MEMORANDUM

DATE February 8, 2019 **JOB NO.** 2015-0121-01

TO John Kelly, Town of Orleans
Jacqueline Beebe, Town of Eastham

FROM Leslie Fields
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Task 7: Analysis of Dredge Channel and Disposal Site Alternatives
The main goal of Task 7 was to combine all the data collected during the 2016 Feasibility Assessment with new data collected during Tasks 5 and 6 to identify a suite of dredge channel and disposal site options that could be evaluated through an alternatives assessment to select a preferred channel/disposal design. As part of Task 7, modifications to the original channel layout were incorporated to avoid impacts to sensitive natural resources (i.e., eelgrass, barrier beach). New channel layouts were also added to provide access to Hemenway Landing and to the main inlet via Cable Creek. Several new dredge material disposal alternatives were also evaluated.

Analysis of Dredge Alternatives
Four (4) primary dredge channel alternatives were evaluated, with each alternative having a number of potential sub-alternate channel layouts. The primary dredge alternatives are described below and shown in Figures 1-4. The dredge volumes for each channel layout and the associated sediment types are shown in Figure 5. Potential disposal alternatives are shown in Figure 6.

- Alternative 1: Provides access to/from the Town Landings and Nauset inlet via the channel behind the barrier beach (Figure 1).
- Alternative 2: Provides access to/from the inner estuary and Nauset Inlet via the channel behind the barrier beach (Figure 2).
- Alternative 3: Provides access to/from the Town Landings and Nauset inlet via Cable Creek (Figure 3).
- Alternative 4: Provides access to/from the Town Landings within the estuary and to the back of the barrier beach (Figure 4).

