Nantasket Beach Characterization Study 2005

Prepared for:

The Commonwealth of Massachusetts
Department of Conservation and Recreation (DCR)
Engineering and Construction

Prepared by:

U.S. Army Corps of Engineers
New England District

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1.0 Introduction

The U.S. Army Corps of Engineers and the Massachusetts Department of Conservation and Recreation (DCR) have been partnered in a Section 103 Storm Damage Reduction Study for the area behind Nantasket Beach and the DCR Seawall since the 1990's. Numerous alternatives have been investigated during the extended study period. A leading candidate has been the construction of a beach fill project in front of the 5,500 foot seawall. Various layouts and material choices have been proposed for the beach fill project, but difficulty has been encountered in choosing a "final" alternative. Often opposing interests within the project, or with the local stakeholders, have made reaching a consensus very difficult. One of the most notable complicating factors has been the lack of comprehensive information/data related to existing beach conditions, i.e. sand grain size, quantity of cobble/gravel, size of cobble/gravel, offshore beach slopes, and sand color. The most recent comprehensive cross-shore survey and sampling effort was completed in 1963. Given the nearly 40-year time lapse it was felt that the study should be updated. There was a small sampling/grain sizing study performed for the DCR by Applied Coastal Incorporated during 2001, but it was felt by numerous parties that its scope was too limited to offer a true characterization of Nantasket Beach. In order to update and expand the data, a comprehensive beach characterization study was completed during September and October 2005.

2.0 Contract Overview

The beach characterization study was contracted to Ocean Survey Incorporated of Old Saybrook, CT. The contract was administered by the Corps Philadelphia District surveying and contracting offices. The development of the final scope of work (SOW) consisted of a lengthy process and numerous negotiation meetings. While this extra effort caused project delays it was felt that the resulting contract was a very complete, well designed, data collection/analysis effort.

The contract consisted of three basic components; eight (8) beach cross sections from the dune, or seawall, to roughly –35 ft-NAVD88 (or a distance of 5,500 hundred feet, which ever came first), the collection of 64 vibracore/ponar grab samples (conducted along five (5) of the beach transects), and geotechnical analysis of the collected samples. Included in the geotechnical analysis were the test pit samples collected during the summer of 2004 by the Corps and the DCR. Three of the cross sections were set to overlay the cross sections collected in 1963. The contract SOW has been included as Attachment #1. The contract deliverables included the XYZ survey data, the XYZ location of each sample collected, the geotechnical data report, cross sectional plots, a summary report, survey notes, etc.

The survey data was collected using real time kinematic (RTK) GPS for both the landside survey and the hydrographic portion of the survey. The horizontal and vertical accuracies for the land side survey were +/-1.0 feet and +/- 0.2 feet, respectively. The horizontal and vertical accuracies for the hydrographic survey were +/-3.0 feet and +/- 0.2 feet, respectively. The vibracore samples were collected on the dry beach using a portable vibracore rig with a three (3) inch diameter sample tube, while the hydro samples were collected using a four (4) inch diameter sample tube. The sample depths were to be four

(4) feet unless penetration was restricted from cobbles, rock, debris, etc. For more details related to the data collection effort please refer to OSI's report.

It was recognized that the beach contained a fair amount of cobble and that with the vibracore tubes being four (4) inches in diameter or less, the sampling performed under the contract may not fully characterize the cobble content of the beach. To help address this issue 15 test pit samples were collected during the summer of 2004 by the DCR and the Corps and the samples were analyzed within the OSI contract. Further details will be provided in Section 4.2.

3.0 Contract Execution

The data collection for the contract was completed between September 28th and October 8th, 2005. The data collection effort went according to plan with no reported problems. Based on observations of the field crew operations by the Corps, frequent discussions with the field crew, and a review of the collected data, the effort appears to have been a complete success. The only point worth noting is that operations were ceased on Saturday October 8th due to an approaching Nor'easter. This resulted in two vibracore samples not being collected at the –35 ft-NAVD88 elevations on transects #1 and #3. It was decided that this would not be an issue since ponar samples (grab samples) had previously been collected for those locations earlier in the sampling effort. The contractor was not paid for the "missed" vibracore samples. Brief consideration was given to hold the crew for an extra day so the samples could be collected, but the significant extra cost for the down time could not be justified for the limited gain in information that would have be obtained.

4.0 Results

The results of the contract will be presented by first presenting the survey data in both plan form and cross-sectional view. The survey data presentation and discussion will be followed by the presentation and discussion of the grain size information. Finally the 2005 data will be compared to the 1963 data in Section 5.0.

4.1 Survey Results

A total of eight (8) survey lines were collected. The transect locations and the actual point data can be seen in Figure 1. Four (4) of the lines were within the DCR reservation while four (4) of the transects were to the north. This was done so that a direct comparison could be made of the beach within the DCR reservation and the beach to the north. This was also done, since the beach to the north has a more complete profile, with a beach berm and dune, which will be extremely useful if further modeling is required for the project. The transect numbers are organized sequentially, one (1) through seven (7) from north to south except for transect number eight (8). Transect number eight (8) is the northern most transect and is numbered out of sequence. This transect was added later in the contract development phase and after the test pit samples were collected in 2004.

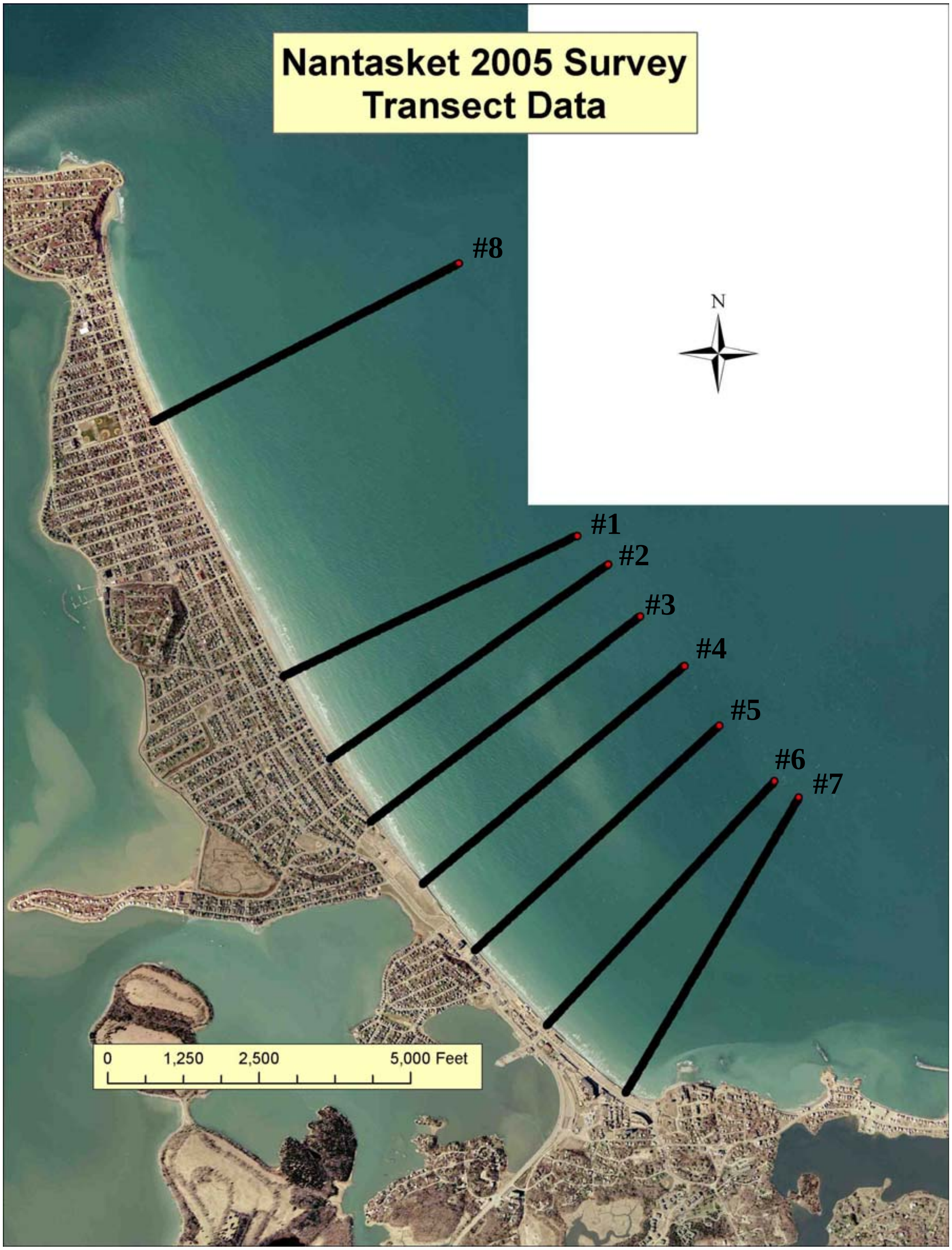


Figure 1: 2005 Survey point data and transect location.

As shown in Figure 1, the point data is fairly dense, and easily met or exceeded the point density required by the contract. To better view the survey data, the profiles have been plotted in groups defined by the various zones. Figures 2 and 3 present the profiles from the northern beach area outside of the DCR reservation. The profiles included are eight (8), one (1), two (2), and three (3). Figure 3 is a close up of the upper profiles, which makes viewing the "recreational" beach area easier.

As shown in Figure 3 and 4, profiles one (1) and (2) are very similar in both the upper and lower profile areas. Profile three (3) is also very similar to one (1) and two (2) until –35 feet-NAVD88, where the bathymetry for profile three (3) continues to deepen and then rises fairly dramatically. Beyond the –35 feet elevation the bathymetry is not really controlled by beach process and is more a result of relic geological features. All three of these profiles contain noticeable dune features (approximately six (6) feet high) and noticeable beach berm features at around elevation 8 feet-NAVD88. Profile eight (8) is the steepest profile until approximately –30 feet-NAVD88, at which point the bottom essentially levels off with undulating elevation changes. The distinct shape difference of profile eight (8) maybe due to the more northerly location of the profile within the headland bay system or a higher cobble and gravel content (evident a later sections).

The next set of profiles provided are from in front of the seawall (within the DCR Reservation). Figures 4 and 5 show profiles four (4), five (5), six (6), and seven (7), with Figure 5 showing the upper portion of the beach slope. Looking at Figure 4, it appears that the general trend of the beach profile slopes were to shallow out while moving from north to south. Profile seven (7) is noticeably different and this maybe due to the extreme southern location within the headland bay system and the proximity to the Atlantic Hill headland at the southern end of the beach.

Looking at the upper profiles in front of the seawall in Figure 5, it can be seen that there are no dune features or beach berm features that are normally part of a beach profile. This is certainly no surprise since the purpose of the Section 103 project is to address the lack of beach within the DCR reservation. The plots do indicate that the profiles simply intersect the seawall, or that they have a small transition area, which is most likely the temporary revetment constructed in 2004 and/or the cobble and gravel berm seen during field observations.

To help compare the profiles of northern Nantasket Beach and the DCR reservation, all eight (8) cross sections are shown in Figure 6. The northern profiles have been color coded in shades of blue, while the southern, or DCR profiles, have been shaded in warm colors. It can be seen, as previously discussed, the profiles from each region are discernable. The major difference being that the northern profiles have a more complete profile that includes dunes and a beach berm. To help show the differences more clearly one profile from each region was plotted. Based on Figure 2, profile one (1) was chosen to represent the north, and based on Figure 4, profile six (6) was chosen to represent the DCR Reservation profiles. The two profiles are shown in Figure 7. Once again the lack of dune and beach berm is evident.

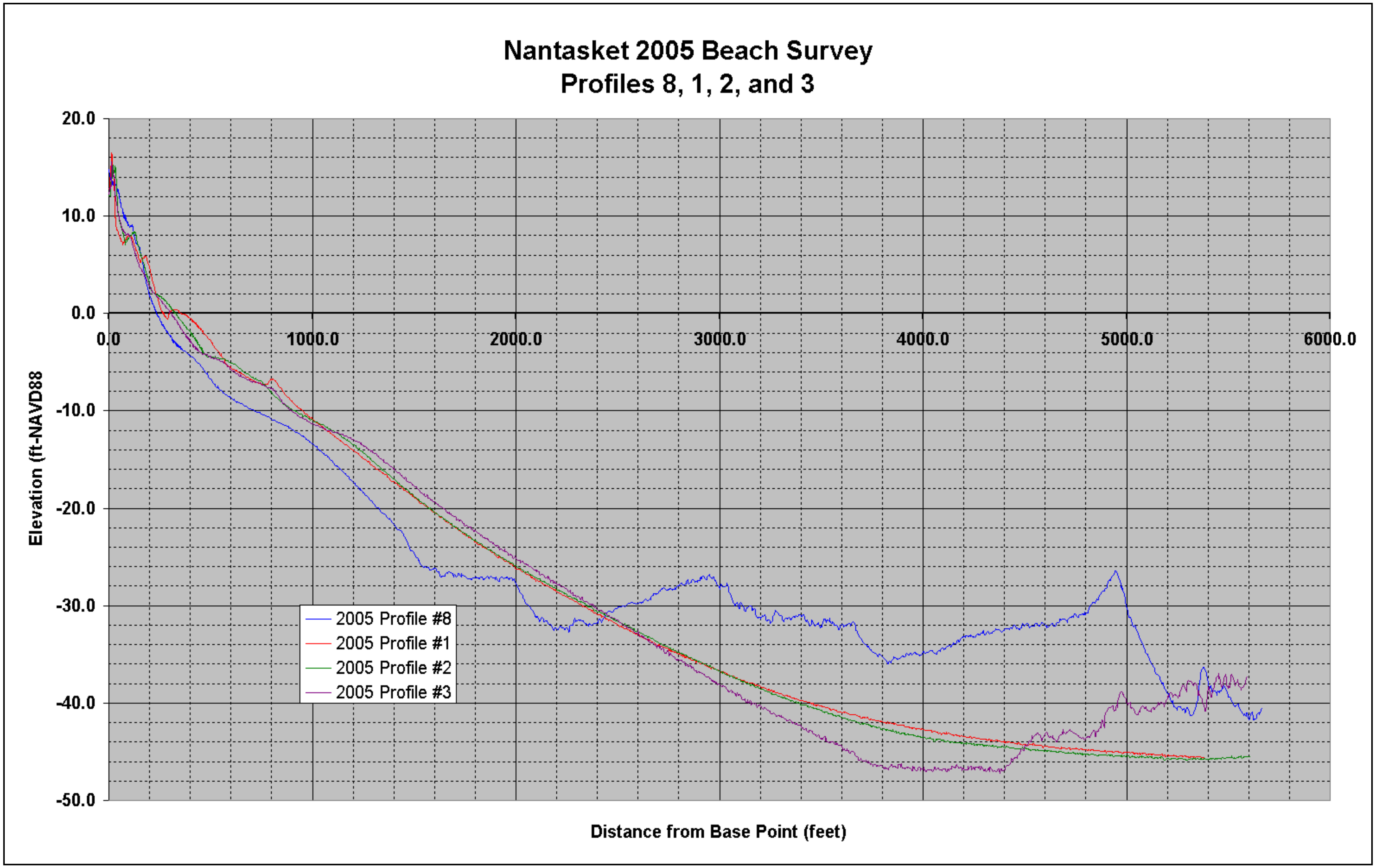


Figure 2. Northern Nantasket Beach Profiles 8, 1, 2, and 3

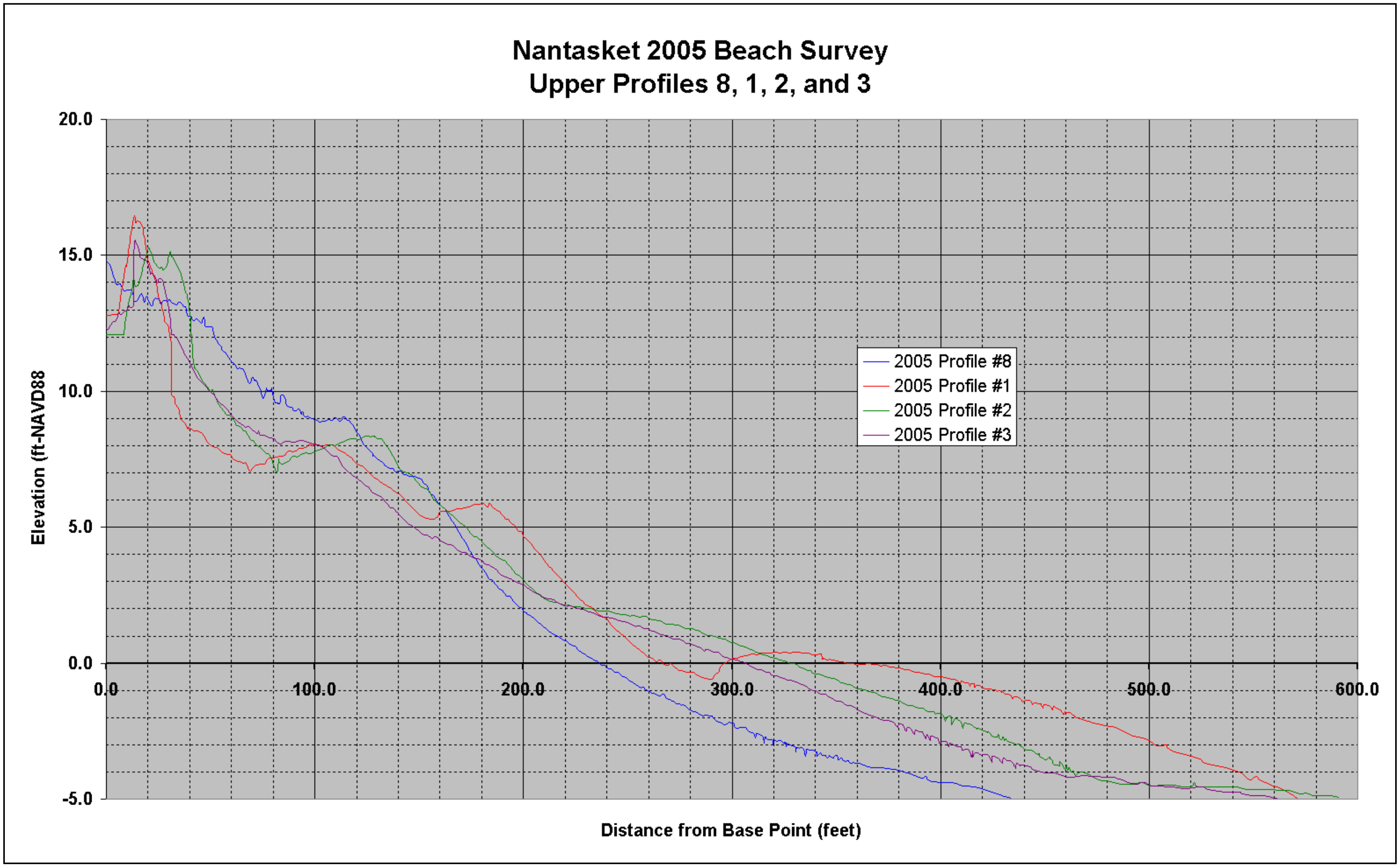


Figure 3. Northern Nantasket profiles 8, 1, 2, and 3 (upper profile plot).

