Menemsha Pond System Modeling and Risks to Resources

By Mitchell Buck

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Presentation Layout

- Background
- Part I – Hydrodynamic Model
- Part II – Sedimentation Considerations
- Part III – Shellfish Considerations
- Summary

Background

- USACE NAE plans to dredge the Federal Channel at Menemsha Harbor and Pond using Hurricane Sandy Emergency Relief Funds.
- Reasons for dredging
  - Federal channel has not been dredged since the 1970's.
  - Channel is severely shoaled
  - Maintain/improve flushing
  - Dredged material will potentially be used to nourish the beach at Chilmark.
- Reasons against dredging
  - Concerns over risks to the thriving commercial scallop fishery from dredging activities and changes hydrodynamics of the pond.

Part I – Hydrodynamic Modeling

- Hydrodynamic Model Background
- Input & Output
- Results

Model Background

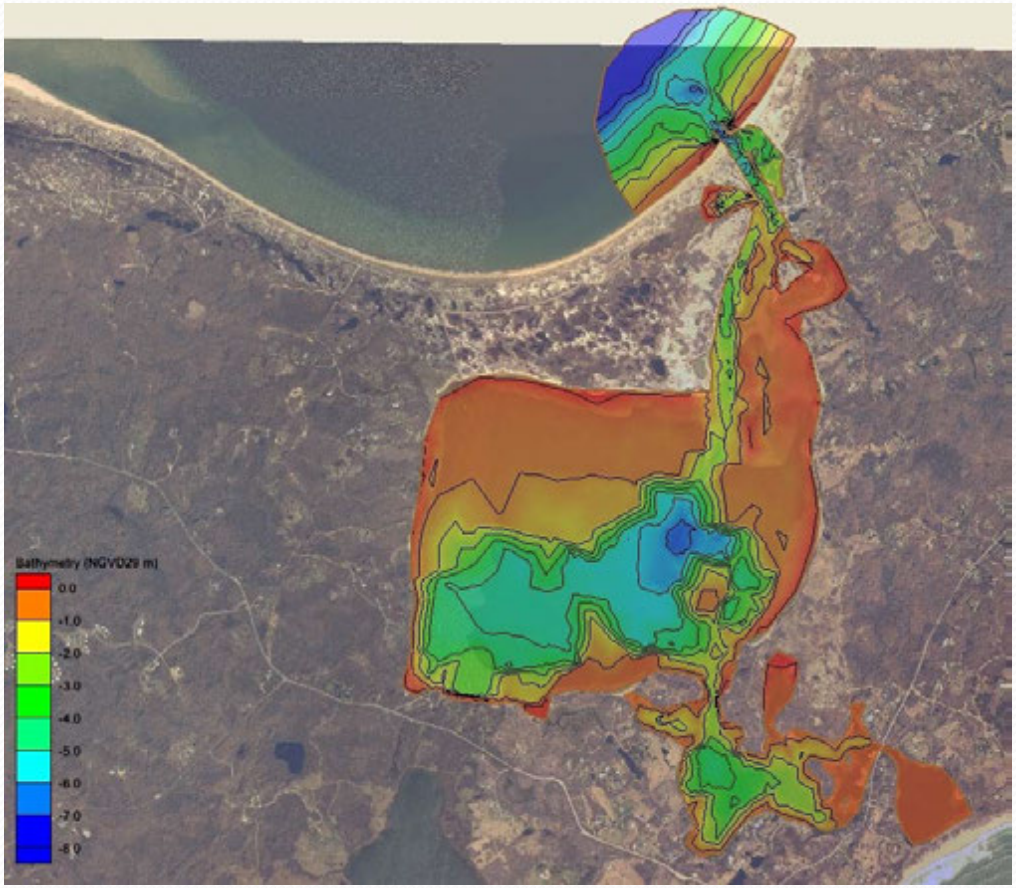
- RMA-2 – hydrodynamic numerical model
  - Developed by William Norton and Ian King for the USACE
  - Integrated with Surface-Water Modeling System (SMS) version 10.1
  - Simulates two-dimensional depth-averaged hydrodynamics using simplified Navier-Stokes Equations

Model Input

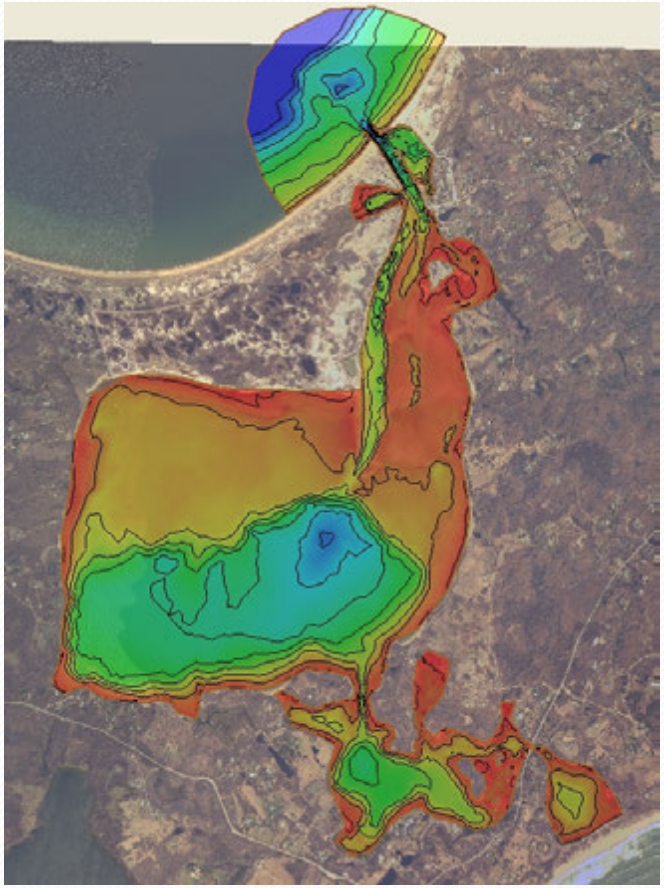
- Bathymetry
  - USACE NAE 2013 LIDAR data
  - USACE NAE 2013 Bathymetric Survey
  - GEODAS Bathymetric Survey #H11920
  - Woods Hole Group 2001 Survey
- Boundary Condition – Woods Hole Group 2001 tide data
- Model Grid – 2001 Model grid with updates

