 ft high and 14 sec period, seas = 6 ft high and 6 sec period) approaching from west-southwest



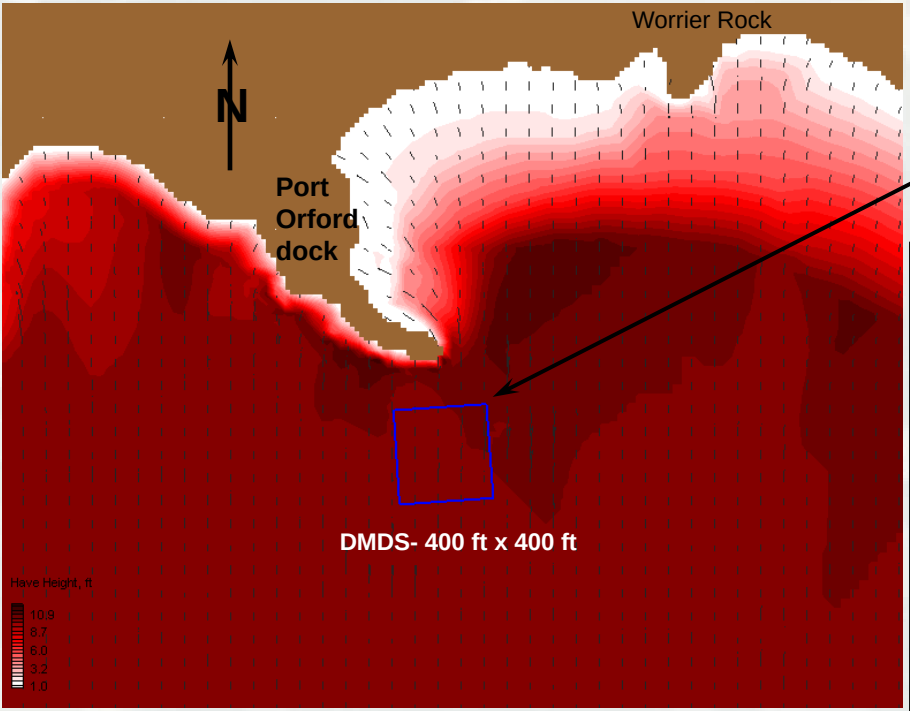
Estimated Wave height Before 2006 dredged material placement



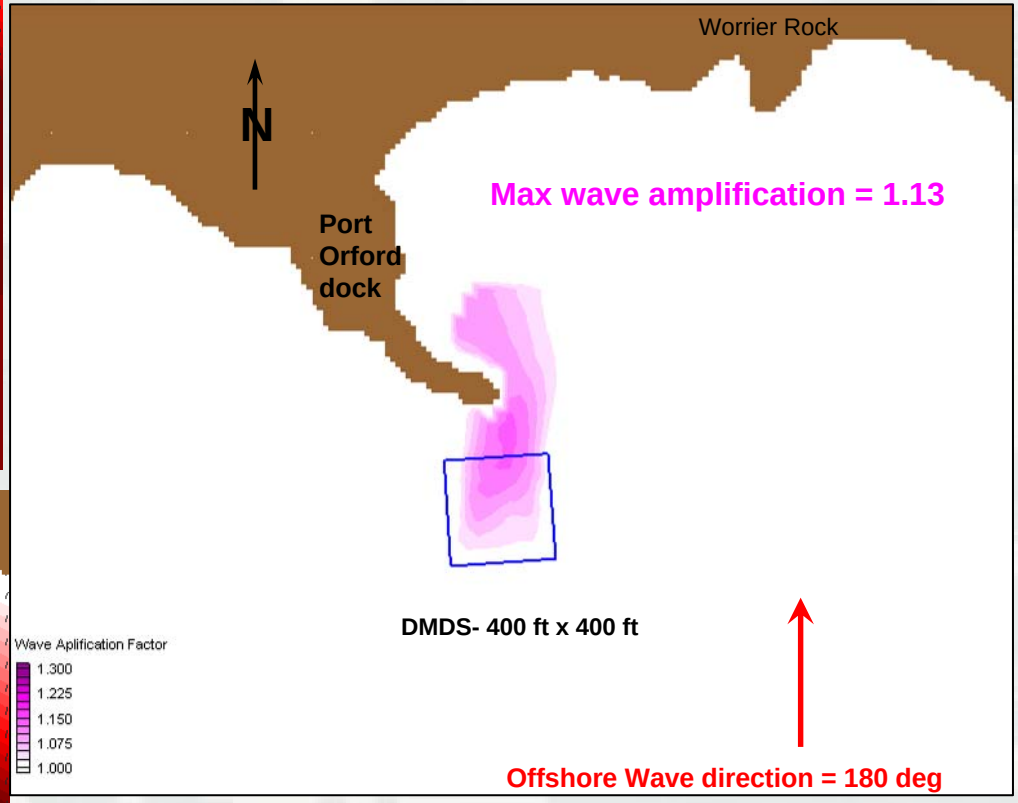
Estimated wave amplification due to bathymetry change within DMDS – for: 10 ft wave (swell = 8 ft high and 14 sec period, seas = 6 ft high and 6 sec period) approaching from south-southwest



