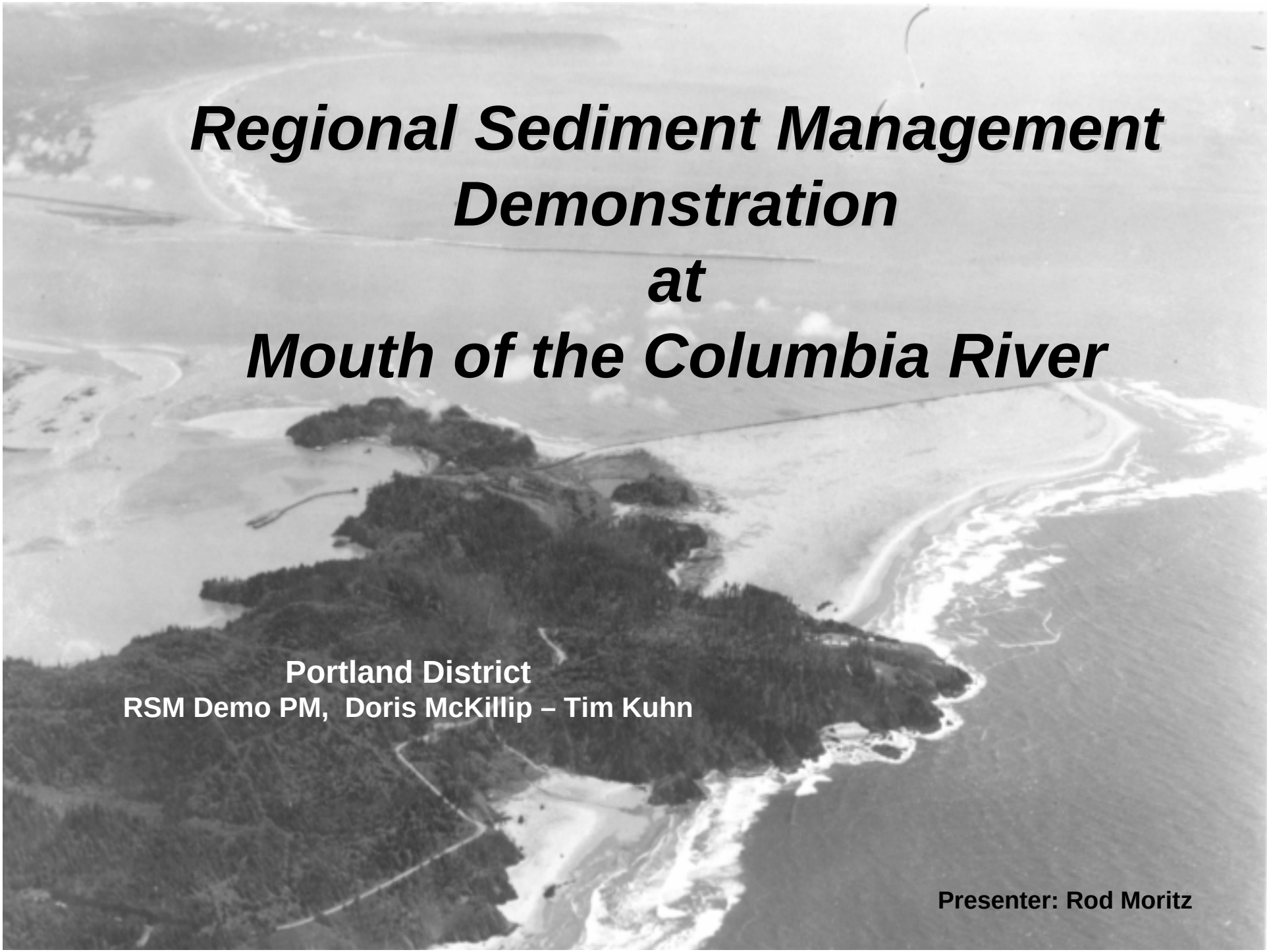


Regional Sediment Management Demonstration at Mouth of the Columbia River

Portland District
RSM Demo PM, Doris McKillip – Tim Kuhn

Presenter: Rod Moritz

MOFFATT & NICHOL

CIRP

Coastal Inlets Research Program

US Army Corps of Engineers ®
Northwestern Division

USGS
science for a changing world

APPLIED COASTAL

OREGON STATE UNIVERSITY
Open minds. Open doors.
O.H. Hinsdale
Wave Research Laboratory

NORTHWEST RESEARCH ASSOCIATES
Innovative Scientific Research and Development

Regional Sediment Management
RSM
RSM . . . for balanced, sustainable solutions

WASHINGTON STATE DEPARTMENT OF ECOLOGY

State Of Oregon

EVANS-HAMILTON, INC.
OCEANOGRAPHERS
SINCE 1971

PACIFIC INTERNATIONAL ENGINEERING

Ohio State University

US Army Corps of Engineers ®
Portland District

Regional Sediment Management

RSM is a *systems-based approach* for managing projects involving sediment.

Sediment is viewed as a natural resource

RSM fosters balance between projects and natural system processes: Resulting in reduced project costs and achievement of greater benefits.

RSM broadens the "planning horizon" for projects by considering the extended time-space scale as defined by *natural sediment processes*.

RSM requires full *collaboration* among agencies, levels of government, and stakeholders.

Some Motivating Questions

* Are there beneficial locations to place dredged sand ?

* What has been the history of sediment movement at MCR? Does the past dictate present & future trends?

* What moves the sediment at MCR?

* Where does the sediment go-- at present??

- North vs. South
- Inshore vs. Offshore
- Into MCR vs. Out of MCR

* How far offshore can we place dredged sand and still have positive impact on nearshore zone ?

Activating *RSM Demo at MCR: FY 2002*

NO RSM Funding in 2002

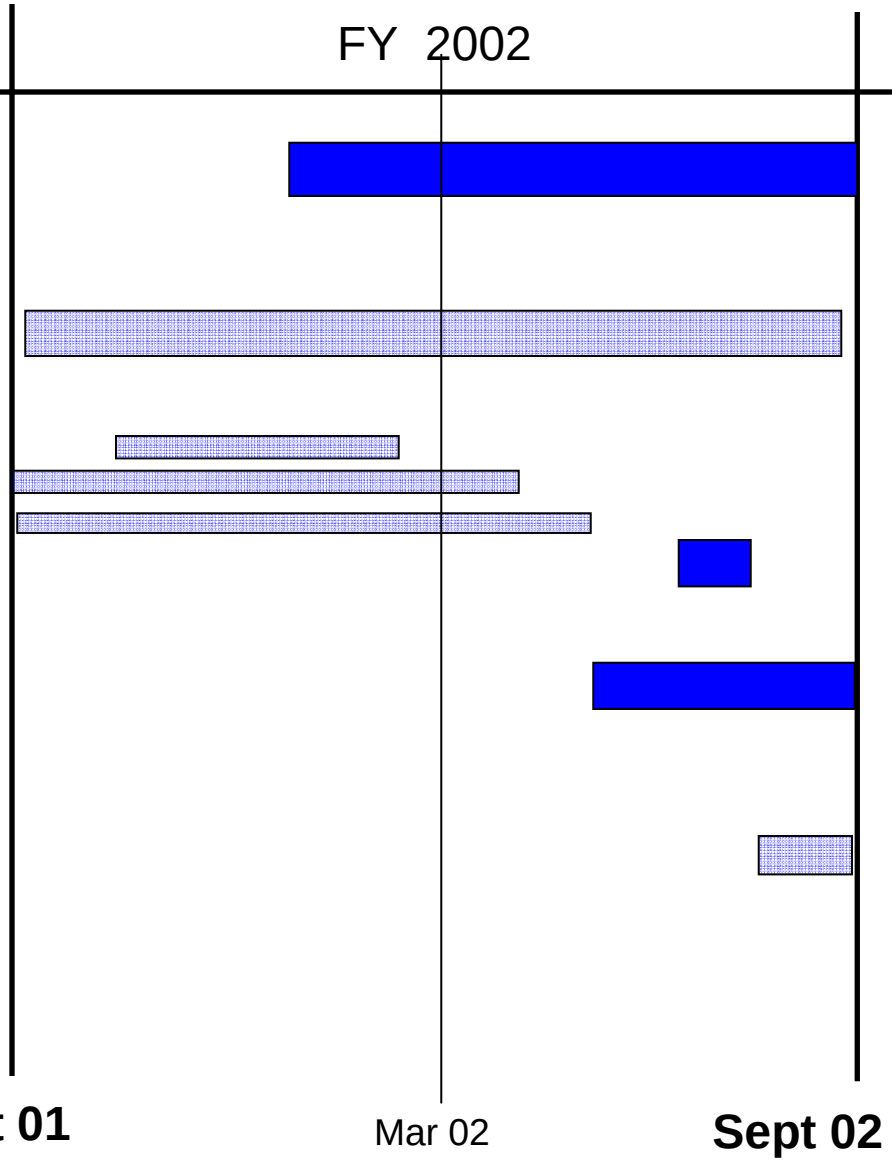
Corps-NWD and WA State Propose RSM Demo for MCR
Proposal made to HQ-USACE and ERDC

44 Kcy Benson Beach Placement - Congress Request
$200,000 Federal combined with $575,000 – $19/cy

Contract Option Development
Coordination with Seattle District
Coordination with Ports, States, Locals
Placement

Benson Beach Monitoring – Surveys and Analysis
Coop Agreement Developed: Corps-USGS

Benson Beach Evaluation Report Submitted to Congress
Portland District, NW Division, HQ, US Congress



2002 "Onshore Placement" at Benson Beach

Total Volume Placed – 43,730 yd^3

Total Cost = $750,000--- $17/cy

US Army Corps of Engineers ®
Portland District

Hopper Dredge *Sugar Island*: 250 ft off jetty

Flexible – floating pipe

US Army Corps of Engineers ®
Portland District

Hydraulic Placement of Dredged Sand on Benson Beach

Total Volume Placed – 43,730 yd^3

Total Cost = $750,000

TIME AND COST ESTIMATE

Activities to Implement Regional Sediment Management RSM at MCR

during FY03

Technical Lead: Hydrologic, Coastal, and Riverine section

includes activities related to Benson Beach Alternative Dredged Material Disposal Investigation and MCR Structures Evaluation

Prepared for: Doris McKillip, NWP-OP-NW

Prepared by: CENWP-EC-HY, 25 June 2003----concluded 30 Sept

Comments: Cost estimate is intended to cover ALL work scoped for FY03 work. Adjustments may be required to account for follow-on activity. Costs are based on compilation from other scopes and apply ONLY to FY 03 activities.

CEFMS FWI for EC-RSM fudning: FWIs =HL1KHB, 52B263, WCC = 60121, WCE = 9000

CEFMS FWI for other funding attributed to RSM at MCR: FWIs =00243P, 00242T, 5232LG, and 00242Q

green = RSM total Funding **$204,000**

blue = MCR Structures - Rehab: Leveraged funding

purple = Benson Beach Alternative Disposal Site - congressional add: Leveraged Funding

red= MCR alternative evaluation: Leveraged Funding

WORK ITEMS	COST
1. Initial scoping for RSM Activities - FY03	
a NWP-PM-E	$1,000
b NWP-PM-P	$1,000
c NWP-EC-HY	$9,000
d NWP-EC-HG	$1,500
e NWP-EC-HM	$1,000
NWP Scoping Activities	**$13,500**
2. Project management and Strategic Oversight: NWP-PM-PM	$9,000
Project Management Support - Staff	$9,000
3. Technical management and Coastal Engineering Support: NWP-EC-HY	$18,000
4. GIS and Website Support for RSM: NWP-EC-HM	$7,000
5. Coordinate Real Estate activities to Support ARGUS Deployment at North Head: NWP-RE	$5,000
6. Contracting Support: NWP-CT	$2,500
NWP Labor Subtotal	**$50,500**
7. Seattle District Scoping FY03, Support, Coordination, and Team Building: NWS-PM	$8,000
NWS Labor Total	**$8,000**
8. Acquire Collaborative Learning Moderator and Begin Facilitating RSM Working Group Meetings	$30,000
9. Procure ARGUS for North Head, MCR: procured from EHI/NWRA via MIPRs to ERDC	$42,300
Supplemental funding from MCR alternative site funding	$50,000
10. Deploy Wave and Current Tripod near South Jetty, MCR procured from EHI: via MIPRs to ERDC	$25,000
Supplemental funding from MCR Strucutures	$3,000
11. Collect Vibra-Cores at Targeted Areas at MCR: WDOE CO-OP Agreement	$40,000
12. Conduct Siesmic Profiling at Proposed Benson Beach Sump: A/E Task Order	$42,300
13. Assess Effect of USACE Instrument Mooring Frame on Data Quality: OSU CO-OP Agreement	$4,000
Supplemental funding from MCR Strucutures	$2,000
14. Conduct Nearshore Bathymetry Survey at Clatsop Spit, MCR using Jetski: USGS-USACE	$10,000
15. Compile Historic USACE Surveys at MCR by Digitiazing and GISing: via MIPR to ERDC	$10,000
Section supervision & administration- EC labor RSM — 10% of work	$2,500
Branch supervision & administration- EC labor RSM — 5% of work	$1,250
EC Budget Branch-labor RSM — 2% of funding	$4,926
CADD-labor RSM — 3% of work	$750
Total Required Budget For RSM FY03:	**$192,726**
Total Contributions from Benson Beach-congressional add:	**$82,300**
Total Constributions MCR Structures Items:	**$36,000**
Total Contributions from MCR Alternative Disposal Sites:	**$50,000**

Example of Annual Cost Estimate Compilation for MCR RSM Demo

Colors are “different” funding sources

Leverage different sources at a given location (sets of projects) to obtain a greater outcome.

MCR RSM Expenditures FY 2003-2006

RSM Base = $ 591 K
RSM CAs = $ 809 K
TOTAL = $ 1.4 M

Initiating RSM Demo at MCR: FY 2003

Funding for RSM Demo-Base: $204,000

ARGUS Station Initiation at North Head, WA
Coordination to obtain permit:
WA State Parks, USCG, Corps, NWRA

Benson Beach Monitoring – Surveys and Analysis
USGS and WDOE

Collect Vibra-Cores at 7 MCR Sites & Seismic
DEA, WA DOE – Developed Corps-WDOE coop agreement

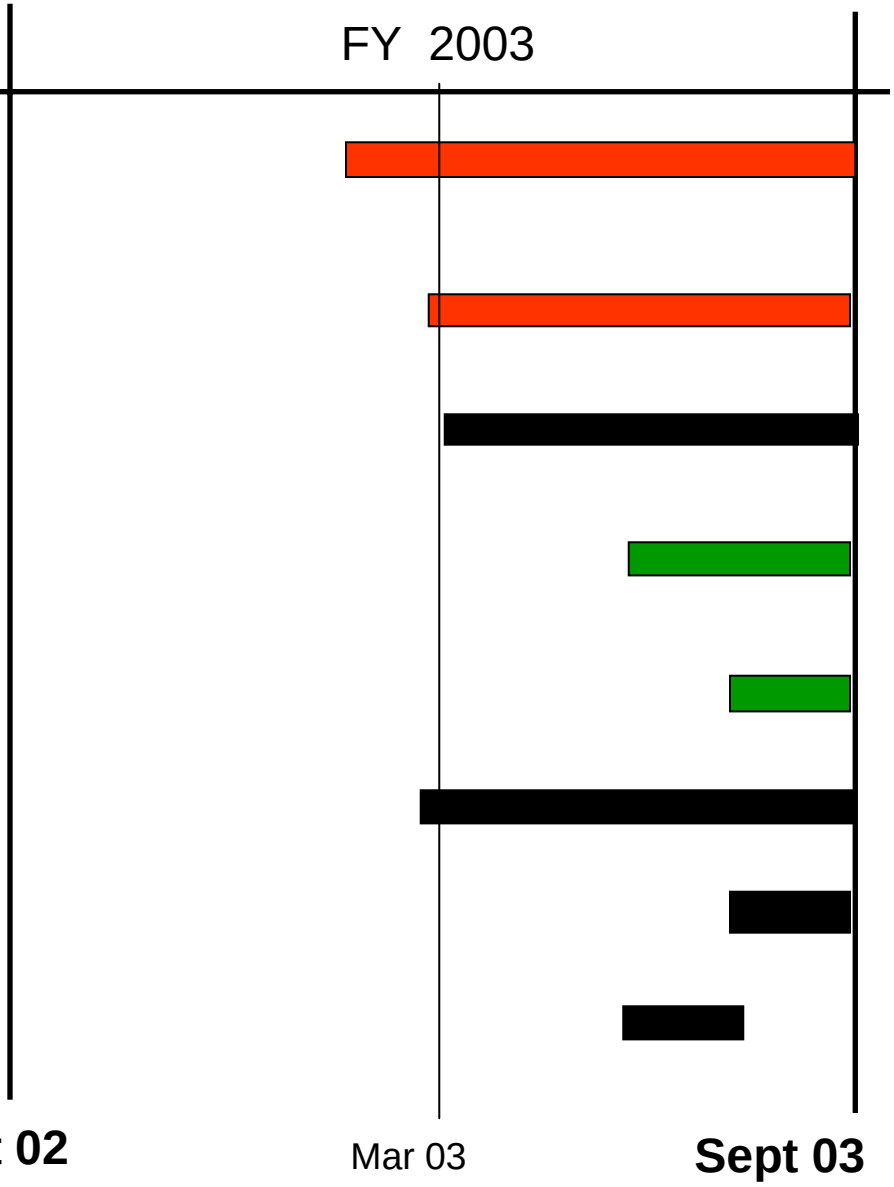
Clatsop Spit Monitoring – Surveys
USGS

Collect Oceanographic Data South of South Jetty
Deploy Tripod –ERDC, EHI, USGS

Initiate Collaborative Learning for RSM at MCR
Walker and Associates

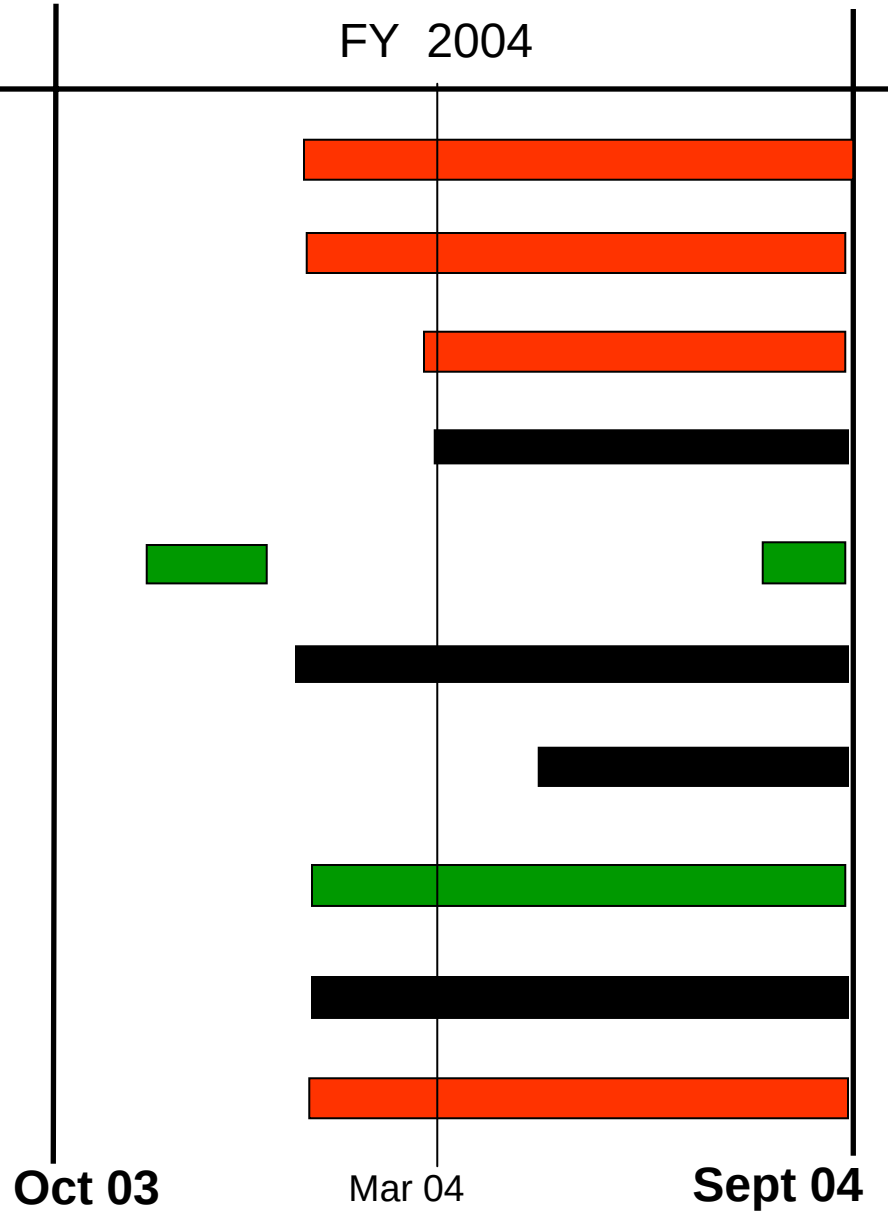
Compile Historic USACE MCR Surveys – GIS
Applied Coastal