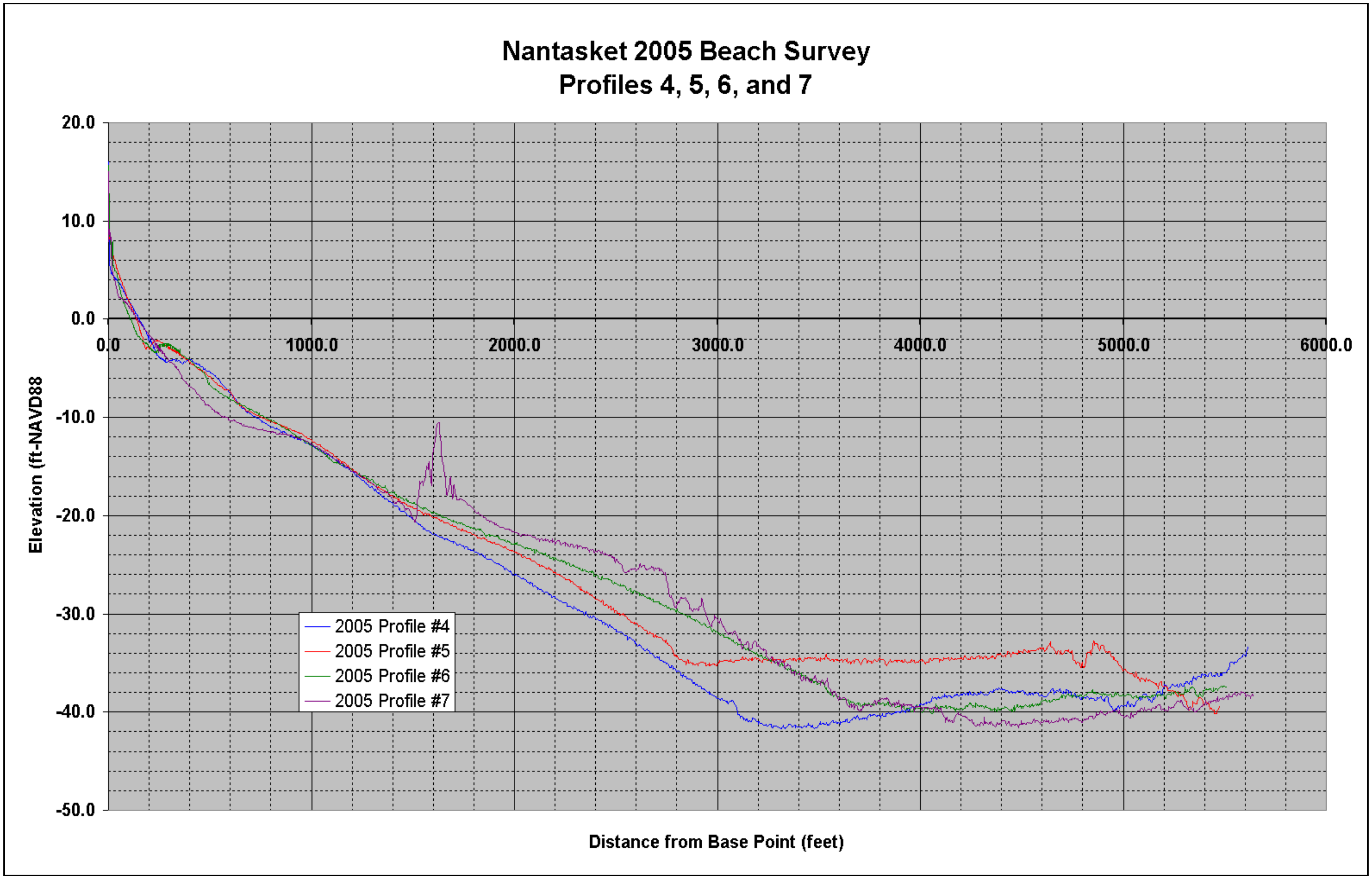


Figure 4. DCRReservation Beach Profiles 4, 5, 6, and 7

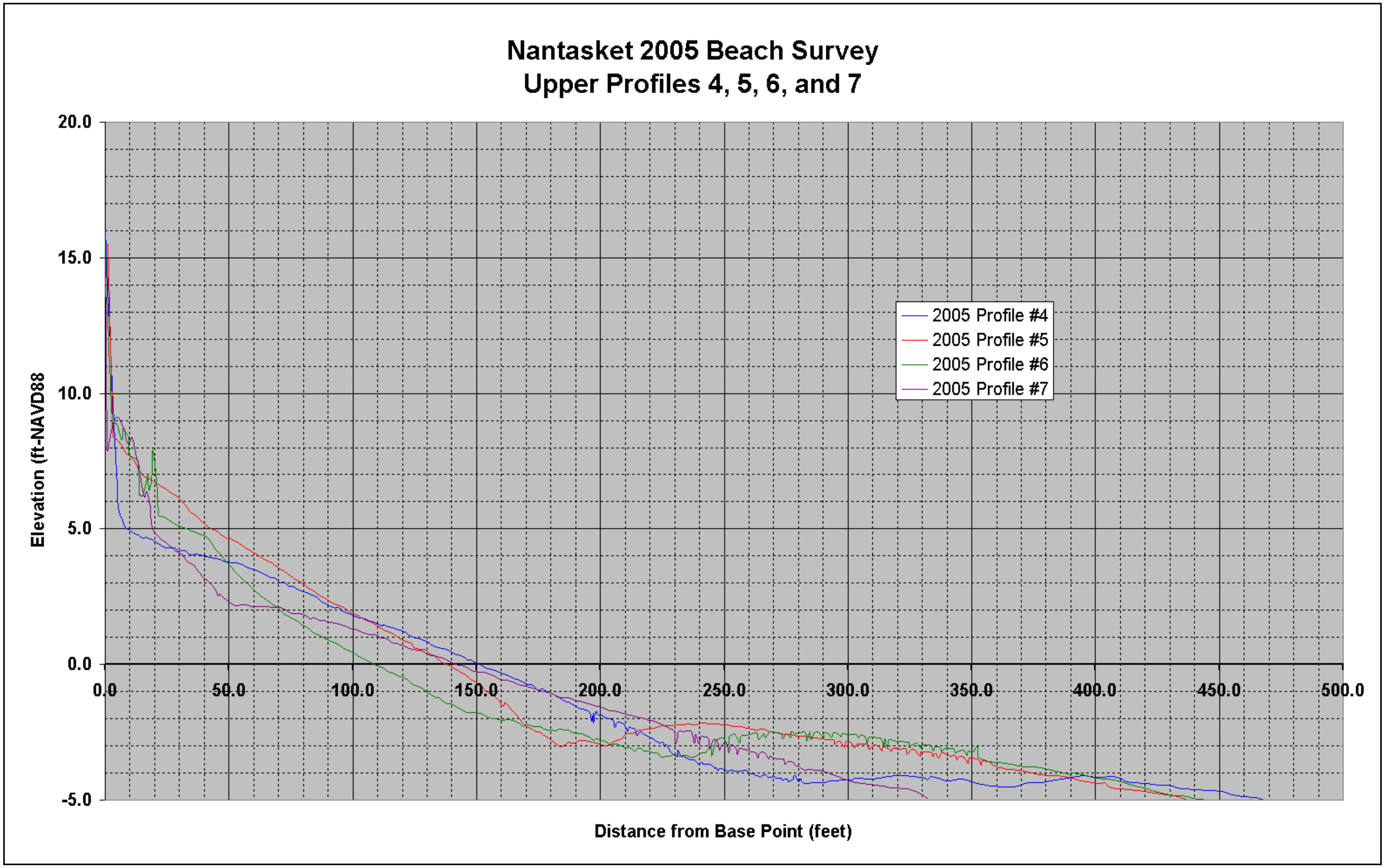


Figure 5. DCR Reservation profiles 4, 5, 6, and 7 (upper profile plot).

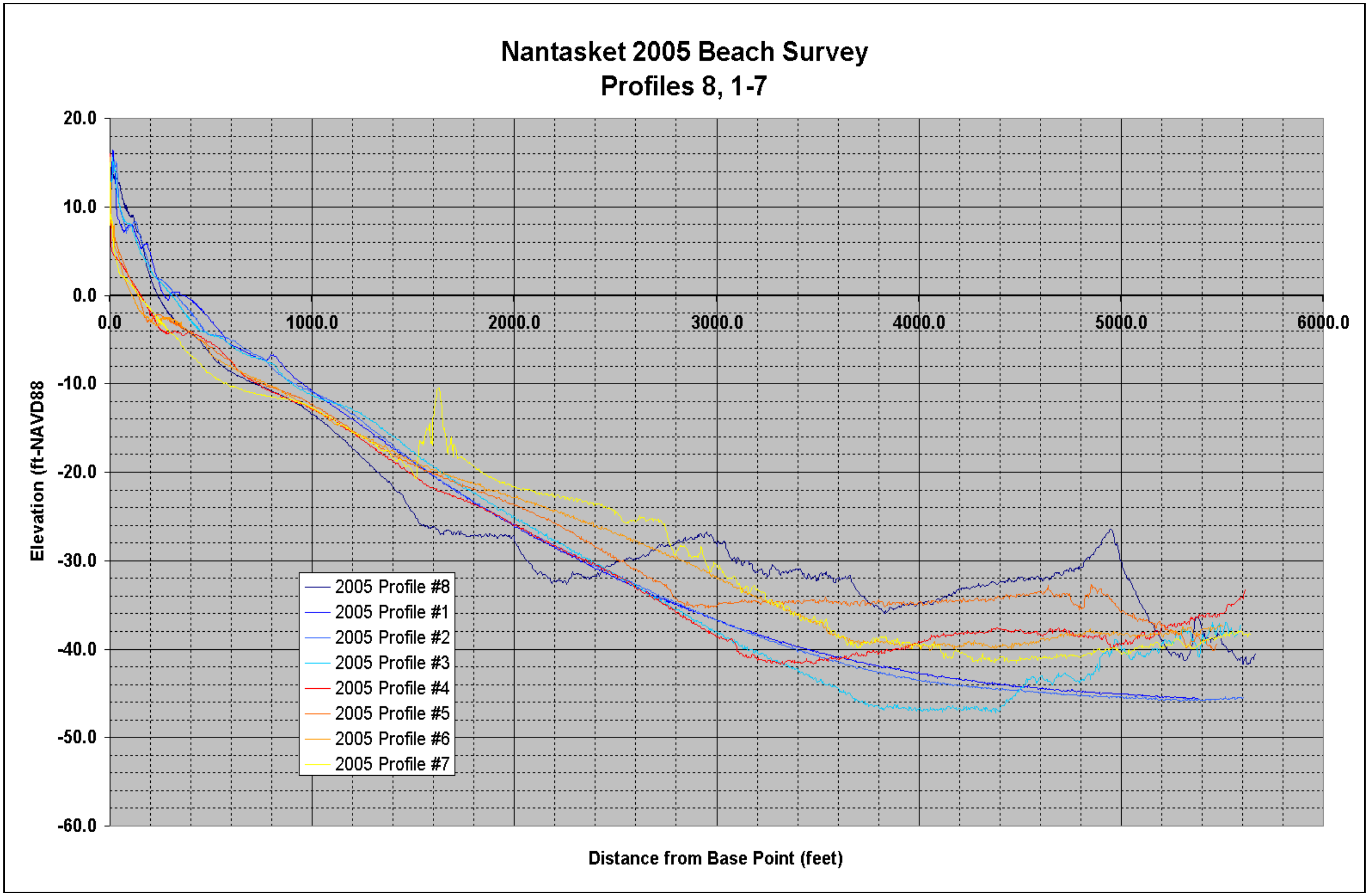


Figure 6. Plot of all eight (8) survey transects.

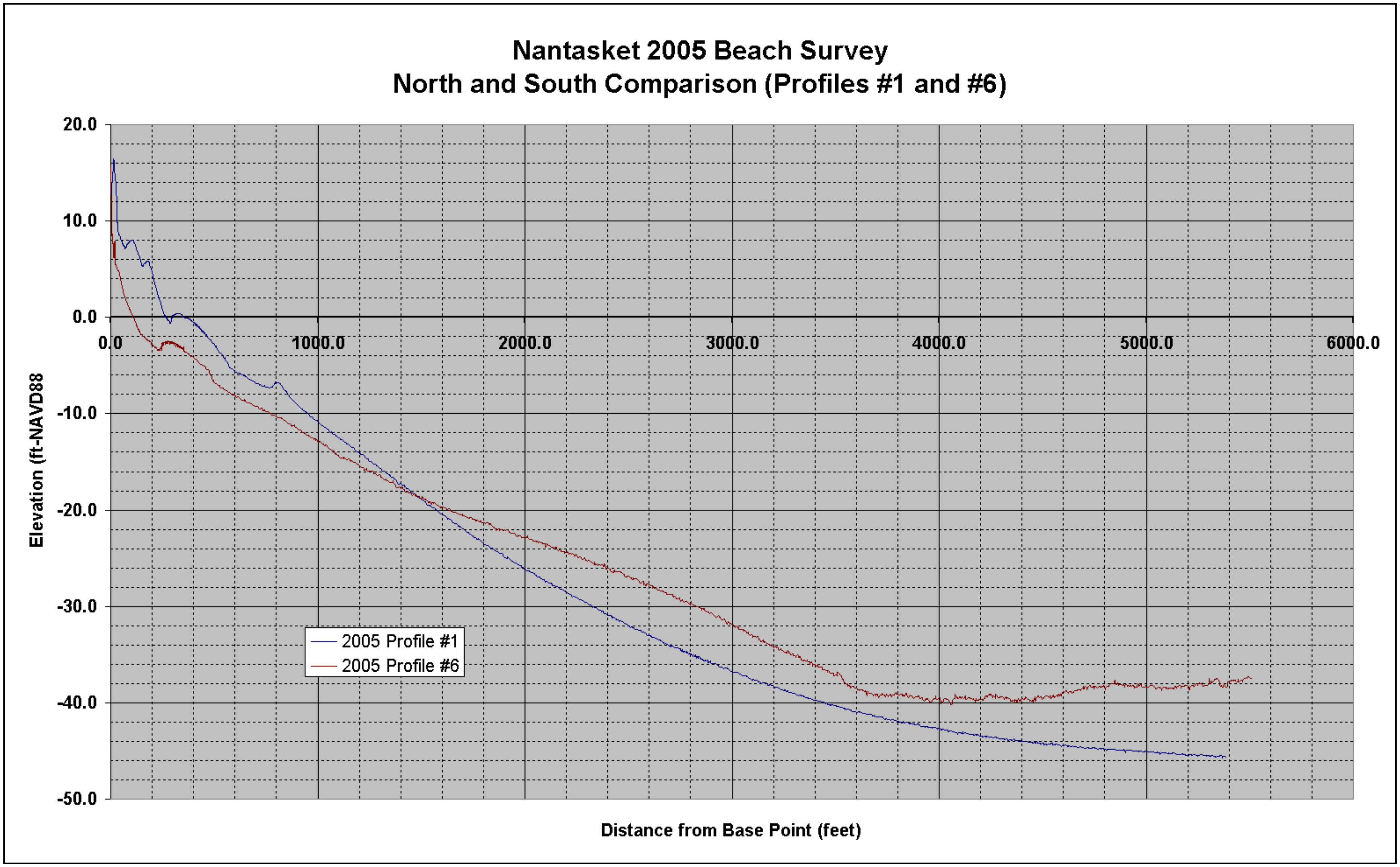


Figure 7. Comparison of North Nantasket and DCR Reservation.

4.2 Geotechnical Analysis

As mentioned in Section 2.0, two sampling efforts were completed as part of the beach characterization study. The larger effort consisted of collecting sixty-four (64) vibracore/ponar samples along five (5) of the beach survey transects discussed in Section 4.1. The location and types of samples collected during the 2005 contract effort are shown in Figure 8. The vibracore samples consisted of three (3) inch diameter cores taken by a land based rig, four (4) inch diameter cores taken by a boat mounted rig, and ponar samples (grab samples). The sample depths of the vibracores was contracted to be four (4) feet, or until refusal. Upon refusal the contractor was required to relocate the vibracore rig slightly and reattempt the sample. If the second attempt did not reach the required four (4) foot depth the sample would be used as collected and the sample depth recorded. The ponar samples were collected in the deeper water areas since significant cobble and gravel was found in the deeper areas during the 1963 study. The ponar sampler was basically used to determine if the more expensive vibracore sample would be successful. Additionally, it was felt that where vibracores were not possible that ponars would provide very reasonable results in the deeper samples since the deeper bottom sediments are much less mobile. The vibracore/sample log has been provided as Table 1 to help provide clearer information on how the samples were collected, the ultimate sample depth, recovery issues, etc.

The second part of the characterization effort was the collection of test pit samples. The samples were collected in the summer of 2004 by the DCR and the Corps. The timing was originally planned to coincide with the beach survey and vibracore effort that was ultimately performed in the early fall of 2005. The test pit locations are shown in Figure 9. Each sample was collected by using a backhoe scoop of beach material (test pit). The scoop of sediment was placed onto a board or other type of surface, from which four five (5) gallon buckets of sediment were taken. The buckets were used to accommodate the larger cobble sizes that were anticipated. Two (2) bucket samples were for the Corps analysis and two (2) bucket samples were for the DCR to allow for their own independent analysis (each sample was comprised of two (2) buckets).

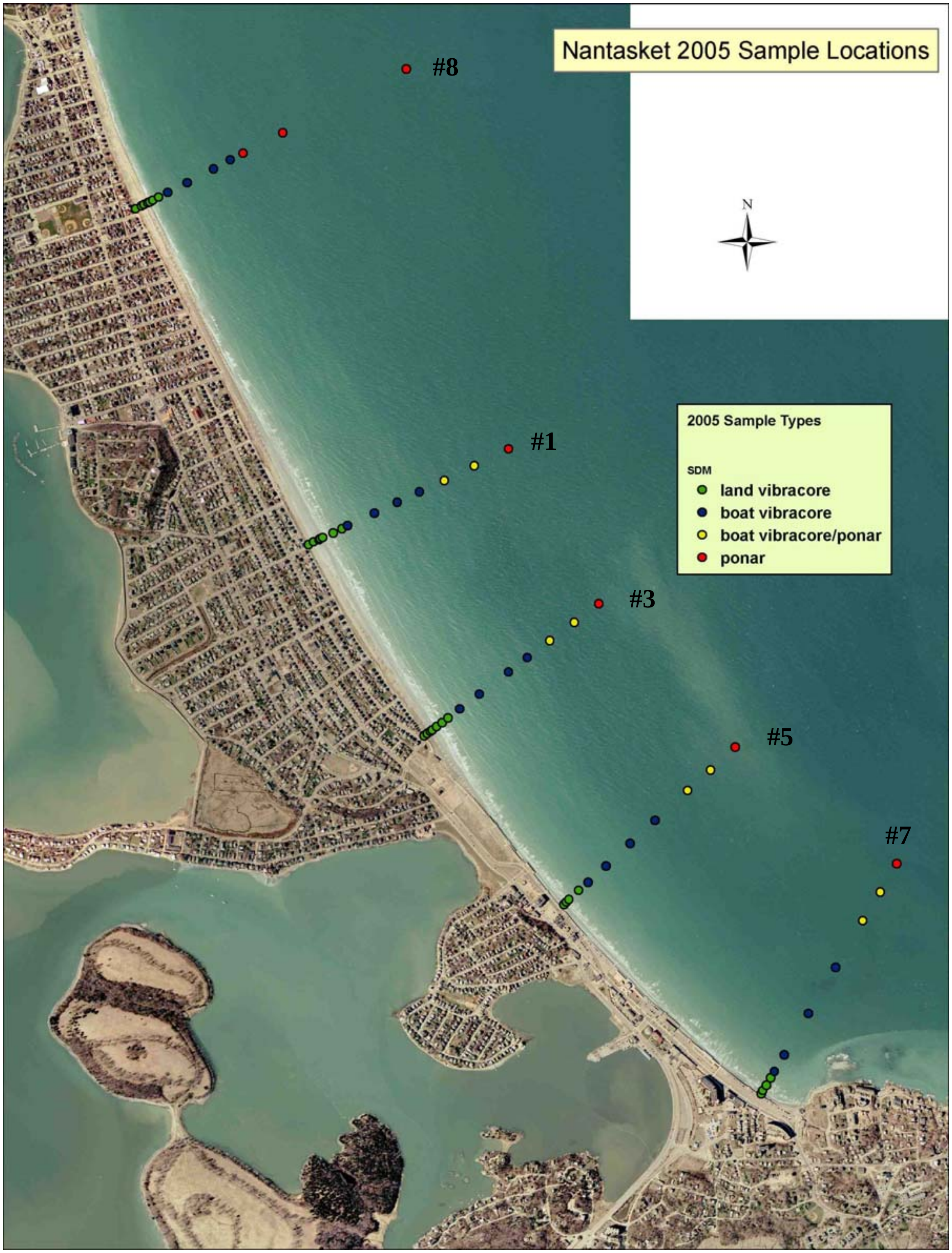


Figure 8. 2005 sample locations (vibracore and ponar)