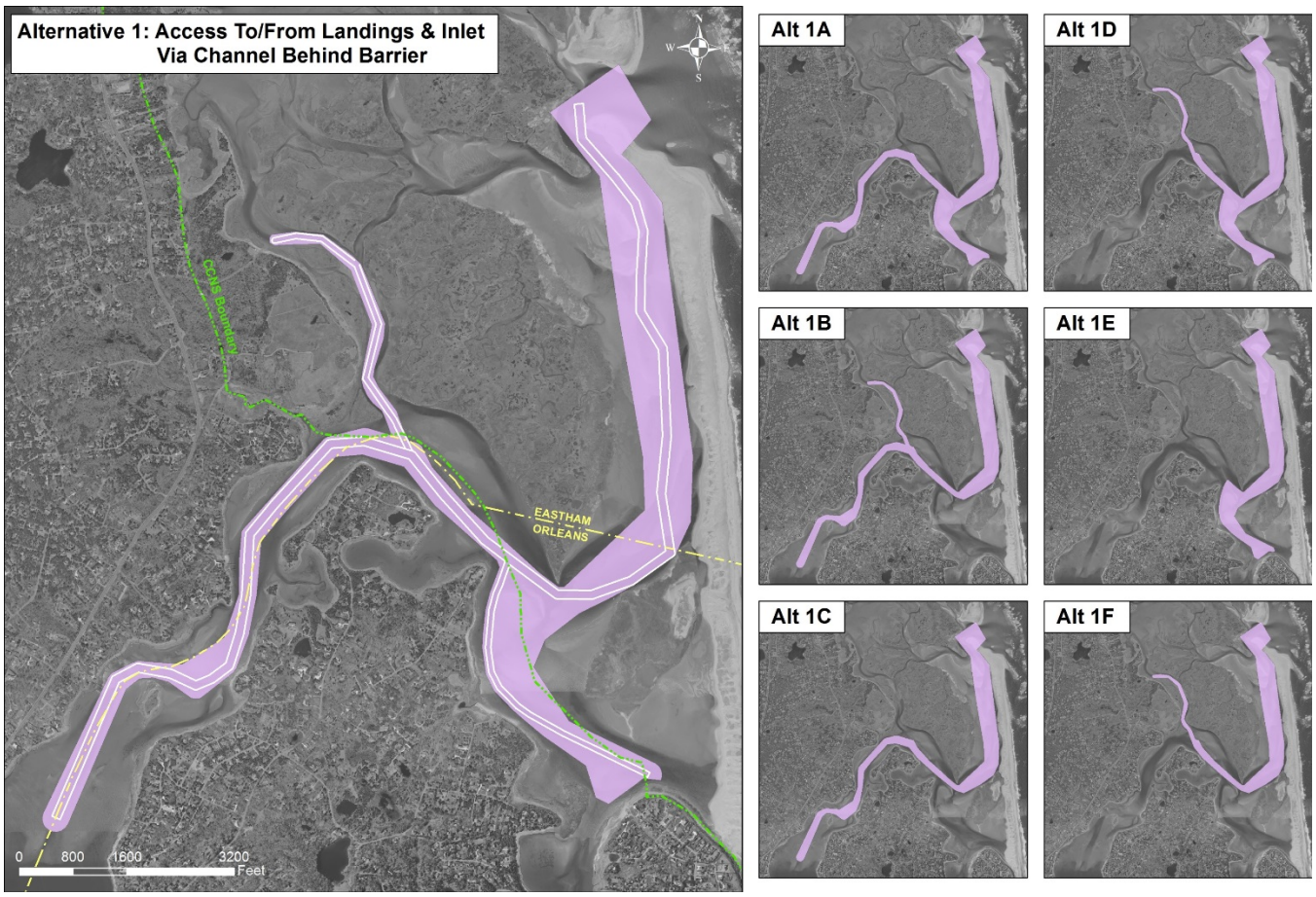

Figure 1. **Channel layout options considered for Alternative 1.**

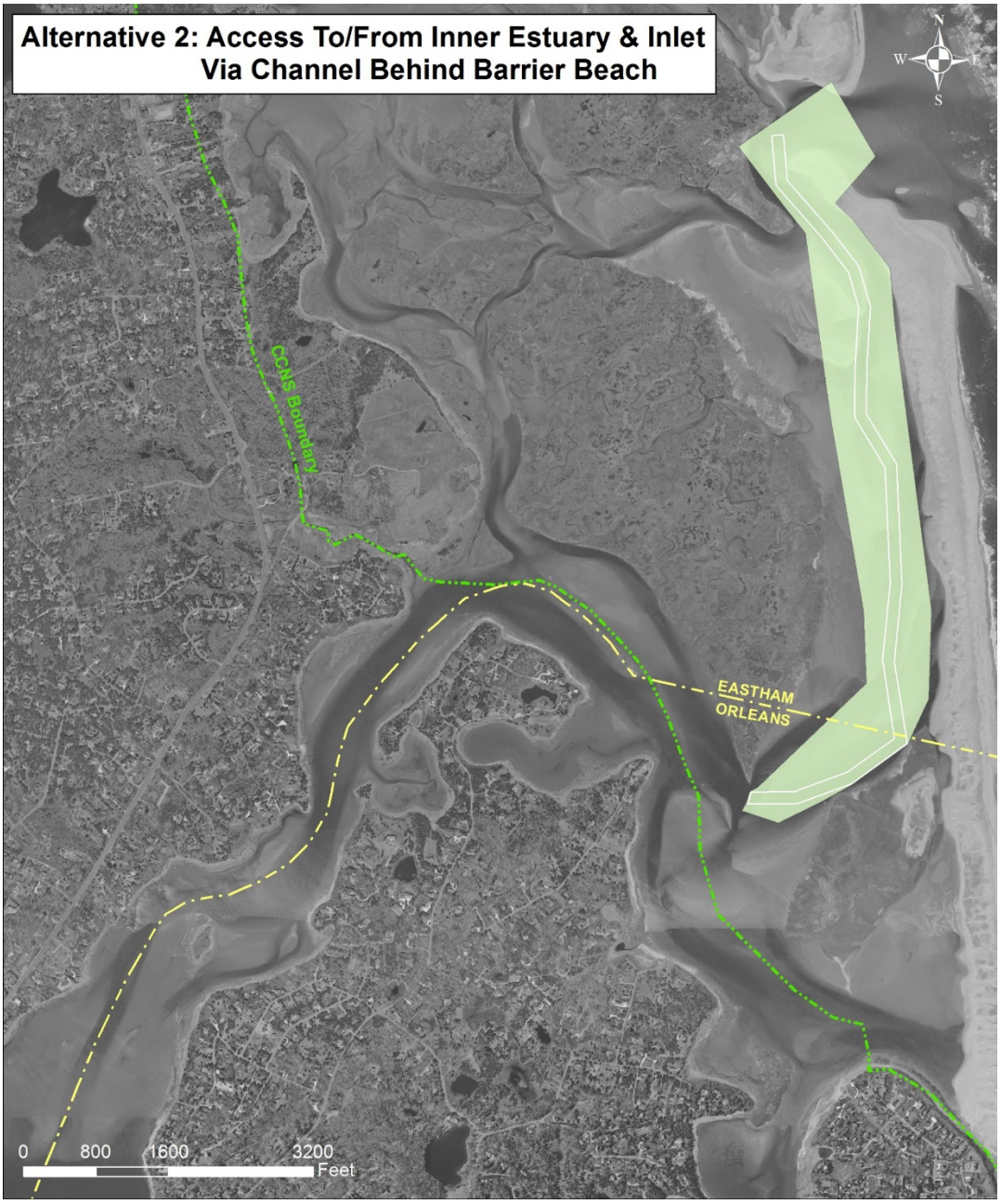

Figure 2. **Channel layout option considered for Alternative 2.**

