Feasibility Evaluation of Upland Truck Haul as a Beach Fill Construction Method in Broward County, FL - Segment II

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EXECUTIVE SUMMARY

This report summarizes a feasibility evaluation of using domestic upland sand as source material for beach restoration along the Broward County Segment II shoreline. Although the report is structured to specifically address the present need for nourishment along the Segment II shoreline, information and findings herein may also be applicable to other areas of the Broward County coastline where future sand nourishment may be required. Upland sand sources are being considered as the potential source of sand for the Segment II project due to concerns regarding sediment quality and color of available offshore sources for the Segment II shoreline and potential impacts to resources around offshore borrow areas and pipeline corridors required for an offshore dredging project.

The evaluation focuses on (1) the identification of potentially suitable upland sand sources from commercial vendors within economically feasible distances from Broward County, (2) issues related to the use of upland sand along the Segment II shoreline, (3) general truck-haul project construction matters, (4) specific Segment II project implementation issues, (5) anticipated time to construct, and (6) project construction costs. This effort included site visits to mines, sampling and analysis of typical sands from the upland sources, coordination with commercial sand vendors, contractors, and other Florida municipal governments with large-scale truck-haul beach fill project experience, and evaluation of site specific conditions that will affect construction of a truck-haul project along the Segment II shoreline.

The Segment II project is expected to include the placement of about 750,000 cubic yards (cy) of sand along two reaches of the central Broward County coastline between Hillsboro and Port Everglades Inlets. This will include about 200,000 cy in Pompano Beach and the northern area of Lauderdale-By-The-Sea (R-36 and R-43), and about 550,000 cy in Fort Lauderdale and the southern area of Lauderdale-By-The-Sea (R-51 and R-72). Of the latter, about 50,000 cy is planned to be associated with a dune feature on the landward edge of the fill berm.

Proposed sediment quality guidelines were formulated for the Segment II shoreline for potential upland sand sources. The guidelines were developed through consideration of the native beach conditions along the Broward County Segment II shoreline and known sediment conditions within 14 upland mines identified during this investigation. Basic sediment parameters used to evaluate potential sources are mean grain size, silt content, gravel content, and color. The guideline ranges for each sediment parameter are summarized in **Table ES.1**.

Table ES.1: Upland mine sediment quality guidelines proposed for the Broward County Segment II project.

Mean Grain Size (mm)	0.35-0.65
Silt Content (passing #230 sieve)	< 2%
Gravel Content (not passing #4 sieve)	< 5%
Color (allowable moist Munsell Value)	≥ 7

As part of this evaluation, 14 commercial sand mines were visited and 30 sand samples from processed material stockpiles were collected and analyzed. Potentially suitable sources were selected through consideration of sediment characteristics, compliance with the sediment quality guidelines, the location of the mines relative to Broward County, and the potentially available methods of transport (i.e., truck vs. rail) at each site. Of these, eight samples from six mines were determined to have characteristics within the proposed limits listed in **Table ES.1**. Also, with the exception of the Cemex Davenport mine, these are within about 135 miles of the Broward County shoreline, a distance for which it may be feasible for a truck to make two trips per day, if necessary. The Cemex Davenport mine is located approximately 200 miles from the Segment II project area, but has direct rail capabilities. The resultant sand mines and sand product characteristic are summarized in **Table ES.2**.

Construction of a beach fill project using the truck-haul approach involves various stages of material transport and handling and numerous types of on and off-road equipment. In general the construction stages include loading at the commercial mine or upland stockpile area, highway transport, beach side delivery and stockpiling, loading from stockpile to off-road vehicles, beach transport, placement and grading. The specific approach and equipment used can vary depending upon site conditions, site access, and contractor preference, and seasonal constraints.

Sixteen beach access points were identified as being suitable for sand delivery and re-handling. These sites are located near major roadways with access across the Intracoastal Waterway, near large offsite staging areas including some undeveloped private parcels, and where the alongshore distance between points is less than one mile. The only area where the distance between points may be problematic is along the Galt Ocean Mile shoreline. For work along Galt Ocean Mile, an access point will be required in Lauderdale-By-The-Sea, likely Palm Avenue, and south of the Galt Ocean Mile, likely at Oakland Park Blvd., to minimize the distance between adjacent sites.

Table EX-1: Summary characteristics of potential upland borrow sources recommended for further consideration by Broward County.

Upland Sand Mine	Dist. (mi.)	Sample Name	Mean (mm)	Median (mm)	Sorting (φ)	% Fines (230)	% Gravel (4)	% Carb.	Color (moist)
Ft. Pierce (Stewart Mining Ind.)	110	Ft. Pierce	0.46	0.38	1.19	1.17	0	31	2.5Y-6/2
Immokalee (Stewart Mining Ind.)	114	Beach Sand	0.35	0.31	0.90	0.46	0	0	2.5Y-8/1
		Beach Sand #2	0.57	0.59	1.01	0.88	0	0	2.5Y-7/1
Witherspoon (Vulcan Materials)	114	Witherspoon	0.59	0.60	0.61	0.22	0	0	2.5Y-8/1
Ortona (E.R. Jahna)	115	Beach Sand C	0.46	0.48	0.79	0.11	0	0.5	10YR-7/1
Palmdale (Cemex)	115	FDOT Concrete	0.48	0.47	0.84	0.87	0.15	1	2.5Y-7/1
Davenport (Cemex)	206 (Rail)	Concrete	0.40	0.40	0.85	0.40	0	0	2.5Y-8/1
		Com. Concrete	0.42	0.44	0.90	0.37	0	0	2.5Y-8/1

Sand transported by trucks and placed mechanically is not as compact as natural beach sand or hydraulically placed sand (i.e., the design condition). The difference in compaction is accommodated for in project planning through bulking factors. Typically for mechanically placed truck-haul sand, the sand volume during truck transport is about 15% greater than natural beach conditions. Likewise, the sand volume following mechanical placement is about 5% greater than natural conditions. So, for the Segment II design of 750,000 cy, it is expected that 862,500 cy (750,000 cy X 1.15 = 862,500 cy) as measured in the trucks would be transported to the beach. Similarly, the measured volume of sand on the beach immediately following mechanical placement would be 787,500 cy (750,000 cy X 1.05 = 787,500 cy) or 5 percent greater than the design volume. Ultimately, the mechanically placed material would compact further under the natural conditions of the beach to the intended volume of 750,000 cy.

The principal unit of sand measured during a truck-haul project is weight. Typically, one cubic yard of bulked sand weighs about1.35 tons; the required sand volume for the Segment II would weight about 1,164,375 tons.

Construction production is not expected to be limited by the sand availability at the mines. Rather production limitations will be related to available work hours, truck availability, traffic congestion on the roads and at the access points, and the re-handling and movement of sand on the beach. The expected daily sand placement rate for one beach access point is about 2,500 tons, on average. For multiple sites, the rate would increase but likely not be a direct multiple of each added access due to limitations on truck availability and traffic congestion near the project site. For example, it may be possible for the two access point rate to be about 4,500 tons per day and for a three access point operation to be about 6,000 tons per day. The operation of four or more access points was not evaluated.

It is assumed that sand placement may only occur without restrictions along the Segment II shoreline from November 1 to February 28, the non-nesting season for marine turtles. During this period, there would only be about 100 working days, assuming Sunday and holiday work is prohibited. Given the expected daily production rates, it will not be possible to complete the entire 750,000 cy Segment II project in one marine turtle non-nesting season. Rather, it may be possible to complete the entire project during two successive seasonal construction events and extending the work period into only a portion of one nesting season. That is, the 550,000 cy (with dune) Fort Lauderdale reach, which is expected to require about 142 work days if three access points are activated simultaneously, could be completed if work is allowed on the beach for about 50 working days into part of a nesting season. It may be most reasonable for this to occur between March 1 and April 30. The location of the work that would occur during the nesting season period could be controlled to minimize the potential effects to nesting activities and nests. The remainder of the project, the 200,000 cy in Pompano Beach, could be completed in one non-nesting season, with no time extension of time, with as few as two active access points.

An evaluation of the probable cost to construct a truck-haul from the identified upland sources suggests that the unit price of sand in-place along the shoreline could vary from between about $29 to $35 per ton ($39 to $48 per cubic yard) depending upon the source and transport and handling methods. The costs are based upon the transport distances and methods required for each mine and the expected unit cost for purchase, transport, placement, surveys, QA/QC, and management. Overall, these costs are generally consistent with the costs for projects recently completed in Broward County including the 2012 Hollywood Truck-Haul Beach Fill Project. It is noted that the final cost of a truck-haul project can vary significantly from estimated values due to changes in fuel prices. Fuel prices have a direct effect on the cost of the sand product, transportation, and placement.

Ultimately, the cost of sand for the Segment II project will be determined through a competitive bidding process. The potential benefits of sand vendor and contractor competition are not specifically incorporated in planning numbers. To maximize the potential benefits of competition among sand vendors and contractors is to make available to the project as many sand sources and identify and secure as many beach access points and reasonably possible. Given the uniqueness of a truck-haul beach fill project, it will also be important to identify and contract with suitability qualified and experienced contractors.

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1.0 INTRODUCTION

This report summarizes a feasibility evaluation of using domestic upland sand as source material for beach restoration along the Broward County Segment II shoreline. Although the report is structured to specifically address the present need for nourishment along the Segment II shoreline, information and findings herein are considered applicable to other areas of the Broward County coastline where future sand nourishment may be required.

The evaluation focuses on (1) the identification of potentially suitable upland sand sources from commercial vendors within economically feasible distances from Broward County, (2) issues related to the use of upland sand along the Segment II shoreline, (3) general truck-haul construction matters, (4) specific Segment II project implementation issues, and (5) anticipated time to construct, and (6) project construction costs. This effort included site visits to mines, sampling and analysis of typical upland source sand, coordination with commercial sand vendors, contractors, and other Florida municipal governments that have large-scale truck-haul beach fill project experience, and evaluation of site specific conditions that will affect construction of a truck-haul project along the Segment II shoreline.

2.0 BACKGROUND

Most beach nourishment projects constructed along the Broward County coastline have used sand located on the seafloor immediately offshore of the County as the source of fill material. To date, more than 11 million cubic yards of sand have been dredged from areas offshore of Broward County and placed as beach fill along portions of the County's Atlantic Ocean shoreline. This sand has been a highly compatible and cost-effective source of material for the restoration and maintenance of the county's beaches. The remaining beach compatible and economical sand resources offshore of Broward County, however, are now very limited due to past use and expanded protections to offshore hardbottom resources near the sources. The remaining sources are expected to soon be depleted or become inaccessible due to continued use and/or increased buffers distances between hardbottom resources and borrow areas.

The limited remaining offshore sand resources and the need for continued future nourishment of portions of Broward County's beaches with high quality sand led Broward County to evaluate possible alternative sources of future beach fill material including upland, distance offshore domestic, and non-domestic sand. This report summarizes the availability and feasibility of using upland sand sources to meet at least a portion of the expected future need.

2.1 Sand Conditions

Broward County Beaches. The beaches in Broward County generally consist of a mixture of silica and carbonate sand. Specific sediment characteristics for comparison with potential upland sources including grain size and silt content are described in **Appendix B**.

Potential Upland Sources. There are no developed upland sand sources within Broward County that contain sufficient quantities of clean beach-compatible sand to supply present and potential future beach nourishment needs in the County. Rather, potentially available sources that may be considered are beyond the Broward County region. Sand mines nearest to Broward County that are known to have sand products suitable for beach placement are north and northwest of the County within about 115 miles of the Segment II beach (**Figure 2.1)**. Most of these are located in the geologic feature known as the Okeechobee Plain. Sand from this geologic feature has been used extensively for several truck-haul beach fill project in southeast Florida counties. Other features that include sand mines with material that has been used for beach fills include the Duval Upland and Lake Wales Ridge.

Sand products from the Okeechobee Plain sand mines used for beach nourishment are almost exclusively silica sand and typically have larger average grain sizes and smaller fines fraction than the materials found in borrow areas offshore of Broward County. Also, sand from the upland mines are generally light yellow in color. These sands are expected to be more stable, produce less turbidity in the nearshore environment, and be more similar in color to Broward County native beach sediments than those available in the offshore borrow areas.

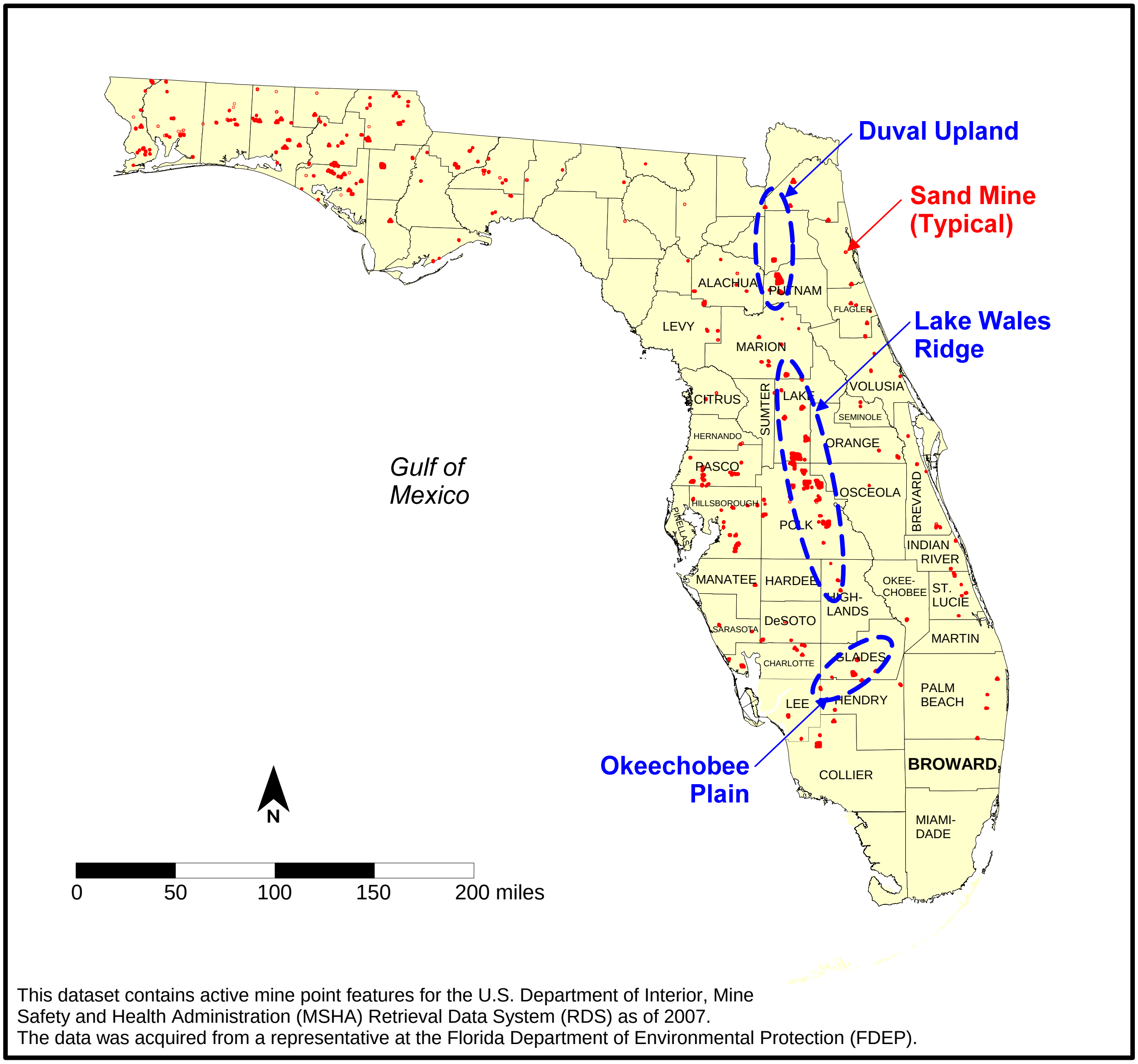


Figure 2.1: Location of existing sand mines (red) in the State of Florida and geologic features with sand mines that have been used to provide sand for beach nourishment.

<u>Upland Sand Mines with Known Beach Compatible Materials.</u> **Table 2.1** lists the upland sand mines nearest to Broward County that are known to have sand products considered suitable for beach placement. The list was compiled from recently issued or presently pending FDEP permits, sand mine industry representatives, and local municipalities and County governments along the east coast of Florida that have experience with beach fill projects constructed with sand from upland mines (Figure 2.2).

Table 2.1: Upland sand mines nearest to Broward County that have been used along east Florida as beach fill material.

Sand Mine	Management Corp.	Location
Jahna Ortona	E.R. Jahna Industries	LaBelle, FL
Stewart Immokalee	Stewart Mining Industries	Immokalee, FL
Stewart Fort Pierce	Stewart Mining Industries	Fort Pierce, FL
JJJ Enterprises Farabee Pit	JJJ Enterprises, LLC	Punta Gorda, FL
Fischer Ranch Road Lake	Henry Fischer & Sons Leasing, Inc.	Vero Beach, FL
Fischer 17th Street SW	Henry Fischer & Sons Leasing, Inc.	Vero Beach, FL
Poma Palm City Sand	Poma Construction Corp.	Palm City, FL

Figure 2.2: Location of upland sand mines nearest to Broward County that have been used for sources of beach fill sand for projects along east Florida.

