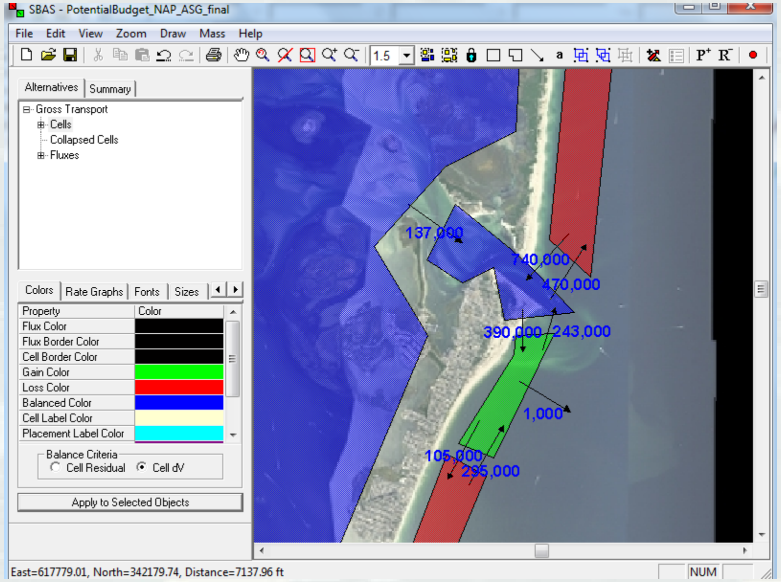
RSM Process

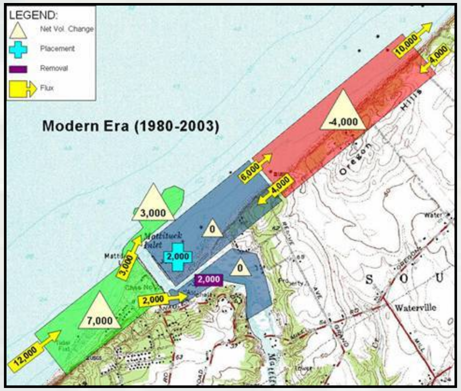
Communication, Collaboration, Innovation, Decision Making
Interagency, Stakeholders, Partners, Resource Agencies

Overview

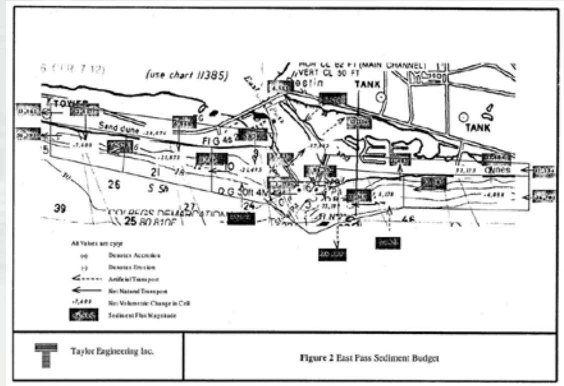
- Applications of sediment budgets
- Terminology
- Steps in formulating a sediment budget
- Simple example: Hillsboro Inlet, FL
- Brief intro to SBAS



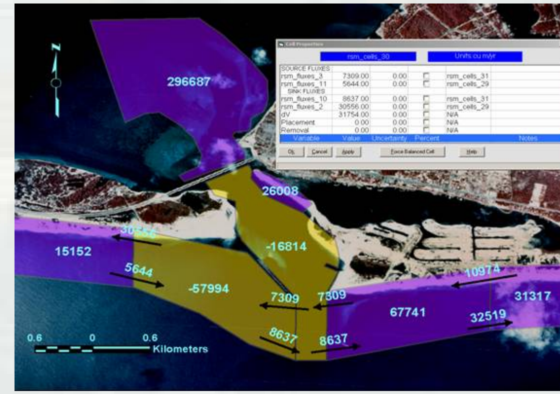
Why and When do we need Sediment Budgets?



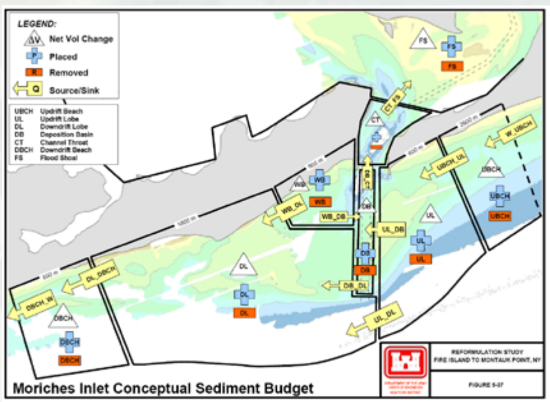
Mattituck Inlet, NY



East Pass, FL
(Taylor Engineering)
from Inlet Management Plan

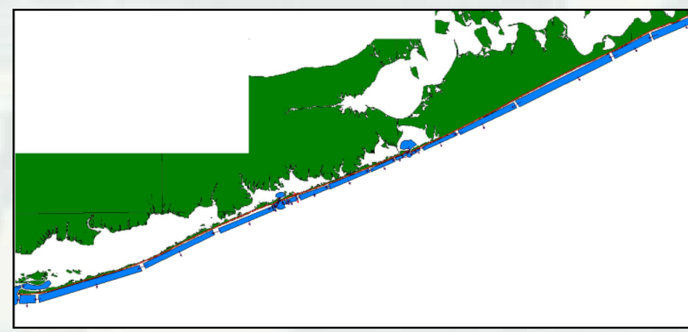


East Pass, FL (USAED Mobile)



Moriches Inlet, NY
(Moffatt & Nichol)

Sabine Pass to Matagorda
Ship Channel, TX



Fire Island Inlet to Montauk Point, NY

Sediment Budgets…

- Define regional and local patterns and magnitudes of sediment transport
  - For different time periods (e.g., “historic” and “present-day”)
  - For different projects (e.g., beach nourishment versus groin field)
  - For different conditions (e.g., “typical” and “storm”)
- Provide ground-truthing for more detailed modeling
- Tool for communication with clients, sponsors, and partners
- May be applied to determine design criteria and mitigation
  - e.g., sand bypassing quantity, adjacent beach nourishment

Definitions of Sediment Budget Types

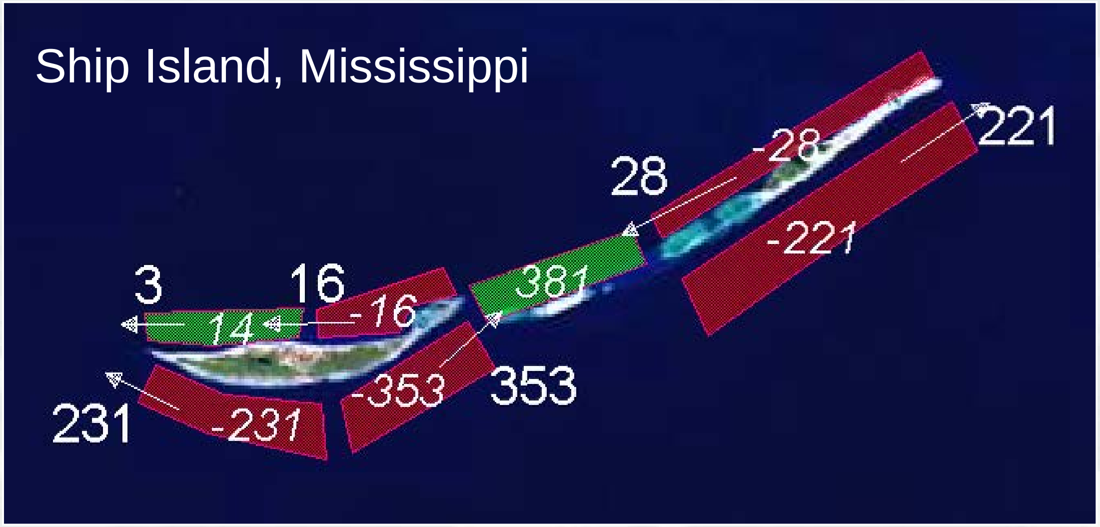
Conceptual

- Developed relatively quickly (~days to weeks)
- Reconnaissance level
- Based on literature review, existing knowledge, observable morphologic change, available databases
- Could be as simple as cells and direction of transport rates
- Used to develop a framework for more detailed budgets and identify gaps in knowledge
- Estimate confidence level

Definitions of Sediment Budget Types

Interim

- "Working budget" based on initial analyses
- Data analyzed may include historical data, dredging records, shoreline change, numerical model calculations
- Interim budget has time period and event = epoch
- May be revised several times in developing operational budget
- Feasibility-level
- Time ~ months



Definitions of Sediment Budget Types

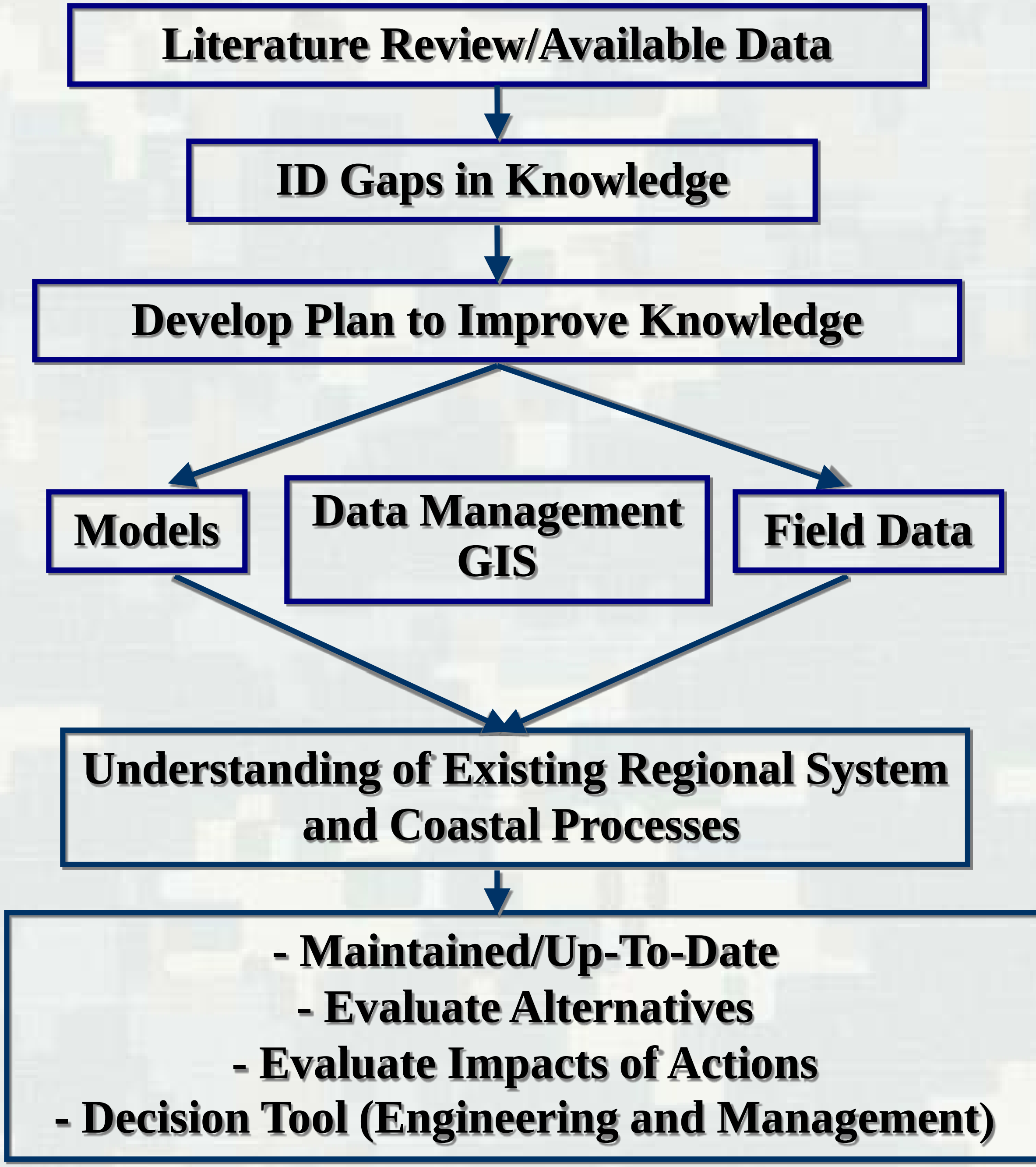
Operational

- A final budget that is used in regional planning and initial design of site-specific projects
- May be a series of budgets representing typical and storm years
- Represents regional as well as project sources and sinks
- Developed with most available data sets, with some redundancy to develop confidence in estimates
- Can be updated with new knowledge and engineering activities
- Typically associated with programmatic efforts used in adaptive management, *e.g., Inlet Management Plans*
- Time ~ months to years

Conceptual

Interim

Operational



Terminology:
Sediment Budget Equation

$$\boxed{\Sigma\, Q_{source} - \Sigma\, Q_{sink} - \Delta V + P - R = \text{Residual}}$$

Q_{source} , Q_{sink} = input or export to cell

ΔV = Volume change within cell

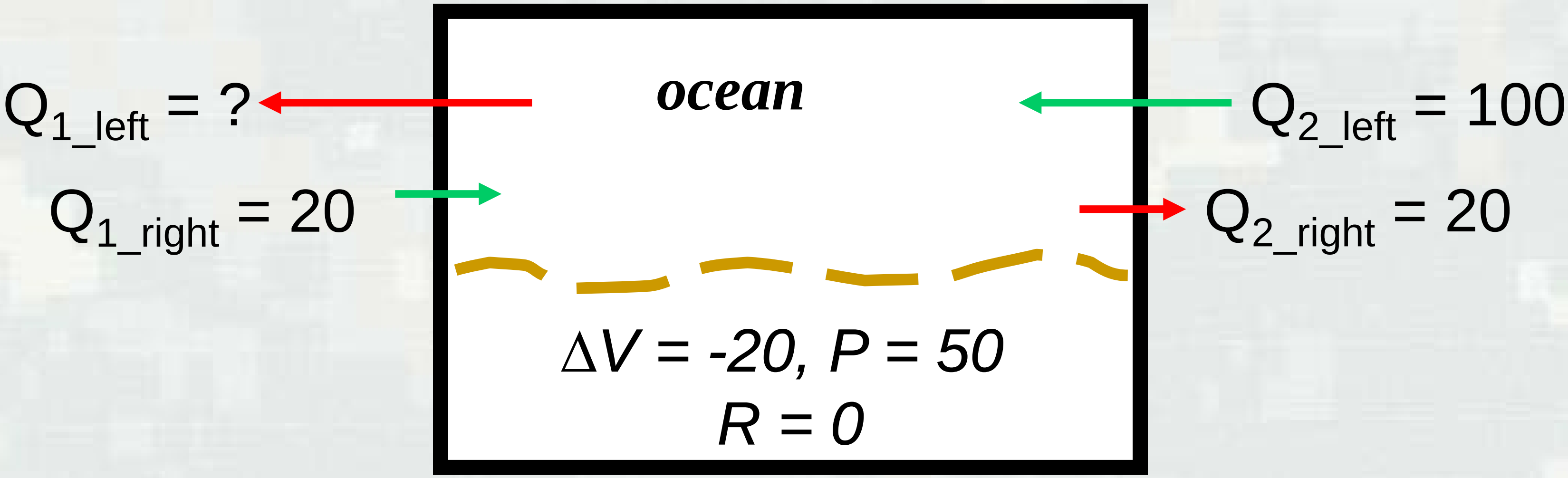
P = Placement into cell

R = Removal from cell

Residual = cell surplus or deficit

(= 0 for balanced cell)

Illustration of Concept

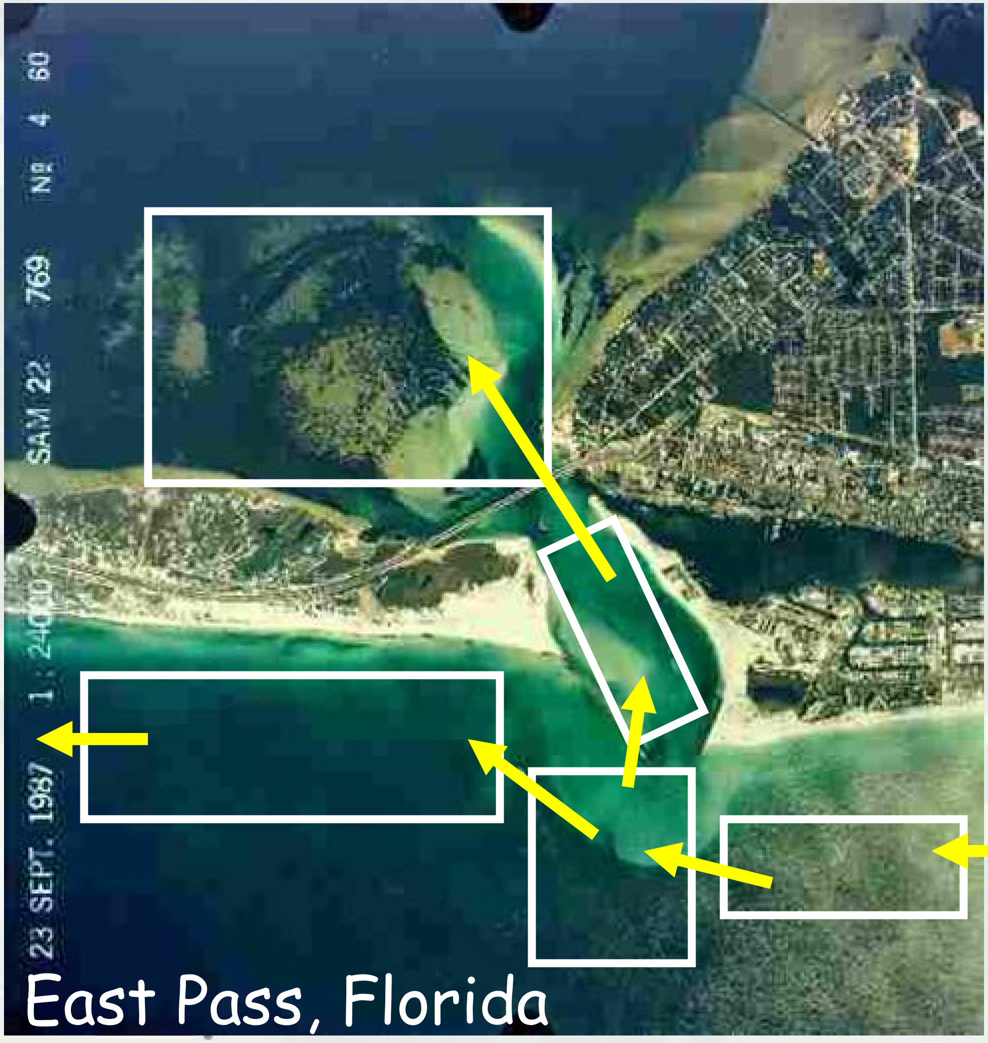


$$\Sigma Q_{source} \quad -\Sigma Q_{sink} \quad - \Delta V \quad + P \quad -R \quad = 0$$

$$100+20 \quad -(20+Q_{1\_left}) \quad - (-20) \quad + 50 \quad - 0 \quad = 0$$

$$\boxed{Q_{1\_left} = 170}$$

Creating a Sediment Budget



1. Develop a conceptual budget
2. Analyze data
3. Develop an interim (working) budget
4. Refine based on uncertainty and sensitivity testing
5. Develop operational (final) budget(s)

Hillsboro Inlet, Florida
Location & Setting

Hillsboro Inlet, Florida
1. Conceptual Sediment Budget

Hillsboro Inlet, Florida
Information from Jacksonville District

120,000 cy/yr is the net longshore sand transport rate updrift of the inlet

54,000 cy/yr is transported over the north jetty weir section into the sediment basin

60,000 cy/yr is deposited into the entrance channel

30,000 cy/yr moves into the inlet from the south

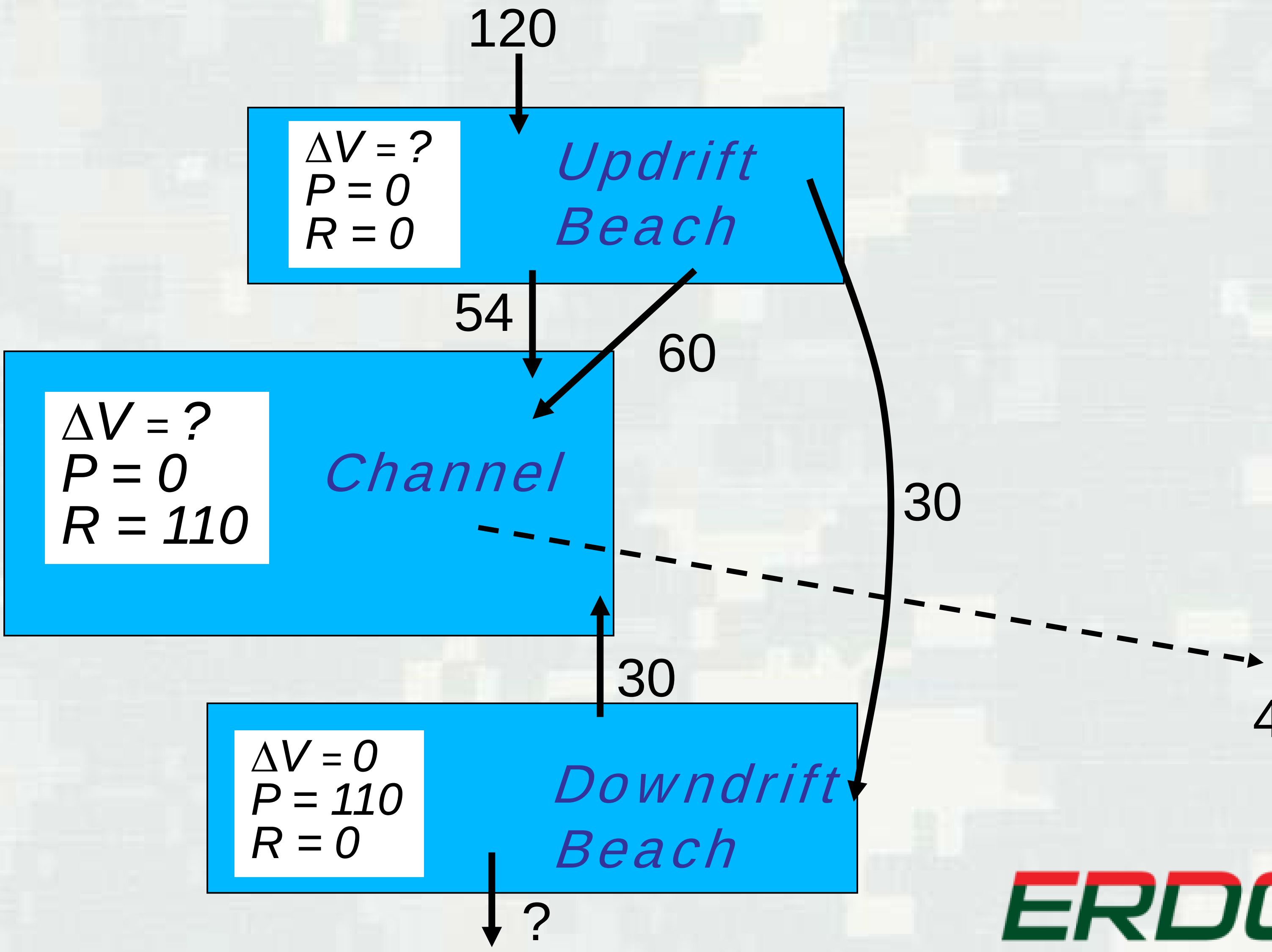
30,000 cy/yr bypasses the inlet naturally (north to south)

4,000 cy/yr lost to deep water on ebb flow

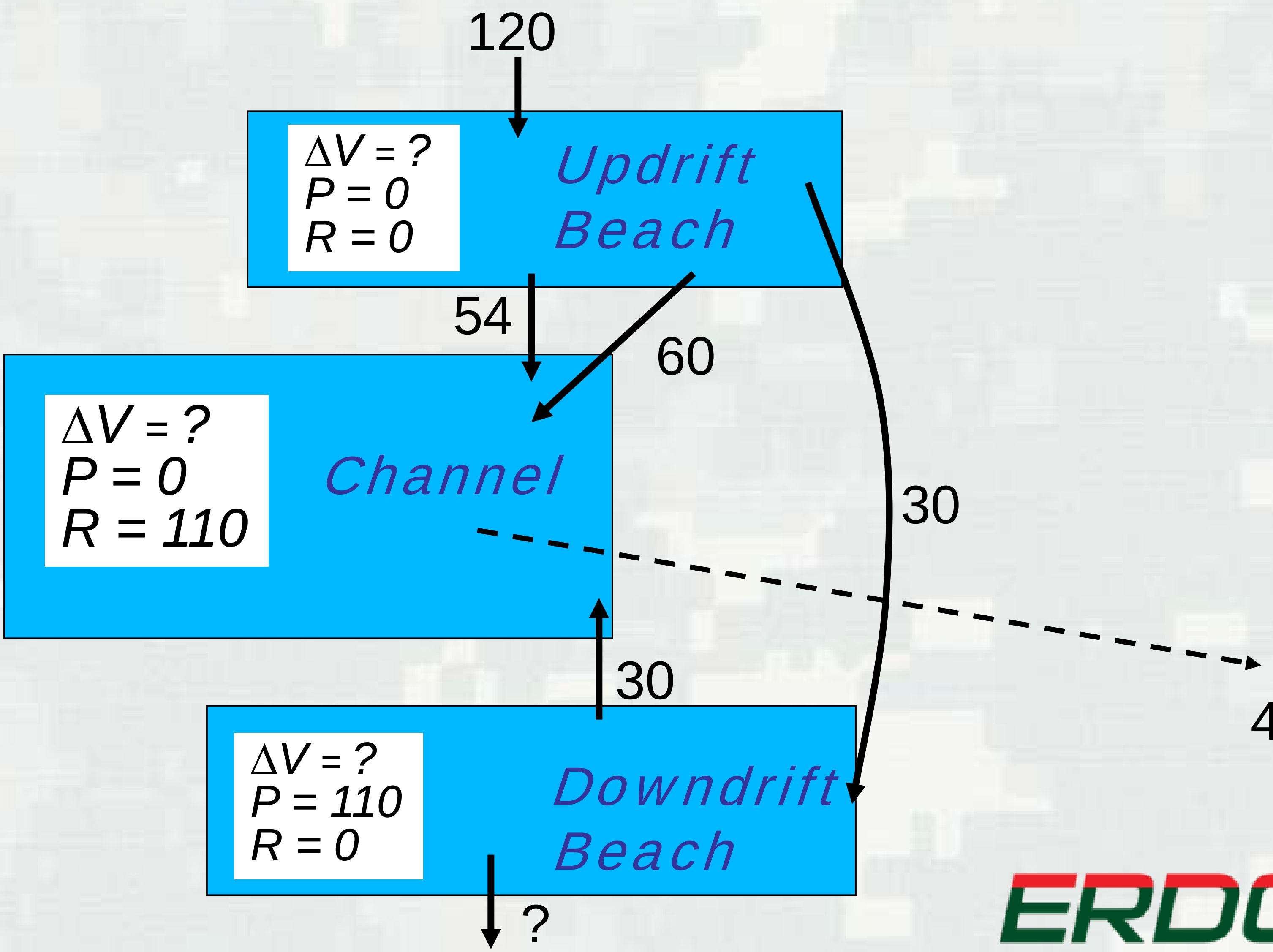
110,000 cy/yr is dredged from the channel and bypassed to the downdrift beach

Hillsboro Inlet, Florida
Sediment Budget

Hillsboro Inlet Sediment Budget

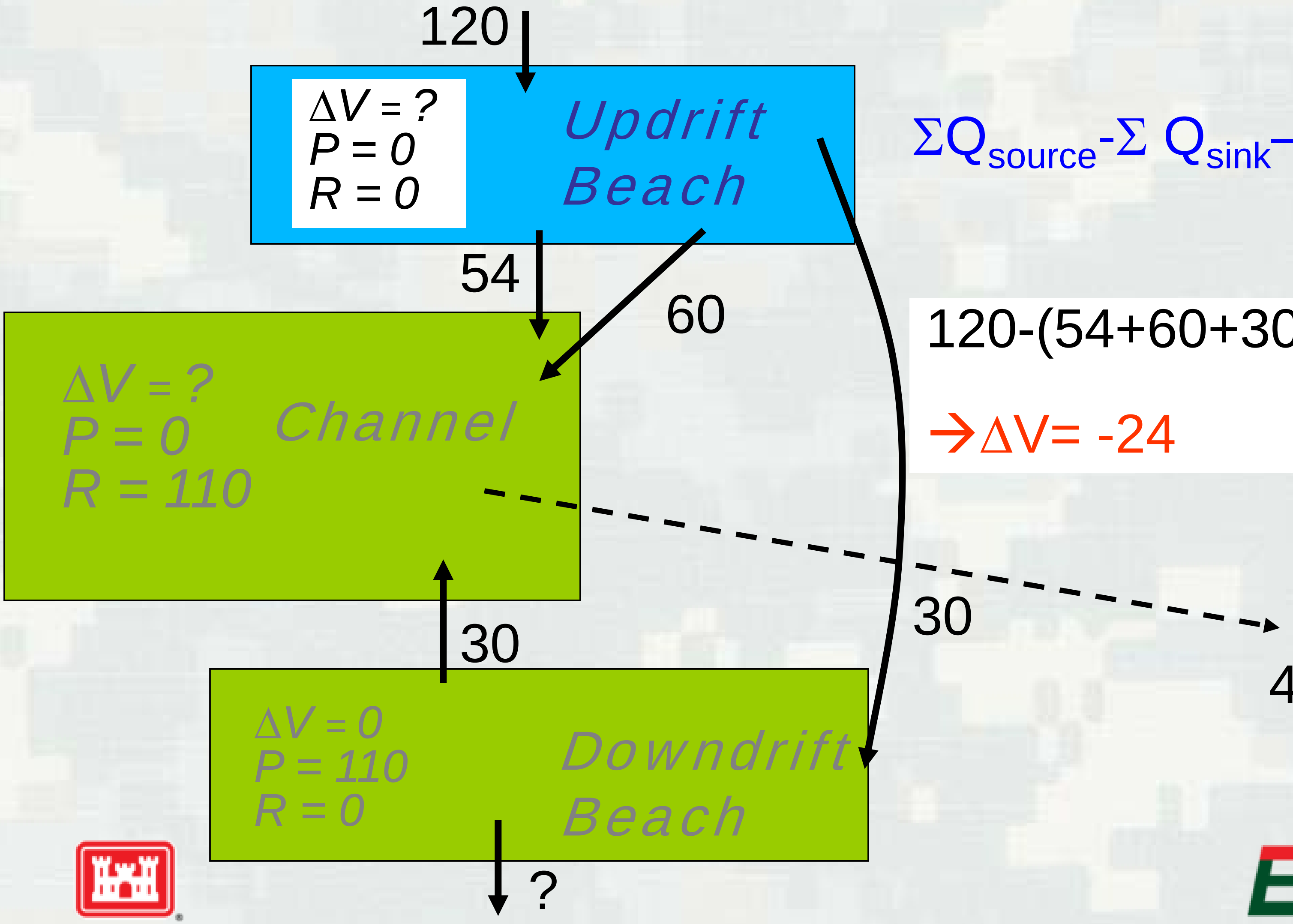


Hillsboro Inlet Sediment Budget



Hillsboro Inlet Sediment Budget:

Updrift Cell



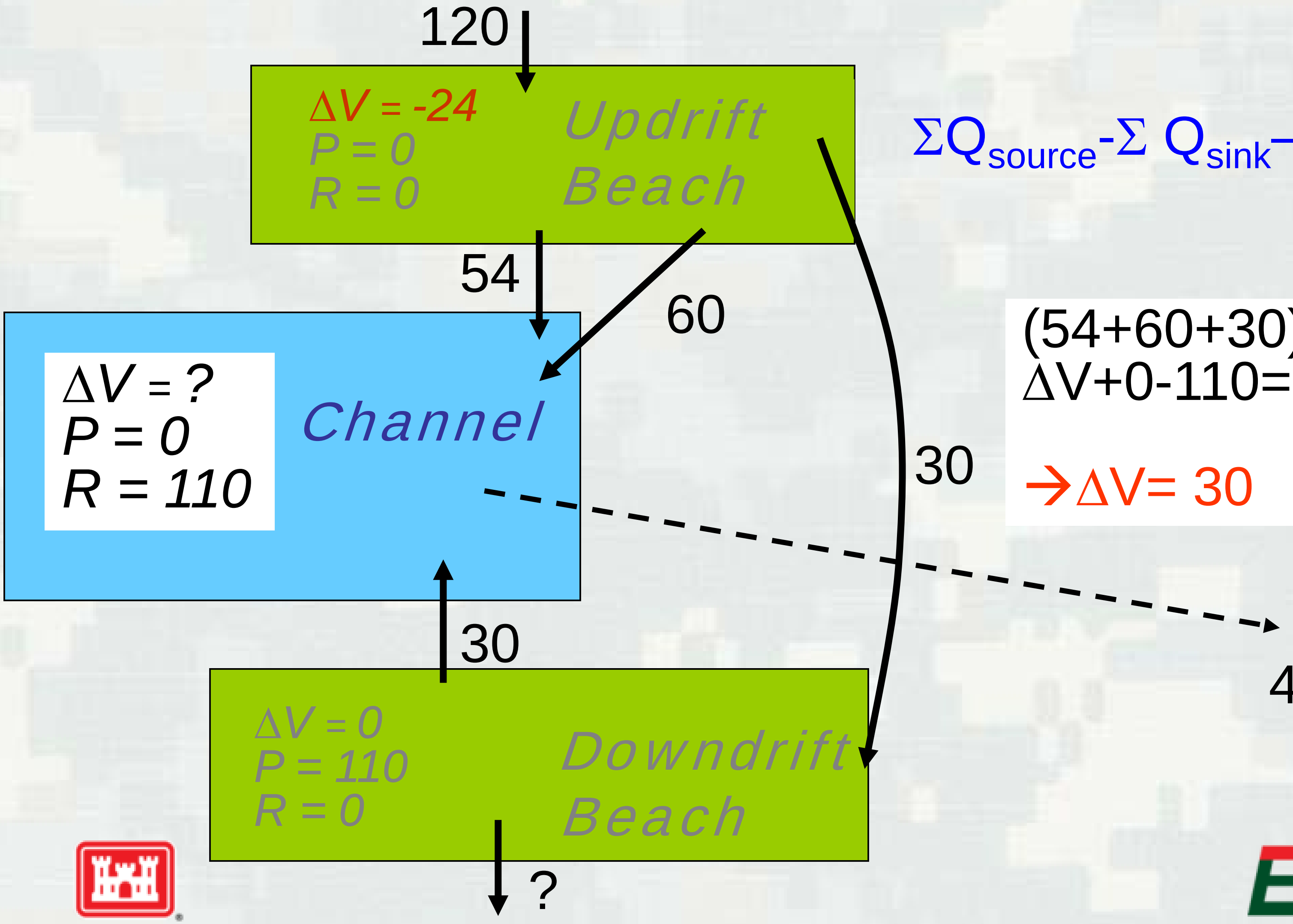
$\Sigma Q_{source} - \Sigma Q_{sink} - \Delta V + P - R = 0$