Flow Test for USACE Tripod Frames
OSU – Development of Corps-OSU coop agreement



Continuing RSM Demo at MCR: FY 2004

Funding for RSM Demo - Base: $187,000
Alt. Site Dvpl. – C/A: $234,000



CERB-76: Review of RSM in NWD
Corps, Contributors, Resource , and Stakeholders

ARGUS Station Installation & Ops at North Head, WA
NWRA, Corps, WDOE, USGS

Benson Beach Monitoring – Surveys and Analysis
USGS and WDOE

Analyze Vibra-Cores for 7 Sites at MCR
WA DOE

Process Oceanographic Data South of South Jetty
Retrieve Tripod – EHI

Collaborative Learning for RSM at MCR
Walker and Associates

Compile Historic USACE MCR Surveys – GIS
Applied Coastal

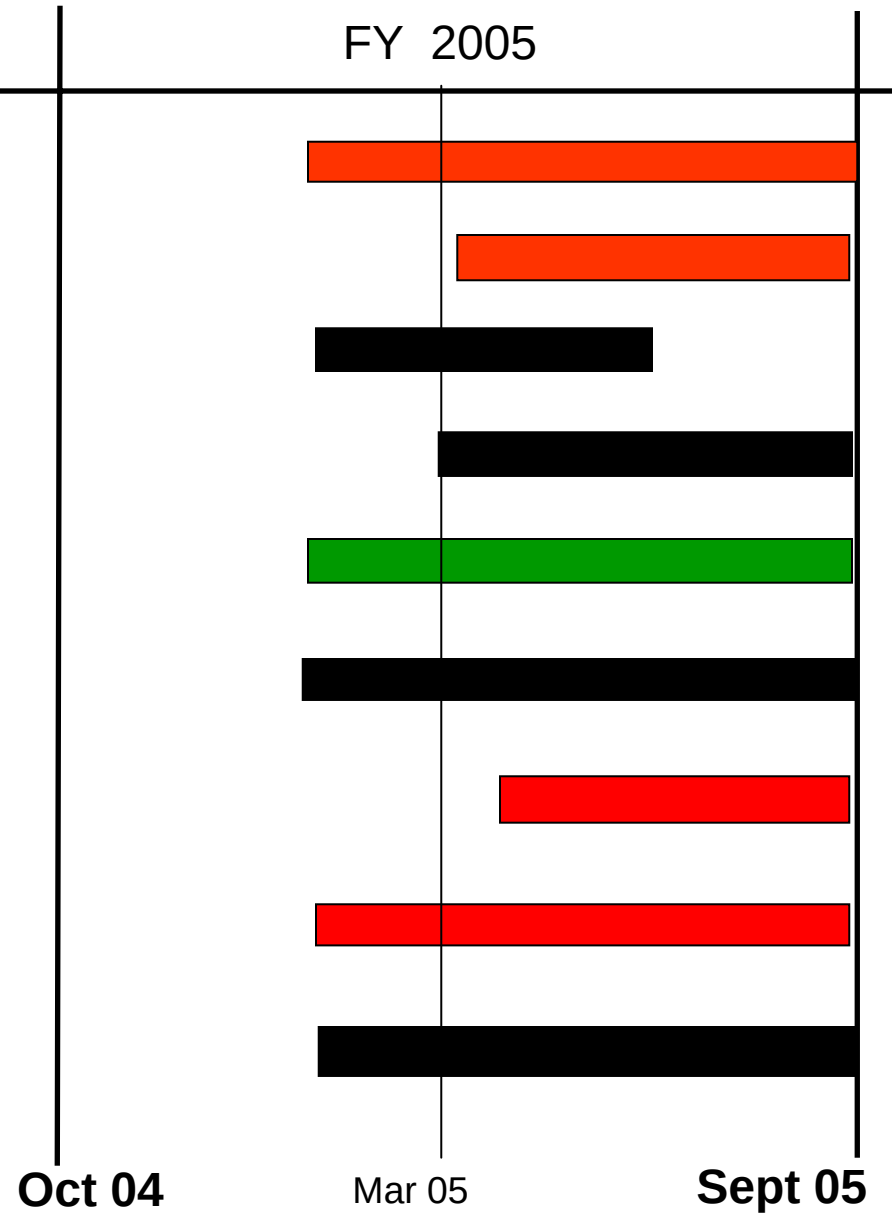
Develop Concept Plan South Jetty Disposal Site
LCRSG, Corps, EPA

Review Numerical Modeling Capabilities for MCR
Corps, USGS, WDOE

Evaluate Disposal Scenarios for WA Littoral DR
PIE, Corps

Continuing RSM Demo at MCR: FY 2005

Funding for RSM Demo - Base: $200,000
Alt. Site Dvpl. – C/A: $275,000



ARGUS Station Operations/Analysis at North Head, WA
NWRA, Corps, WDOE, USGS

Benson Beach Monitoring – Surveys and Analysis
USGS and WDOE

Final Report for Vibra-Cores at MCR
WA DOE

Compile & Analyze Historic USACE MCR Surveys – GIS
Applied Coastal

Implement Phase I South Jetty Disposal Site
LCRSG, Corps, EPA

Implement Delft 3D Numerical Modeling at MCR
Corps, USGS, WDOE

Prepare Cost-Estimate for WA Littoral DR
Corps – NWD Dredging Team

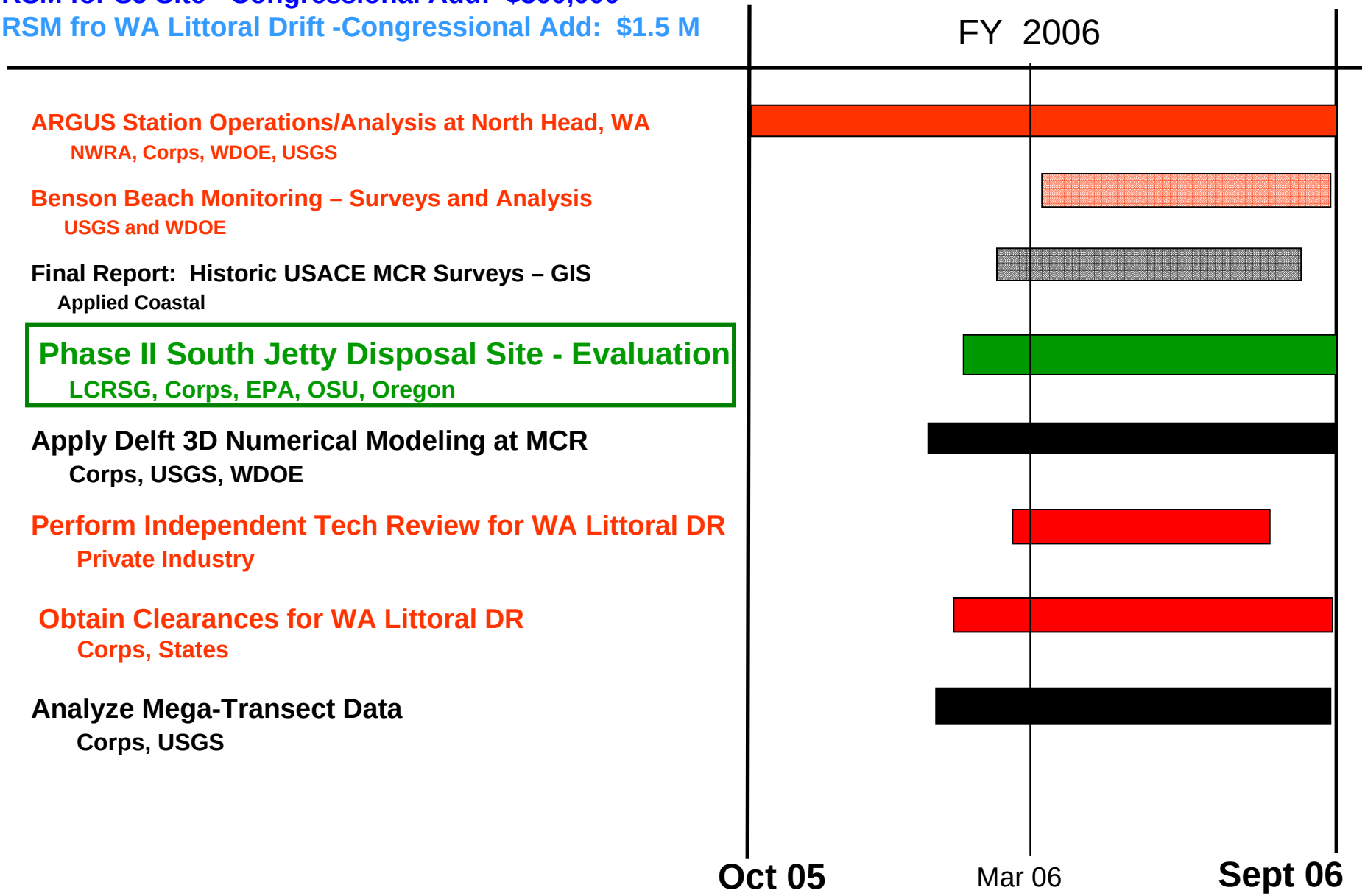
Prepare EA for WA Littoral DR
Corps

Execute Mega-Transect Data Collection at MCR
Corps, Moffatt-Nichol, EHI, USGS

Continuing RSM Demo at MCR: FY 2006

RSM for SJ Site - Congressional Add: $300,000

RSM fro WA Littoral Drift -Congressional Add: $1.5 M



What Have We Learned: RSM Demo at MCR

- Cooperative Agreements are effective at providing key services and building relationships

  Understanding thru Collaboration

- We CAN place dredged material nearshore (40 ft depth) with a hopper dredge and produce bottom accumulation less than 4 inches

- Multi-beam surveys can detect dredged material when very little accumulation results - Backscatter

What Have We Learned: RSM Demo at MCR

- To model bottom current and sediment transport within/near an estuary, 3-D effects of river-marine water interaction MUST be included

- The MCR sediment “system” is at a point where the ambient sediment supply is running its course; we must strive to use all dredged sediment to augment the sediment budget

- We should balance Sediment Management – Sediment Processes and Objectives

Sustainability Thru Balance

What Have We Learned: RSM Demo at MCR

- Shallow Water Disposal Site is working as intended; SWS is feeding Peacock Spit

- Wave action at MCR is highly variable; big effect on circulation and sediment transport

- Turbidity Maximum at MCR transient; it's "everywhere"

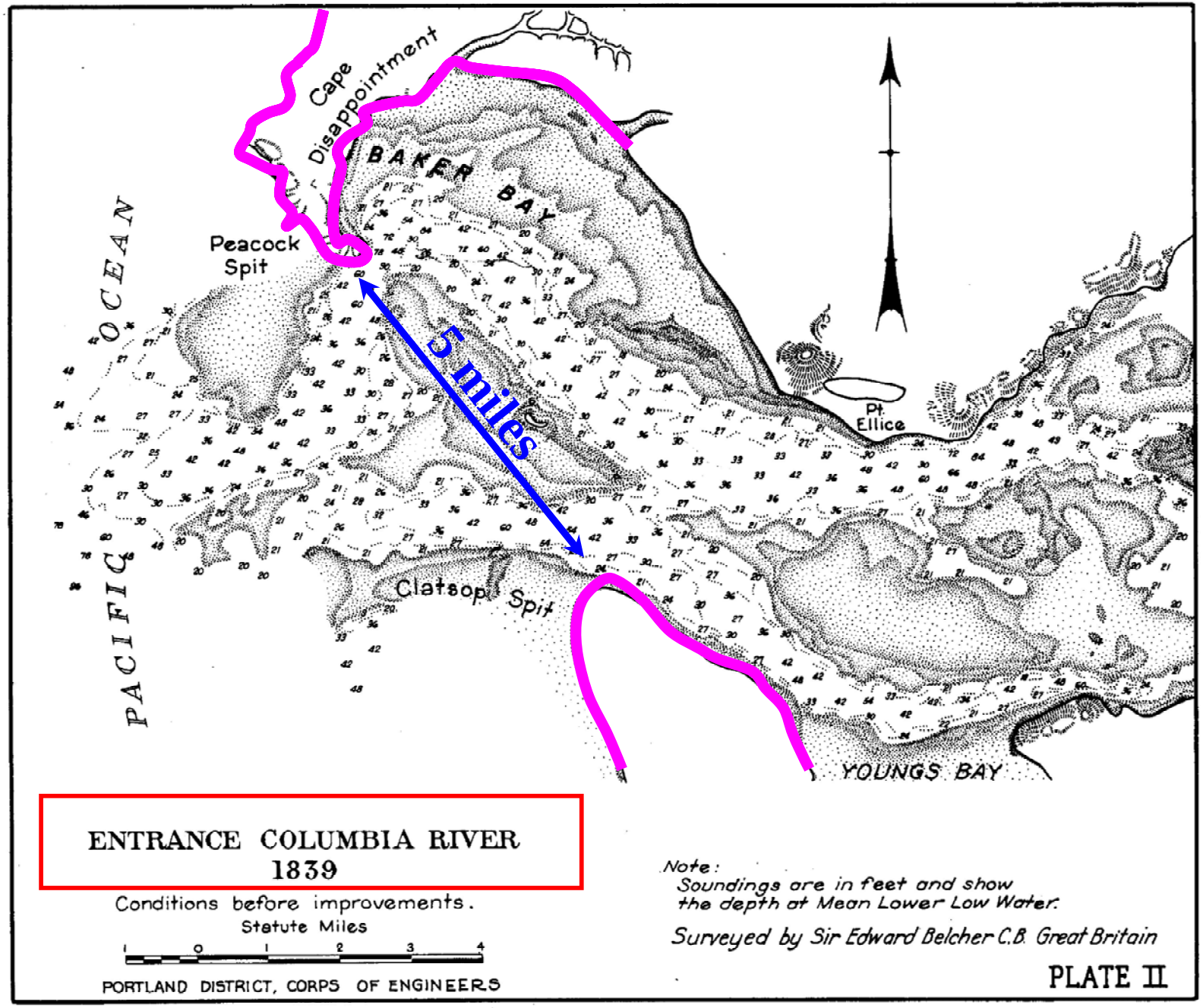
- The Mega-Transect Dataset provides data to improve understanding of flow and sediment transport processes - calibrate/verify 3-D flow/sed. transport models; for summer conditions

What Have We Learned: RSM Demo at MCR

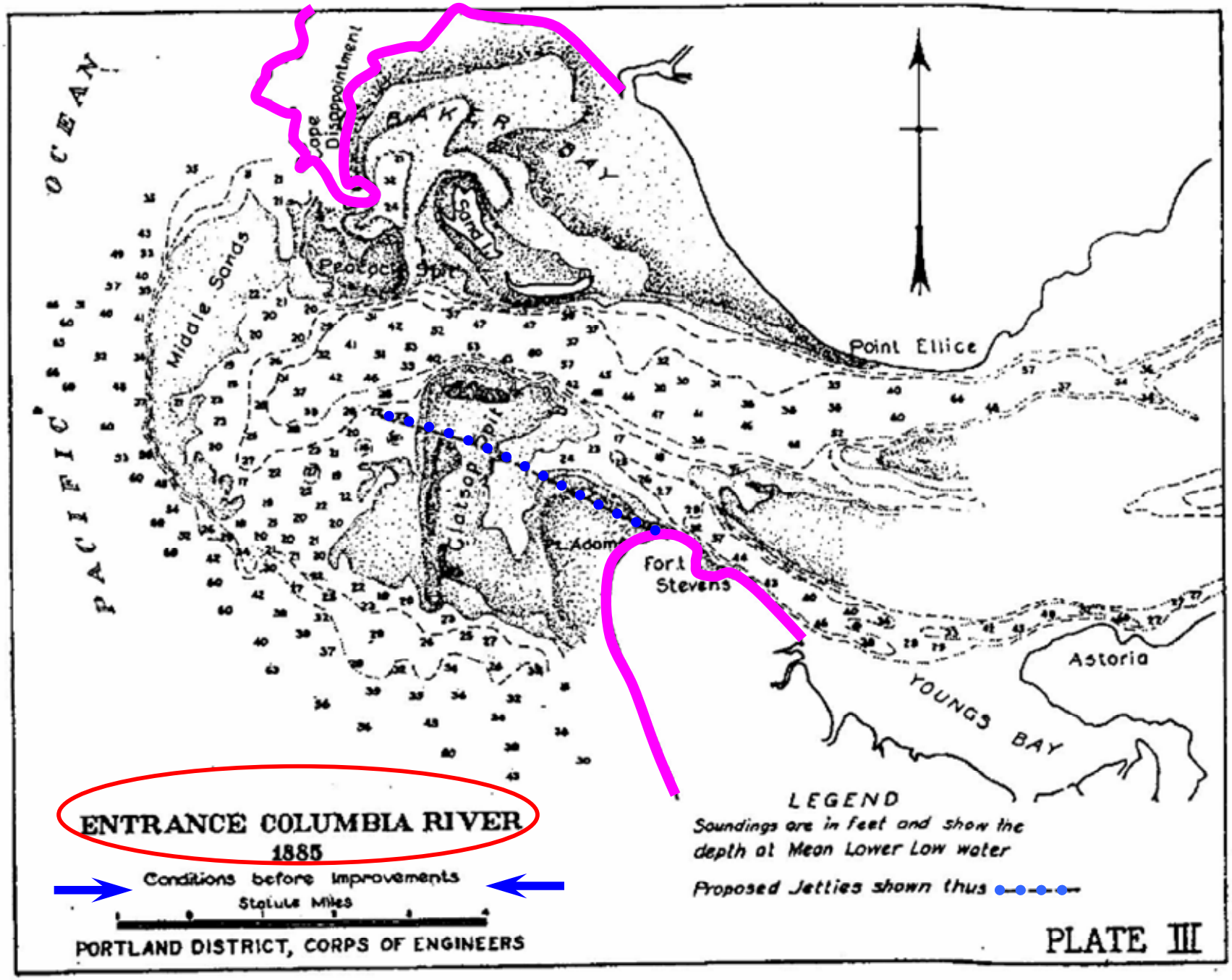
- *Bottom Current is active on Channel Slopes- Sediment Transport high on channel slopes?*

- *Sand Layer at MCR is 50 ft + thick at present; no limit on scour/erosion*

- *MCR has been active prior to jetty construction; the inlet was not static; periods of sand and finer materials being deposited at MCR. Rapid/substantial Channel Shifting prior to jetties.*



Conditions 46 years <u>before</u> jetties

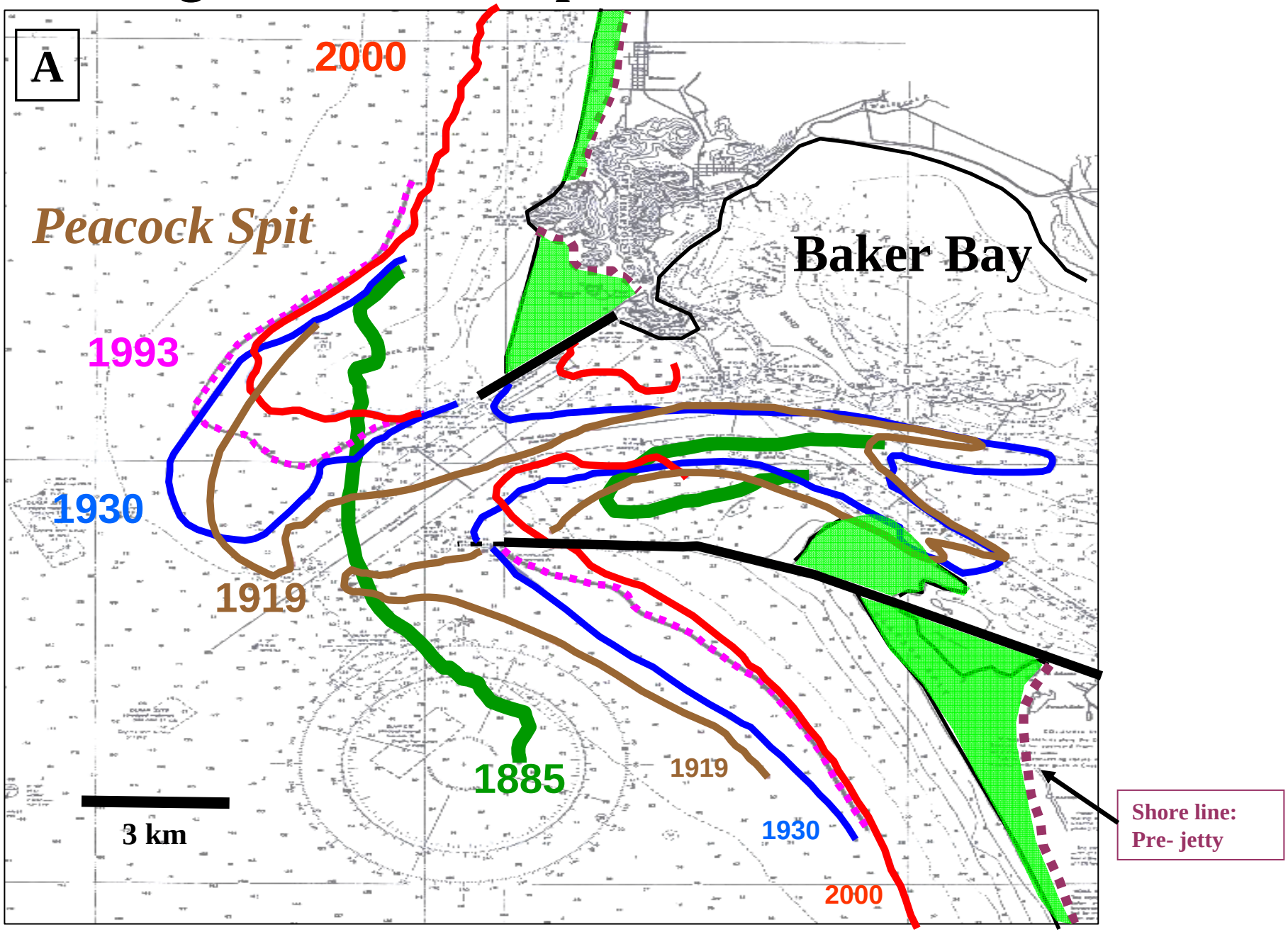


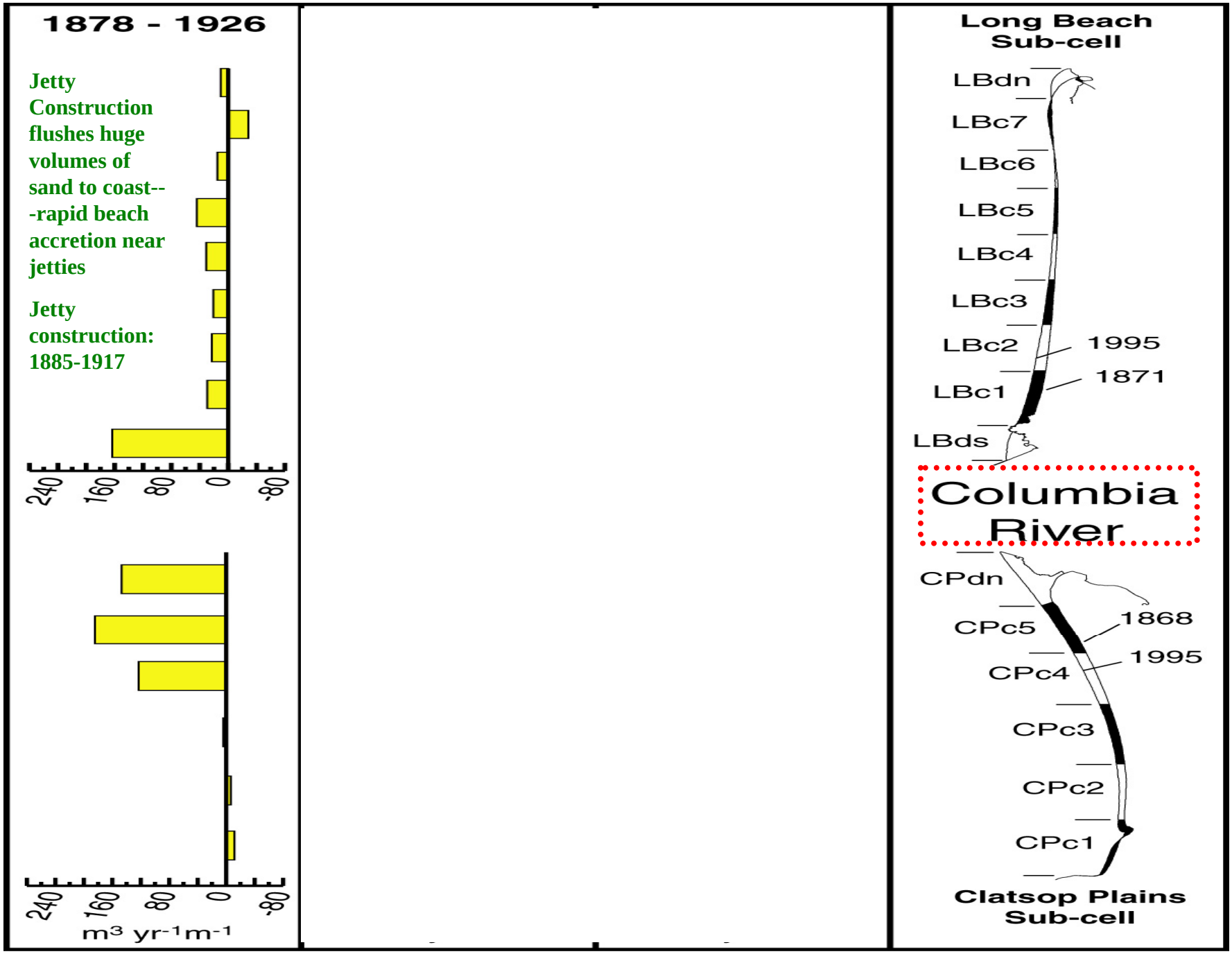
Conditions < 1 year prior to south jetty construction