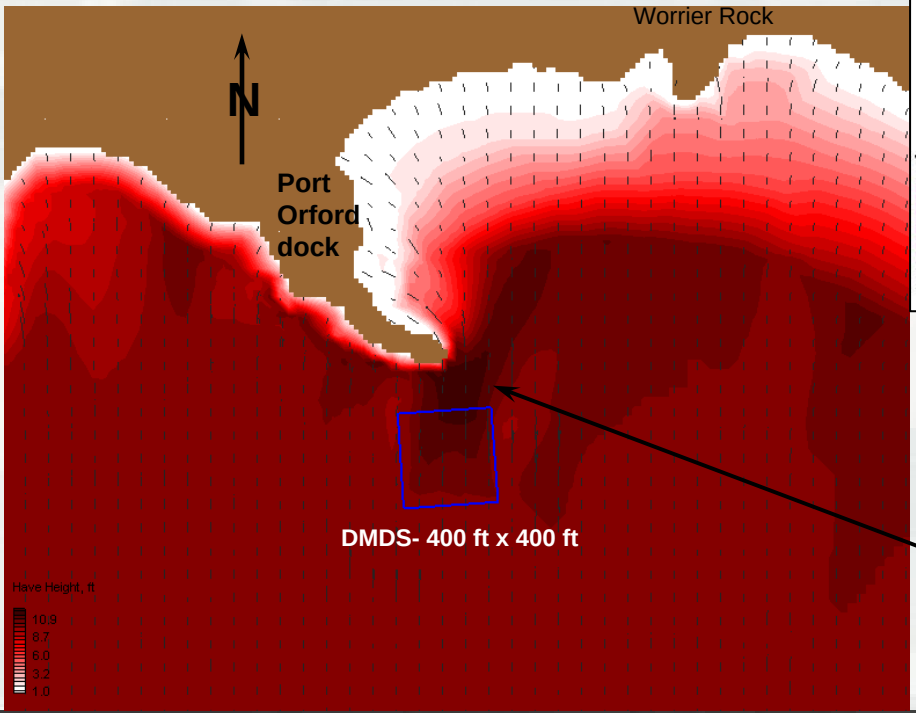
Estimated Wave height After 2006 dredged material placement – 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site