$120-(54+60+30)-\Delta V+0-0=0$

$\rightarrow \Delta V = -24$

Hillsboro Inlet Sediment Budget:

Channel Cell



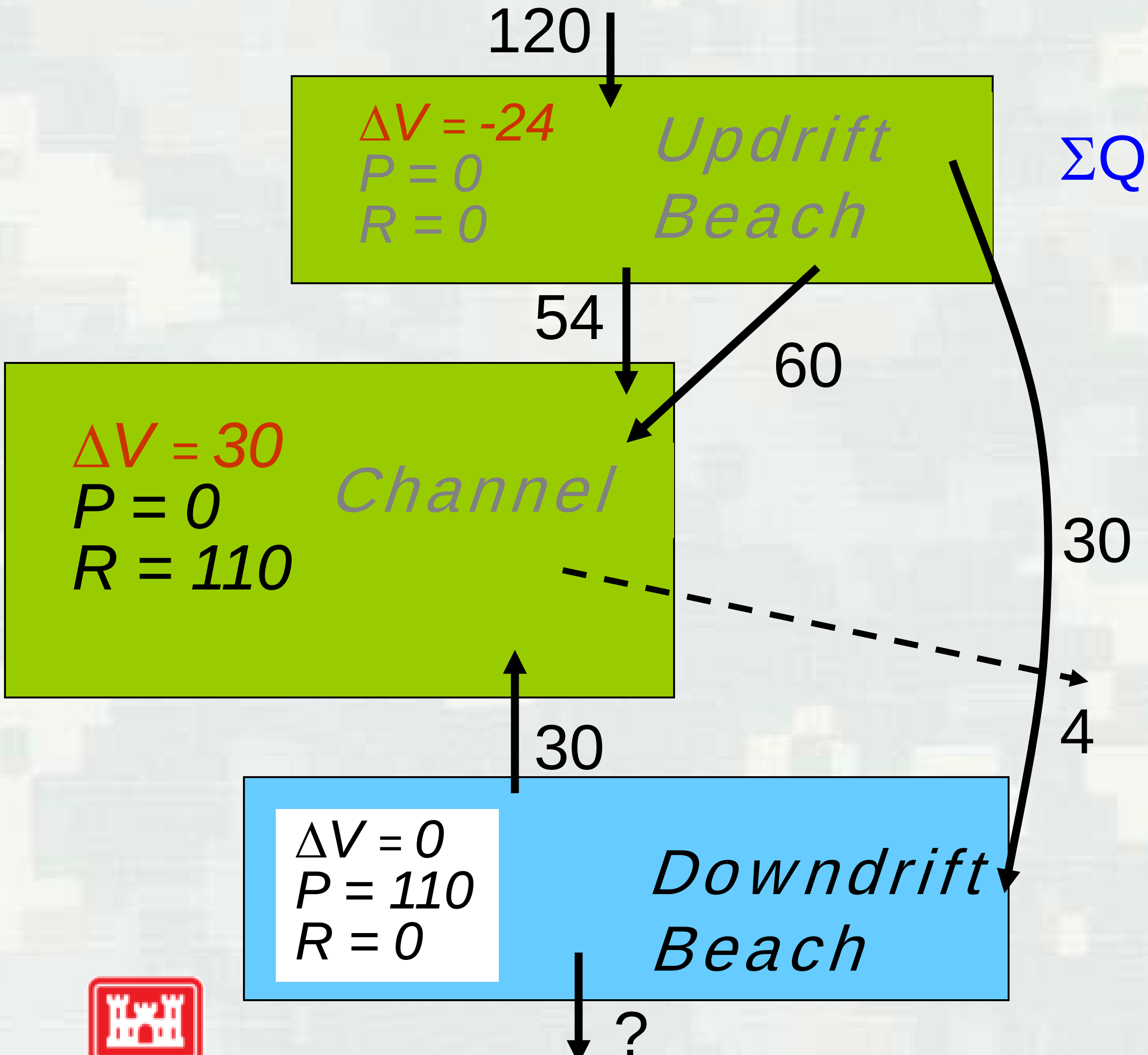
$\Sigma Q_{source} - \Sigma Q_{sink} - \Delta V + P - R = 0$

$(54+60+30)-(4)-\Delta V+0-110=0$

$\rightarrow \Delta V = 30$

Hillsboro Inlet Sediment Budget:

Downdrift Cell



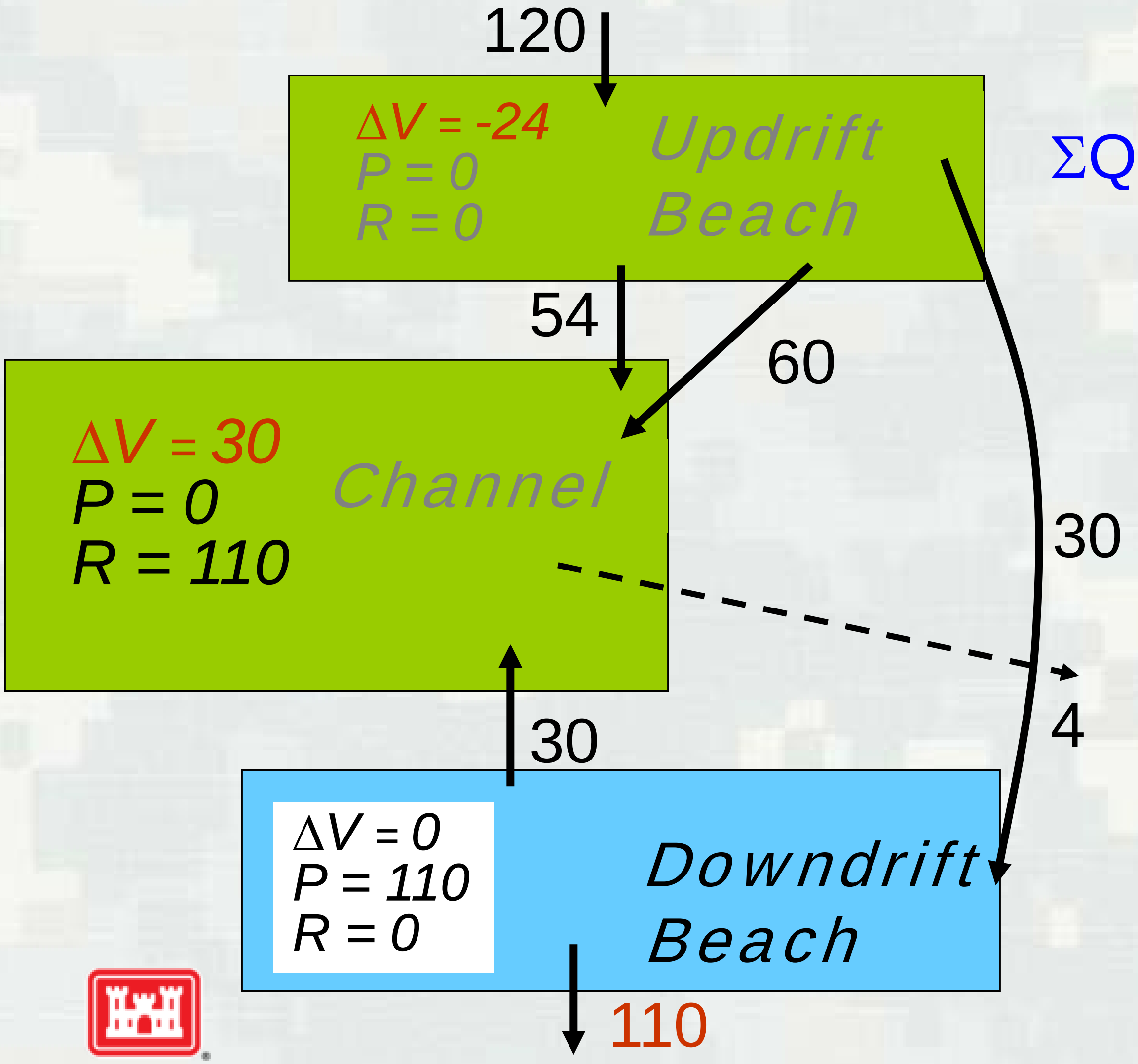
$\Sigma Q_{source} - \Sigma Q_{sink} - \Delta V + P - R = 0$

$(30) - (30 + Q_{out}) - 0 + 110 - 0 = 0$

$\rightarrow Q_{out} = 110$

Hillsboro Inlet Sediment Budget:

Downdrift Cell



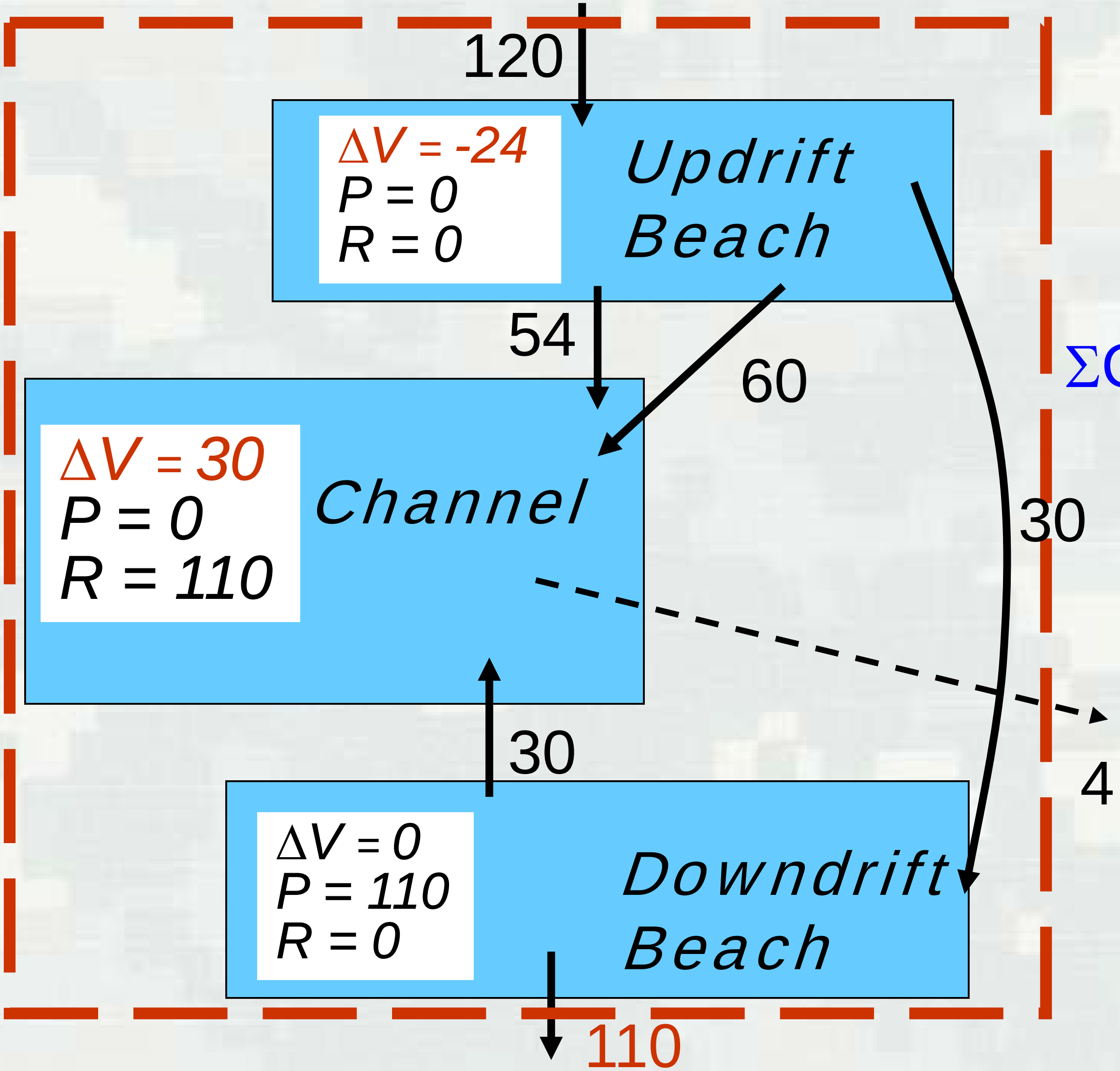
$\Sigma Q_{source} - \Sigma Q_{sink} - \Delta V + P - R = 0$

$(30)-(30+Q_{out})-0+110-0=0$

$\rightarrow Q_{out} = 110$

Hillsboro Inlet Sediment Budget:

Macrobudget



Macrobudget:
Budget of all cells

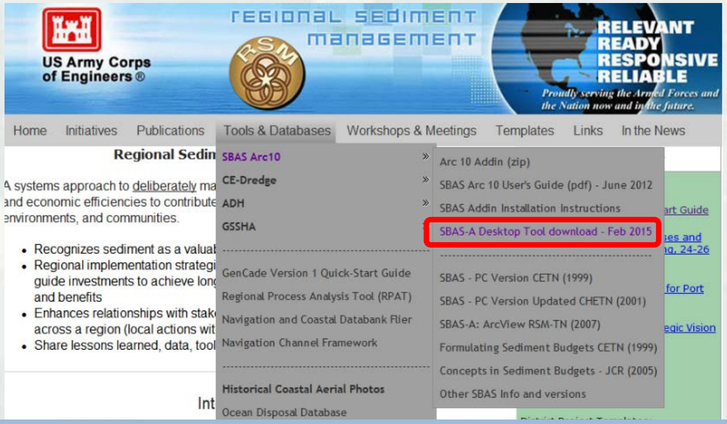
$\Sigma Q_{source} - \Sigma\ Q_{sink} - \Delta V + P - R = 0$

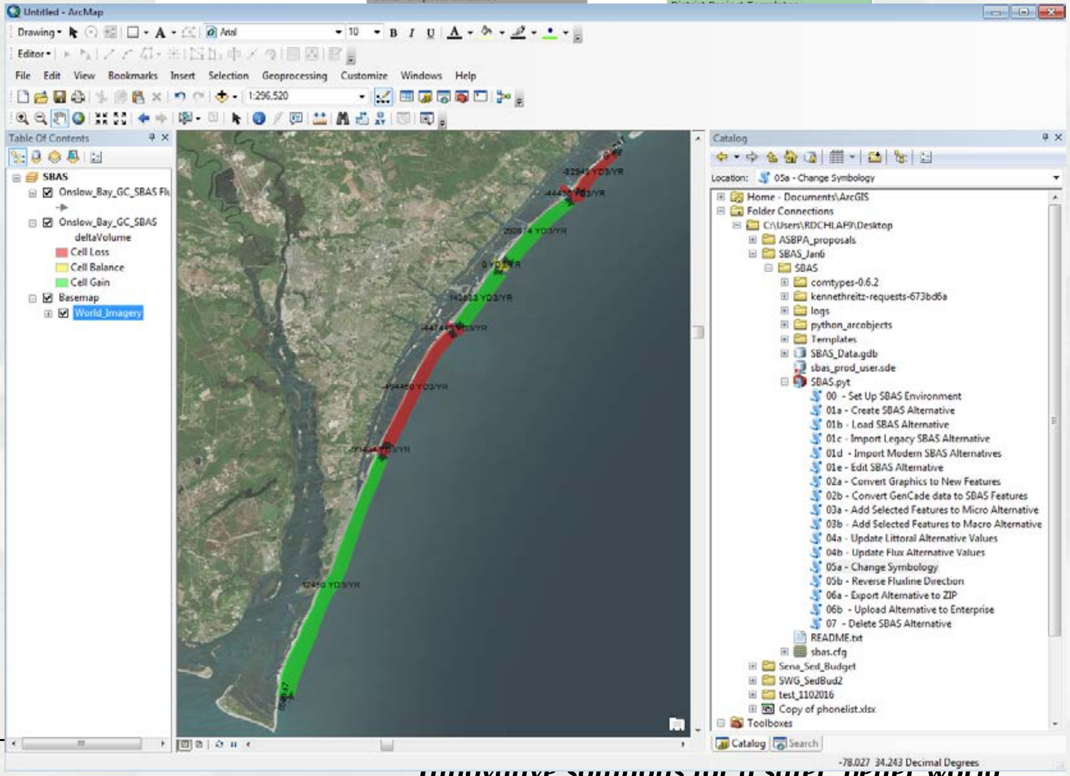
(120)-(110+4)-(-24+30+0)+(110)-(110)=0

Checks correctly!

SBAS

Sediment **B**udget **A**nalysis **S**ystem (SBAS) – provides a framework for formulating, documenting, and calculating sediment budgets, including estimation of uncertainty





ArcGIS version and documentation: http://rsm.usace.army.mil/

Summary

- We use sediment budgets for a range of applications
  - Simple: communication/illustration tool
  - Detailed: determine design elements
  - May be many budgets to characterize a particular coastal setting
- Steps in formulating a sediment budget:
  1. Conceptual budget (quickly formulated, use available information)
  2. Interim (Working) budget (analyze data, new modeling, sensitivity testing)
  3. Operational (Final) budget(s)
- Important concepts:
  - Macro-budget – provides a check on calculations
  - Residuals – should be zero for balanced budget, but can carry residuals to illustrate problems with data or lack of available information
- SBAS – tool useful for:
  - Communications – free to all partners, easily share files
  - Check on algebra
  - Keeping track of various budgets and data

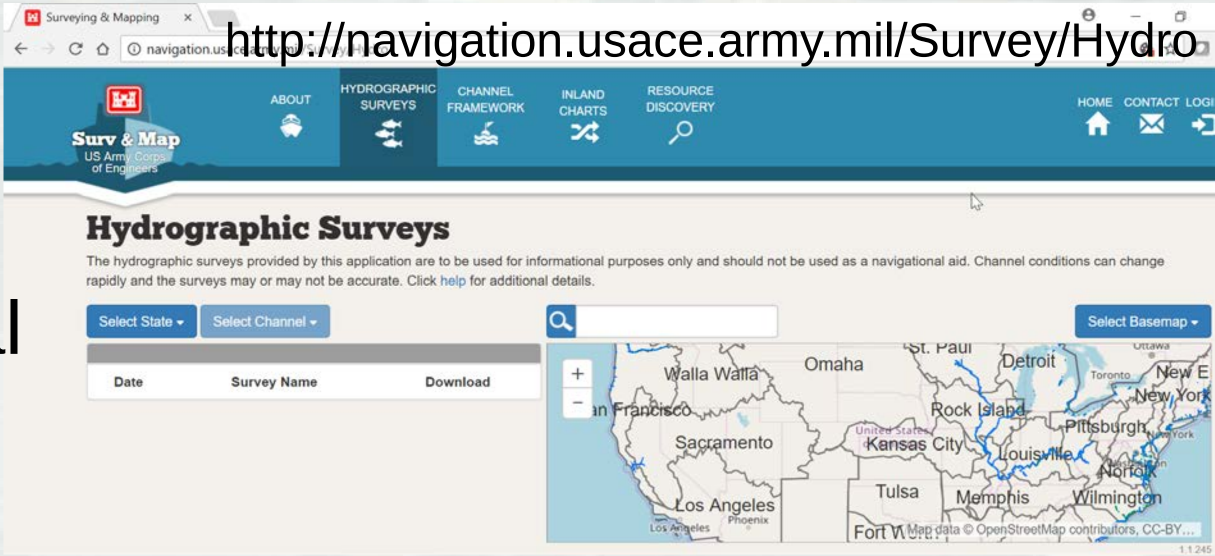
Sediment Budget Components

1. Dredging
2. Beach Nourishment
3. Beach Volume and Shoreline Chg
4. Inlet Morphology
5. Coastal Processes
6. Cross-shore Change
7. Sediment Budget

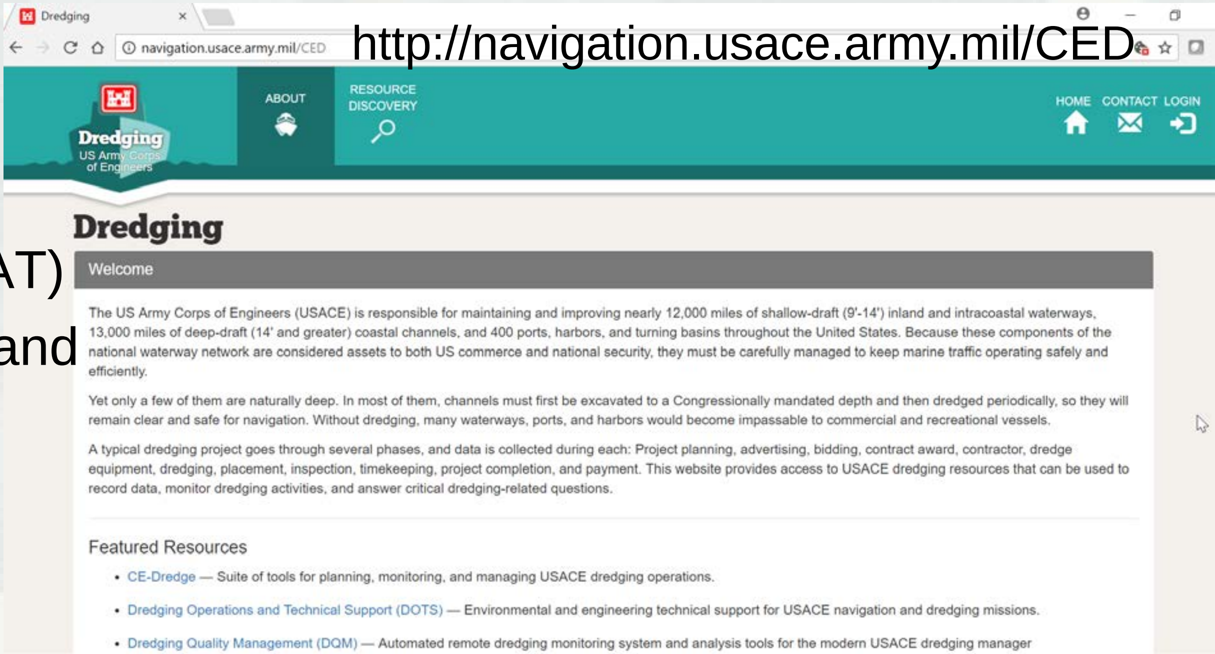
1. Dredging

- Conceptual
  - Reports, Dredging Database, Beachfill Database
  - CE-Dredge
- Interim/Operational
  - National Channel Framework & eHydro
    - Channel Condition Reports
  - Shoaling Analysis
    - Corps Shoaling Analysis Tool (CSAT)
    - Shoaling Patterns and Rates

http://navigation.usace.army.mil/Survey/Hydro



http://navigation.usace.army.mil/CED



1. Dredging

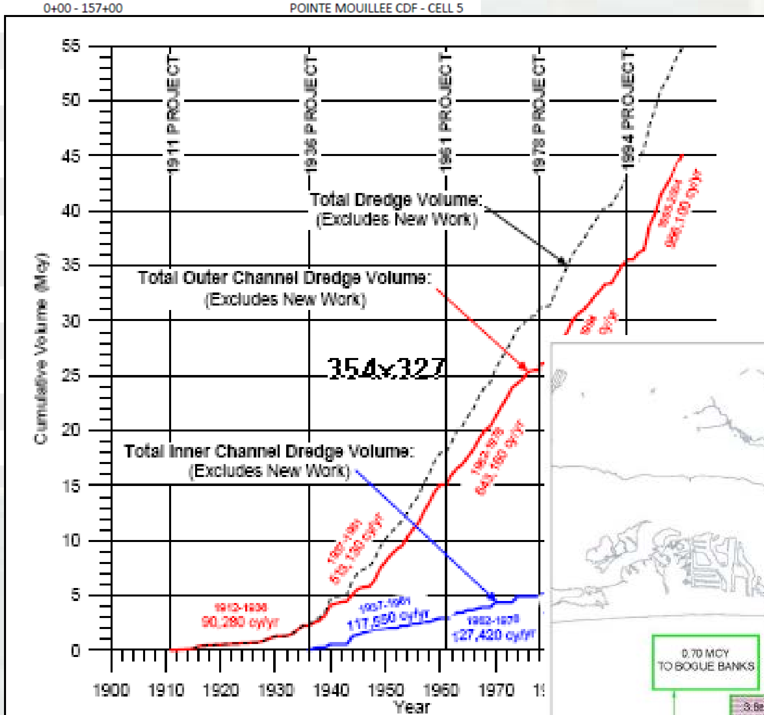
- Conceptual
- Dredging Reports

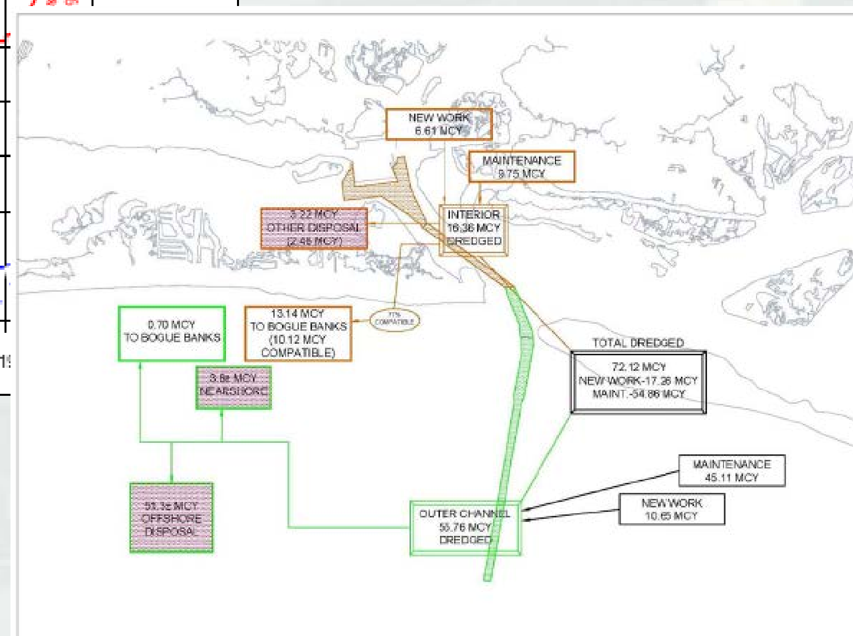
US Army Corps of Engineers

As of: 24-Mar-2014

CONTRACT DREDGING REPORT, DETROIT DISTRICT, OPERATIONS OFFICE

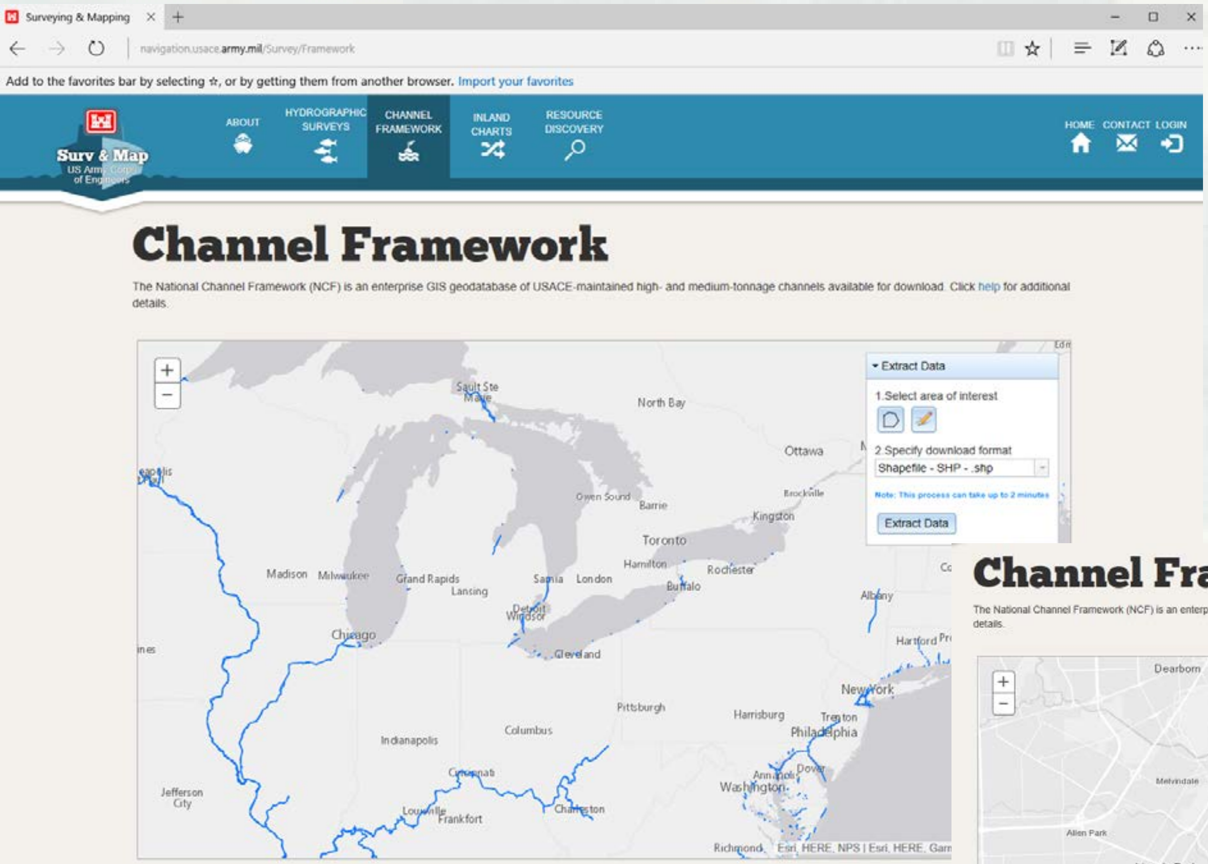
FY	START	COMPLETION	CUBIC YARDS	CONTRACT AMOUNT	CONTRACTOR CONTRACT NUMBER	DREDGE AREA	PLACEMENT AREA
Rouge River							
2012	8/3/2012	8/21/2012	39,951	$363,886	LUEDTKE ENGINEERING CO. W911XK-12-D-0008		Pt. Mouillee Confined Disposal Facility (CDF) Cell 5
2008	8/20/2008	9/4/2008	34,296	$612,147	LUEDTKE W911XK-08-C-0020	145+00-155+00 (13,419CY), 123+80-144+00 (14865CY), 92+00-123+80 (6012CY)	CONFINED POINTE MOUILLEE CDF CELL5
2006	9/25/2006	11/5/2006	64,000	$581,000	MCM MARINE(LUEDTKE) W911XK-06-C-0008	0+00-157+11	CONFINED PTE MOUILLEE CELL 5
2002	10/28/2002	11/25/2002	65,531	$609,248	MCM MARINE DACW35-02-C-0021	0+00-157+11	POINTE MOUILLEE CDF - CELL 5
1999	9/24/1999	10/20/1999	54,102	$501,714	LK MI CONT DACW35-99-C-0015	CRITICAL SHOALS	CONFINED
1997	9/12/1997	10/20/1997	74,162	$582,719	KING(SUB-LK MI CONT) DACW35-97-C-0025	0+00-157+00	POINTE MOUILLEE CDF - CELL 5
1995	8/1/1995	8/9/1995	33,592	$207,848	GREAT LAKES DACW35-95-C-0018	123+80-157+11	POINTE MOUILLEE CDF - CELL 5
1993	9/8/1993	9/17/1993	34,812	$248,524	GREAT LAKES DACW35-93-C-0020	90+00-157+00	POINTE MOUILLEE CDF CELL 5
1991	5/10/1991	6/9/1991	72,886	$721,530	KING DACW35-91-C-0007	0+00 - 157+00	POINTE MOUILLEE CDF - CELL 5
1989	8/28/1989	9/18/1989	52,974	$539,331	GREAT LAKES DACW35-89-C-0037		
1987	8/6/1987	8/10/1987	22,454	$304,724	GREAT LAKES DACW35-87-C-0010		
1986	7/11/1986	7/22/1986	59,357	$544,618	GREAT LAKES DACW35-86-C-0017		
1985	5/29/1985	6/13/1985	40,142	$474,586	DUNBAR & SULLIVAN DACW35-85-C-0020		
1984	6/22/1984	7/28/1984	57,013	$573,588	NATCO DACW35-84-C-0016		
1983			30,000	$190,000	GOVT/HAINS		
1982			44,310	$325,318	LUEDTKE DACW35-82-C-0054		
1981	5/6/1981	7/7/1981	115,549	$496,289	GOVT/HOFFMAN		
1980	7/31/1980	10/6/1980	117,997	$485,687	GOVT/LYMAN		
1979	6/19/1979	9/17/1979	134,083	$557,385	GOVT/LYMAN		
1978	9/25/1978	10/3/1978	13,677	$69,999	GOVT/LYMAN		
1978	7/5/1978	9/11/1978	152,845	$529,493	GOVT/HAINS		
1978	8/30/1978	9/1/1978	8,464	$31,999	GOVT/HOFFMAN		