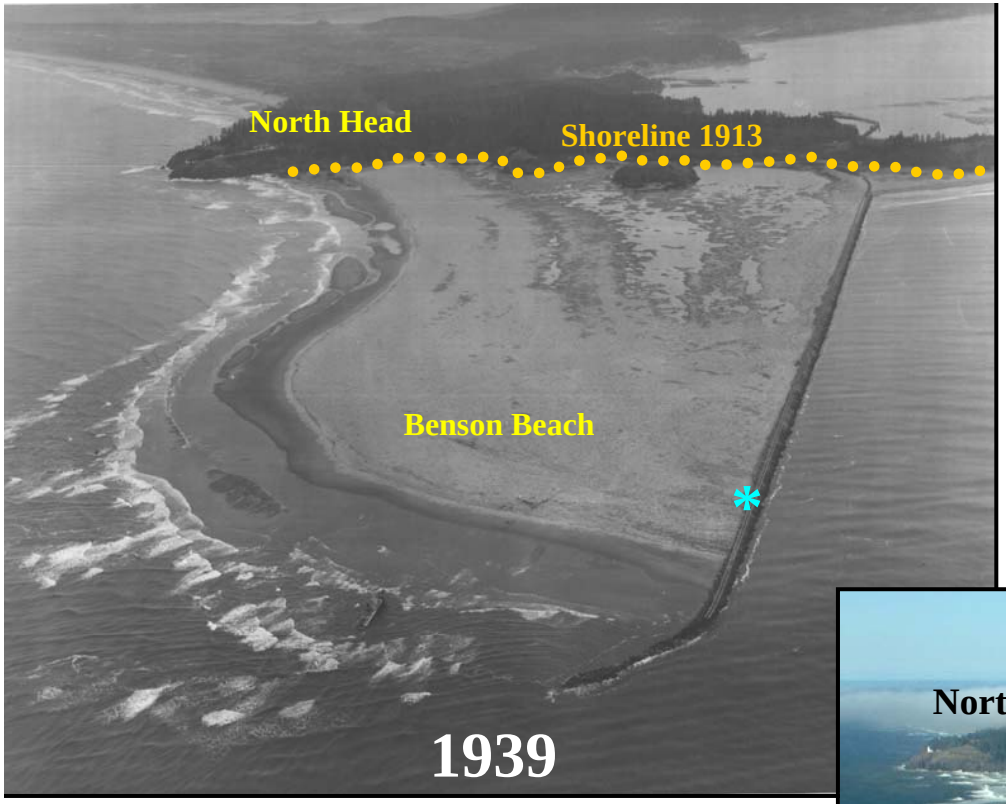
Natural Inlet

Engineered Inlet

Change in the 40-ft depth Contour thru Time




1878 - 1926
Jetty Construction flushes huge volumes of sand to coast--rapid beach accretion near jetties
Jetty construction: 1885-1917
240
160
80
0
-80
m³ yr⁻¹m⁻¹
Long Beach Sub-cell
LBdn
LBc7
LBc6
LBc5
LBc4
LBc3
LBc2
LBc1
LBds
1995
1871
Columbia River
CPdn
CPc5
CPc4
CPc3
CPc2
CPc1
1868
1995
Clatsop Plains Sub-cell


North Head
Shoreline 1913
Benson Beach
1939

North Head
Shoreline 1913
Benson Beach has receded
2,000 ft since 1939
North Jetty
2002

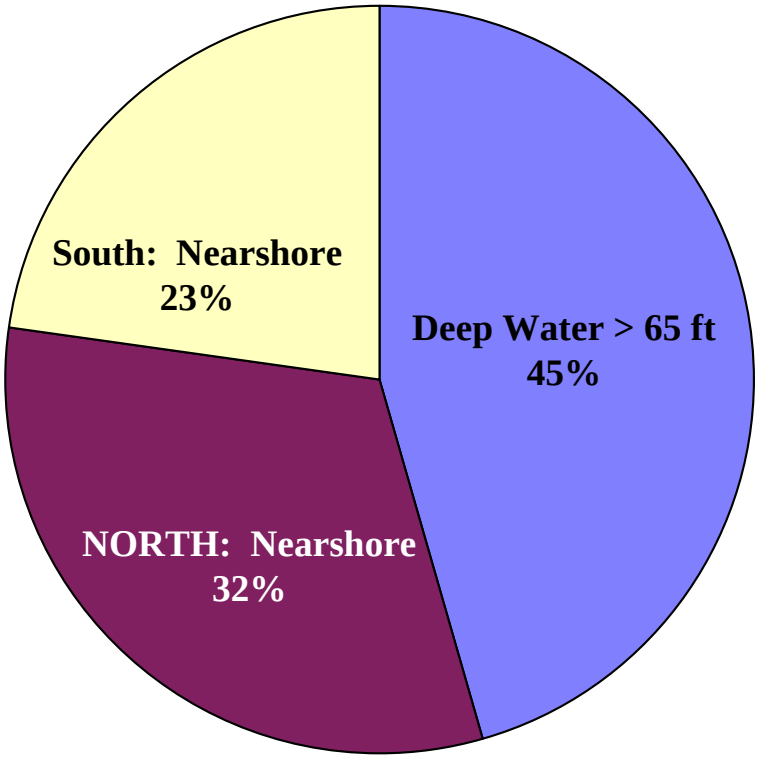
MCR Channel (RM –3to 3): Annual O&M Dredging (5 miles) = 4-5 Mcy/yr

Lower Columbia River (RM 4 to 105+): Annual O&M Dredging (100 miles) = 6-8 Mcy/yr

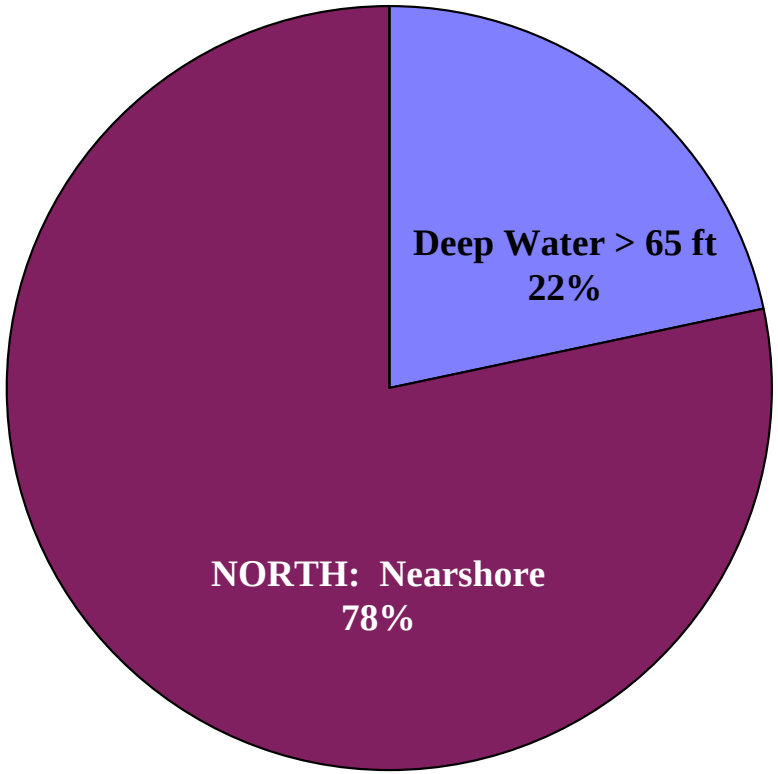
Dredges working at MCR
Essayons
Sugar Island

WHERE Has MCR Dredged Material Been Placed?
North vs South vs Deepwater

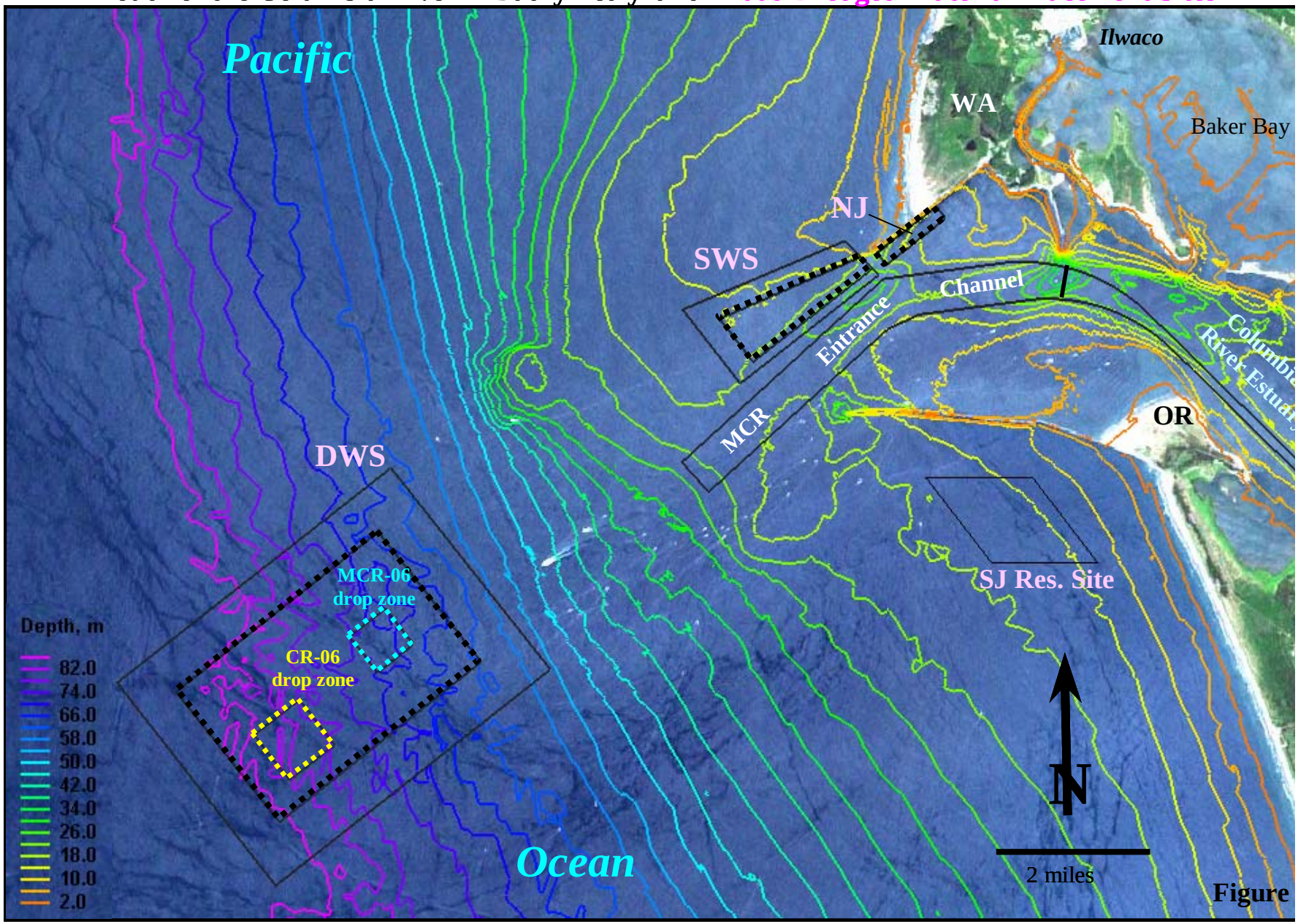
MCR Ocean Dredging-Disposal 1956-1996
181 million cy



MCR Ocean Dredging-Disposal 1997-2003
26 million cy



Mouth of the Columbia River - Bathymetry and 2006 Dredged Material Placement Sites

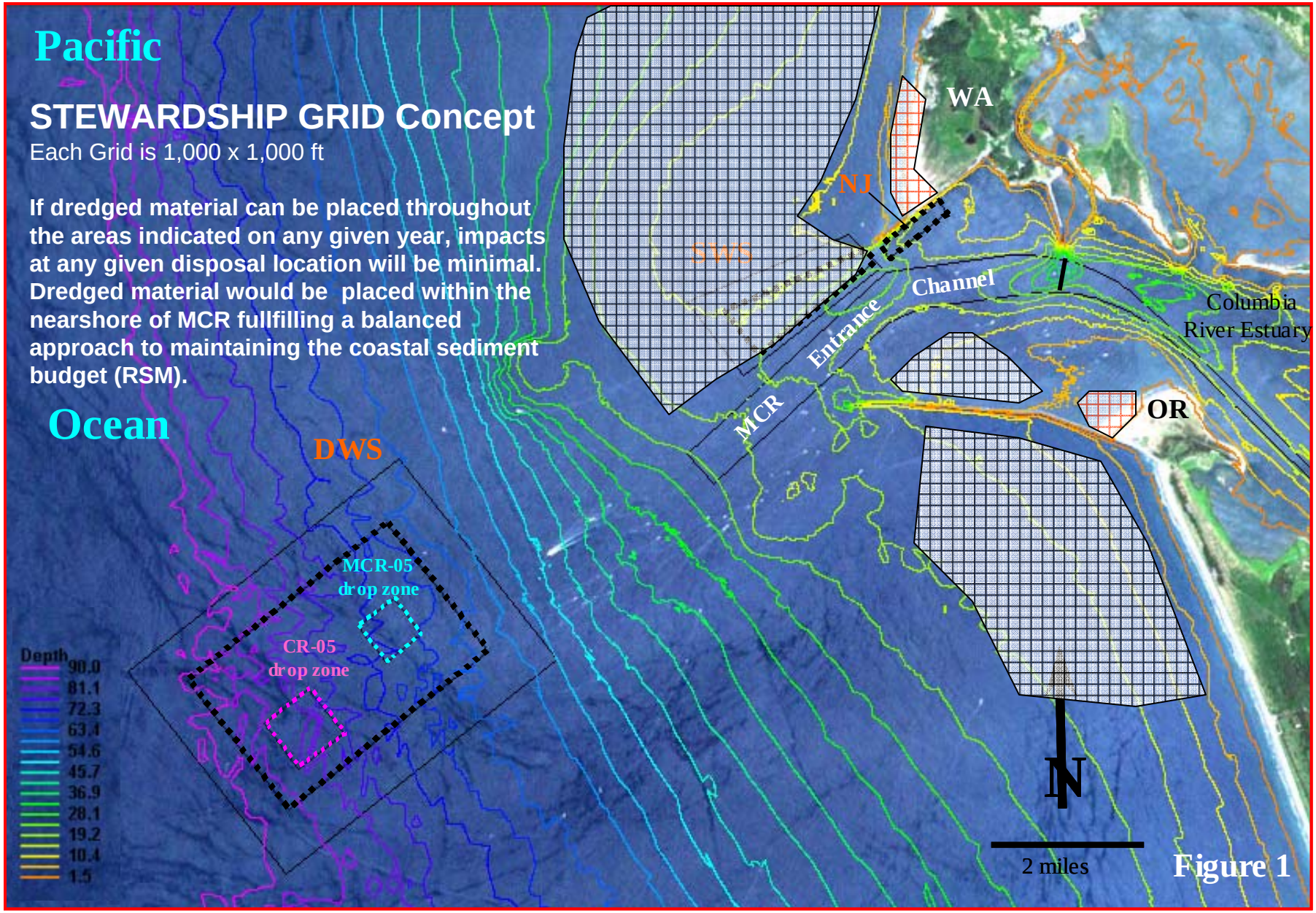


DWS= Deep Water Site, 102 MPRSA NJ Site = North Jetty disposal site, 404 CWA

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

SJ Res. Site = South Jetty research sit
restricted use by EPA permit

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



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

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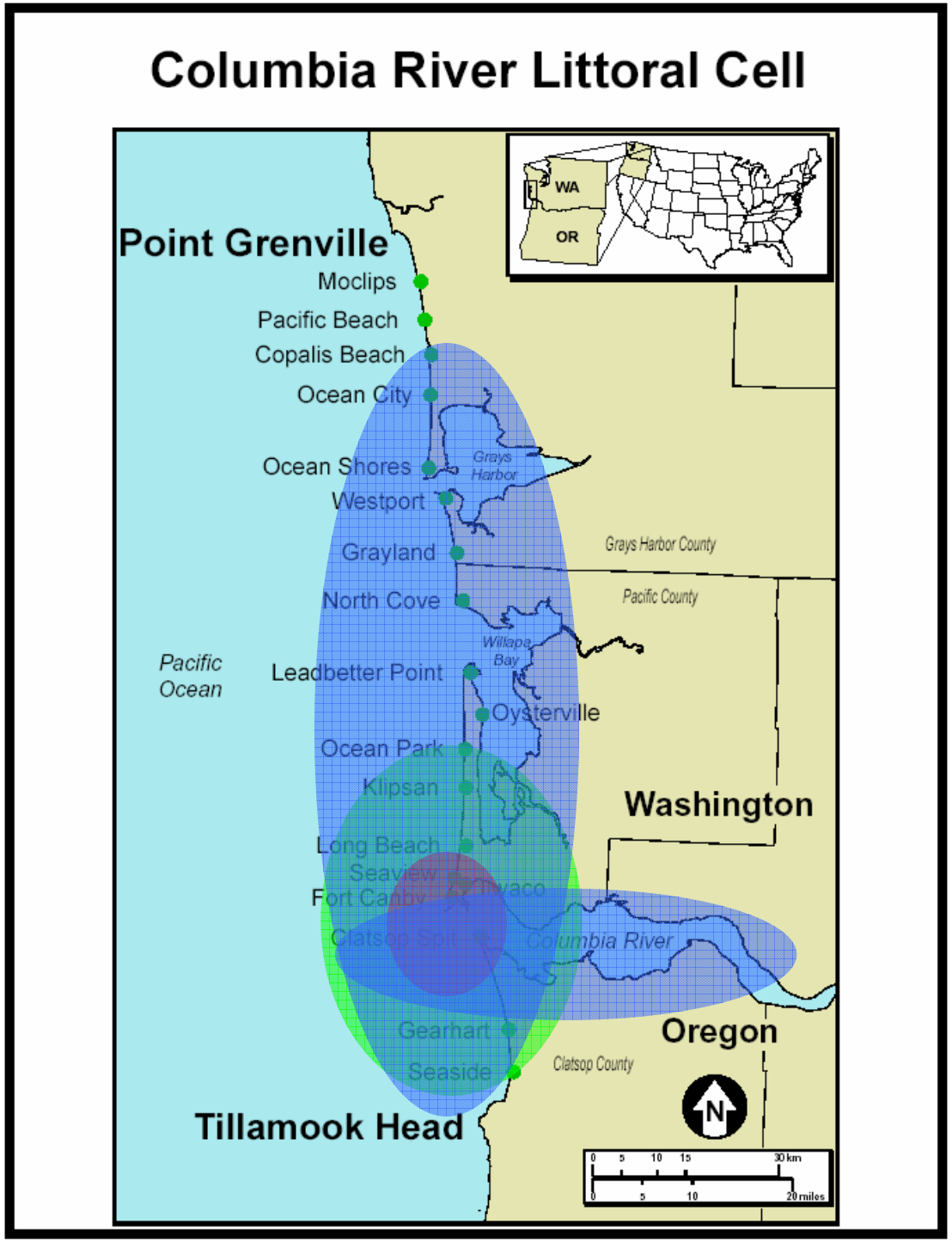


Executing a RSM Demonstration Project Requires Us to Focus on a Priority Area as First Step-MCR