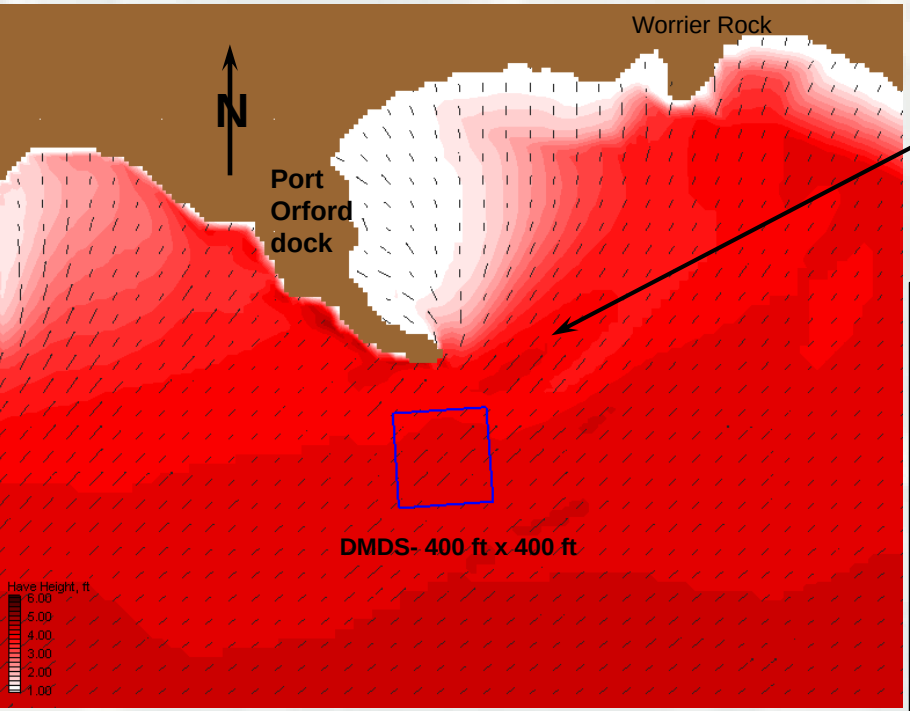
Estimated Wave height Before 2006 dredged material placement



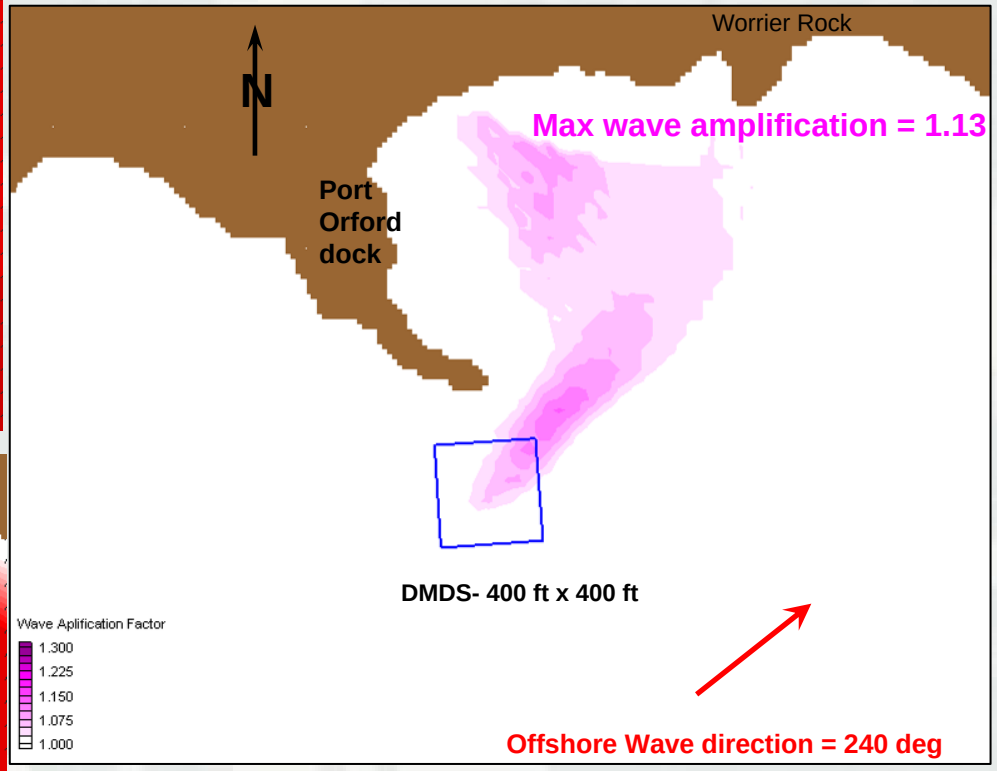
Estimated wave amplification due to bathymetry change within DMDS – for: 10 ft wave (swell = 8 ft high and 14 sec period, seas = 6 ft high and 6 sec period) approaching from south