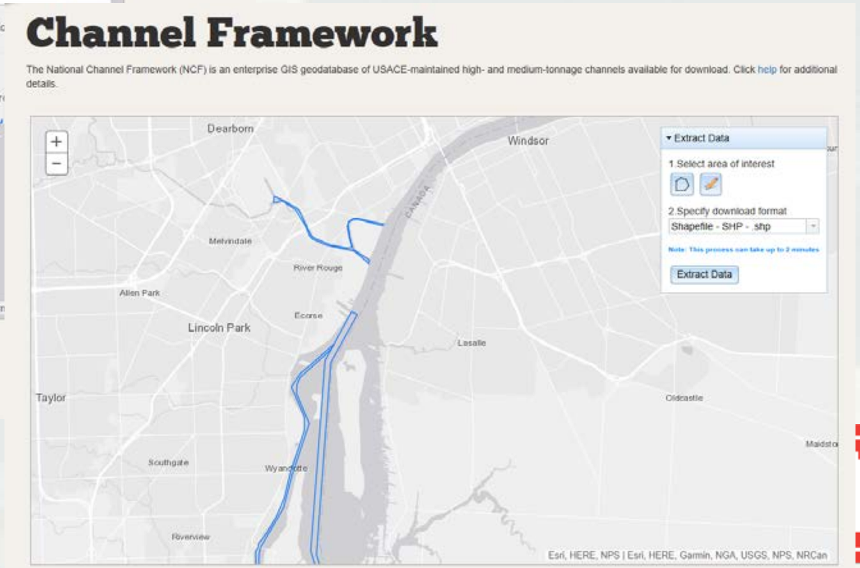




National Channel Framework

1. Dredging

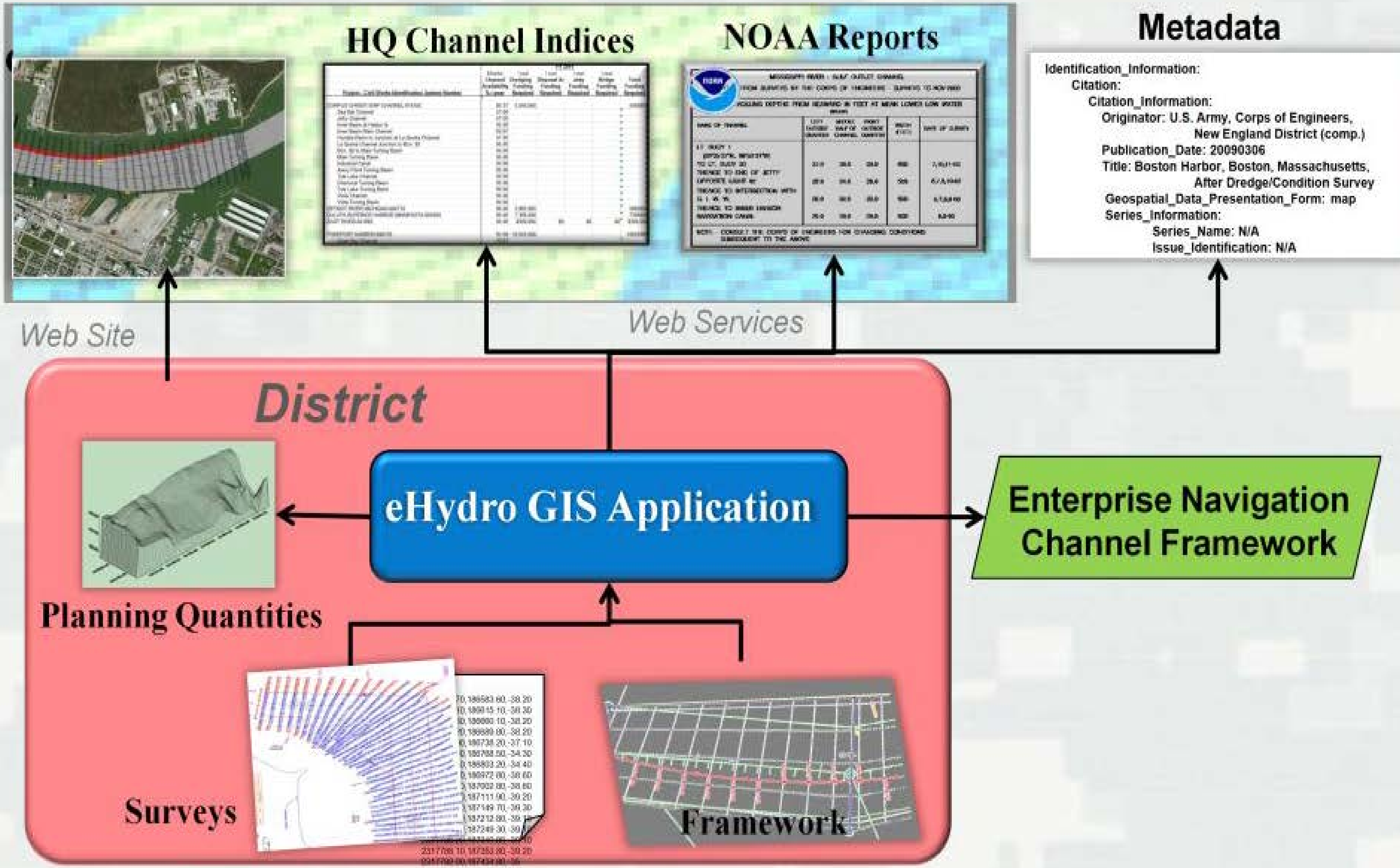




- Interim/Operational
- Location of Channels
- Navigation Portal
- http://navigation.usace.army.mil/Survey/Framework

eHydro: Application and Reporting Process

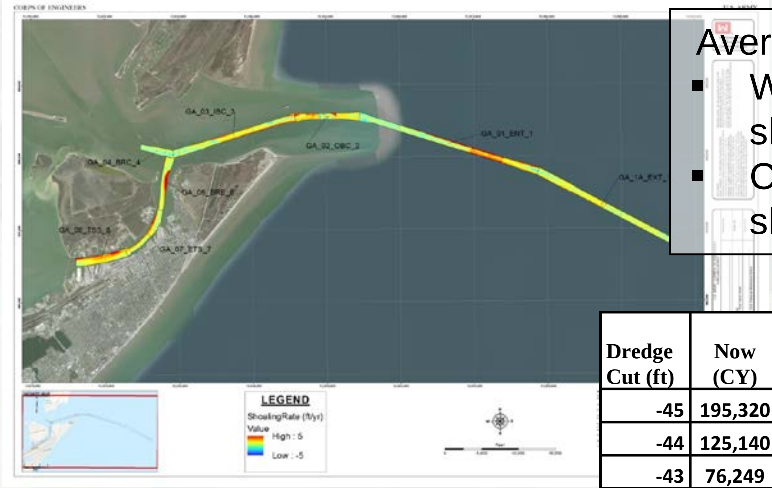
1. Dredging



Channel Shoaling

1. Dredging

- *What will the channels look like in the future?*
- Corps Shoaling Analysis Tool
  - Use historical survey data from eHydro to generate difference grid sets between dredging events
  - Predict average shoaling rates and dredging requirements per channel reach
  - Report volumes at different depth/time intervals



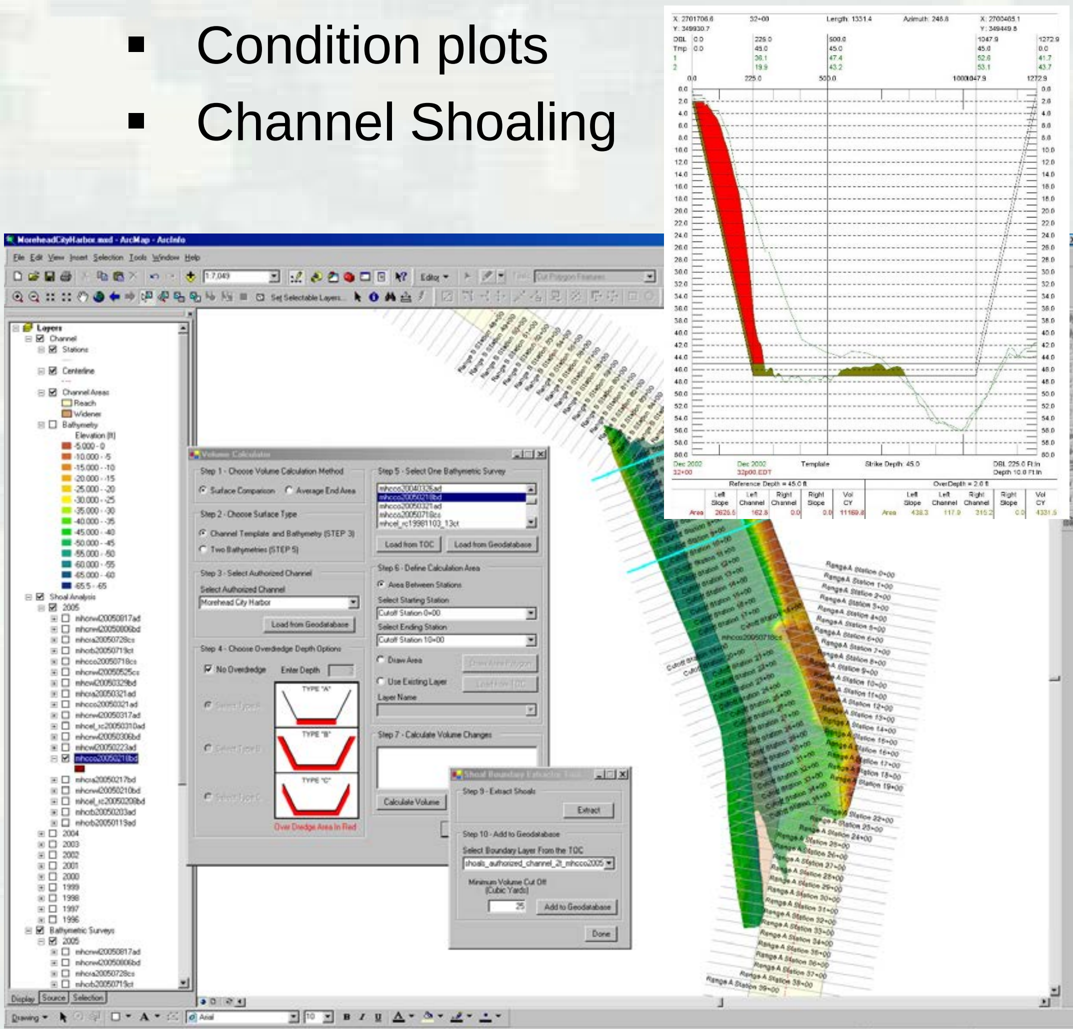
Average annual shoaling rate
- Warm colors – higher shoaling rates
- Cool colors – lower shoaling rates

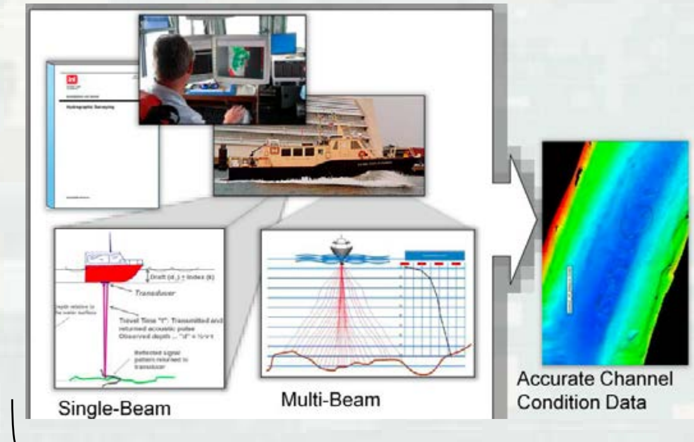
Shoaling rate w/ last survey

Dredge Cut (ft)	Now (CY)	6 months (CY)	12 months (CY)	18 months (CY)	24 months (CY)	30 months (CY)	36 months (CY)
-45	195,320	271,020	373,070	492,200	624,890	771,020	931,220
-44	125,140	173,140	238,620	331,710	444,910	572,680	713,450
-43	76,249	109,860	153,260	210,570	293,080	399,730	522,310
-42	43,628	65,655	95,990	135,350	186,480	258,070	356,920
-41	24,409	37,093	56,313	83,402	119,100	165,270	227,370
-40	14,958	21,022	31,470	48,147	72,041	104,370	146,170
-39	10,060	13,343	18,250	26,832	41,017	61,922	91,020
-38	7,083	9,092	11,945	16,084	23,035	34,823	53,059
-37	5,194	6,480	8,241	10,728	14,312	19,888	29,576
-36	3,865	4,787	5,944	7,496	9,673	12,784	17,358
-35	2,806	3,555	4,412	5,465	6,843	8,751	11,457

1. Dredging

- Interim/Operational
  - Channel Condition Report (CCR)
  - Channel Condition Index (CCI)
  - Channel Availability Reports
  - Condition plots
  - Channel Shoaling





REPORT OF CHANNEL CONDITIONS — Page 1 of 4
400 FEET WIDE OR GREATER — Date 3/3/2015

To: Navigation Interests

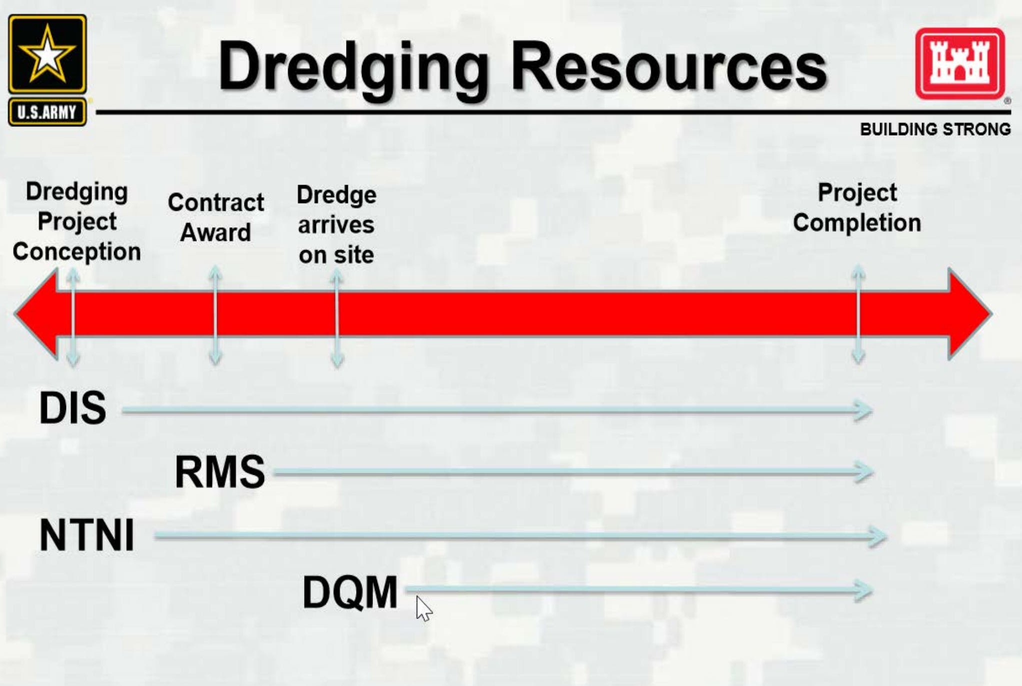
From: US Army Engineer District, Portland
333 SW First Avenue
Portland, OR 97204-3495

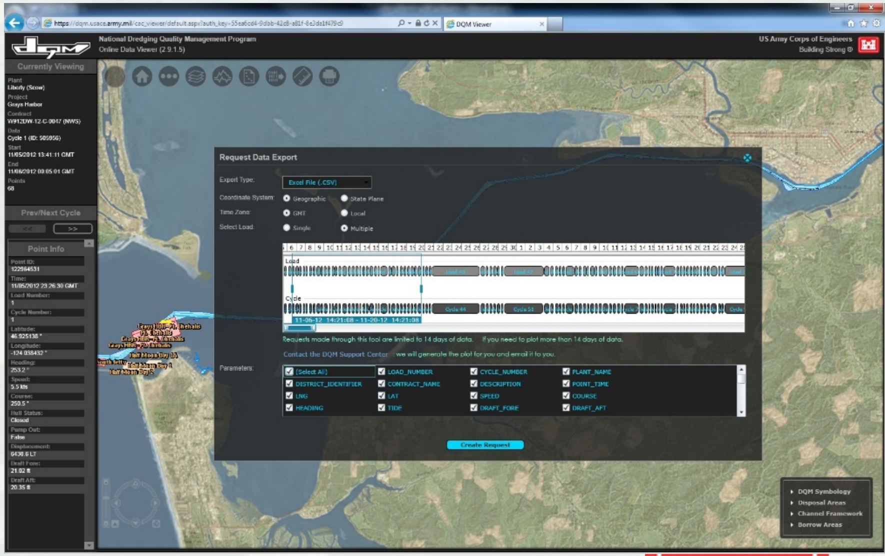
RIVER/HARBOR NAME AND STATE
COLUMBIA RIVER
OREGON & WASHINGTON

NAME OF CHANNEL	DATE OF SURVEY	AUTHORIZED PROJECT			MINIMUM DEPTHS IN EACH 1/4 WIDTH OF CHANNEL ENTERING FROM SEAWARD			
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)	LEFT OUTSIDE QUARTER (feet)	LEFT INSIDE QUARTER (feet)	RIGHT INSIDE QUARTER (feet)	RIGHT OUTSIDE QUARTER (feet)
MOUTH OF COLUMBIA RIVER Entrance Range	11-07-2014	2000	3.30	55	51	51	52	
MOUTH OF COLUMBIA RIVER Entrance Range	11-07-2014	640	3.30	48				41
MOUTH OF COLUMBIA RIVER Sand Island Range	11-07-2014	2000	2.20	55	50	52	53	
MOUTH OF COLUMBIA RIVER Sand Island Range	11-07-2014	640	2.20	48				42
LOWER DESDEMONA SHOAL Lower Desdemona Shoal	02-18-2015	600	3.40	43	46	47	49	50
UPPER DESDEMONA SHOAL Upper Desdemona Shoal	01-22-2015	600	3.60	43	42	44	43	41

1. Dredging

- Interim/Operational
- DIS – Dredging Information System – overall project info for all USACE performed & contracted dredging projects
- http://www.navigationdatacenter.us/dredge/dredge.htm
- RMS - Resident Management System – automated construction management/quality assurance information system primarily oriented to the daily requirements of USACE field-level construction personnel
- http://rms.usace.army.mil
- Dredging Quality Management – http://dqm.usace.army.mil



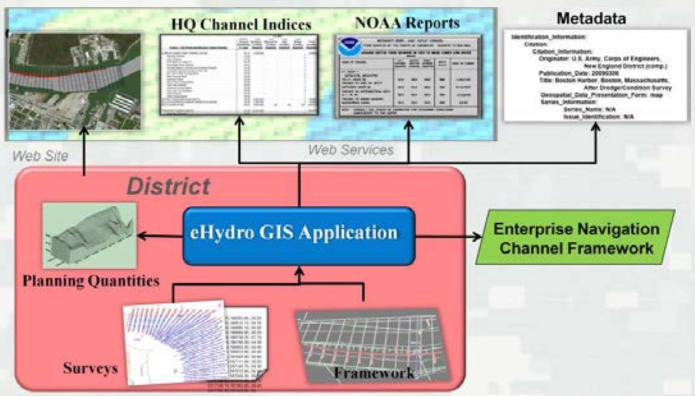


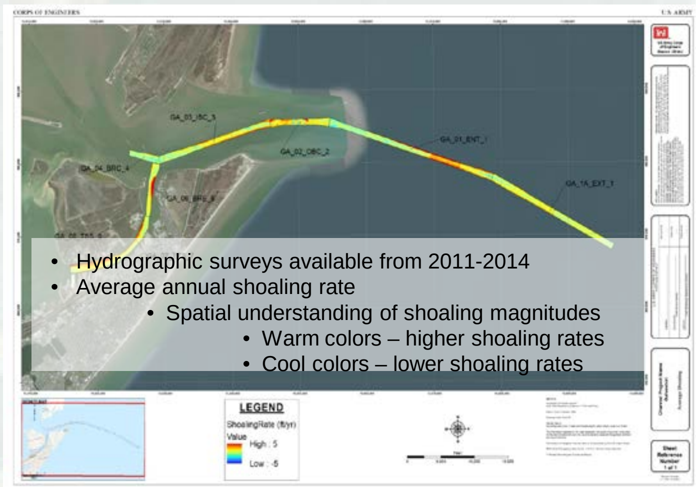
1. Dredging

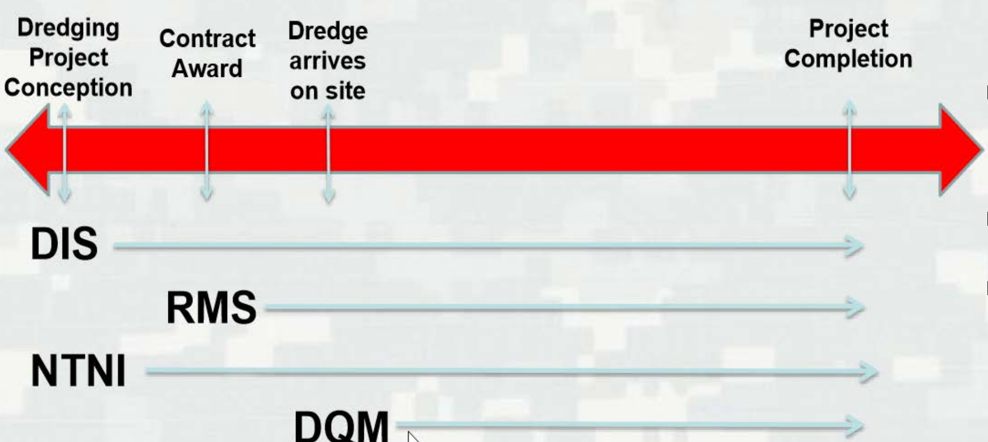
- Big Picture

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - \boxed{R} = Residual$$

- Dredging records available online, local district
- Improve dredging communication and coordination



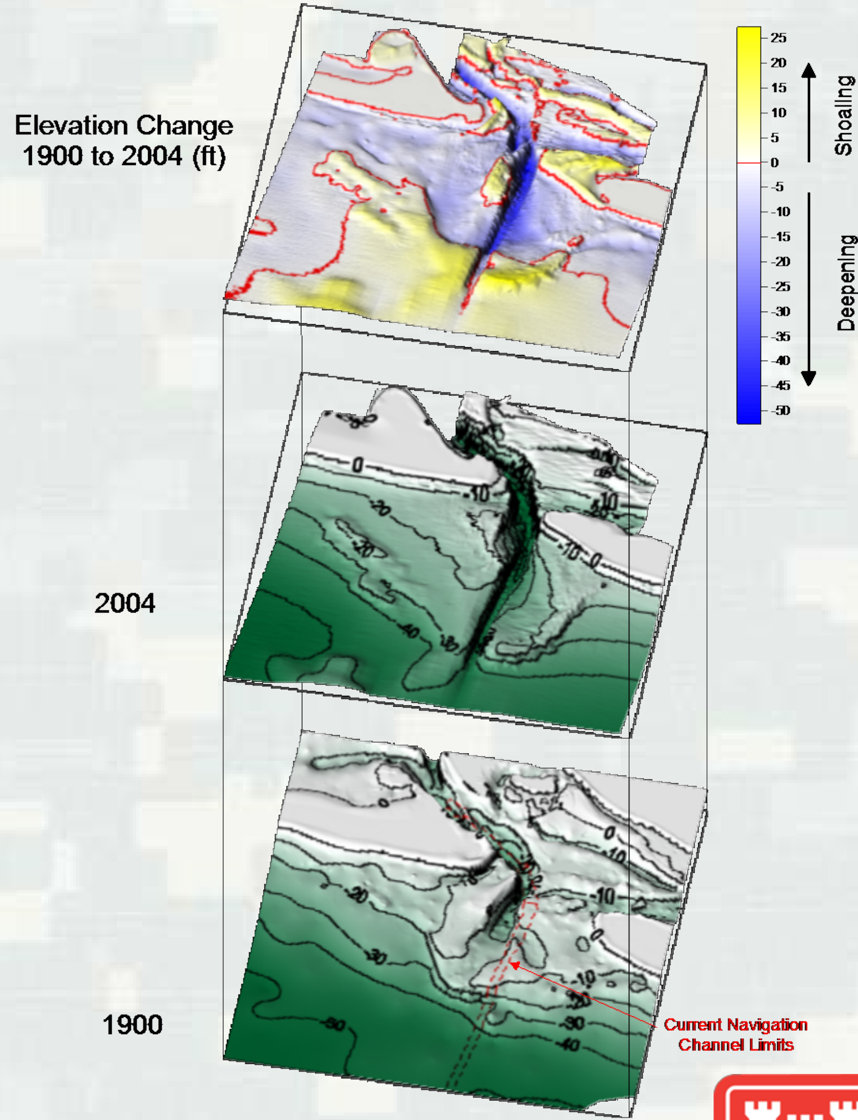




- http://www.navigationdatacenter.us/dredge/dredge.htm
- http://rms.usace.army.mil
- Dredging Quality Management – http://dqm.usace.army.mil

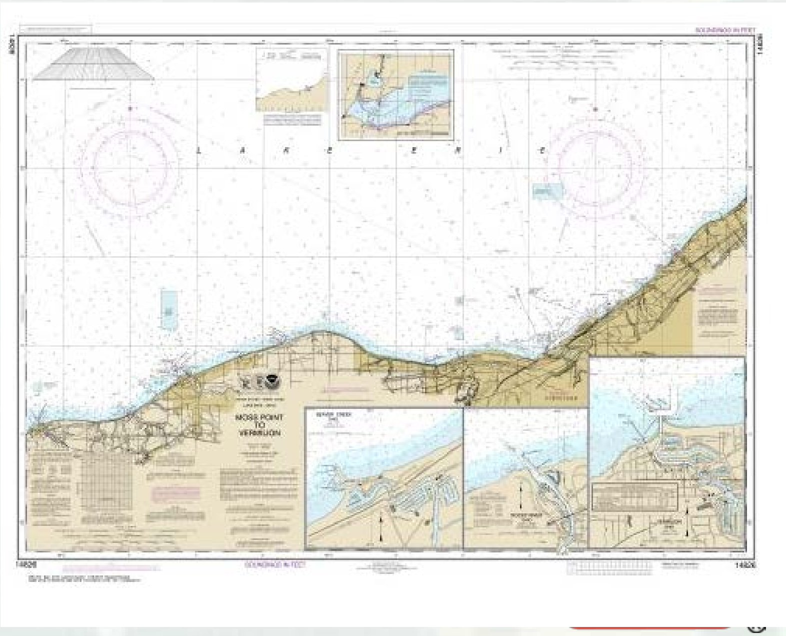
4. Inlet Morphology

- **Conceptual**
  - ▶ Reports, Historic Charts, Imagery
- **Interim/Operational**
  - ▶ Net Changes
  - ▶ Volumes
    - ArcGIS
      - ▷ Lidar
      - ▷ profiles
    - Surface Modeling
    - Change Rates
  - ▶ Equilibrium
    - Ebb Shoal Volume
    - Cross-Sectional Area

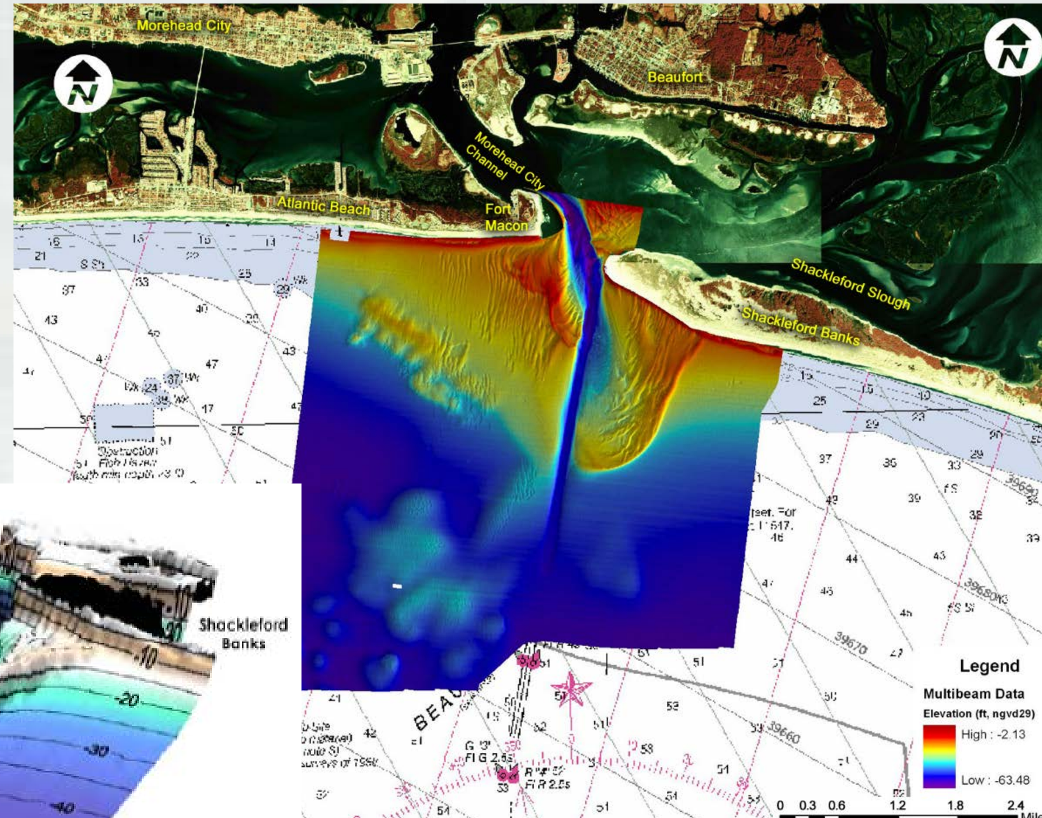


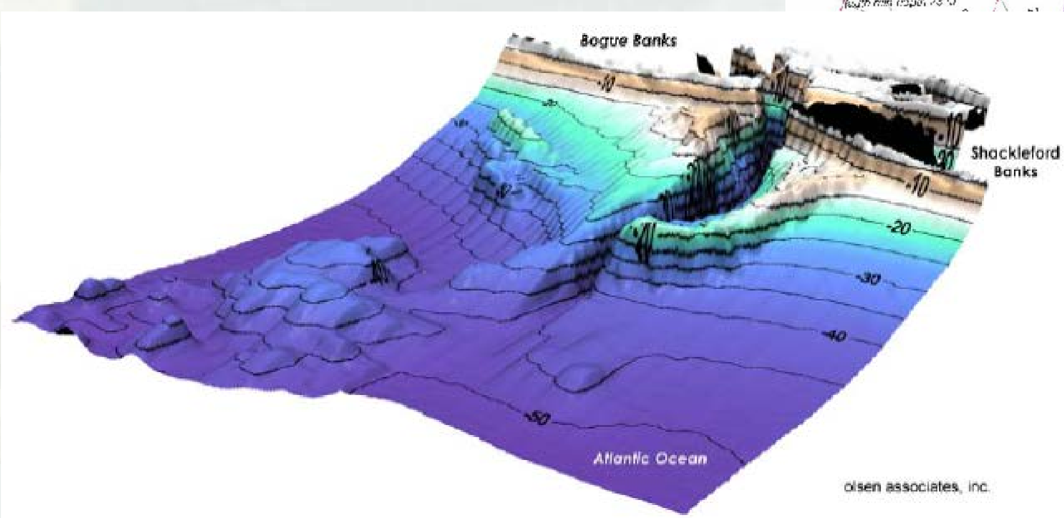
4. Inlet Morphology

- Conceptual
- Inlets Online: http://www.oceanscience.net/inletsonline
  - Aerial images
  - Reports
- Historic Charts
- NOAA's Digital Coast – lidar data

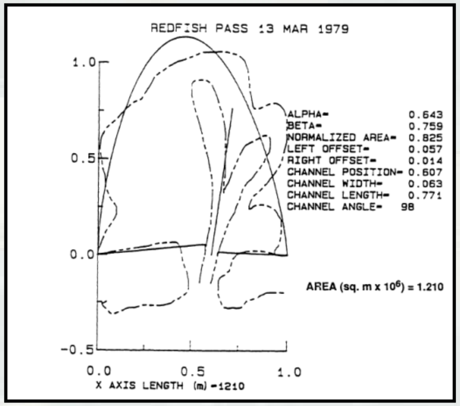


- Interim/Operational
- Volumetric Analyses
  - ▶ Classify
  - ▶ Volume above Contour
  - ▶ Surface Comparisons

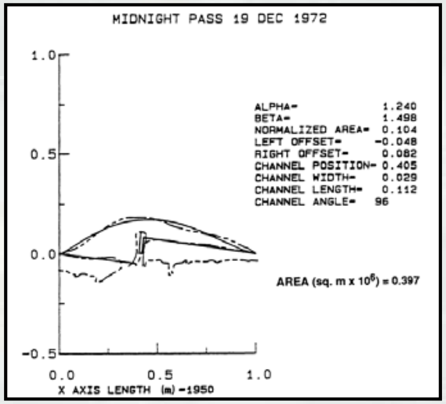




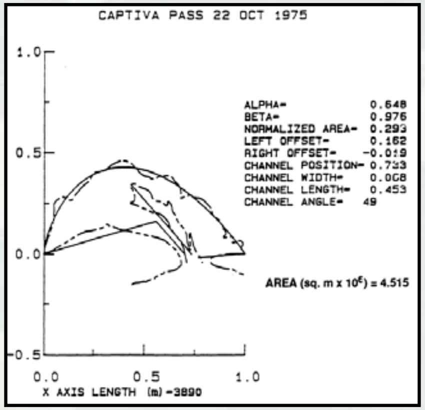
- Interim/Operational
- Classification of Ebb Shoals



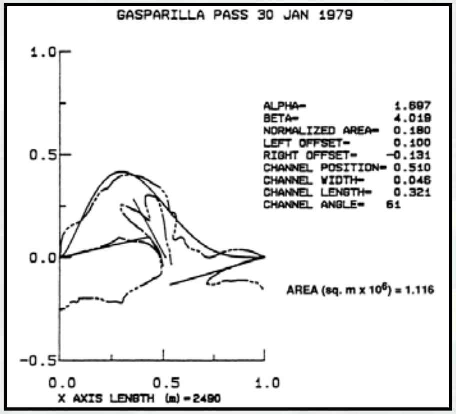
Tide Dominated



Wave Dominated



Mixed Energy



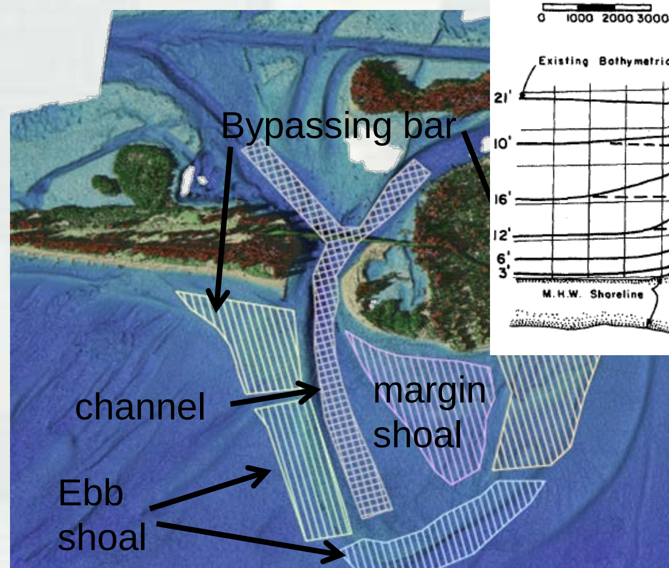
Mixed Energy - offset

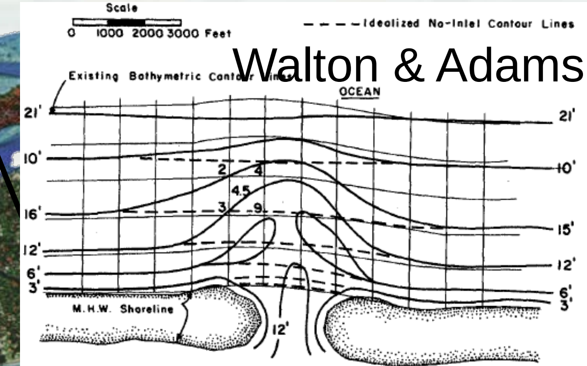
- 1) identify viable fill material and quantify impacts from mining the ebb shoal,
- 2) delineate sediment pathways to provide input to sediment budgets,
- 3) determine trends for the migration of the ebb shoal that could impact navigation, and
- 4) develop a long term sediment management plan.