Address First Order Effects First

Then Expand Outward Thru Continued Work

RSM Demo at MCR

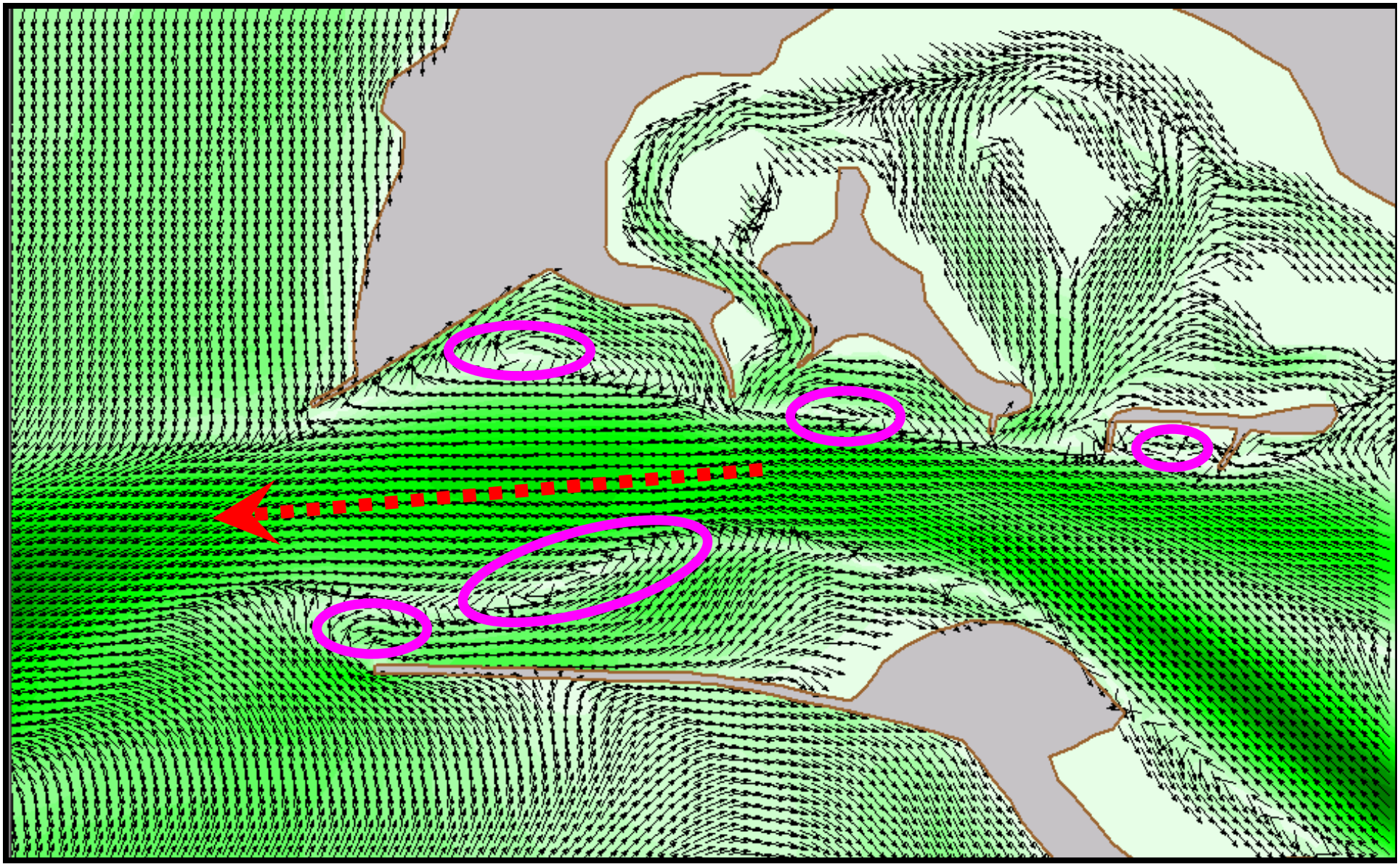
A Collaborative Approach to Improving the Sustainability of MCR

Learning by "DOING"

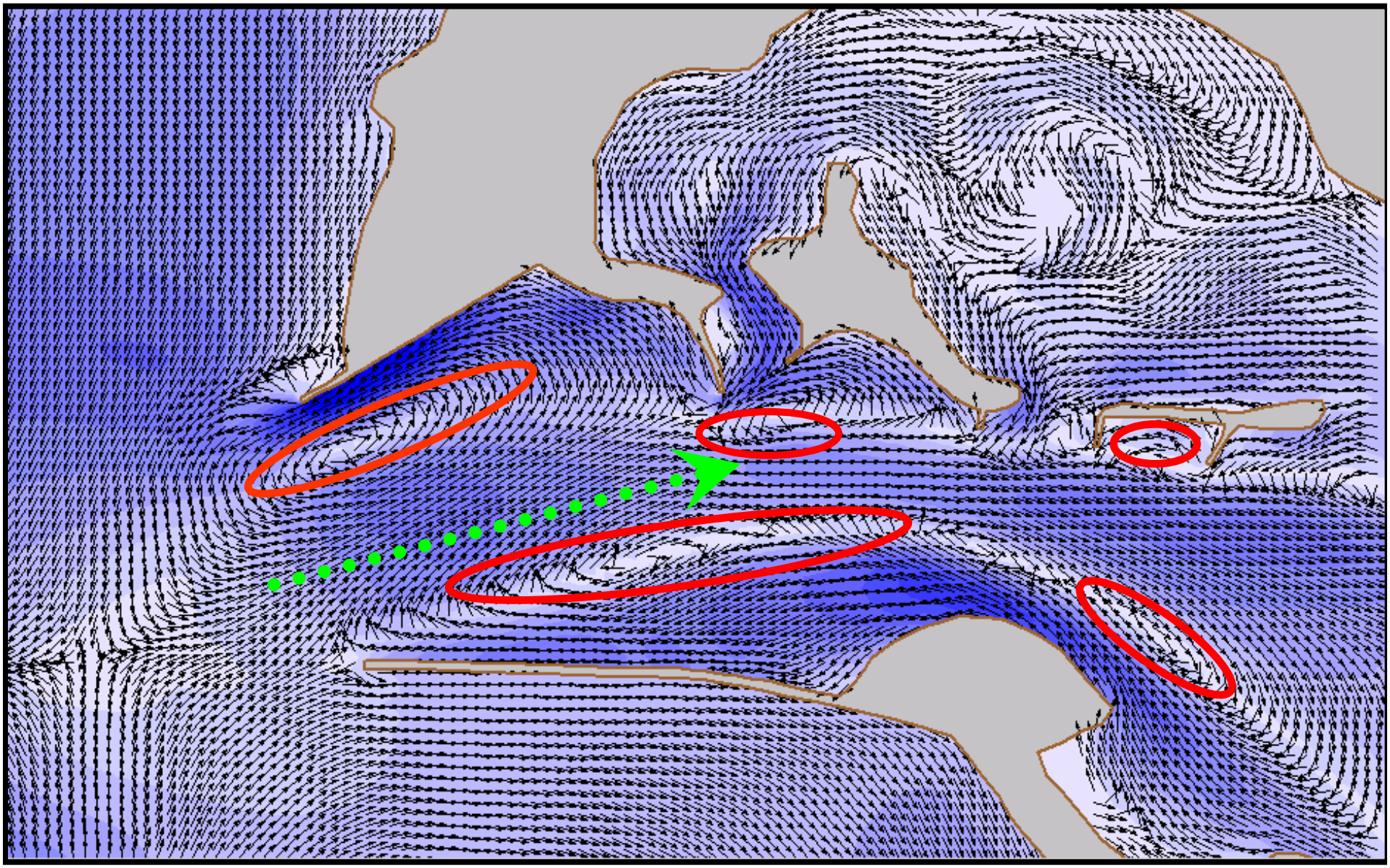
A sampling of two (of many) Initiatives

Mega-Transect Oceanographic Data Collection

Simulated Flow Pattern During ***Ebb*** & ***Eddies***

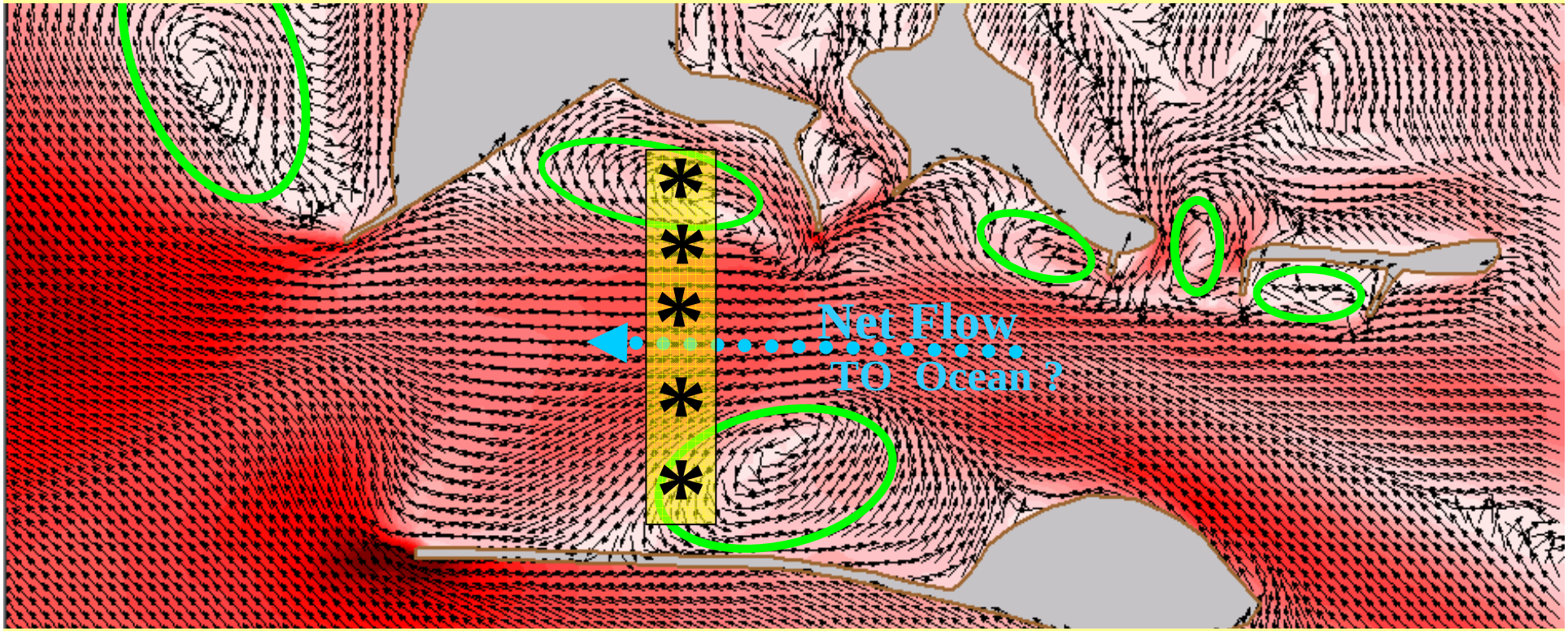


Simulated Flow Pattern During ***Flood*** & ***Eddies***

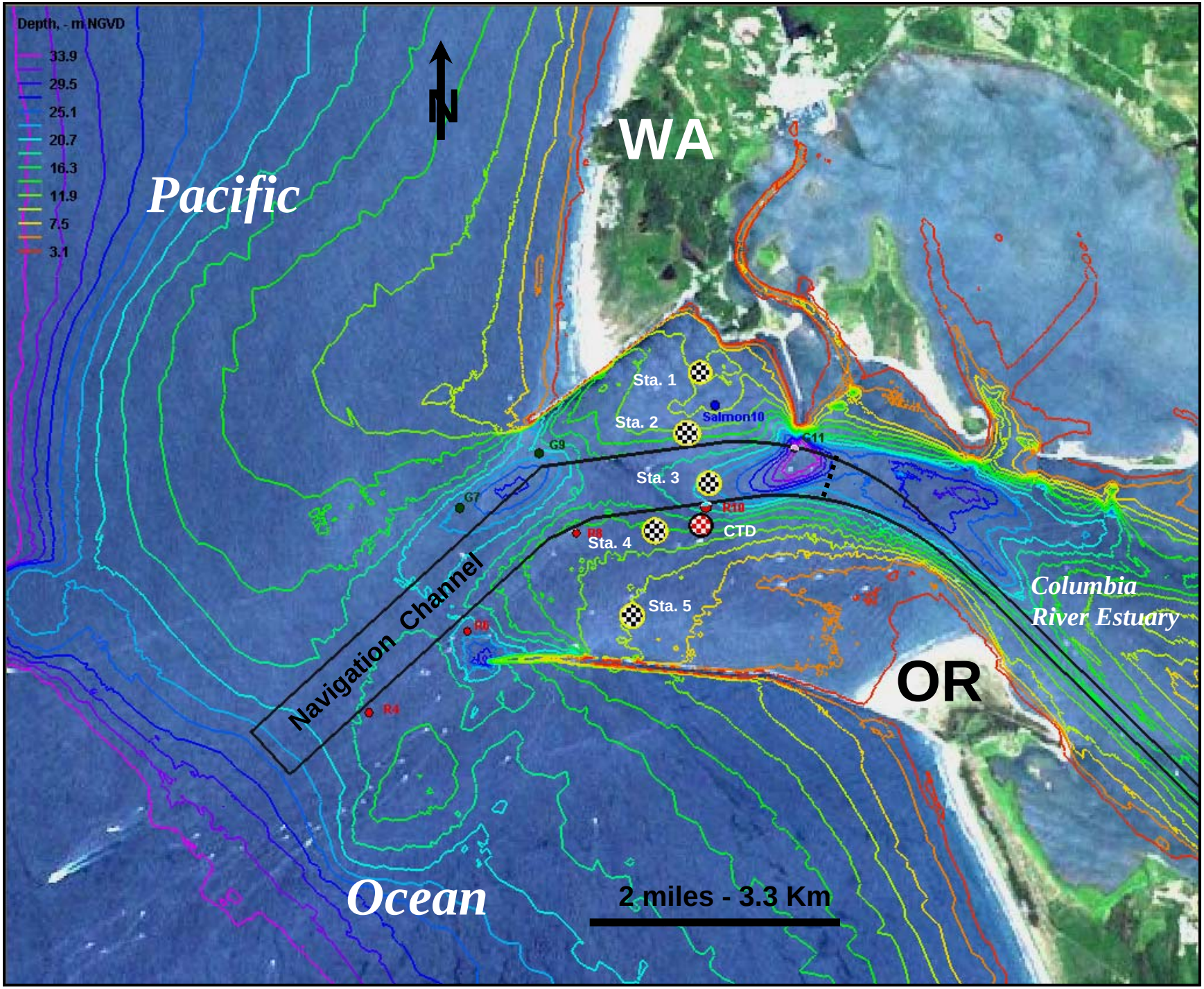


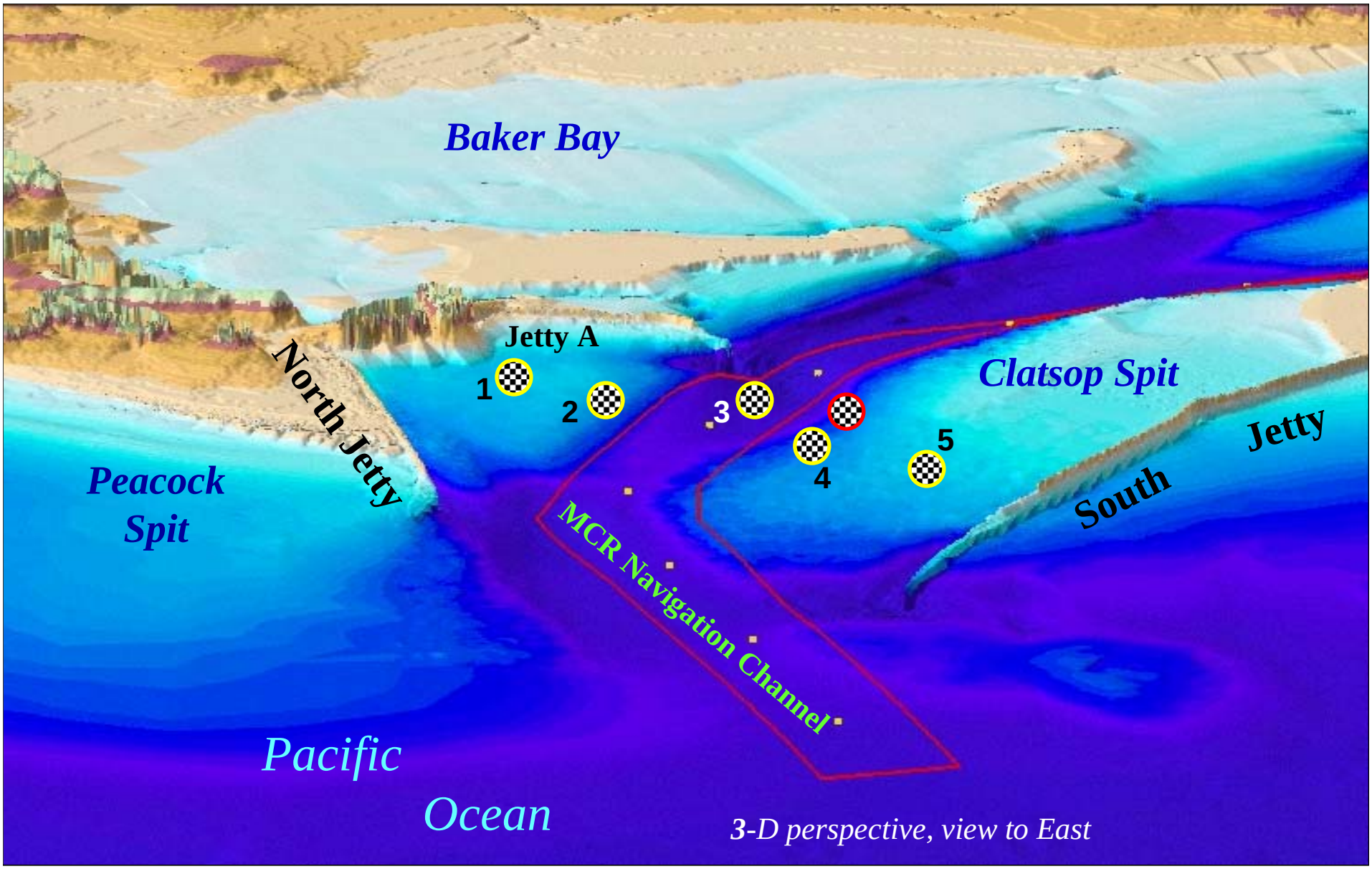
NET Simulated **Flow Pattern** & ***Eddies*** *for 1-10 Oct 1997*

PROPOSE: Conduct Simultaneous Flow & Sediment Measurements along "Mega-Transect", across MCR.

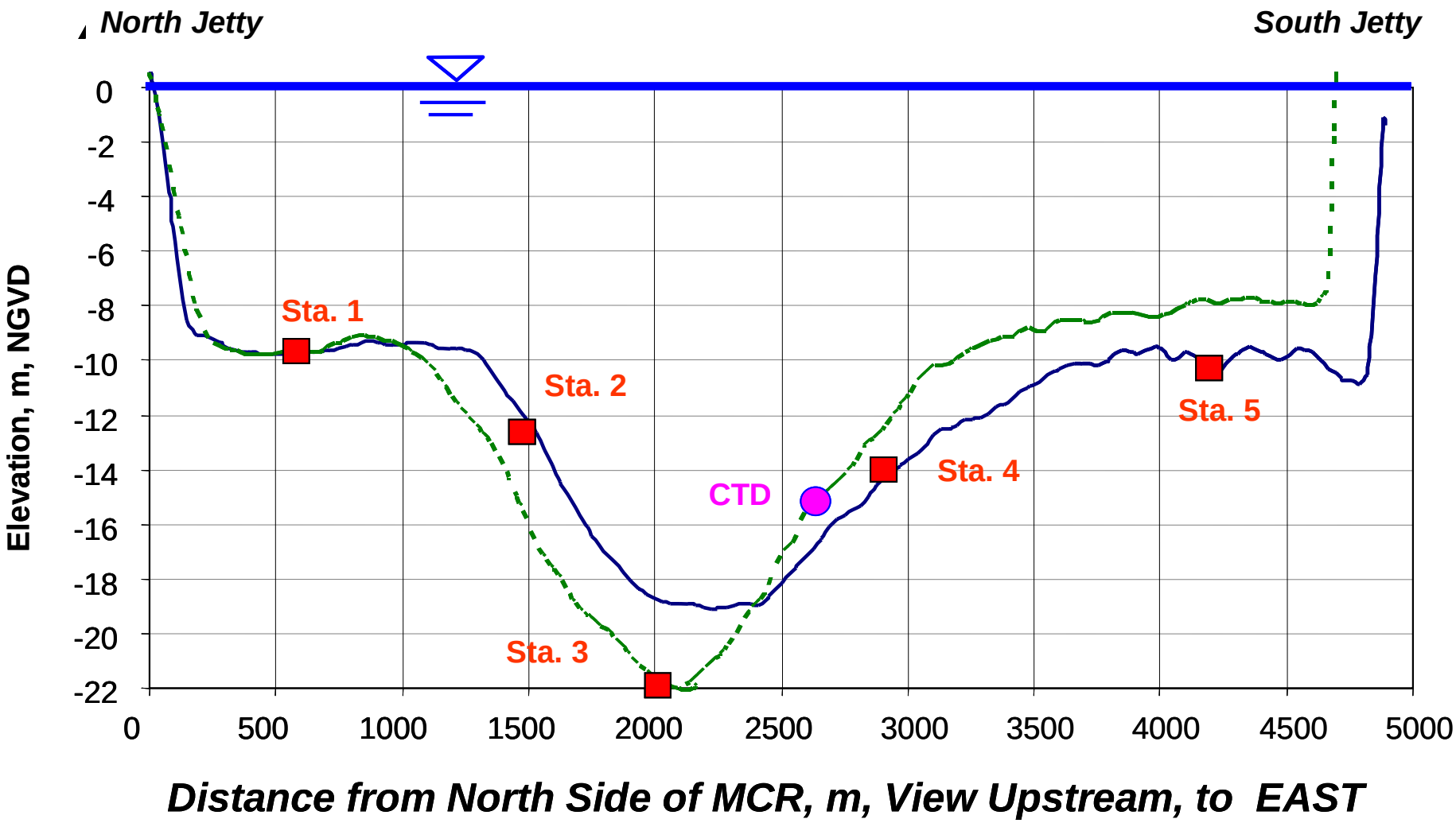


Deploy 4-8 "tripods" on bottom for 1-3 months and collect DATA


Depth, - m NGVD
33.9
29.5
25.1
20.7
16.3
11.9
7.5
3.1
N
WA
Pacific
Sta. 1
Salmon10
Sta. 2
C11
G9
Sta. 3
G7
R10
CTD
R8
Sta. 4
Navigation Channel
Sta. 5
R6
R4
Columbia
River Estuary
OR
Ocean
2 miles - 3.3 Km


Baker Bay
Jetty A
1
2
3
4
5
North Jetty
Clatsop Spit
South Jetty
Peacock Spit
MCR Navigation Channel
Pacific Ocean
3-D perspective, view to East