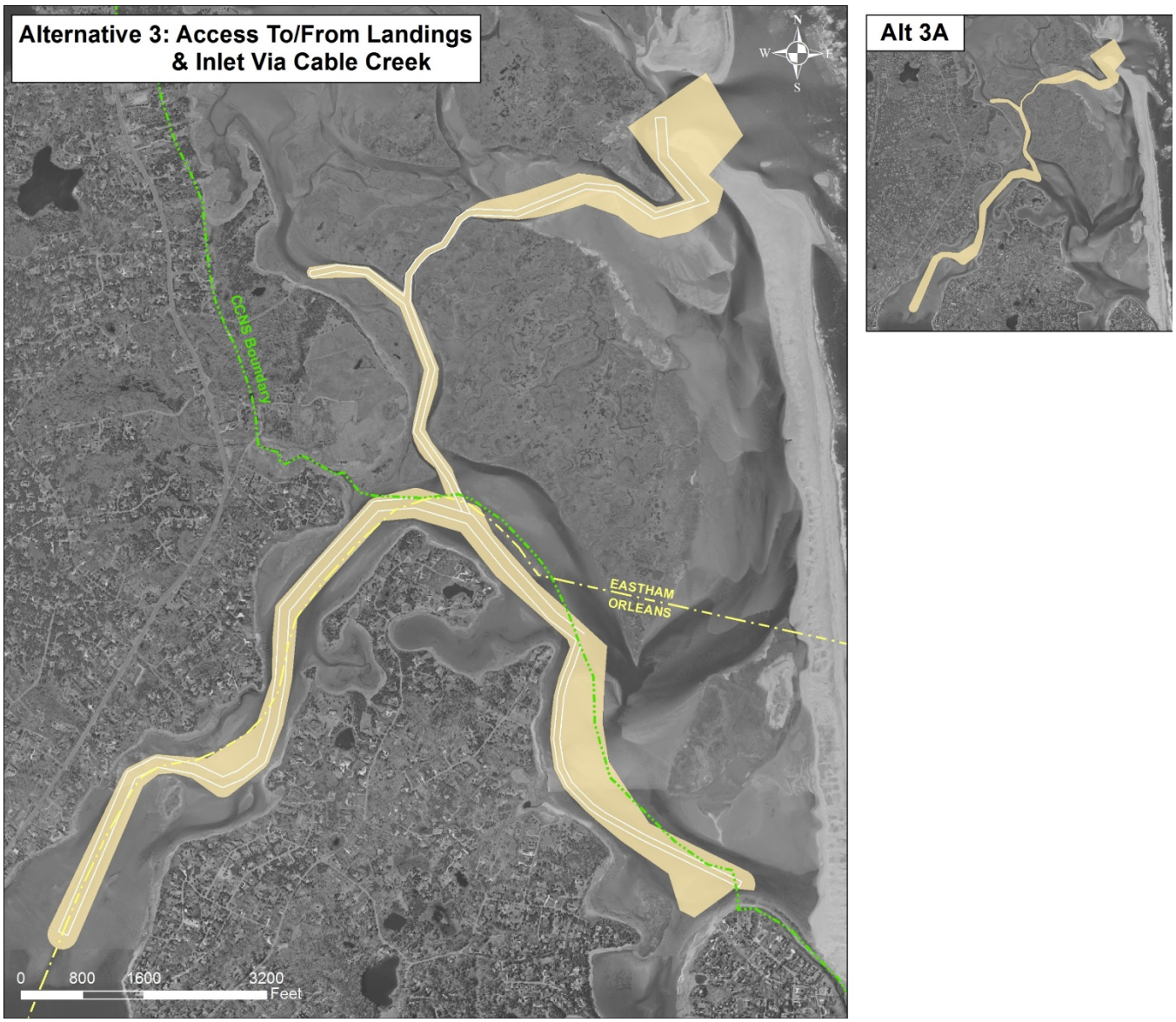

Figure 3. **Channel layout options considered for Alternative 3.**

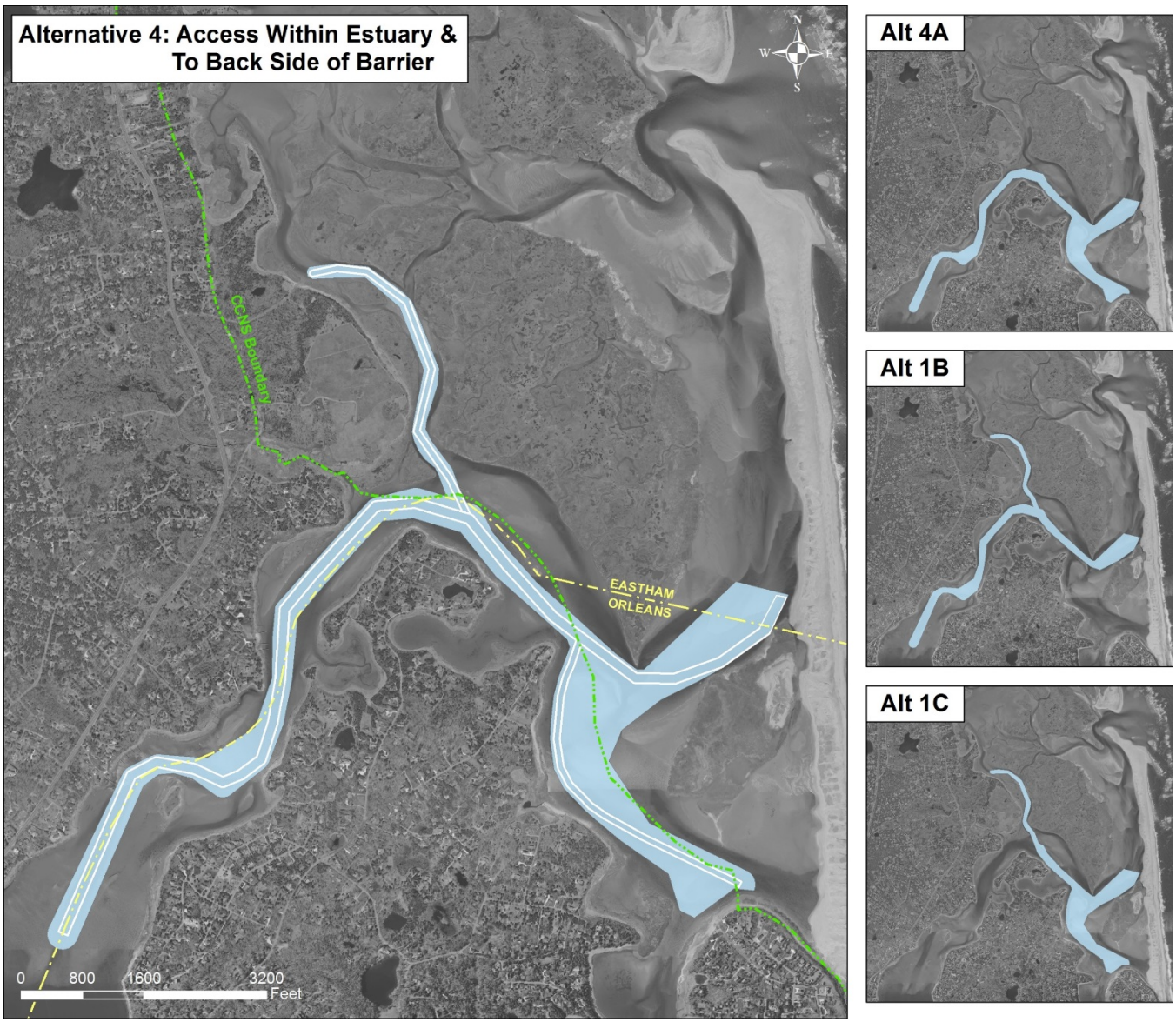