Projects constructed with sand from these mines and the approximate material volume placed during the projects is listed below.

Jahna Ortona **(Figure 2.3)**

Location: *LaBelle, FL*
Owner: *E.R. Jahna Industries*

1) Project Name: *South End Palm Beach Restoration Project*
   Volume Requirement: *293,000 cy*
2) Project Name: Phipps *Ocean Park Beach Restoration*[1]
   Volume Requirement: *10,000 cy*
3) Project Name: *Hillsboro Beach Truck-Haul Renourishment Project*
   Volume Requirement: *14,000 cy*
4) Project Name: *City of Hollywood Beach Interim Beach Renourishment Project*
   Volume Requirement: *136,000 cy*
5) Project Name: *City of Hallandale Beach Interim Beach Renourishment Project*
   Volume Requirement: *110,000 cy*
6) Project Name: *Singer Island Dune Restoration*
   Volume Requirement: *75,000 cy*
7) Project Name: *Miami: Truck-Haul Nourishment and Sand Redistribution*
   Volume Requirement: *84,570 cy*
8) Project Name: *Key Biscayne Beach Nourishment*
   Volume Requirement: *2,400 cy*
9) Project Name: *Rest Beach Nourishment*
   Volume Requirement: *5,821 cy*
10) Project Name: *Smathers Beach Nourishment*
    Volume Requirement: *13,000 cy*
11) Project Name: *Fort Zachary*
    Volume Requirement: *3,600 cy*
12) Project Name: *Lighthouse Park Beach Fill*
    Volume Requirement: *4,000 cy*
13) Project Name: *Longboat Key Renourishment Project*[2]
    Volume Requirement: *130,000 cy*

Figure 2.3:
Sand stockpiles at Jahna Ortona sand mine.

1 This project is a FEMA project in response to Tropical Storm Fay and also includes 25,000 cy fill in Reach 8 of Palm Beach.
2 Permitted as a sand source alternative along with offshore borrow pit.

Stewart Immokalee **(Figure 2.4)**

Location: *Immokalee, FL*

Owner: *Stewart Mining Industries*

1) Project Name: *Collier County Beach Nourishment Truck-Haul*
   Volume Requirement: *22,400 cy*

Figure 2.4: Stewart Immokalee sand mine.

Stewart Fort Pierce

Location: *Fort Pierce, FL*

Owner: *Stewart Mining Industries*

1) Project Name: *Fort Pierce Inlet Nourishment Truck-Haul*
   Volume Requirement: *unknown*

JJJ Enterprises Farabee Pit

Location: *Punta Gorda, FL*

Owner: *JJJ Enterprises LLC*

1) Project Name: *Pelican Landing Community Association Beach Erosion Control Project on Big Hickory Island, Lee County, Florida*
   Volume Requirement: *75,000 cy*

Fischer Ranch Road Lake (**Figure 2.5**)

Location: *Vero Beach, FL*

Owner: *Ranch Road Lake LLC; managed by Henry Fischer & Sons Leasing, Inc.*

1) Project Name: *Sector 3 Beach & Dune Restoration – Indian River County*[3]
   Volume Requirement: *650,000 cy (2 phases)*

Figure 2.5: Fischer Ranch Road Lake sand mine.

Fischer 17th St. SW

Location: *Vero Beach, FL*

Owner: *Henry Fischer & Sons Leasing, Inc.*

1) Project Name: *Sector 3 Beach & Dune Restoration – Indian River County*[3]
   Volume Requirement: *650,000 cy (2 phases)*

Poma Palm City Sand

Location: *Palm City, FL*

Owner: *Poma Construction Corp.*

2) Project Name: *Fisher Island Club Beach Restoration*
   Volume Requirement: *5,000 cy*

[3] Two upland mines (Fischer Ranch Road Lake mine and Fischer 17th St. SW mine) were permitted as a sand source alternative along with offshore borrow pit.

3.0 POTENTIAL UPLAND SAND SOURCES FOR SEGMENT II

This section summaries the results of an evaluation of upland sand mine sediments for the purpose of identifying possible sources for a Broward County upland truck-haul beach fill project. As part of this effort, sand mines where visited and sand samples were collected and analyzed for comparison to typical sediment quality guidelines and native beach conditions. Sand mine visits and sand sampling and testing were conducted by geologists from Coastal Planning and Engineering, Inc. in 2011. The same mines selected for consideration in this investigation were determined from those used for past projects, recommendations from other governmental entities with upland sand source use experience and commercial sand mine companies. The site visits allowed qualitative review of production capabilities and sand quality and the collection of representative samples for quantitative analysis.

The mines considered were located within four general regions of the state. These regions included South Florida, Lake Wales, North Florida, and Atlantic Coastal Ridge. Fourteen sand mines and 30 sediment samples were investigated. Specific details about each mine and the sediment samples are included in **Appendix A**.

3.1 Sediment Quality Guidelines

Table 3.1 lists sediment quality guidelines recommended for upland sand sources that may be considered for use along the Broward County Segment II beaches. These guidelines were developed through consideration of native beach conditions along the Broward County Segment II shoreline and known sediment conditions within upland mines. The latter was determined from a comprehensive sampling and testing effort of 30 sand samples from 14 potential upland sources. Details about the development of these guidelines are provided in **Appendix B**. Basic sediment parameters used to evaluate potential sources are mean grain size, silt content, gravel content, and color. Sediments with characteristics that fall within each noted range would be considered potentially acceptable for use along the Broward County Segment II beaches.

Table 3.1: Upland mine sediment quality guidelines recommended for Broward County.

Mean Grain Size (mm)	0.35-0.65
Silt Content (passing #230 sieve)	< 2%
Gravel Content (not passing #4 sieve)	< 5%
Color (allowable moist Munsell Value)	≥ 7

3.2 Compliant Sand Samples

Of the 30 processed samples collected, 14 samples from 9 different mines had characteristics that fell within the ranges and limits recommended for Broward County (**Table 3.2)**. Additionally, the sand mines are sorted by highway distance between the mine and a point on the central Broward County coastline.[4]

Table 3.2: Sediment characteristics of the Broward County – Segment II native beach and various upland sand sources investigated as potential fill.

Company	Mine	Sample	Dist. (mi.)	Mean (mm)	Color (moist)	Sorting (φ)	% Fines (230)	% Gravel (4)	% Carb.	Price ($/cy)	Rail
Recommended Sediment Quality Guidelines			-	0.35-0.65	Value ≥ 7	-	< 2	< 5	-	-	-
Native – 2011 Study (D2E)			-	0.41	10YR-5.3/2.4	0.78	0.6	1.1	51.6	-	-
Native – 1999 Study (USACE)			-	0.31	*	0.77	1.5	1.4	55.8	-	-
Stewart Mining Industries	Ft. Pierce	Ft. Pierce	110	0.46	2.5Y-6/2**	1.19	1.17	0	31	10	N
Stewart Mining Industries	Immokalee	Beach Sand	114	0.35	2.5Y-8/1	0.90	0.46	0	0	10	N
Stewart Mining Industries	Immokalee	Beach Sand #2	114	0.57	2.5Y-7/1	1.01	0.88	0	0	10	N
Vulcan Materials	Witherspoon	Witherspoon	114	0.59	2.5Y-8/1	0.61	0.22	0	0	12	N
E.R. Jahna***	Ortona	Beach Sand C	115	0.46	10YR-7/1	0.79	0.11	0	0.5	11	N
Cemex	Palmdale	FDOT Concrete	115	0.48	2.5Y-7/1	0.84	0.87	0.15	1	13	N
Cemex	Lake Wales	FDOT Concrete	176	0.47	5Y-8/3	0.84	0.14	0	0	13	N
Cemex	Davenport	DEP Filter	206	0.62	2.5Y-8/2	0.71	0.24	0	2	30	Y
Cemex	Davenport	Concrete	206	0.40	2.5Y-8/1	0.85	0.40	0	0	12	Y
Cemex	Davenport	Commercial Concrete	206	0.42	2.5Y-8/1	0.90	0.37	0	0	11	Y
E.R. Jahna	Green Bay	Beach Sand C	213	0.43	5Y-8/1	0.92	0.75	0	0	13	N
E.R. Jahna	Green Bay	FDOT	213	0.41	5Y-8/1	0.79	0.16	0	0	12	N
Vulcan Materials	Keuka	301T Concrete	316	0.41	2.5Y-8/4	0.84	0.30	0	0	13	N
Vulcan Materials	Keuka	315 Conveyor	316	0.36	5Y-8/3	0.63	0.20	0	0	13	N

* A Munsell color system value was not assigned to the sediment collected in 1999 study. It was described as nearly white to gray that has a slight tan or orange cast to it.

** The Stewart Ft. Pierce sample has a slightly lower moist Munsell *Value* (6) than recommended in the sediment quality guidelines (≥ 7). Stewart Ft. Pierce is included in the list of samples that fell within the range of the sediment quality guidelines because the sample's Munsell Value is only slightly outside the color range and all other sediment characteristics are well within the specified ranges.

*** The Jahna Ortona Beach Sand C sediment data was obtained directly from construction sediment samples collected as part of the recently completed truck-haul project in Hollywood Beach (CSI, 2012).

[4] The Palm Ave. street end in LBTS was selected as the central shoreline location. Transport distances were determined using Google Earth.

3.3 Upland Sand Sources Recommended for Further Consideration

The list of sand sources with compliant samples was reduced to include only those considered to be the most suitable for Broward County. The "potential" suitable sources were selected through consideration of sediment characteristics, the location of the mines relative to Broward County, and potentially available methods of transport (i.e., truck vs. rail). Of the nine sand mines with material within the ranges and limits specified in the sediment quality guidelines (**Table 3.1**), five of the sand mines are located within 115 road miles of the Segment II project area and would be considered suitable for road truck delivery of material. The remaining mines are likely too far from Broward County to make direct road truck transport a feasible option.[5] The Cemex Davenport mine, however, which is located approximately 200 miles from the Segment II project area, has direct rail capabilities.[6] Therefore, material from this mine could also be considered potentially suitable. In total, six sand mines are recommended for further consideration (**Table 3.3, Figure 3.1)**. These are the Stewart Ft. Pierce mine, Stewart Immokalee mine, Vulcan Witherspoon mine, E.R. Jahna Ortona mine, Cemex Palmdale mine, and Cemex Davenport mine.

Table 3.3: Summary characteristics of potential upland borrow sources recommended for further consideration by Broward County based on sediment characteristics, distance from Broward County, and method of transportation.

Upland Sand Mine	Dist. (mi.)	Sample Name	Mean (mm)	Median (mm)	Sorting (φ)	% Fines (230)	% Gravel (4)	% Carb.	Color (moist)
Ft. Pierce (Stewart Mining Ind.)	110	Ft. Pierce	0.46	0.38	1.19	1.17	0	31	2.5Y-6/2
Immokalee (Stewart Mining Ind.)	114	Beach Sand	0.35	0.31	0.90	0.46	0	0	2.5Y-8/1
		Beach Sand #2	0.57	0.59	1.01	0.88	0	0	2.5Y-7/1
Witherspoon (Vulcan Materials)	114	Witherspoon	0.59	0.60	0.61	0.22	0	0	2.5Y-8/1
Ortona (E.R. Jahna)	115	Beach Sand C	0.46	0.48	0.79	0.11	0	0.5	10YR-7/1
Palmdale (Cemex)	115	FDOT Concrete	0.48	0.47	0.84	0.87	0.15	1	2.5Y-7/1
Davenport (Cemex)	206 (Rail)	Concrete	0.40	0.40	0.85	0.40	0	0	2.5Y-8/1
		Com. Concrete	0.42	0.44	0.90	0.37	0	0	2.5Y-8/1

5 Sand mines located beyond 135 miles of the Broward County coastline are not considered to be candidates for a truck-haul project. This distance is based upon past truck-haul project experience in Broward County and truck fleet size (see **Figure 7.1**).

6 That is, the site possesses a fully functional rail line in which material can be directly loaded into rail cars. Rail capability at the site could make this a feasible and cost-effective option, but details of rail transport would have to be investigated further. Because the sand at the Davenport mine is of high quality, it is considered potentially suitable. Since rail transport may not be the most reliable method of transportation of material, however, some caution should be applied to this option.

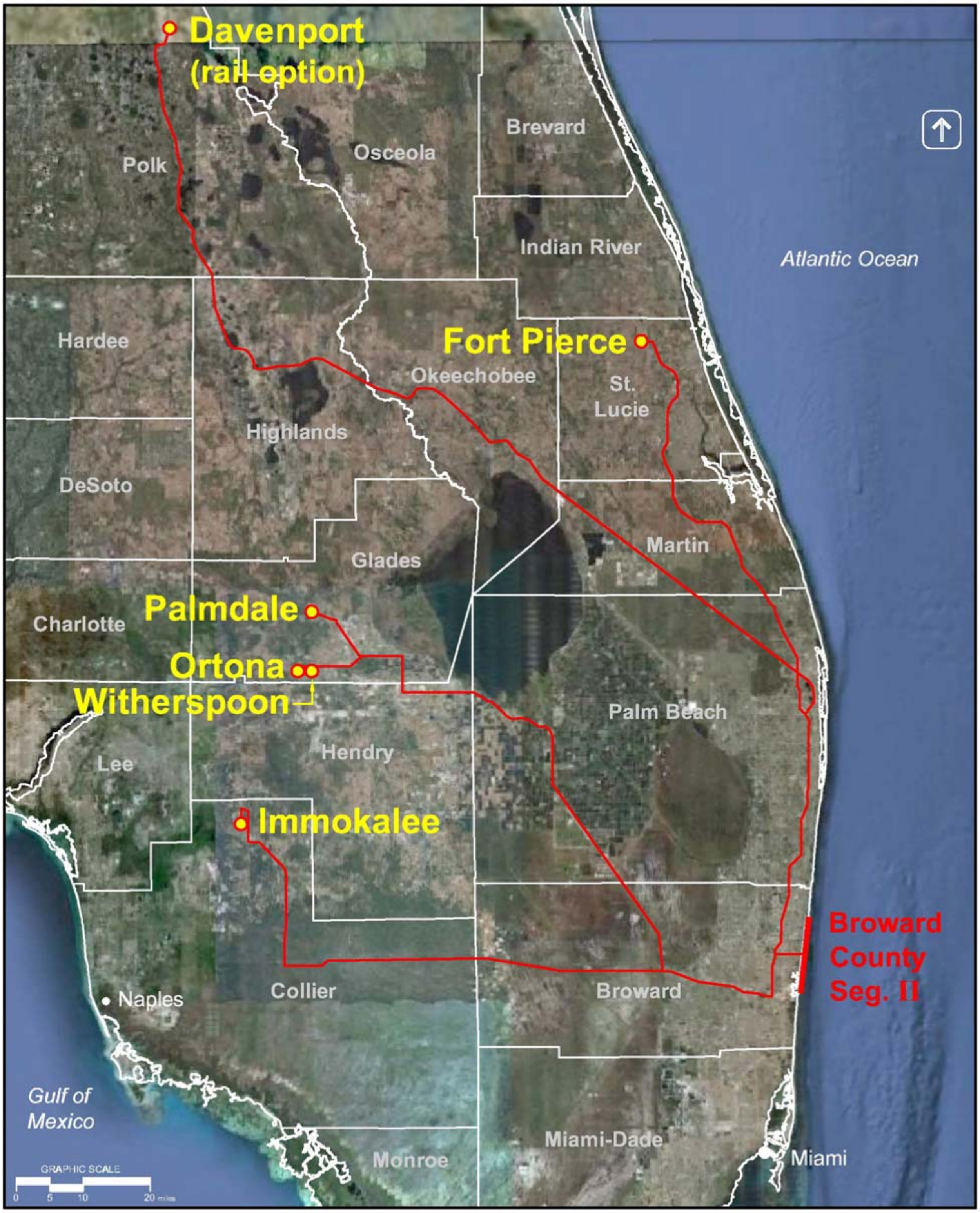


Figure 3.1: Upland sand mines with potentially feasible sources of material that could be considered for a truck-haul beach fill project in Broward County – Segment II.

Sand with larger average grains are expected to be more stable along the Broward County beaches and are less likely to migrate offshore to nearshore hardbottom areas. Also, sand with low fines contents are also expected to perform well and minimize the potential for adverse turbidity and sedimentation effects on the nearshore environmental.

Figure 3.2 displays the grain size distributions for each of the potentially feasible upland sand mines. For a relative comparison, the Segment II native beach composite is also plotted. As previously noted, two different samples are considered at both Immokalee and Davenport. Since the two Davenport samples are generally similar, they are represented as a single (averaged) curve on the composite grain size distribution graph. The two Immokalee samples are relatively different; therefore both sand products are displayed on the graph. It is also noted that the Ortona sediment data used in the analysis was obtained from construction sediment samples collected as part of the recently completed truck-haul project in Hollywood Beach (CSI, 2012) rather than the sediment collected during the site visit.