Table 1. Vibracore/Sample Collection Log

Date Core Completed	Profile Number	Physical Setting	Easting-MA Mainland (NAD83)	Northing-MA Mainland (NAD83)	Surface Elevation (NAVD88)	Crew Names	Sampling Details and Methods	Vibracore Recovery (ft)	Material Description	Penetration (ft)	Recovery (Length Recovered/Length of Penetration) %	Comments
9/30/2005	1	Base of dune	826,034	2,930,258	8.6	JGW SCB	land vibracore	4.8	sand	4.8	100%	
9/30/2005	1	Mid berm	826,101	2,930,291	7.8	JGW SCB	land vibracore	4.9	sand	4.9	100%	
9/30/2005	1	Berm crest	826,167	2,930,320	5.7	JGW SCB	land vibracore	4.1	sand	4.1	100%	
9/30/2005	1	MHW	826,183	2,930,329	4.3	JGW SCB	land vibracore	4.0	sand	4.1	98%	
10/3/2005	1	+2	826,209	2,930,343	2.0	JGW GMS	land vibracore	4.2	sand	4.2	100%	
10/3/2005	1	MSL	826,341	2,930,402	-0.3	JGW GMS	land vibracore	4.1	sand	4.1	100%	
9/30/2005	1	-3	826,455	2,930,456	-3.0	JGW SCB	land vibracore	4.0	sand	4.2	95%	
10/4/2005	1	MLW	826,522	2,930,495	-5.3	STG KOM GRM	boat vibracore	4.0	sand	4.0	100%	
10/5/2005	1	-10	826,858	2,930,651	-10.0	STG KOM GRM	boat vibracore	4.42	sand	4.5	98%	
10/5/2005	1	-15	827,141	2,930,783	-15.1	STG KOM GRM	boat vibracore	4.45	fine sand	4.5	99%	
10/5/2005	1	-20	827,418	2,930,916	-19.9	STG KOM GRM	boat vibracore	4.6	sand	4.6	100%	
10/7/2005	1	-25	827,728	2,931,059	-25.0	STG KOM GRM	boat vibracore/ponar	4.32	sand	4.5	96%	Grab all sand core went easy to 4.5
10/7/2005	1	-30	828,102	2,931,244	-30.0	STG KOM GRM	boat vibracore/ponar	4.0	sand	4.3	93%	Grab all sand core went easy to 4.3
10/8/2005	1	-35	828,533	2,931,450	-35.0	STG KOM GRM	ponar	N/A	sand	N/A	N/A	
9/30/2005	3	Base of dune	827,477	2,927,866	12.3	JGW SCB	land vibracore	3.3	sand/cobble	3.4	97%	2 attempts, refusal due to cobble
9/30/2005	3	Mid berm	827,516	2,927,895	8.2	JGW SCB	land vibracore	3.3	sand/cobble	3.3	100%	2 attempts, refusal due to cobble
9/30/2005	3	Berm crest	827,554	2,927,921	6.5	JGW SCB	land vibracore	2.4	sand/cobble	2.4	100%	2 attempts, refusal due to cobble
10/3/2005	3	MHW	827,580	2,927,942	4.3	JGW GMS	land vibracore	2.1	sand/cobble	2.1	100%	2 attempts, refusal at cobble
10/1/2005	3	+2	827,635	2,927,982	2.0	JGW GMS	land vibracore	2.2	sand/cobble	2.2	100%	2 attempts, refusal at cobble
10/3/2005	3	MSL	827,701	2,928,035	-0.3	JGW GMS	land vibracore	4.9	sand	4.9	100%	
9/30/2005	3	-3	827,776	2,928,090	-3.0	JGW SCB	land vibracore	4.65	sand	4.65	100%	
10/2/2005	3	MLW	827,921	2,928,202	-5.4	JGW GMS	boat vibracore	2.3	sand/gravel	2.3	100%	2 attempts, refusal at gravel
10/5/2005	3	-10	828,168	2,928,388	-10.0	STG KOM GRM	boat vibracore	4.2	sand/gravel	4.4	95%	Refusal at 4.4
10/5/2005	3	-15	828,530	2,928,663	-15.1	STG KOM GRM	boat vibracore	4.1	sand /gravel	4.1	100%	
10/5/2005	3	-20	828,763	2,928,841	-20.1	STG KOM GRM	boat vibracore	4.0	sand /gravel	4.0	100%	
10/5/2005	3	-25	829,044	2,929,056	-25.0	STG KOM GRM	boat vibracore/ponar	3.57	fine sand	3.9	92%	Refusal at 3.9 on hard pack sand
10/6/2005	3	-30	829,352	2,929,285	-30.0	STG KOM GRM	boat vibracore/ponar	3.93	sand /gravel	4.0	98%	
10/8/2005	3	-35	829,658	2,929,517	-35.0	STG KOM GRM	ponar	N/A	sand	N/A	N/A	
10/3/2005	5	MHW	829,221	2,925,761	4.3	JGW GMS	land vibracore	3.4	sand/cobble	3.5	97%	2 attempts, refusal at cobble
10/1/2005	5	+2	829,249	2,925,791	2.0	JGW GMS	land vibracore	4.1	sand	4.1	100%	
10/3/2005	5	MSL	829,285	2,925,823	-0.3	JGW GMS	land vibracore	4.0	sand	4.0	100%	
9/30/2005	5	-3	829,406	2,925,937	-3.0	JGW SCB	land vibracore	2.0	sand/cobble	2.1	95%	2 attempts, refusal due to cobble
10/6/2005	5	MLW	829,522	2,926,039	-5.2	STG KOM GRM	boat vibracore	4.0	sand /gravel	4.0	100%	
10/7/2005	5	-10	829,743	2,926,242	-10.1	STG KOM GRM	boat vibracore	3.92	sand /gravel	4.0	98%	
10/6/2005	5	-15	830,047	2,926,522	-14.9	STG KOM GRM	boat vibracore	4.3	sand /gravel	4.5	96%	2nd attempt - poor recovery on first attempt, rig probably fell over
10/6/2005	5	-20	830,357	2,926,808	-20.2	STG KOM GRM	boat vibracore	4.0	sand /gravel	4.0	100%	
10/6/2005	5	-25	830,764	2,927,182	-25.2	STG KOM GRM	boat vibracore/ponar	3.9	sand	4.0	98%	Looks like all sand
10/6/2005	5	-30	831,052	2,927,442	-30.1	STG KOM GRM	boat vibracore/ponar	4.4	sand/cobbles	4.5	98%	1st bad recovery 2nd attempt good
10/8/2005	5	-35	831,359	2,927,729	-35.0	STG KOM GRM	ponar	N/A	gravel and cobble	N/A	N/A	
10/3/2005	7	MHW	831,682	2,923,395	4.3	JGW GMS	land vibracore	2.0	sand/rip rap	2.0	100	2 attempts, hit large rock on both
10/3/2005	7	+2	831,701	2,923,433	2.0	JGW GMS	land vibracore	3.9	sand	4.0	98%	
10/3/2005	7	MSL	831,746	2,923,504	-0.3	JGW GMS	land vibracore	4.5	sand	4.5	100%	
9/30/2005	7	-3	831,799	2,923,596	-3.0	JGW SCB	land vibracore	4.2	sand	4.2	100%	
10/6/2005	7	MLW	831,847	2,923,673	-5.2	STG KOM GRM	boat vibracore	4.0	sand /gravel	4.0	100%	Cobbles in shoe sand and gravel in core
10/6/2005	7	-10	831,970	2,923,882	-10.1	STG KOM GRM	boat vibracore	1.8	sand to cobbles	1.9	95%	1st had 3.4 pen 2.75 recovery 2nd had 1.9 pen with 1.8 recovery refusal in cobbles for both
10/7/2005	7	-15	832,270	2,924,394	-15.1	STG KOM GRM	boat vibracore	4.0	sand /gravel	4.0	100%	Large gravel in shoe stopped dead at 4'
10/7/2005	7	-20	832,608	2,924,972	-20.2	STG KOM GRM	boat vibracore	3.42	sand/shells at top	3.8	90%	Refusal sand/possible rock shoe dented catcher washed out
10/7/2005	7	-25	832,948	2,925,557	-25.1	STG KOM GRM	boat vibracore/ponar	1.9	sand to cobbles	2.1	90%	Sand in grab

Table 1 (continued). Vibracore/Sample Collection Log

Date Core Completed	Profile Number	Physical Setting	Easting-MA Mainland (NAD83)	Northing-MA Mainland (NAD83)	Surface Elevation (NAVD88)	Crew Names	Sampling Details and Methods	Vibracore Recovery (ft)	Material Description	Penetration (ft)	Recovery (Length Recovered/Length of Penetration) %	Comments
10/7/2005	7	-30	833,166	2,925,918	-30.0	STG KOM GRM	boat vibracore/ponar	3.38	gravel to till	3.6	94%	Gravel in grab, core refusal in till at 3.6', about 1' till in bottom of core
10/8/2005	7	-35	833,370	2,926,268	-34.8	STG KOM GRM	ponar	N/A	cobbles	N/A	N/A	
9/30/2005	8	Base of dune	823,881	2,934,452	13.9	JGW SCB	land vibracore	2.1	sand/cobble	2.1	100%	2 attempts, in cobble
9/30/2005	8	Mid berm	823,951	2,934,488	9.5	JGW SCB	land vibracore	2.1	cobble/sand	2.3	91%	2 attempts, in cobble
9/30/2005	8	Berm crest	823,983	2,934,506	8.3	JGW SCB	land vibracore	2.2	sand/cobble	2.2	100%	2 attempts, refusal due to cobble
9/30/2005	8	MHW	824,032	2,934,528	4.3	JGW SCB	land vibracore	1.7	sand/gravel	1.7	100%	2 attempts, refusal due to gravel
9/30/2005	8	+2	824,054	2,934,539	2.0	JGW SCB	land vibracore	2.1	sand, cobble	2.1	100%	2 attempts, refusal at cobble
10/3/2005	8	MSL	824,092	2,934,560	-0.3	JGW GMS	land vibracore	4.2	sand	4.2	100%	
9/30/2005	8	-3	824,165	2,934,598	-3.0	JGW SCB	land vibracore	4.0	sand	4.0	100%	
10/2/2005	8	MLW	824,280	2,934,657	-5.2	JGW GMS	boat vibracore	2.0	sand/gravel	2.0	100%	2 attempts, refusal at gravel
10/4/2005	8	-10	824,522	2,934,778	-10.1	STG KOM GRM	boat vibracore	3.75	sand/gravel	4.0	94%	
10/4/2005	8	-15	824,850	2,934,950	-15.1	STG KOM GRM	boat vibracore	3.9	sand/gravel	4.1	95%	
10/4/2005	8	-20	825,060	2,935,061	-20.1	STG KOM GRM	boat vibracore	4.1	sand/gravel	4.3	95%	2nd attempt - poor recovery on first
10/7/2005	8	-25	825,221	2,935,145	-25.0	STG KOM GRM	ponar	N/A	Cobbles	N/A	N/A	3 grabs all cobbles no core attempted
10/8/2005	8	-30	825,716	2,935,403	-30.2	STG KOM GRM	ponar	N/A	gravel and cobble	N/A	N/A	
10/8/2005	8	-35	827,255	2,936,198	-35.2	STG KOM GRM	ponar	N/A	gravel and cobble	N/A	N/A	

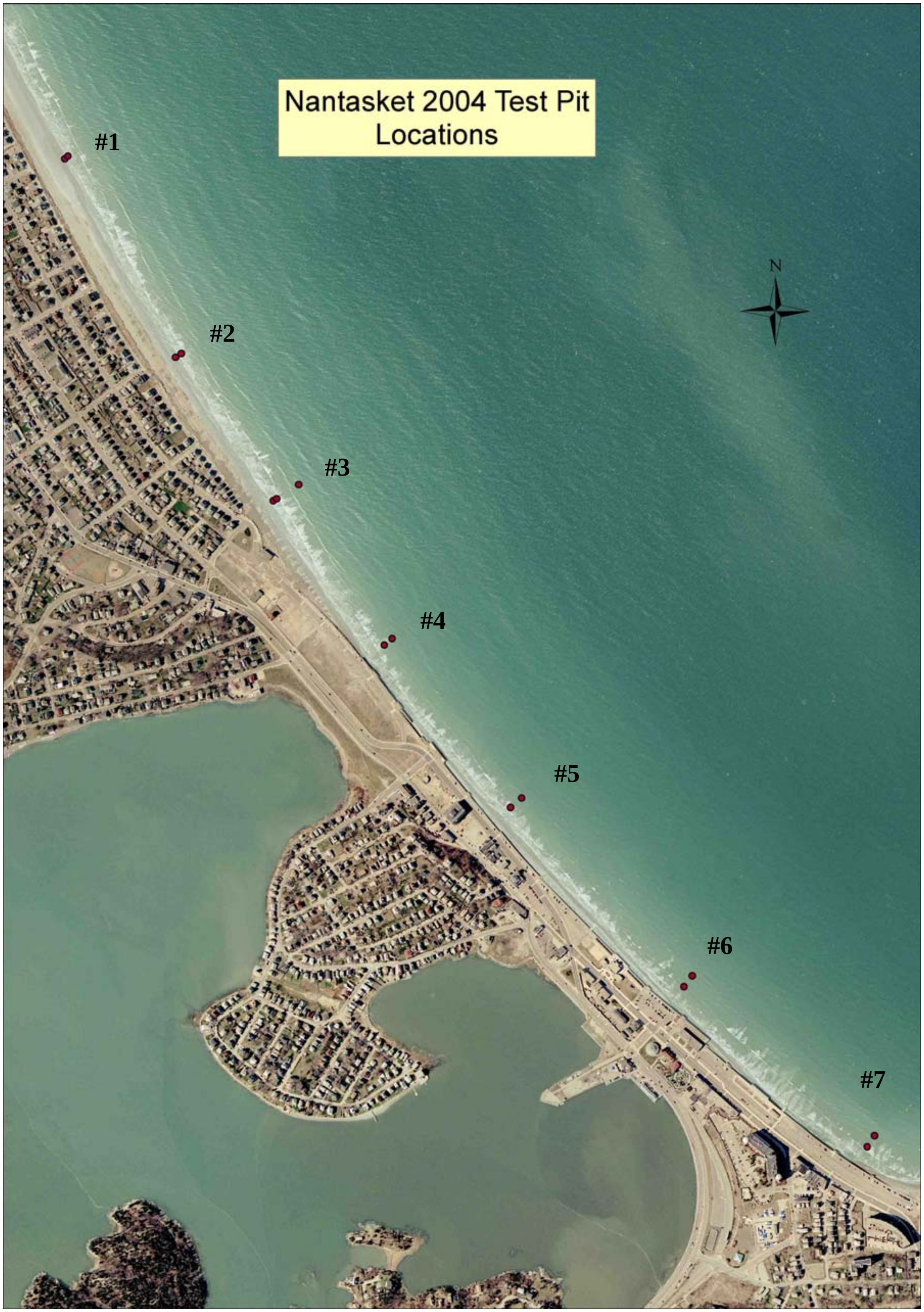


Figure 9. 2004 Test Pit Locations.

4.2.1 <u>Vibracore and Ponar Sample Analysis</u>

Given the large number of samples and the analysis of both the upper and lower portions of each sample (excluding ponars and test pits), the amount of grain size data was substantial. To help present the material, a series of GIS base maps were developed to present the data for both the vibracore/ponar sampling effort and the test pit effort. The first set of data presented is the mean grain size or D_{n50} of each sample and can be seen in Figures 10 and 11. Only the lower sample data is presented since it was found that the upper and lower samples were very similar. In general the material is fine sand ranging from 0.15mm to 0.25 mm, with coarser sediments occurring on the upper profile and in the deeper locations. This is not surprising since cobble is very evident along the beach in certain areas and the 1963 samples reported that cobble was present in the deeper water sample locations. Profile #8's vibracores and ponar samples contained the coarsest material out of the new profiles.

To look at the samples more closely and to determine the true nature of the beach, the level of cobble and gravel in each sample was investigated. First the percentage of sand of each sample was calculated using the grain size information and is shown as Figures 12-15, for both the lower and upper samples. Since the material only contained sand, cobble, and gravel, reporting the sand fraction was essentially the same as reporting the cobble and gravel fraction (what ever was not sand was either cobble or gravel). As expected, when the sand fraction figures are compared to the D_{n50} figures, the samples high in sand content are finer (0.15mm to 0.25mm) and the samples lower in sand content are coarser due to the increased gravel and cobble content. Also, the samples along profile #8 contained some of the lowest sand percentages. It should also be noted that the lower samples, in general, contain slightly more cobble and gravel since the sand fraction percentages are slightly less than that of the lower samples. This may be the result of cobble and gravel settling into the beach material as the finer sand is transported along shore and cross shore. To further understand the cobble and gravel content it is worth looking at Table 1 once again and viewing the sampling comments. For many of the samples second attempts were needed and the full penetration depth of four (4) feet was not reached. This indicates the presence of cobble and gravel not captured by the sample as well.

To further clarify the beach characterization, the grain size (D_{n50}) of the sand fraction of each sample (both lower and upper) was determined. Figures 16-19 provide the D_{n50} of just the sand fraction of each sample. For most of the samples the sand's D_{n50} was approximately 0.15mm to 0.25mm, but there were definite exceptions. The exceptions were typically in the same locations that reported higher cobble and gravel percentages. This makes sense since areas that contain higher cobble and gravel would also likely contain coarser sand. These areas of coarser sand were not numerous and were certainly the exception. This was the case for both the upper and lower samples.

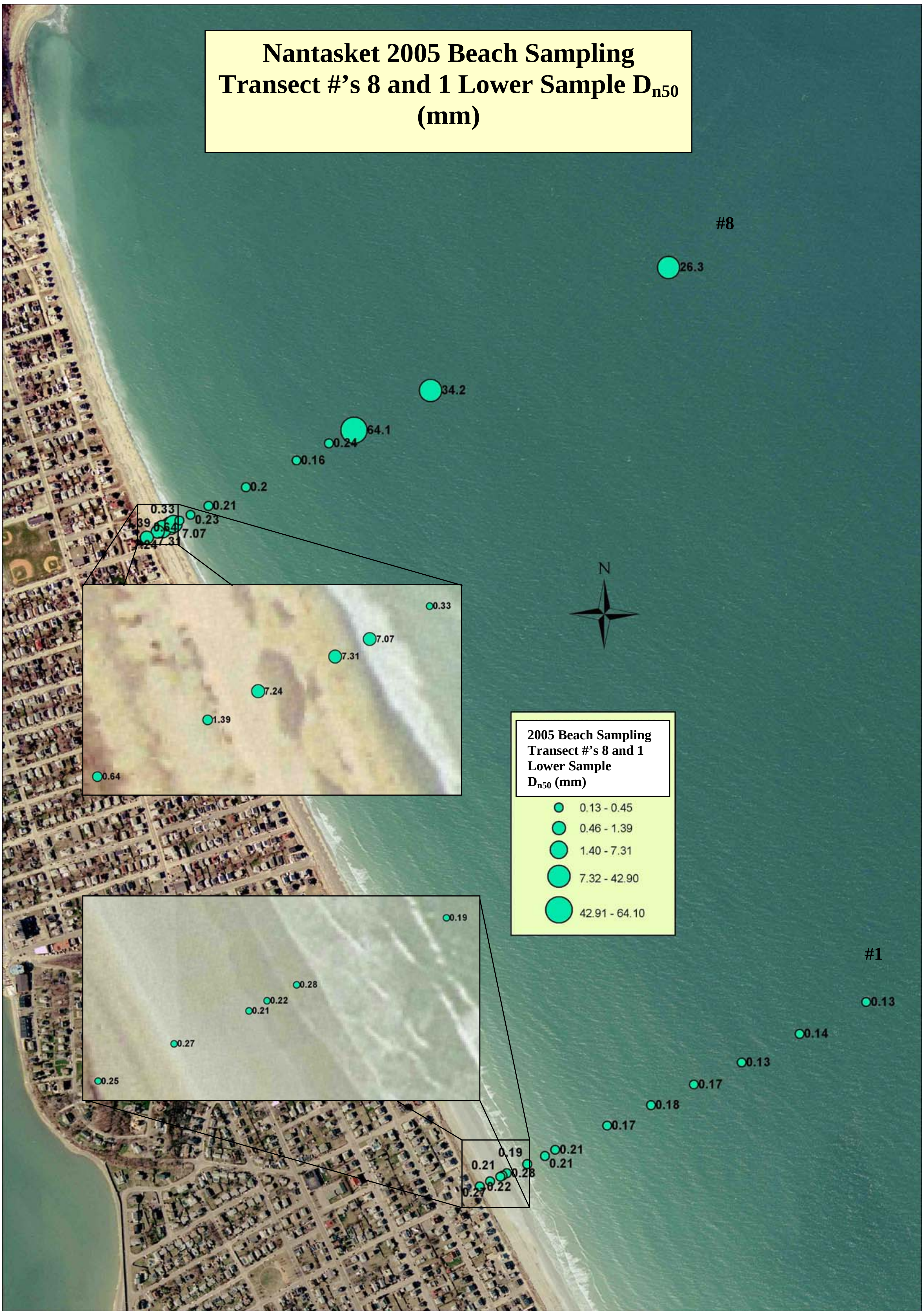


Figure 10. Median diameter(D_{n50}) for the lower samples (transects 8 and 1).