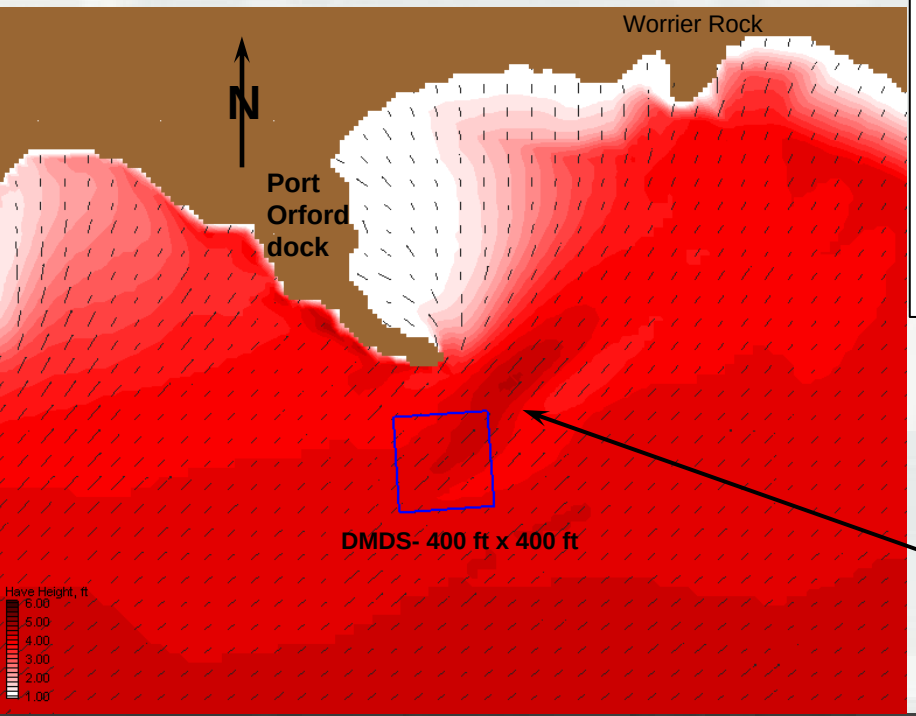
Estimated Wave height After 2006 dredged material placement – 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site



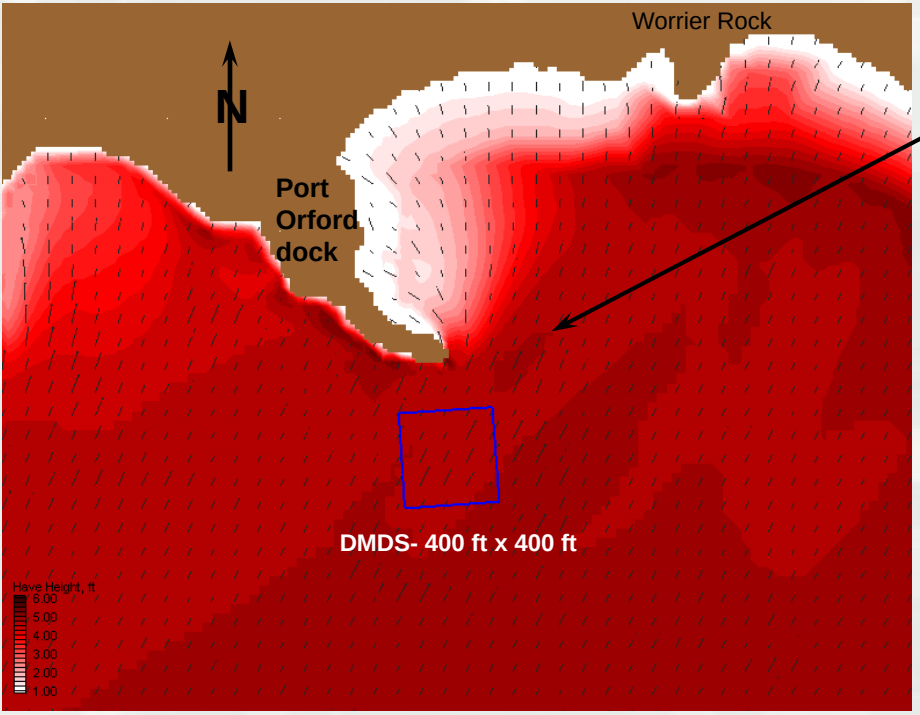
Estimated Wave height Before 2006 dredged material placement