Of the six upland mines that are believe to be compliant with the proposed sediment quality guidelines, the sources with the largest mean grain sizes are the Vulcan Witherspoon mine (0.59 mm) and Stewart Immokalee mine (0.57 mm - Beach Sand #2). The sources with the finest typical mean grain size are Stewart Immokalee (0.35 mm – Beach Sand) and Cemex Davenport (0.40 mm - Concrete). The material from the Vulcan mine, however, appears to be the most dissimilar to the Segment II native material of all samples considered.

The most well sorted sand sources -- comprised mostly of similar sand grains sizes -- is Vulcan Witherspoon (0.61 φ). The most poorly sorted sand -- comprised of sand with a wide range of grain sizes -- is from Stewart Ft. Pierce (1.19 φ).

All but one of the recommended mines has a fines content of less than 1%. The sample with the highest fines content is from Stewart Ft. Pierce. The fines content for this sample, 1.17%, is well within the suggested < 2% sediment quality guideline.

All but one of the recommended mines has a gravel content of zero. The Cemex Palmdale sample contains only 0.15% gravel; far less than the suggested < 5% sediment quality guideline.

All potential upland sand sources have an equal or greater moist Munsell *Value* of 7, as suggested by the sediment quality guidelines (**Table 3.1**), except for the sample from Stewart Ft. Pierce. The material from Fort Pierce is the darkest of the upland sources with a moist Munsell *Value* of 6; only slightly lower than the recommended ≥ 7 *Value*. Stewart Ft. Pierce is included as a recommended potential upland borrow source because the sample's moist Munsell *Value* is only slightly darker than the recommended color guideline and all other sediment characteristics are well within the sediment quality guidelines.

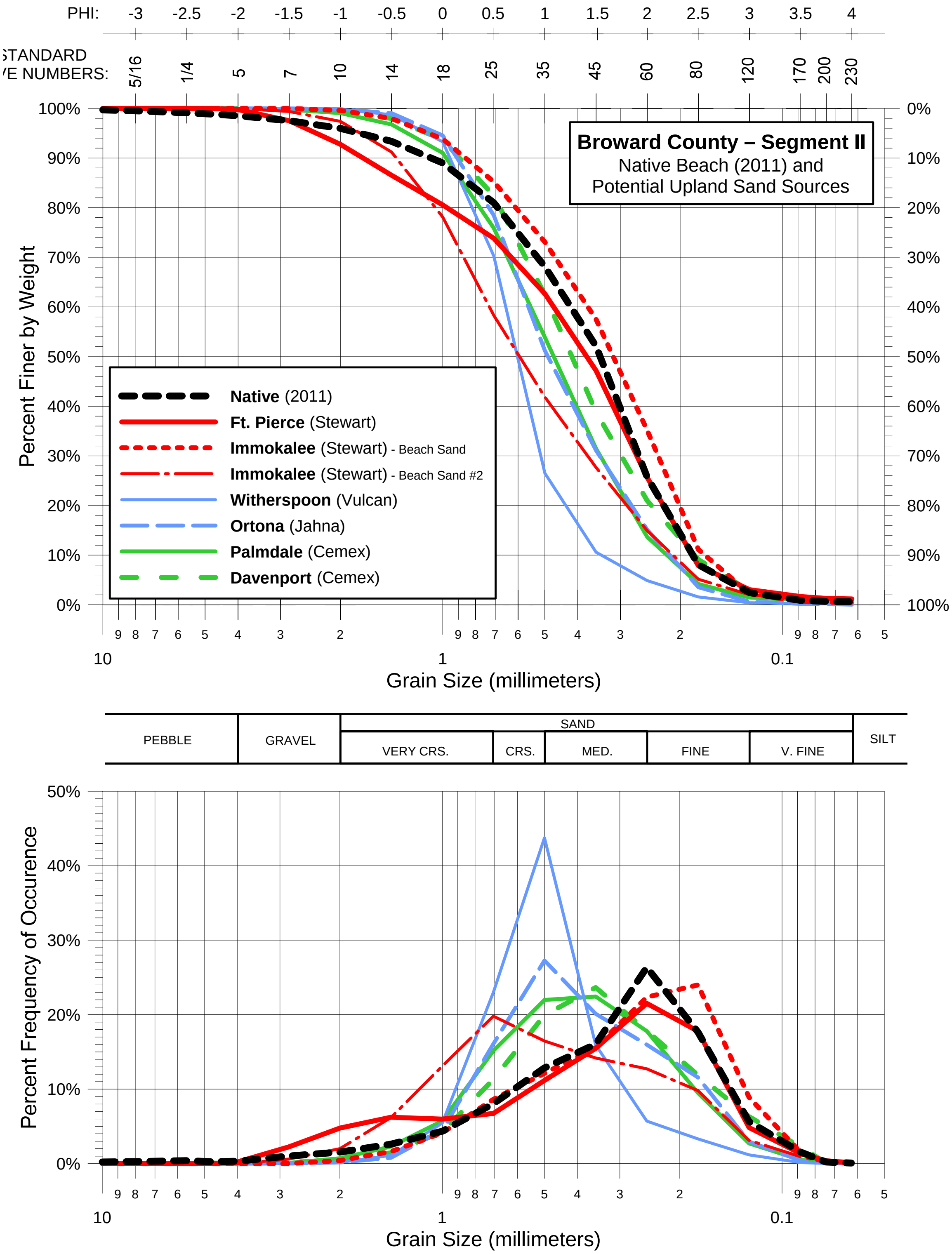


Figure 3.2: Composite grain size distribution and frequency curves of potentially feasible upland sand mines utilized for an upland truck-haul project in Broward County – Segment II.

It is also noted that the Cemex Palmdale sample is representative of sediments from that mine which are commonly a little darker in color than the other noted sources. It is understood that often, sand from the Palmdale mine is tested for color and when the material color does not meet a particular specification, the material is washed/scrubbed with a sodium hydroxide solution (50% NaOH in water). It is expected that sand from the Palmdale mine may need to be treated in this manner if used as a source along the Segment II beaches. It is not clear how this process will impact the material costs. Also, it is not clear if there would be regulatory issues related to concerns about the effect of the sand treatment may have upon the marine environment. It is also noted that the Cemex Davenport mine will apply chemicals to their sand if the material does not meet color requirements. It is unclear whether the Davenport samples collected, all with moist Munsell *Values* of 8, were treated by chemicals during the processing of the material.

4.0 SEGMENT II PROJECT SCOPE and SITE CONSIDERATIONS

The Segment II project was originally designed assuming the sand source would be from borrows areas offshore of Broward County. In this study, the feasibility of constructing the same project with an upland source is studied. In general, this would involve transporting the sand to the beach by truck and placing the material along the beach mechanically rather than hydraulically. Options for delivering the sand to the Broward County region may be by either truck or train.

For the purposes of evaluating possible upland truck-haul construction methods for a Broward County Segment II project, a project scope generally consistent with that described in the 2003 Broward County General Reevaluation Report (GRR) (USACE, 2003) is assumed. That project called for sand placement along two reaches of the Segment II shoreline; (1) Pompano Beach/ Lauderdale-By-The-Sea (LBTS) (R-36 to R-43) and (2) LBTS/Fort Lauderdale (R-51 to R-72) (**Figure 4.1**).

Based upon 2001 conditions, the 2003 project design called for the placement of about 930,000 cy of sand fill along the two reaches: 198,000 cy along 1.7 miles between R-36 and R-43 and 732,000 cy along 3.5 miles between R-51 and R-72. A comparison of 2001 and 2011 beach condition data, however, indicates that within this period there was a net increase in beach sand volume along these project areas of about 234,000 cy. As such, it is assumed that a project constructed for current conditions would require only about 700,000 cy of sand to produce an equivalent design beach: about 200,000 cy between R-36 and R-43 and about 500,000 cy between R-51 and R-72. It is also expected that an additional 50,000 cy may be placed along the Fort Lauderdale reach as a dune feature on the landward edge of the fill berm. For this evaluation, a project design of 750,000 cy is assumed, with alongshore fill placement densities presumed to be generally uniform.

Figure 4.1: Segment II project location and extent.

4.1 Construction Season and Available Work Time

For the purposes of this investigation, it is assumed that sand placement may only occur along the Segment II shoreline from November 1 to February 28, the non-nesting season for marine turtles. As such, there would only be a maximum of about 120 total days, including weekends and holidays, for which work could occur on the active beach. Actual available work days for sand placement on the Segment II beach may be less if restrictions are placed on Sunday and holiday work. If no work occurs on Sundays and holidays, a total of about 100 work days would be available for sand placement along the Segment II shoreline. In the event that construction could occur during the marine turtle nesting season (i.e., March through October) the potential construction period would not be impacted seasonally for marine turtle nesting considerations.

It also is assumed that sand placement and acceptance of sand deliveries would be limited to daylight hours only. This is principally due to safety and noise concerns at the access points and along the beach during the night-time hours. During the winter months in Broward County, there are about 10 hours of "daylight hours" (i.e., about one-half hour following sunrise to about one-half hour prior to sunset), on average. For a 100 day work window, there would be 1,000 available working hours on the beach during a given season. In addition to the 10-hour work day on the beach, additional time -- prior to and following daylight hours -- will be utilized by delivery trucks from and to the sand mine.

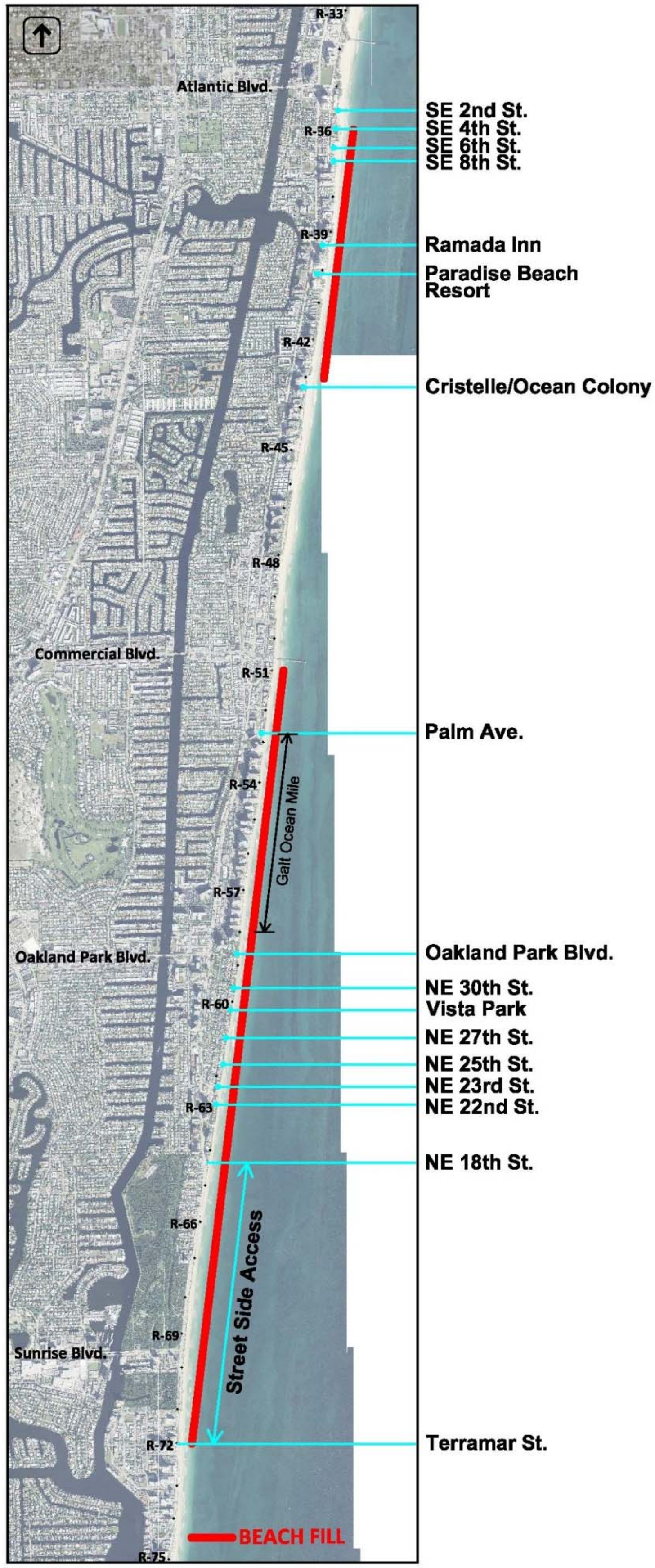
It is noted that the non-nesting season for marine turtles is coincident with the tourist "season" in Broward County. As such, beach fill construction will occur during the period of the year when the population and traffic density within the Broward County beach communities is the greatest. For this reason, there may be some consideration of delivery and stockpile work occurring during nighttime hours, but the production rate of beach fill work is expected to be limited by the amount of time that work can occur on the beach. Work beyond the beach system, such as mobilization/demobilization and offsite stockpiling of materials, would not be influenced by the turtle nesting season.

4.2 Beach Access and Staging Areas

A goal of any truck-haul project is to gain access to the beach at as many locations as possible. This minimizes the amount of travel required along the beach and also limits the amount of time that one access is in use.

Multiple beach access and staging areas along the project length will be required for construction of a truck-haul beach fill project along the Segment II shoreline. Beach access and staging locations along the Segment II shoreline, however, are limited. **Figure 4.2** displays the location of potential access areas that have been identified through a windshield study of the project shorelines. **Figure 4.3** displays details of each of these with aerial and ground photographs. The aerial photography was acquired from the Broward County Property Appraisers -- December 2009 conditions. The ground photographs were assembled from Google and Bing Maps "street-views" and area assumed to represent recent conditions.

In total, 16 potential access points were identified. These sites are mostly located near major roadways with access across the Intracoastal Waterway. Also, most of the sites are no farther apart than about one mile. This minimizes off-road truck travel distances along the beach. The only area where there may be an issue with the distance between access points is along Galt Ocean Mile as there is not an access point in this area. An access point will be required in Lauderdale-By-The-Sea, likely Palm Avenue, and in the vicinity of Oakland Park Blvd. to minimize the distance between the two adjacent access points.



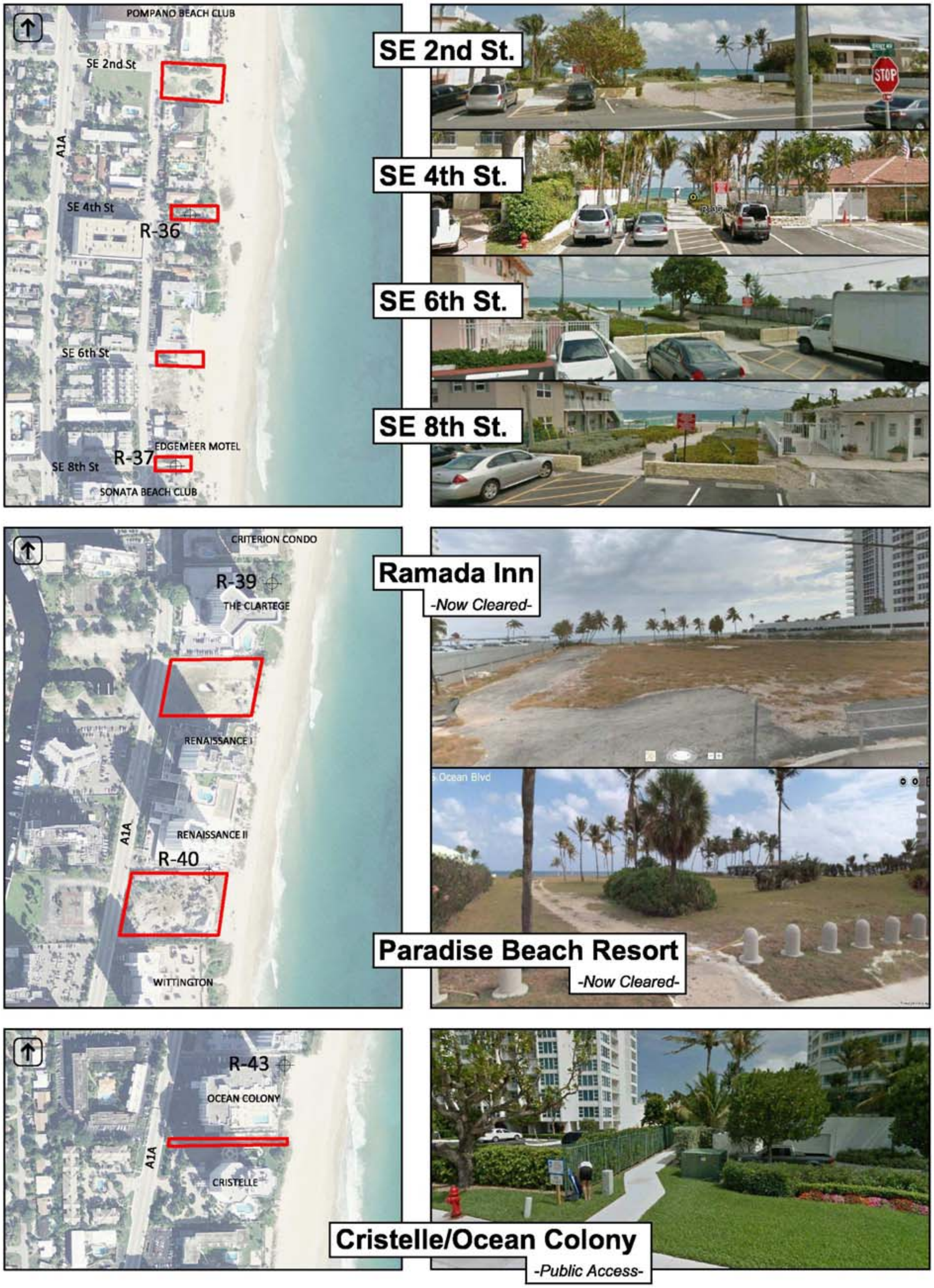


Figure 4.3: Potential construction access points along the Broward County – Segment II shoreline.