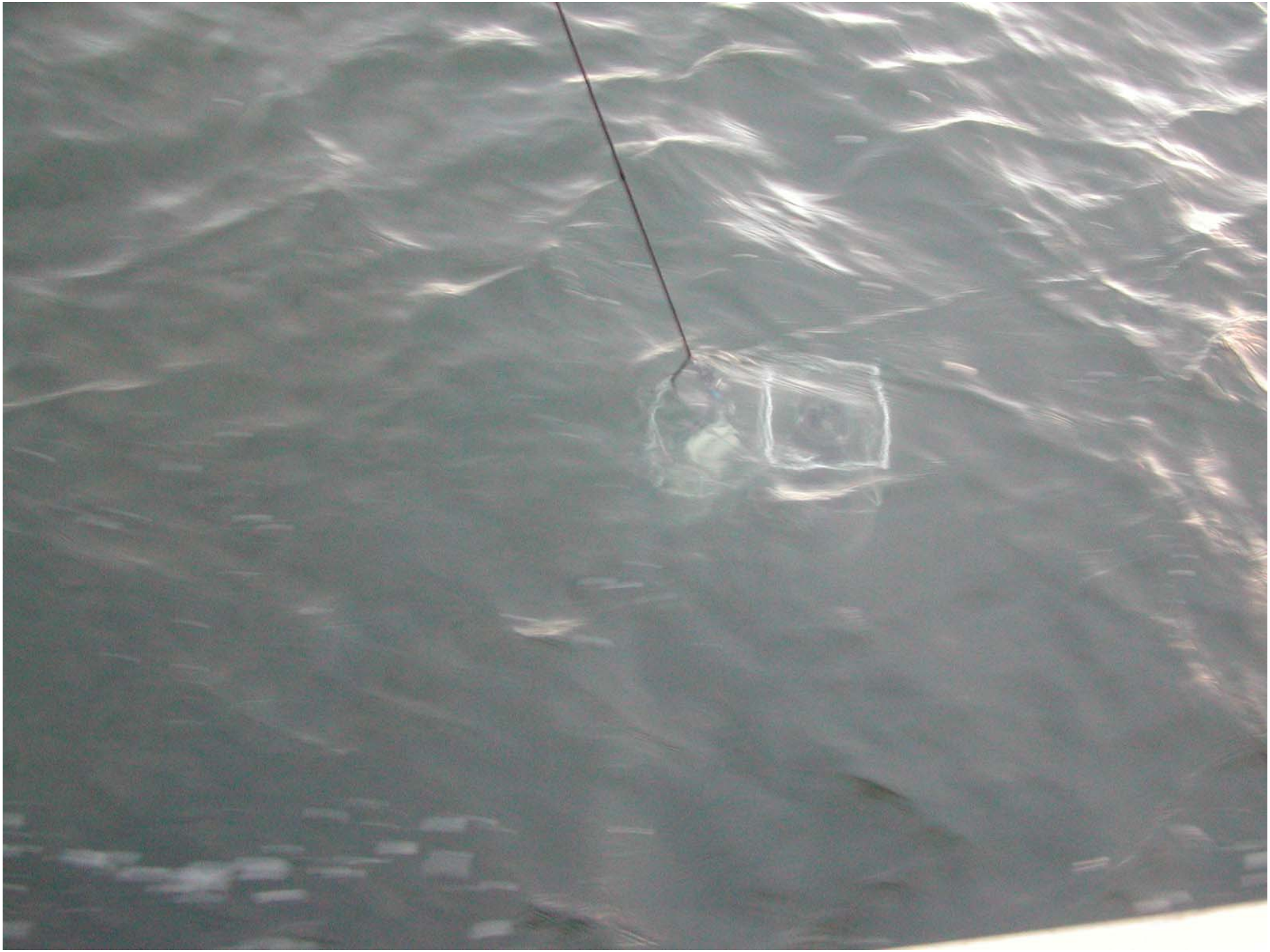
Cross-Section View Across MCR along Mega-Transect

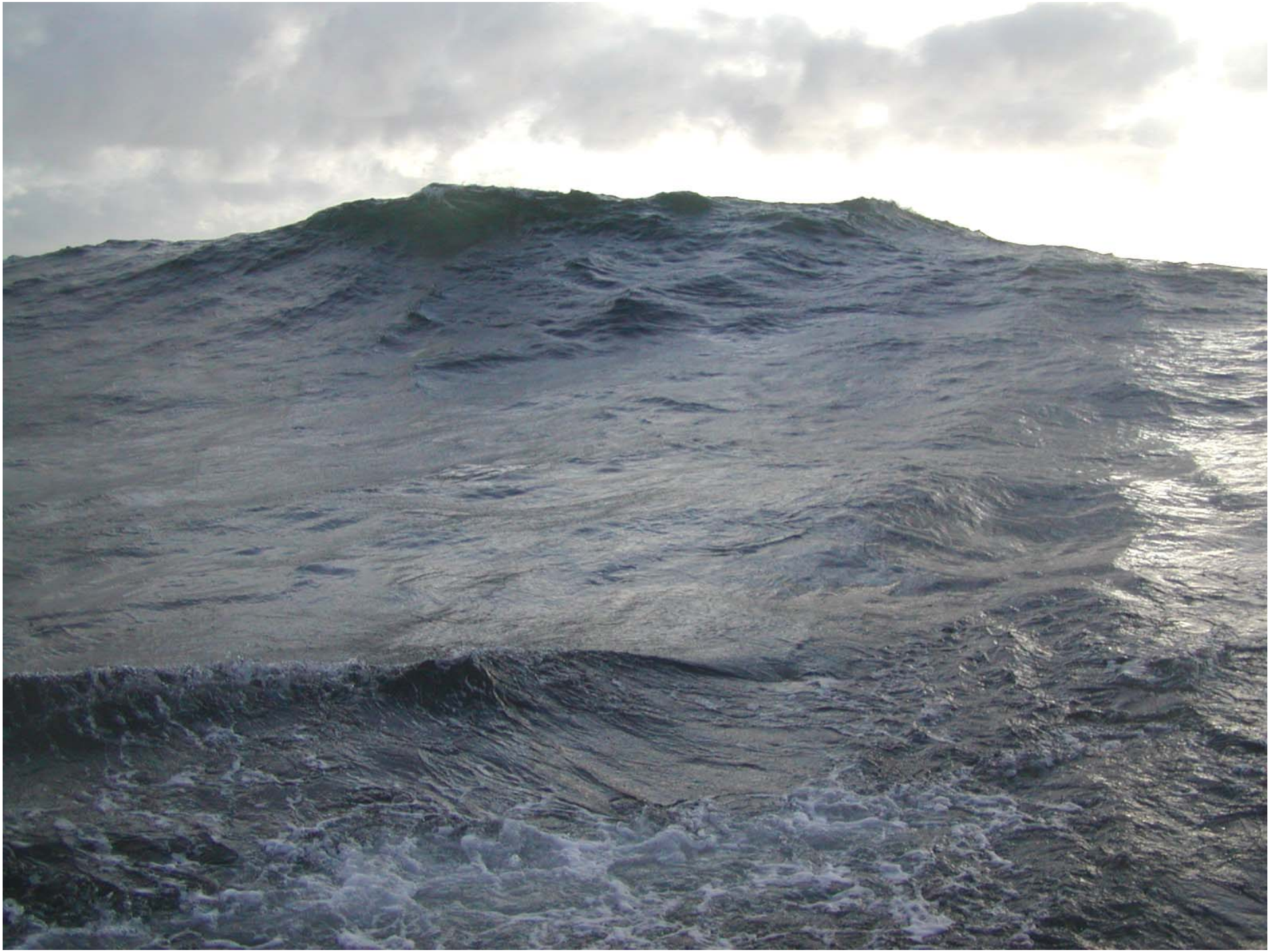


NO
PARKING

USGS

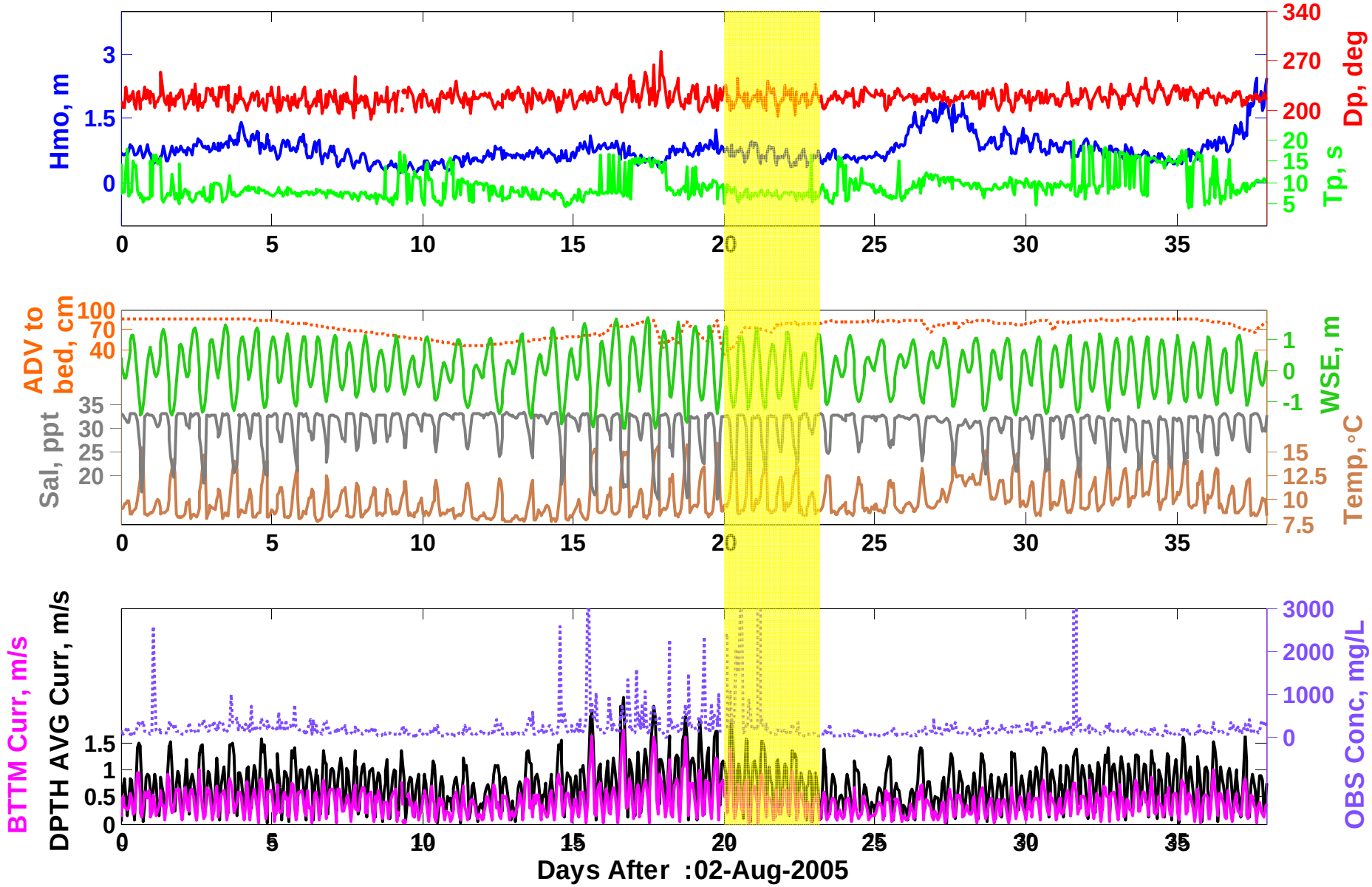
LISST-100



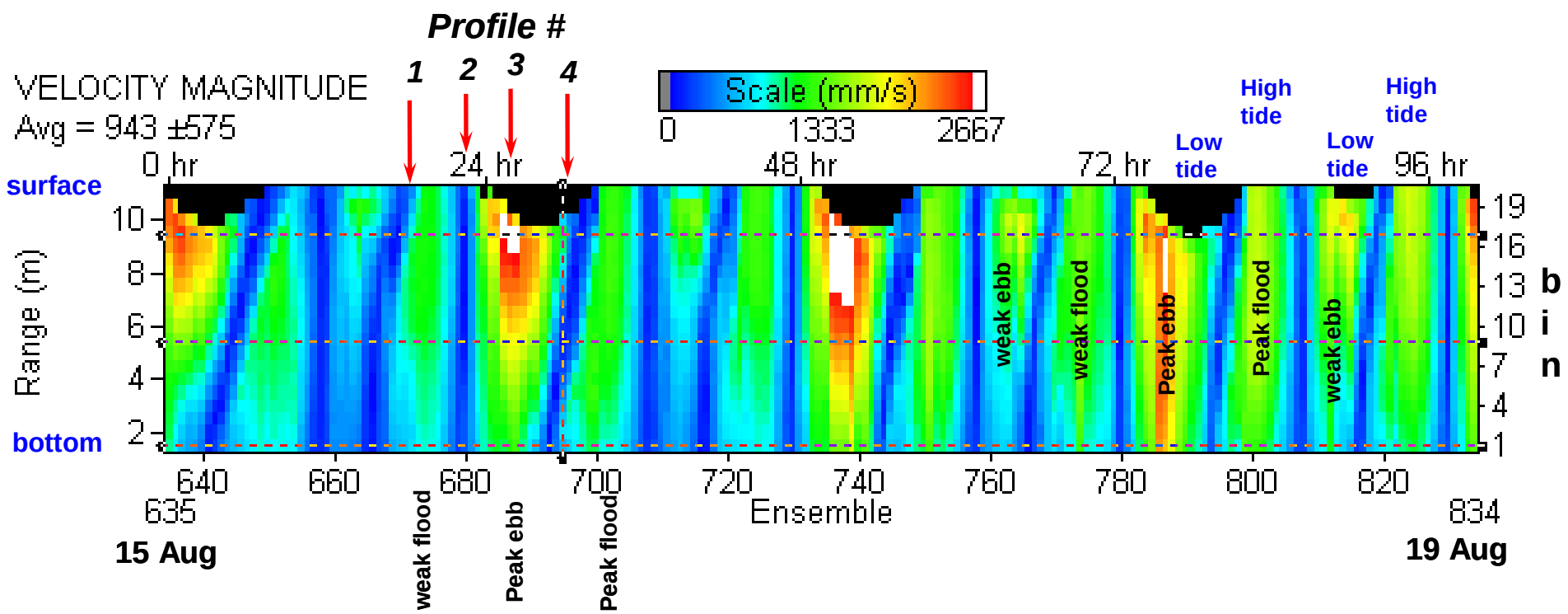


EHI

STA 2 -Summary



4-Day Current Profile Sequence at Station 3



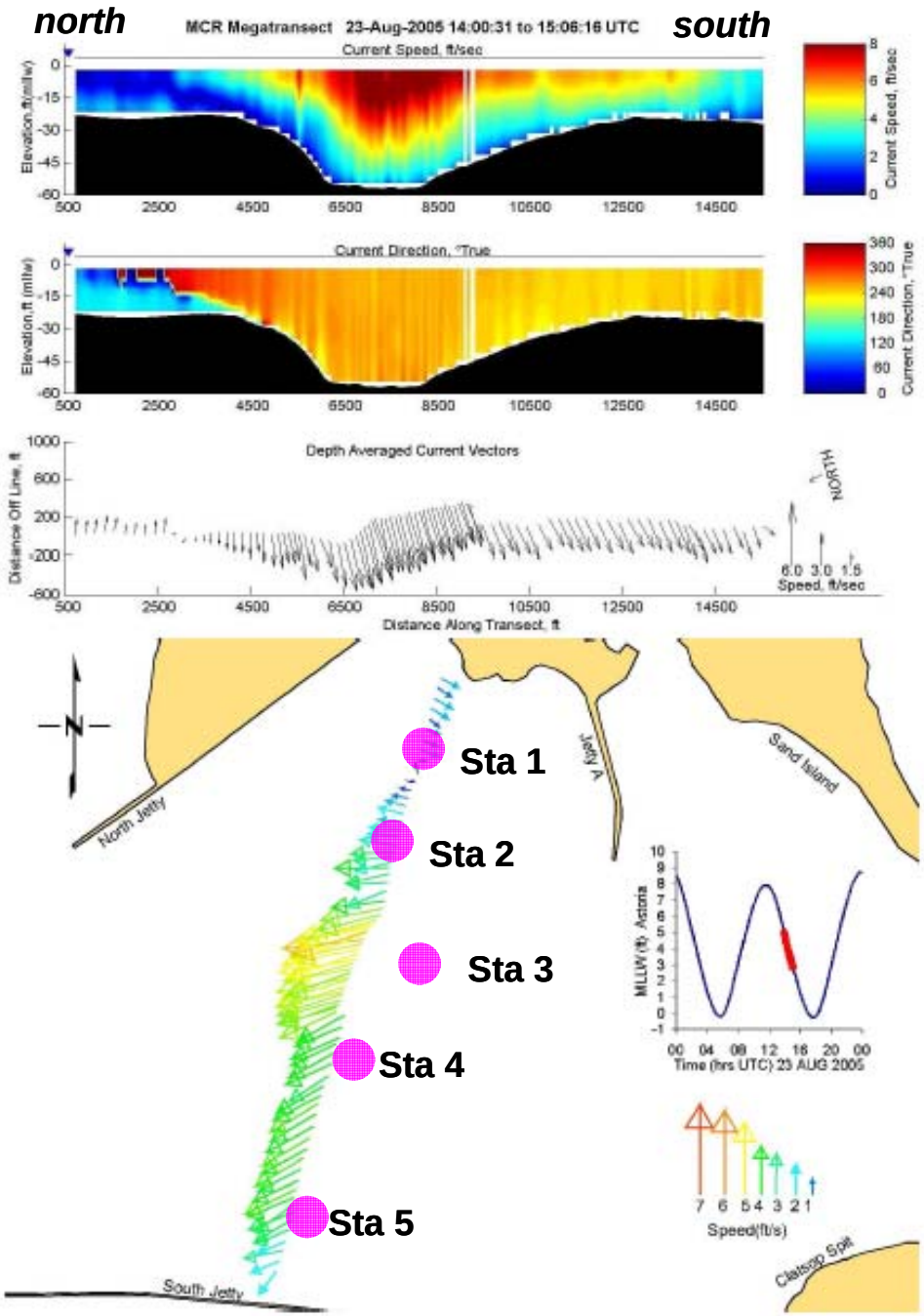


Figure 4. Mid-Ebb - Cross section view (looking East) of current speed and dire
and plan view of depth-averaged current velocity

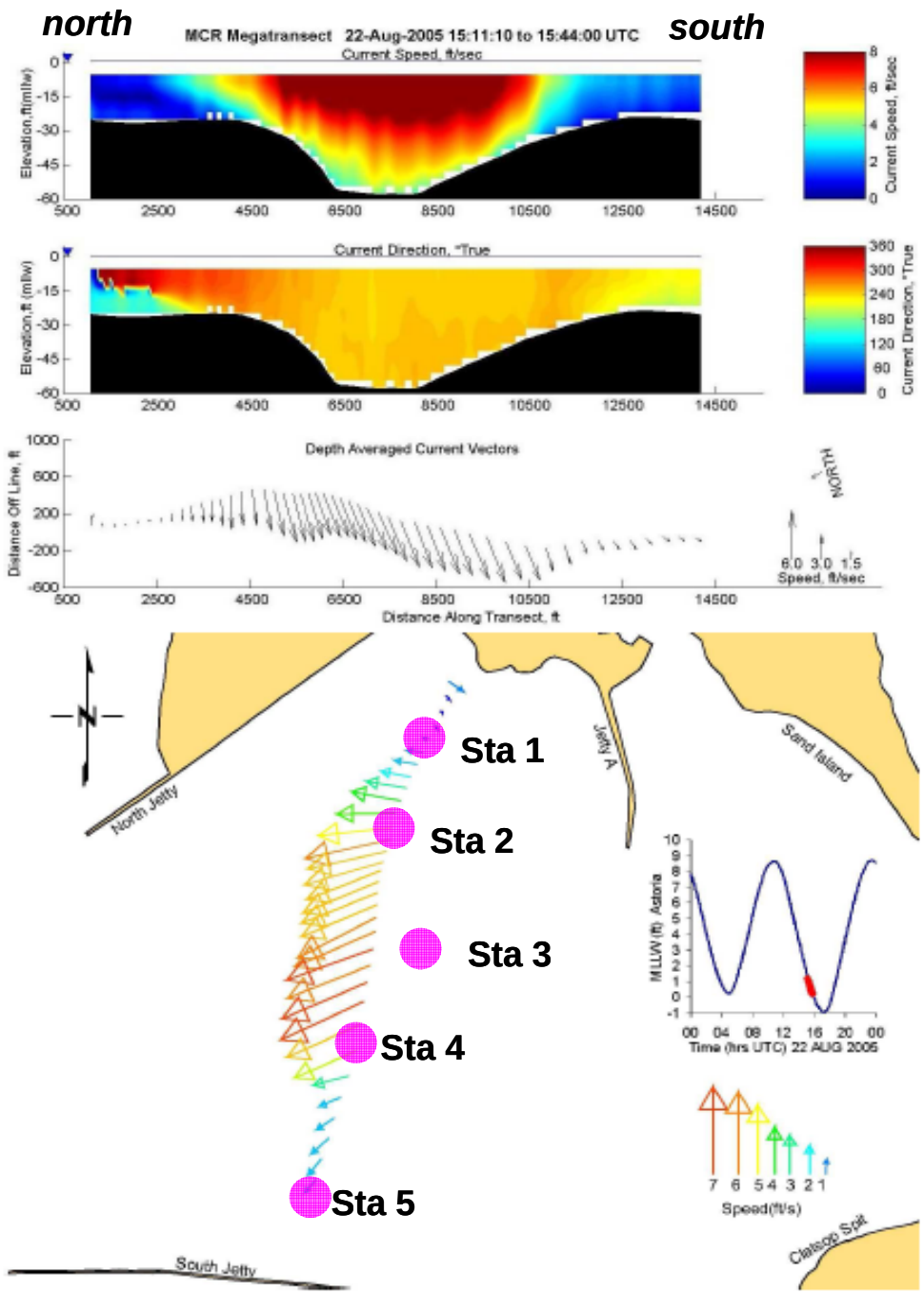


Figure 5. Late Ebb - Cross section view (looking East) of current speed and dire
and plan view of depth-averaged current velocity