Updated Model Bathymetry

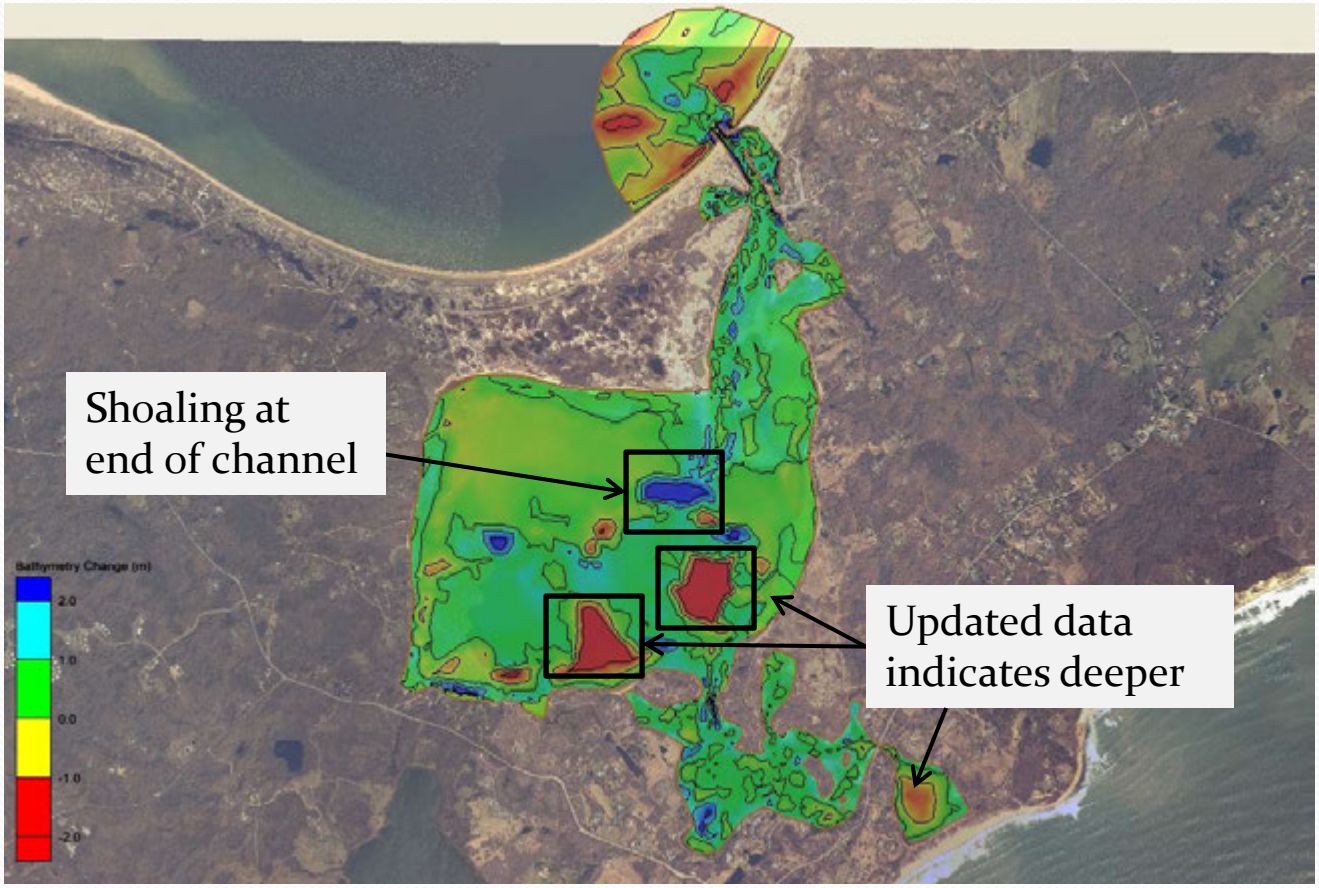
2001



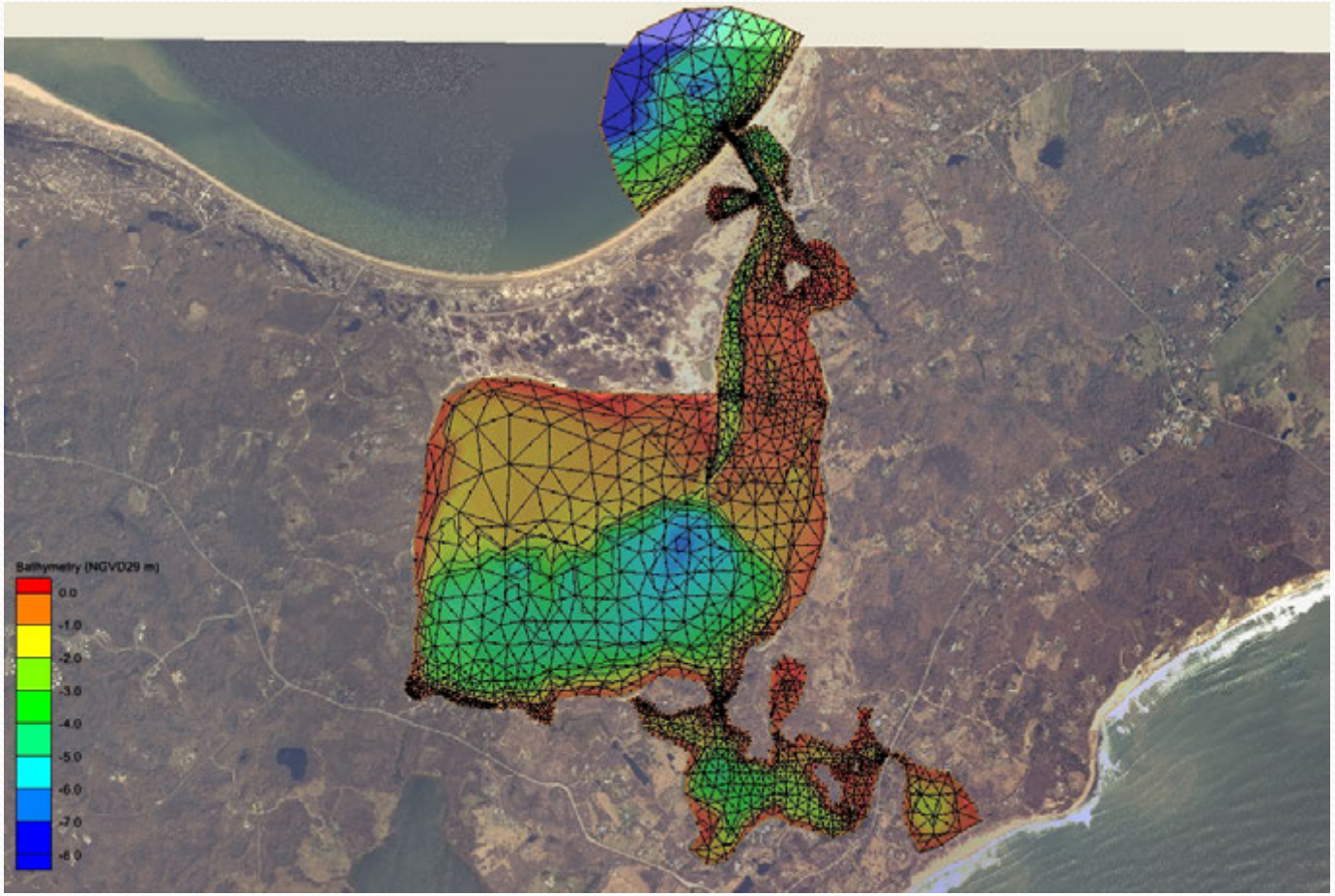
2013



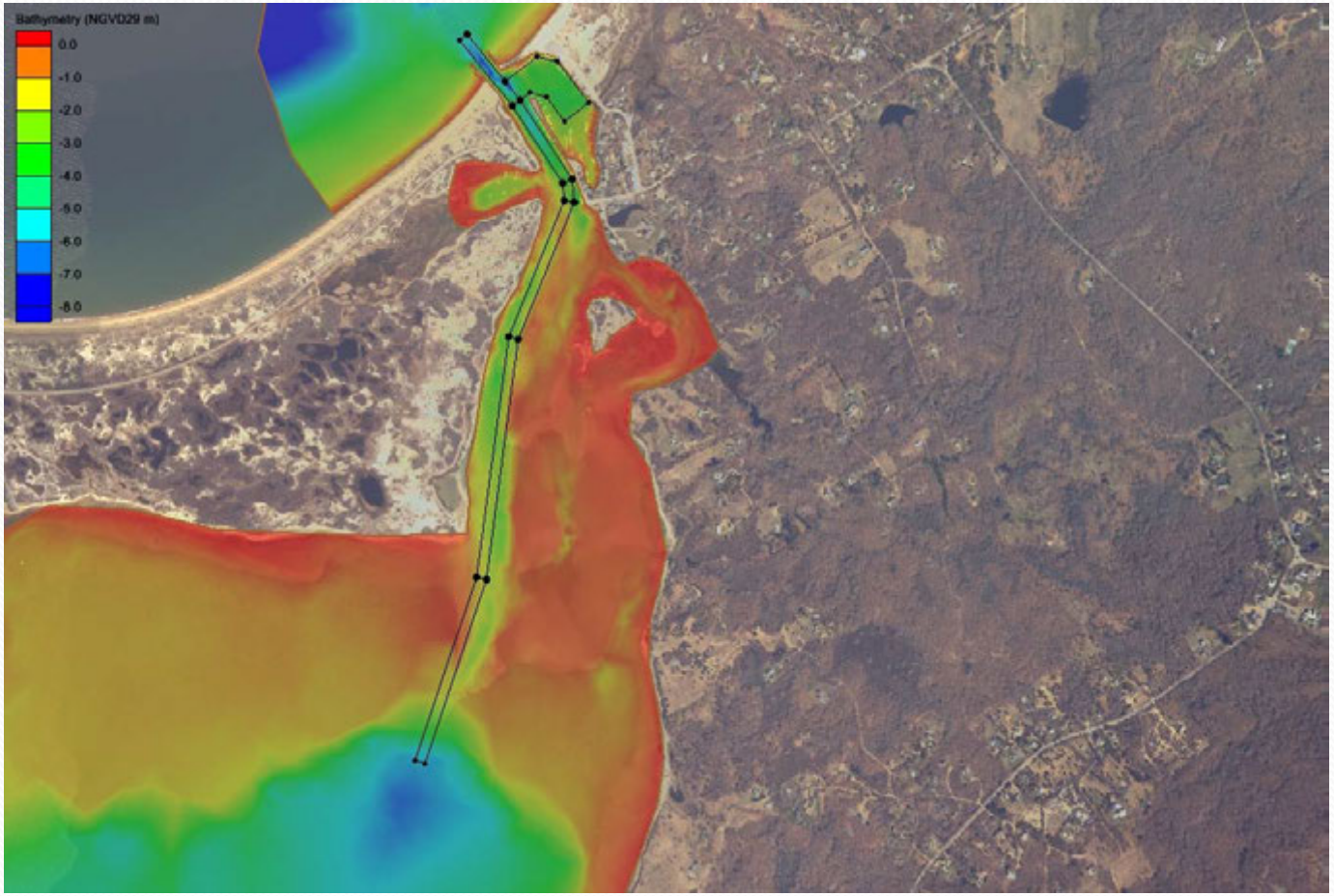
Bathymetry change from 2001 to 2013



Updated Model Grid

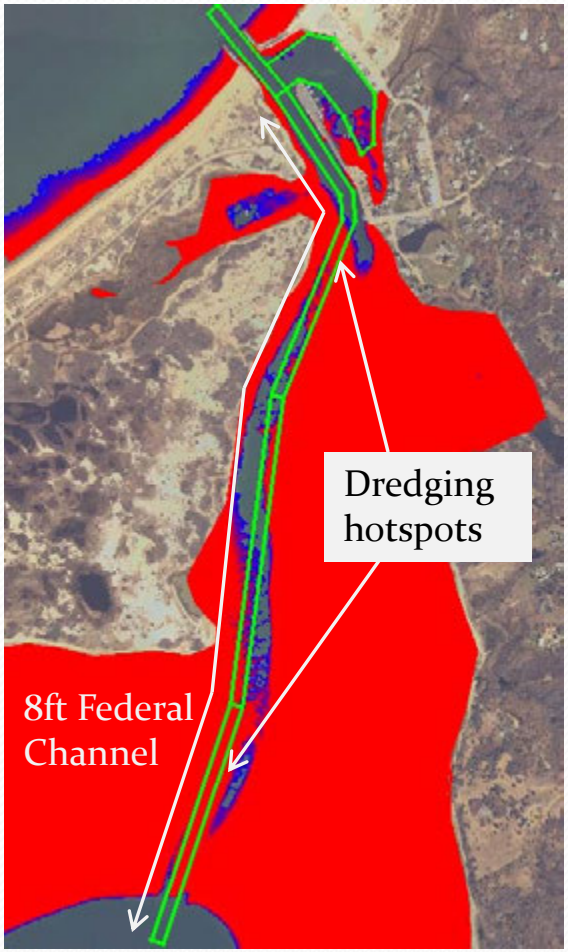


Federal Channel & Anchorage



Areas less than 6ft (red) and 8 ft (blue)

- The existing 8-foot Federal channel (white line) extends from the entrance of Menemsha Harbor to Menemsha Pond.
- In addition to modeling the existing 8-foot deep, an alternative 6-foot channel was also modeled to analyze whether dredging risks were decreased. This marks about a 25% reduction in the material dredged.
- Areas that would need to be dredged within the federal channel (green) for the 6 foot channel are highlighted in red.
- Additional areas between 6 and 8 feet that would be dredged for an 8 foot channel are highlighted in blue.
- Much of the federal channel is already deeper than 6 & 8 feet and would not require dredging (no color).
- The two main dredging hotspots in the Federal channel are pointed out the in figure.