Figure 4.3 (cont.): Potential construction access points along Broward County – Segment II.

Figure 4.3 (cont.): Potential construction access points along Broward County – Segment II.

To the extent possible, preference is given to potential access points that would require minimal change to the access vegetation and infrastructure. Access points large enough to incorporate staging of equipment or sand stockpiles with minimal modifications are ideal.

It also is preferred that the sites have a route for trucks to loop out of the dump area without having to exit the same way it entered. The circular pattern will maximize efficiency and avoid the potential for a truck to be blocked in by a subsequent truck. This may not be possible at every access point of the project due to limited area. In cases where a loop delivery route is not possible, planning of the staging area and traffic patterns must consider the maneuvers required of the trucks to facilitate the most efficient routes.

If a beach access is too constricted, an alternative would be to transport the material via conveyer belt (or a series of conveyer belts) from the staging area to the beach (Figure 4.4). This approach, however, can reduce sand delivery rates. The reduced time for delivery would need to be weighed against the benefits of reduced transport distance along the beach. As this method slows production, it should only be considered if access is so limited that road trucks cannot dump material in locations accessible for the loading of off-road trucks. It is noted, however, that not all potentially qualified contractors will have access to a conveyor system. So, it is not recommended that an access plan be specifically formulated around the use of conveyors.

Public areas are preferred over private parcels as access points, however there are three private undeveloped parcels in Pompano Beach and one in Fort Lauderdale that should be considered as possible staging and access points. In Pompano Beach, these are a parcel immediately south of the NE 2nd beach access point and the former sites of the Ramada Inn and Paradise Beach Resort (both now cleared). In Fort Lauderdale, the parcel to be considered is the Ireland's Inn Beach Resort site located between NE 22nd and 23rd Streets. The resort is currently closed with plans for future redevelopment.

For the Segment II project, especially the Fort Lauderdale/LBTS reach, multiple beach access and delivery sites can increase productivity of sand placement operations and reduce the time required to construct the project by reducing the effect of back-ups or "bottle-necks" on construction production. Having multiple sites available for sand deliveries can increases the overall project production rate by allowing for a larger number of total truck visits to the project site each day. It is expected that the frequency of truck visits to any one site can be between about 3 and 12 minutes. On average, the visit time per truck is typically about 5 minutes.

Although multiple sites can improve production over just one site, there is believed to be a point of diminishing returns. It is expected that operation of more than about three sites may create difficulties with increased truck traffic on local roadways and coordination between beach and delivery crews.

Coordination with the local communities along the Segment II shoreline, Pompano Beach, Lauderdale-By-The-Sea, and Fort Lauderdale, will be essential to identify, secure, and develop use strategies for beach access sites. It is recommended that these communities be approached and permission to use as many access points as possible be secured. It also is recommended that the project contractor or contractors be required to submit a detailed staging area plan with traffic control and operational information prior to use of any of the areas.

Figure 4.4: Transporting material to the beach via conveyer belt at a project in Collier County in 2010.

4.3 Roads and Bridges

This section identifies the potential delivery routes that will likely be considered for use during a Segment II truck-haul project to transport upland sand to the barrier island. The size of bridges and location to the barrier island will control the routes used by truck traffic to deliver sand for a truck-haul project.

There are eight bridges that provide access to the Segment II barrier island (**Figure 4.5**). **Table 4.1** lists the bridges from north to south, along with details of each bridge condition reported by FDOT. A description of the bridge condition terminology is listed following the table (FDOT, 2010).

These bridges are used continuously to transport heavy materials to the island, so it is assumed that each bridge would have the necessary load carrying capacity to accommodate the equipment and sand deliveries during the truck-haul project. It is suggested, however, that the burden of bridge use and restrictions be placed upon the project contractor. The contractor should also be responsible for attaining proper documentation and adhering to local, state, and federal laws and rules as they pertain to commercial vehicles transporting heavy shipments, as well as compliance with the Florida Department of Transportation road use policy. Such compliance includes obtaining all permits, licenses, easements, and rights-of-way required for transport or staging of equipment and materials.

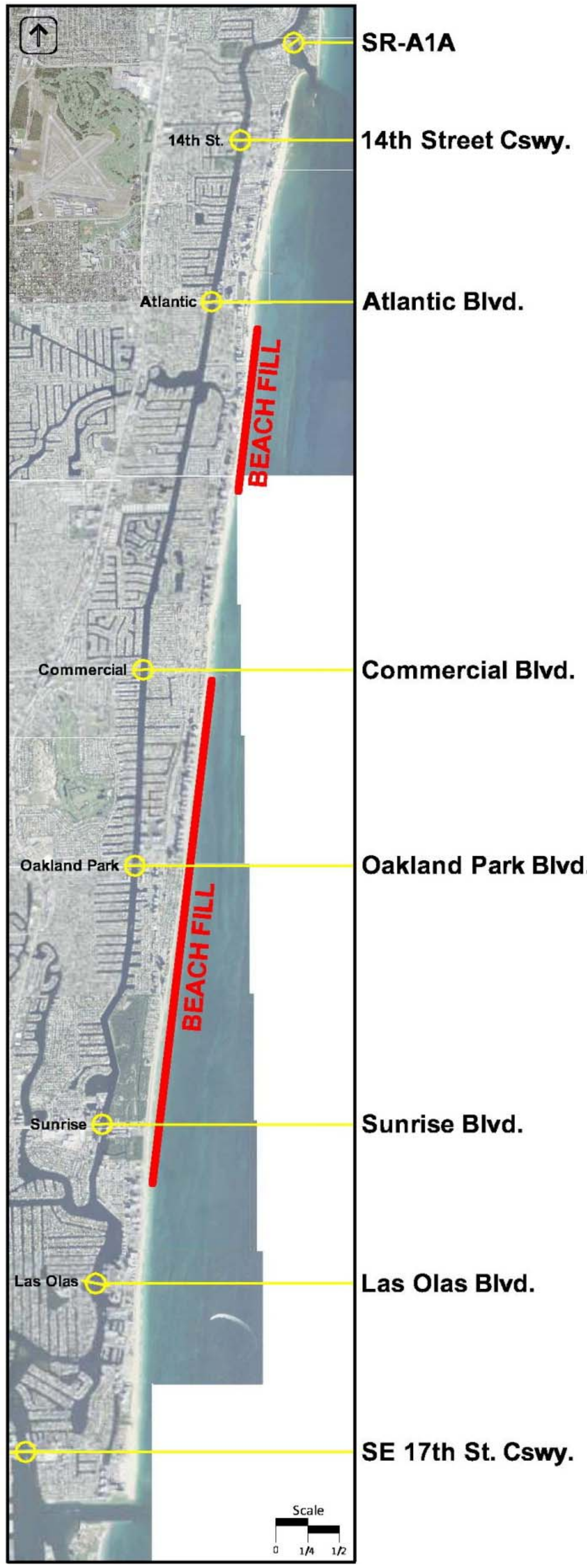


Figure 4.5: Location of bridges that may be used for the Segment II project.

It is most likely that the Atlantic Blvd., Commercial Blvd., Oakland Park Blvd., and Sunrise Blvd. roadway and bridges will be the principal corridors. These roads provide a direct link between I-95 and A1A and are in close proximity to the most possible beach access sites.

Table 4.1: Bridges a vehicle could cross to reach the Segment II barrier island.

Bridge Number	Roadway	Structure Name	ADT	Year Built	Sufficiency Rating	Health Index	NBI Rating
860011	SR-A1A (crossing Hillsboro Inlet)	-	10,200	1966	76.2	89.68	
860060	14th Street Cswy.	-	14,400	1967*	91.3	87.97	
860157	Atlantic Blvd.	S.C. Fox Memorial Bridge	28,000	1955	59.1	87.95	FO
860144	Commercial Blvd.	-	37,500	1964	56.0	87.73	FO
860941	Oakland Park Blvd.	Dave Turner Bridge	33,000	1955	49.8	93.20	FO
860467	Sunrise Blvd.	-	15,250	1987	92.8	83.04	
860018	Las Olas Blvd.	Dwight L Rogers Cswy.	17,500	1958	54.7	87.71	FO
860622	SE 17th St Cswy.	E. Clay Shaw Jr. Bridge	14,500	2001	92.9	97.42	

*Reconstructed in 2006
ADT=Average Daily Traffic
NBI=National Bridge Inventory
FO=Functionally Obsolete

- Average Daily Traffic is the average number of vehicles two-way passing a specific point in a 24-hour period, normally measured throughout a year. ADT is the standard measurement for vehicle traffic load on a section of road, and the basis for most decisions regarding transport planning, or to the environmental hazards of pollution related to road transport. Road authorities have norms based on ADT, with decisions to expand road capacity at given thresholds.
- Sufficiency Rating is a tool that is used to help determine whether a bridge that is structurally deficient or functionally obsolete should be repaired or just replaced. The sufficiency rating considers a number of factors, only about half of which relate to the condition of the bridge itself. The sufficiency ratings for bridges are part of a formula used by the Federal Highway Administration when it allocates federal funds to the states for bridge replacement.
- Health Index is a tool that measures the overall condition of a bridge. The health index typically includes about 10 to 12 different elements that are evaluated by the department. A lower health index means that more work would be required to improve the bridge to an ideal condition. A health index below 85 generally indicates that some repairs are needed, although it doesn't mean the bridge is unsafe. A low health index may also indicate that it would be more economical to replace the bridge than to repair it.
- Functionally Obsolete only means that a bridge does not meet current road design standards. For example, some bridges are "functionally obsolete" because they were built at a time when lane widths were narrower than the current standard.

4.4 Effects to Community

A truck-haul beach fill project includes some activities that are different from those associated with a typical beach fill project constructed by dredge from an offshore borrow sources. The most notable differences include the elevated amount of truck traffic through the communities adjacent to the project site, long-duration activity at the designated beach access locations, and the frequent and continuous movement of large off-road trucks between the access points and the fill placement site.

Impacts to daily traffic can occur due to an increase of vehicles on the road. With strategic staging and truck timing, however, the impact to traffic can be managed and minimized. The most noticeable effect can be at the beach side delivery area where delivery trucks and equipment concentrate. To manage potential problems, active sand delivery points and staging areas are closed to local vehicular and pedestrian traffic and a traffic control and management effort is usually implemented. The latter typically requires a full-time presence of contractor staff to direct trucks and quickly address activities that can be impactive to traffic flow, pedestrian use, and public safety. Accommodations are made to allow local access as required.

Also, the presence of heavy machinery and other construction equipment, blocked-off beach access sites, and fenced-off portions of the beach can be aesthetically displeasing and inconvenient for locals and beach users. Likewise, beach access points can experience temporary infrastructure modifications, physical impacts, and damage. All affected infrastructure at each access will be repaired to pre-project conditions following completion of the project. This requirement is commonly placed upon the contractor as part of the construction contract.

5.0 CONSTRUCTION APPROACH and CONSIDERATIONS

Construction of a beach fill project using the truck-haul approach involves various stages of material transport and handling and numerous types of on- and off-road equipment. In general the construction stages include loading at the commercial mine or upland stockpile area, highway transport, beach side delivery and stockpiling, loading from stockpile to off-road vehicles, beach transport, placement and grading. The specific approach and equipment used can vary depending upon site conditions, site access, and contractor preference.

5.1 Transport

Highway transport of sand from the mines is commonly accomplished with long-haul road trucks (i.e. large dump trucks configured for highway travel). These trucks are loaded with sand at the mine and then transport the material from the mine to the beachside access points near the fill site. Typical trucks used, two-axel to six-axel, have net hauling capacities from about 20 to 27 tons or roughly 15 to 20 cubic yards per load, respectively[7] (**Figure 5.1**). It is not uncommon for a project that includes the movement of large quantities of material, such as a truck-haul beach fill project, to use a mixed fleet of two-, four-, and six-axel dump trucks. For the purposes of evaluating potential expected production rates for a Segment II project later in this report, an average truck capacity of 22 tons is assumed (16 to 17 cubic yards).

Figure 5.1: Typical four-axel road truck used to haul sand from the sand mine to the project site.

[7] This conversion is based on a standard industry conversion of 1.35 tons = 1 cubic yard. This conversion is used in this report herein. The gross weight of the largest truck fully loaded can be as much as 37 tons or 74,000 lbs.

Sand from more distant sources could also be used for a truck-haul project in Broward County, but bulk delivery using trains or barges and a local bulk stockpiling/staging area within Broward County would be required.

Rail Transport. Rail transportation plays a key role in the movement of aggregate materials including sand to and within the State of Florida. The CSX and the Florida East Coast (FEC) railroads operate the trains and rail lines used to move the majority of the materials in the state. The rail network and terminals serving the Lake Belt[8] distribution network are shown on **Figure 5.2**. Railcars are supplied from several sources including the CSX and FEC railroads as well as mining companies that provide cars individually to the railcar "pool" that serves Florida. Approximately 4,000, 100-ton hopper cars are in the railcar pool with most under long-term lease to individual companies (Lampl Herbert, 2007). The actual number of rail cars available at any given time can vary by season and market demand. Information from aggregate industry representatives suggest that significant quantities of aggregate and sand materials are routinely delivered to Broward County by rail.

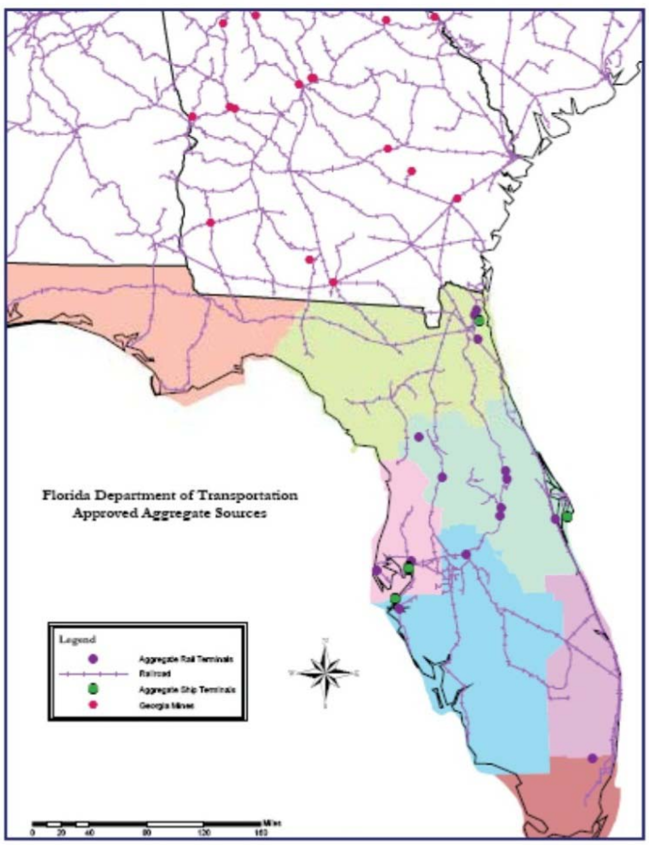


Figure 5.2: Railroad lines and FDOT rail terminals for Lake Belt materials (Source: FDOT).

8 The Lake Belt is an approximately 57,515-acre area that was established by the Florida Legislature in 1997 for the purpose of implementing the Miami-Dade County Lake Belt Plan. The area lies west of Miami and east of Everglades National Park.

Rail can be a highly efficient method of transporting large quantities of bulk materials. A single railcar is capable of carrying 100 tons of material -- roughly 74 cubic yards of sand per car. Freight trains transport material either as a single railcar, a small group of cars (10 or so), or a unit train. Unit trains typically have 80 to 100 cars each, which could deliver between 8,000 and 10,000 tons (5,900 and 7,400 cy, bulked) of sand in total. Utilizing a unit train as opposed to a smaller fleet of rail cars would be the most cost effective way to transport large volumes of sand. Common rail car availability limitations and line scheduling problems, however, can impact regular delivery schedules. As such, this approach alone may not be sufficiently reliable for required production rates for a beach fill project.

For rail transport to be viable, the sand mine must have on-site rail facilities. That is, rail lines and direct loading equipment such as conveyors (**Figure 5.3**) or other equivalent systems must be available at the mine. Once the material is loaded, it must be transported to a rail yard or rail siding near the recipient beach for offloading, re-handling and truck transport to the beach. The material can either be unloaded and stockpiled at the rail yard/siding or transferred directly from the railcars into road trucks for transport to the beach.

Figure 5.3: Example of conveyor loading.