Figure 11. Median diameter (D_{n50}) for the lower samples (transects 3, 5, 6, and 7).

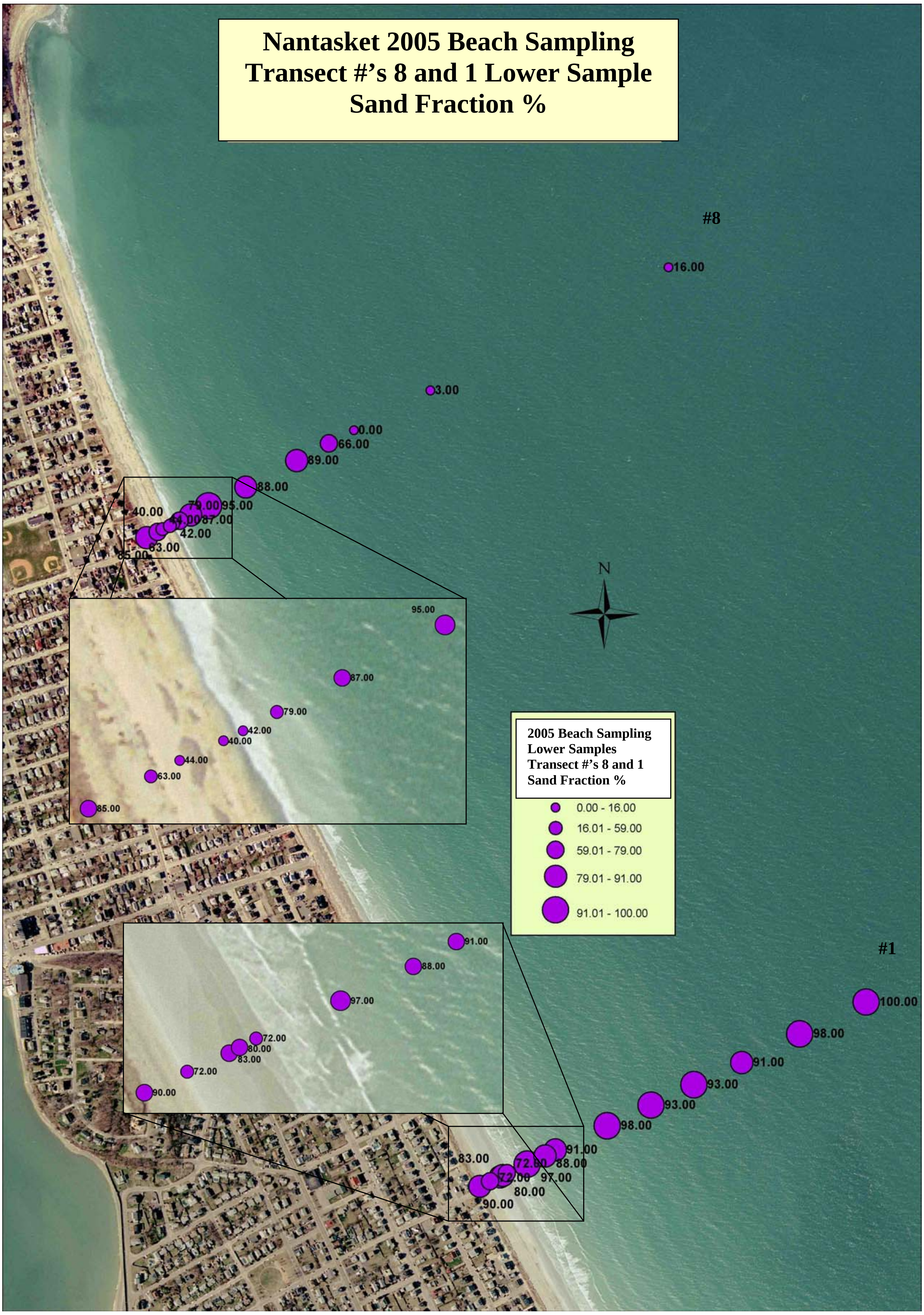


Figure 12. Sand fraction of lower samples (transects 8 and 1).

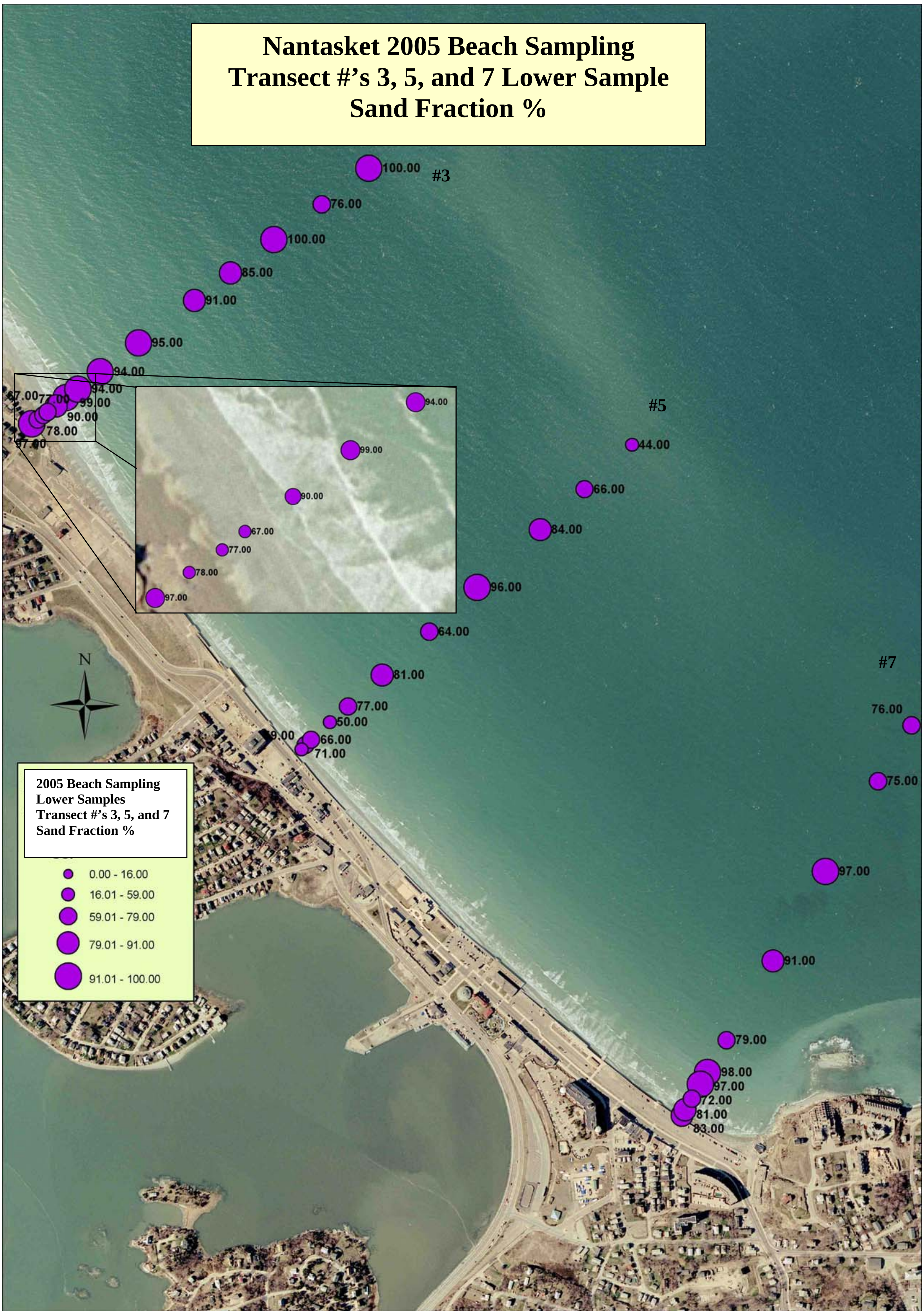


Figure 13. Sand fraction of lower samples (transects 3, 5, and 7).

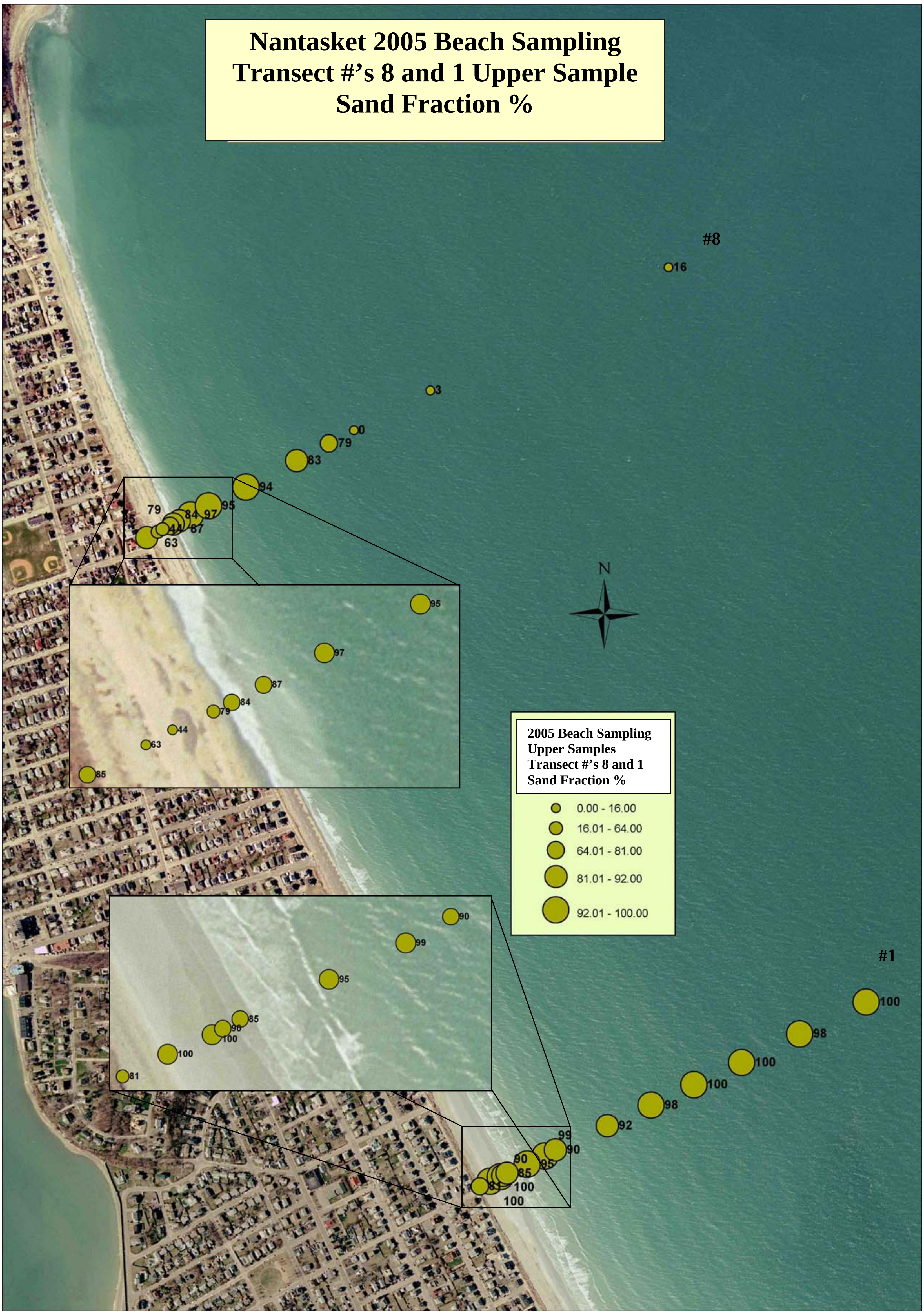


Figure 14. Sand fraction of upper samples (transects 8 and 1).

Figure 15. Sand fraction of upper samples (transects 3, 5, and 7).

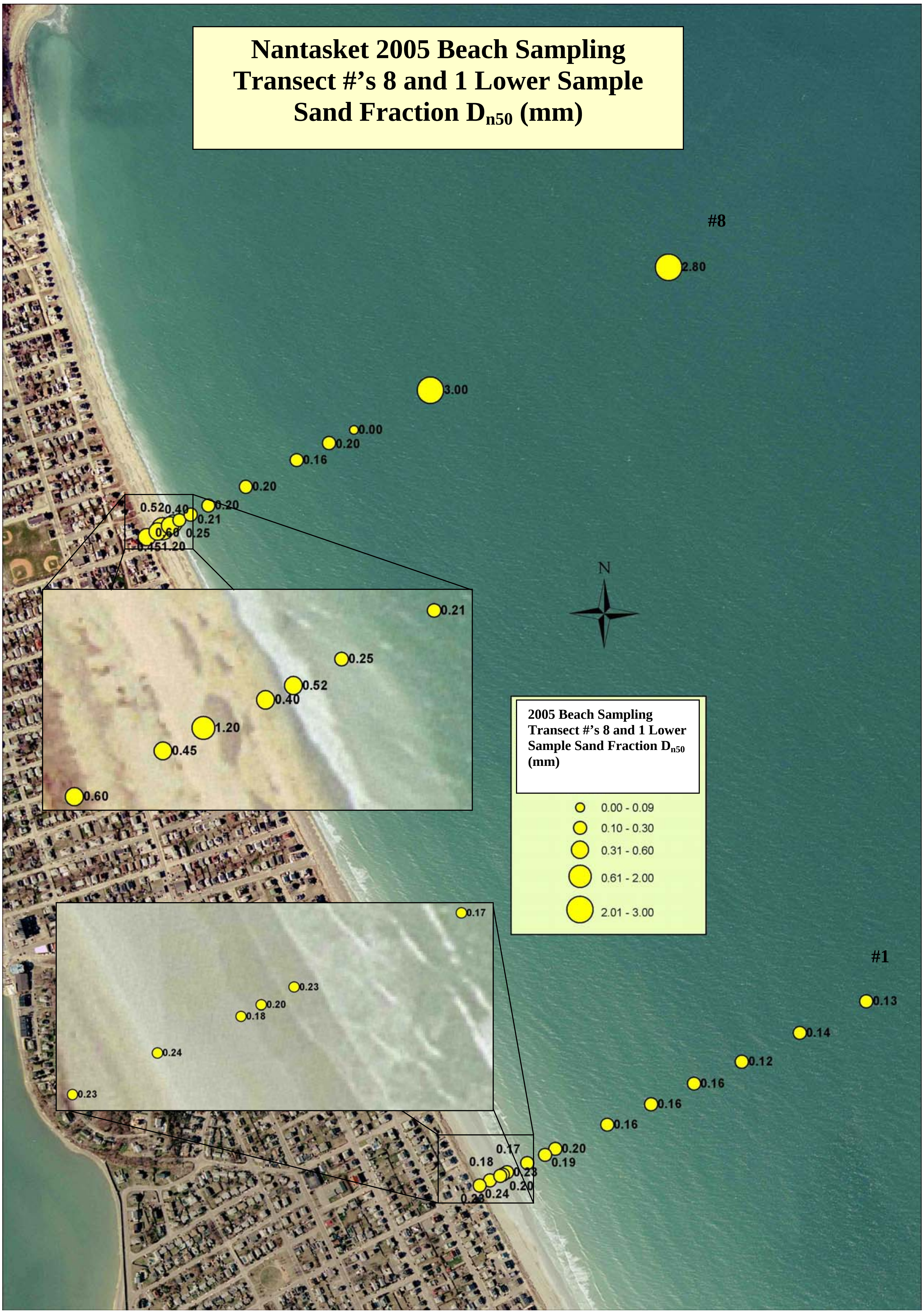


Figure 16. Sand fraction D_{n50} of lower samples (transects 8 and 1).

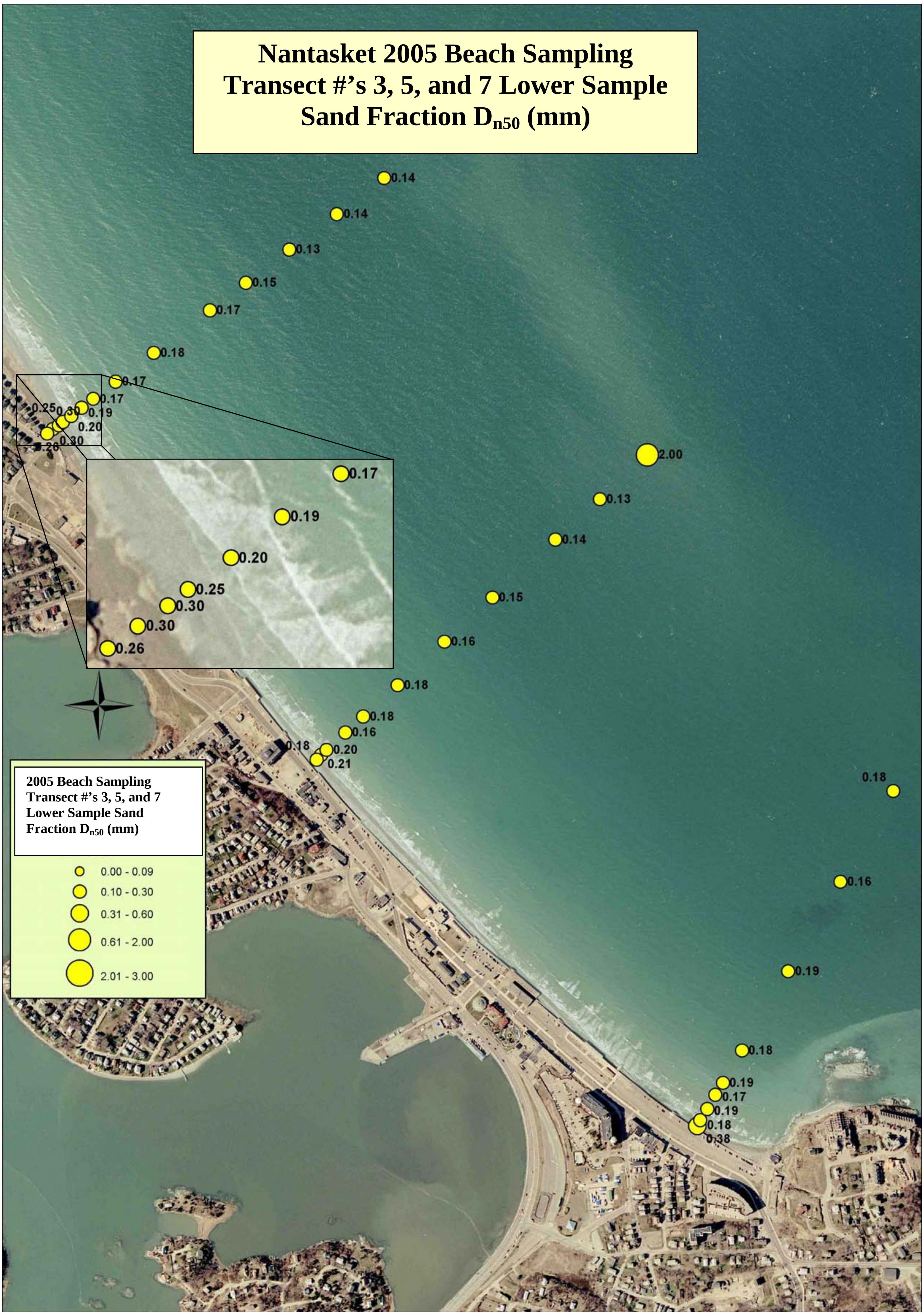


Figure 17. Sand fraction D_{n50} of lower samples (transects 3, 5, and 7).