Figure 4. **Channel layout options considered for Alternative 4.**

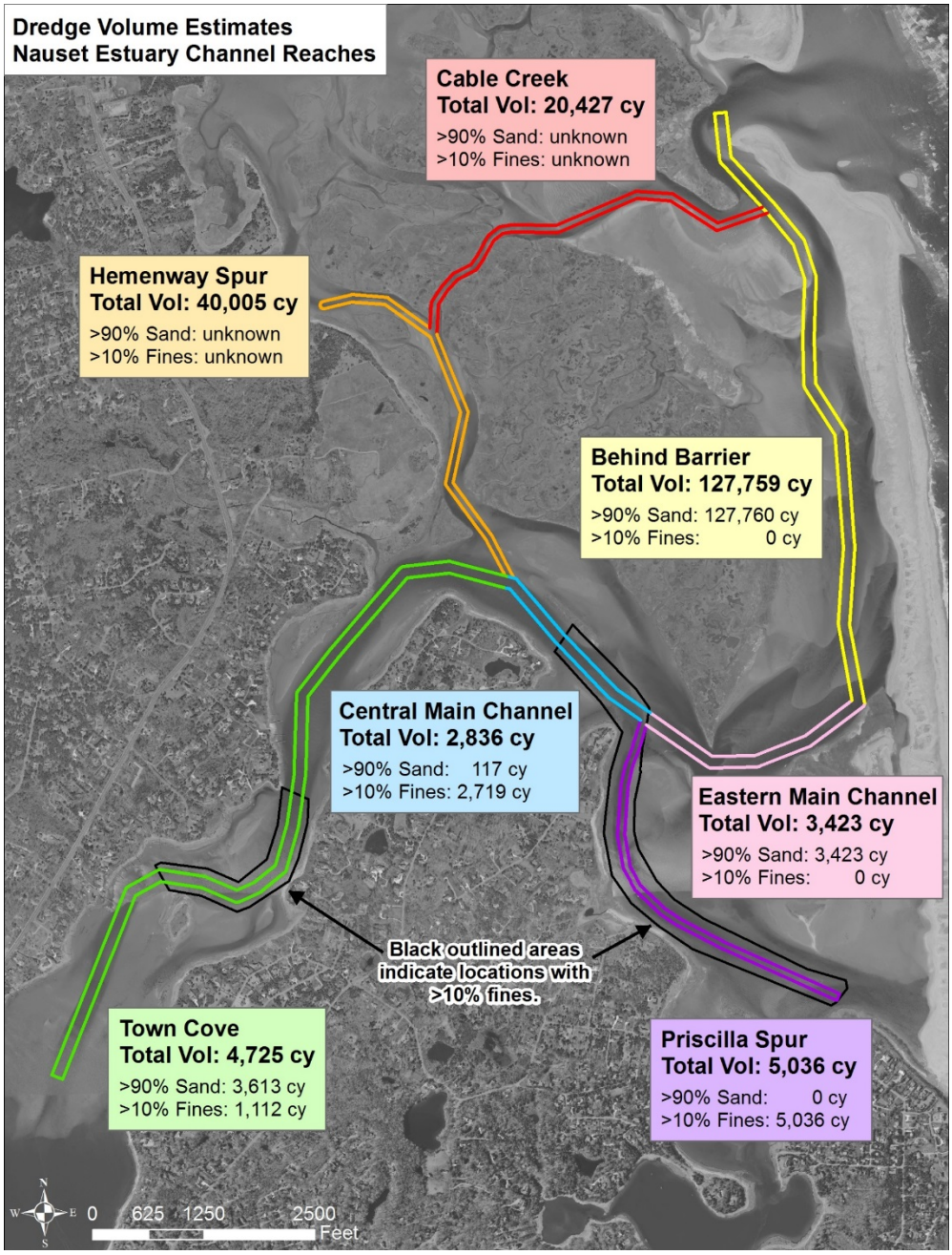

Figure 5. **Dredge volume estimates and sediment types for the primary Nauset Estuary channel alternatives.**