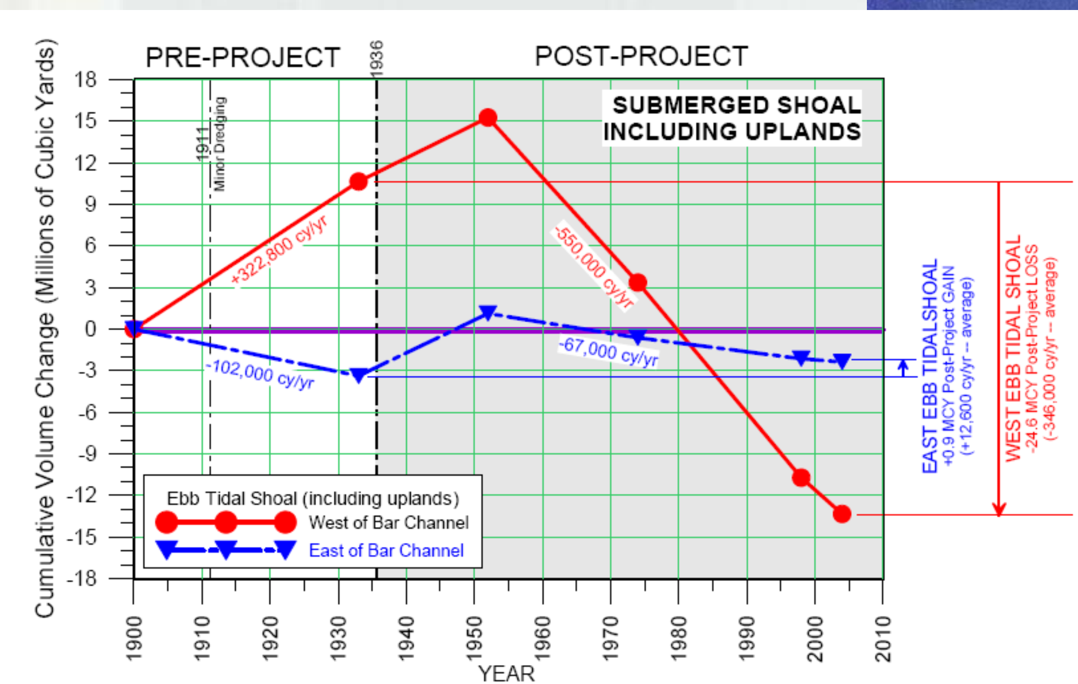
GIBEAUT, J.C. and DAVIS, R.A., Jr., 1993. Statistical geomorphic classification of ebb-tidal deltas along the west-central Florida coast. *Journal of Coastal Research*, Special Issue No. 18, 165-184. Fort Lauderdale (Florida). ISSN 0749-0208.

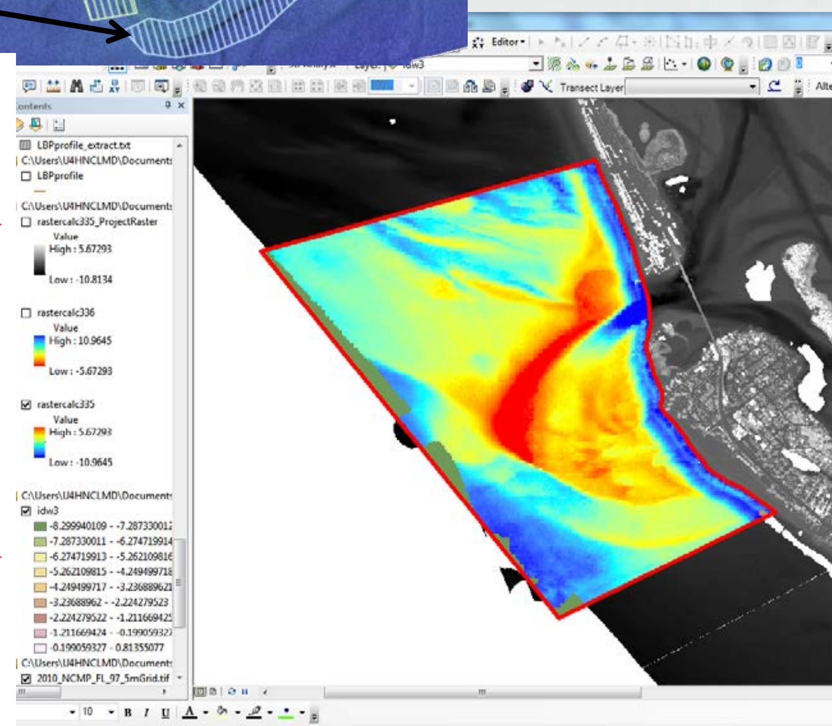
4. Inlet Morphology

- Interim/Operational
- Volume Above Contour
- ArcGIS
  - Regional Process Analysis Tool
  - Compare the idealized 'no inlet' bathymetry with the existing bathymetry



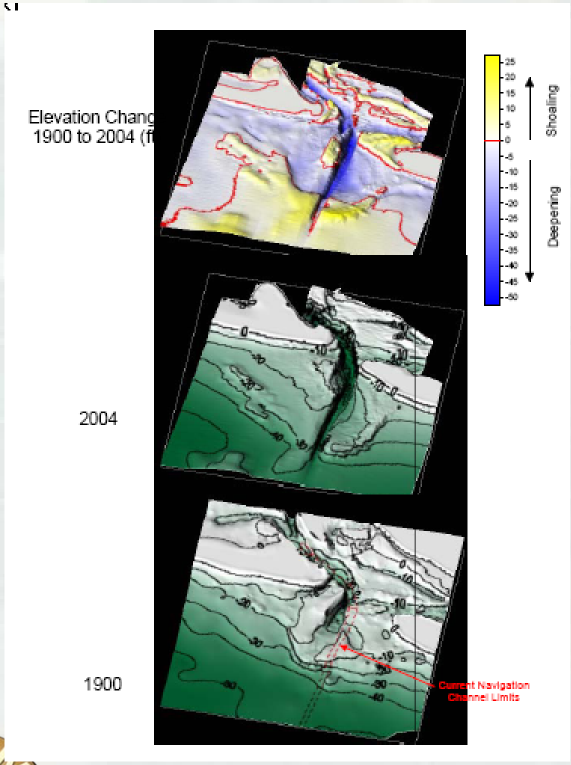






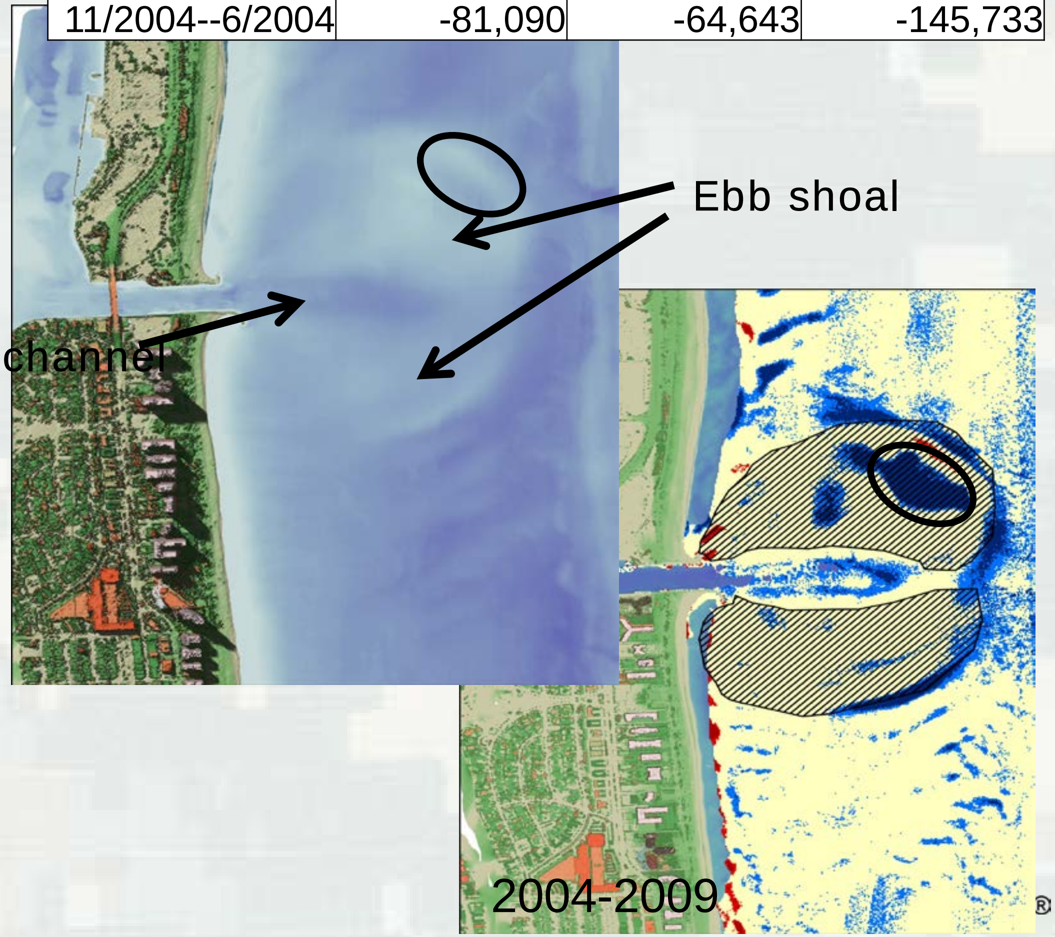
4. Inlet Morphology

- Interim/Operational
- Volumetric Analyses
  - ▸ Surface Comparisons
    - ArcGIS



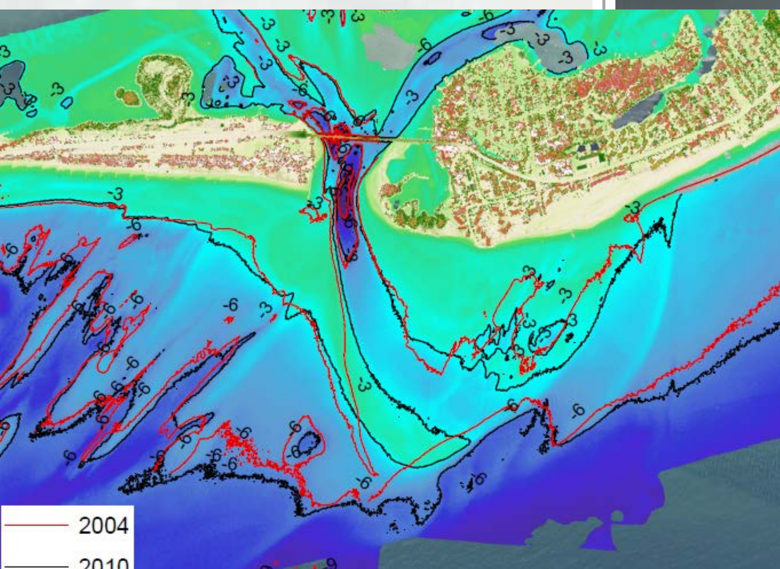
Volume Change (CY)

Survey	North Shoal	South Shoal	Total
10/2009--6/2004	266,158	174,736	440,894
10/2009--1/2006	232,284	150,703	382,987
1/2006--11/2004	106,561	21,548	128,109
11/2004--6/2004	-81,090	-64,643	-145,733



4. Inlet Morphology

- Interim/Operational
- Shoreline and Channel Changes
  - ArcGIS

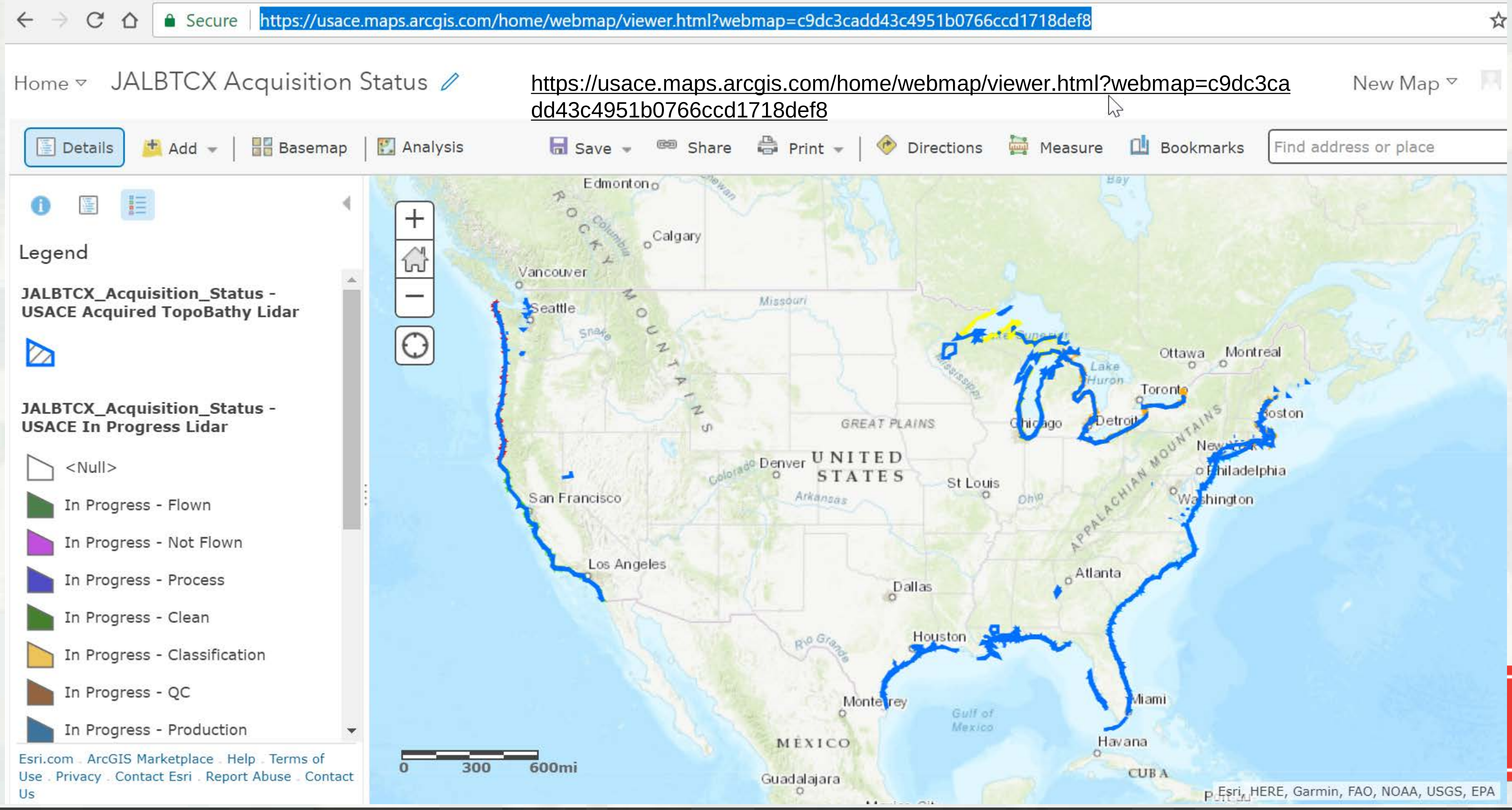


4. Inlet Morphology

- Big Picture

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = \text{Residual}$$

- Coastal Inlets Research Program
- Joint Airborne Lidar Bathymetry Technical Center of Expertise

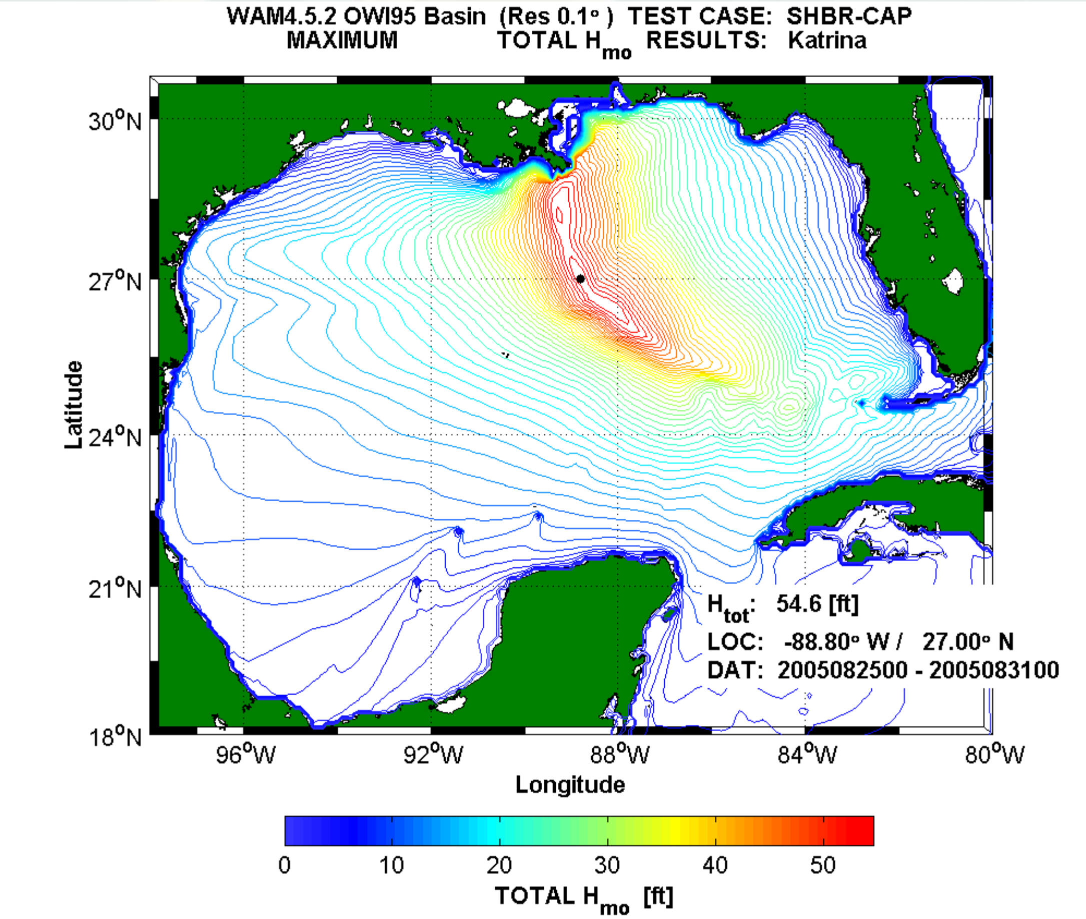


Categories of Models

- Waves
- Tides & Circulation
- Sediment Transport

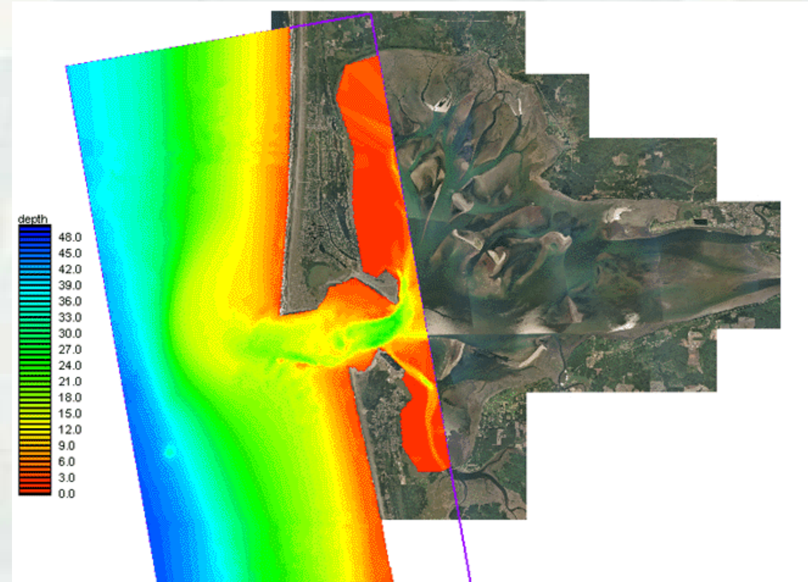
Wave Generation Model (Hindcast & Forecast)

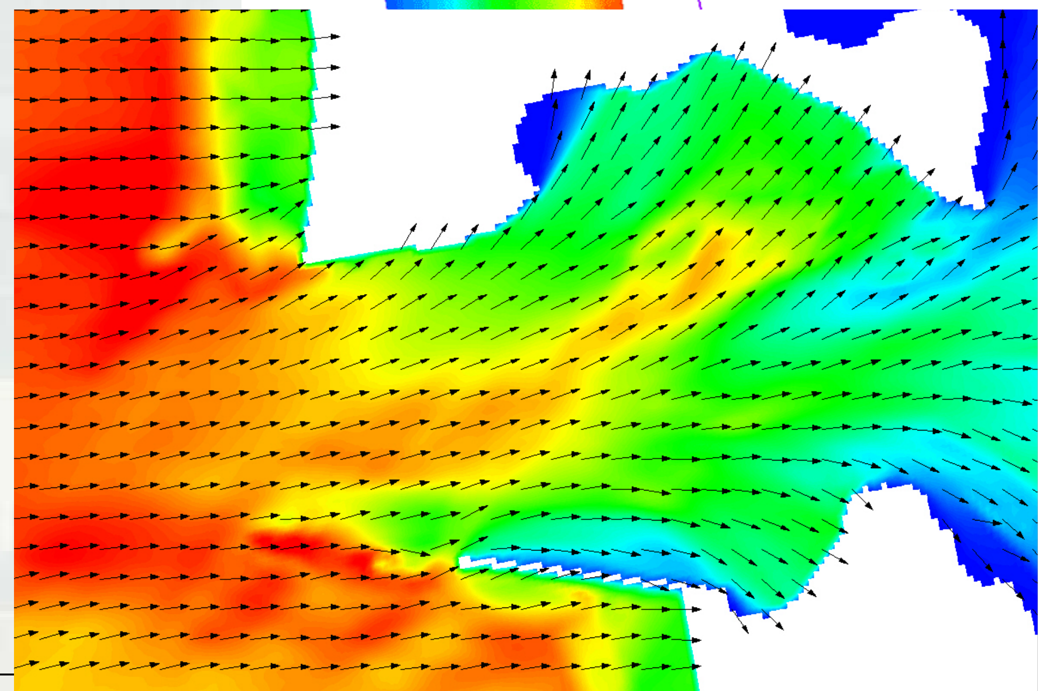
- Large-scale Wave Generation
  - Wave Information Studies (wis.usace.army.mil)
- Uses:
  - Wave Climate for Projects
  - Input to nearshore models
  - Operations (forecast)
- Processes:
  - Wind Generation
  - Propagation
  - Sheltering



Wave Transformation Models

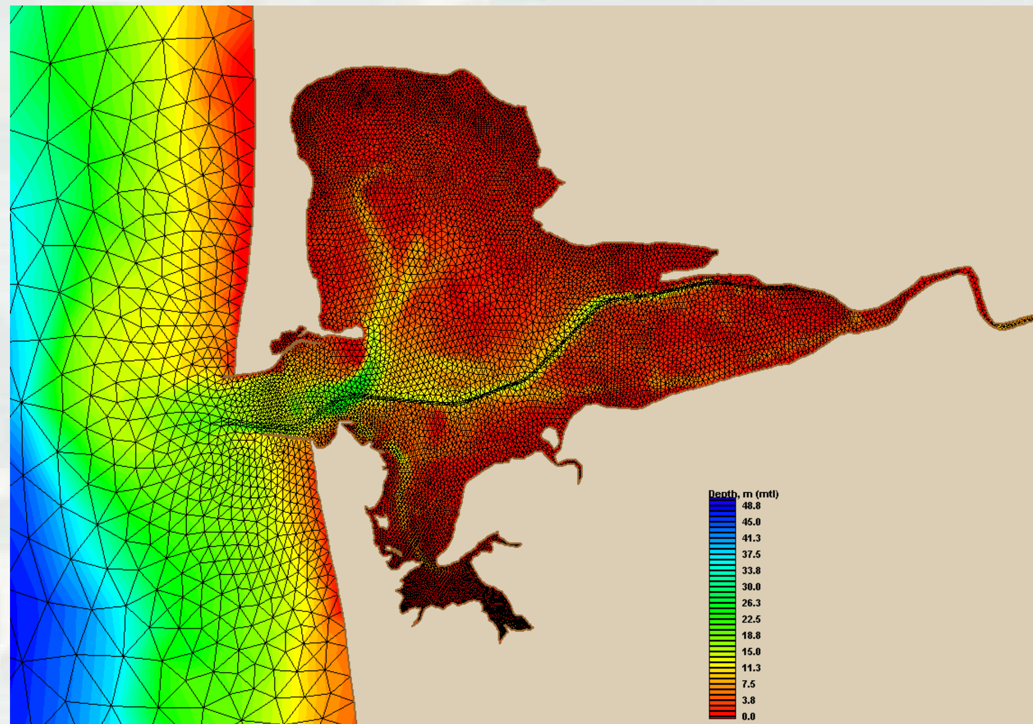
- STWAVE is Workhorse Corps Model
- Uses:
  - Sediment transport modeling
  - Structure design
  - Navigability
  - Shoal mining/bathymetry modifications
- Processes:
  - Refraction
  - Shoaling
  - Breaking
  - Wave-Current Interaction
  - Generation
- SWAN – Delft equivalent
- CMSWAVE -- CIRP





Circulation Models

- Time-Stepping Solution of Momentum and Continuity (2D & 3D)
- Models:
  - ADCIRC, CH3D, RMA Suite, ADH, CMSFLOW
- Uses:
  - Sediment transport
  - Tidal current
  - Storm surge
  - Water quality (?)
- Processes:
  - Tides
  - Wind-forcing
  - Coriolis
  - Wave-forcing
  - Wetting & Drying
  - Frictional Losses



Sediment Transport Models

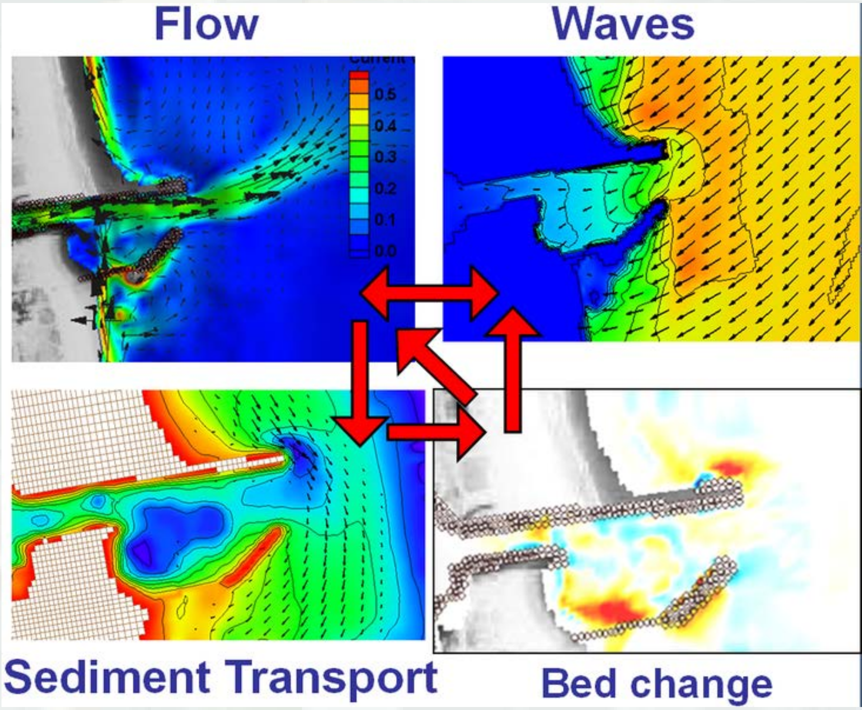
- Shoreline Change
- Profile Change
- Morphology Change
- Particle Tracking

Morphology Change Models

- Models:
  - Coastal Storm Modeling System (CSTORM)
  - Coastal Modeling System (CMS)
- Uses:
  - Short to mid-term bathymetry evolution
  - Beach fill
  - Inlet evolution
  - Storm response
- Processes:
  - Wave- and current-driven sediment transport
  - Physics based, but some empiricism; Models under development
  - Present weakness – shoreline processes (shoreline change, overwash, breaching, etc.)

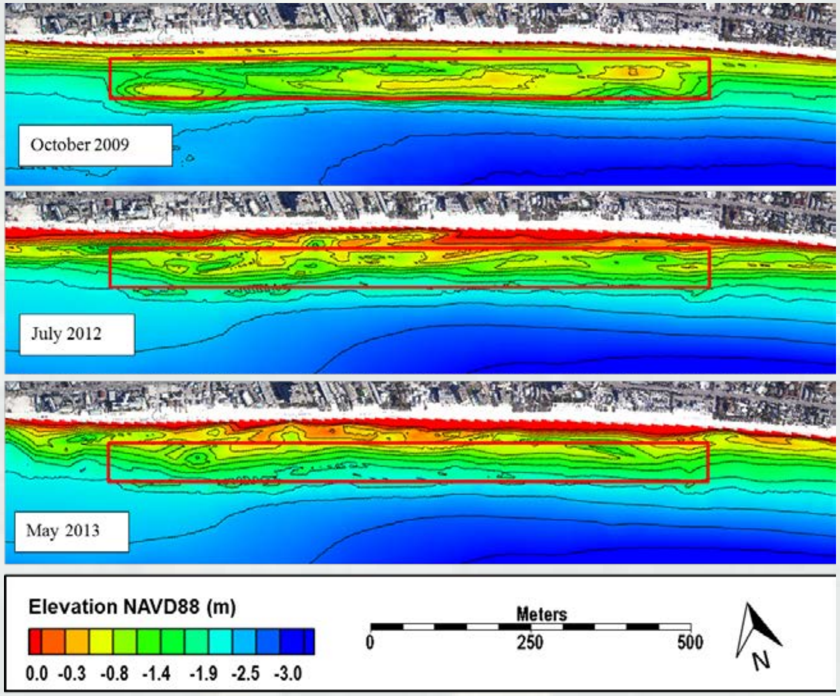
Coastal Modeling System

- **Coupled calculations of waves, currents, water levels, sediment transport and morphology change** in and around inlets
- **Short- (weeks) to mid-term (seasonal to multiple years) project scale** simulations
- **Representation of** wetting and drying, advection, turbulent mixing, tides, wind, atmospheric pressure, and waves; river flows, wave-current interaction, multiple-sized sediment transport, bed sorting, and morphology change



Coastal Modeling System

- Tool Input
  - Waves
  - Tides
  - Bathymetry
  - Grain size
- Tool Output
  - Currents
  - Waves
  - Water Levels
  - Morphology/Sed Transport
- How does the tool help the Districts?
  - Gives an idea of waves and currents at the placement site
  - Limited computation of sed transport & morphology change



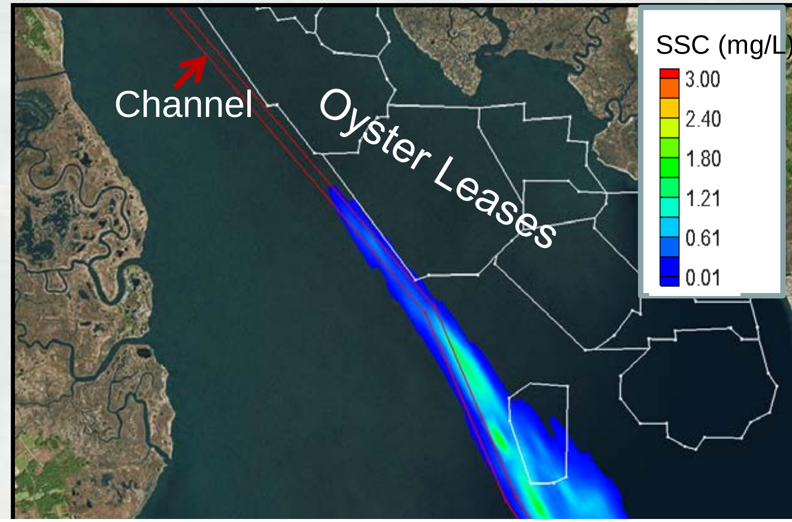
The Particle Tracking Model

- **The Particle Tracking Model (PTM)** is a Lagrangian particle tracker that models transport processes (advection, diffusion, deposition, etc)

- PTM is designed to predict the fate of multiple constituents (sediment, chemicals, debris, biota, etc) released from local sources (dredges, placement sites, outfalls, propeller wash, etc) in complex hydrodynamic and wave environments.