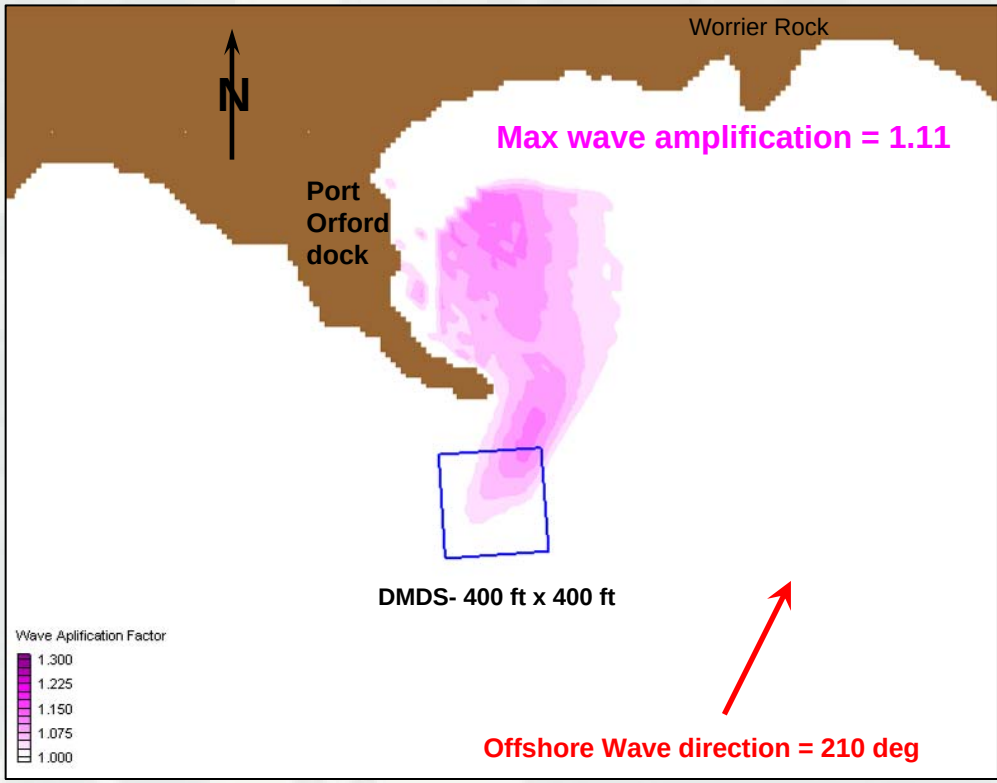
Estimated wave amplification due to bathymetry change within DMDS – for: 5 ft waves (swell = 3 ft high and 10 sec period, seas = 4 ft high and 6 sec period) approaching from west-southwest



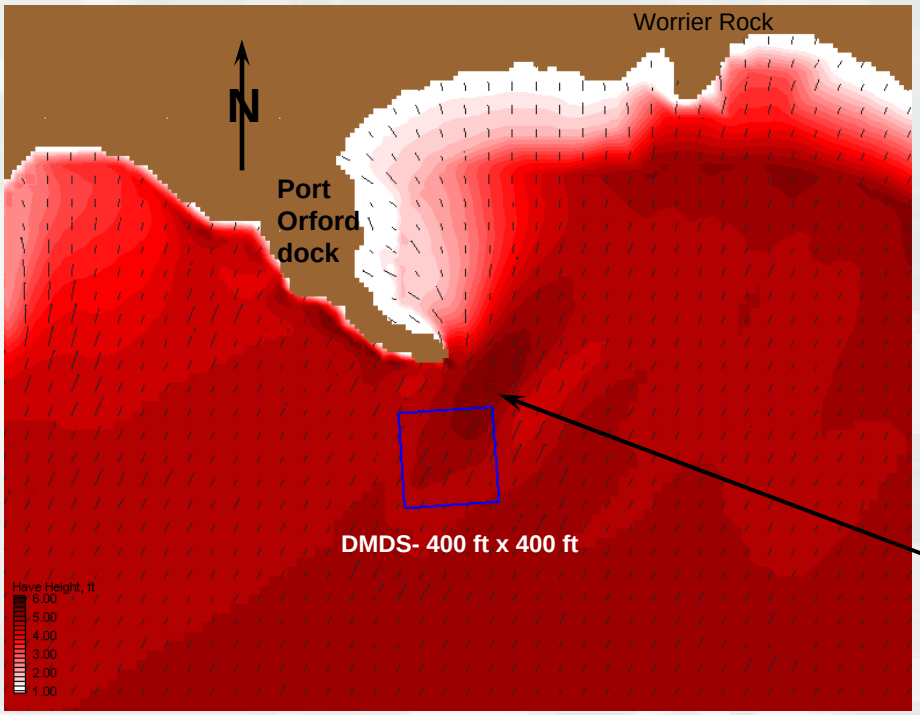
Estimated Wave height After 2006 dredged material placement – 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site