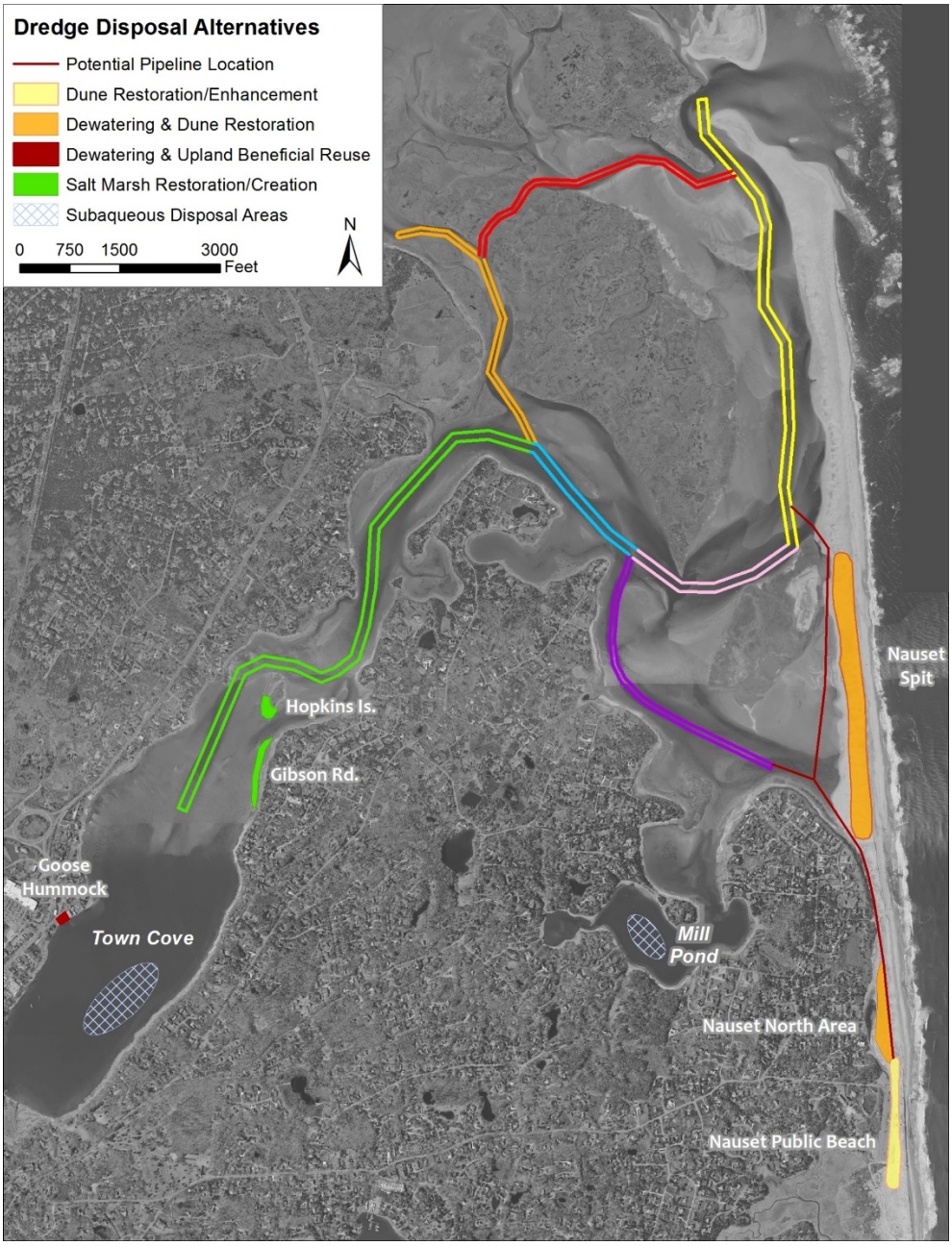

Figure 6. Dredge material disposal options considered for Nauset Estuary.

To evaluate the various dredging alternatives, a series of twelve (12) selection criteria were identified which address logistics, permittability, benefits and potential impacts. The dredging alternatives and selection criteria were populated in a matrix based on information from the 2016 Feasibility Assessment, as well as more recent information gathered during Tasks 5-6. A scoring system was then developed for the values in the matrix so that an overall ranking could be developed for each channel alternative. A brief description of each selection criteria is provided below along with a summary of the scoring categories. The resulting Draft Dredging Alternatives matrix is presented in Table 1. The final part of Task 7 includes a joint meeting with the Towns of Orleans and Eastham to review and revise the matrix based on local input, so that a preferred alternative can be selected.

	Logistics								Benefits						Impacts										
Alternatives	Potential for Beneficial Reuse (Based on GS)		Cost per Cubic Yard		Frequency of Maintenance Dredging		Additional Data Needs		Improved Access to Landings & Mooring Areas		Improvements to Safety		Businesses Served		Potential Impacts to Eelgrass		Potential Impacts to Shellfish		Potential Impacts to Salt Marsh		Permittability		Potential for Barrier Beach Impacts		**Overall Score**
Alternative 1: Access To/From Landings & Inlet Via Channel Behind Barrier																									
1: Access To/From Town Cove, Priscilla and Hemenway	134,912 cy: direct placement 8,867 cy: requires sorting 40,005 cy: unknown	5	$ 15.55	3	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	411 Moorings + Inlet moorings 7 Landings Improved navigation behind barrier	5	+ Emergency Response (both Towns) +Improved Safety Behind Barrier	5	Direct Business Access Improvements + Behind Barrier	5	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	High: Behind Barrier; Med: Priscilla; Low: All Other Sections	1	37
1A: Access To/From Town Cove and Priscilla	134,912 cy: direct placemnt 8,867 cy: requires sorting	5	$ 15.17	4	Low: Inner High: Outer	2	-Chem for fines -Shellfish	3	411 Moorings + Inlet moorings 6 Landings Improved navigation behind barrier	5	+ Emergency Response (Orleans only) +Improved Safety Behind Barrier	4	Direct Business Access Improvements + Behind Barrier	5	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW requirements	8	High: Behind Barrier; Med: Priscilla; Low: All Other Sections	1	**46**
1B: Access To/From Town Cove and Hemenway	134,912 cy: direct placemnt 3,831 cy: requires sorting 40,005 cy: unknown	5	$ 15.61	3	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	205 Moorings + Inlet moorings 4 Landings Improved navigation behind barrier	4	+ Emergency Response (both Towns) +Improved Safety Behind Barrier	5	Direct Business Access Improvements + Behind Barrier	5	Greater than 75' from Eelgrass	5	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	High: Behind Barrier; Low: All Other Sections	1	37
1C: Access To/From Town Cove	134,912 cy: direct placemnt 3,831 cy: requires sorting	5	$ 15.23	4	Low: Inner High: Outer	2	-Chem for fines -Shellfish	3	205 Moorings + Inlet moorings 3 Landings Improved navigation behind barrier	4	+ Emergency Response (Orleans only) +Improved Safety Behind Barrier	4	Direct Business Access Improvements + Behind Barrier	5	Greater than 75' from Eelgrass	5	Within 50' of Aquaculture	2	Within 50' of Salt Marsh	4	NEPA Required; ORW requirements	8	High: Behind Barrier; Low: All Other Sections	1	**47**
1D: Access To/From Priscilla and Hemenway	131,299 cy: direct placemnt 7,755 cy: requires sorting 40,005 cy: unknown	5	$ 15.44	4	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	213 Moorings + Inlet moorings 4 Landings Improved navigation behind barrier	4	+ Emergency Response (Eastham only) +Improved Safety Behind Barrier	4	Indirect Business Access Improvements (Behind Barrier)	3	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	High: Behind Barrier; Med: Priscilla; Low: All Other Sections	1	34
1E: Access To/From Priscilla	131,182 cy: direct placemnt 5,036 cy: requires sorting	5	$ 14.99	5	Low: Inner High: Outer	2	-Chem for fines -Shellfish	3	206 Moorings + Inlet moorings 3 Landings Improved navigation behind barrier	4	+Improved Safety Behind Barrier	3	Indirect Business Access Improvements (Behind Barrier)	3	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas	1	Within 50' of Salt Marsh	4	NEPA Required; ORW requirements	8	High: Behind Barrier; Med: Priscilla; Low: All Other Sections	1	**43**
1F: Access To/From Hemenway	131,299 cy: direct placemnt 2,719 cy: requires sorting 40,005 cy: unknown	5	$ 15.48	4	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	7 Moorings + Inlet moorings 1 Landings Improved navigation behind barrier	1	+ Emergency Response (Eastham only) +Improved Safety Behind Barrier	4	Indirect Business Access Improvements (Behind Barrier)	3	Greater than 75' from Eelgrass	5	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	High: Behind Barrier; Low: All Other Sections	1	32