- Motivation for model development is the need for accurate risk assessment for environmental receptors near local sources.
  - Total Suspended Solids (TSS) concentration (light attenuation, fish and larval migrations)
  - Contaminants
  - Sediment deposition (Egg burial, oyster lease, Coral reefs)

Environmental Concerns:



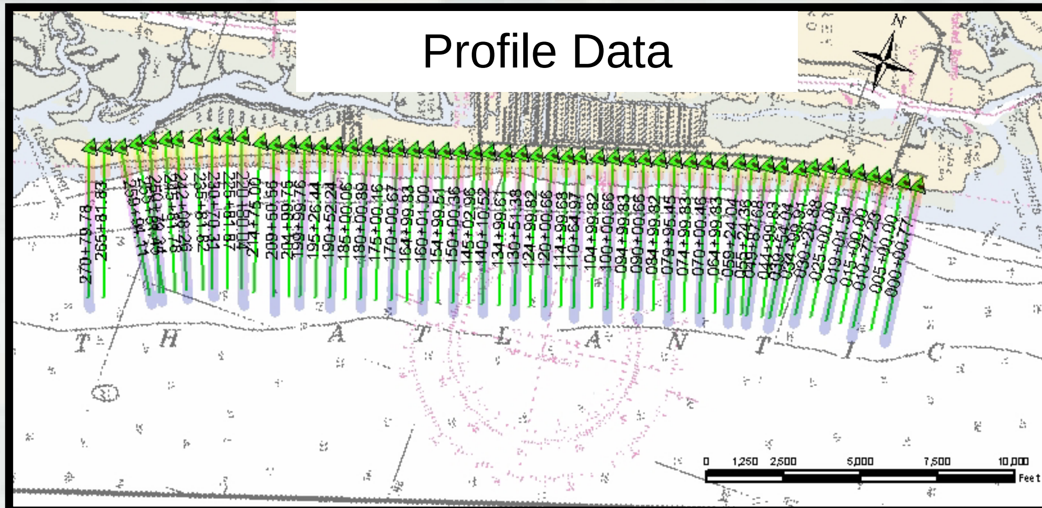
PTM Suspended Sediment Concentration modeling from Hopper Dredge Overflow near Oyster

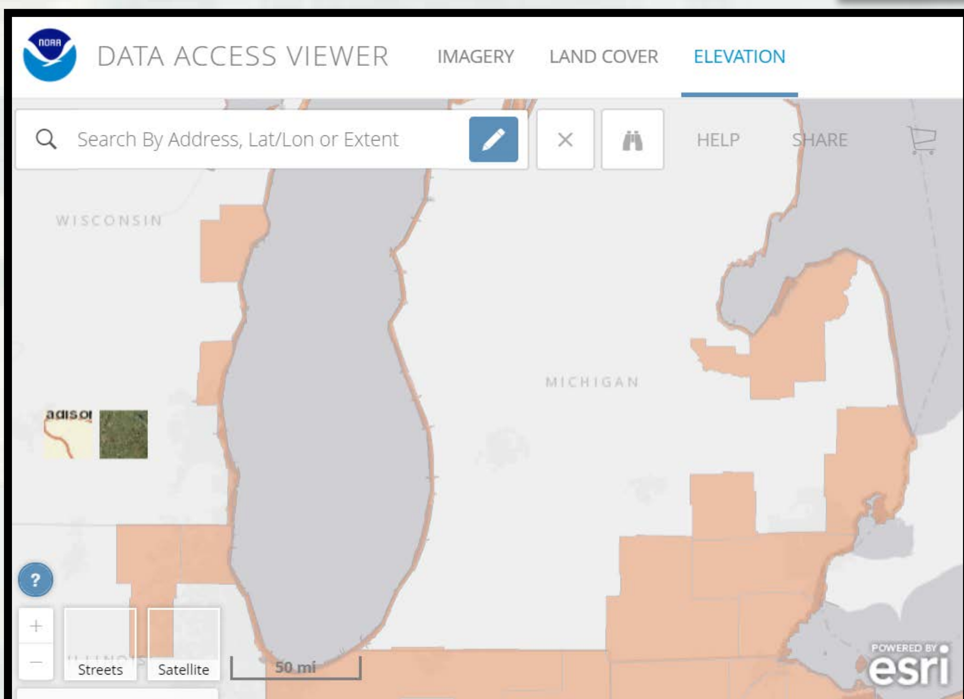
Data Sources

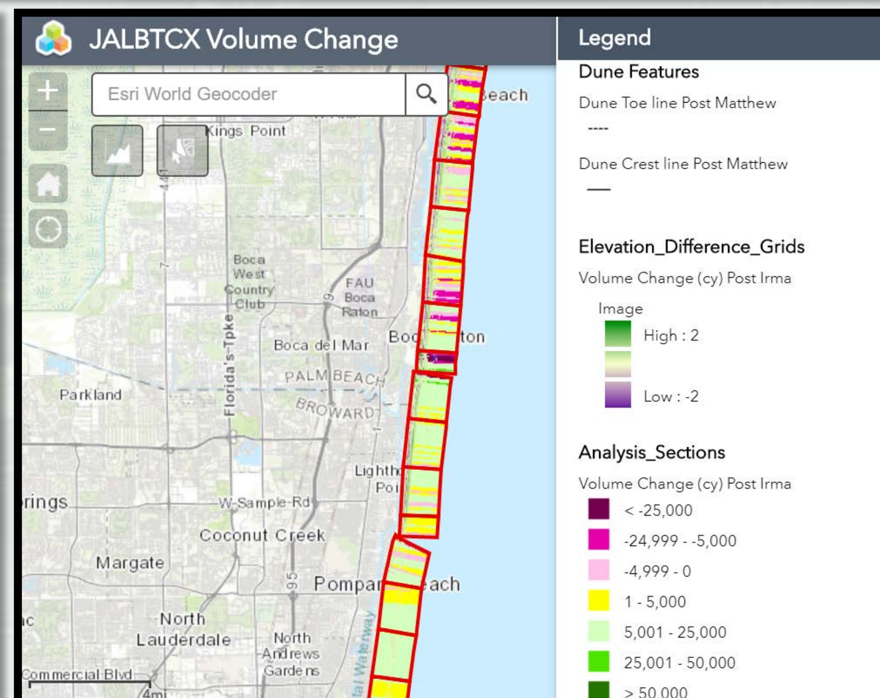
- Waves
  - NDBC, WIS, WAVEWATCHIII, ADCPs, pressure gage
- Currents/tides
  - NDBC, ADCPs
- Bathymetry
  - JALBTCX, NOAA Digital Coast, Profile surveys
- Sediment
  - SAGA Tool, Geotechnical data, sediment samples

3. Beach Volume and Shoreline Change

- Conceptual
  - Monitoring Reports
  - Online Databases







- Interim/Operational
  - ▸ BMAP/RMAP
  - ▸ ArcGIS
    - Volume Change Toolbox
  - ▸ MATLAB
    - Bluff Crest & Toe Detection

Morang et al. 2009

3. Beach Volume and Shoreline Change

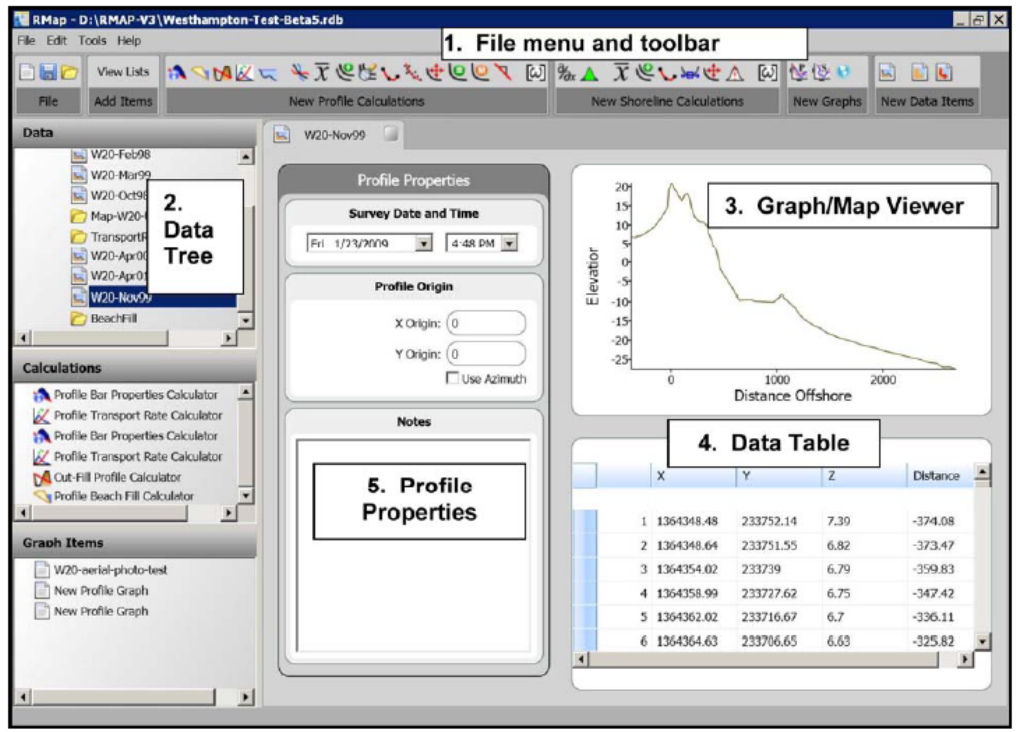
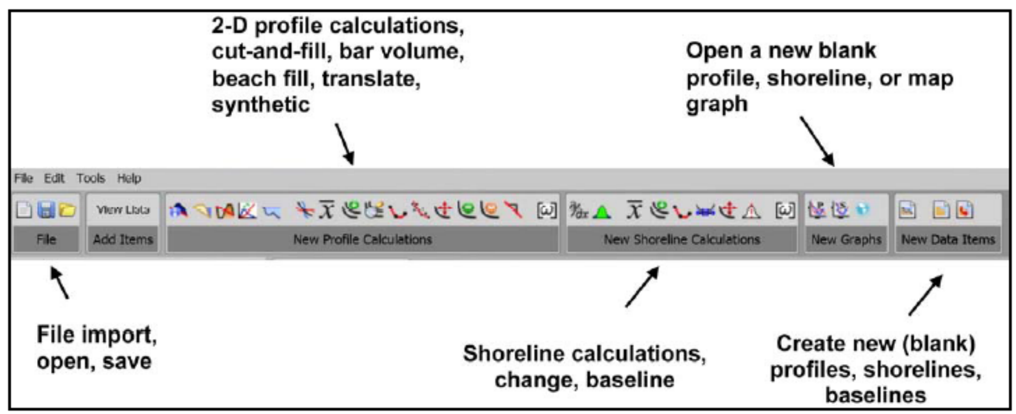
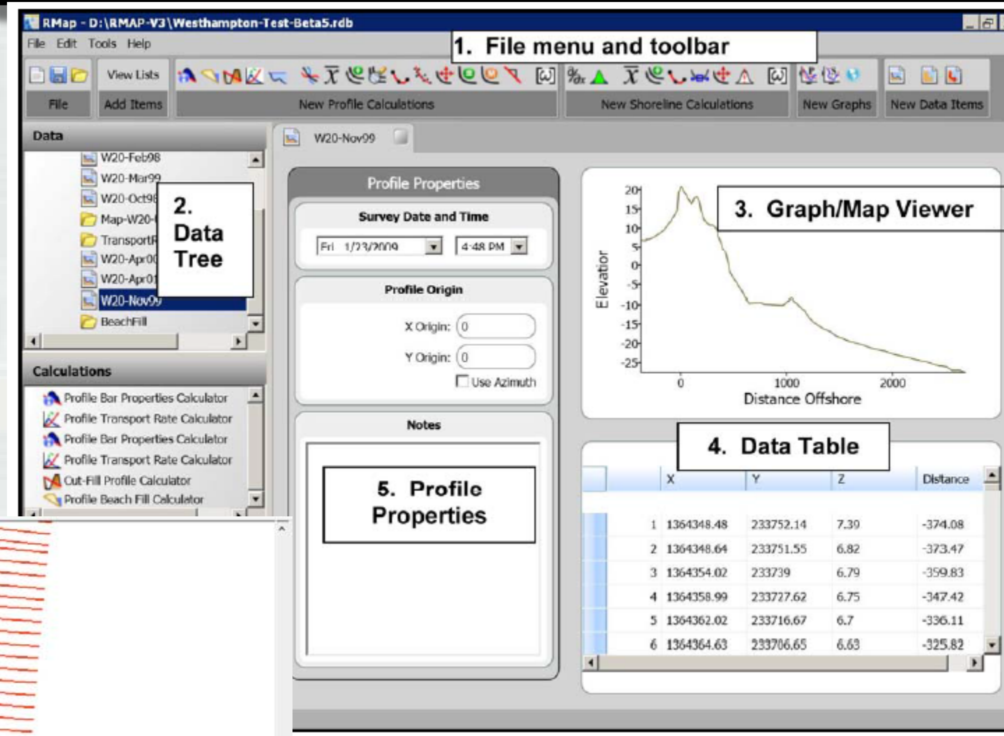


Figure 1. RMAP Version 3 interface is organized as: (1) file menu and toolbar, (2) data tree, (3) graph/map viewer, (4) data table, and (5) profile properties.



3. Beach Volume and Shoreline Change

- Interim/Operational
  - BMAP/RMAP
  - ArcGIS
    - Volume Change Toolbox
  - MATLAB
    - Bluff Crest & Toe Detection



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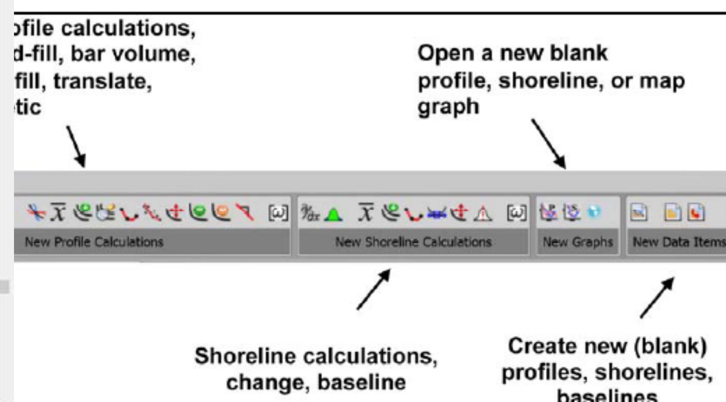
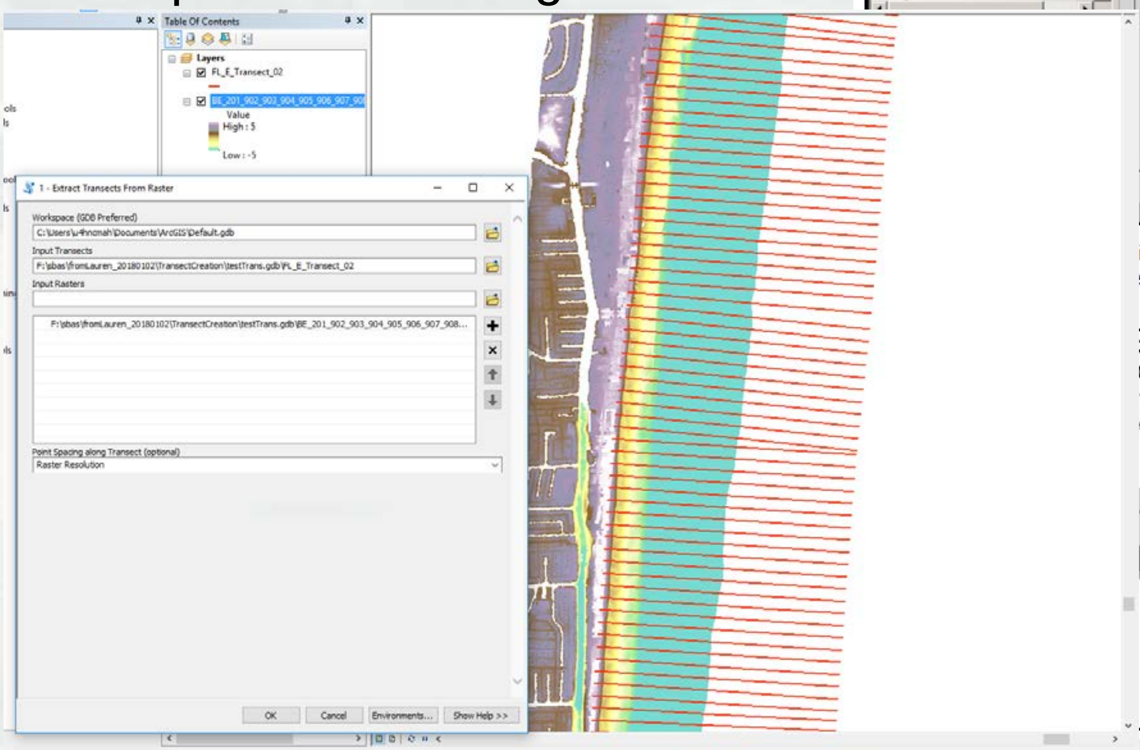


ArcMap - Extract Along Transect



3. Beach Volume and Shoreline Change

- Interim/Operational
  - BMAP/RMAP
  - ArcGIS
    - Volume Change Toolbox
  - MATLAB
    - Bluff Crest & Toe Detection

3. Beach Volume and Shoreline Change

- Interim/Operational
  - BMAP/RMAP
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    - Bluff Crest & Toe Detection

JALBTCX_quick_response_v2.tbx
- QR 01. Label Baseline and Generate Transects (optional)
- QR 01b. Update Transect Coordinates (optional)
- QR 02. Generate Transect Mask and Clip Mask (optional)
- QR 03. Generate Difference Grid by Clip Mask (optional)
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- QR 07. Calculate MHW Volume and Volume above MHW
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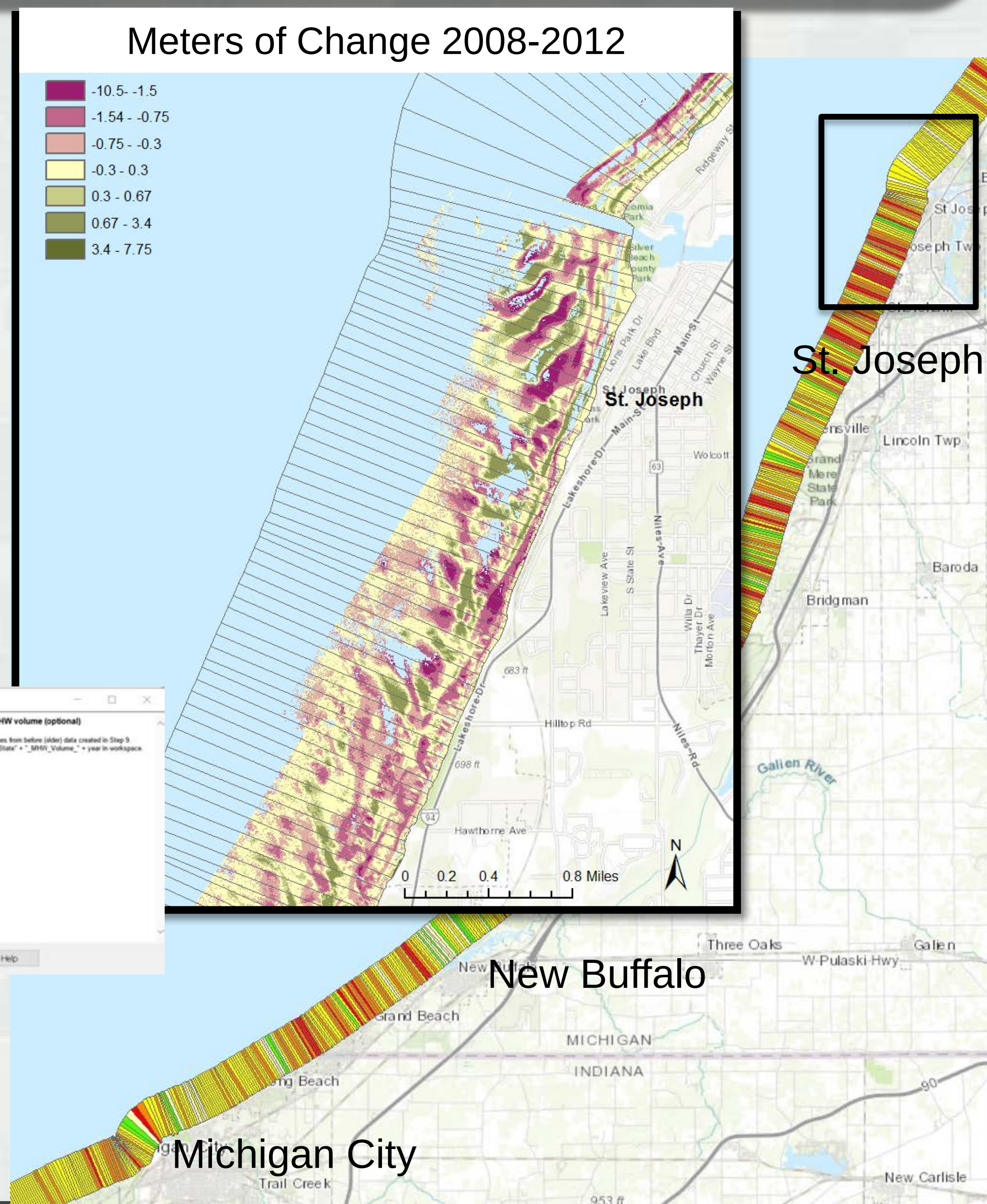
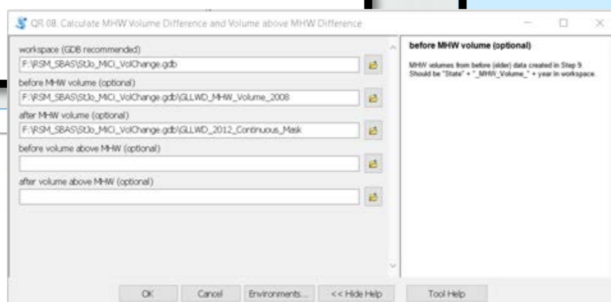
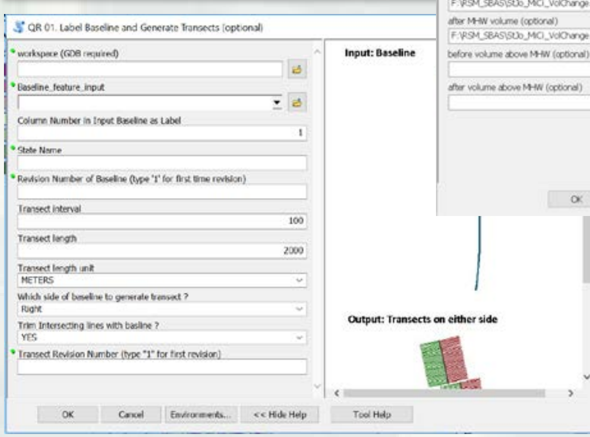
- QR 09. Calculate Shoreline Change
- QR 10. Generate Final Table
- QR 11. Summarize Table







3. Beach Volume and Shoreline Change

- Interim/Operational
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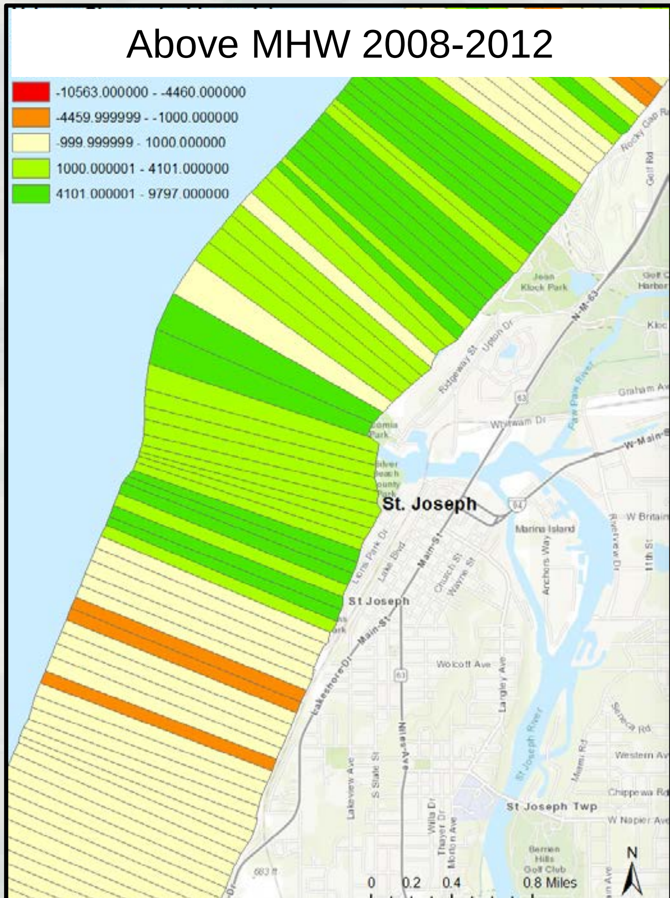
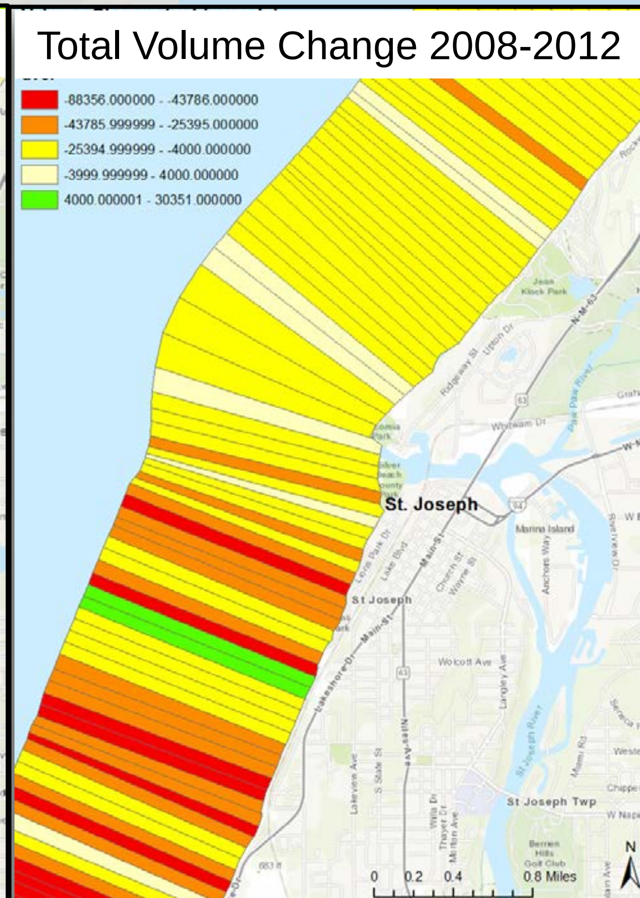
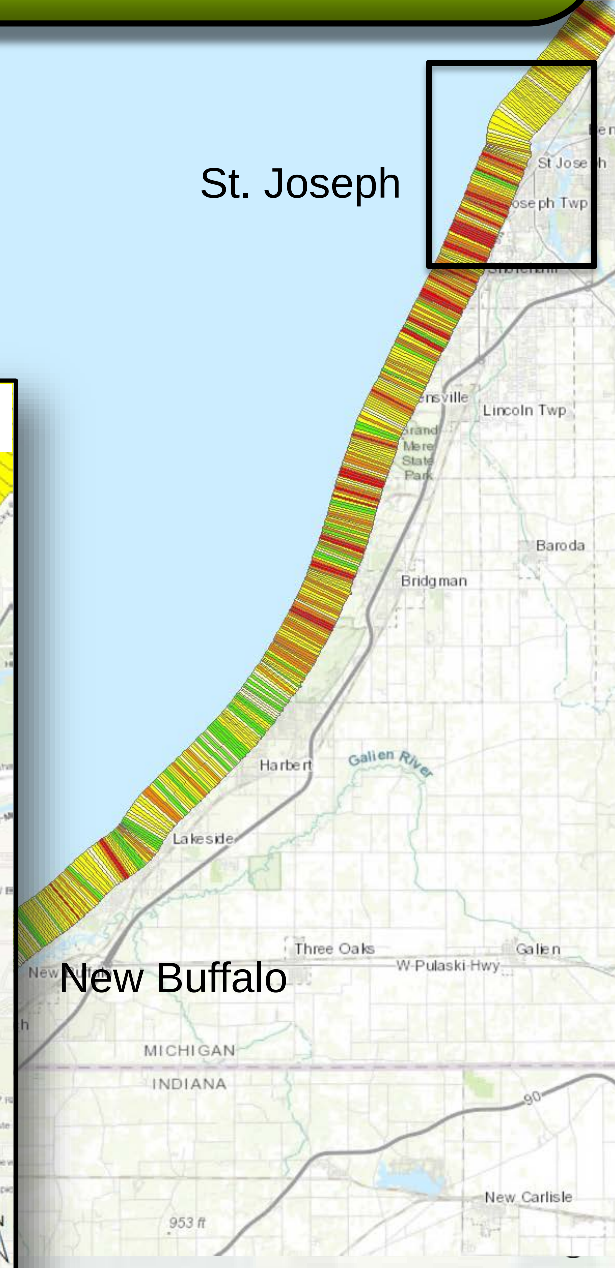
  - ArcGIS
    - Volume Change Toolbox
  - MATLAB
    - Bluff Crest & Toe Detection