A known railcar bulk material offloading and handling area in Broward County, Conrad Yelvington Yard, is located in Pompano Beach between Atlantic and Commercial Boulevards (**Figure 5.4).** It is understood that sand from the Cemex Davenport mine is frequently delivered to this rail siding and it is assumed that this site could be used for sand from the Davenport mine for the Segment II project.

Barge. Although physically possible, delivery of domestic upland sand sources to Broward County by barge would be a highly inefficient method of material delivery compared to other available alternatives. Numerous handling events would be required to transfer material to and from the barges. It is expected that barge deliveries would be through Port Everglades since the barges cannot be unloaded offshore for direct placement to the beach due to the frequent occurrence of rough sea conditions during the winter months. So, even with this approach, the sand would need to be delivered to the beach by truck, which would not eliminate the issue of truck traffic and beach access operations. Consideration of a barge delivery project is not recommended.

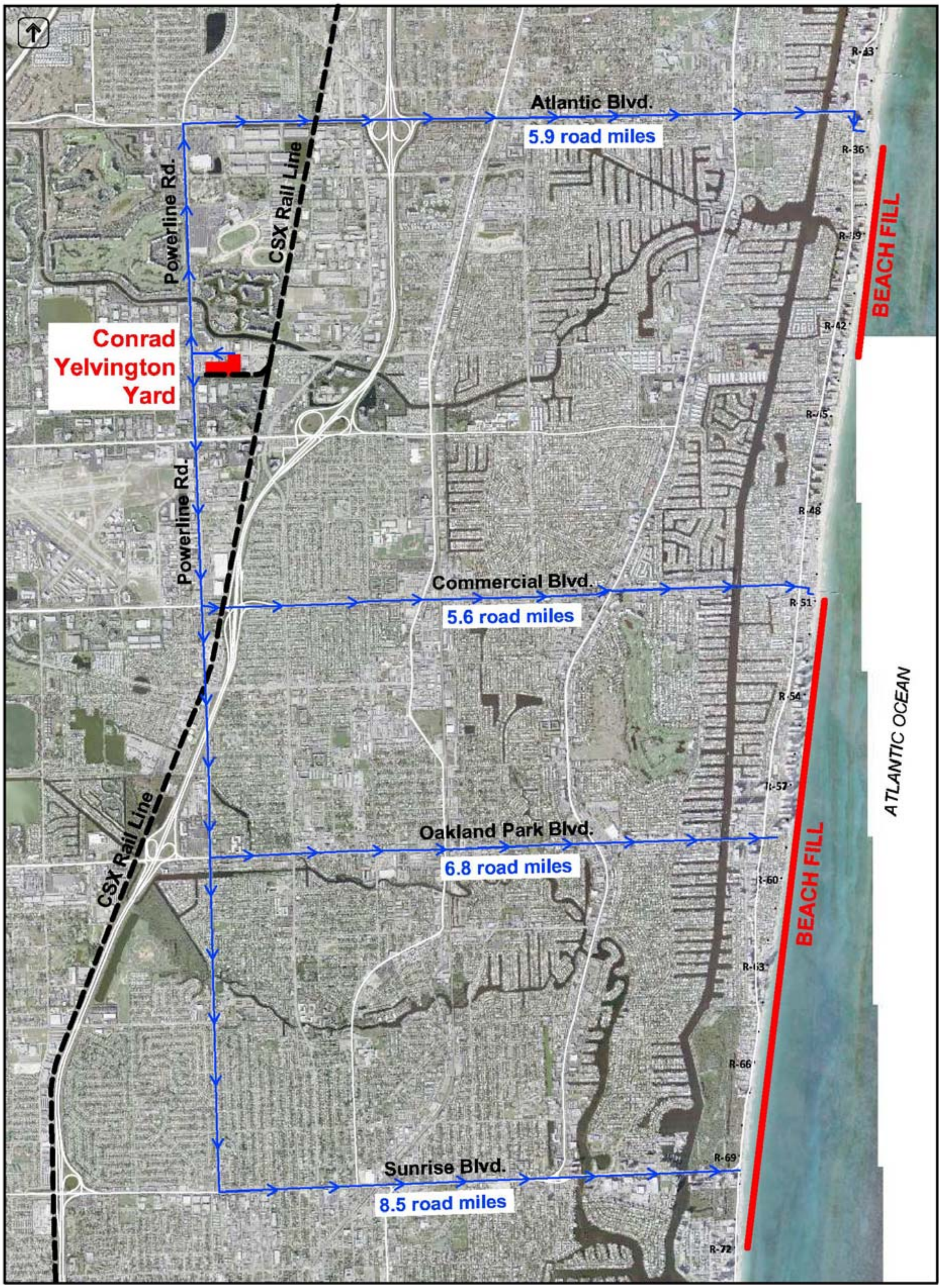


Figure 5.4: Conrad Yelvington Yard rail yard - location of possible delivery point of rail transport and its proximity to the Broward County Segment II beaches.

5.1.1 Delivery, Handling and Placement

Common delivery, handling, placement, and grading elements for delivery of sand to the beach from an upland mine or stockpile include: (1) transfer of material from road delivery trucks to the beachside stockpile area (**Figure 5.5a**), (2) loading of material from the stockpile to an off-road truck (**Figure 5.5b**), (3) transfer and delivery of the material to the fill site by the off-road truck (**Figure 5.5c**), and (4) grading and shaping of the fill material into the design berm configuration (**Figure 5.5d**). Material would need to be delivered to the stockpile area at a rate necessary to maintain a sufficient supply of sand to keep the beach-side off-road equipment working continuously.

The equipment profile at each staging area will generally consist of the following:

- Long-haul road truck – 20 to 27 tons (15 to 20 cy) net capacity (two-axel to six-axel)
- Front-end loader or excavator
- Off-road dump truck – large rubber tire vehicle, approx. 25 cy capacity Occasional work trucks and maintenance vehicles
- Fuel trucks – 2 to 3 times per week to fuel equipment

The equipment profile at each beach fill area will generally consist of the following:

- Off-road dump truck – depending on the Contractor's production rate and staging area location(s), there may be between 2 and 4 off-road trucks operating simultaneously between the staging area and the placement areas.
- Bulldozers – one or multiple
- Occasional work trucks and maintenance vehicles
- Fuel trucks – 2 to 3 times per week to fuel equipment

Figure 5.5a: Long-haul road truck dumping its sand load into a stockpile staging area.

Figure 5.5b: Excavator moving material from a stockpile to an off-road dump truck.

Figure 5.5c: Off-road truck dumping sand on the beach where it will then be spread and groomed by a dozer.

Figure 5.5d: Two dozers grooming fill sand to design specifications.

5.2 Transport Volume Compared to Placed Volume ("Bulking")

When sand from a mine is loaded onto trucks for transport, the material can occupy between 10 - 20% more volume than the compact, in-situ material and the expected compact condition at the beach. The difference in compaction is described as "bulking" or "fluffing." As such, sand delivered to the beach occupies a larger volume than the material in its expected final compacted condition. To ensure a sufficient volume of sand is delivered to and placed along a beach during a truck-haul project, consideration of, and allowance for, the bulking effect is central to project planning.

Beach fill sand placed by traditional hydraulic dredging process arrives on the beach saturated with water; and as the water drains from the sand, the sand settles into a compact mass. Conversely, when sand is placed mechanically during a truck-haul project, it does not compact immediately like hydraulically placed sand. Rather, heavy equipment moving and sculpting the beach results in only partial compaction. That is, the mechanically placed and graded sand typically still occupies about 5% more volume than fully compact sand typical of natural beach conditions. Full compaction (consolidation) does not occur for some time following completion of the project, due to gradual settling and other processes like wave and rainfall effects. To account for the expected post-placement settling/compaction, the fill template should be specified to accommodate the expected 5% difference between the initial and ultimate consolidated condition.

For the purposes of this report, it is assumed that a truck-haul project in Segment II will need to consider a bulking factor of 15% for material deliveries. Also, it is assumed that the mechanical placement will result in an initial beach volume that is 5% greater than that expected for fully consolidated conditions.

To accommodate a bulking factor of 15% for truck deliveries, the sand volume specified for transport should be 15% greater than the desired design compact volume. For example, if the design beach fill volume is 750,000 cy, it would be expected that 862,500 cy (750,000 cy X 1.15 = 862,500 cy) of "bulked" sand, measured in transit, would need to be transported to the project beach to meet the required compact design volume.

To accommodate the 5% mechanical compaction deficiencies for placed/graded sand, the placement template should allow for 5% more volume than the desired design compact volume. For example, if the design beach fill volume is 750,000 cy, it would be expected that the design template on the beach would need to accommodate 787,500 cy (750,000 cy X 1.05 = 787,500 cy) of partially compacted "as-built" sand fill.

5.3 Sand Availability, Production and Transport Issues

The availability of sufficient quantities of sand within the upland sources to meet project requirements is central to selecting sand mines and planning for an upland-sources beach fill project. The mine(s) must be capable of producing a sufficient volume of compliant sand to meet the volume requirements of the beach project while also meeting the needs of competing uses of the material.

Availability can be affected by sediment conditions in a particulate mine, dredging rates, and processing rates. Sediments are rarely completely homogeneous throughout a site due to natural variations in grain size, fines content, and color. As such, excavations within some mines may need to be customized within a source to access material that is required to meet a particular specification. Also, processing can be designed to accommodate variations in source material such that the product made available to the beach project is relatively uniform.

The production rate of a beach fill project can be impacted by numerous factors. Specific issues can be associated with the sand mines ability to produce the product to quality specifications at the rate required, transportation limitations, and the ability to effectively and efficiently deliver and handle the material at the beach site.

The rate of sand delivery can be impacted by sand mine operations. Limitations on dredging, processing, and competition with other buyers can impact a mine's ability to maintain a continuous flow of material to the job site. It is reported that larger mines can process up to 10,000 tons (~13,500 cy) of sand per day. It is expected that a rate of between 2,500 and 6,000 tons per day could be required for the Segment II project, depending upon how many access points might be active at any one time. Given enough lead time, a sand mine can stockpile a in advance of sand deliver and placement activities so that material processing of material does not have to keep pace with delivery during construction. This can enable the mine to deliver more sand each day than typical daily production rates and also alleviate some problems with competition from other uses for the mines and resources. The amount stockpiled at each mine would vary depending on available acreage, workload, and other factors. When selecting possible sand mines for the Segment II project, consideration should be given to production rates and multiple sand sources. A contractor could elect to use numerous sources which could be beneficial to production rates as well as the cost of sand.

The distance between the mine and the project beach site affects the rate that any one truck can deliver sand to the beach. As such, placement efficiency can be highly dependent upon the number of trucks assigned to the project and the number of access points available to receive sand deliveries. To maximize efficiency, the Contractor must manage the number of delivery trucks, off-road trucks, equipment, and personnel necessary to maintain a steady transport of flow from the upland mine(s) to the fill site with sufficient loads to maintain steady delivery of material to the beach. In the event that deliveries outpace the rate sand can be handled on the beach, trucks can become backed-up in the area of the access point which can contribute to larger than expected impacts to local traffic. This problem can be managed by having a nearby, but offsite truck waiting/staging area. Trucks can be held at this location and relocate to the beach-side sand delivery area as needed. The responsibility of identifying these offsite staging areas is typically that of the contractor.

Conversely, if sand deliveries do not keep pace with the beach work, the production rate is impacted directly. Trucks carrying material will be subject to varying degrees of traffic during the day which may slow delivery at different times. The contractor also incurs added expense for equipment not utilized to its full potential. Any added cost, however, would be the responsibility of the contractor and not the County. A contractor qualified and familiar with large truck-haul beach fill projects such as Segment II would be aware of this potential issue and plan and manage operations accordingly.

The transport by rail option for the Davenport mine may also be an opportunity for the Segment II project as a single source of material or to compliment to other options to limit the potential for adverse production impacts due to sand availability. A rail siding located west of the project site would likely be used to receive the material in or near Broward County (**Figure 5.4**). The material can either be stockpiled at the rail siding or unloaded and delivered directly to the beach. Concerns regarding rail car availability, train schedules, and conflicts with other material delivery needs at this rail siding should be considered when evaluating this approach. It is recommended, however, that this option be considered and offered to contractors as a possible complimentary sand source option to further reduce potential risks associated with the production and delivery rates of any one source or mine.

6.0 PERMITTING REQUIREMENTS and APPROACH

Both FDEP and USACE permits will be required to place upland sand along the Broward County beaches in a typical beach fill berm configuration (i.e., above and below the mean high water line). The permits will include conditions related to beach placement activities, sediment conditions, and operations at the sand mine(s). Unlike traditional offshore projects where the dredge operated within one or more sand borrow sources near the project site, a number of different upland sources could be considered and permitted for use during the project.

There are a couple of different approaches to permitting upland sand sources. The first, and likely preferred, would be for the County to permit all sources that would be used during the project. The County also could consider allowing additional or alternate sand sources if a vendor and/or contractor could demonstrate that such sources could be more cost-effective and could be approved by FDEP and the USACE for use on the Segment II project. For any planned source, a thorough geotechnical description including source geological characteristics, sand conditions, sand processing methods, and sand compatibility with Broward County beach sediments must be performed. A sediment quality control/quality assurance (QC/QA) plan would be developed and implemented that described the geotechnical conditions of the source and allowable ranges of grain size, gradation, color, and carbonate and silt content. The plan would be amended if additional sources are considered and proven to be appropriate following issuance of the permits.

A second option would be to permit the fill project with a sediment specification and approved Sediment QC/QA plan and require that project contractors demonstrate that the source or sources they intend to use comply with the permit conditions and contract specifications. Given the amount of information gathered during this investigation, as well for other recent upland sand source projects in southeast Florida, it is likely that all suitable commercial sources are known to Broward County and FDEP. Therefore, this second approach may not result in any additional or alternative sources of sand.

Sediment QC/QA. The sediment QC/QA plan would be coordinated with and approved by FDEP. FDEP requires the sediment QC/QA to comply with Fla. Admin. Code r. 62B-41.008 (1) (k) 4.b. which requires permit applications for inlet excavation, beach restoration or nourishment to include a QC/QA plan. The plan is intended to ensure that the sediment from the borrow areas to be used in the project will meet the standard in Fla. Admin. Code r. 62B-41.007(2)(j). It is also required to specifically ensure that only beach compatible fill is placed on the beach or in any associated dune system to protect the environmental function of Florida's beach and dune systems. The QC/QA Plan specifies quality control conditions at the mine and on the beach. The QC effort requires inspection and reporting requirements to ensure that the sediment from the upland sand source(s) meet the sediment quality guidelines. As described by FDEP in standard Sediment QC/QA language…

This plan outlines the responsibilities of each stakeholder in the project as they relate to the placement of beach compatible material on the beach. These responsibilities are in response to the possibility that non-beach compatible sediments may exist within the upland sand source(s) and could be unintentionally placed on the beach. The QC Plan specifies the minimum construction management, inspection and reporting requirements placed on the Contractor and enforced by the Permittee, to ensure that the sediment from the upland sand source(s) to be used in the project meet the compliance specifications. The QA Plan specifies the minimum construction oversight, inspection and reporting requirements to be undertaken by the Permittee or the Permittee's On-Site Representative to observe, sample, and test the placed sediments to verify the sediments are in compliance.

A sediment QC/QA plan will be part of the FDEP permit issued for the project. FDEP has a QC/QA template document that will be the starting portion for negotiations of conditions that will be specific to the Segment II project. Proposed sediment quality guidelines for an upland source for Broward County beaches are developed in **Appendix B**.

Specific conditions of the QC portion of the plan are intended to address sediment quality control at the mine and at the beach site. These may include, but not be limited to, (1) the sampling frequency and testing methodology at the sand mine and beach site, (2) information related to the sampling approach and handling as well as the testing facilities, and (3) the general approach for assessing compliance with the sediments quality guidelines.

Sampling of the processed sand proposed to be placed on the beach must be conducted at the upland mines before the material is transported to the construction access/staging areas. The typical sampling frequency covers about 2,000 tons of the "processed sand" fill and occurs as frequently as required for the project production rate. **Figure 6.1** displays an example of a processed sand stockpile being sampled for Sediment QC/QA Plan compliance. In addition to specific sampling, the material is also observed visually for compliance while the material is being loaded into the trucks for transport. At the beach fill area,

Figure 6.1: QC activities on sand stockpile in Indian River County.

sampling typically is conducted at the rate of one sample representing 500 tons of sand delivered. In additional to specific sampling, the sediments are continuously monitored visually as it is delivered, placed, and graded. If any material appears to be noncompliant, it must be set aside for testing and/or further processing and not transported to and placed along the beach.

7.0 EVALUATION OF PROBABLE TIME TO CONSTRUCT

The production rate of a truck-haul beach fill project is typically significantly less than a project constructed using hydraulic dredging equipment. The total time to construction an upland source truck-haul project with and without potential environmental season constraints is of particular importance in the planning process. Central to evaluating the time required to construct the project is the total volume of sand required and the rate at which sand can be delivered and placed along the beach.