Alternative 2: Access To/From Inner Estuary & Inlet Via Channel Behind Barrier Beach																														
2: Channel Behind Barrier Beach	129,944 cy: direct placement	5	$	15.04	4	High	1	-Shellfish	5	Inlet moorings only No landings Improved navigation behind barrier	1	+Improved Safety Behind Barrier	3	Indirect Business Access Improvements (Behind Barrier)	3	Greater than 75' from Eelgrass	5	No Shellfish Impacts	3	Within 50' of Salt Marsh	4	NEPA Required; ORW requirements	8	High: Behind Barrier	1	**43**
Alternative 3: Access To/From Landings & Inlet Via Cable Creek																														
3: Access To/From Town Cove, Priscilla and Hemenway	14,229 cy: direct placemnt 8,867 cy: requires sorting 60,432 cy: unknown	1	$	16.84	1	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	411 Moorings + Inlet moorings 7 Landings	3	+ Emergency Response (both Towns)	3	Direct Business Access Improvements	4	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 5' of Salt Marsh	0	NEPA Required; ORW may preclude Hem	1	Med: Priscilla; Low: All Other Sections	2	23
3A: Access To/From Town Cove and Hemenway	14,112 cy: direct placemnt 1,112 cy: requires sorting 60,432 cy: unknown	1	$	17.13	0	Low: Inner High: Outer	2	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	205 Moorings + Inlet moorings 4 Landings	3	+ Emergency Response (both Towns)	3	Direct Business Access Improvements	4	Greater than 75' from Eelgrass	5	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 5' of Salt Marsh	0	NEPA Required; ORW may preclude Hem	1	Low: All Other Sections	3	24
Alternative 4: Access Within Estuary and to Back Side of Barrier																														
4: Access To/From Town Cove, Priscilla and Hemenway	28,251 cy: direct placemnt 8,867 cy: requires sorting 40,005 cy: unknown	2	$	16.32	2	Low	3	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	411 Moorings 7 Landings	3	+ Emergency Response (both Towns)	3	Direct Business Access Improvements	4	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	Med: Priscilla; Low: All Other Sections	2	30
4A: Access To/From Town Cove and Priscilla	28,251 cy: direct placemnt 8,867 cy: requires sorting	2	$	17.56	0	Low	3	-Chem for fines -Shellfish	3	411 Moorings 6 Landings	3	+ Emergency Response (Orleans only)	1	Direct Business Access Improvements	4	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Greater than 50' from Salt Marsh	5	No NEPA; No ORW Restrictions	10	Med: Priscilla; Low: All Other Sections	2	38
4B: Access To/From Town Cove and Hemenway	30,970 cy: direct placemnt 1,112 cy: requires sorting 40,005 cy: unknown	2	$	16.52	1	Low	3	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	205 Moorings 4 Landings	2	+ Emergency Response (both Towns)	3	Direct Business Access Improvements	4	Greater than 75' from Eelgrass	5	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	Low: All Other Sections	3	30
4C: Access To/From Priscilla and Hemenway	24,638 cy: direct placemnt 7,755 cy: requires sorting 40,005 cy: unknown	1	$	16.08	2	Low	3	-Eastham Areas GS Analysis -Chem for fines -Shellfish	1	213 Moorings 4 Landings	2	+ Emergency Response (Eastham only)	1	No Business Access Improvements	1	Within 75' of Eelgrass	4	Overlaps Historical Shellfish Harvest Areas; Within 50' of Aquaculture	1	Within 50' of Salt Marsh	4	NEPA Required; ORW may preclude Hem	1	Med: Priscilla; Low: All Other Sections	2	23

1. **Potential for Beneficial Reuse:**

Explanation: This criterion addresses the issue of grain size, and the restriction that only material with less than 10% fines (passing the #200 sieve) can be used directly for beach and dune nourishment. In some areas the Nauset Estuary sediment is predominantly sand and can be used for beach/dune enhancement. Other areas have a higher percentage of fine-grained material; sediment from these areas will have to be sorted prior to use for nourishment projects. There are also channel areas that have an unknown grain size distribution as they were newly added to the list of alternatives and sampling has not yet been conducted (i.e., Hemenway Spur, Cable Creek channel). For this criterion, alternatives were ranked based on the known volume of sandy material suitable for use as beach/dune enhancement.

Scoring Categories:
5: >100,000 cy of sandy material suitable for beach/dune enhancement
4: 75,000 – 100,000 cy of sandy material suitable for beach/dune enhancement
3: 50,000 – 75,000 cy of sandy material suitable for beach/dune enhancement
2: 25,000 - 50,000 cy of sandy material suitable for beach/dune enhancement
1: <25,000 cy of sandy material suitable for beach/dune enhancement

2. **Cost per Cubic Yard:**

Explanation: Costs for all dredging alternatives were calculated assuming the material would be hydraulically pumped by the Barnstable County dredge to a temporary dewatering area just north of the Nauset public beach parking lot. Costs for hydraulic dredging vary depending on how far the dredge location is from the disposal site. For the Barnstable County dredge, areas within 4,000 feet of the disposal site can be pumped without the use of a booster; the cost in these areas is a $5,000 mobilization fee plus $13/cy. Areas between 4,000 and 14,000 feet from the disposal site will require a booster to adequately pump the dredged material to the disposal site; the cost in these areas is an additional $2,000 for equipment handling and remobilization plus $15/cy. Finally, areas further from the disposal site than 14,000 ft can still be hydraulically dredged, but would require a second booster; costs for these areas assumed an additional $2,000 equipment handling and remobilization fee, plus $20/cy. The total dredge cost for each alternative was calculated and divided by the total number of cubic yards to be dredged to develop a cost per cubic yard that could be compared across alternatives.