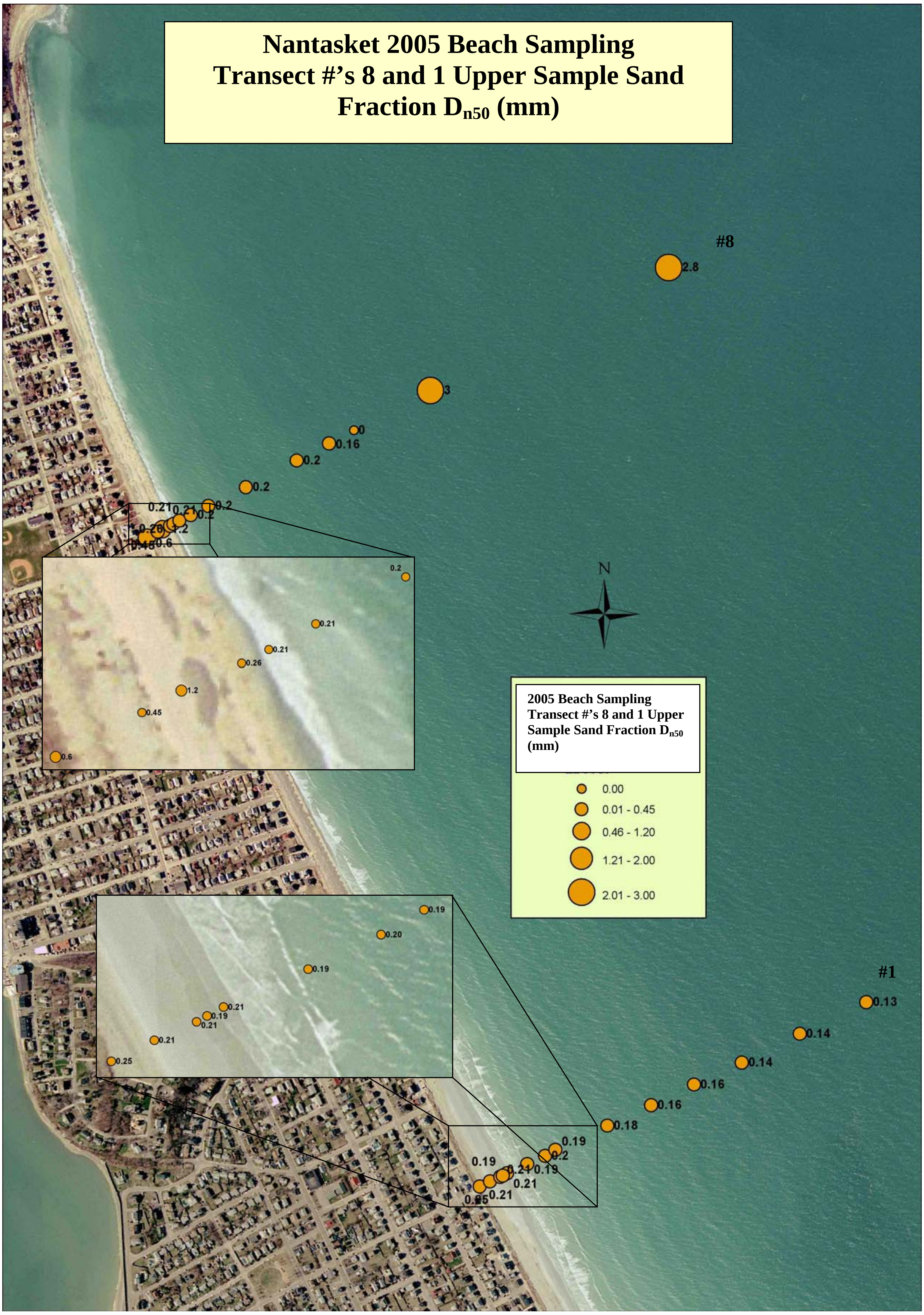


Figure 18. Sand fraction D_{n50} of upper samples (transects 8 and 1).

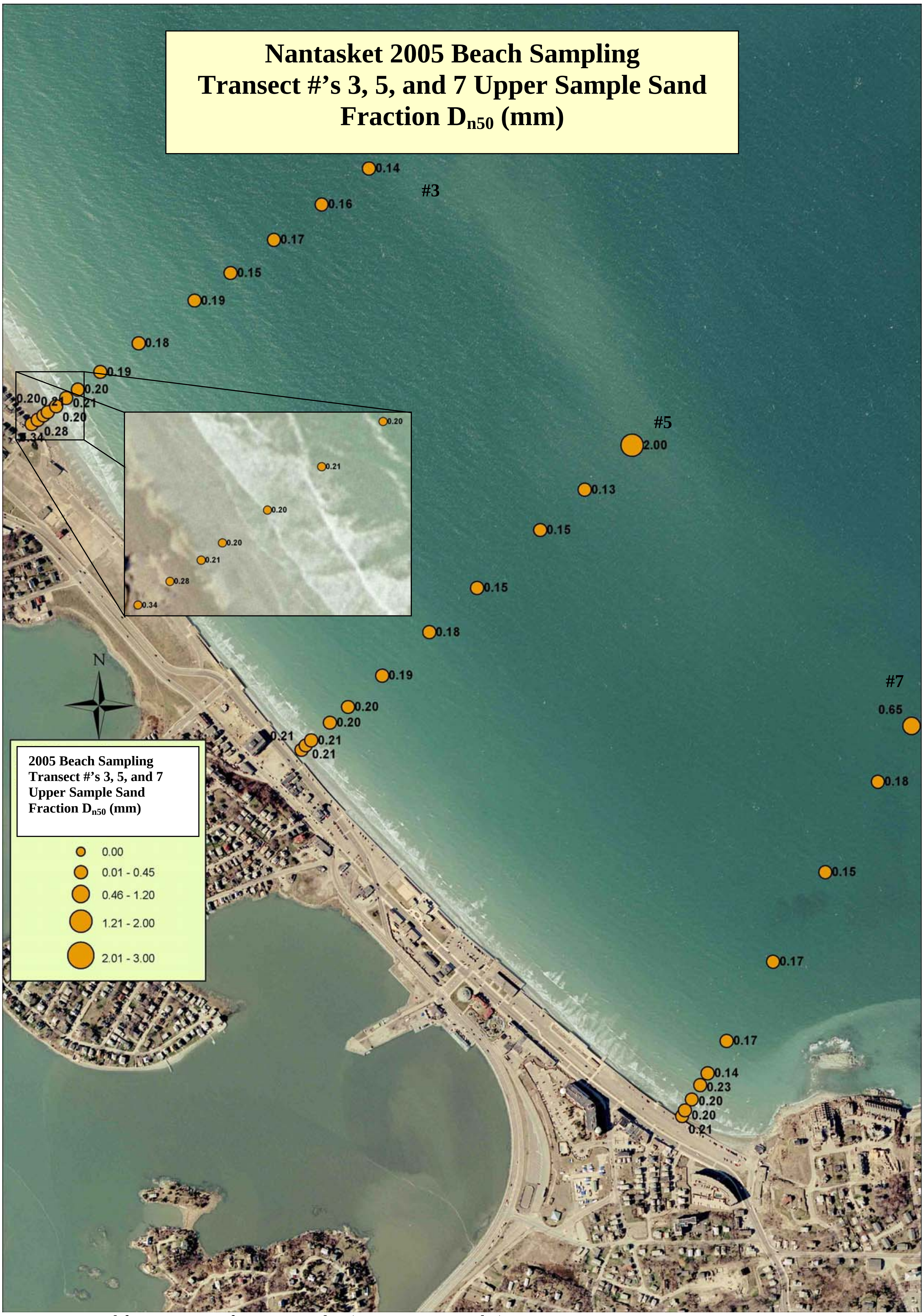


Figure 19. Sand fraction D_{n50} of upper samples (transects 3, 5, and 7).

4.2.2 Test Pit Sample Analysis

As mentioned previously there was a definite concern that the vibracore sampling would not correctly characterize the full extent of cobble and gravel on the beach due to the limited core tube diameters. As shown in Table 1, this concern was legitimate since numerous samples were not collected successfully on the first attempt, or the full penetration depth of four (4) feet was not reached. With the exception of transect number one (1), the other four (4) transects all had some type of issue with cobble or gravel. To help address this concern, test pit samples were taken (as described in Section 4.2). As with the vibracore samples, the D_{n50} of the entire sample has been provided (Figure 20), the sand fraction percentage of each sample has been provided (Figure 21), and the D_{n50} of the sand fraction has been provided (Figure 22). The testing shows that overall the results between the test pits and the vibracore samples are actually very similar. The overall D_{n50} sizes are similar, but in general, slightly more coarse for the test pits. The sand percentages are also similar, which was slightly unexpected since it was hypothesized that the test pits would capture more of the cobble and gravel leading to lower sand fractions. Finally, looking at the sand fraction D_{n50} of the test pits, it was found that the sand grain size was very similar to the vibracore samples. This was expected since the vibracores could easily accommodate the sand during the sampling process.

4.2.3 Geotechnical Analysis Summary

To summarize the grain size testing results of both the vibracore/ponar effort and the test pit samples, Nantasket beach is a bimodal beach that contains a tightly graded sand fraction along with cobble and gravel. A majority of the coarser material is actually classified as gravel, but to most lay people (and often engineers) it appears to be cobble. The samples taken along transect number one (1) were the only set that did not encounter penetration issues and were comprised almost entirely of sand (lowest sand fraction was 70%). The other transects (8, 3, 5, 7) all contained some samples low in sand (high in cobble or gravel) or penetration issues. The sand fraction of the samples for the most part has a D_{n50} ranging from (0.15mm to 0.25mm). There were some samples, close to shore or in deeper water that contained slightly coarse sand fractions in the .30 to 0.45mm range, but they were definitely the exception. This was the case for both the vibracores and the test pit samples. The cobble and gravel appears to be concentrated more closely to shore or in the deeper water sample areas. There were certainly exceptions to this, but for the most part the intermediate water depth samples contained a high percentage of fine sand. Although not shown on the figures, but evident in the grain size curves of the OSI report, the cobble and gravel screened size ranged from the sub-one inch range to three (3) inches for the vibracore samples (not unexpected given the sample tube size), but this was also the case for the test pits. For the test pits there was some cobble up to six (6) inches (screened size), but this was definitely the exception. The gravel that is two (2) to three (3) inches is fairly significant since cobble and gravel on a beach is often oblong with one axis significantly longer than the other two. This means that the cobble that is classified as being three inches may actually be significantly longer. Based on the vibracore samples and the test pits, in general, the near shore samples exhibited 20% to 30% gravel and cobble. Some exceptions were noted however.

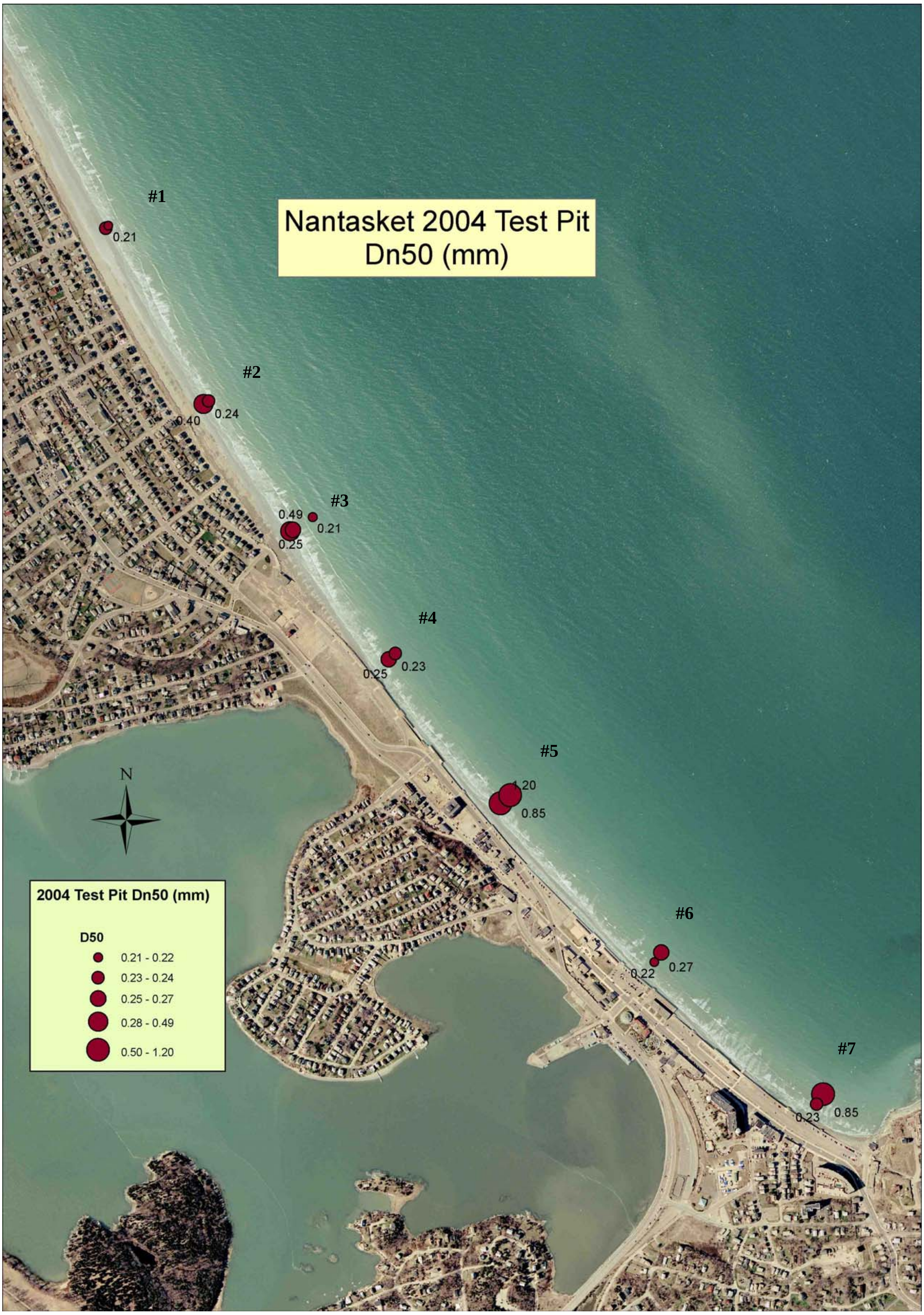


Figure 20. Summer 2004 Test Pit D_{n50} (mm).

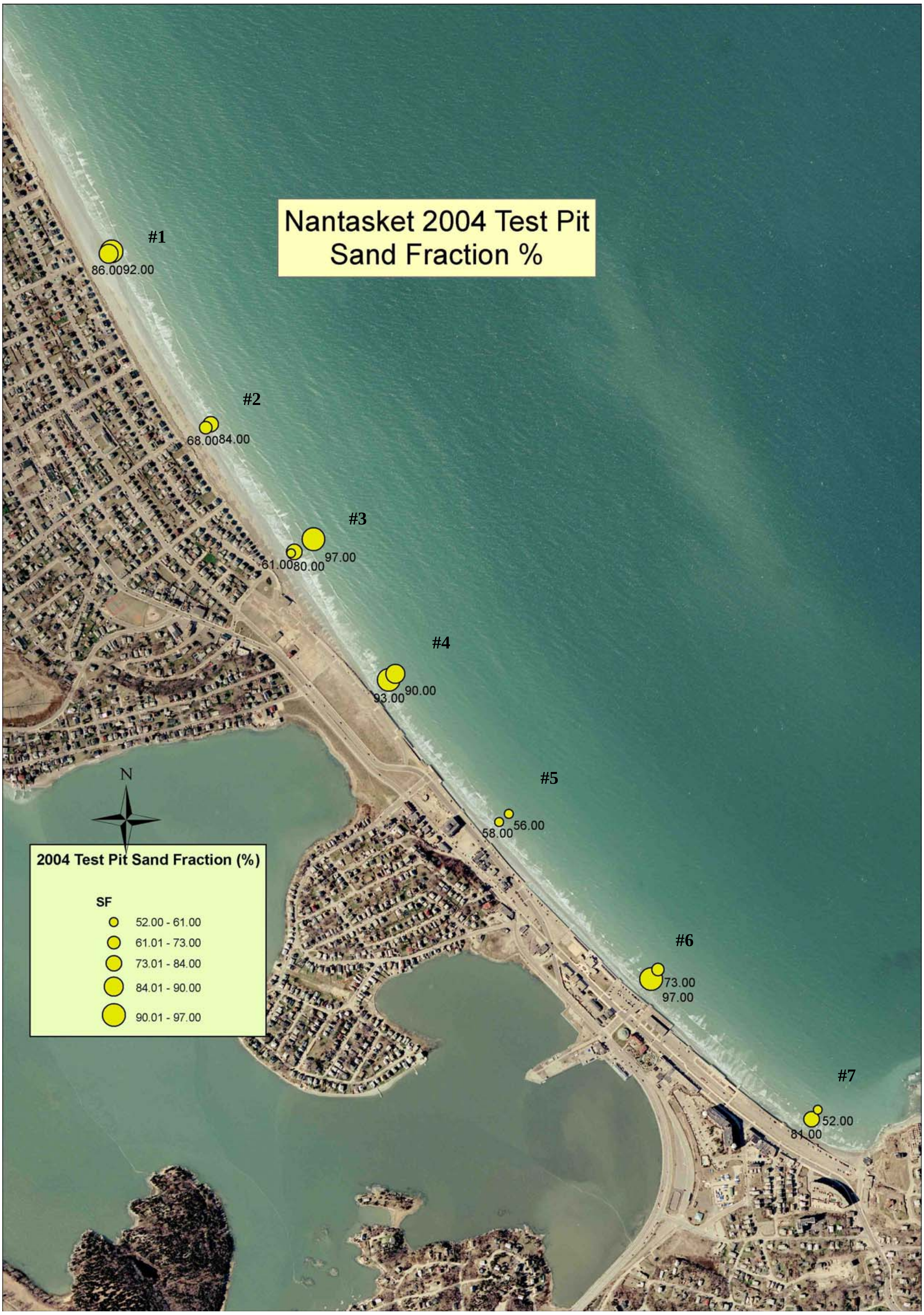


Figure 21. Summer 2004 Test Pit Sand Fraction (%).

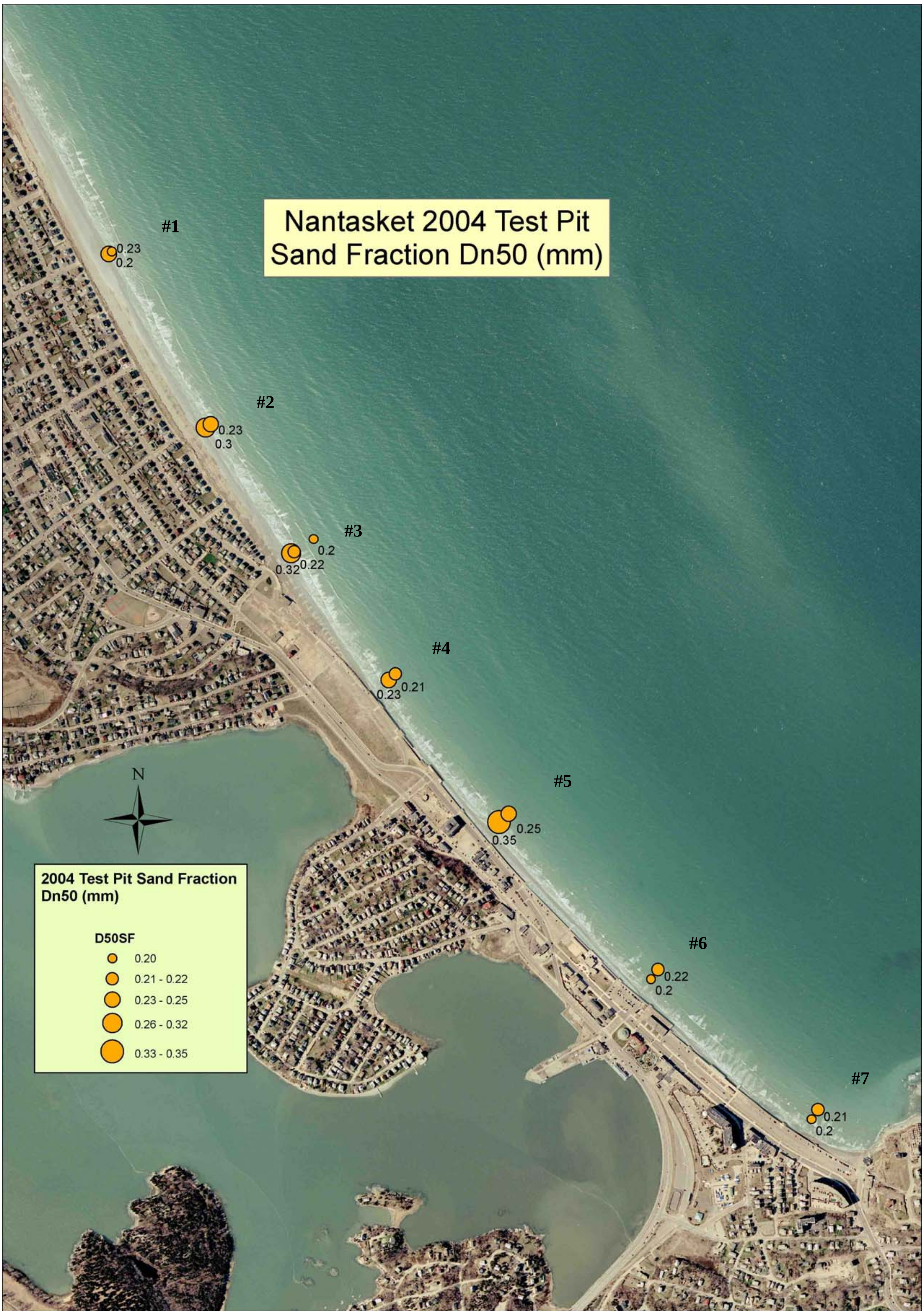


Figure 22. Summer 2004 Test Pit Sand Fraction D_{n50} (mm).