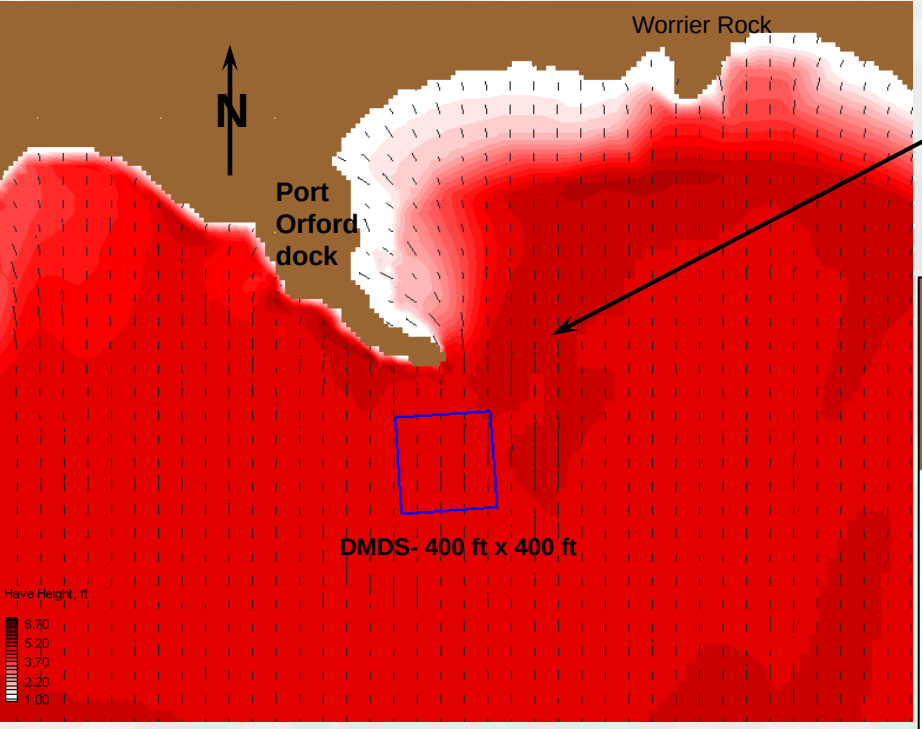
Estimated Wave height Before 2006 dredged material placement