Scoring Categories:
5: <$15.00/cy
4: $15.00 - $15.50/cy
3: $15.50 - $16.00/cy
2: $16.00 - $16.50/cy
1: $16.50 - $17.00/cy
0: >$17.00/cy

3. **Frequency of Maintenance Dredging:**

Explanation: This criterion is a qualitative assessment of how frequently the dredge footprint for each alternative would need to be maintained. Due to the dynamic nature of the inlet, the area immediately behind the barrier beach would require more frequent maintenance, while inner portions of the estuary would likely require less frequent maintenance.

Scoring Categories:
3: Low frequency maintenance
2: Alternative includes both areas of low and high frequency maintenance
1: High frequency maintenance

4. **Additional Data Needs:**

Explanation: Based on the January 11th pre-application meeting, additional data will need to be collected prior to submittal of the dredge permit applications. The type and amount of additional data collection varies between the alternatives. The main anticipated data needs are: grain size analysis within Cable Creek and the channel to Hemenway landing, sediment chemistry analyses in areas with a high percentage of fine-grained material, targeted shellfish surveys, and an essential fish habitat assessment.

Scoring Categories:
5: Shellfish survey only
3: Shellfish survey and chemistry analysis on fine-grained sediment
1: Shellfish survey, additional grain size sampling, chemistry analysis on fine-grained sediment

5. **Improved Access to Landings & Mooring Areas:**

Explanation: This criterion addresses the potential improved access to landings and moorings within Nauset Estuary. Landings considered for this comparison include Goose Hummock, Cove Road, Asa's Landing, Tonset Road, Priscilla, Snow Shore, and Hemenway. Mooring fields in the Town Cove area (Asa's, Cove Road, Goose Hummock, Prides Path, Rachel's Cove, Snow Point, Tonset, Town Cove and Yacht Club – a total of 198 moorings), the Priscilla area (Doane Road, Mill Pond, Nauset Heights, Priscilla, Robert's Cove, Sheep's Pasture Point, Snow Shore – a total of 206 moorings), and the Central Main Channel area (Stoney Island and Woods Cove – a total of 7 moorings), as well as the inlet mooring area, were also factored into this comparison. Higher scores were given to alternatives that serviced a greater number of these mooring fields and landings.

Scoring Categories:
5: All 411 + inlet moorings, 6-7 landings, and improved navigation behind the barrier beach
4: >200 + inlet moorings, All 3-4 landings, and improved navigation behind the barrier beach
3: All 411 moorings and 6-7 landings, but no inlet moorings and no improved navigation behind barrier beach
2: >200 moorings and 3-4 landings, but no inlet moorings and no improved navigation behind barrier beach
1: <10 moorings, 0-1 Landings, may or may not include improved navigation behind barrier beach and/or access to inlet moorings

6. **Improvements to Safety:**

Explanation: This criterion evaluated each alternative's ability to improve safety throughout Nauset Estuary. It was assumed that benefits to safety would be achieved through increasing safe navigation behind the barrier beach and improving emergency access for water-based response by municipal officials from Orleans and Eastham. Emergency response from Orleans and Eastham was assumed to be improved if access to the main launching area in Town Cove is enhanced, while emergency response from Eastham was assumed to be improved if access to the main launching area at Hemenway is enhanced.

Scoring Categories:
5: Emergency response from both Towns enhanced, and safety behind the barrier beach is improved
4: Emergency response from one Town enhanced, and safety behind the barrier beach is improved
3: Safety behind the barrier beach is improved OR Emergency response from both Towns is enhanced
1: Emergency response from one Town enhanced but no improvements behind the barrier beach are made

7. **Businesses Served:**

Explanation: This criterion evaluated the ability of each alternative to improve access to and from marine-dependent businesses that rely on the ability of their customers to safely navigate the estuary and travel to and from the inlet. There are two primary marine-dependent businesses located in Town Cove (Goose Hummock and Nauset Marine), as well as numerous commercial fishermen that utilize the estuary.

Scoring Categories:
5: Direct business access improvements and improved access behind the barrier beach
4: Direct business access improvements but no improved access behind the barrier beach
3: Indirect business access improvements through improved access behind barrier beach
1: No business access improvements

8. **Potential Impacts to Eelgrass:**

Explanation: This criterion evaluated potential impacts from each alternative on existing eelgrass resources. It will be easier to permit a dredge alternative that does not impact existing eelgrass resources, directly or indirectly. Although none of the alternatives directly overlaps with mapped eelgrass beds, the further away the proposed dredge footprint is from existing eelgrass resources, the less likely it will be to cause adverse impacts.

Scoring Categories:
5: All portions of the dredge footprint are >75' from mapped eelgrass beds
4: Some portions of the dredge footprint are <75' from mapped eelgrass beds

9. **Potential Impacts to Shellfish:**

Explanation: This criterion evaluated each alternative's potential impact to existing shellfish resources. It will be easier to permit a dredge alternative that does not impact these resources, directly or indirectly. Based on initial data collection efforts, historical shellfish harvest areas and permitted aquaculture areas have been identified. Although additional shellfish surveys will be required to confirm the presence or absence of shellfish in all areas of the selected dredge alternative footprint, the mapped historical shellfish harvest areas provide some indication of where existing shellfish populations may exist. Alternatives that avoid these historical shellfish harvest and aquaculture areas were ranked higher for this criterion than those that do not.

Scoring Categories:
3: >50' away from historical shellfish harvest or aquaculture areas
2: Within 50' of aquaculture
1: Overlaps historical shellfish harvest areas (may also be within 50' of aquaculture)

10. **Potential Impacts to Salt Marsh:**

Explanation: This criterion evaluated each alternative's potential impact to existing salt marsh resources. It will be easier to permit a dredge alternative that does not impact existing salt marsh resources. Although none of

the alternatives directly overlaps with mapped salt marsh areas, the further away the proposed dredge footprint is from existing salt marsh resources, the less likely it will be to cause adverse impacts.
Scoring Categories:
5: >50' from salt marsh areas
4: Within 50' of salt marsh areas
0: Within 5' of salt marsh areas (unlikely to be permittable)

11. Permittability:

Explanation: This criterion evaluated the permittability of each alternative. Although some level of permitting will be required for all alternatives, some involve dredging in areas of the estuary that will require additional permits, or be subject to additional regulations (e.g., NEPA, compliance with additional ORW regulations, etc.). For areas within the Cape Cod National Seashore, not only will a NEPA review be required, but it will also be necessary to show that navigation has been impaired by natural migration of the inlet and barrier beach in order to comply with the Outstanding Resource Water (ORW) regulations for improvement dredging. Overcoming this presumption will be easier for some areas within the CCNS than for others. For example, it will be harder for areas within Hemenway channel and Cable Creek, which are further from the inlet and its effects. Because permitting obstacles could ultimately preclude certain alternatives, the scoring range for this criterion was adjusted to give it additional weight.