5.0 1963 and 2005 Comparison

The second half of the analysis is a comparative discussion to the 1963 survey data and sediment sample data. Survey data and sediment samples were taken in April 1963. In order to make the survey data more useful, the hard copy survey plot was scanned and rectified using ArcInfo. The survey data was then digitized using ArcMap. The locations of the sediment samples were also digitized using the demarcation provided on the map and using the sample depth/transect number information. The survey and sediment sample locations are shown in Figure 23. Also, shown are the 2005 survey transect base points.

5.1 Survey Data Comparison

As with the 2005 data, the survey data will be discussed first. As shown in Figure 23, there were three transects from the 2005 effort that fell directly over the 1963 surveys. The other 2005 survey transects fell in between the 1963 data. Using both sets of data a series of plots have been created and included as Figures 24 through 33. The reader must take note that the 1963 data was "adjusted" by adding "false survey" points or base points so that hard features such as the seawall would align when the two profiles were plotted. This basically reset the 1963 transect points to the 2005 base points. Additionally, the 1963 data lacked data points directly adjacent to the seawall. Since this "corner" point significantly impacts the shape of the near shore profile, the elevation was extrapolated using the very near shore slope from the survey data. This means that the 1963 survey data points closest to the seawall shown in the figures was not a true survey point and potentially causes error. Given the tendency for cobble to build against the seawall during the winter, which holds a steeper slope, it is likely the beach elevations along the seawall were actually slightly higher than the ones extrapolated. However, this cannot be known for certain.

Our review of the data revealed an obvious similarity between the profiles from 2005 and 1963. This is certainly the case for 2005 profiles 3, 5, 7, which are the profiles that directly correspond to the 1963 profiles. The 2005 profiles 4 and 6 also match the survey profiles from 1963 that fall on either side of the respective survey lines very closely. The profiles have the largest differences near shore (offshore is very similar), which may be a result of the lack of beach elevation data in the 1963 survey directly adjacent to the seawall. As shown in profiles 6 and 7 from the 2005 survey (Figures 30 and 31), the area very close to the seawall is raised and most likely represents either the temporary revetment constructed in 2004 or the cobble and gravel build up evident during field visits. Due to the extrapolated data used to estimate the 1963 beach/seawall elevation it is not known if this feature was present. One factor to consider when comparing the profiles is the time of year in which the surveys were taken. The 1963 data was collected in April 1963 while the 2005 survey data was collected during the last week of September. This is problematic since summer beaches are typically wider and higher in elevation while winter beaches, or early spring beaches are narrower and lower in elevation. This would indicate that the 1963 survey captured the beach at its minimal size and the 2005 survey captured the beach at its maximum. However, this does not truly explain why the 1963 beach looks so similar to the 2005 beach since the sand that would normally build up the larger dry beach in the summer does not seem evident in the offshore area, where it would normally be "stored" during a winter profile. To better examine this issue, volumetric calculations between the profiles would be required and these were beyond the scope of work developed for this report. Interestingly though this data seems to dispute the belief that the beach in front of the seawall has eroded significantly over the past 40 years. During discussions with the DCR, in which this study along with further scrutiny of the 1949 and 1968 reports was undertaken, it was concluded that the available information indicates that the seawall was under designed from the beginning in that it does not seem that the seawall was designed adequately for winter beach (lower beach elevation) conditions. This would further indicate that the level of erosion in front of the seawall over the last forty plus (40+) years was largely overstated.

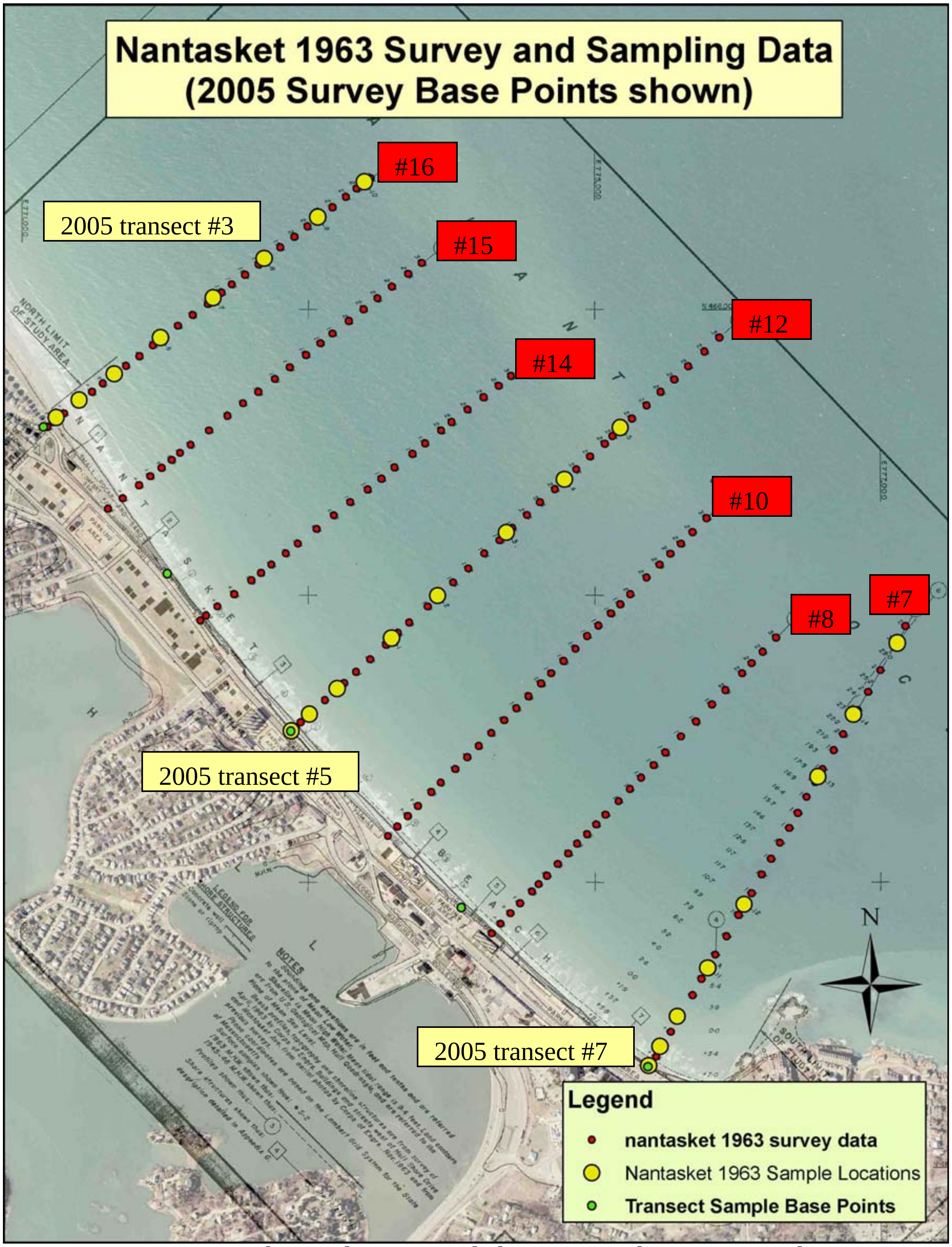


Figure 23. 1963 Survey data, sediment sample locations, and 2005 transect locations.

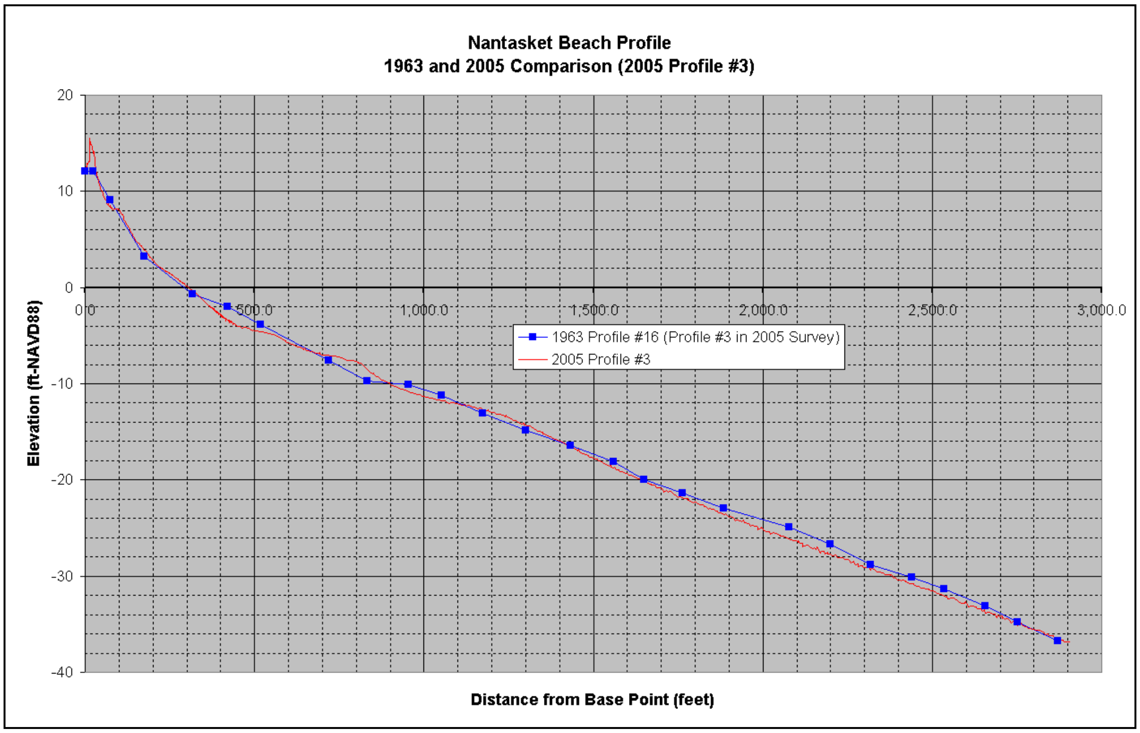


Figure 24. Comparison of 1963 survey line #16 and 2005 survey line #3.

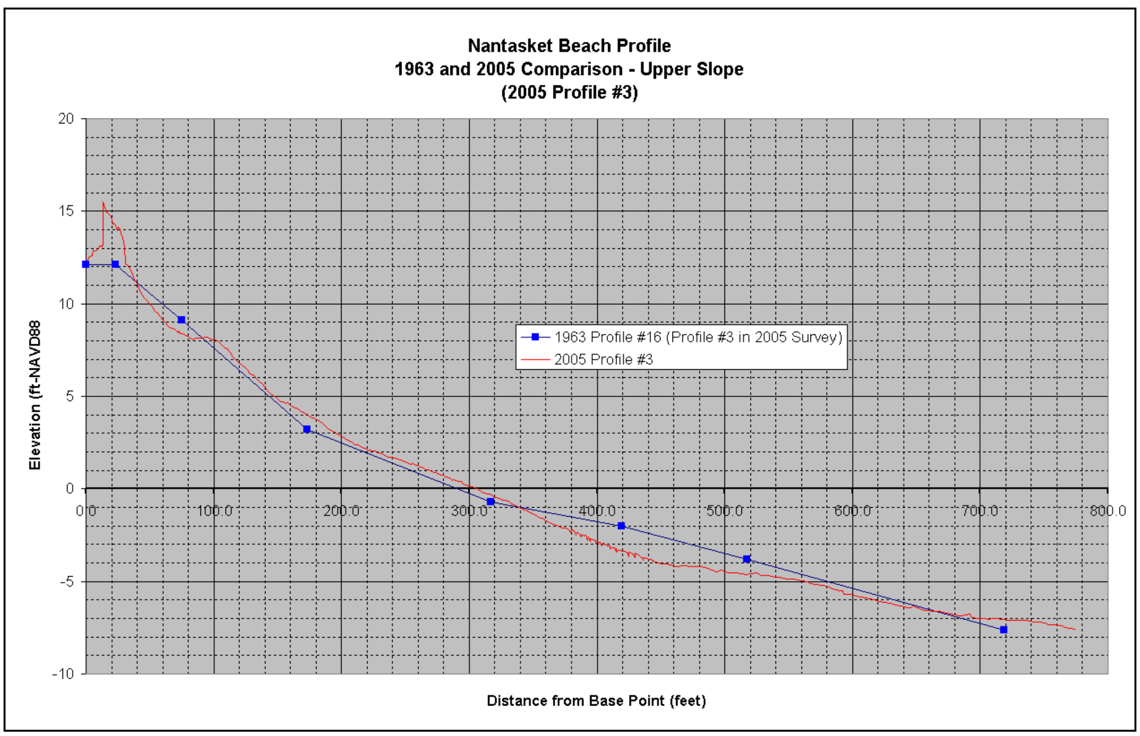


Figure 25. Comparison of 1963 survey line #16 and 2005 survey line #3 (upper slope).

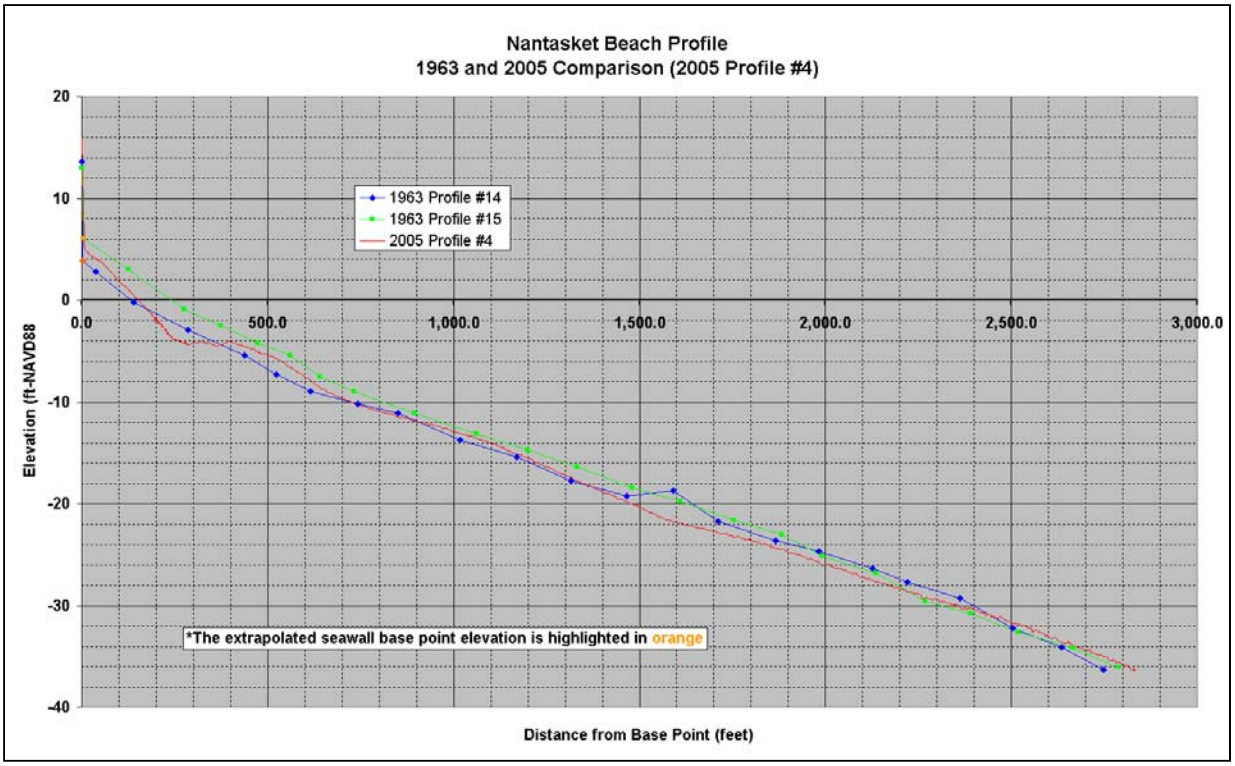


Figure 26. Comparison of 1963 survey lines #14 and #15 to 2005 survey line #4.

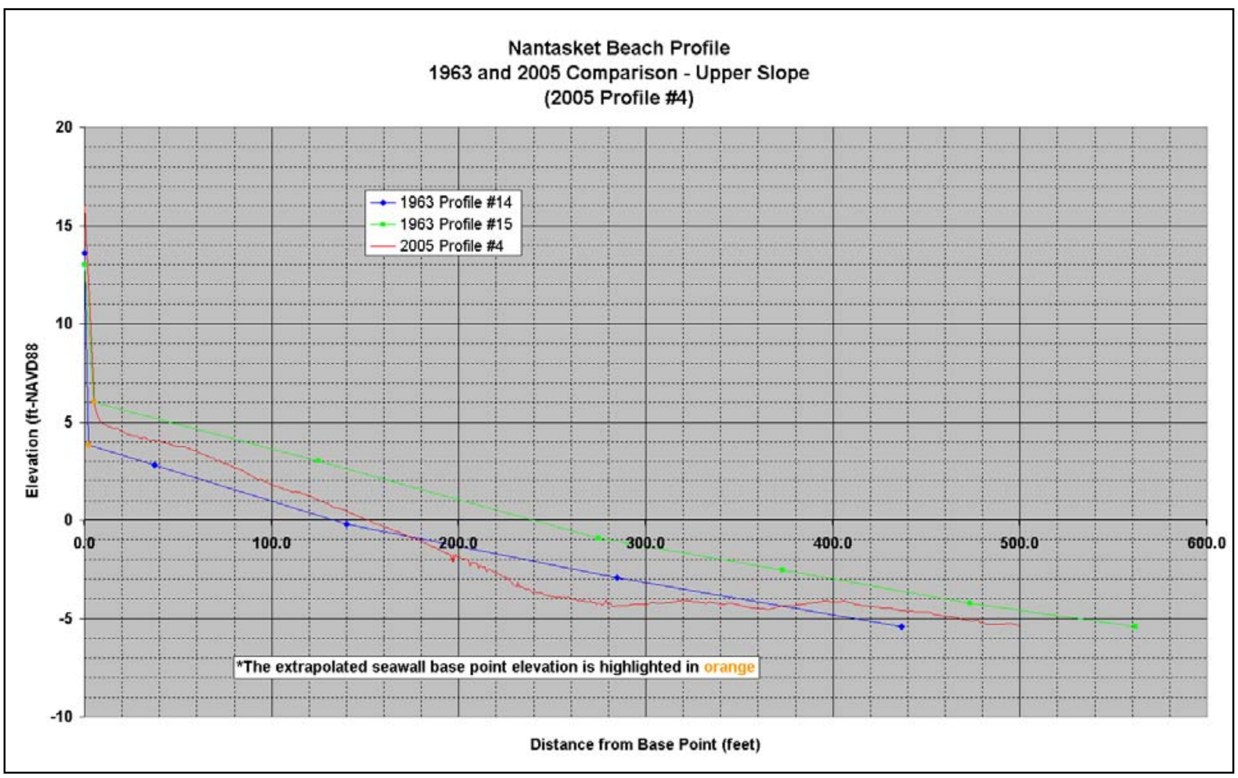


Figure 27. Comparison of 1963 survey lines #14 and #15 to 2005 survey line #4 (upper slope).