3. Beach Volume and Shoreline Change

- Interim/Operational
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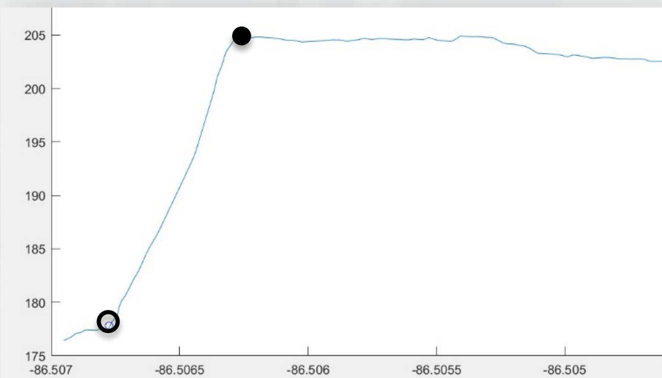
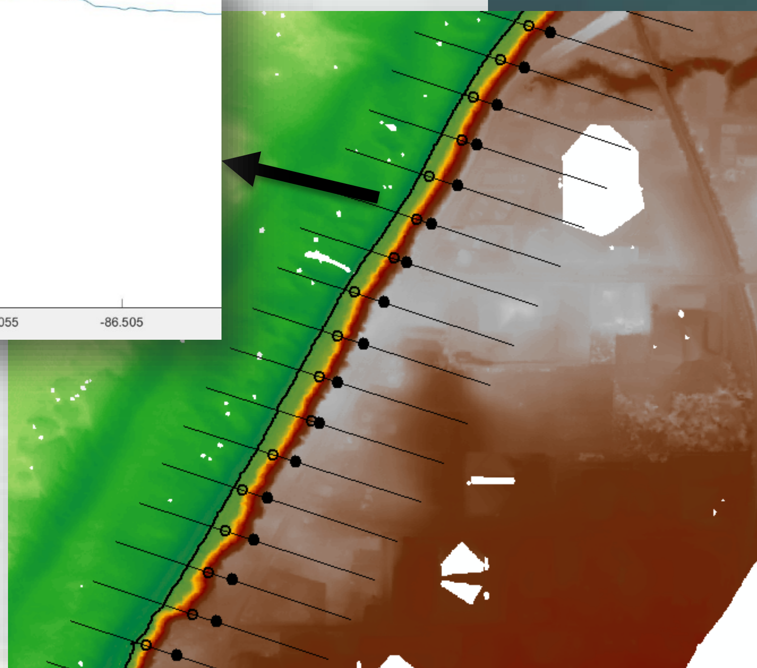
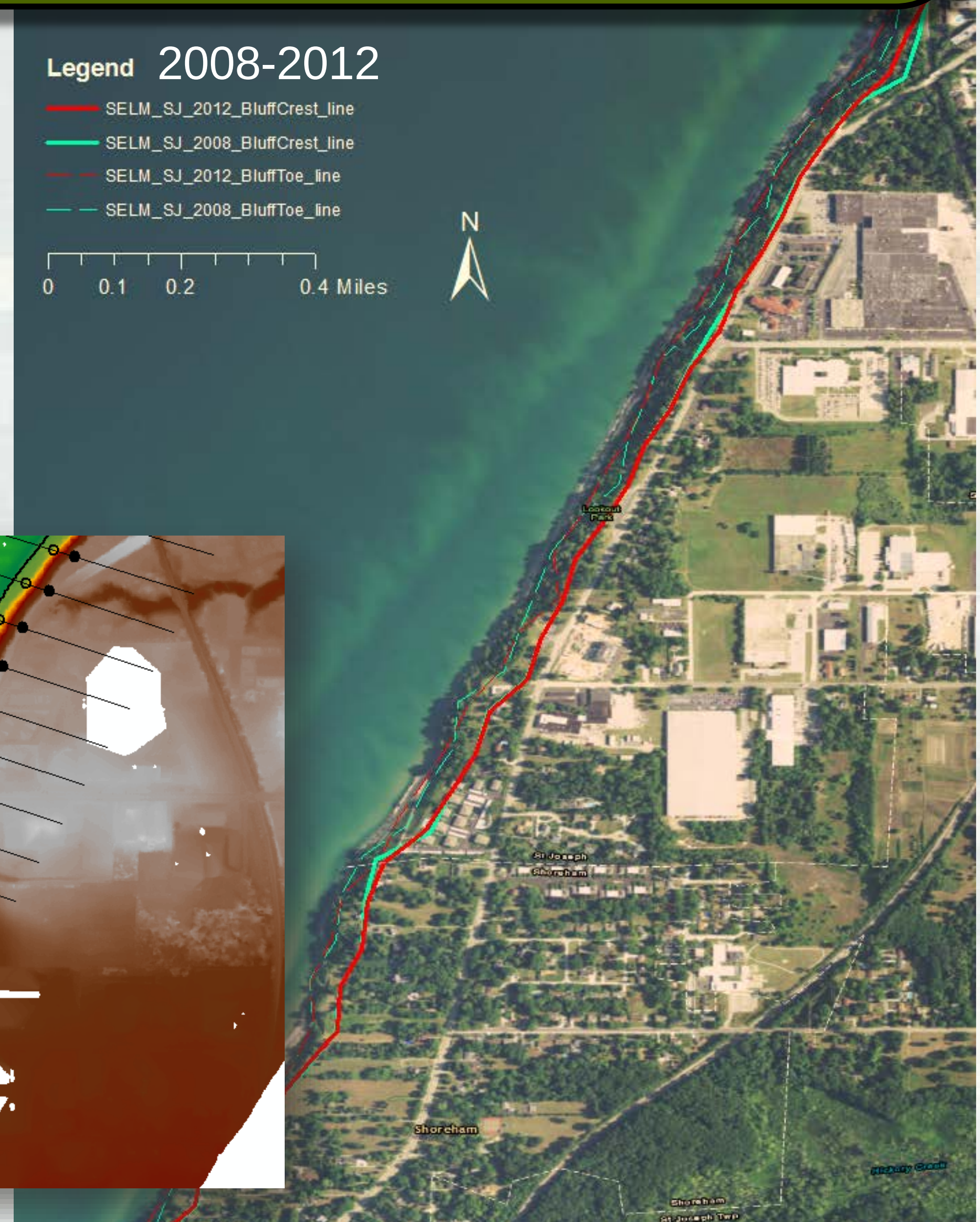
  - ArcGIS
    - Volume Change Toolbox
  - MATLAB
    - Bluff Crest & Toe Detection





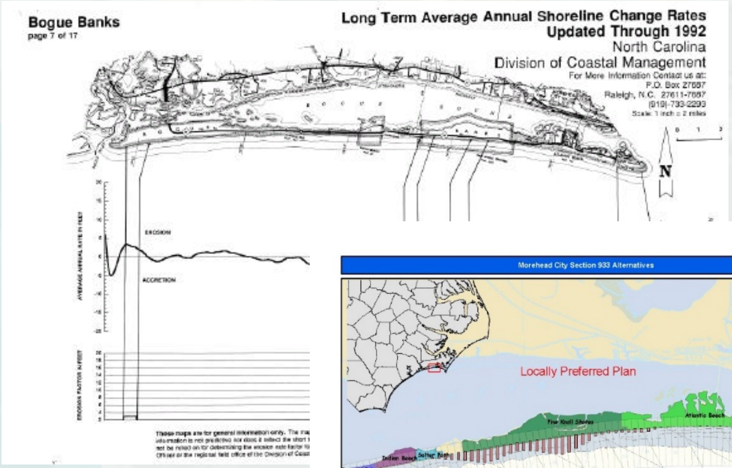


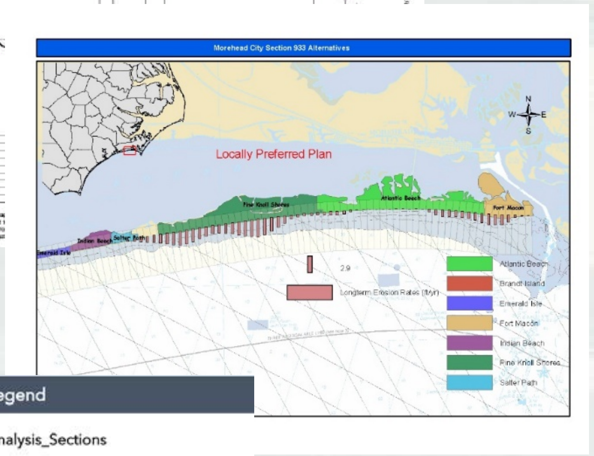
3. Beach Volume and Shoreline Change

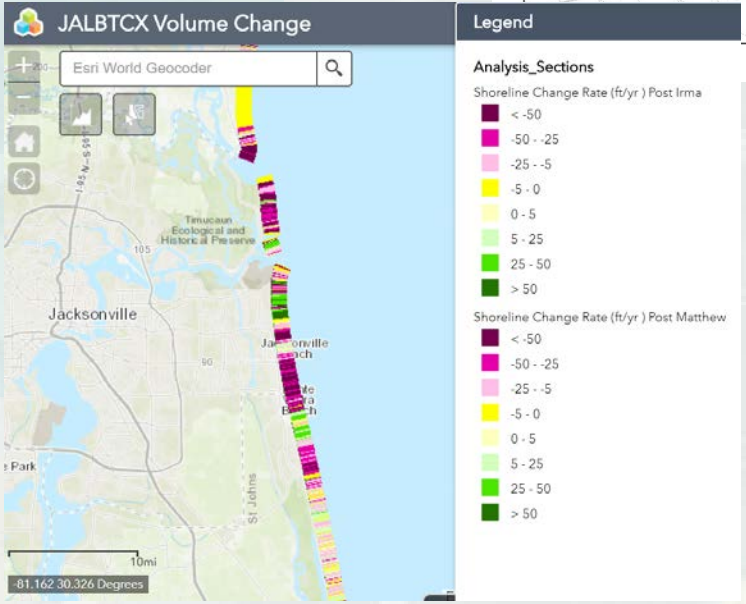
- Conceptual

Shoreline Data & Sources

- ▶ USGS
- ▶ Coastal Zone Management
- ▶ NOS T-sheets
- ▶ Photogrammetric
- ▶ LIDAR
- ▶ Beach Profiles
- ▶ Other…







3. Beach Volume and Shoreline Change

- Interim/Operational
  - ArcGIS
    - JALBTCX toolbox
    - DSAS

JALBTCX_quick_response_v2.tbx
- QR 01. Label Baseline and Generate Transects (optional)
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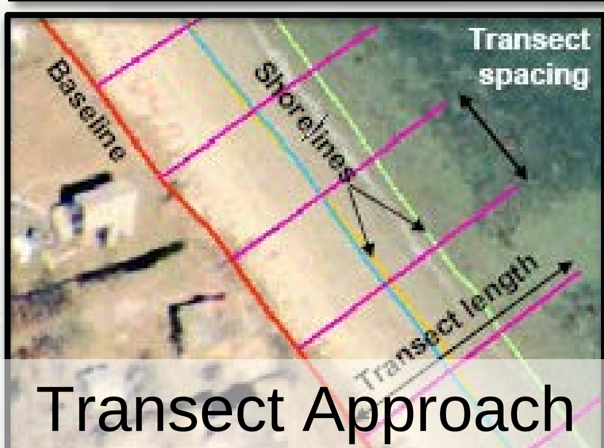
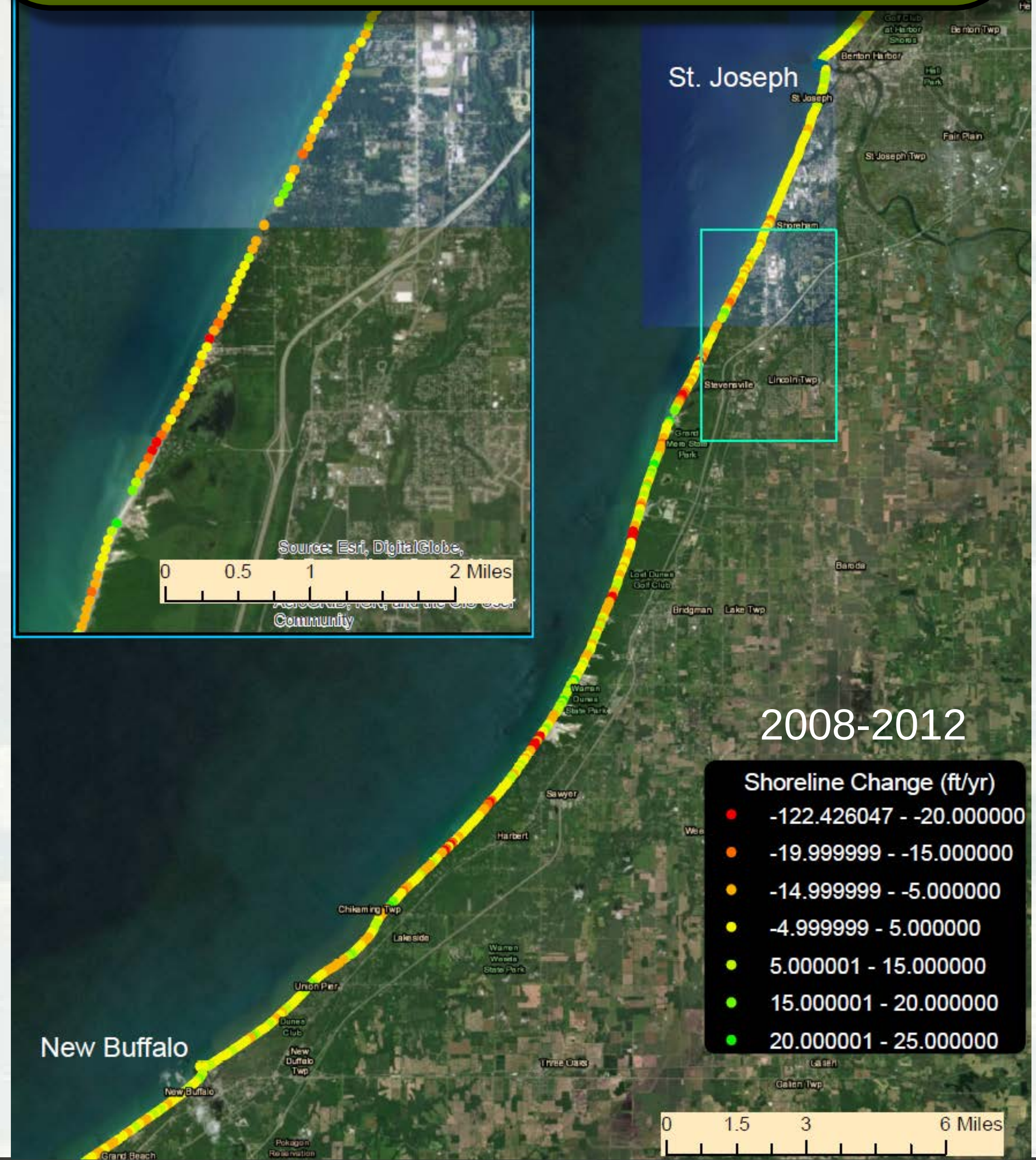


Transect Approach



3. Beach Volume and Shoreline Change

- Interim/Operational
  - ArcGIS
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    - DSAS

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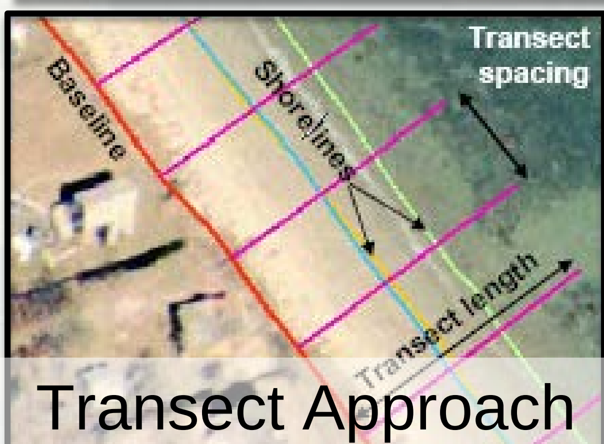
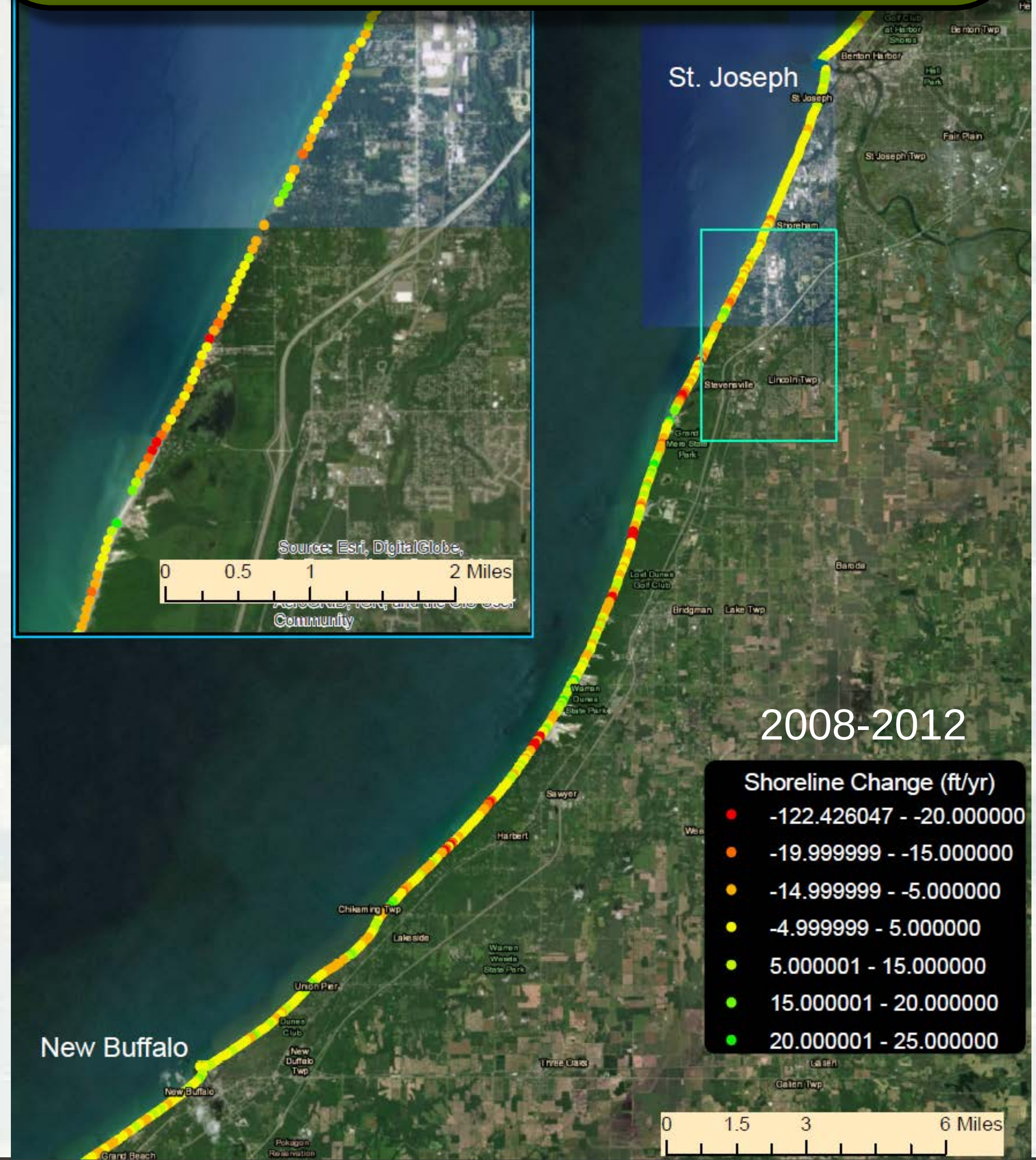
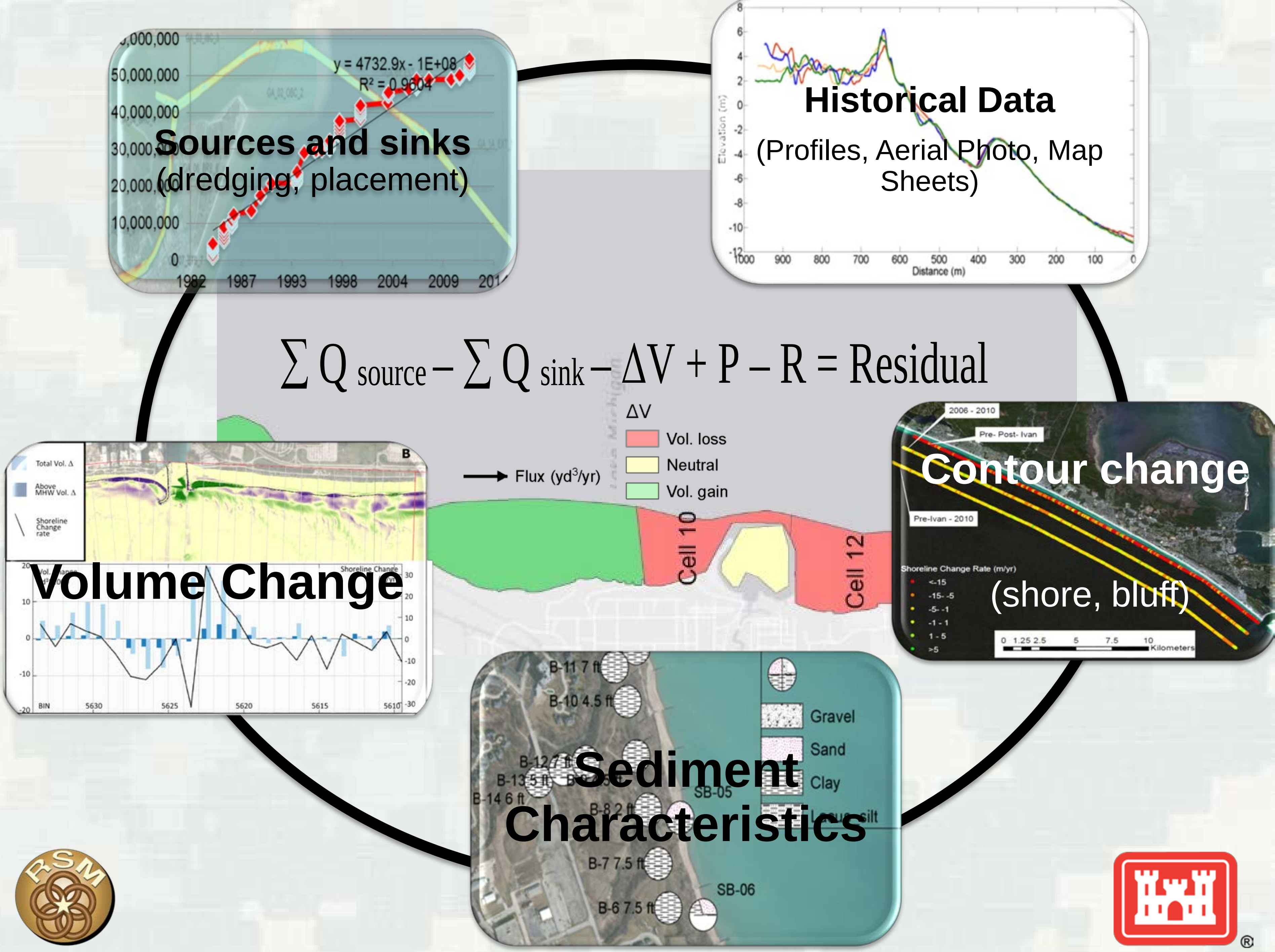
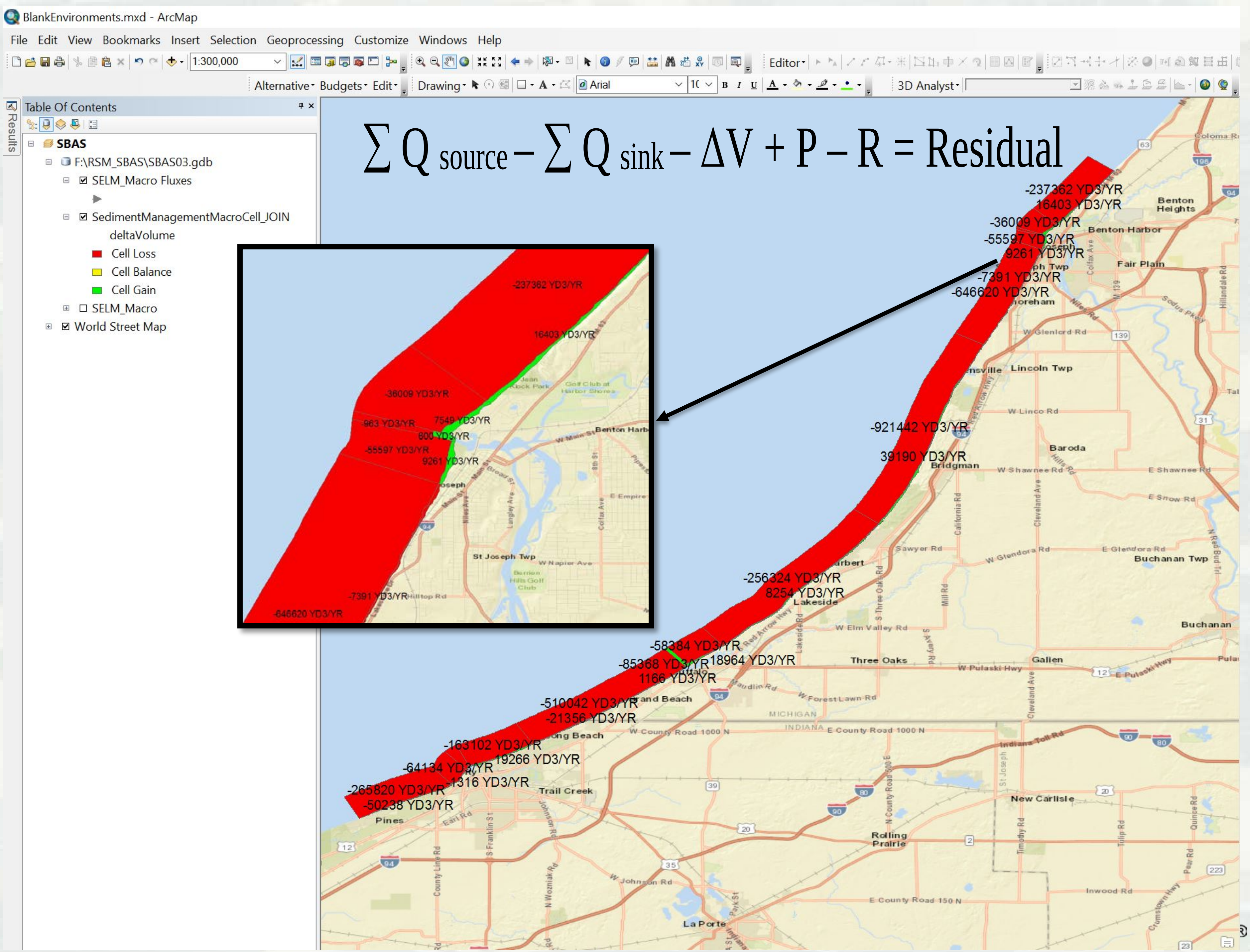


Transect Approach




Sources and sinks
(dredging, placement)
y = 4732.9x - 1E+08
R² = 0.9604
Historical Data
(Profiles, Aerial Photo, Map Sheets)
Elevation (m)
Distance (m)
∑ Q source – ∑ Q sink – ΔV + P – R = Residual
ΔV
Vol. loss
Neutral
Vol. gain
Flux (yd³/yr)
Cell 10
Cell 12
Contour change
(shore, bluff)
2006 - 2010
Pre- Post- Ivan
Pre-Ivan - 2010
Shoreline Change Rate (m/yr)
Kilometers
Volume Change
Total Vol. Δ
Above MHW Vol. Δ
Shoreline Change rate
Sediment Characteristics
Gravel
Sand
Clay
SB-05
SB-06
B-11 7 ft
B-10 4.5 ft
B-7 7.5 ft
B-6 7.5 ft
B-14 6 ft
B-8 2 ft
RSM

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = Residual$$



Sediment Budget Analysis

$$\sum Q_{source} - \sum Q_{sink} - \boxed{\Delta V} + P - R = Residual$$

Q_{source}

Sediment Transport Rates

Avg. Rates per Cell

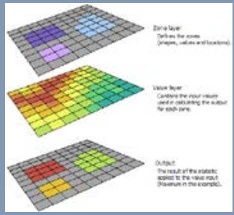
Q_{sink}

Grid Surface #2

Grid Surface #1

Elevation Difference

Volume Change – per cell



ΔV – volume change toolbox

Historic Data (Maps, Charts, Profiles)

Extract profile from Grid

Grid Surface #1

Elevation Difference

Volume Change Per Cell

Placement Values: Beach Fill
* values from Beach Nourishment web site

Removal Values: Dredge Events

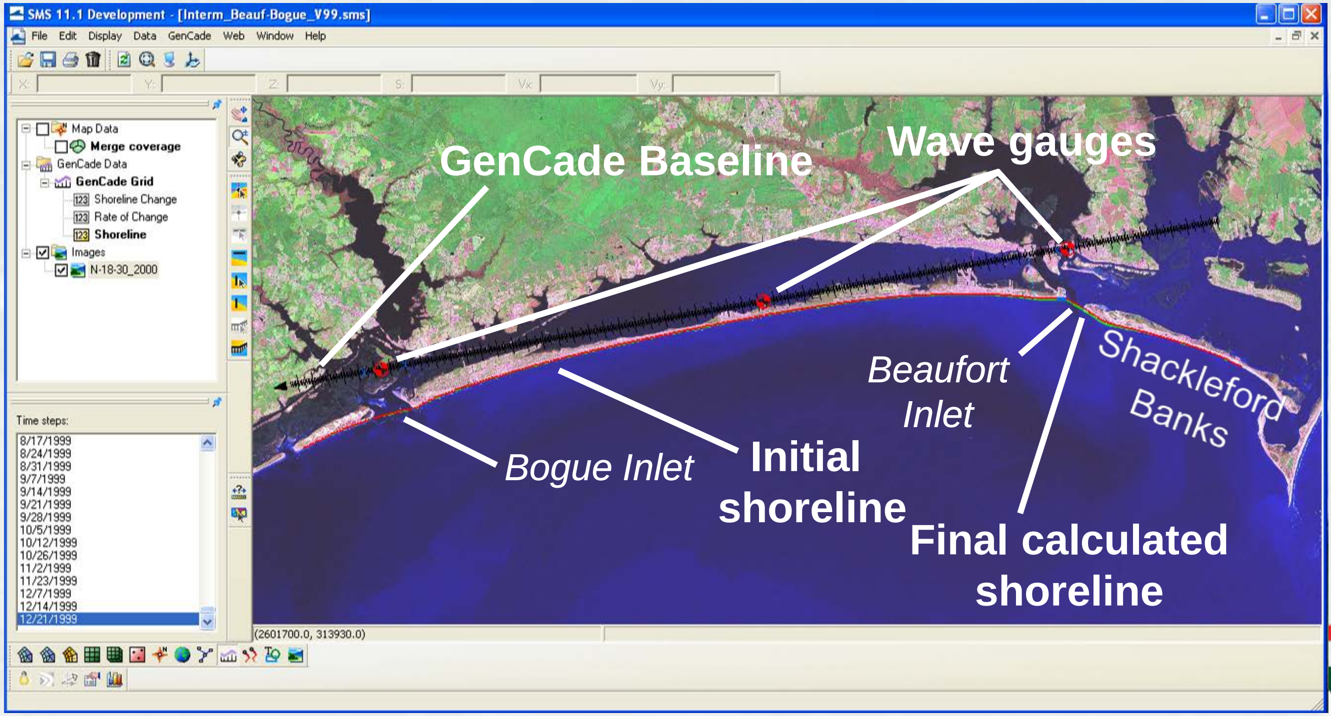
Flux Data Entry

Cell Data Entry

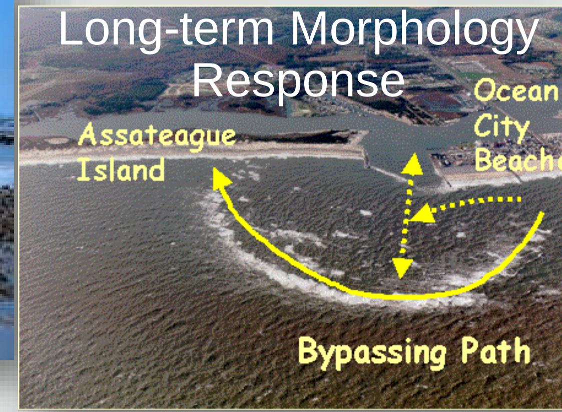
Residual

GenCade

- Integrated GENESIS and Cascade models for shoreline change and regional sediment calculation
- Connects inlets, navigation channels, ebb and flood shoals, and beaches in engineering activities in a regional framework
- Decision-making support for planning, operation, and engineering
- In SMS 11.1; PC, user-friendly interface for engineers & scientists



GenCade

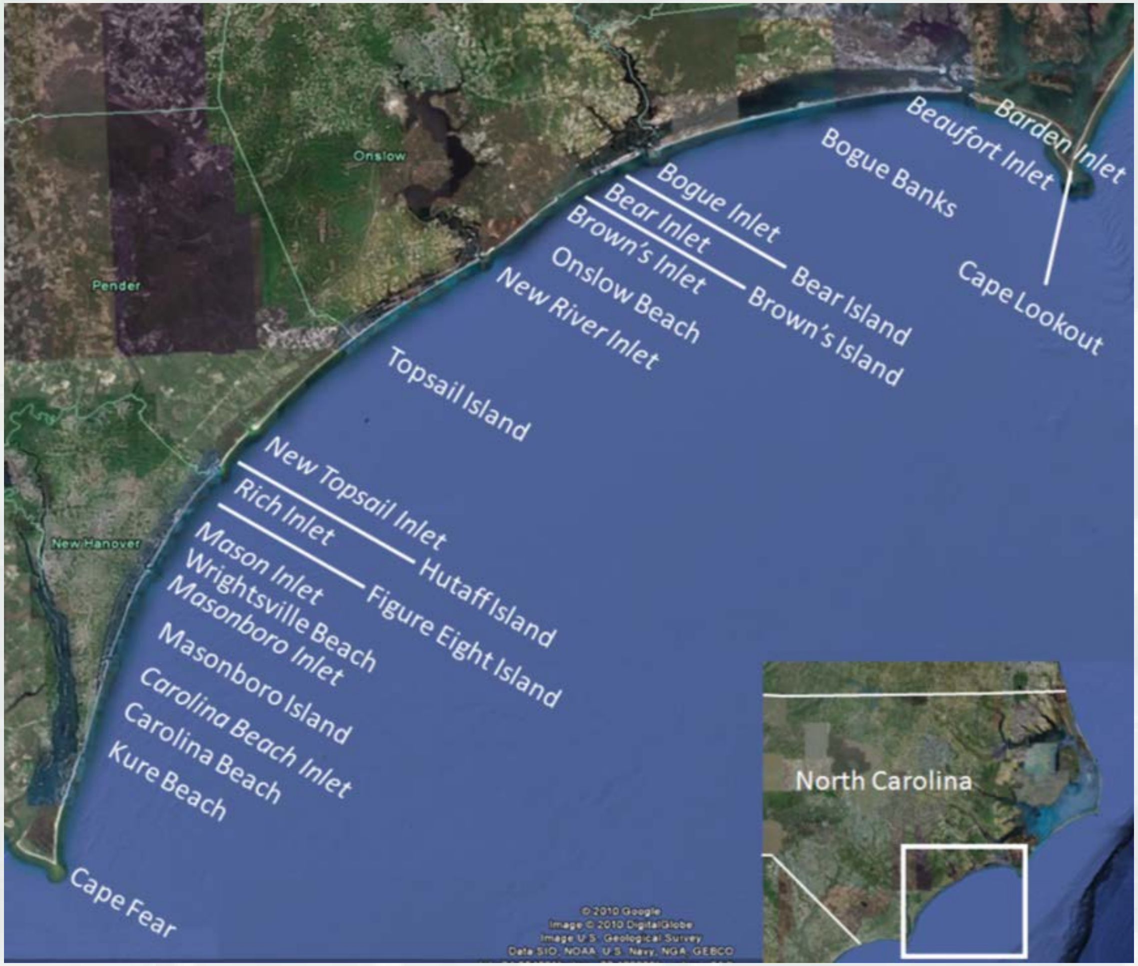


Why GenCade?