Scoring Categories:
10: Entire alternative is outside the CCNS; No NEPA permit required; No ORW restrictions
8: NEPA permit required; ORW regulations apply, but could possibly be overcome
1: NEPA permit required; ORW restrictions apply, and are likely to preclude portions of footprint

12. Potential for Barrier Beach Impacts:

Explanation: This criterion addressed the potential for dredging activities to weaken the barrier beach. The assumption is that dredging activities immediately behind the barrier beach, and to a lesser extent dredging at the southern end of the Priscilla Landing spur, could increase the likelihood of a breach through the barrier beach. While the breaching process is likely to occur naturally in the future, the potential for dredging to accelerate or initiate this process would be considered a negative impact. Alternatives were qualitatively scored for their likelihood to adversely impact the stability of the barrier beach.

Scoring Categories:
3: Low
2: Med
1: High

Analysis of Disposal Alternatives
As shown in Figure 6, seven (7) disposal alternatives have been considered for the Nauset Estuary dredging project:

1. Dewatering and reuse for dune enhancement at Nauset public beach
2. Dewatering along Nauset Spit with beneficial reuse at municipal dunes and/or beaches
3. Dewatering north of the Nauset Beach parking lot with beneficial reuse at municipal dunes/beaches
4. Upland dewatering and beneficial reuse (mechanical dredging)
5. Subaqueous placement

6. Marsh creation
7. Marsh enhancement through thin layer deposition

Four of these alternatives (upland reuse, subaqueous placement, marsh creation and marsh enhancement) were determined not to be feasible as disposal options for material dredged from Nauset Estuary. An explanation for removing each of these disposal alternatives from further consideration is provided below:

- Upland dewatering and beneficial reuse: This option would beneficially reuse the dredged material at an upland site, or at a site farther away than a hydraulic dredge can pump the material, thereby requiring the use of upland trucking to transport the material. Reasons this option was considered infeasible are 1.) there is very little space for dewatering, a required step prior to transporting the dredged material via truck 2.) there would be considerable impacts to traffic and upland infrastructure given the number of trips required to remove the dredged material and 3.) the costs associated with this alternative would be considerably higher than those associated with hydraulic dredging and direct placement.

- Subaqueous placement: This option would involve spreading sandy dredge material over the surface of the salt ponds, thereby burying the *Alexandrium* cysts that are present in these areas. This option was considered infeasible for the following reasons 1.) the placement would accommodate only a small fraction of material to be dredged 2.) there would be direct impacts to benthic habitat, and significant studies would be required to quantify these potential impacts prior to permitting 3.) the potential to reduce future red tide blooms by smothering existing cysts is experimental and 4.) high levels of turbidity would create water quality problems during placement.

- Marsh creation: This option would involve the creation and expansion of salt marsh along the shoreline north of Asa's Landing. This option was considered infeasible for the following reasons 1.) potential impacts to nearby shellfish habitat 2.) marsh creation would require the conversion of existing tidal flat and benthic habitat to salt marsh, adding significant complexity to the permitting process 3.) the area of proposed placement is entirely under private ownership and would require a great deal of outreach and coordination with the homeowners in the area, and 4.) there would be extensive additional design, permitting and monitoring associated with the marsh creation component of this project.

- Marsh enhancement: This option would involve placing the dredged sediment as a thin layer over portions of the salt marsh to allow the it to keep pace with rising sea levels. Reasons this option is infeasible are 1.) the only areas of marsh that are large enough to potentially be viable for this option are within the Cape Cod National Seashore (CCNS), but disposal of dredged material within the CCNS is prohibited, 2.) thin layer deposition is typically carried out in areas that are degraded or subsided, and this does not appear to be the case for the majority of marshes within Nauset Estuary, and 3.) even if CCNS did not have a restriction concerning disposal of dredged material, a thin layer deposition project has not yet been permitted in Massachusetts, and obtaining a permit would likely be very difficult.

Given the issues outlined above, we do not recommend pursuing these four options (upland reuse, subaqueous placement, marsh creation or thin layer deposition) as dredged material disposal options for the Nauset Estuary dredge project.

There are, however, three potentially viable options for disposal and beneficial reuse of the material dredged from Nauset Estuary:

1. Direct nourishment of coastal dunes at Nauset Beach
2. Dewatering and temporary holding in the dune on Nauset Beach near Nauset Heights
3. Dewatering and temporary holding in the dune north of the Nauset public beach parking lot

Comparison of these three dredge disposal options in terms of permittability, potential threatened and endangered species impacts (i.e., potential impacts to shorebirds), capacity, equipment access and potential coastal resiliency benefits is documented in the table below.

Disposal Alternative	**Permittability**	**T&ES Impacts (shorebirds)**	**Capacity**	**Equipment Access**	**Coastal Resiliency Benefits**	**Distance from Dredge Area**
1. Direct nourishment of dunes at Nauset Beach	**Moderate**	**Low**	**Moderate**	**Easy**	• **High**	• **Far**
2. Dewatering in dune on Nauset Beach near Nauset Heights	**Difficult**	**High**	**Substantial**	**Mod-Dif**	**Medium**	**Moderate**
3. Dewatering in dune north of Nauset public beach parking lot	**Moderate**	**Low**	**Substantial**	**Easy**	**Medium**	• **Far**