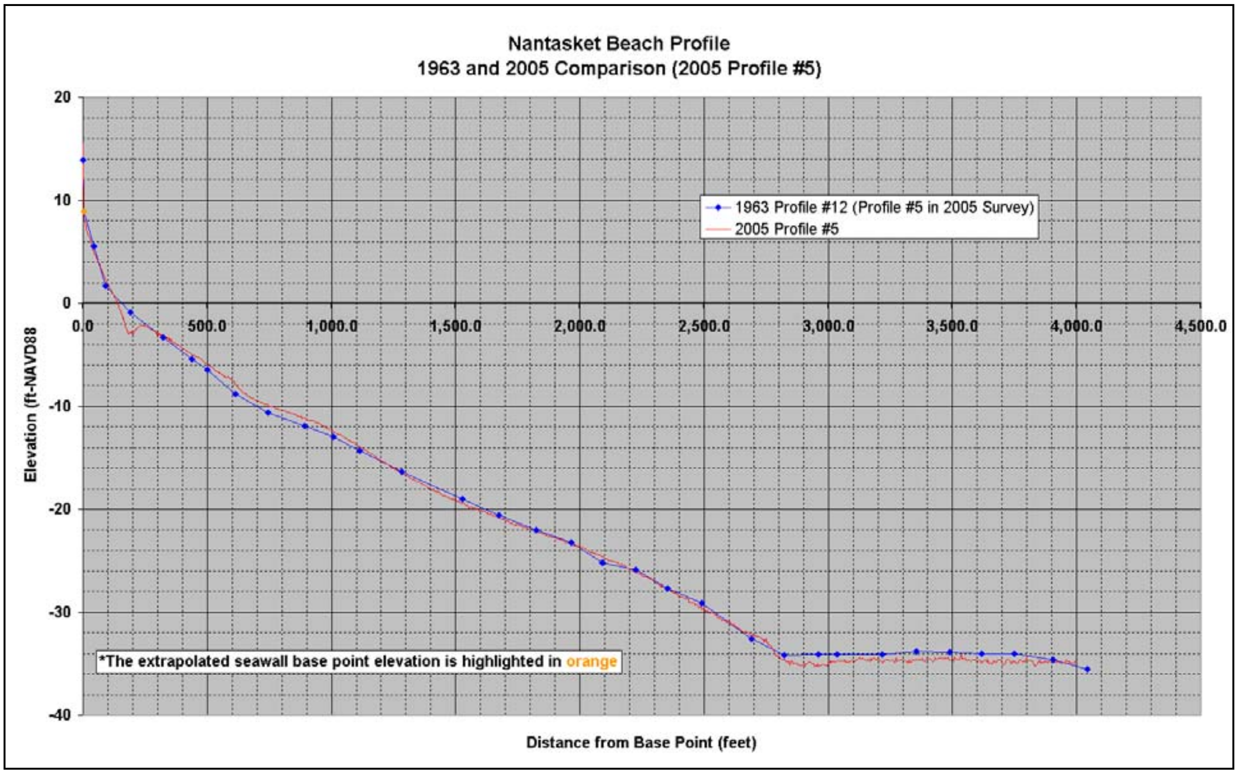


Figure 28. Comparison of 1963 survey line #12 and 2005 survey line #5.

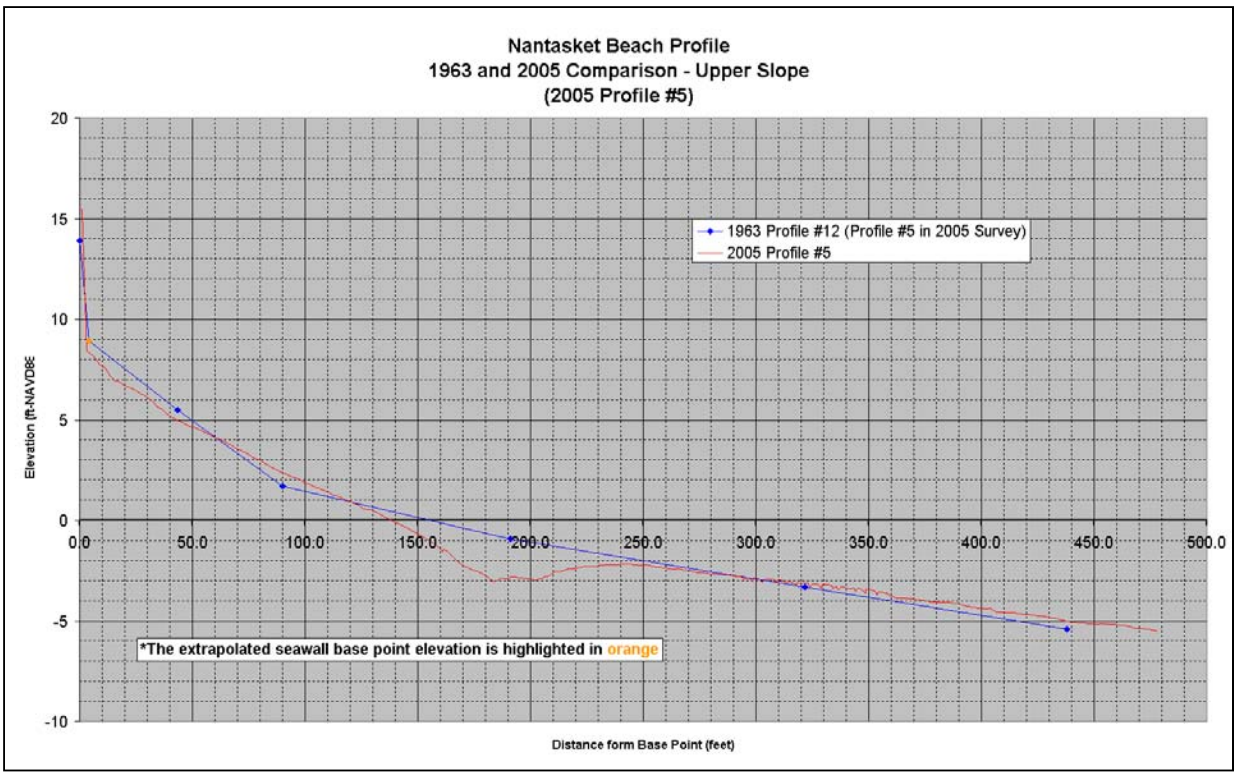


Figure 29. Comparison of 1963 survey line #12 and 2005 survey line #5 (upper slope).

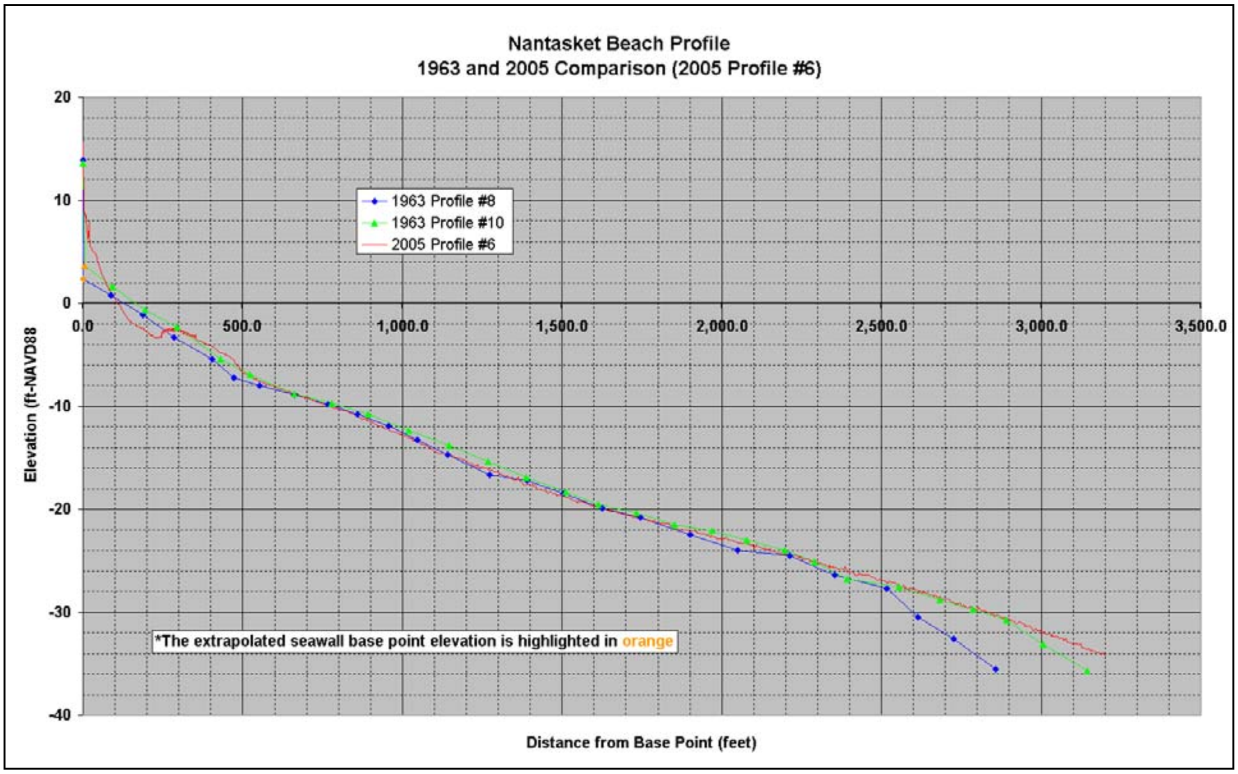


Figure 30. Comparison of 1963 survey lines #10 and #8 to 2005 survey line #6.

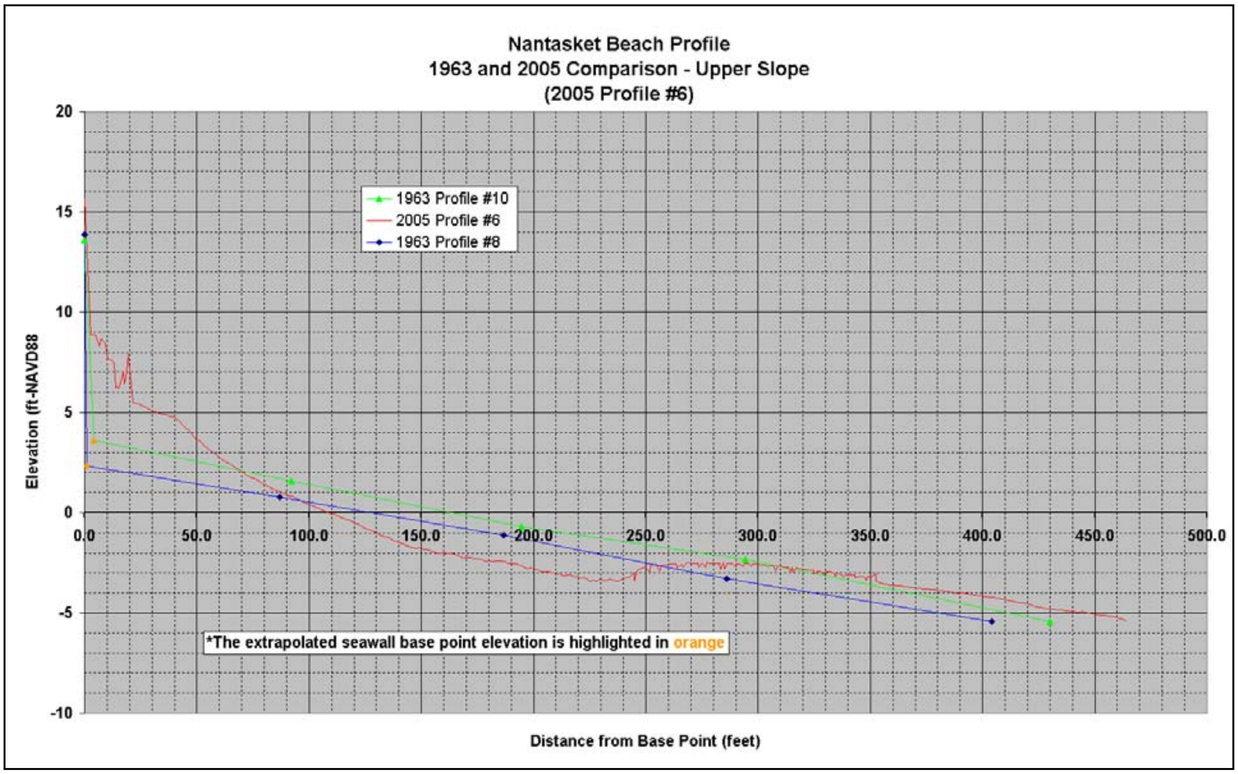


Figure 31. Comparison of 1963 survey lines #10 and #8 to 2005 survey line #6 (upper slope).

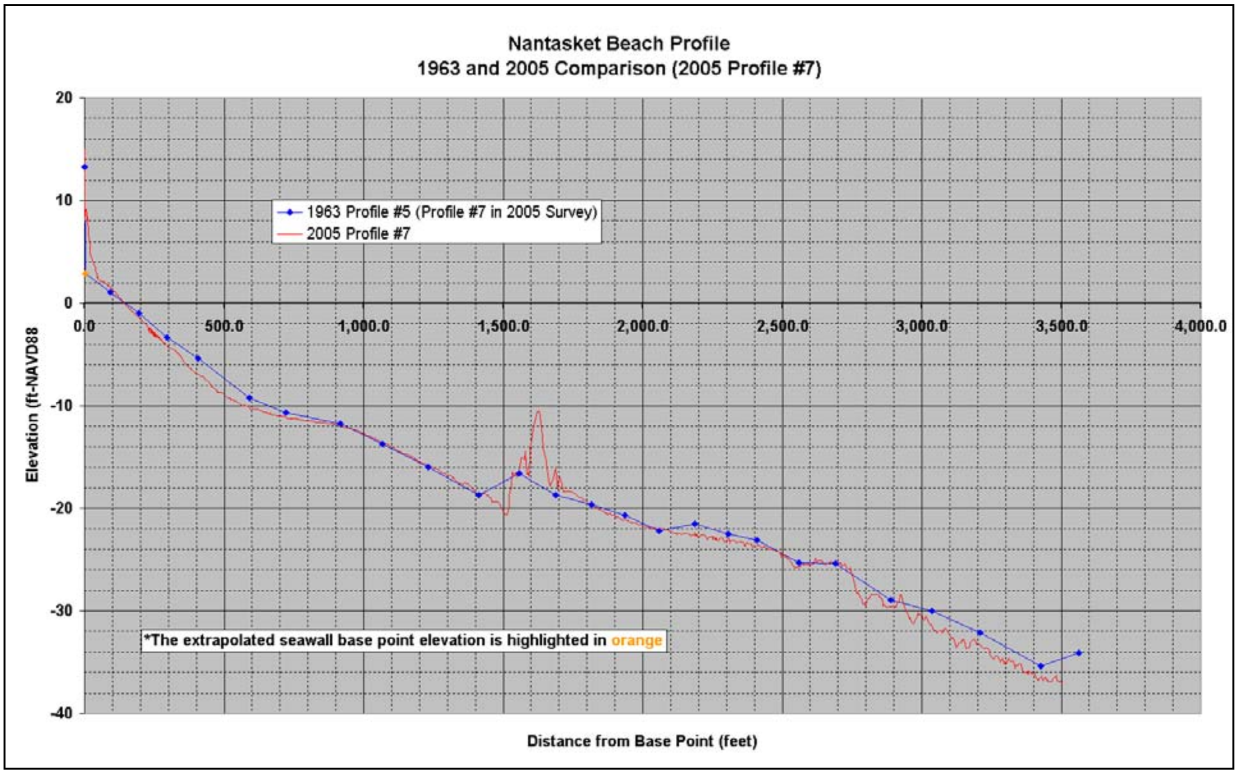


Figure 32. Comparison of 1963 survey line #5 and 2005 survey line #7.

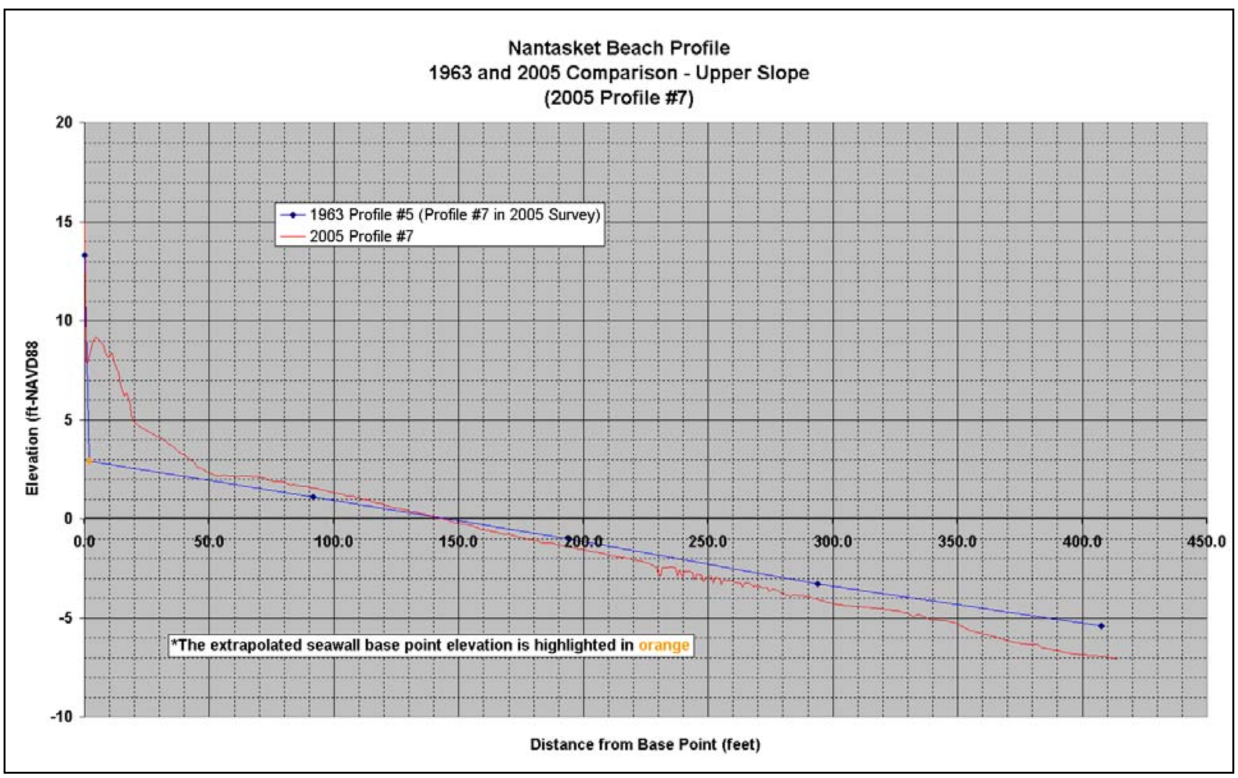


Figure 33. Comparison of 1963 survey line #5 and 2005 survey line #7 (upper slope).

5.2 Comparison of Geotechnical Data

As the second part of the comparison between the 1963 data and the 2005 data, sediment size was looked at. Shown in Figure 34, it can be seen that the overall D_{n50} grain size for the samples collected in 1963 are similar to the 2005 samples, or at least, exhibit the same general pattern of coarser material near the shoreline and in deeper water. However, the sediment near shore and in the deeper water was much coarser in 1963 than in 2005. To provide more details of the data the sand fraction percentage was calculated (Figure 35) along with the D_{n50} of the sand fraction (Figure 36). As shown in the Figures and comparing them to Figures 10 through 19 in Section 4.2.1, the overall D_{n50} is coarser, with the samples near shore and offshore being noticeably more coarse. The sand fraction in 1963 was noticeably higher in the middle depths, and the sand in 1963 was also slightly more-coarse. This could possibly be due to the finer sand from the north being transported down to the DCR Reservation.

Given that the 1963 data was collected in early spring or when the beach was likely in a winter condition it is not surprising that the near shore beach would have more cobble exposed and that the middle depths would be comprised of more sand (sand pulled offshore during winter). Looking at the vibracore and sample logs it can be seen that many of the samples (especially near shore) were cut short or ended by hitting cobble or gravel. This makes sense since the 2005 effort occurred when the beach should have a summer beach or more sand in the upper profile. This could explain why the near shore samples contained less cobble and more sand. However the similarities of the profiles between 1963 and 2005 sort of refutes these explanations. One complicating factor in the effort to compare the 1963 data and 2005 data is the mining or removal of the cobbles and gravel from Nantasket beach during the middle part of the century. As reported in the March 1968 Corps report, approximately 125,000 cubic yards of cobble were removed between 1945 and 1963. It is uncertain for how long beyond 1963 this practice was continued.