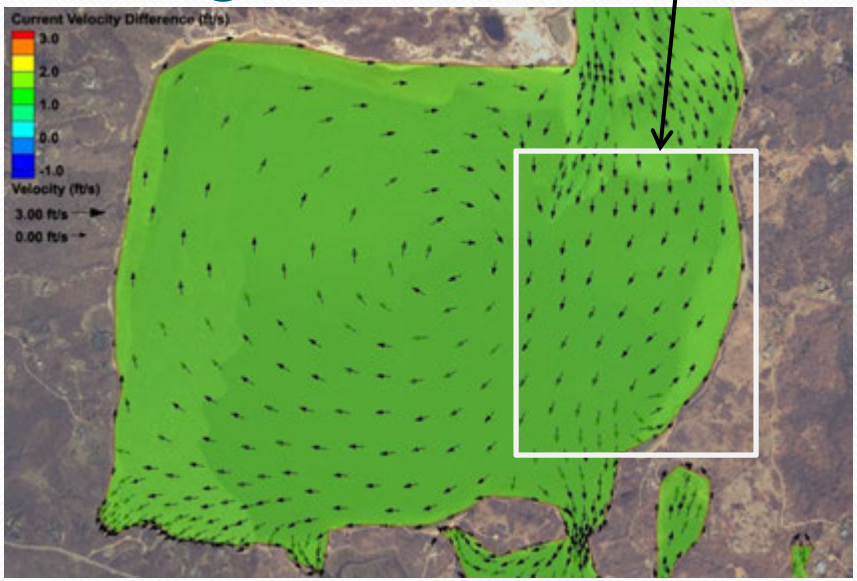
Model Results

- Overall the maximum water surface elevation in the pond does not change.
- The maximum current velocities increase in the vicinity of the channel.
- Residence time experiences minor decreases and the tidal prism experiences minor increases.
- Other than potential modifications to episodic circulation patterns (next slide), the dredging does not induce significant change to the hydrodynamics of system.

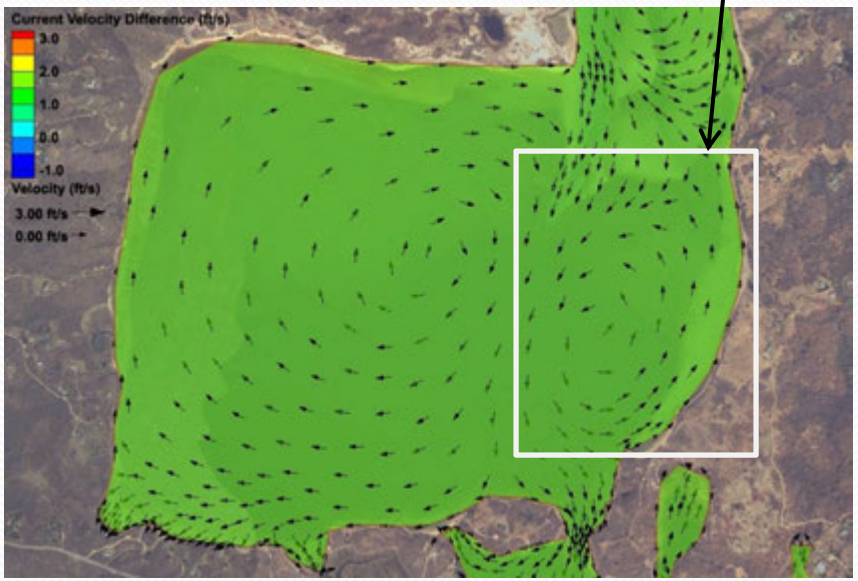
Parameter	Existing	6-foot channel		8-foot Channel	
	Max	Max	Difference	Max	Difference
WSE (ft)	3.31	3.31	0	3.31	0
Velocity (ft/s)	3.93	4.38	+0.45	4.13	+0.20
Residence Time (Days)	1.46	1.45	-1%	1.43	-2%
Tidal Prism (cyds)	3,290,630	3,344,112	+1.6%	3,437,277	+4.3%