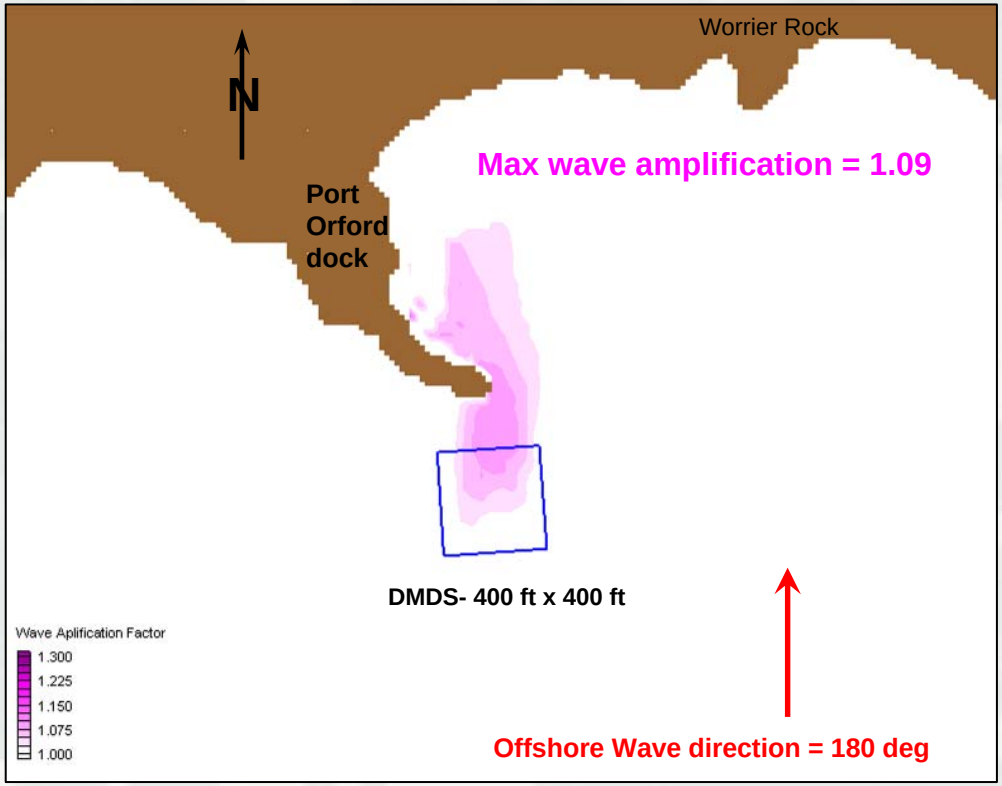
Estimated wave amplification due to bathymetry change within DMDS – for: 5 ft waves (swell = 3 ft high and 10 sec period, seas = 4 ft high and 6 sec period) approaching from south-southwest



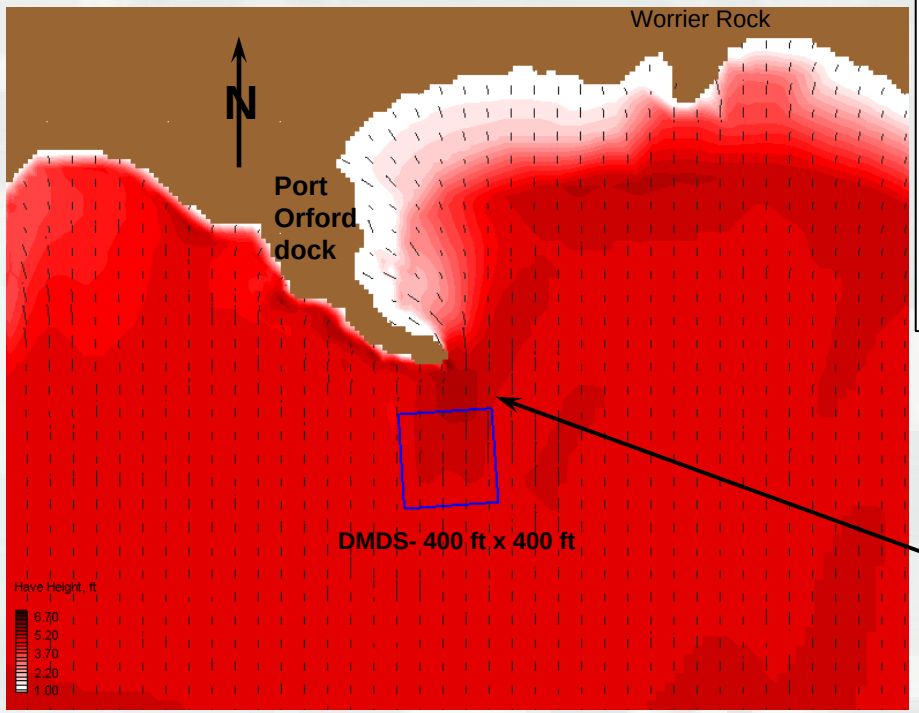
Estimated Wave height After 2006 dredged material placement – 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site



Estimated Wave height Before 2006 dredged material placement



Estimated wave amplification due to bathymetry change within DMDS – for: 5 ft waves (swell = 3 ft high and 10 sec period, seas = 4 ft high and 6 sec period) approaching from south



Estimated Wave height After 2006 dredged material placement – 40,000 cy resulting in estimated 8 ft deposition on seabed within south half of site and 6 ft deposition within northern half of site