In this section, information compiled as part of this investigation is used to evaluate (1) possible sand placement rates, (2) the time required to place all sand along the project shoreline, (3) the amount of project work that could be expected to be completed during the seasonal period outside of marine turtle nesting season, and (4) the amount of sand that could be placed for an "extended" seasonal consideration. This evaluation is accomplished by applying what are believed to be the factors that would limit the time and sand placement rate during the project. The project development is set up to determine the amount of trips that would be required to transport the required sand volume to the beach, how long it will take to complete the trips with and without seasonal restrictions. The principal assumptions and elements in the evaluation are:

- Bulking factor during transport (compared to in-place compact): 15%
- 1 cubic yard of sand (bulked): 1.35 tons
- Average capacity of road dump truck: 22 tons (~17 cy bulked)
- Active Access Points: 1 to 3
- Frequency of deliveries per access site: 1 every 3-12 minutes, 5 minutes on average
- Construction Hours:
    - 10 hours per day – daylight hours only (sand delivery and construction work on beach – not including delivery driving time)
    - 6 days a week, typical (No Sundays or holidays)
- Daily Production Rate:
    - 2,500 tons (one access point), 4,500 tons (two access points), and 6,000 ton (three access points)
- Construction Window:
    - Option 1) - November 1st through February 28th
        - About 100 working days (no Sundays or holidays)
    - Option 2) - November 1st through April 30th
        - About 150 working days (no Sundays or holidays)
- Sand availability rate at mine(s): 10,000 ton (~13,500 cy) per day minimum
    - sand mine production capacity is not considered to be a limiting factor in the analysis.

Fill Volume: The project design is intended to provide for an in-place volume of sand with a density equivalent to typical beach conditions. This volume has been estimated to be approximately 750,000 cy, including an allowance of 50,000 cy for a dune along portions of the Fort Lauderdale shoreline.

Fill Distribution. The Segment II project will include two separate and distinct fill sections; (1) the Pompano Beach/LBTS section and (2) the LBTS/Fort Lauderdale section. The Pompano Beach/LBTS section has a design volume requirement of about 200,000 cy of sand. The Fort Lauderdale/LBTS section has a design volume requirement of about 550,000 cy (with the dune) of sand.

Transport Volume Compared to In-Place Volume. The sand transported from the mine and arriving in the truck to the project site is loose compared to the more compact and dense sand typical of native and expected post-project conditions along the project shoreline. The loose or "bulked" form of the sand material during transport occupies a larger volume per unit weight than the compact, in-place sand. Typically, the "bulked" material can occupy 10 - 20% more volume for equivalent weights than the in-place compact volume (see **Section 5.2** for detailed discussion on bulking). For this evaluation, it is assumed that the bulking factor will be 15%. For example, to create an in-place, compact sand volume of 750,000 cy on the project beach, 862,500 cy of loose or bulked sand will need to be transported between the mine and the beach. Assuming that the unit weight of the "bulked" sand is about 1.35 tons per cubic yard, the project will need to transport 1,164,375 tons of sand to the project site.

Production/Delivery Rates. Given that multiple mines may be made available for use on the project, it is not anticipated that sand mine production will limit the availability of sand for the project. For example, it is reported that the Ortona mine alone can produce up to about 10,000 tons (~7,400 cy - bulked) of sand on a typical day. Rather, it is expected that any limitations on production rates will be associated with the number of beach access/delivery points along the project shoreline, traffic congestion, and to some degree the number of trucks in a fleet that may be available to transport the sand.

Based upon recent experience in Broward County (i.e., the 2012 Hollywood Truck-Haul Project), it is anticipated that with one operational beach delivery point, approximately 2,500 tons of sand can be delivered to the project site each day from sand mines within about 115 miles. Given that a typical long-haul road truck carries about 22 tons per trip, about 115 truckloads would be required each day. Again, this is generally consistent with the recent experience at Hollywood (Bernie Eastman, personal communication). For a 10 hour work day, this would mean that a truck would arrive at the delivery site about once every five minutes.

If multiple access points are available, this number would increase. Given potential limitations due to traffic congestion, personnel, and equipment, however, it is not expected that 2,500 tons per day could be handled at each site if multiple sites were available. Accordingly, for this evaluation, the production rate for additional access points is discounted for each additive site. For example, it is assumed that the one site rate would be 2,500 tons/days, the two site rate would be 4,500 tons per day, and the three site rate would be 6,000 tons per day. This is just an estimate and has not been verified through analysis or example.

Confirmation of Delivery Rate and Evaluation of Truck Requirements. In an attempt to verify/confirm the amount of sand that could be placed during any given day, an assessment of required delivery rates, transport distances, travel times, and fleet requirements was performed.

To meet the minimum required daily production rate for the one access option (2,500 tons/days), it is assumed that one truck would need to arrive with about 22 tons of sand, on average, about every 5 minutes (+/-) during a 10 hour work day. To accomplish this, it is expected that about 115 trips would be required.

With the exception of the Davenport mine, the most suitable sand mines that should be considered further for the Segment II project are located within about 115 miles (one-way driving distance) from the Segment II shoreline. These mines would be accessed and the material transported exclusively by road truck. The total round trip travel time between the mines and beach site for a road truck will include the travel time as well as the time required for loading, unloading, and sediment QA/QC. A 115 mile trip between the mine and the beach site is expected to require about 2 hours driving time each way traveling about 50 miles per hour, on average. The round trip driving time for a mine at this distance would take about 4 hours. Check-in, loading unloading, and sediment QA/QC would be expected to take about another hour per trip. So, the round trip time for each truck trip would be about 5 hours, on average. During a typical work day, it is expected that each truck could make two trips. So, to deliver 2,500 tons to the beach site each day (one access point) and for each truck to make two trips each day, a fleet of about 60 trucks would be required. For greater distances between the mine and fill site and for multiple access points, the truck fleet size would need to be increased to maintain required production rates.

If the distance between the sand mine and the beach becomes too great, a truck would not be able to make two trips per day. Therefore, the truck fleet size would have to increase, likely double if each truck can only make one trip per day, to maintain an equivalent production rate.

To verify the probable maximum distance between a sand mine and the beach that would allow a truck to make two trips per truck per day, the maximum work day time is compared to individual trip time with trip distance being a variable. For this verification, three work day alternatives area considered. These include a 10-hr, 12-hr, and 14-hr day per truck. Following the assumptions regarding travel speed and time required for check-in, loading, unloading, and QA/QC listed previously (i.e., 50 miles per hour and 1 hour for check-in, loading, unloading, and QA/QC), the maximum distance between the mine and the beach site that would allow for two trips per day per truck for each of these alternatives is as follows:

10-hr day = 100 miles (one-way driving distance)
12-hr day = 125 miles (one-way driving distance)
14-hr day = 150 miles (one-way driving distance)

Therefore, for each truck to make two trips to one of the mines between 110 and 115 miles from the Segment II project site, each truck would have a work day of just over 11 hours, on average.

If the number of access points used simultaneously is increased to two or three, the total number of trucks required to meet the demand of these sites would need to be increased as well. If the production rate for a project with two active access points has a desired production rates of 4,500 tons per day, this would require about 205 total deliveries per day (22 ton/truck capacity) and a minimum total fleet size of around 100 trucks if two trips were made each day to a mine within about 135 miles of the project site. For a three access point project and a desired production rate of about 6,000 tons per day, there would be about 270 truck deliveries made each day. In this instance, the two trips per truck per day approach would require a truck fleet of about 135 trucks, more than twice that required for the one access point project.

The limiting truck fleet size for the southeast Florida area is not known but, it is expected that longer haul distances and multiple delivery points could burden the available regional truck feet such that there may be a direct impact on the amount of sand that can be delivered to the project site on any given day. Past projects in Broward County with only one access point have not reported that truck availability was a limiting factor on sand placement rates.

If some or all of the sand for the project is delivered to Broward County by train, the haul distance and truck fleet size would be reduced significantly and would not be a factor in determining the sand placement rate. For a rail delivery project, it is expected that rail delays and beach side delivery constraints would limit the sand placement rate.

Time to Construct. The time to construct an upland truck-haul project is directly related to the rate at which sand can be delivered to and placed along the beach and the amount of available time during a given day, week, month, etc. when construction activities are allowed to occur. The reasonably expected sand delivery rates for the Segment II project were discussed above. Regarding the available work time, it is assumed that work at the beach site (i.e., delivery and placement) will occur (1) only during daylight hours, (2) 10 hours per day, on average, and

(3) a maximum of six days a week. No work will be allowed on Sundays or major government and religious holidays. Therefore, during a typical week, there would be 60 hours available for sand delivery and placement to occur.

The production rate is best evaluated through the weight of the sand (i.e., tons) rather than the volume (i.e., cubic yards, cy), since the material is purchased and measured for transport and delivery by weight. The volume is only used as the measure of design requirements. Again, the total measure of weight for a given amount of sand is larger than the volume. For example, a design volume of 750,000 cy of sand, in-place, requires about 1,164,375 tons of sand. The time required to construct the project is based upon the amount of time required to transport and place the total equivalent tonnage of sand.

For the evaluation of the construction time, various project volume requirements are considered. Although the project design calls for a total of about 750,000 cy of sand to be placed along all project reaches, it is likely that the entire project could not be built without some interruption due to seasonal restrictions associated with marine turtle nesting season. To study possible scenarios that could result in completion of contiguous sub-reaches of the project during a particular seasonal event, the total project volume is sub-divided by project reach (Pompano Beach vs. Fort Lauderdale) and project features (i.e., beach fill vs. dune). The scenarios considered include …

- Pompano Beach and Fort Lauderdale with Dune = 750,000 cy => 1,164,375 tons
- Pompano Beach and Fort Lauderdale without Dune = 700,000 cy => 1,086,750 tons
- Fort Lauderdale Only with Dune = 550,000 cy => 853,875 tons
- Fort Lauderdale Only without Dune = 500,000 cy => 776,250 tons
- Pompano Beach Only = 200,000 cy => 310,500 tons

Table 7.1 summarizes the expected total time required to construct the various noted project scenarios for one, two and three active beach access and delivery points. As shown from the results, it is not expected that the entire 750,000 cy project volume could be placed during one non-nesting season (Nov. 1 to Feb. 28) for a project that includes up to three beach access and delivery points. Due to likely mine production, truck fleet, and traffic limitations it is not expected that simply increasing the number of access points would make the completion of the entire project during one non-nesting season possible.

A more realistic goal would likely be to strategically construct a portion of the project during one non-nesting season, or an extended season, and the other in a subsequent and different non-nesting season.

Considering the results from **Table 7.1**, it may be possible to complete the entire project during two construction events and extending only one of the events into only a portion of one marine turtle nesting season. That is, the 550,000 cy (with dune) Fort Lauderdale reach, which is expected to require about 142 work days if three access points are active, could occur during one full non-nesting season plus about 50 working days into the first part of the subsequent nesting season (i.e., March 1 to April 30). The location of the work that would occur during the nesting season period could be controlled to minimize the potential effects to nesting activities and nests. The remainder of the project, the 200,000 cy in Pompano Beach, could be completed in one non-nesting season, with no extension of time, with as few as two active access points.

As represented, there are other options available for consideration as possible construction approaches. Those, however, are expected to extend the time to complete the entire project to three and possibly four or more seasons depending upon the number of access points that could be reliability operated simultaneously. If marine turtle nesting season is avoided completely and three access points were fully operational continuously, the entire project, could potentially be constructed in about two non-season periods. It is not expected, however, that three access points could be operational the entire project time along the Pompano Beach shoreline. Therefore, it may take up to three non-nesting seasons to complete the project.

Table 7.1: Expected Time to Construct Truck-Haul Project of Various Sizes and Using Either One, Two, or Three Beach Access Points.

Project Description	In-Place Volume (cy)	Transported Bulked Volume (15%) (cy)	Sand Weight (1.35 tons/cy) (tons)	Total Work Days Required to Construct	Truck Trips Per Day (22 tons/truck)	Total Truck Trips Required to Construct	Start Date	Finish Date (No Season Restriction)	Marine Turtle Nesting Seasons Required to Complete Project (Nov 1- Feb 28)	Nesting Seasons + 50 Workdays Required to Complete Project (Nov 1- Apr 30)
One Access Point	**One Access Point**									
Pompano Beach and Fort Lauderdale Reaches with Dune	750,000	862,500	1,164,375	466	114	53,124	11/1/2013	4/28/2015	4.7	3.1
Pompano Beach and Fort Lauderdale Reaches without Dune	700,000	805,000	1,086,750	435	114	49,590	11/1/2013	3/23/2015	4.3	2.9
Fort Lauderdale Reach Only with Dune	550,000	632,500	853,875	342	114	38,988	11/1/2013	12/5/2014	3.4	2.3
Fort Lauderdale Reache Only without Dune	500,000	575,000	776,250	311	114	35,454	11/1/2013	10/29/2014	3.1	2.1
Pompano Beach Reach Only	200,000	230,000	310,500	124	114	14,136	11/1/2013	3/25/2014	1.2	0.8
Two Access Points	**Two Access Points**									
Pompano Beach and Fort Lauderdale Reaches with Dune	750,000	862,500	1,164,375	259	204	52,836	11/1/2013	8/30/2014	2.6	1.7
Pompano Beach and Fort Lauderdale Reaches without Dune	700,000	805,000	1,086,750	242	204	49,368	11/1/2013	8/10/2014	2.4	1.6
Fort Lauderdale Reach Only with Dune	550,000	632,500	853,875	190	204	38,760	11/1/2013	6/10/2014	1.9	1.3
Fort Lauderdale Reache Only without Dune	500,000	575,000	776,250	173	204	35,292	11/1/2013	5/21/2014	1.7	1.2
Pompano Beach Reach Only	200,000	230,000	310,500	69	204	14,076	11/1/2013	1/20/2014	0.7	0.5
Three Access Points	**Three Access Points**									
Pompano Beach and Fort Lauderdale Reaches with Dune	750,000	862,500	1,164,375	194	273	52,962	11/1/2013	6/15/2014	1.9	1.3
Pompano Beach and Fort Lauderdale Reaches without Dune	700,000	805,000	1,086,750	181	273	49,413	11/1/2013	5/31/2014	1.8	1.2
Fort Lauderdale Reach Only with Dune	550,000	632,500	853,875	142	273	38,766	11/1/2013	4/15/2014	1.4	0.9
Fort Lauderdale Reache Only without Dune	500,000	575,000	776,250	129	273	35,217	11/1/2013	3/31/2014	1.3	0.9
Pompano Beach Reach Only	200,000	230,000	310,500	52	273	14,196	11/1/2013	12/31/2013	0.5	0.3

8.0 PROBABLE COSTS FOR SEGMENT II UPLAND TRUCK-HAUL PROJECT

The cost of constructing a beach nourishment project from an upland source is related principally to the purchase price of sand and the transport distance between the source and the fill site. Here, the information gathered and developed as part of this study is used to evaluate the probable cost of placing sand along the Segment II beaches from the various potential upland sources listed in **Table 3.3**. The opinion of probable cost was generated by identifying values for three principal cost elements associated with an upland sourced truck-haul fill. These are: 1) material cost, 2) transport and delivery cost, 3) placement cost including surveys, QC/QA, and management. The assumptions applied to each of these elements are listed below[9].

Material costs were obtained from the various sand mines and were simply general quotes for typical conditions (Table A.1). These values do not represent the potential benefits of a competitive bid process that would be recommended for the beach nourishment project. The quotes represent a price per bulked cubic yard. For this analysis, these quoted prices have been modified to approximately represent the equivalent price per ton assuming 1.35 tons per bulked cubic yard.

The in-place cost of sand is influenced most by the transport cost. Transport cost is directly related to fuel costs. Based upon recent experience, the truck transport rate of $0.08 per mile per ton is generally consist with cost for recent fuel prices (2011/12) and is used in this evaluation. It is assumed that the cost for rail transport would be $0.04 per rail mile given the benefits of bulk transport but this could not be verified with quarry or rail line companies.

The cost to handle and place material once it arrives at the project site, can vary depending on a number of factors, including the number of access points, the condition of the access point, fill density, and haul distance along the beach. It is not often that this cost is quoted or specified separately within the overall cost of a project. Rather the cost is incorporated in the total in-place unit cost which includes purchase, transport, delivery, rehandling at the beach access point, transport along the beach, placement and final grading. Only a few examples exist that can be considered for developing a representative cost. A recent truck-haul project in Brevard County had access point handling/beach transport/spreading/grading itemized with a unit cost equivalent to about $6.00 per ton. The cost of post-delivery handling and placement can also vary with changes in fuel prices. Based upon 2010/11 experience for a dune project at Patrick Air Force Base and scaling for the relative size of the projects, the cost for surveys, QC/QA, and management may be equivalent to about $1.00 per ton. Therefore, following these values, the total placement cost, following delivery, would be on the order of $7.00 per ton.

[9] All monetary values in this section are presented in a unit cost format.

Table 8.1 summarizes the opinion of probable cost to construct the Segment II beach fill project from the various potentially suitable sand sources identified herein. The costs are based upon the identified transport distances and transport methods required for each mine and the expected unit cost for purchase, transport, placement, surveys, QC/QA, and management. Overall, these costs are generally consistent with the cost from projects recently completed in Broward County including the Hollywood Truck-Haul Beach Fill Project that was completed in January 2012. It is noted, however, that the ultimate price of a truck-haul project can vary significantly from these presented here due to changes in fuel prices. Fuel prices have a direct effect on the cost of the sand product, transportation, and placement.