- Sediment storage and transfer (bypassing, back-passing)
- Navigation channel maintenance
- Multiple interacting inlet dredging & placements on beaches
- Cumulative impacts
- Sources & sinks (shoal dredging and beach nourishment)
- Compatibility with data and previous calculations

Overview of Onslow Bay

- Cape Lookout to Cape Fear
- More than 185 km of shoreline
- 11 inlets
- Developed and undeveloped barrier islands
- Few coastal structures



Problem Statement

Main goal – Improve understanding of the Onslow Bay regional sediment system

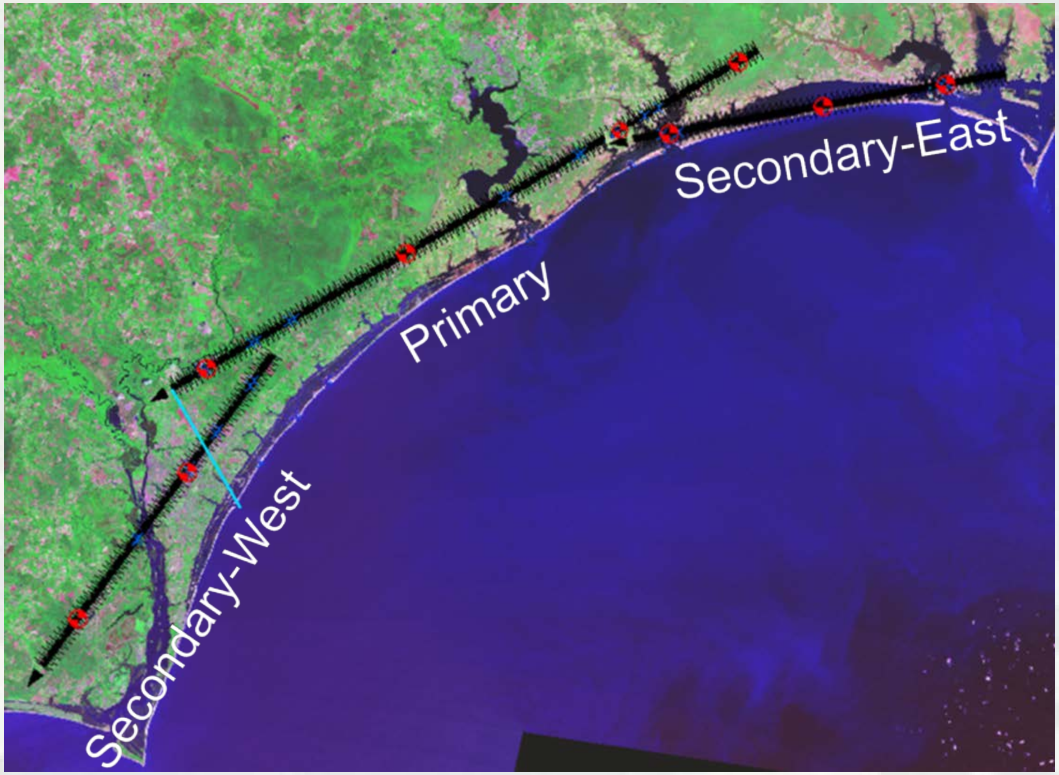
Initial Task

- use a numerical model to calculate shoreline change and longshore sand transport in Onslow Bay

Final Tasks

- develop a sediment budget based on the numerical modeling results
- develop a tool to connect GenCade results to the Sediment Budget Analysis System (SBAS) automatically

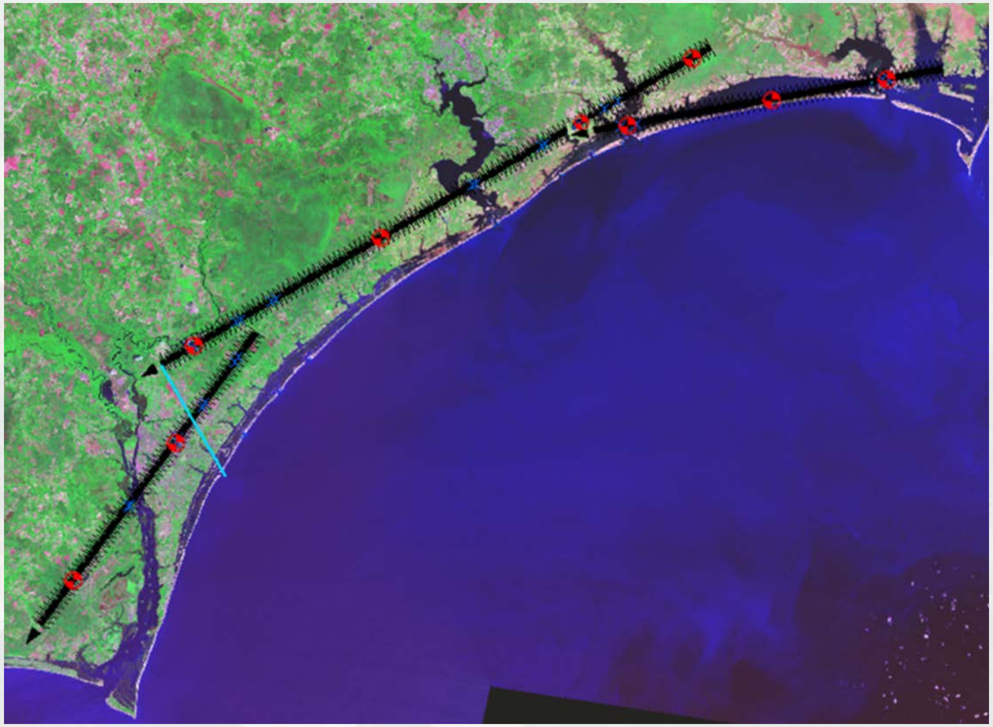
GenCade Calibration



Three separate GenCade models

- Primary
  - 8 inlets
  - 4 wave gauges
- Secondary-East
  - 2 inlets
  - 3 wave gauges
- Secondary-West
  - 4 inlets
  - 2 wave gauges

GenCade Calibration

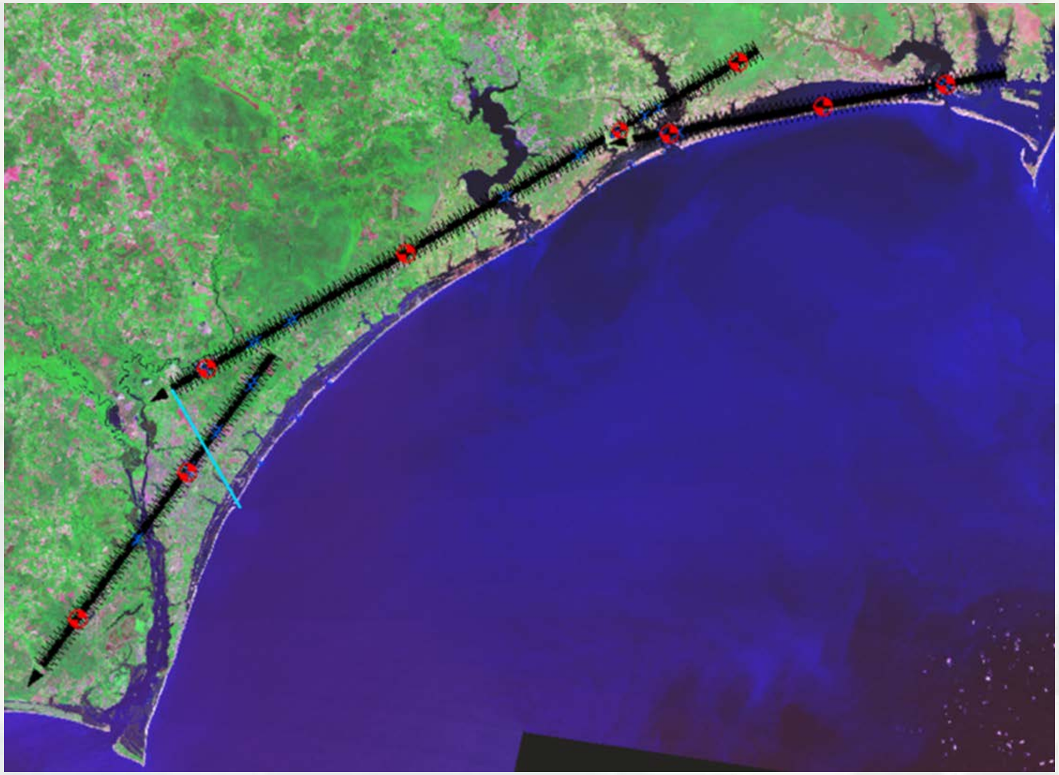


GenCade Input

- 1997 and 2004 shorelines
- Waves (WIS 63274, 63276, 63279, 63292, 63298, 63304)
- Masonboro Inlet jetties
- Carolina Beach seawall
- Fort Fisher revetment
- Beaufort Inlet terminal groin

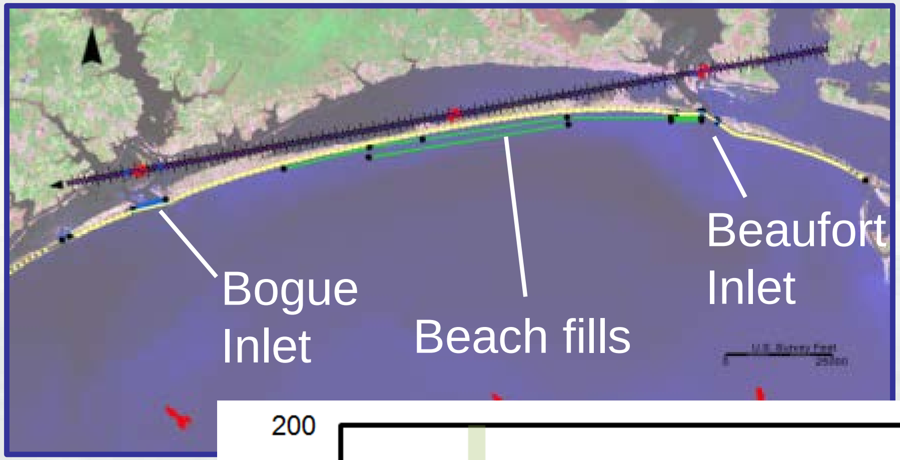
- Beach fills on Bogue Banks, Figure Eight Island, Masonboro Island, Wrightsville Beach, Carolina Beach, and Kure Beach
- Beaufort Inlet, New River Inlet, Rich Inlet, Masonboro Inlet, Carolina Beach Inlet dredging events

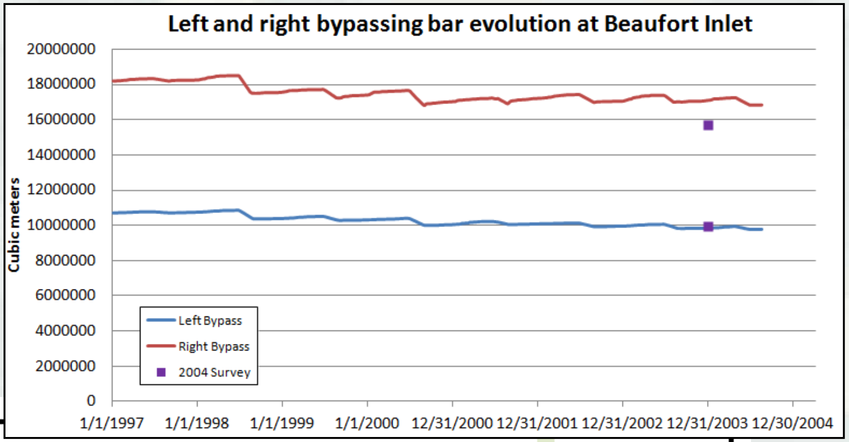
GenCade Calibration

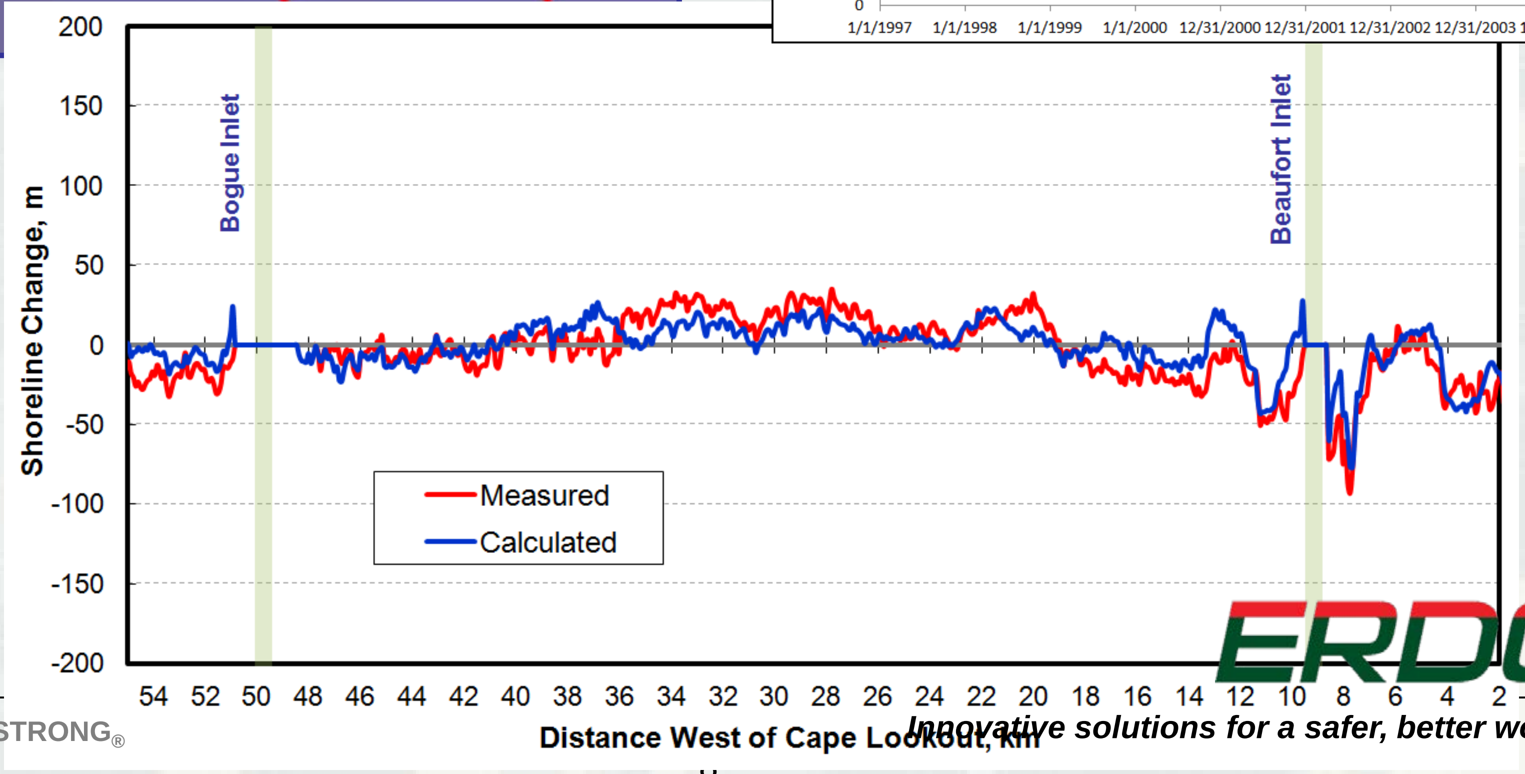


Parameter	Value
Start Date	1/1/1997 0:00
End Date	8/27/2004 0:00
Time Step	0.5 hr
Recording Time Step	168 hr
Effective Grain Size, mm	0.17
Average Berm Height, m	1.4
Average Depth of Closure, m	8.1
Lateral Boundary Conditions	Moving
K1	0.6
K2	0.4
ISMOOTH (smoothing window)	100
Cell spacing, m	91

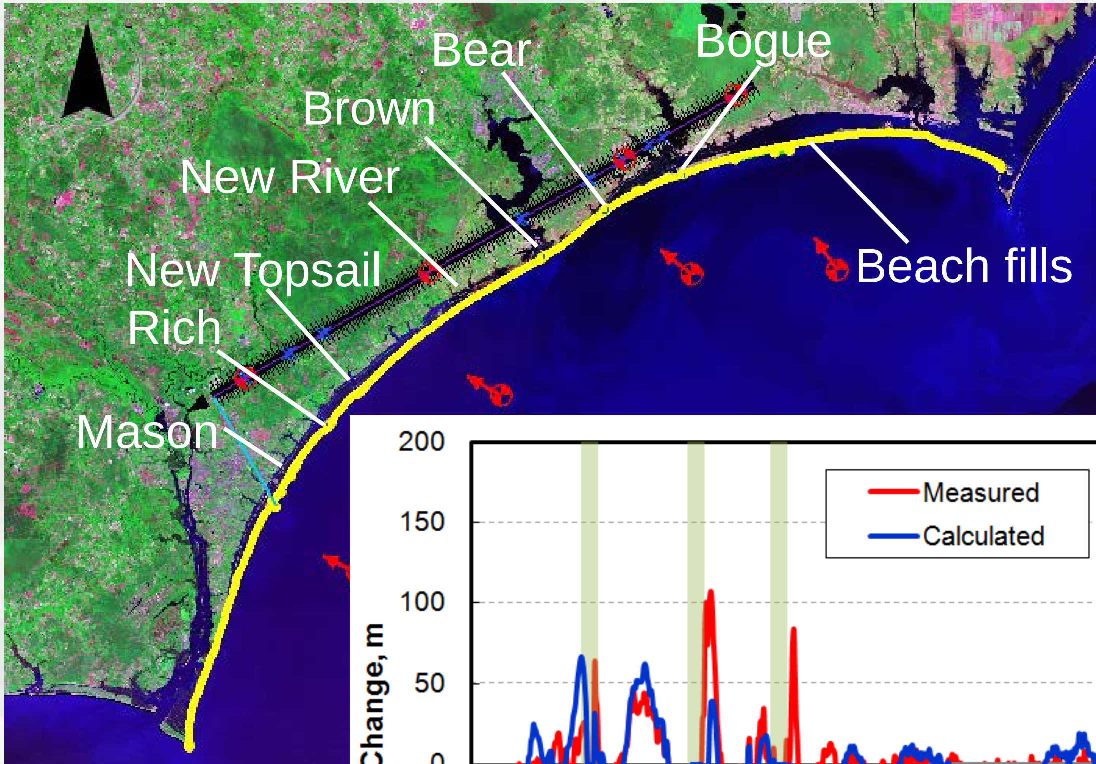
GenCade Results: Secondary-East

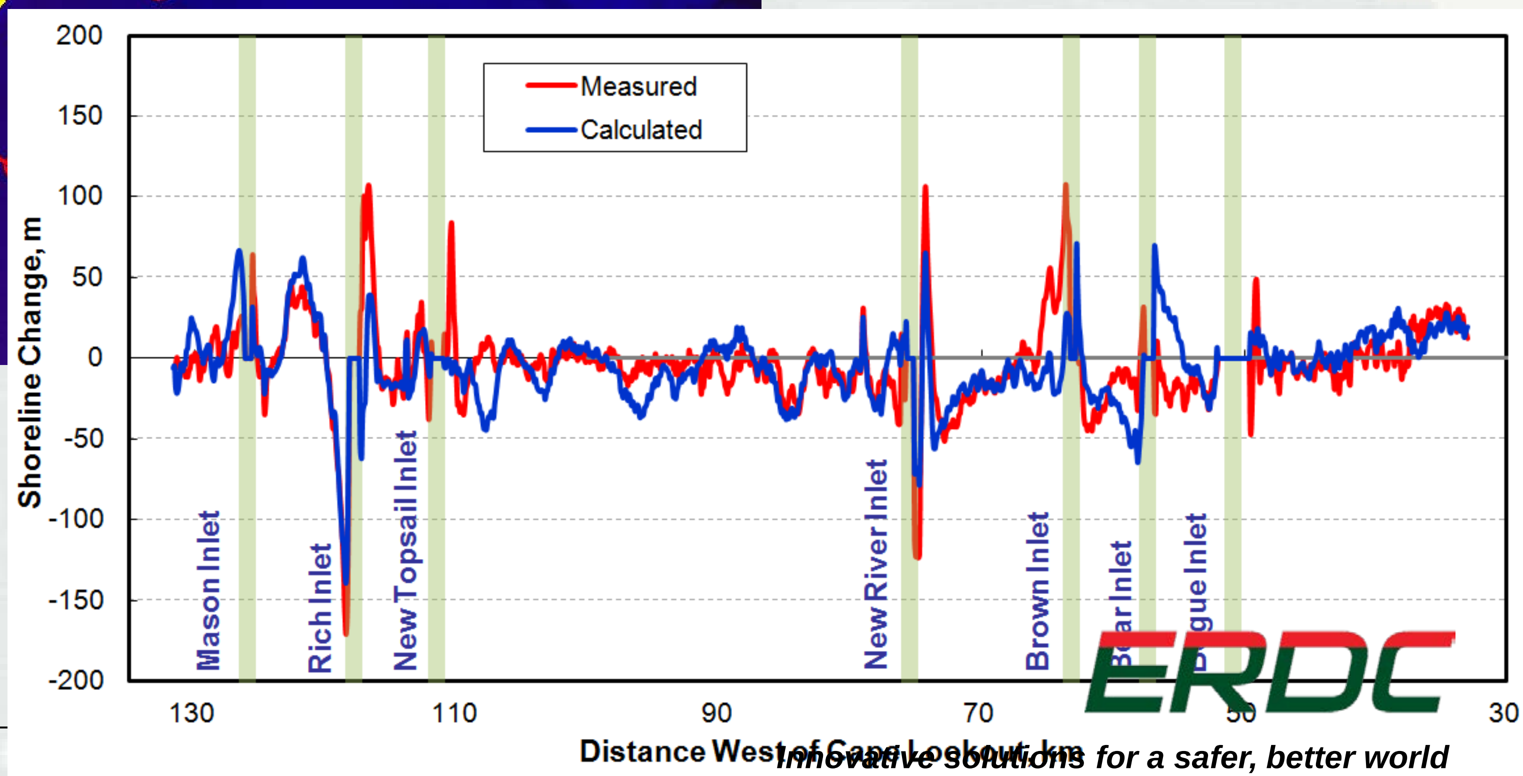




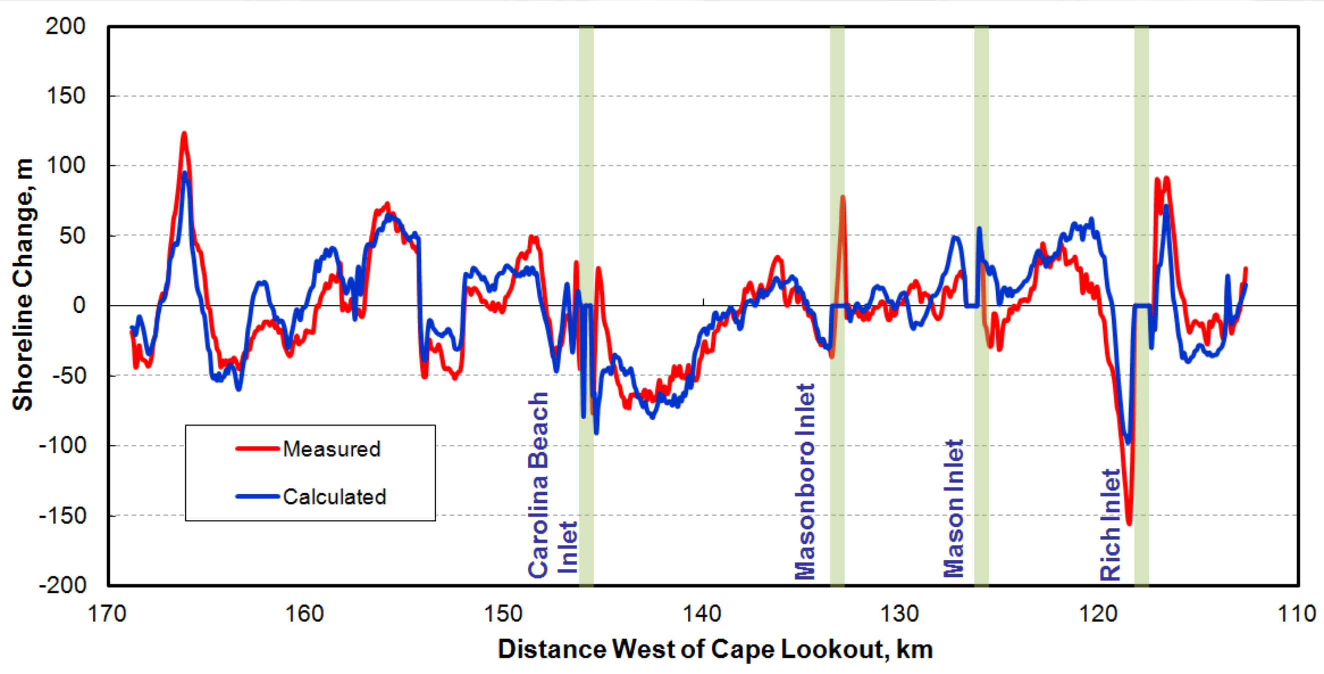


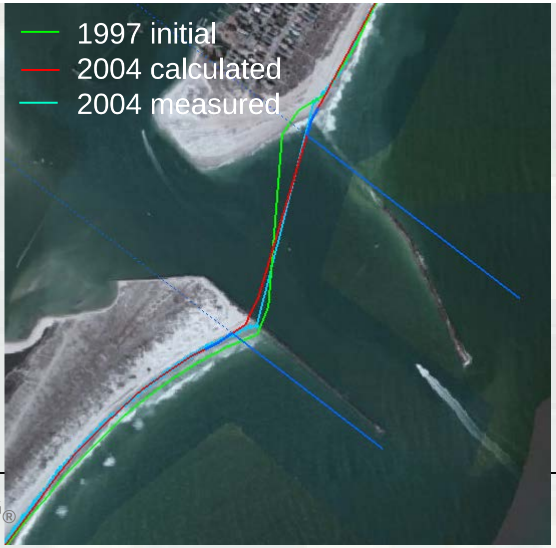
GenCade Results: Primary

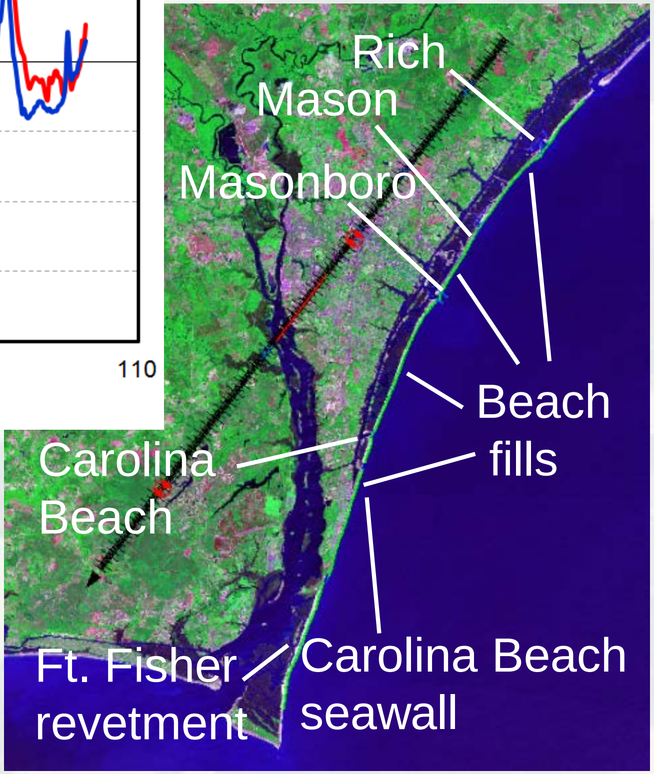




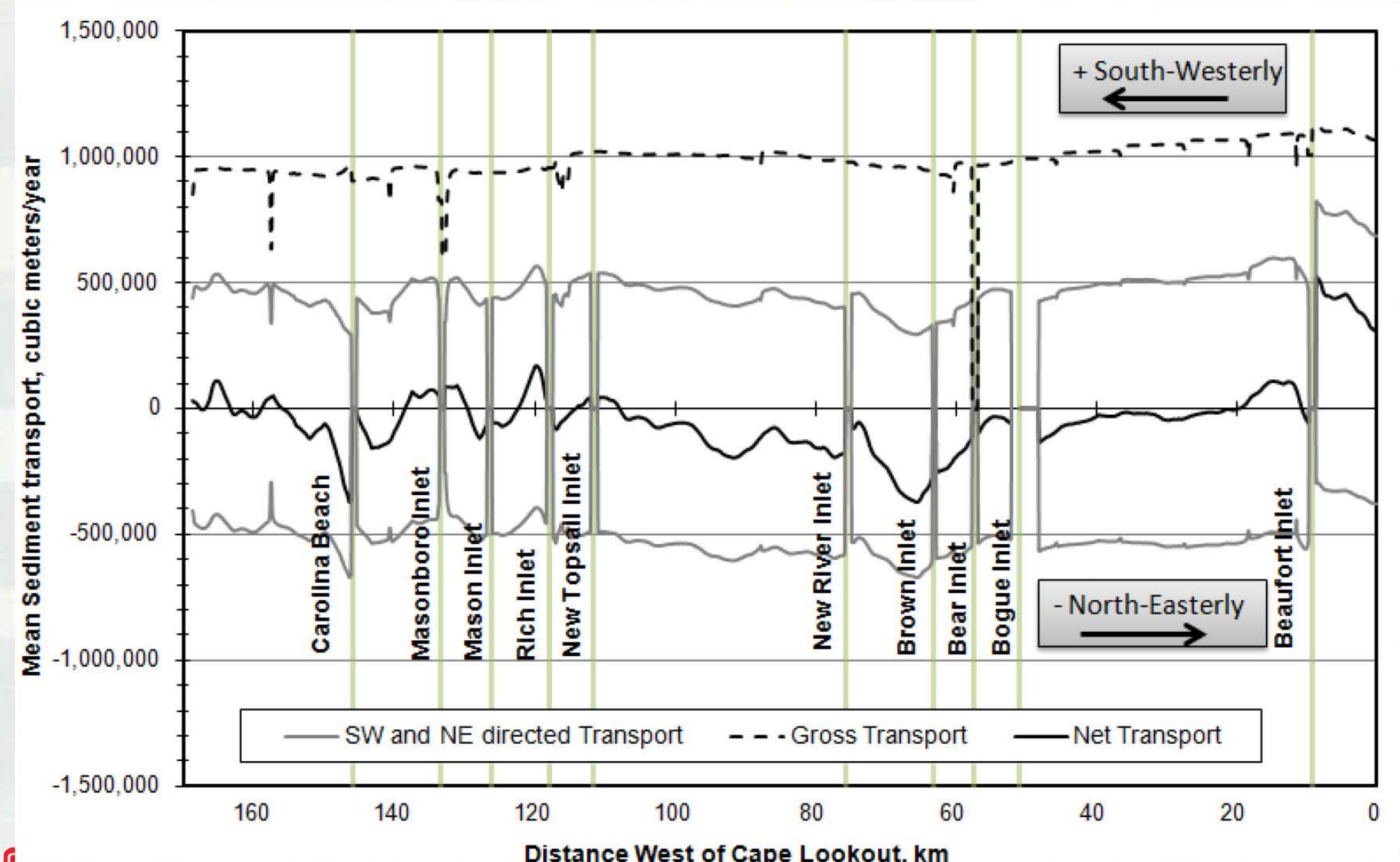
GenCade Results: Secondary-West



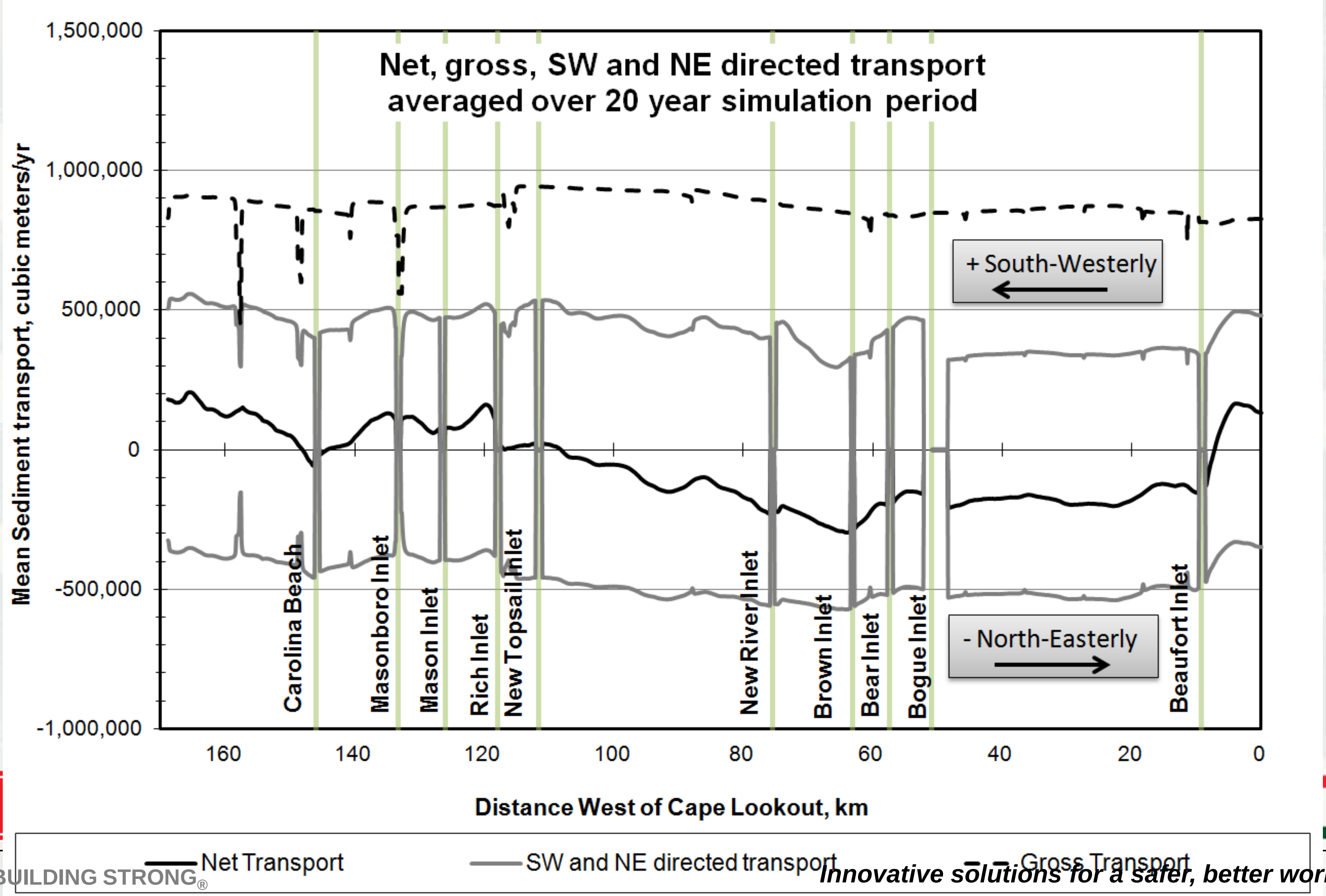




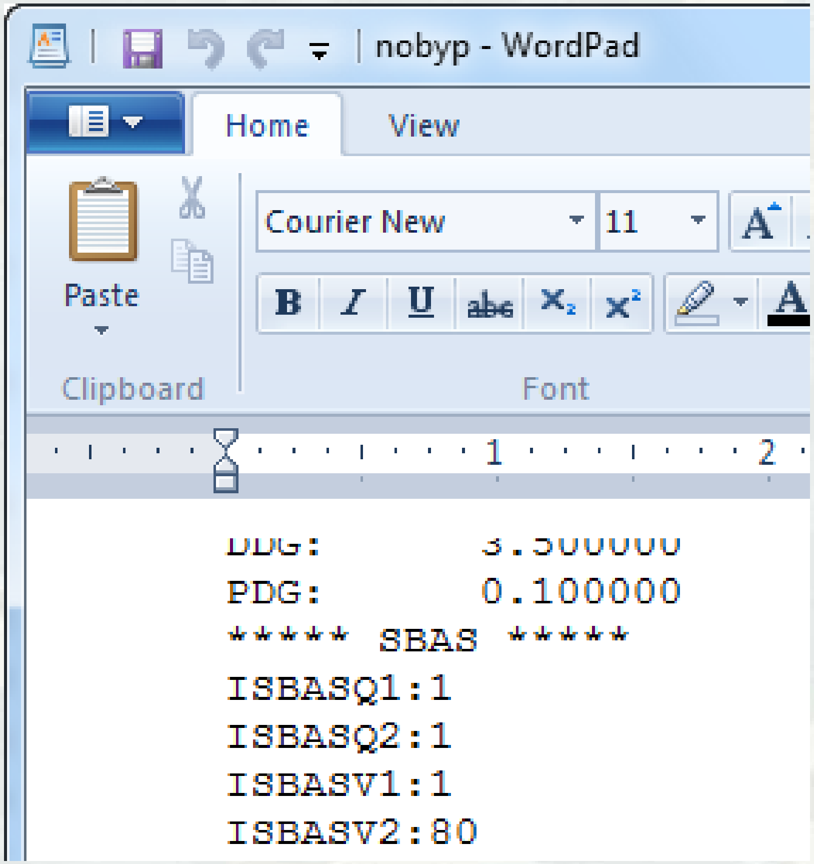
GenCade Results: Longshore Transport



GenCade Results: Longshore Transport (20 years)