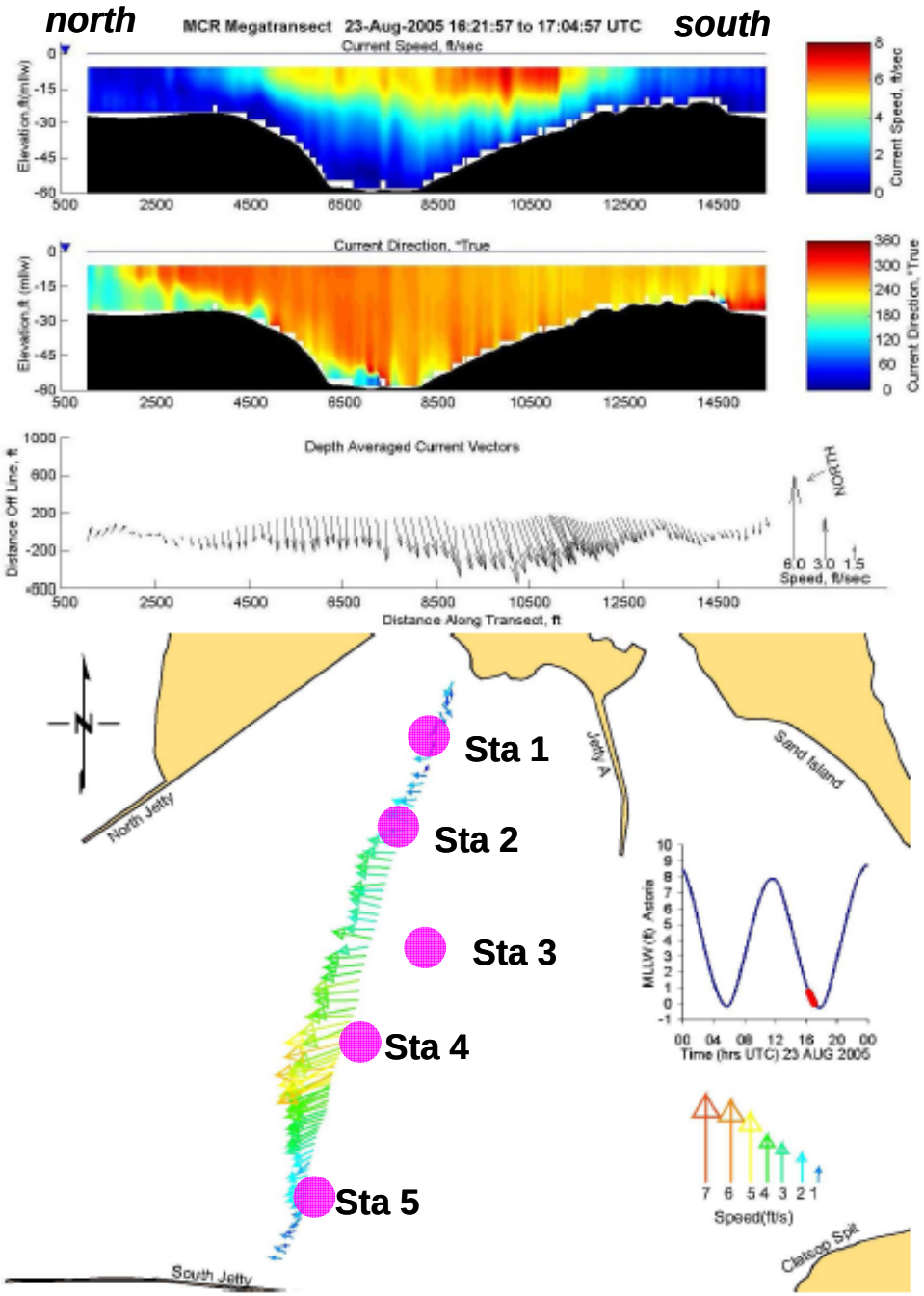


Figure 6. End of Ebb - Cross section view (looking East) of current speed and direction and plan view of depth-averaged current velocity

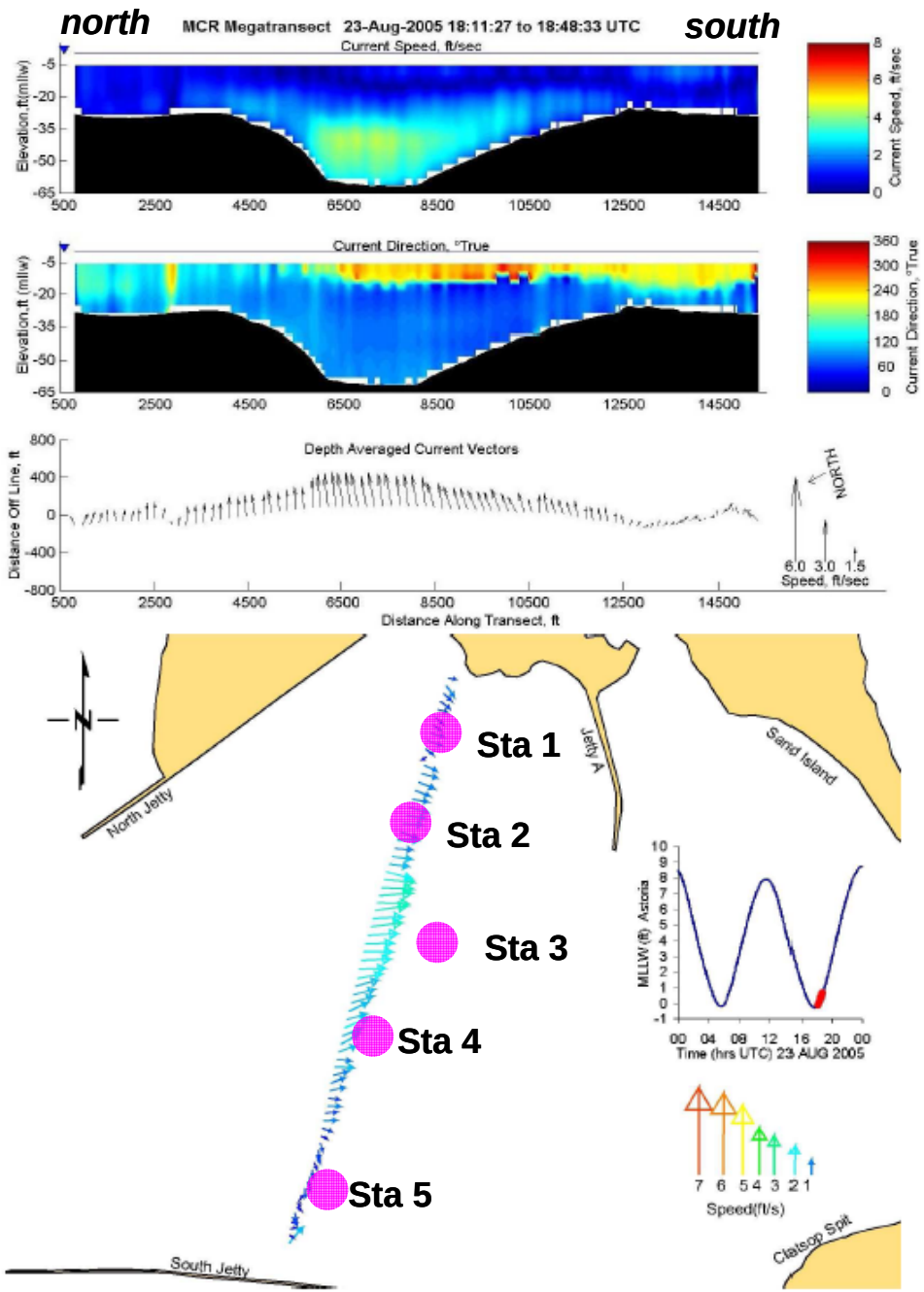


Figure 7. Beginning of Flood - Cross section view (looking East) of current speed and direction and plan view of depth-averaged current velocity

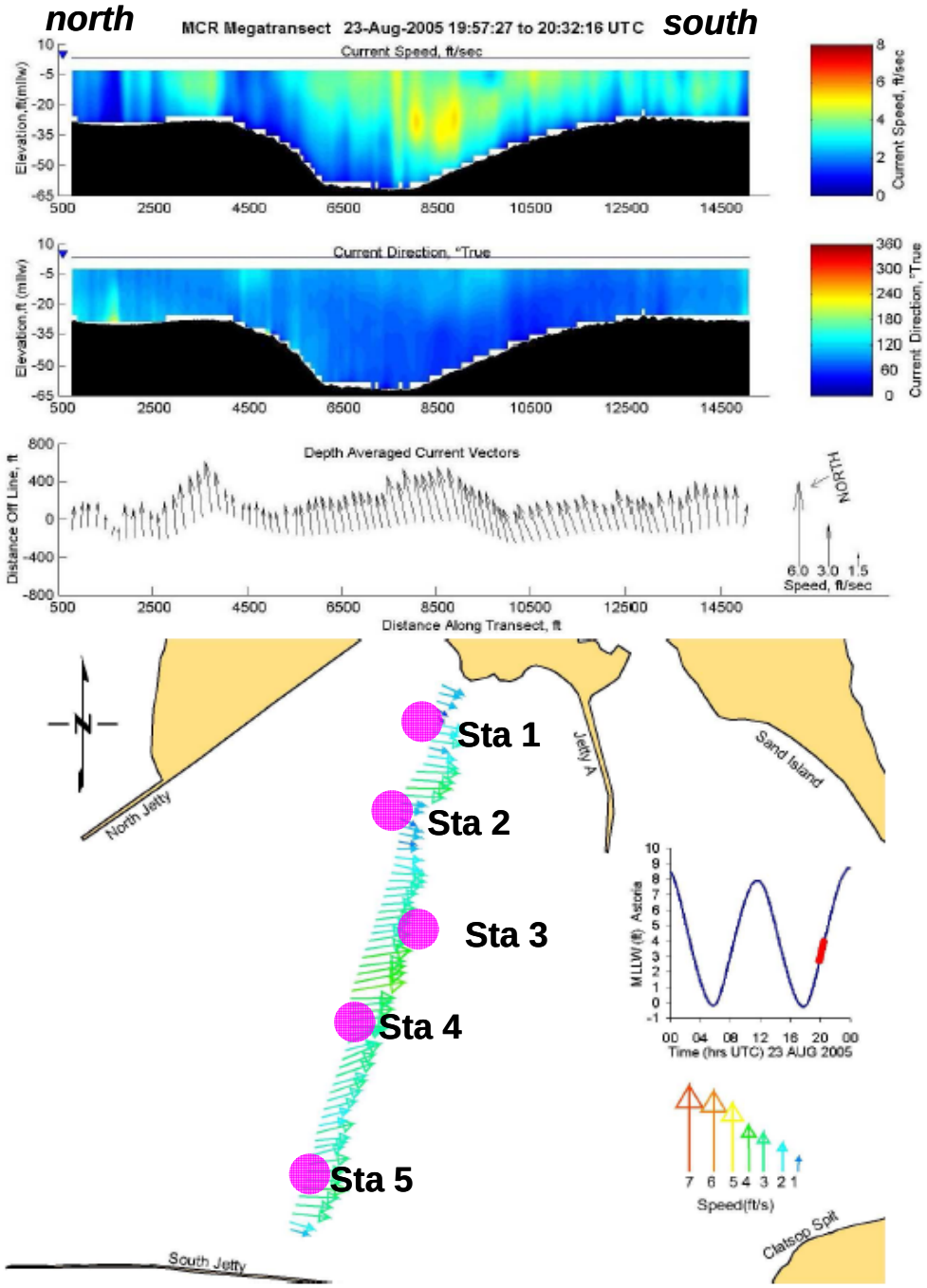


Figure 8. Early Flood-Cross section view (looking East) of current speed and direction and plan view of depth-averaged current velocity

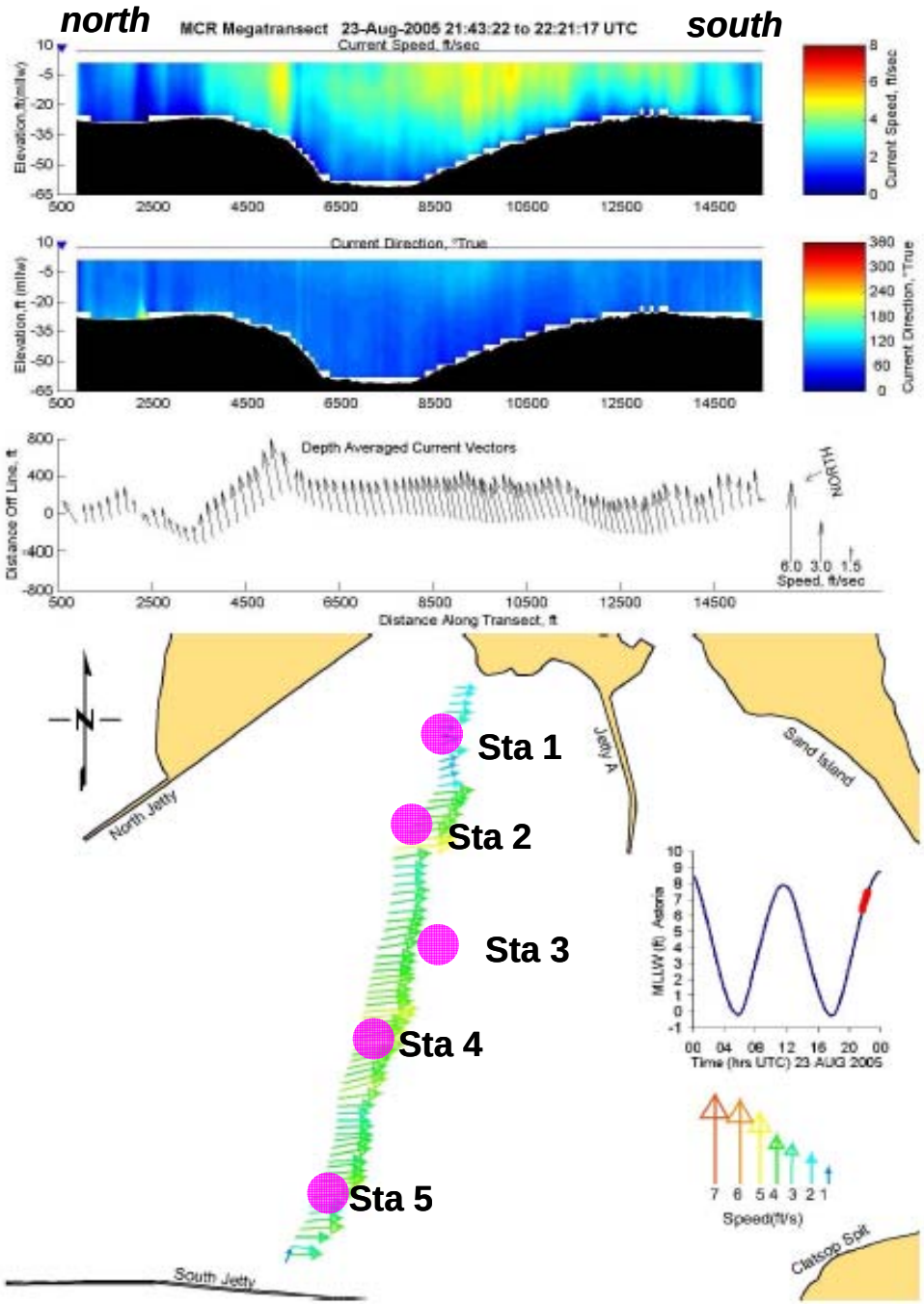


Figure 9. Mid-Flood - Cross section view (looking East) of current speed and direction and plan view of depth-averaged current velocity

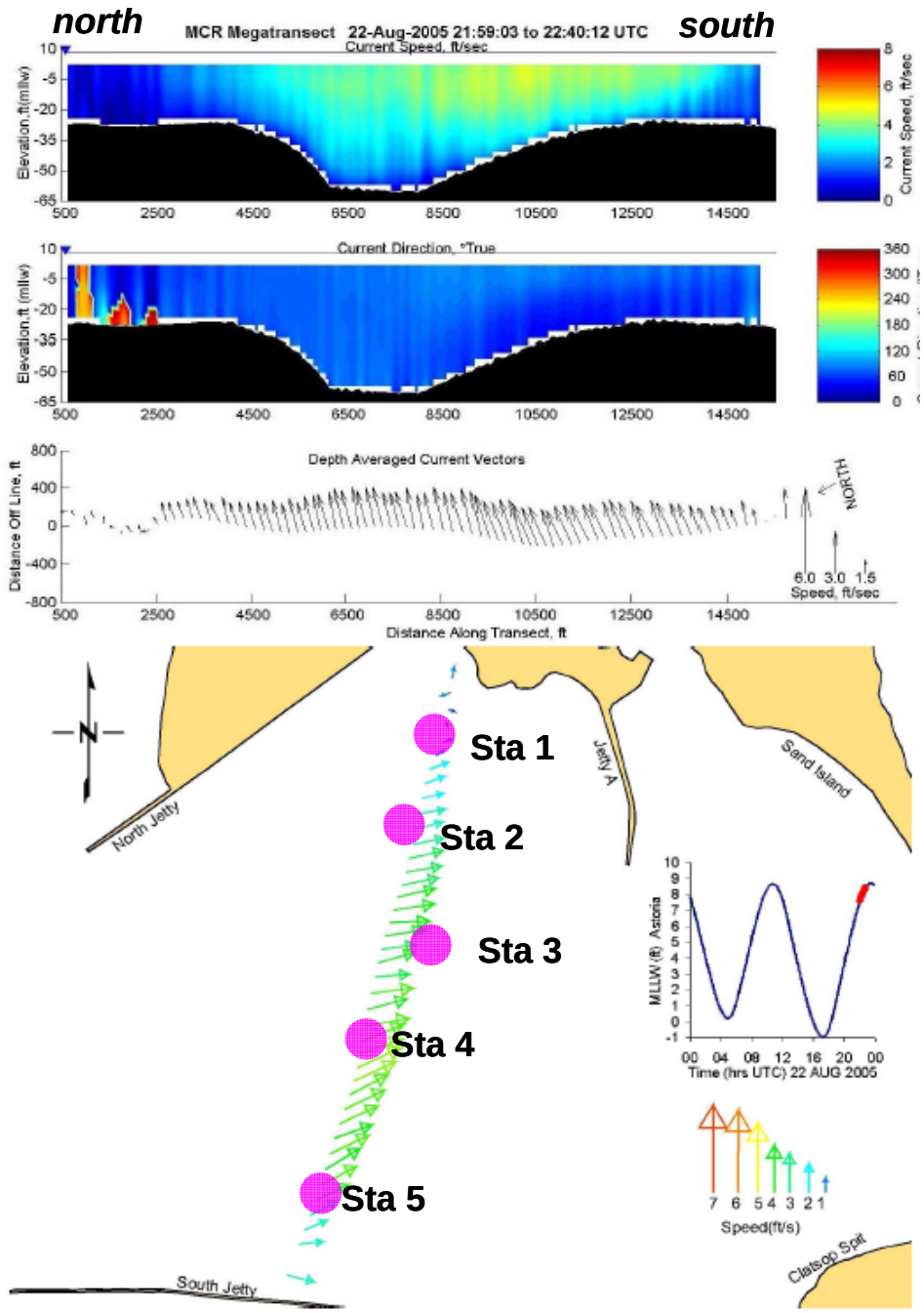
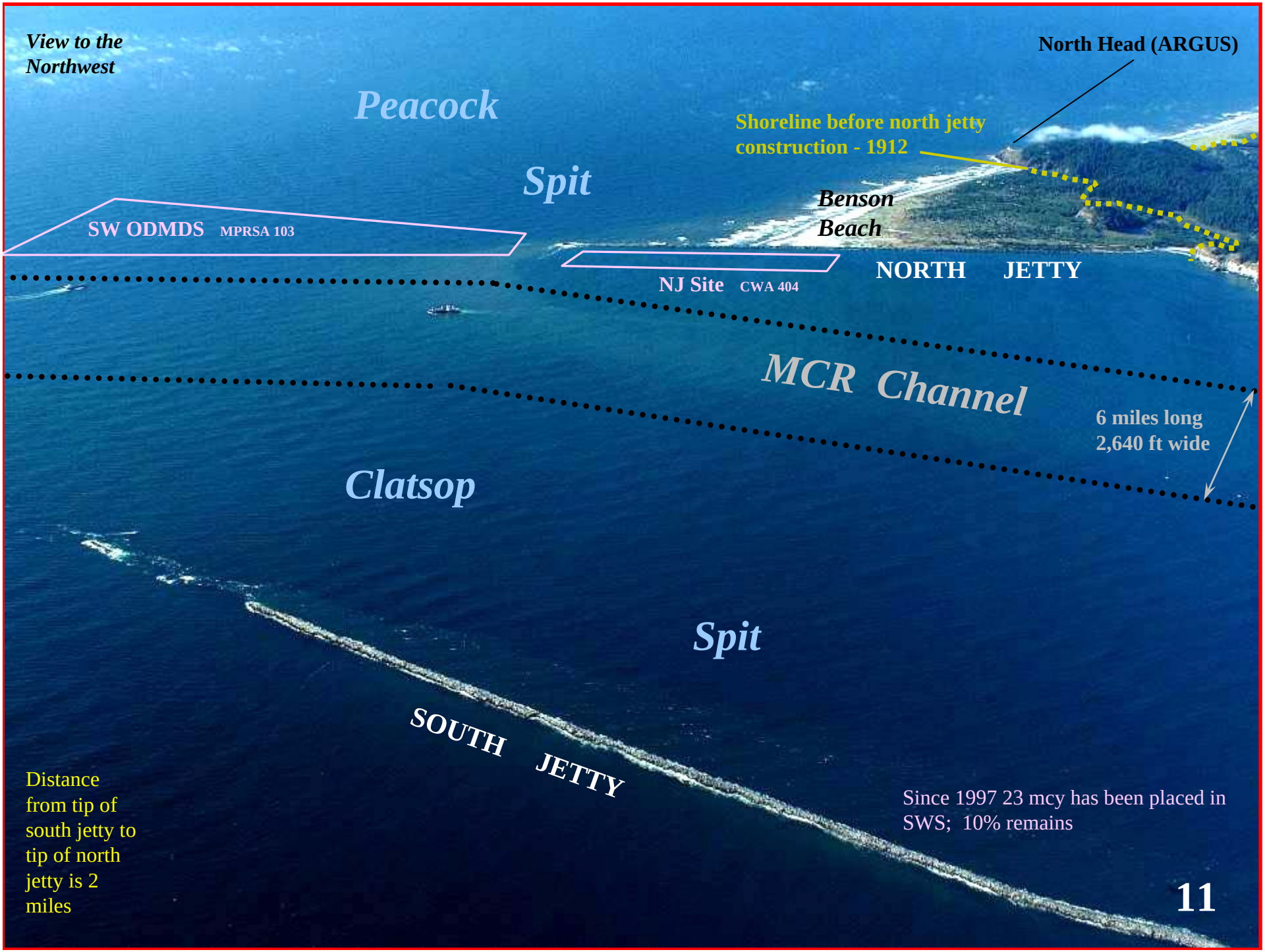
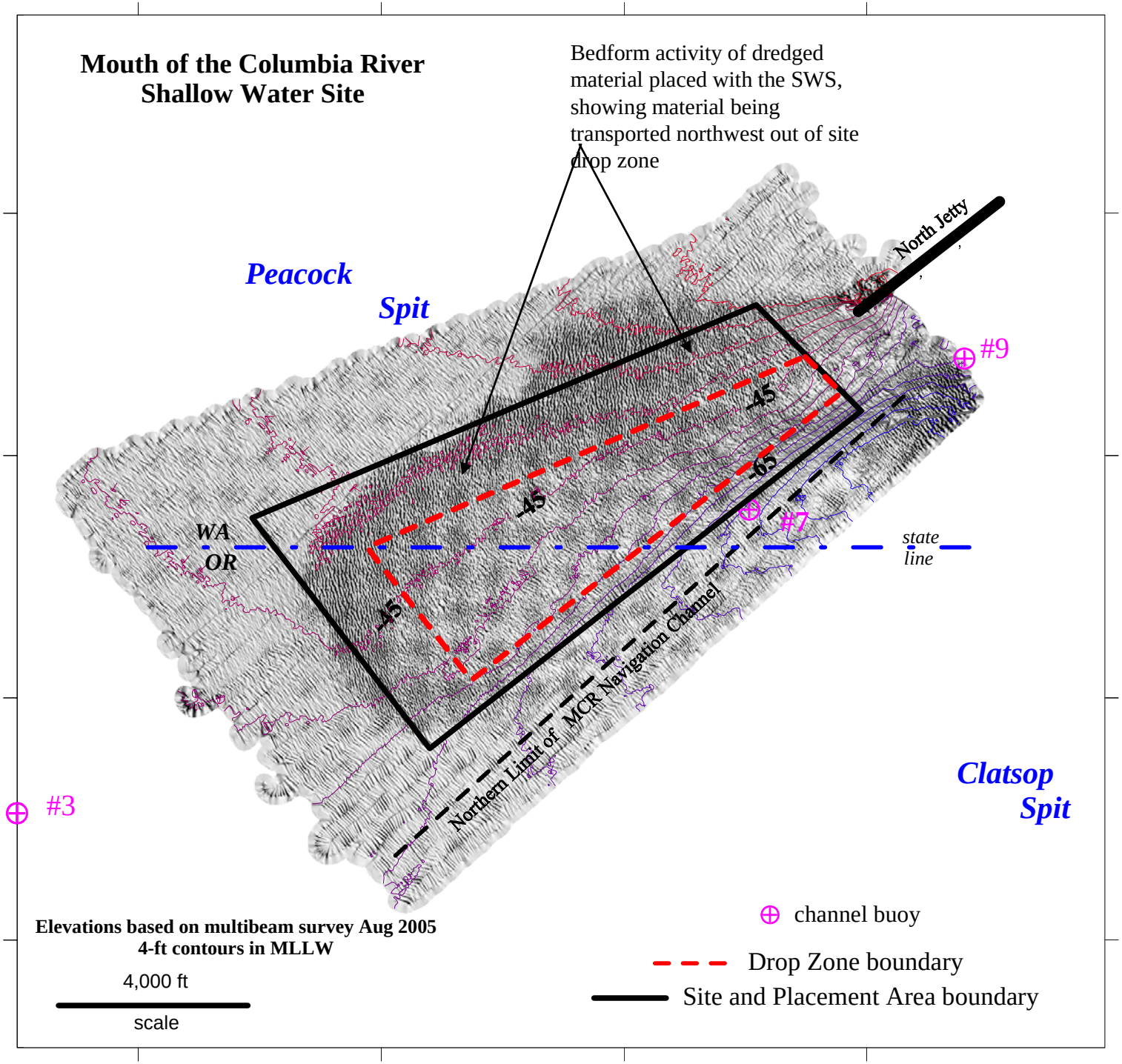
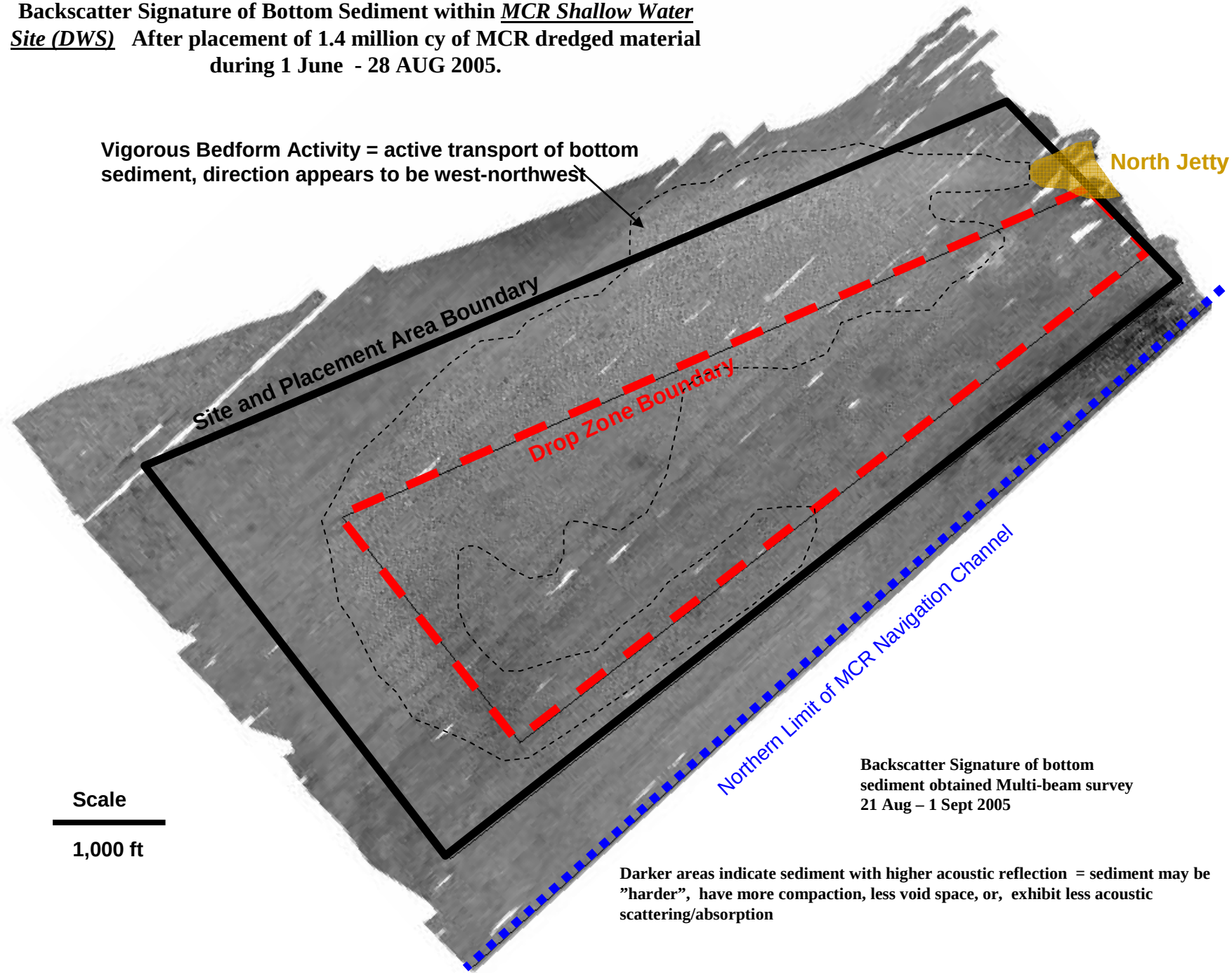