The unit price of sand in-place along the shoreline could vary from between about $29 to $35 per ton ($39 to $48 per cubic yard) depending upon the source and transport and handling methods (Table 8.1). The prices vary to some degree by the cost of the material at the mine, but as expected they vary to a much larger degree by the distance between the mine and the Segment II project beach, and the mode of transportation (i.e., rail vs. truck). Although this analysis suggests that rail may be a more cost-effective approach, the unit prices for rail transport have not been specifically verified. Nonetheless, the values presented are likely within the range of those that may be expected for an upland source project and are believed to be generally reasonable for planning purposes.

Ultimately, the cost of sand for the Segment II project will be determined through a competitive bidding process. The potential benefits of sand vendor and contractor competition are not specifically incorporated in planning numbers. To maximize the potential benefits of competition among sand vendors and contractors, however, the County should consider making the project available to as many qualified sand sources and qualified contractors as possible. Likewise, flexibility at the work site and for work days and hours can further reduce project costs.

Also, the timing of a project relative to mine production schedules is important. Cost savings can be realized if sufficient advance lead time (e.g. 6 months to one year) is provided so mine operators are able to plan around the project requirement. The extra time allows the operators to produce the needed quantities during the periods of reduced need from other sand users. As this beach project will be considered small compared to the normal business of the mines, there will be competition from other customers for the production and products at each mine. Multi-year contracts with the mines can also be beneficial to costs as the mines will be able to plan for a definite need over a given period of time.

Table 8.1: Opinion of probable cost to construct based upon recent experience with sand purchase, delivery, and placement in SE and Central Florida. Cost is highly dependent upon fuel prices.

Company	Mine	Sample	Material Cost		Delivery Cost		Placement Cost	Total In-Place Unit Cost ($/ton)	Total In-Place Unit Cost ($/cy)(8)
			Sand Unit Cost ($/cy) (1)	*Sand Unit Cost ($/ton)* (2)	*Trucking Distance (miles)* (3)	*Delivery Unit Cost ($/ton)* (4)(5)(6)	*Placement Unit Cost ($/ton)* (7)		
Stewart Mining Industries	Ft. Pierce	Ft. Pierce	$ 10.00	$ 7.50	110	$ 17.60	$ 7.00	$ 32.10	$ 49.76
Stewart Mining Industries	Immokalee	Beach Sand	$ 10.00	$ 7.50	114	$ 18.24	$ 7.00	$ 32.74	$ 50.75
Stewart Mining Industries	Immokalee	Beach Sand #2	$ 10.00	$ 7.50	114	$ 18.24	$ 7.00	$ 32.74	$ 50.75
Vulcan Materials	Witherspoon	Witherspoon	$ 12.00	$ 9.00	114	$ 18.24	$ 7.00	$ 34.24	$ 53.07
E.R. Jahna	Ortona	Beach Sand C	$ 11.00	$ 8.00	115	$ 18.40	$ 7.00	$ 33.40	$ 51.77
Cemex	Palmdale	FDOT Concrete	$ 13.00	$ 10.00	115	$ 18.40	$ 7.00	$ 35.40	$ 54.87
Cemex(6)	Davenport	Concrete	$ 12.00	$ 9.00	Rail: 200 Truck: 7	$ 12.12	$ 7.00	$ 28.12	$ 43.59
Cemex(6)	Davenport	Commercial Concrete	$ 11.00	$ 8.00	Rail: 200 Truck: 7	$ 12.12	$ 7.00	$ 27.12	$ 42.04
		Average	*$ 11.13*	*$ 8.31*		*$ 16.67*	*$ 7.00*	***$ 31.98***	***$ 49.57***

Notes:

(1) Sand unit costs were quoted by each sand mine and are not representative of a competitively bid pricing.
(2) Assumes 1.35 tons per cubic yard and rounded to nearest half dollar.
(3) Distances were determined using Google Earth directions.
(4) Trucking delivery unit cost is assumed to be 8 cents per mile per ton. Can vary with fuel costs.
(5) Rail delivery unit cost is assumed to be 4 cents per mile per ton. Can vary with fuel costs.
(6) Assumed $3 per ton for rehandling at rail-siding. Can vary with fuel costs.
(7) Sand placement, surveys, QA/QC, mgt cost is assumed to be $7.00 per ton. Can vary with contractor competition and approach.
(8) Assumes 1.55 tons per cubic yard (compact, in-place) (1.35 tons/cy for sand that is bulked 15 percent from compact, in-place conditions).

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Appendix A:

Sand Mines and Sediment Sampling

This appendix describes the findings from a comprehensive evaluation of potential upland sand sources in Florida, including visits to sand mines and analyses of representative sand samples from each mine. The sand mine visits, sand sampling, and sample analyses were performed by Coastal Planning and Engineering, Inc. staff geologists in 2011. A list of potential sand mines were developed from a review of past projects in southeast Florida that have used upland sand sources, and information from commercial sand vendors. Each identified sand mine was contacted for an initial assessment of sand products available and those that were considered to potentially have beach suitable sand products were visited. Information gathered during the site visits included sand samples and sand production details and capabilities. Samples were analyzed to quantify sand characteristics for comparison to Broward County beaches and other potential sand sources, upland and offshore.

The State of Florida has an active mining industry that primarily supports construction of roads and infrastructure. The mines used to produce the needed aggregates are sand, gravel, and rock mines located throughout the state. Although beach compatible sand could be produced from the gravel and rock mines, this sand is considered manufactured sand and may be difficult to permit and is not recommended for Broward County beaches. Therefore, only the facilities that specifically mine sand were investigated.

There are four regions where sand mines were researched: South Florida, Lake Wales, North Florida, and Atlantic Coastal Ridge. The sand mines are located where thick sequences of mid-Jurassic to Holocence sediments lie upon the eroded surfaces of igneous, sedimentary, and sometimes volcanic basement rocks (Arthur, 1988). The sediment sources are primarily silica sand from the uplift and erosion of the Appalachian Mountains and carbonate sedimentation deposited during the various Pleistocene sea level highs.

Fourteen sand mines were investigated in total. Each mine was visually inspected and 30 samples (total) were collected for further analysis. **Sections A.1** through **A.4** discuss in detail the sand mines visited. **Section A.5** lists the geotechnical results of the 30 collected samples.

A.1 South Florida

The South Florida mines are relatively close to Broward County with one way transport distances around 110 to 140 miles (Figure 4.1). These mines are lake pit or open pit mines that produce silica sand.

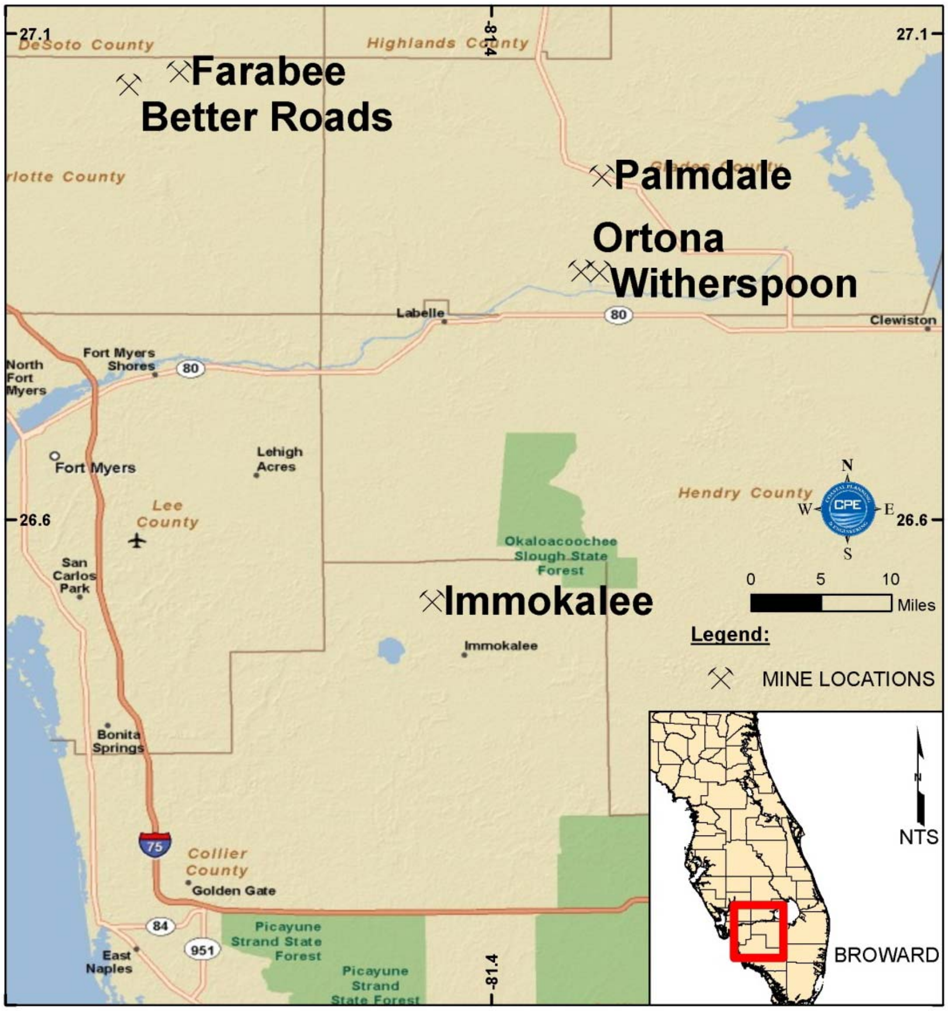


Figure A.1: Location of mines reviewed in the South Florida region.

Stewart Immokalee

The Stewart Immokalee mine is located in the South Florida region in northern Collier County (**Figure A.1**). The mine is a relict shoal likely formed offshore of the Pamlico Sand Marine Terrace (Beever and Thomas, 2006). The mine's close proximity to Alligator Alley makes the site a relatively short trucking distance to Broward County. The mine has supplied sand for several successful beach nourishment projects in the past. Capacity for the purpose of sand nourishment in Broward County is not considered problematic as Stewart Immokalee expects to produce sand for at least 30 more years.

The Immokalee sand is extracted from the lake pit by hydraulic dredge and pumped through pipes to a sand processing plant (**Figure A.2**). The processing plant first removes larger material using vibrating screens with spray bars. The remaining smaller grains are separated into 11 different gradations using water and gravity. The sand is then remixed depending on the client's specifications and fed into dewatering screws. The dewatering screws remove remaining fines due to their weir-like effect. The resulting sand is placed onto a conveyor and stacked in a sand pile.

Figure A.2: Stewart Immokalee hydraulic dredge (left) and processing plant (right).

Vulcan Witherspoon

The Vulcan Witherspoon mine is located in the South Florida region in southern Glades County (**Figure A.1**). The Witherspoon mine is located adjacent to the Jahna Ortona mine and claims the deepest dredge in the western hemisphere (200 ft,, **Figure A.3**). Capacity for the purpose of sand nourishment in Broward County is not considered problematic as the Witherspoon mine expects to produce sand for at least 30 more years.

Figure A.3: Vulcan Witherspoon hydraulic dredge (left) and processing plant (right).

The sand is extracted from the lake pit by hydraulic dredge and pumped through pipes to a sand processing plant (**Figure A.3**). The processing plant first removes larger material using vibrating screens. The remaining smaller grains are separated into 11 different gradations using water and gravity. The sand is then remixed depending on the client's specifications and fed into dewatering screws. The dewatering screws remove remaining fines due to their weir-like effect. The resulting sand is placed onto a conveyor and stacked in a sand pile.

Jahna Ortona

The Jahna Ortona mine is located in the South Florida region in southern Glades County (**Figure A.1**). Ortona sand is well known for beach compatible sediment due to several beach nourishment projects. Transportation from the Ortona mine is primarily done by trucking material, but the property is located on a canal system and there is potential to barge material from the site if the canals were dredged. Capacity for the purpose of sand nourishment in Broward County is not considered problematic as Jahna Ortona expects to produce sand for at least 30 more years.

Sand is extracted using one of two cutter-head dredges and pumped to a central processing plant (**Figure A.4**). The processing plant first removes larger material using vibrating screens with spray bars. The remaining material is sent through a gravity classifier and then remixed to match customer specifications. The sand is then remixed depending on the client's specifications and fed into dewatering screws. The dewatering screws remove remaining fines due to their weir-like effect. The resulting sand is placed onto a conveyor and stacked in a sand pile.

Figure A.4: Jahna Ortona dewatering screws (left) and processing plant (right).

Cemex Palmdale

The Cemex Palmdale mine is located in the South Florida region in central Glades County (**Figure A.1**). The Palmdale mine is located immediately north of the Ortona and Witherpoon mines, but the source material tends to be slightly darker in color (**Figure 4.5**).

Figure A.5: Cemex Palmdale processing plant (left) and one of the sand stacks (right).

The sand is extracted with a hydraulic suction dredge and pumped to the processing plant (**Figure A.5**). The plant initially removes larger material by washing the sediment over scalping screens (vibrating screens) using wash bars. Palmdale uses an 11 station gravity classifier and remixes those sediments to create products of a specified grain size. Due to the slightly darker color, chemical color test are performed on all products. When material does not pass the chemical color test it is washed/scrubbed with a sodium hydroxide solution (50% NaOH in water).

JJJ Enterprises Farabee

The JJJ Enterprises Farabee mine is located in the South Florida region in northern Charlotte County (**Figure A.1**). The Farabee mine produces relatively fine sand with some shell and is located approximately 153 road miles from Broward County. Remaining capacity is estimated at 2,000,000 cubic yards.

The material is removed from a dry pit with a large excavator and run through a power screen wash plant where it is washed over a double deck wet screen to remove the larger material (**Figure A.6**). The remaining material is drained into the settling pile where fines are washed out by flow of water draining from the wash plant. Two samples were collected due to possible deviations of grain size depending on where the samples are taken from the settling pile. One sample was taken close to the mouth of the pipe (coarser), and one sample was taken further away (finer). JJJ Enterprises is willing to lease a sorting machine if needed for the Broward County project.

Figure A.6: JJJ Enterprises Farabee processing plant (left) and settling pile (right).

Florida Shell and Fill Better Roads

The Better Roads Mine is located in the South Florida region in northern Charlotte County located approximately 150 road miles from Broward County (**Figure A.1**). Remaining capacity is unknown, but the mine can expand to another 6,500 acres which should be sufficient for the purpose of sand nourishment in Broward County.

The Better Roads Mine produces fine sand with some shell. Material is excavated from a dry pit using an excavator. The raw material is sent through screens to remove coarse material and washed with spray bars, then placed on a conveyor and stacked in piles (**Figure A.7**).

Figure A.7: Florida Shell and Fill sand piles.

A.2 Lake Wales

The Lake Wales mines are located on or near the Lake Wales Ridge (Figure 4.8), which is a remnant beach and sand dune system of reworked Cypresshead Formation sediments oriented north-south (Scott, 2001). The Lake Wales mines are relatively distant from Broward County beaches, but some mines have the option of loading sand onto freight trains. Using rail to transport sand could be a cost effective option for Broward County. However, as discussed in **Section 3.1.1**, transport by rail is not currently viable due to track conditions and location making transport inaccessibility by unit train. If future track conditions and location allow for transport by unit train, rail transport from these sites should be reinvestigated in detail.

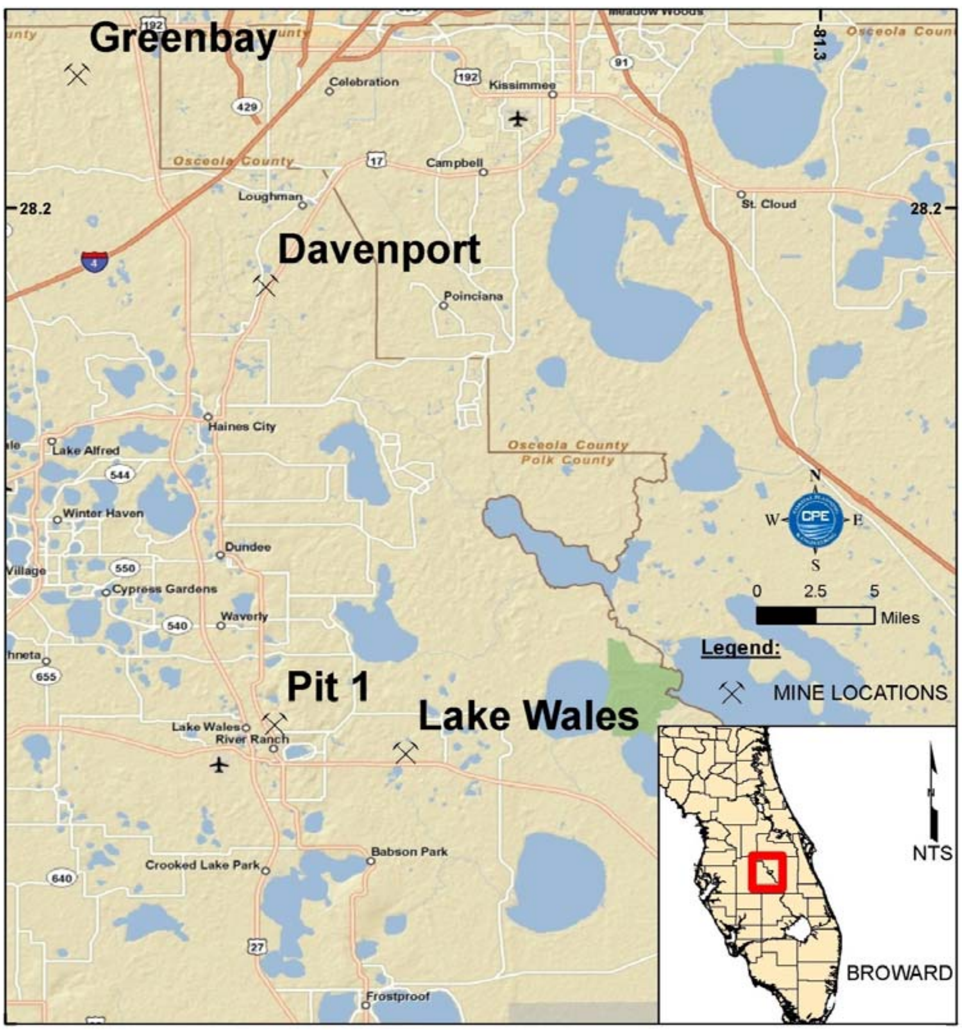


Figure A.8: Location of mines reviewed in the Lake Wales Ridge region. The Davenport location represents Cemex Davenport and Standard Sand & Silica Davenport, as Standard Sand & Silica gets their sand from Cemex Davenport.