Circulation Patterns in the Pond

Existing



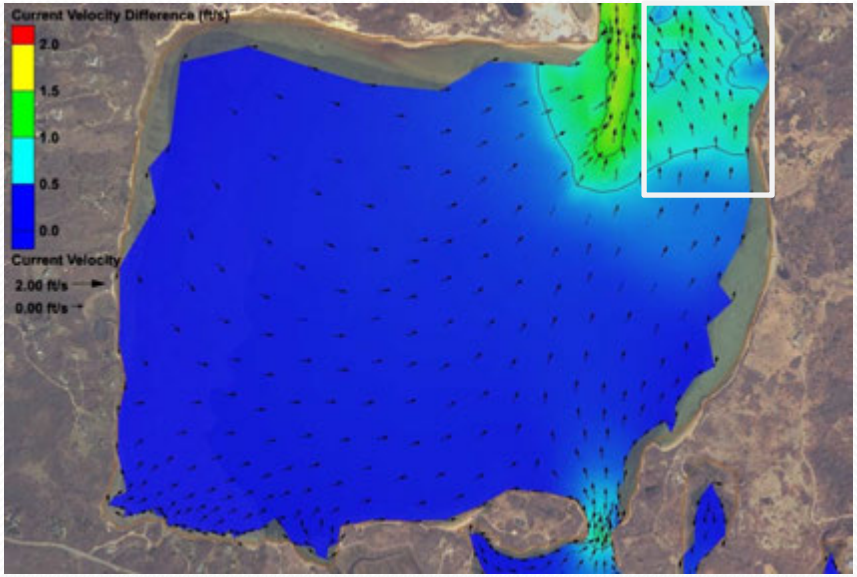
8-ft channel



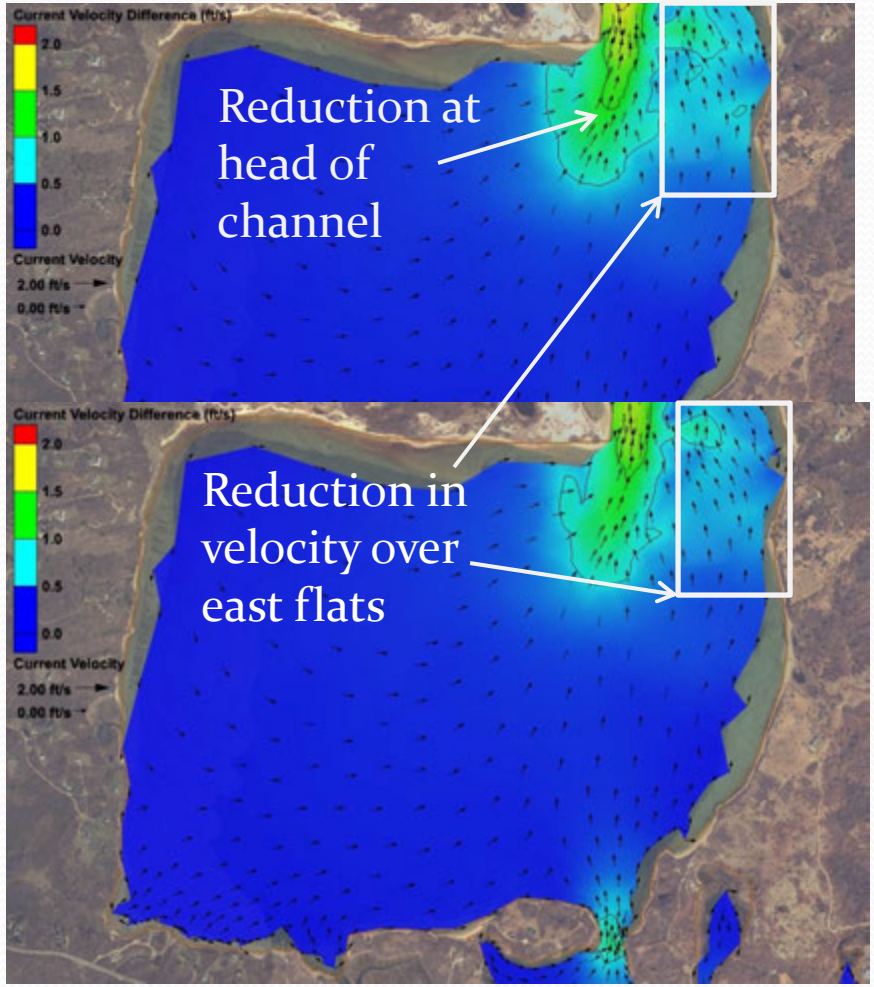
The overall clockwise circulation pattern in the pond on the incoming tide is not affected. An additional localized counter-clockwise eddy may form in the southeast corner of the pond in both dredged cases, but this eddy would last less than an hour.

Current Velocity reduction (max ebb) over the Eastern Flats

Existing Conditions

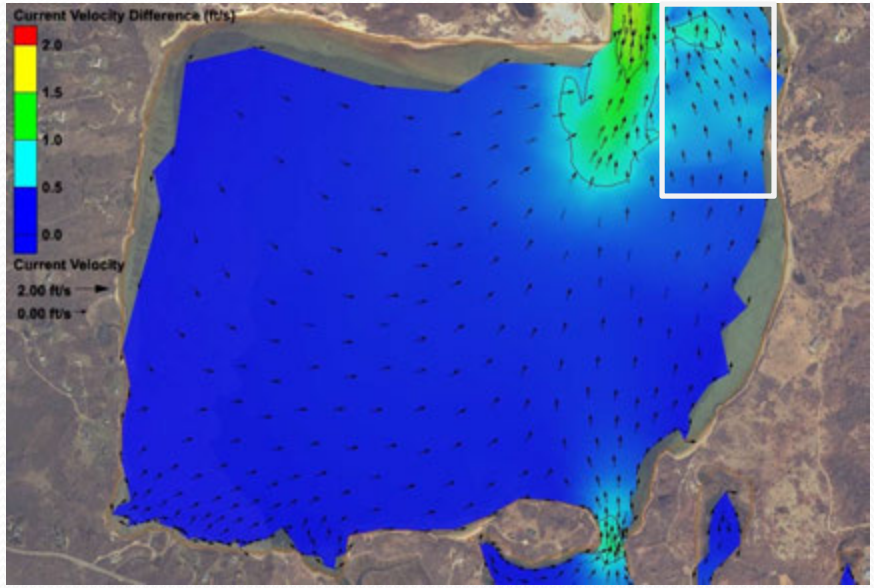


6 foot (top) and 8ft (bottom) Channels



Current Velocities during max ebb

- There is not significant change in current velocities in the main body of the pond.
- Some reduction in current velocities at the head of the federal channel.
- Velocities within the federal channel itself increased, but the change was generally less than 1 ft/s
- On the eastern flats (white box) the current velocities are reduced from 0.6 ft/s for existing to 0.5ft/s (-15%) and 0.4 ft/s (-30%) for the 6-ft and 8-ft channels, respectively.
- While the percentage of change is significant, the overall magnitude of change in velocity is relatively small.