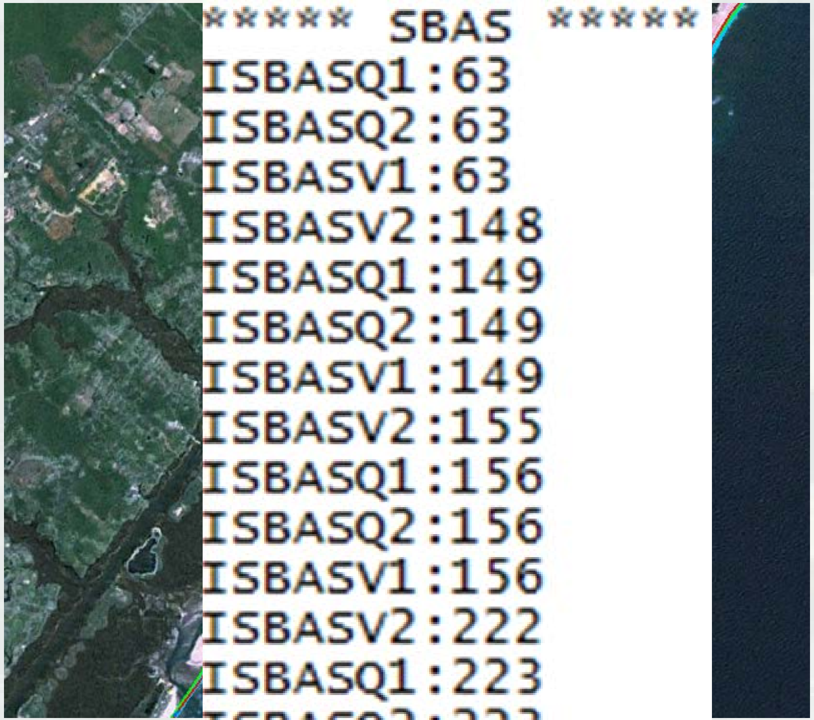
Advanced Cards



Sediment Budget: Producing output from GenCade

Typical outputs
- Shoreline change
- Longshore transport
- Inlet shoal volumes

New input file created to output volume change for specific cells and longshore transport rates between cells



```
***** SBAS *****
ISBASQ1:63
ISBASQ2:63
ISBASV1:63
ISBASV2:148
ISBASQ1:149
ISBASQ2:149
ISBASV1:149
ISBASV2:155
ISBASQ1:156
ISBASQ2:156
ISBASV1:156
ISBASV2:222
ISBASQ1:223
ISBASQ2:223
ISBASV1:223
ISBASV2:229
ISBASQ1:230
ISBASQ2:230
```

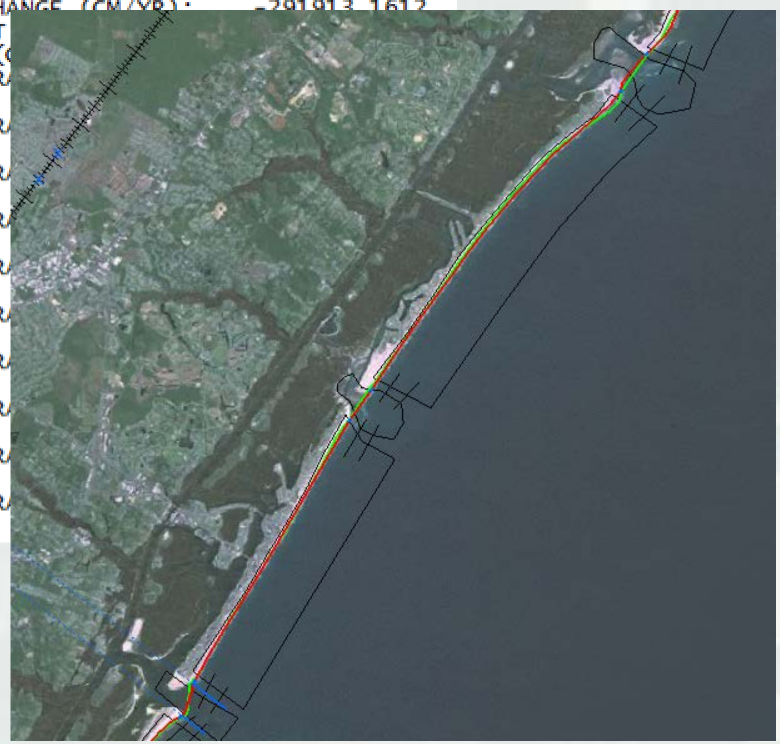
Sediment Budget: Producing output from GenCade


```
***** SBAS *****
ISBASQ1:63
ISBASQ2:63
ISBASV1:63
ISBASV2:148
ISBASQ1:149
ISBASQ2:149
ISBASV1:149
ISBASV2:155
ISBASQ1:156
ISBASQ2:156
ISBASV1:156
ISBASV2:222
ISBASQ1:223
ISBASQ2:223
ISBASV1:223
ISBASV2:229
ISBASQ1:230
ISBASQ2:230
```

```
*************************************************************************
*                              SBAS OUTPUT                              *
*************************************************************************

 SBAS CELL            1   VOLUME CHANGE (CM/YR):    209398.5782
                          PLACEMENT (CM/YR):        116497.5174
                          REMOVAL (CM/YR):          0.0000E+000
 SBAS CELL            2   VOLUME CHANGE (CM/YR):    0.0000E+000
                          PLACEMENT (CM/YR):        0.0000E+000
                          REMOVAL (CM/YR):          0.0000E+000
 SBAS CELL            3   VOLUME CHANGE (CM/YR):    71521.8133
                          PLACEMENT (CM/YR):        217076.2381
                          REMOVAL (CM/YR):          0.0000E+000
 SBAS CELL            4   VOLUME CHANGE (CM/YR):    -291913.1612
                          PLACEMENT (CM/YR):        0.0000E+000
                          REMOVAL (CM/YR):          327990.9759
 SBAS FLUX ARROW              1   TRANSPORT FLUX TO RIGHT (CM/YR):
  362863.0875
 SBAS FLUX ARROW              1   TRANSPORT FLUX TO LEFT (CM/YR):
 -332898.6535
 SBAS FLUX ARROW              2   TRANSPORT FLUX TO RIGHT (CM/YR):
  436323.8119
 SBAS FLUX ARROW              2   TRANSPORT FLUX TO LEFT (CM/YR):
 -499260.4387
 SBAS FLUX ARROW              3   TRANSPORT FLUX TO RIGHT (CM/YR):
  436323.8119
 SBAS FLUX ARROW              3   TRANSPORT FLUX TO LEFT (CM/YR):
 -499260.4387
 SBAS FLUX ARROW              4   TRANSPORT FLUX TO RIGHT (CM/YR):
 342132.9471
 SBAS FLUX ARROW              4   TRANSPORT FLUX TO LEFT (CM/YR):
 -259515.1491
 SBAS FLUX ARROW              5   TRANSPORT FLUX TO RIGHT (CM/YR):
 436456.8445
 SBAS FLUX ARROW              5   TRANSPORT FLUX TO LEFT (CM/YR):
 -389916.8611
```

Sedimentt Budget: Using GenCade results in SBAS

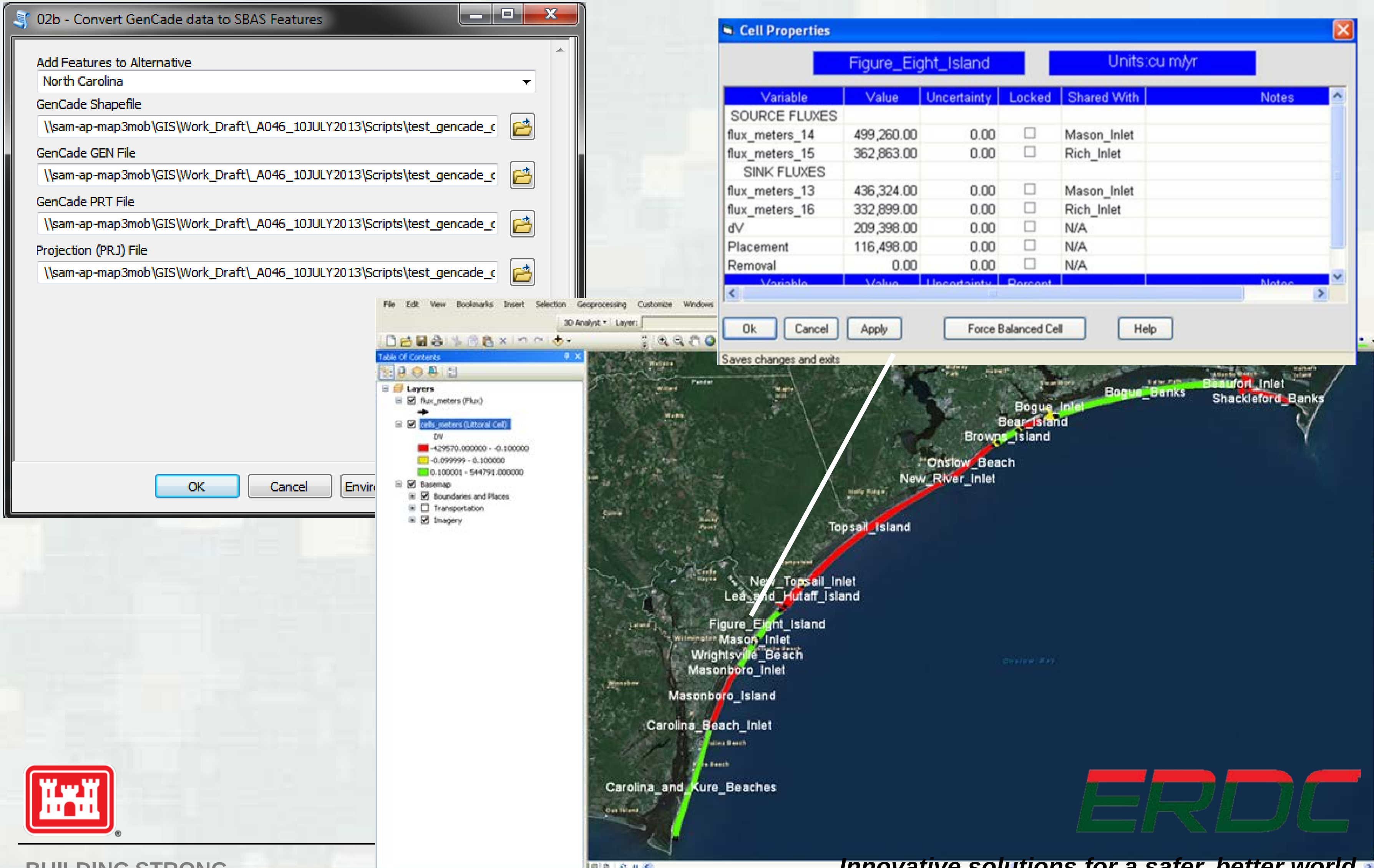
```
*************************************************************************
*                          SBAS OUTPUT                                  *
*************************************************************************

 SBAS CELL            1  VOLUME CHANGE (CM/YR):     209398.5782
                         PLACEMENT (CM/YR):         116497.5174
                         REMOVAL (CM/YR):           0.0000E+000
 SBAS CELL            2  VOLUME CHANGE (CM/YR):     0.0000E+000
                         PLACEMENT (CM/YR):         0.0000E+000
                         REMOVAL (CM/YR):           0.0000E+000
 SBAS CELL            3  VOLUME CHANGE (CM/YR):     71521.8133
                         PLACEMENT (CM/YR):         217076.2381
                         REMOVAL (CM/YR):           0.0000E+000
 SBAS CELL            4  VOLUME CHANGE (CM/YR):     -291913.1612
                         PLACEMENT
                         REMOVAL (
 SBAS FLUX ARROW               1  TR
  362863.0875
 SBAS FLUX ARROW               1  TR
 -332898.6535
 SBAS FLUX ARROW               2  TR
  436323.8119
 SBAS FLUX ARROW               2  TR
 -499260.4387
 SBAS FLUX ARROW               3  TR
  436323.8119
 SBAS FLUX ARROW               3  TR
 -499260.4387
 SBAS FLUX ARROW               4  TR
 342132.9471
 SBAS FLUX ARROW               4  TR
 -259515.1491
 SBAS FLUX ARROW               5  TR
 436456.8445
 SBAS FLUX ARROW               5  TR
 -389916.8611
```



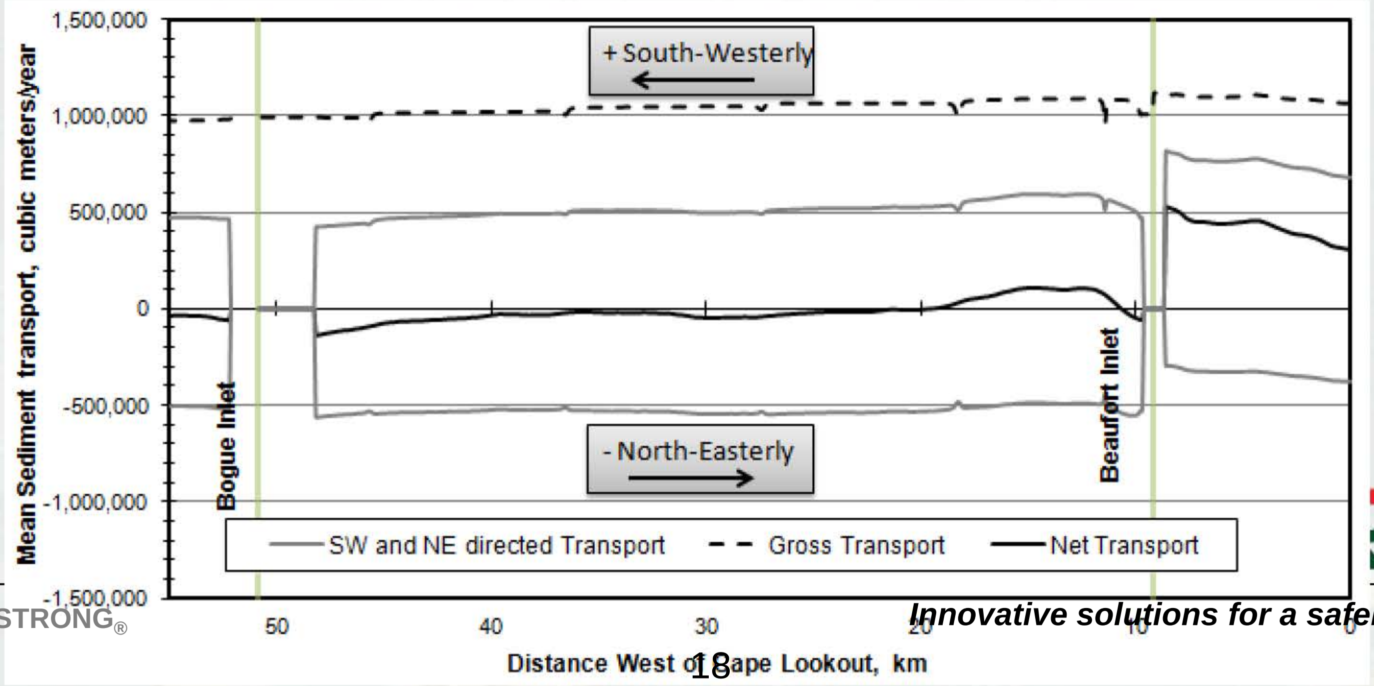
Two pieces of information needed for input into SBAS

- SBAS output from GenCade
- Shapefile of SBAS cells (from SMS)

Sediment Budget: Using GenCade results in SBAS



Sediment Budget in SBAS



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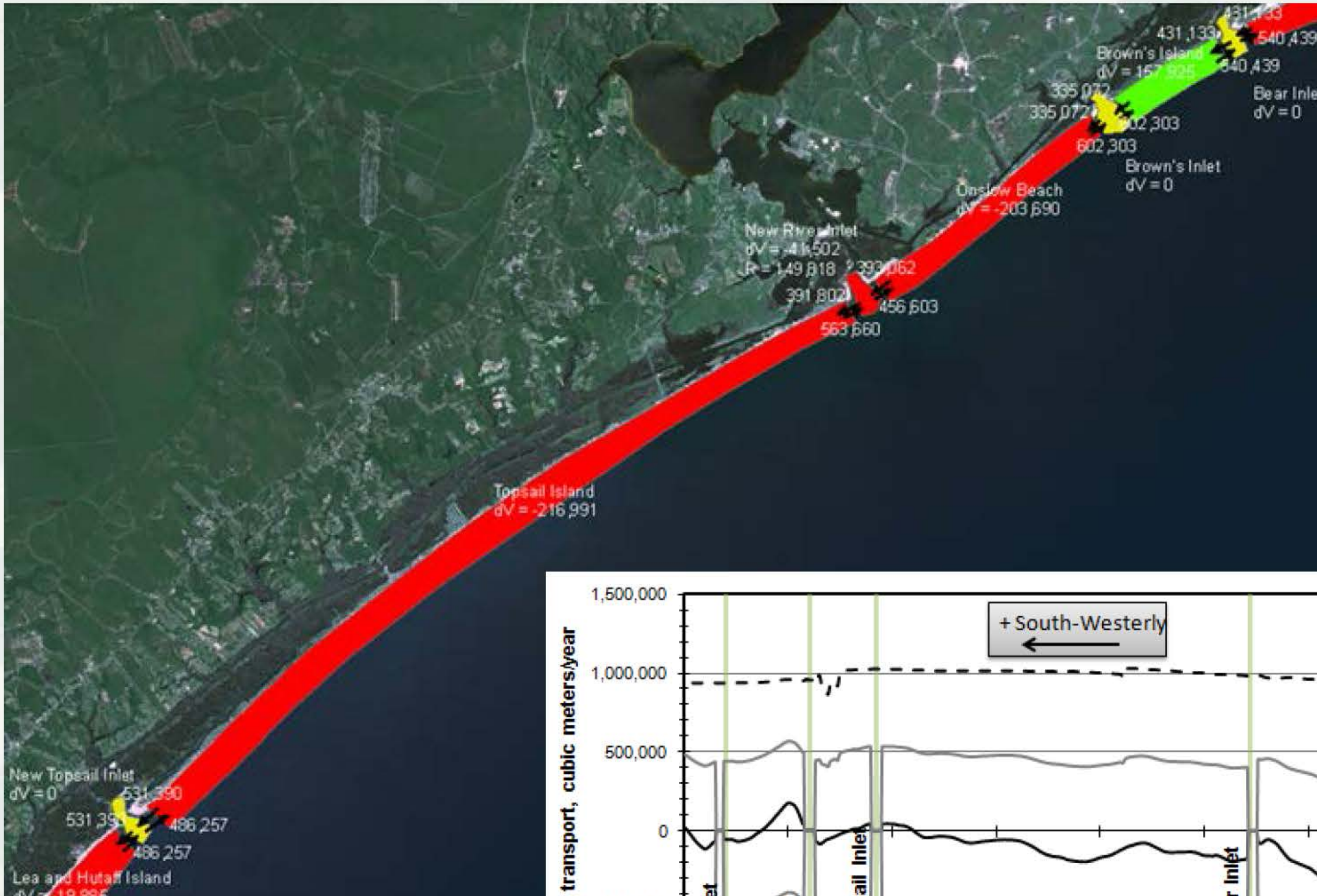
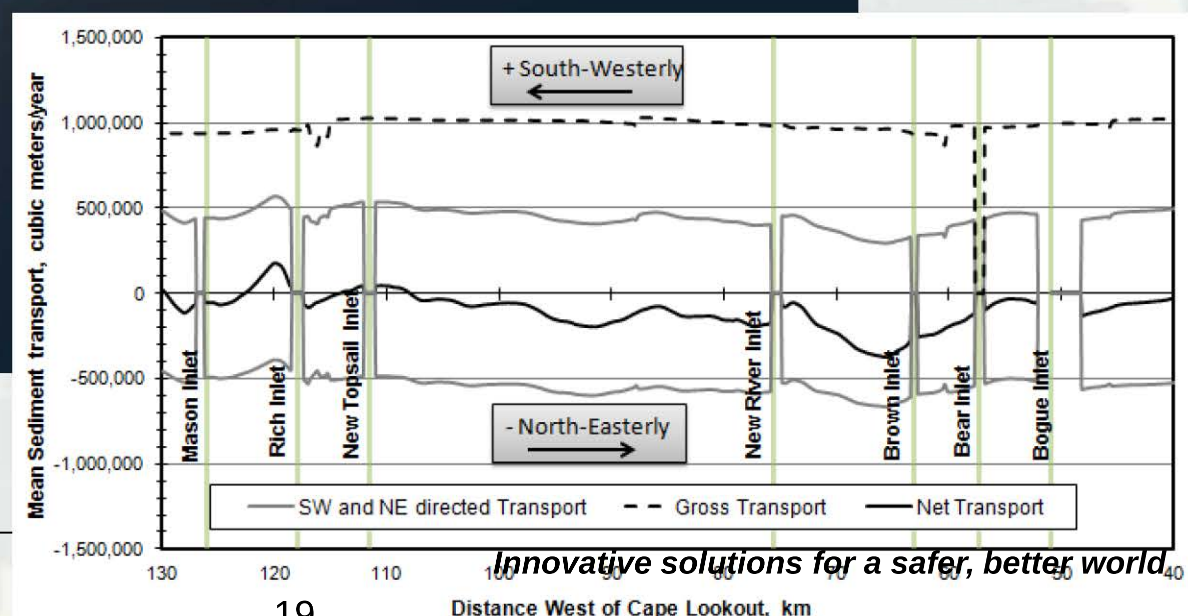
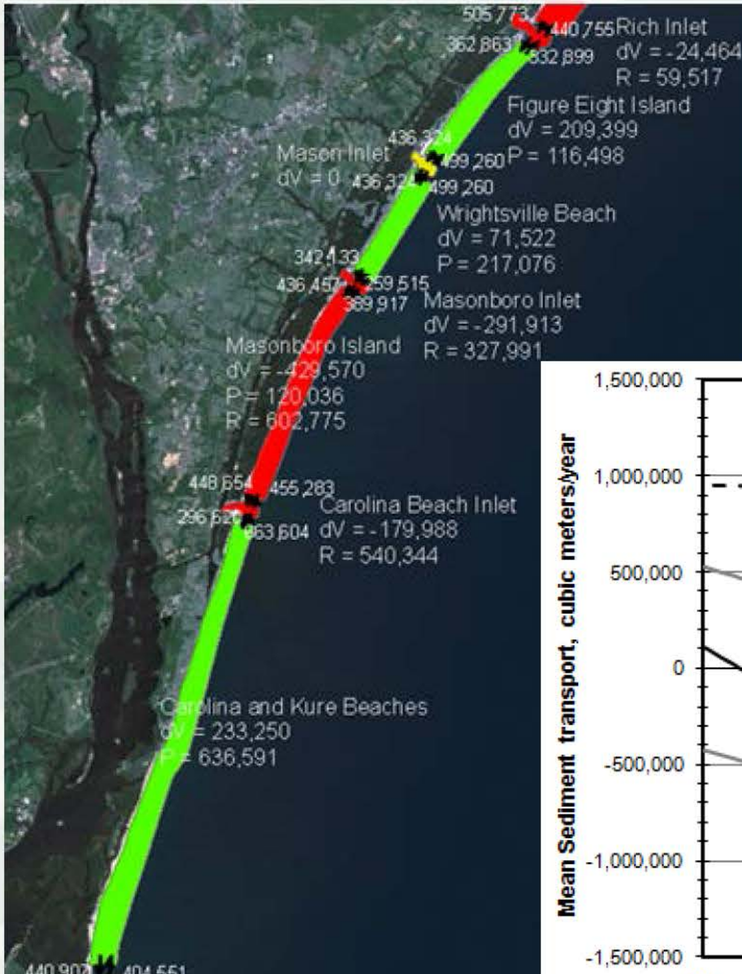
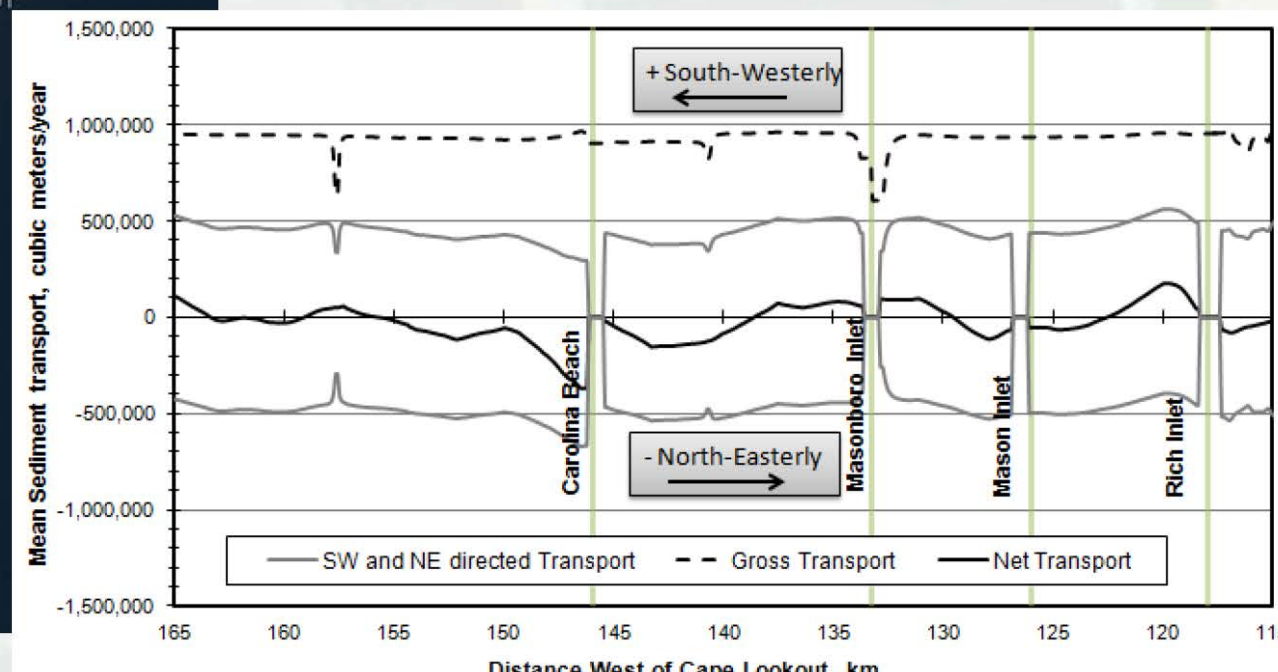
Sediment Budget in SBAS



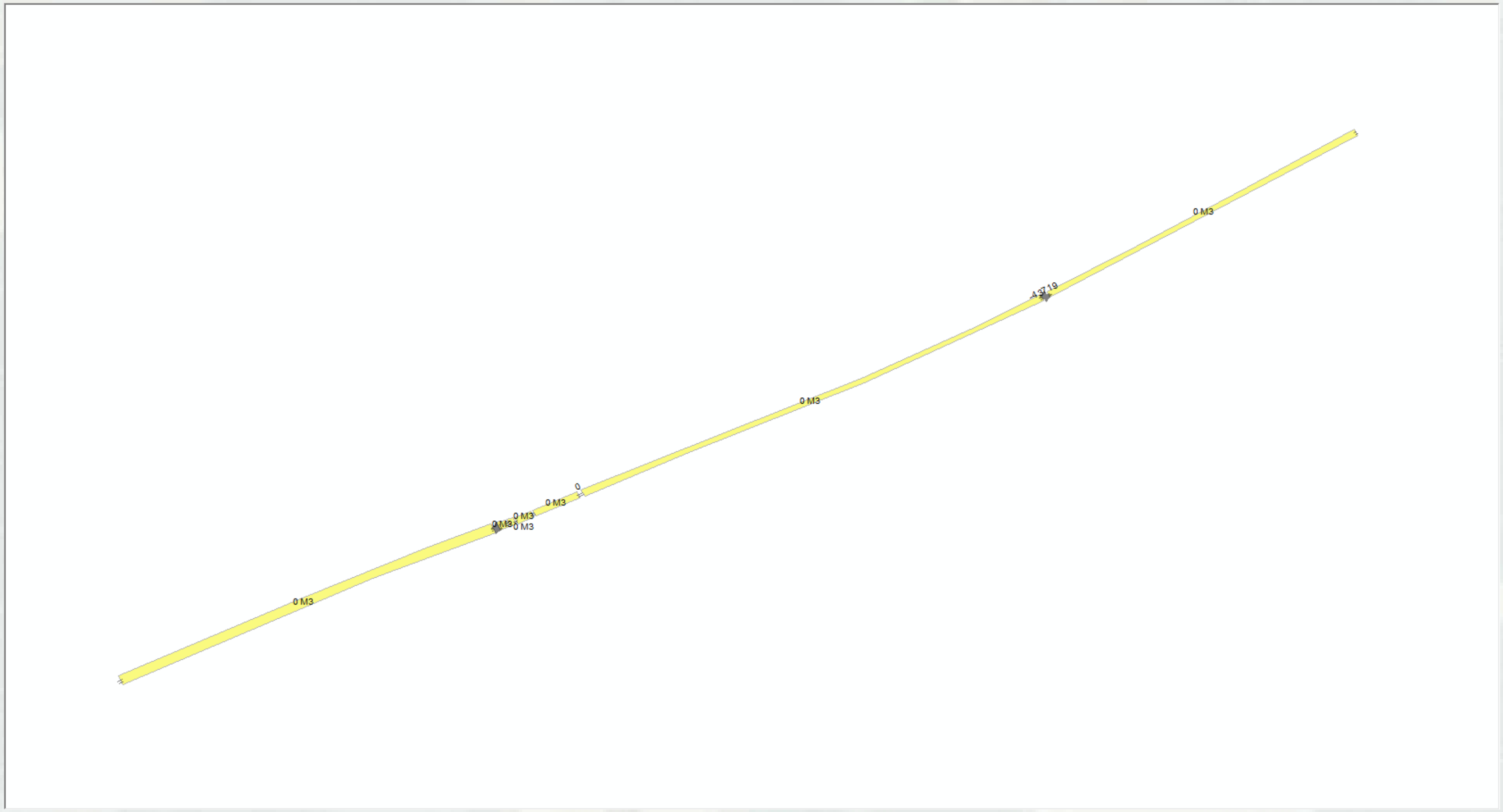


Sediment Budget in SBAS





Imported GenCade Results



Summary and Conclusions

- Shoreline change and longshore transport calculated by GenCade were similar to measured values
- GenCade modeling was conducted to improve the understanding of Onslow Bay as a regional sediment system and provide information for a sediment budget
- GenCade can be applied to produce a sediment budget in SBAS