6.0 Results Consideration

While this report was not intended as design report for beach fill alternatives it does highlight the current condition of Nantasket Beach. As in the 1960's, Nantasket beach is largely comprised of fine sand, which contains a noticeable fraction of cobble and gravel (especially near shore and in the deeper water areas). It would be a definite mistake to take the D_{n50} results from each whole sample and use that as a design sand specification. If a beach fill that matches existing conditions is desired then a source that can provide both fine sand and cobble/gravel is needed. However, this material would likely be difficult to locate and/or expensive. Sand would most likely have to be screened or "filtered" to reach the desired fine sand specification, and then cobble and gravel would have to be added. This "designer" sand would be difficult to obtain. Also, as shown in the Corps AAS report, a large amount of this fill would be necessary to achieve a beach width adequate for preventing frequent storm damage. As a better alternative, if fine sand and cobble were desired, it is recommended that the cobble be placed near the seawall to help with storm protection, since cobble and gravel have a tendency to move up the beach and to form a berm along the seawall. This could be considered a replacement of the cobble and gravel that was removed from the beach during the mid twentieth century and would potentially reduce the volume of sand needed for storm protection, since the cobble berm would provide significant protection. Cobble that is placed in the sand mix in deeper water would not provide storm protection. An alternative to using fine sand would be to use coarser sand in the range of 0.45 mm. It was shown in the Corps Alternatives Analysis Study (2003) that a significantly lower volume of this sand (perhaps only 1/3 the fine sand volume) would be needed to provide adequate storm protection.

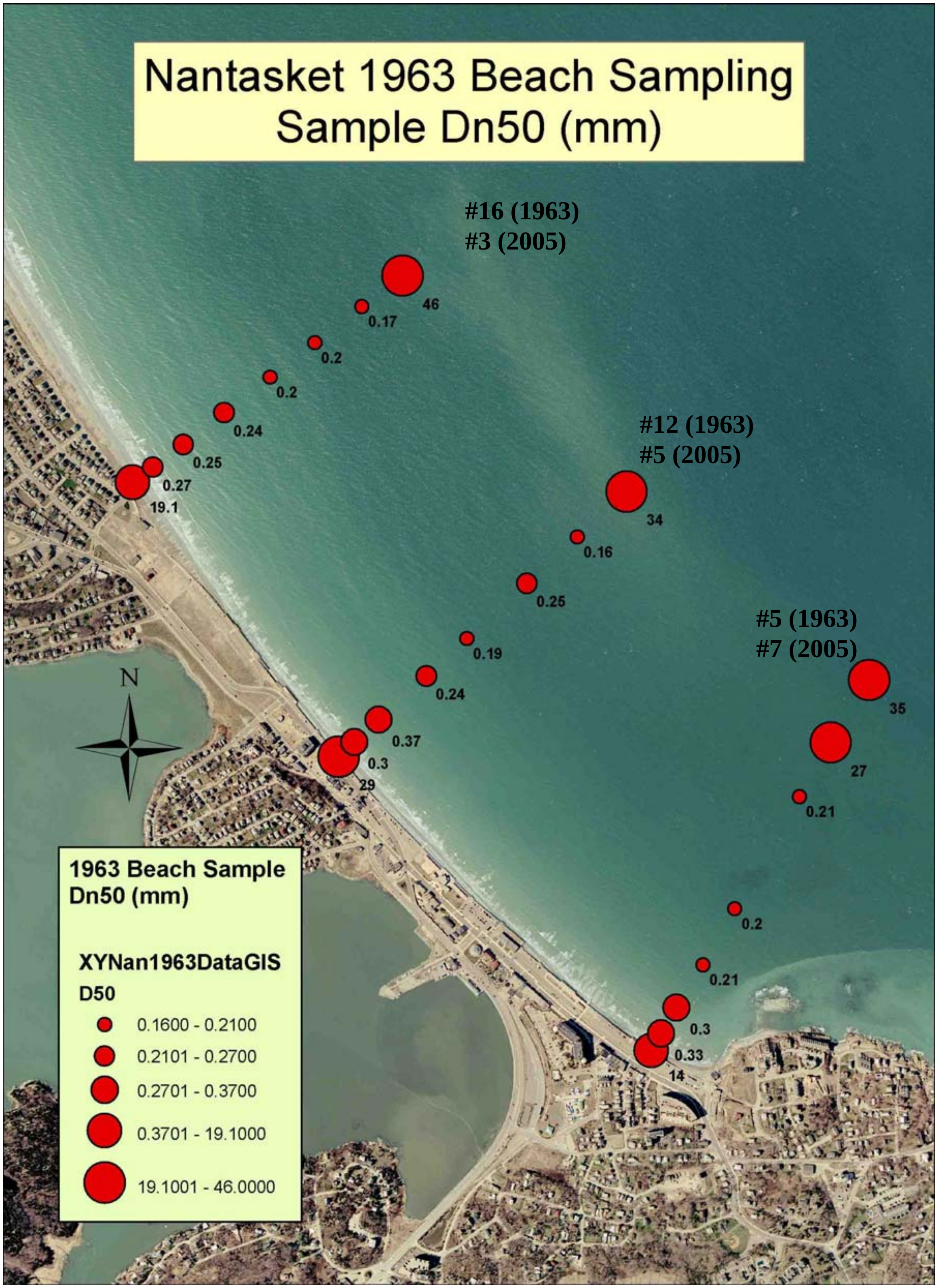


Figure 34. 1963 Beach samples D_{n50} (mm).

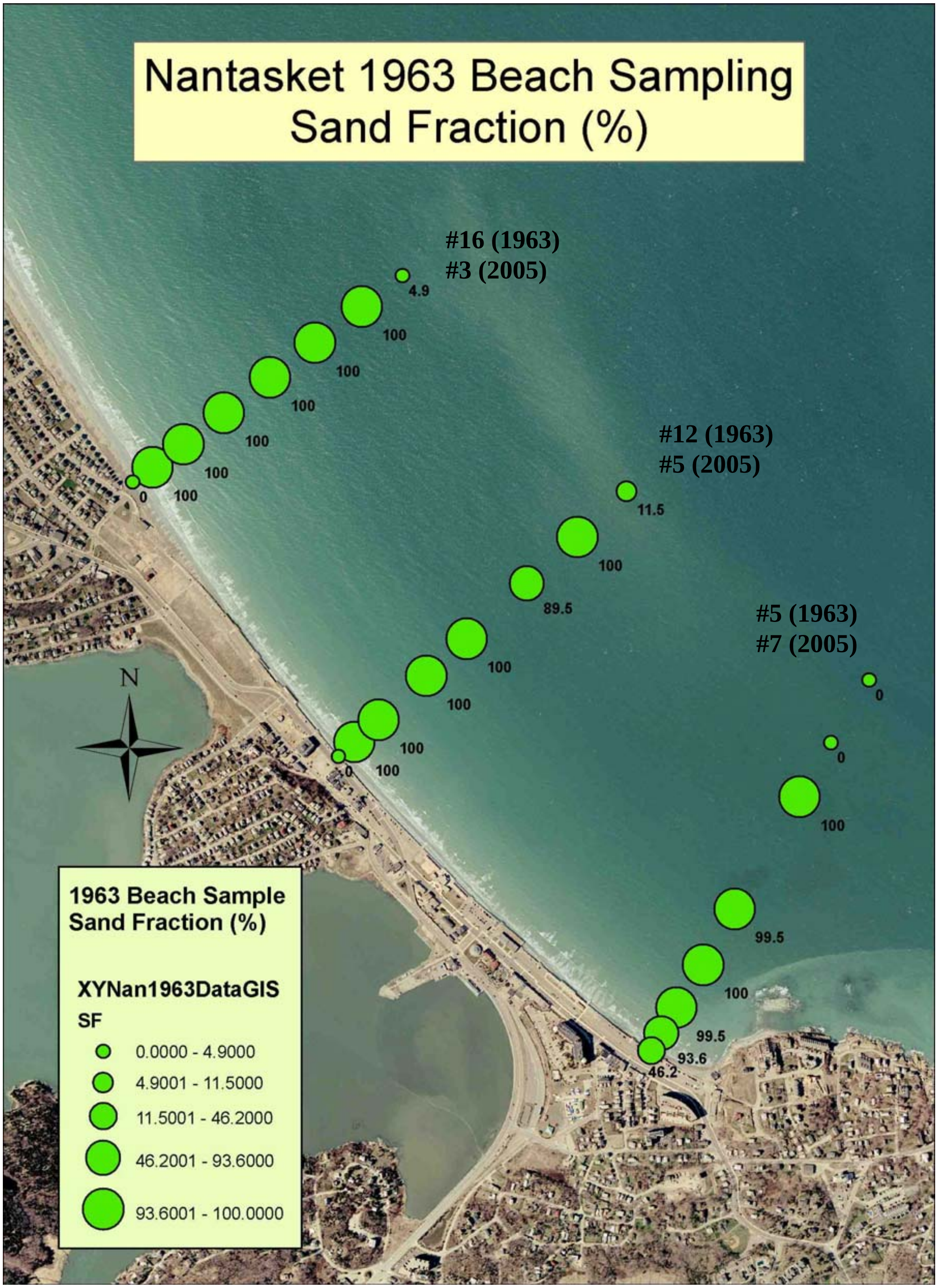


Figure 35. 1963 Beach sample sand fraction (%).

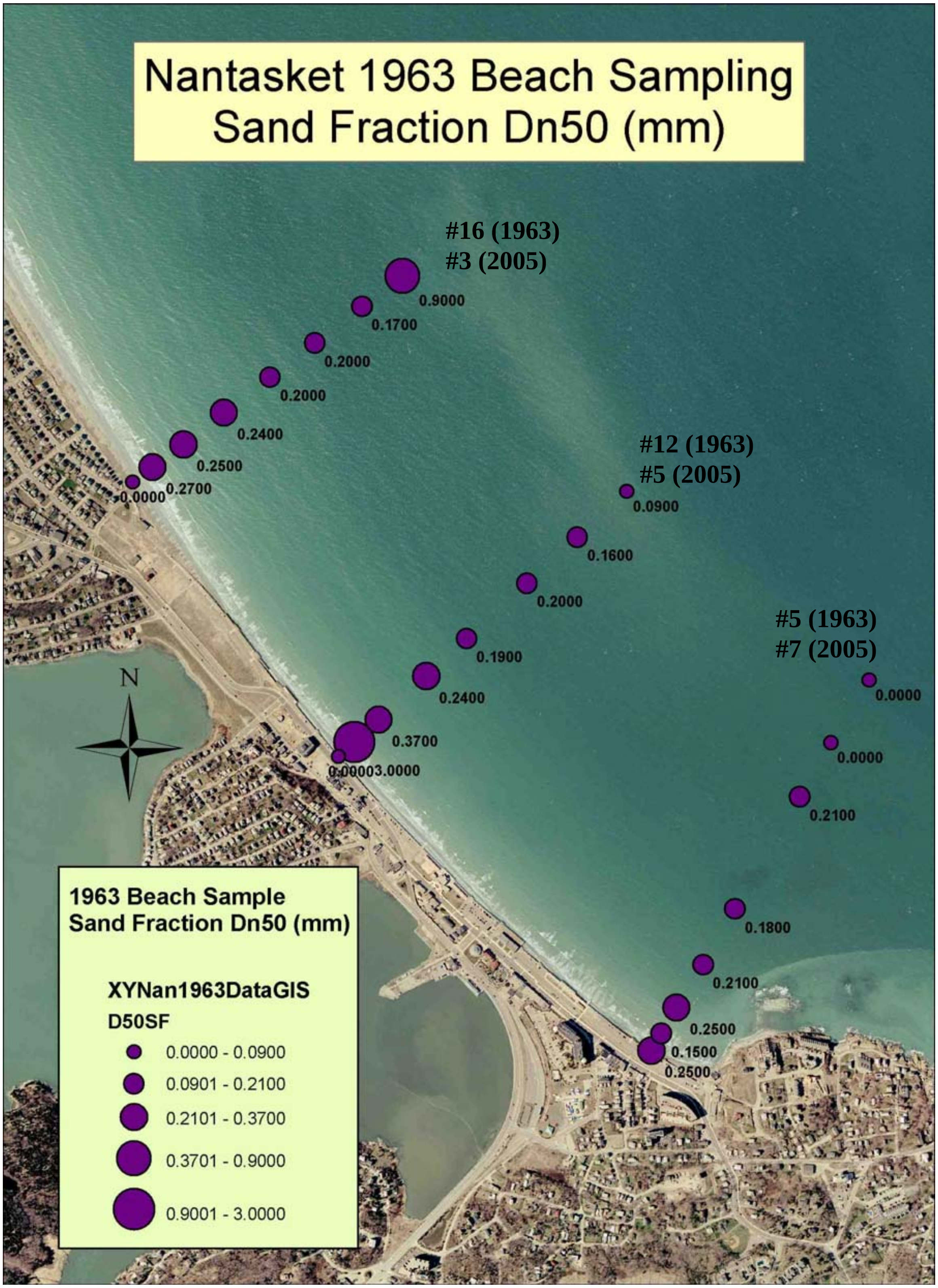


Figure 36. 1963 Beach sample sand fraction D_{n50} (mm).

Enclosure 2
Location Map

Location Map.

Enclosure 3
Profile/Transect Locations

Profile 1

	X	Y
Base Point	825999.8072	2930240.2756
1	826654.2650	2930554.1730
2	827392.3497	2930905.6215
3	828382.0595	2931376.9135

Profile 2

	X	Y
Base Point	826770.9950	2928871.3924
1	827276.5101	2929224.0616
2	828044.1361	2929759.4721
3	828945.7989	2930388.4277

Profile 3

	X	Y
Base Point	827452.2476	2927846.0595
1	828071.2451	2928315.8558
2	828852.8059	2928909.0248
3	829859.4032	2929672.9707

Profile 4

	X	Y
Base Point	828317.7748	2926822.9108
1	828952.2356	2927351.3158
2	829855.9078	2928103.8327
3	831169.6160	2929197.7965

Profile 5

	X	Y
Base Point	829179.9070	2925725.4738
1	829627.1833	2926136.4456
2	830815.5419	2927228.4461
3	832314.0329	2928605.4836

Profile 6

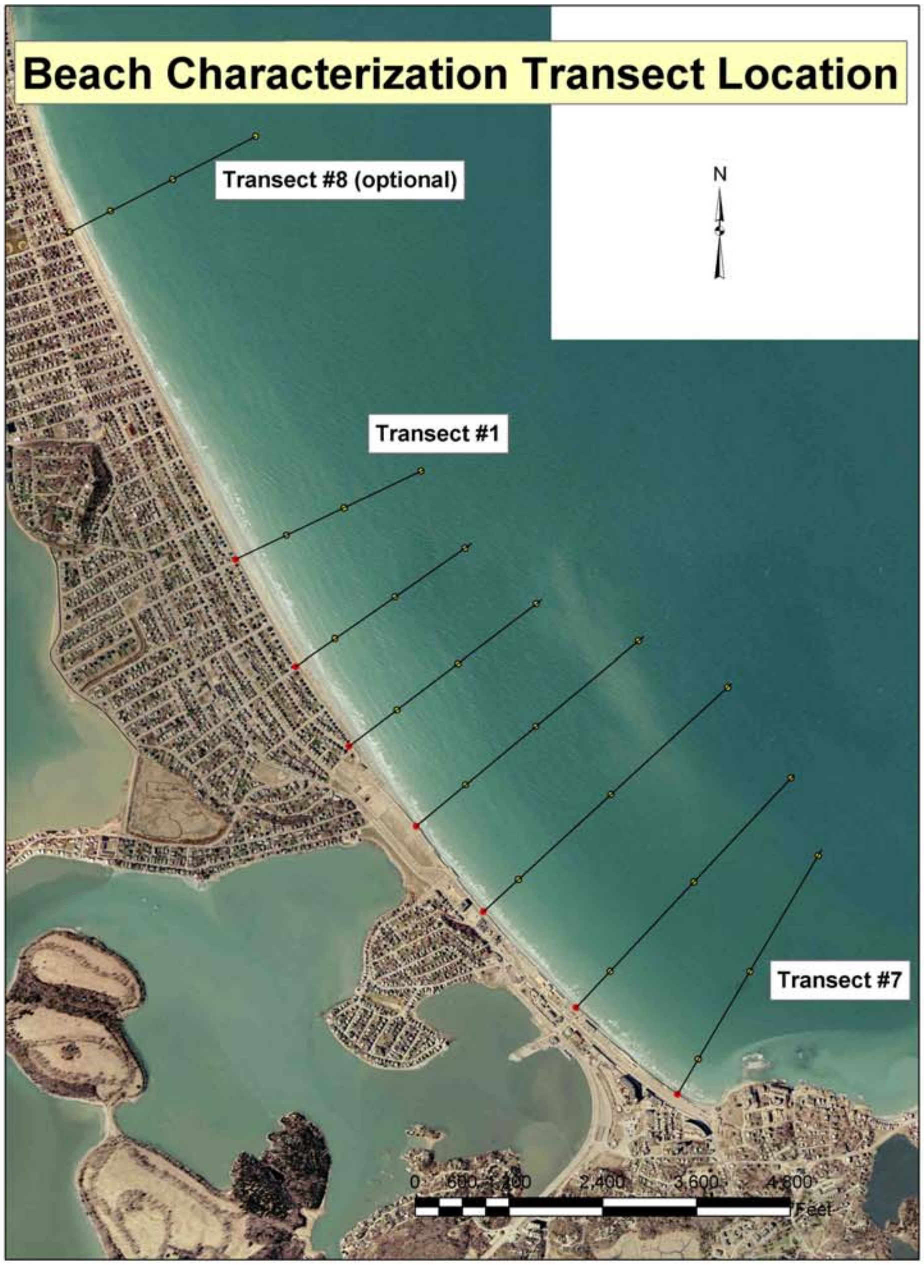
	X	Y
Base Point	830369.7931	2924489.6020
1	830806.7182	2924957.6318
2	831880.0828	2926107.4286
3	833124.7102	2927440.6923

Profile 7

	X	Y
Base Point	831671.0460	2923375.3696
1	831935.7333	2923826.2561
2	832597.7475	2924953.9592
3	833472.6293	2926444.2788

Profile 8 (optional)

	X	Y
Base Point	823876.6555	2934448.5120
1	824395.8804	2934717.4750
2	825191.0981	2935128.5270
3	826259.4198	2935681.3717


Beach Characterization Transect Location
Transect #8 (optional)
N
Transect #1
Transect #7
0 600 1,200 2,400 3,600 4,800
Feet

Enclosure 4
Beach Sample Locations

Nantasket Beach
Beach Sample Locations
Summer 2005

2. Profile	**Dune Base**	**Mid Berm**	**Berm Crest**	**MHW**	**+2**	**MEAN**	**-3**	**MLW**	**-10**	**-15**	**-20**	**-25**	**-30**	**-35**	**TOTAL LAND**	**TOTAL Hydro**	**TOTAL PONAR**
1	L	L	L	L	L	L	V	V	V	V	V	P	P	P	6	5	3
3	L	L	L	L	L	L	V	V	V	V	V	P	P	P	6	5	3
5				L	L	L	V	V	V	V	V	P	P	P	3	5	3
7				L	L	L	V	V	V	V	V	P	P	P	3	5	3
TOTAL															18	20	12
8	L	L	L	L	L	L	V	V	V	V	V	P	P	P	6	5	3

Notes:
Letters indicate where samples can be collected.

L = assume sample will be collected by land equipment
V= assume sample will be collected from vessel
P= collect sample with ponar; proceed with vibracore only if material is conducive to such
V+P = Task 6 (OPTION)
L/V/P = Task 10 (OPTION)

Elevations are relative to NAVD88.
At locations in deep water, where cobbly/gravel bottom are expected, ponar samples shall be collected first. If bottom conditions indicate vibracores are feasible, then Task #9 (OPTION) for vibracores in deep water will be exercised and vibracores collected.
Profile 8 will be sampled and surveyed only if Task #10 (OPTION) is exercised.

Enclosure 5
Standard Attribute Codes

Enclosure 6
Word document with sample data formats (copy attached)