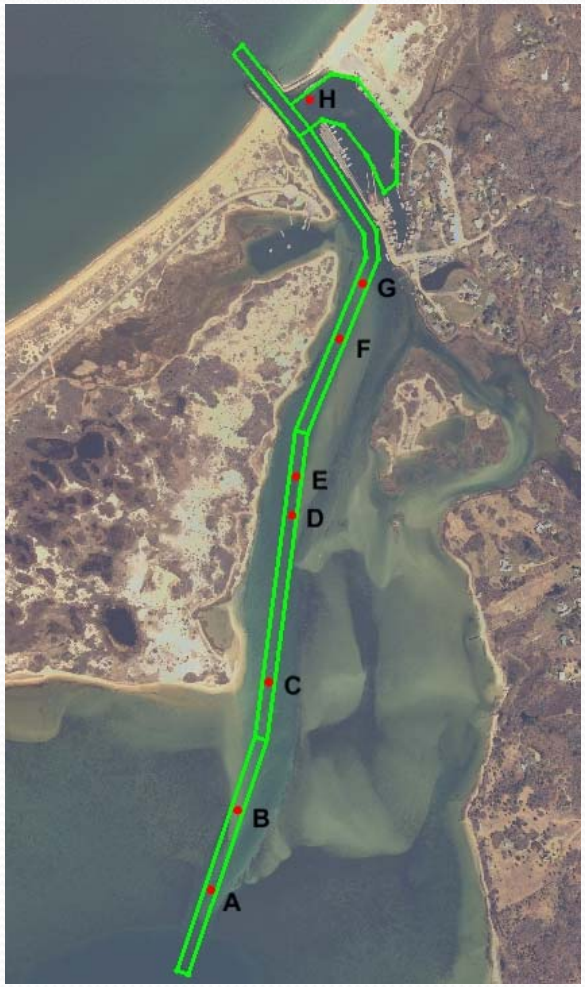
Hydrodynamic Modeling Summary

- Tidal prism increased slightly by 1.5% and 4.4% for the 6-foot and 8-foot channels over the existing conditions.
- Residence time decreased by less than an hour for both the 6-foot and 8-foot channels over the existing conditions.
- Circulation patterns within the pond largely remain intact between the existing and dredged scenarios, except for episodic (<1 hr) eddy in the southeast corner of the pond.
- Current velocities in the central portion of the pond largely remained unchanged.
- The most pronounced velocity changes for the dredged scenarios occur within the federal channel, but they are generally less than 1 ft/s.
- Velocity on the eastern flats are reduced by 15% and 30% for the 6 and 8 foot channels, respectively, over existing conditions, though the magnitude of decrease is relatively small.
- Overall, there is less change to the hydrodynamics for the 6-foot channel versus the 8-foot channel, but overall the changes in hydrodynamics are small and likely on the scale of natural variability such as a storm.

Part II – Sediment Considerations

- Sediment core data
- Mitigation efforts

Sedimentation



- Sediment cores were taken at 8 locations starting at A, the head of the Federal channel, and ending at H, within the harbor.
- Cores were analyzed for the grain size distribution of sediment to determine whether there was fine material present.

Sediment Core Grain Size Data

Core ID	D50 (mm)	% Cobble	%Gravel		%Sand			% Fines
			Coarse	Fine	Coarse	Medium	Fine	
A	0.9913	0	0	0.3	2.9	73.1	23.7	0
B	0.8368	0	0	0	0	67.7	32.3	0
C	0.8126	0	0	0	0.7	65.4	33.9	0
D	1.0922	0	0	1.1	4.2	77.6	17.0	0.1
E	1.3112	0	0	9.5	9.6	70.8	10.0	0.1
F	1.1462	0	0	0.2	0.2	91.6	8.1	0
G	1.1509	0	0	0.3	1.5	89.5	8.7	0
H	0.9066	0	0	1.0	3.2	66.1	24.1	5.7

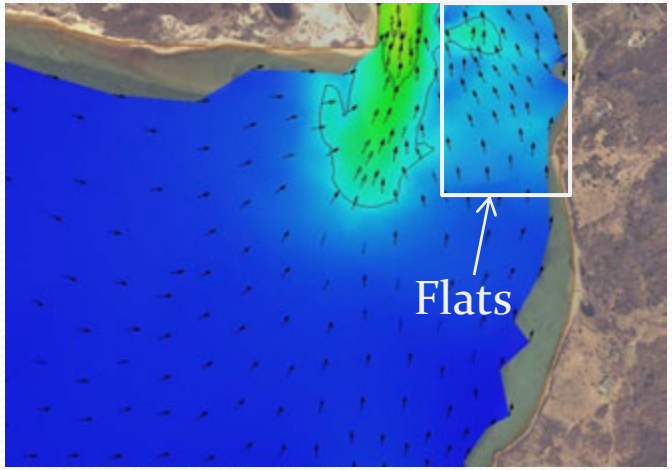
1 mm = 0.04 inch

Sediment Core Grain Size Data

- The mean grain size (D50) is 1.03 mm (0.04 inch), which indicates sediment is primarily medium grain sand.
  - The corresponding fall velocity of 5.91 inches/second (~0.5 ft/sec) suggests sediment will settle close to the point of the release.
  - In addition, the material should be compatible with the material present in the nourishment site.
- There is little to no fine material in the cores.
  - No significant sediment plum expected at dredge site (hydraulic method).
  - Limited sediment plume at discharge site.
- Only location H in Menemsha Harbor had fines above 1%.
  - This is still well below the threshold for concern of 10-15% fines.

Sediment Settling in East Flats

Parameter	Exist.	6ft	8ft
Max Ebb Velocity (ft/s)	0.6	0.5	0.4
Settling distance(ft) from release	2.4	2.0	1.6



- Velocities decrease over flats for dredged cases, so the potential for increased shoaling was analyzed.
- Mean grain size (D50) is 0.04 in, which has a corresponding fall velocity of 5.91 inches/second.
- Mean depth on flats is ~2 ft.
- The result is that the distance it takes for sand grain to settle decreases slightly, meaning there is a minor increased risk of shoaling in this area; however, this area may continue to shoal even if dredging doesn't occur.