Figure 10. Late Flood - Cross section view (looking East) of current speed and direction and plan view of depth-averaged current velocity


View to the Northwest
North Head (ARGUS)
Peacock
Spit
Shoreline before north jetty construction - 1912
Benson Beach
SW ODMDS MPRSA 103
NJ Site CWA 404
NORTH JETTY
MCR Channel
6 miles long
2,640 ft wide
Clatsop
Spit
SOUTH JETTY
Distance from tip of south jetty to tip of north jetty is 2 miles
Since 1997 23 mcy has been placed in SWS; 10% remains

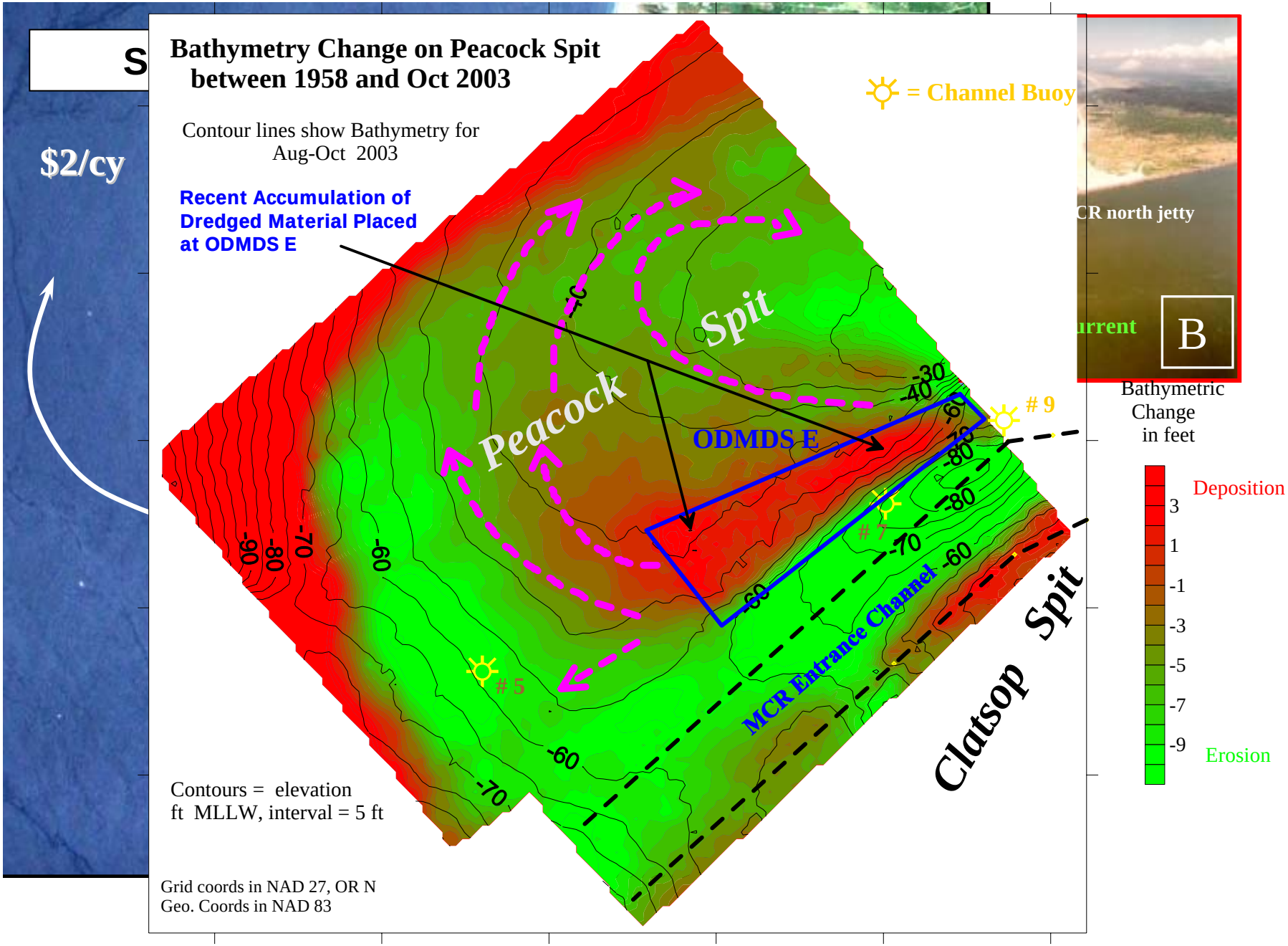

Mouth of the Columbia River
Shallow Water Site
Bedform activity of dredged material placed with the SWS, showing material being transported northwest out of site drop zone
Peacock Spit
North Jetty
#9
-45
-65
-45
-45
#7
WA
OR
state line
Northern Limit of MCR Navigation Channel
Clatsop Spit
#3
Elevations based on multibeam survey Aug 2005
4-ft contours in MLLW
4,000 ft
scale
channel buoy
Drop Zone boundary
Site and Placement Area boundary

Backscatter Signature of Bottom Sediment within *MCR Shallow Water Site (DWS)* After placement of 1.4 million cy of MCR dredged material during 1 June - 28 AUG 2005.



Backscatter Signature of bottom sediment obtained Multi-beam survey 21 Aug – 1 Sept 2005

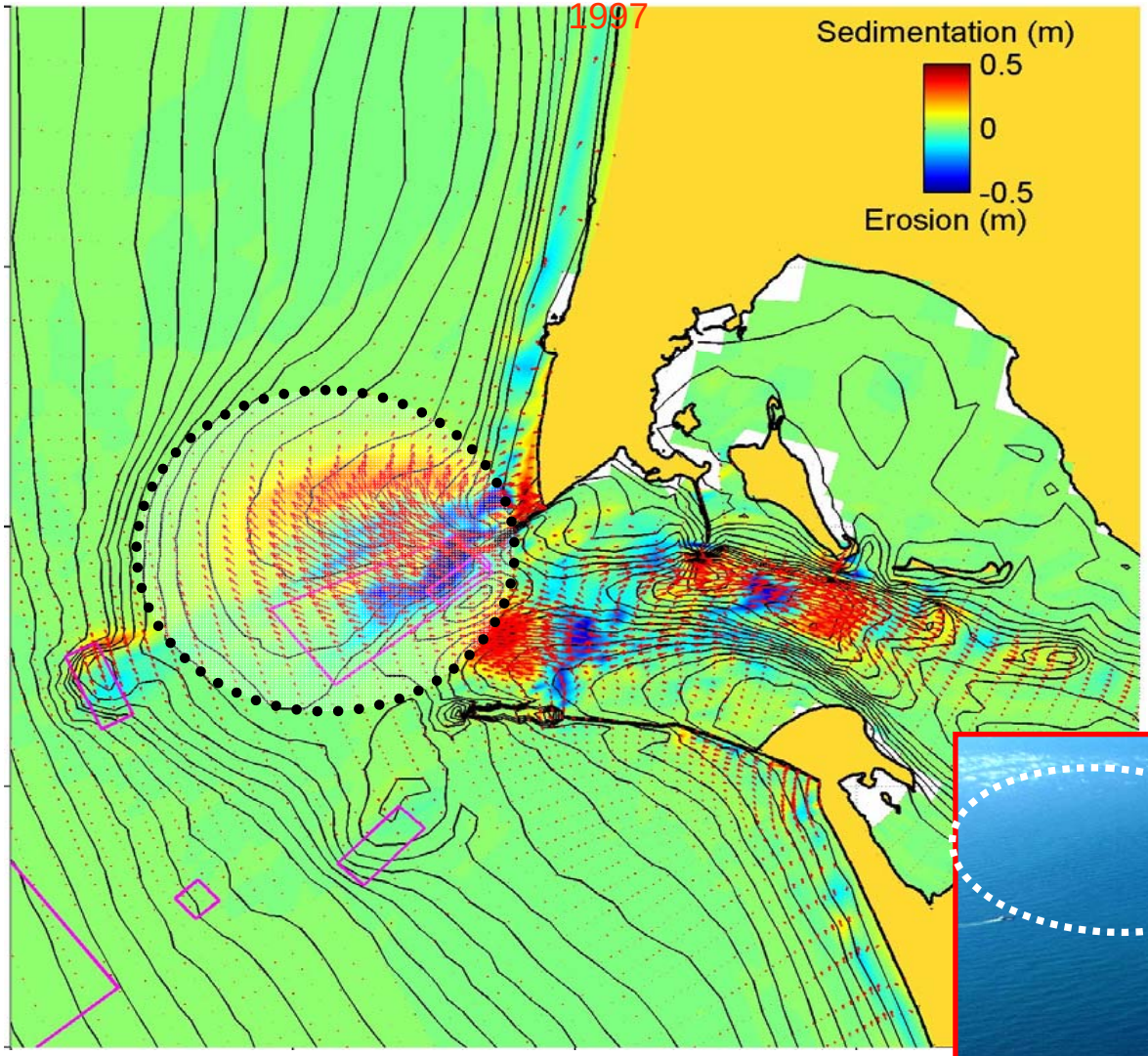
Darker areas indicate sediment with higher acoustic reflection = sediment may be "harder", have more compaction, less void space, or, exhibit less acoustic scattering/absorption



1973-1997: 50 M cy of dredged sand placed in SWS)

1997-2005: 23 M cy has been placed within SWS

Net Sand Transport and Morphological Change during October 1997



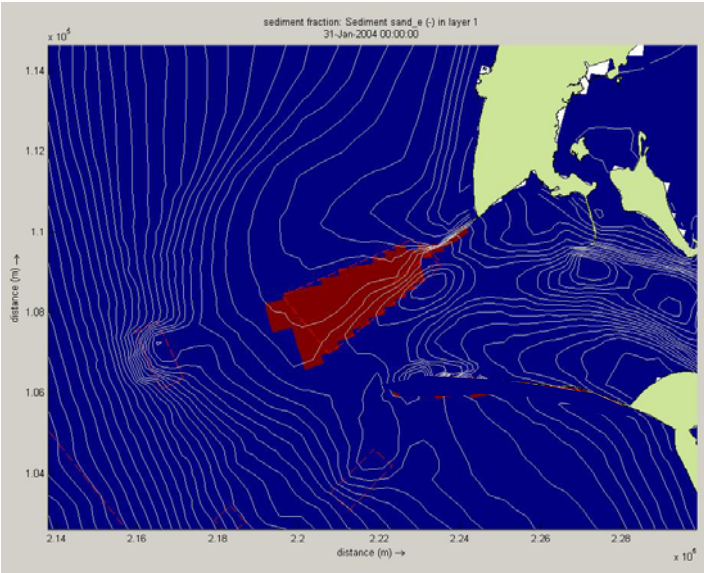
SWS Application

- Sand transport at MCR is spatially and temporarily complex.
- A complex model is required to analyze and evaluate sand management alternatives

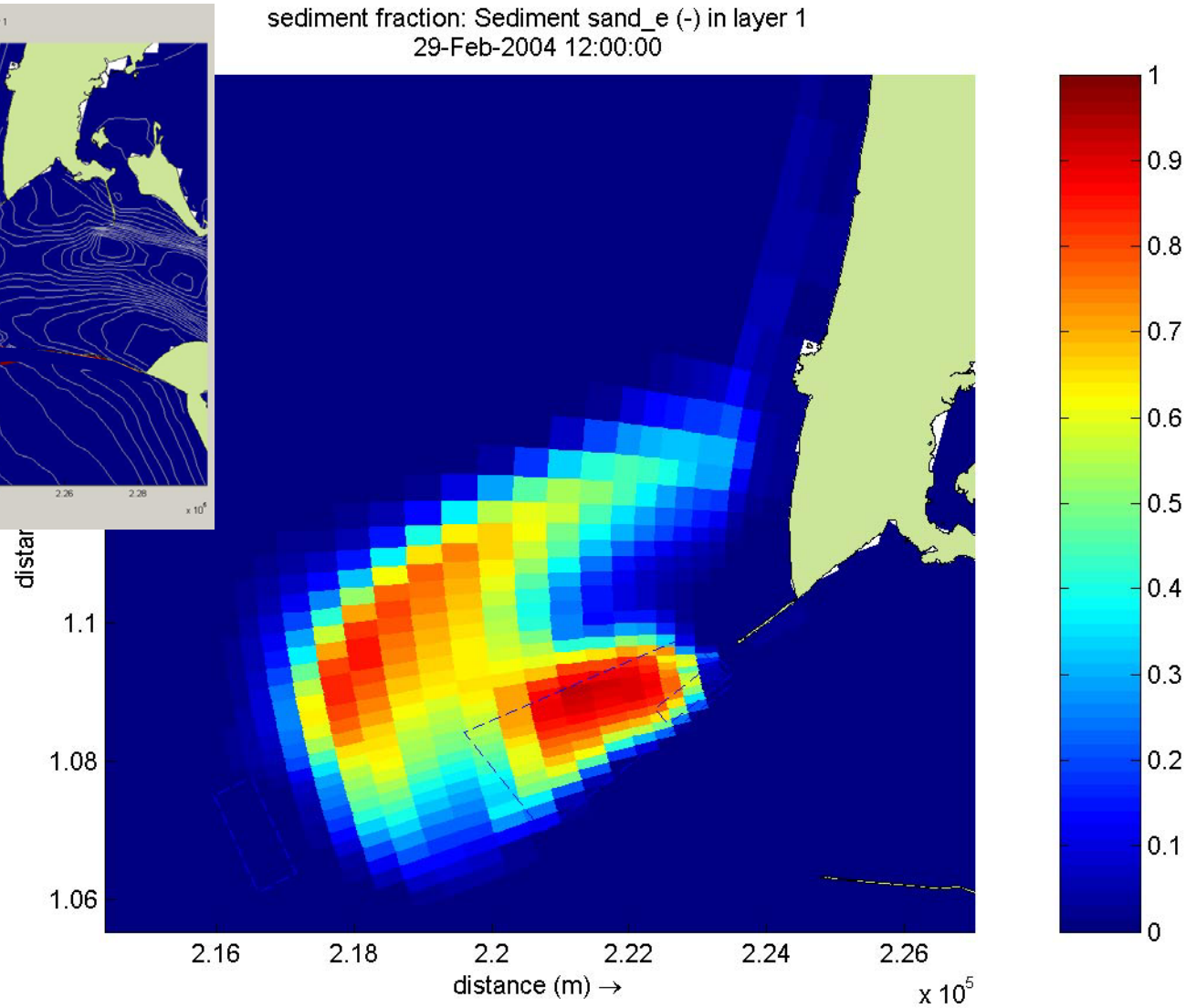
DELFT 3-D Model USGS

Recent results

DELFT 3-D Model USGS

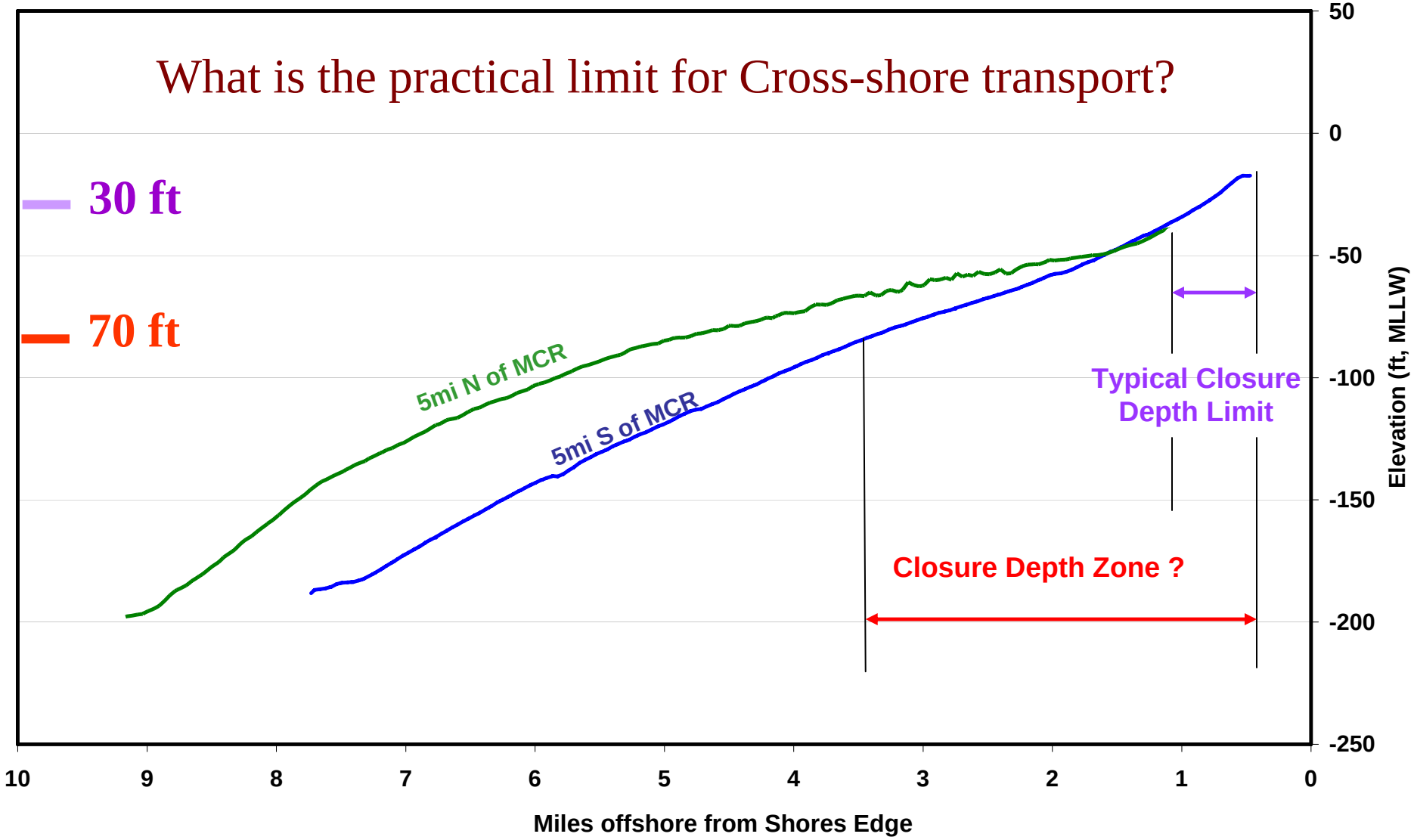


Initial distribution of “SWS” sand (and fixed layers)