Fine Sediments at location H

- Location H had 5.7% fines concentrated mostly in the top 0.9 ft of the core. The volume of material in this upper layer to be dredged in the harbor area was estimated from the USACE dredging map to be about 4,000 cyds, which amounts to 228 cyd of fine material.
- Fine material is considered to be sediment that passes through a 200 µm sieve with a D50 of 0.074 mm.
- The corresponding fall velocity for this material is roughly 0.1 in/sec, yielding settling times of 13.6 and 17.7 minutes for the 6 and 8 foot channels
- The maximum flood tide currents through the channel are 2.1 ft/s, meaning that this fine material can travel ~1,700 and 2,200 feet from Menemsha Harbor, which means the material should be settled by the time it reaches Edy's Island.

Sedimentation Summary

- The mean grain size (D50) is 0.04 inch (1 mm) suggesting primary material to be dredged is medium grain sand that should settle close to where it was dredged or released.
- Small reductions in transport distances over the eastern flats suggests only minor increase in the risk of shoaling.
- The percentage of fine material in the sediment cores is extremely low (<1%), and well below the threshold of 10-15%. Only location H in the harbor had fines exceeding 1%; however, this was to the top 0.9 foot of the core and still below the threshold.
- The 6-foot channel would reduce the amount of material dredged in the Federal Channel by 25%.

Part III - Shellfish Considerations

- Changes to hydrodynamics
- Dredged sediments
- Mitigation efforts

Hydrodynamic Changes

- Minor improvements water quality gained from a minor increases in tidal prism and minor reduction in residence time should not increase risk to shellfish.
- Circulation patterns within the main pond remain largely intact and should not increase risk to shellfish
- The reduction in current velocity during maximum ebb tide on the eastern flats could potentially allow more time for spat to adhere to the eelgrass present and should not increase risk to shellfish.

Dredged Sediments

- The material to be dredged is primarily medium grain sand that is generally too heavy to generate a sediment plume.
  - Risk sediment settling on shellfish and eelgrass is low.
- Percentage of fine material in dredge footprint is very low (1%), meaning that there is not much risk .
- Location H has the highest amount of fines (~5.7%), but they should settle before reaching the main pond.
  - Should not increase risk to shellfish.

Dredging Mitigation Efforts

- The hydraulic cutterhead suction dredge to be employed has virtually no suspension of sediments since sediment is simply sucked up by the pump and distributed to the beach nourishment site.
  - The only disturbance of bottom sediments near the dredge would be from setting and moving of the dredge winch anchors and spuds, which would be minor.
  - Targeted use of sediment curtains at dredge sites with fine material if localized plume expected.
- The USACE reviewed NOAA tidal current charts for Vineyard Sound and the Bight and determined that the nourishment site on Chilmark Beach is ideal to keep fines out of the pond.
  - The current during ebb tide at the nourishment site is 1.2-1.3 knots in a direction towards the inlet, but the ebbing tide from the pond will likely keep fines from entering the inlet.
- USACE can also place a requirement on the contractor to:
  - Dredge and discharge on the ebbing tide
  - Place material from sample location H (with the 5.7% fines) at the far end of the nourishment site giving an additional distance buffer to reduce the risk of fines entering the pond.

Mitigation of Risks to Shellfish

- Adjusting the propagation program.
  - Timing and location of brood stock release
  - Adding more brood stock
  - Spat collectors

Summary of Risk to Shellfish

- The hydrodynamic modeling indicates there is little to no increase in risk to shellfish from dredging.
- The sediment core data indicates there is little fine material in the dredge footprint, meaning there is little to no increased risk of sediment settling on eel grass and shellfish in the main pond.
  - USACE is taking preventative measures to prevent fine sediment from entering and settling in the pond.
- The overall risk to shellfish from dredging is small and likely on the scale of natural variability.
  - The risks are small enough that they could be offset by making adjustments to the propagation program, if necessary.

Final Conclusions

- The hydrodynamic modeling indicates only minor changes to hydrodynamics resulting from the dredging.
- The overall changes to the hydrodynamics for the 6-foot are less than the 8-foot channel scenario are relatively small in magnitude and likely on the scale of natural variability such as storms. The 6-foot channel would mark a 25% reduction in the volume of material dredged from the Federal Channel.
- Current velocities increase in the federal channel, while they are slightly reduced over the eastern flats due to flow being concentrated to the main channel. While velocity reduction over the eastern flats may result in a minor increase in the risk of shoaling there, it may also allow more time for the spat to settle in the eel grass.
- Risks of sedimentation in the pond are minimal due to the lack of fine material and mitigation efforts to be employed.
- The overall increase in risk to shellfish from dredging is minimal and likely on the scale natural variability.
  - Mitigation efforts will be employed.
- Propagation program can be adjusted, if necessary, to offset any dredging risks.

Other considerations

- Menemsha Pond is currently well flushed; however, if the shoaled areas continue to shoal, then the pond flushing may become impacted.
  - This could be a slow long term process or be accelerated by a large storm event.
- The availability of sand to nourish Chilmark Beach may prove difficult in the future.
- The opportunity to dredge may not become available again for a long time even if conditions deteriorate in the pond. This needs to be considered in context with the previous bullet.