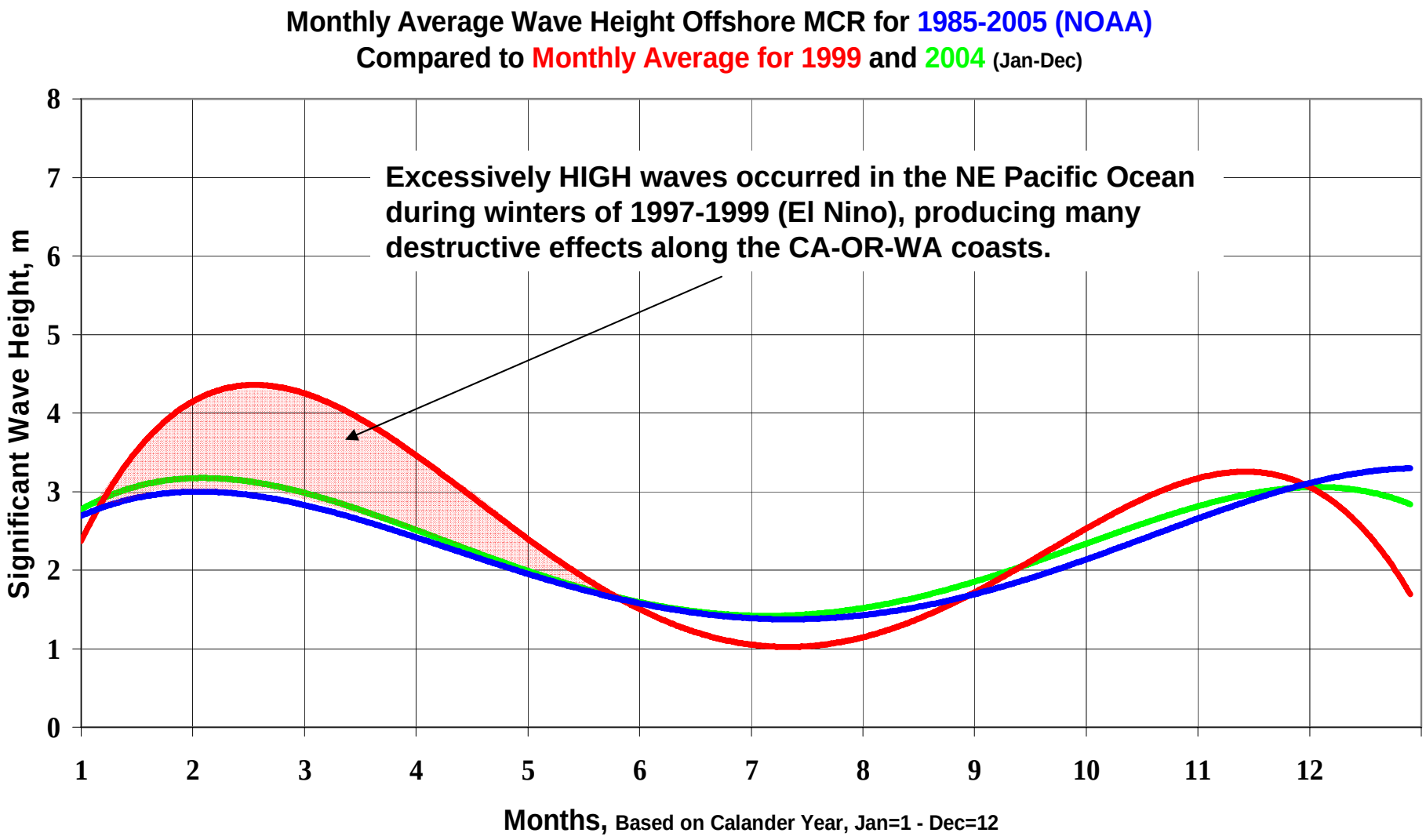
"Final" distribution of site E disposal sand in the top 5cm of bed at the end of February 2004

Cross-Shore Profile: **5 Miles North & South of MCR**



The intra-annual changes in the coastal wave environment can have a pronounced effect on coastal erosion and jetty deterioration.

Prudent Life-Cycle Management of Coastal Infrastructure Requires Knowing "What" to Expect and "How" to Respond



Unit Cost of MCR Dredging/Disposal: *Contract Dredge Cost for Placement at ODMDS E vs. Incremental Cost for Placement at Benson Beach or Deepwater ODMDS*

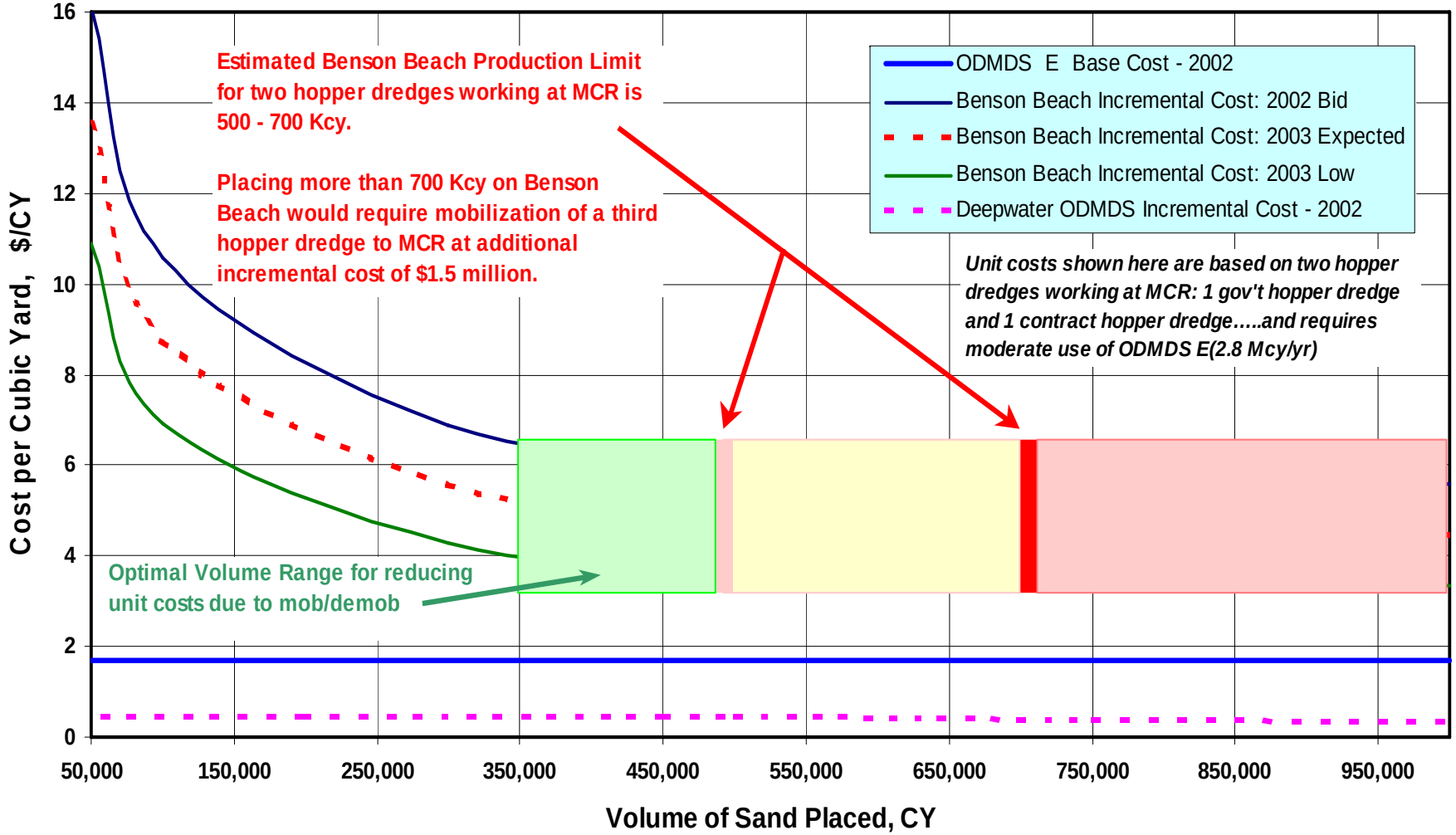
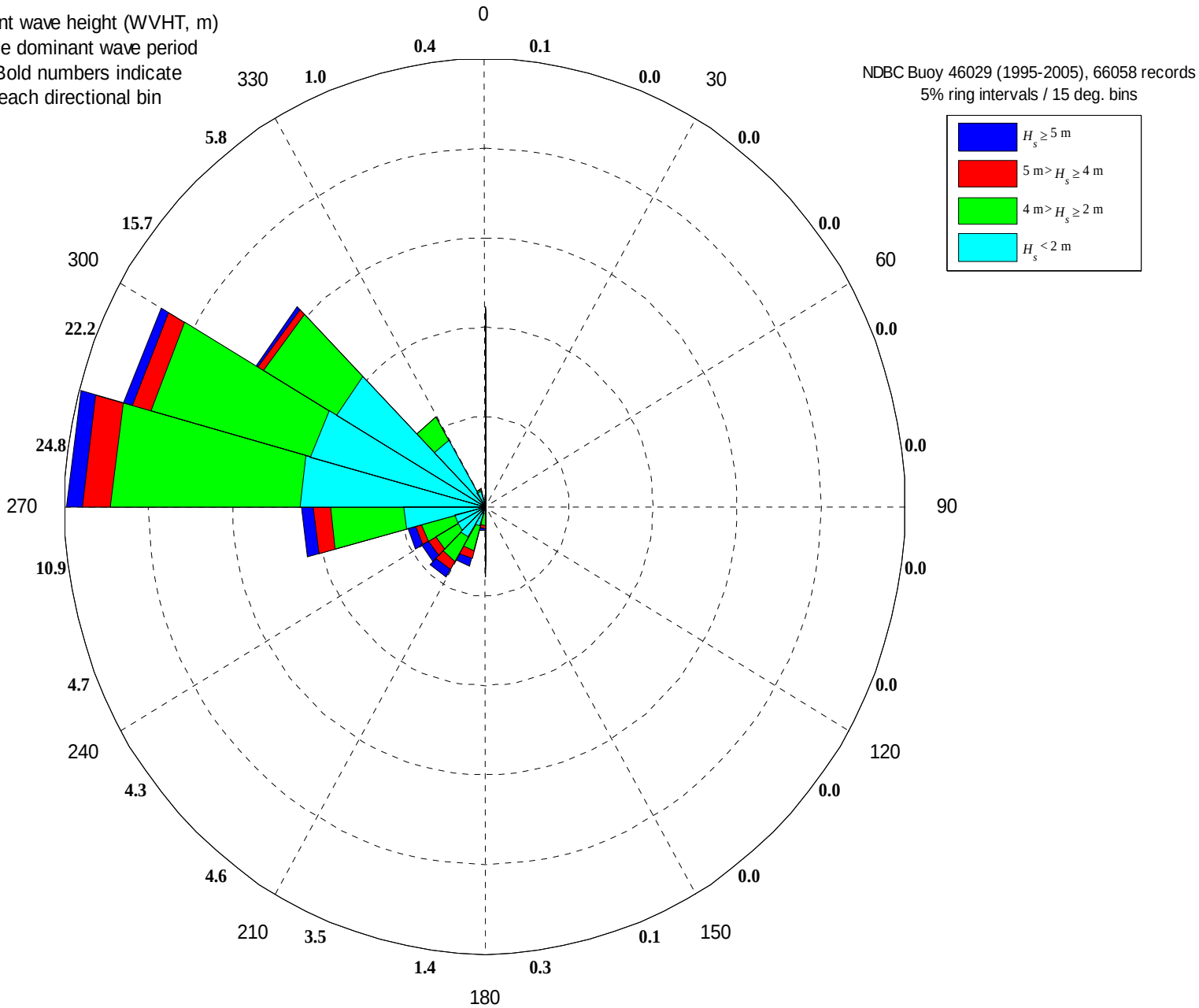
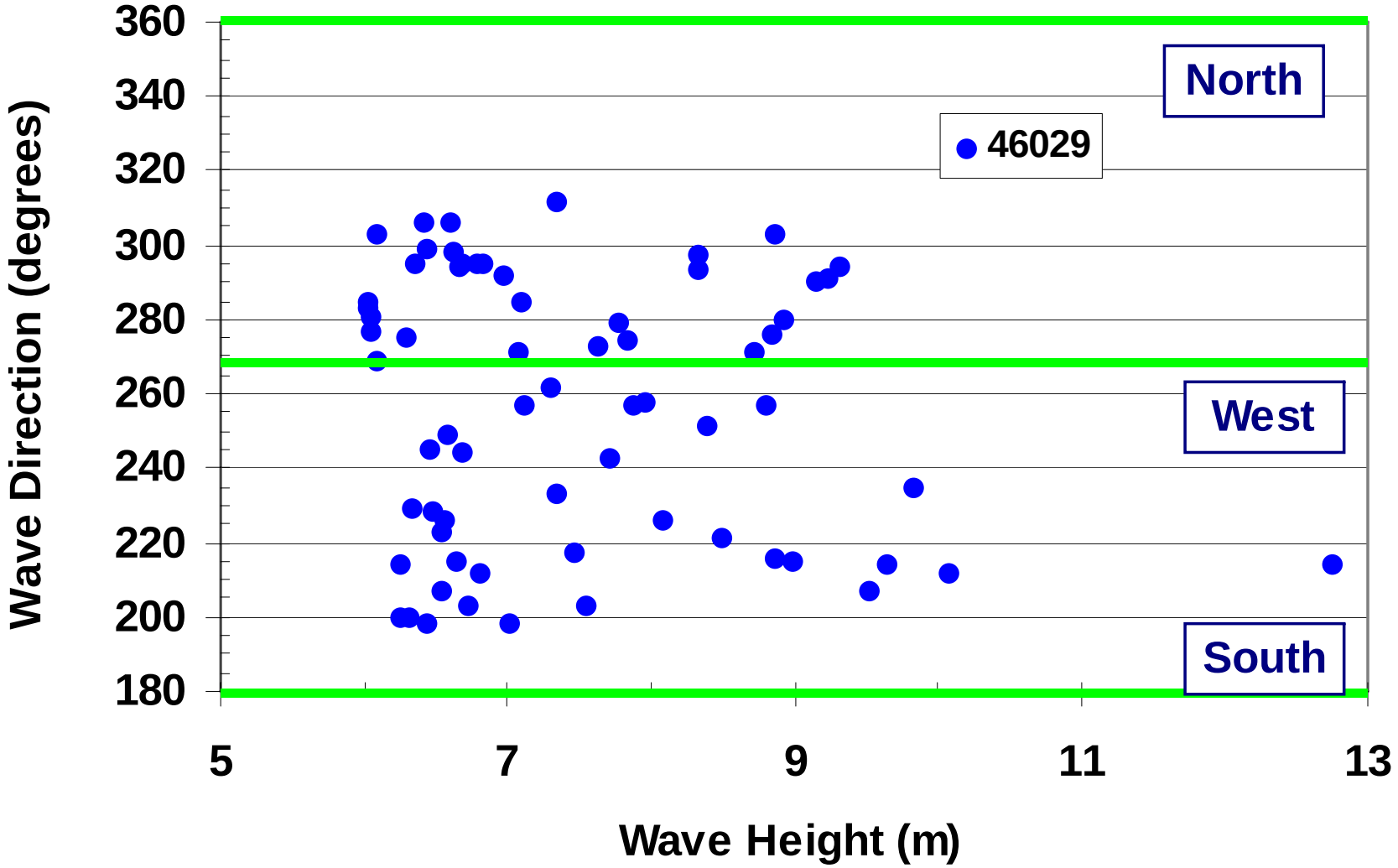


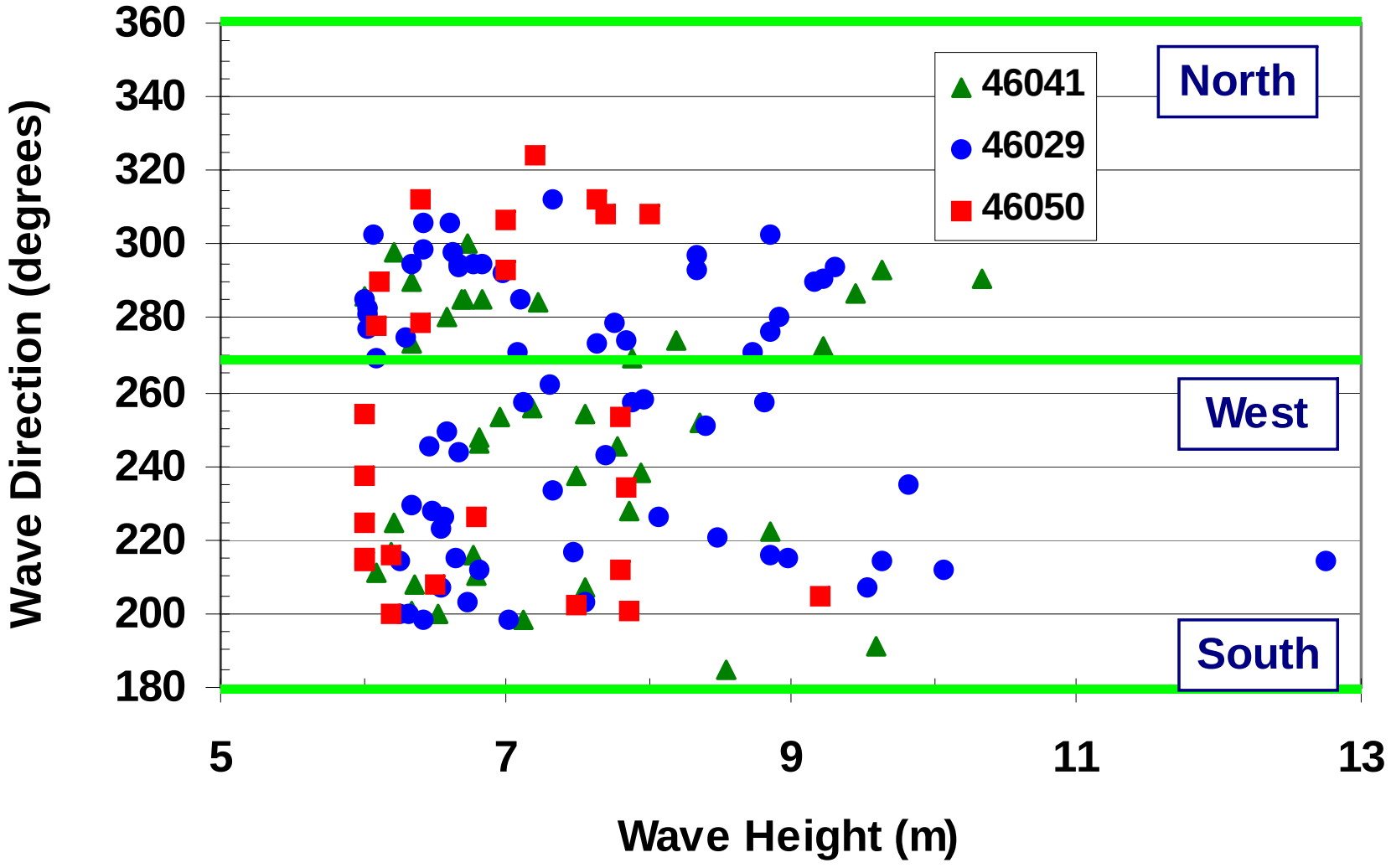
Fig. 1: Wave rose of significant wave height (WVHT, m) and mean wave direction of the dominant wave period (MWD, deg from true north); Bold numbers indicate cummalative percentages for each directional bin



Extremal Event Wave Direction

Columbia River (H > 6 m)



Extremal Event Wave Direction

All Buoys (H > 6 m)