Jahna Greenbay

The Jahna Greenbay mine is located in the Lake Wales Ridge region in northern Polk County (**Figure A.8**). Transportation costs are the limiting factor as Greenbay is greater than 200 miles from Broward County beaches. The Greenbay mine does not have a rail option.

The material produced at the Greenbay facility is mined by cutter-head dredge (**Figure A.9**). The dredged material is passed through a shaker screen to remove coarse material and then a cyclone tower to remove the fine and organic material. The washed source material is then transported to the production tower where a programmable density separator outputs the desired grain size.

Figure A.9: Jahna Greenbay cutter head dredge (left) and processing plant (right).

Cemex Davenport

The Cemex Davenport mine is located in the Lake Wales Ridge region in northern Polk County (**Figure A.8**). Transportation costs may be a limiting factor as Davenport is greater than 200 miles from Broward County beaches. However, Cemex Davenport is located on a rail line and has the ability to load sand onto railcars.

Davenport is a fractionated plant and can blend sand to the customer's specifications by mixing 4 source sizes (**Figure A.10**). Material is excavated by hydraulic suction dredge and pumped to a rotating Trommel screen. The material is then pumped to the main plant where it is separated by Hydrosizers and dewatering screens into 4 classifications: coarse, medium coarse, medium fine, and fine. An American Association of State Highway and Transportation Officials (ASSHTO) T21 chemical color test is performed on all products. If the material fails the color test it is washed with a sodium hydroxide solution (50% NaOH in water).

Figure A.10: Cemex Davenport processing plant (left) and train loading area (right).

Standard Sand & Silica Davenport

Standard Sand & Silica Davenport uses sand mined from Cemex Davenport, thus sand quality can be accessed from the Cemex Davenport plant.

CC Calhoun Pit 1

CC Calhoun's Pit 1 is located in the Lake Wales Ridge region in central Polk County (**Figure A.8**). Pit 1 is a relatively long distance from Broward County beaches (180 miles), and does not have a rail option. Pit 1 produces fine to medium white sand. The mine's future quantity is unknown. It is the judgment of CPE geologists that Pit 1 may not be able to produce 500,000 cubic yards.

Processing of Pit 1 sand is relatively minimal. Sand is removed from the dry pit by front end loaders and poured over vibrating screens (**Figure A.11**). Larger and finer material are separated out and the processed sand is placed on a conveyor and stacked in piles. This minimal processing may result with inconsistent sand quality which would require stringent QC/QA during construction.

Figure A.11: CC Calhoun Pit 1 front end loader (left) and processing plant (right).

Cemex Lake Wales

The Cemex Lake Wales mine is located in the Lake Wales Ridge region in central Polk County (**Figure A.8**). Transportation cost is the limiting factor as Lake Wales is greater than 170 miles from Broward County beaches and does not have a rail option.

The material produced at the Lake Wales site is mined by a hydraulic dredge (**Figure A.12**). The slurry is pumped to an initial processing plant that uses vibrating screens and spray bars. The remaining smaller grains are pumped to another processing plant that separates the material into 11 different gradations using water and gravity. The sand is then remixed depending on the client's specifications and fed into dewatering screws. The dewatering screws remove remaining fines due to their weir-like effect. The resulting sand is placed onto a conveyor and stacked in a sand pile.

Figure A.12: Initial processing removing large material (left) and the hydraulic dredge (right) at Cemex Lake Wales.

A.3 North Florida

Vulcan Kauka

Vulcan's Kauka sand mine was the only mine visited in North Florida located in southern Putnam County (**Figure A.13**). Sand is mined from the Cypresshead Formation (Scott, 2001). Trucking sand from Kauka is not realistic due to the approximately 320 mile distance. Kauka is located on a rail line and has the ability to directly load railcars using conveyor belts. However, transport by rail is not currently viable due to track conditions and location making transport inaccessibility by unit train (Section 3.1.1). If future track conditions and location allow for transport by unit train, rail transport from these sites should be reinvestigated in detail.

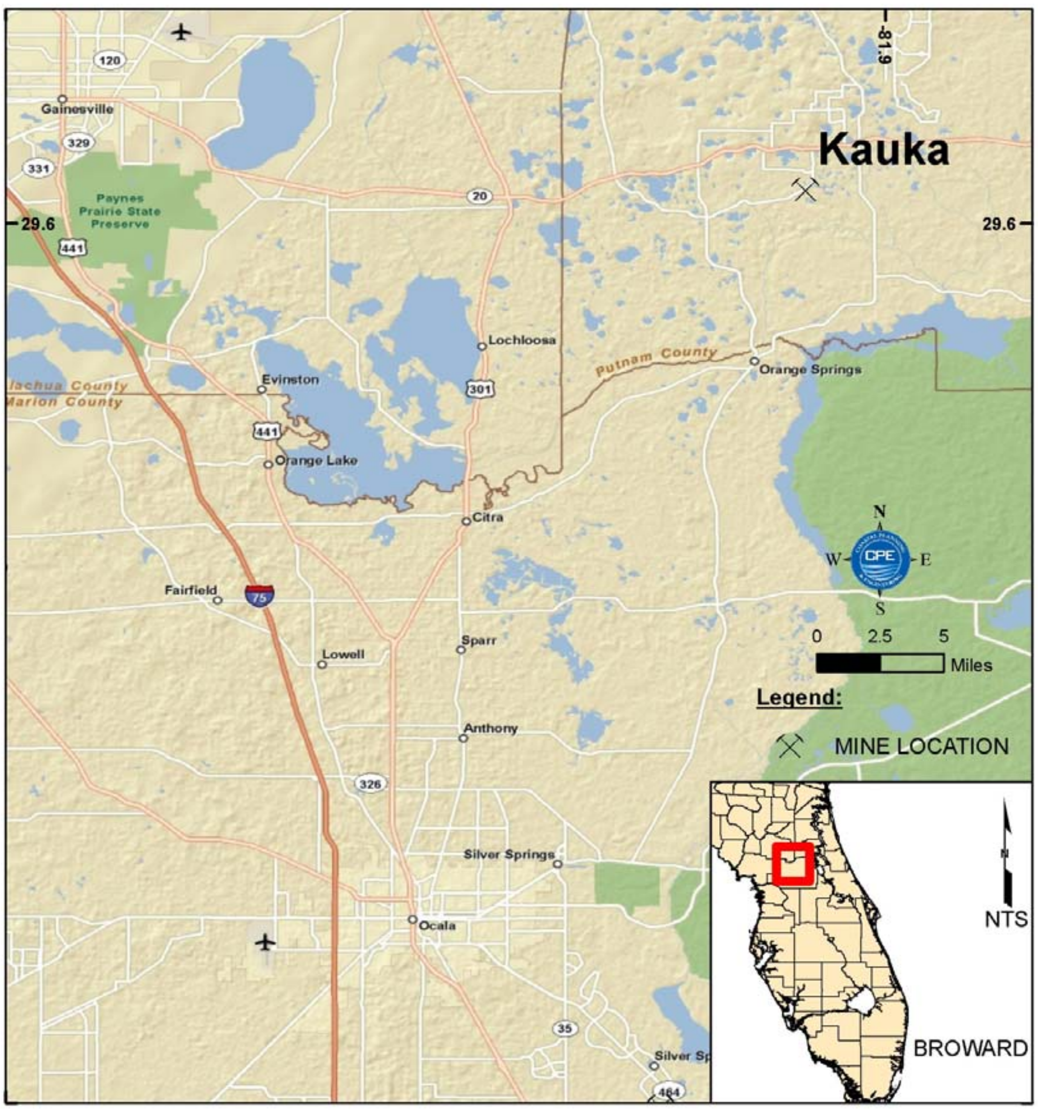


Figure A.13: Location of mines reviewed in the North Florida region.

The Kauka sand is extracted from the lake pit by hydraulic dredge and pumped through pipes to a sand processing plant. The processing plant first removes larger material using vibrating screens with spray bars. The remaining smaller grains are separated into 15 different gradations using water and gravity. Sand can also be processed with chemicals to reduce heavy minerals, but these sands were not sampled due to the increase in sand cost (estimated at 3 times). The sand is then remixed depending on the client's specifications and fed into dewatering screws. The dewatering screws remove remaining fines due to their weir-like effect, and the resulting sand is placed onto a conveyor and stacked in a sand pile. The final product after processing is slightly more yellow than the silica sands found in the Lake Wales and south Florida mines (**Figure A.14**). Capacity for the purpose of sand nourishment in Broward County is not considered problematic as the Kauka mine expects to produce sand for at least 30 more years.

Figure A.14: Vulcan Kauka sand processing plant (left) and chemical plant (right). Notice the slightly yellow hue on the sand piles and high traffic areas.

A.4 Atlantic Coastal Ridge

The Atlantic Coastal Ridge mines are similar in trucking distance to Broward County when compared to the South Florida mines, one-way transport distances around 110 to 140 miles (**Figure A.15**). The sites along the Atlantic Coastal Ridge are mining the interbedded sands and limestones of the Anastasia Formation (Scott, 2001). Thick layers of limestone rock and overburden were removed at each mine to reach the sand deposits (**Figure A.16**). Given the variable nature of the Anastasia Formation, mines have produced siliclastic sand and a mixture of siliclastic sand and carbonates.

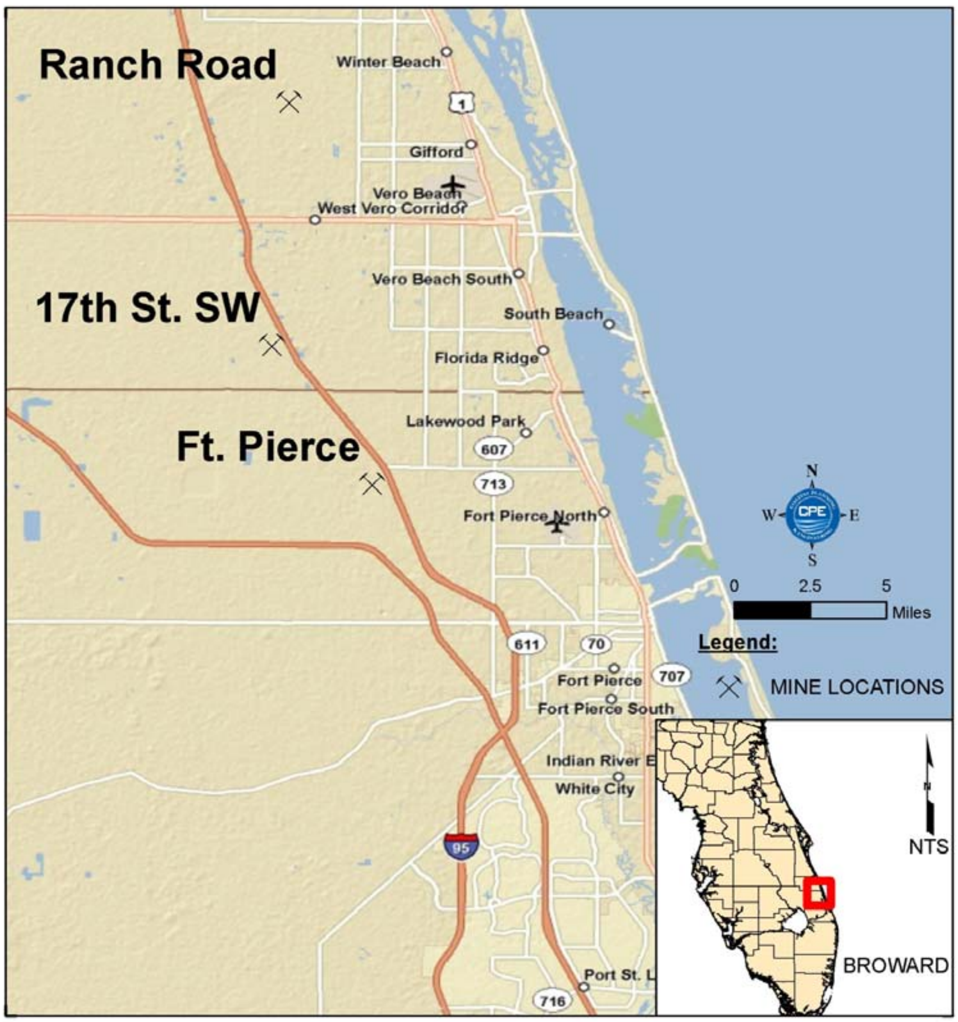


Figure A.15: Location of mines reviewed in the Atlantic Coastal Ridge region.

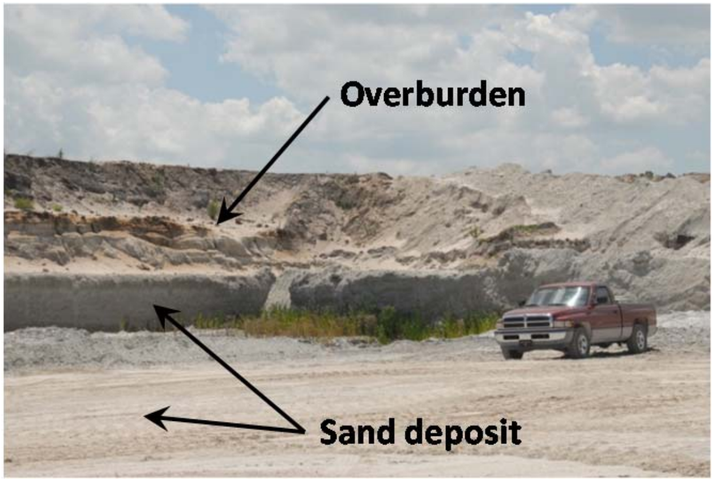


Figure A.16: The Stewart Ft. Pierce mine showing thick layers of overburden and limestone which were removed to expose the top of the sand deposit.

Fischer Ranch Road Lake

The Fischer Ranch Road Lake mine is located in central Indian River County (**Figure A.15**) and was recently used to complete a truck-haul project for a beach fill project in Indian River County. The sand is a mixture of siliclastics and carbonates mostly in the form of broken shells. The mine is owned by Ranch Road Lake LLC, but the production of beach quality sand is managed by Henry Fischer & Sons.

The material produced at the Ranch Road Lake site is mined by cutter-head dredge (**Figure A.17**). The dredged material is pumped to staging piles, and then loaded into Trommels. The Trommels are a dry system of rotating screens that removes the large and fine material. The sand is stacked in piles from which it is loaded into a truck via front end loaders.

Figure A.17: Fischer Ranch Road Lake mine with a cutter-head (left) and Trommel (right).

Fischer 17th St. SW

The Fischer 17th St. SW mine is located in southern Indian River County (**Figure A.15**). The sand is siliclastic with no carbonates. The mine was not active during the site visit, so the description below is based on conversations with Henry Fischer & Sons. The sample taken at the site was from remaining sand from a previous project after they cleaned the site. There is likely some overburden (dark topsoil) mixed with the sample taken.

The material produced at the 17th St. site is mined by cutter-head dredge. The dredged material is pumped to staging piles and loaded into Trommels using front end loaders. The Trommels are a dry system of rotating screens that removes the large and fine material. The sand is stacked in piles from which it is loaded into a truck via front end loaders.

Stewart Ft. Pierce

The Stewart Ft. Pierce mine is located in northern St. Lucie County (**Figure A.15**). The mine produces two types of sand: siliclastic only and a mixture of siliclastics and carbonates mostly in the form of broken shells. The siliclastic only samples were likely too fine for Broward County, thus samples were not taken. Samples were taken of the mixture of the siliclastics and carbonates, and the description below reflects this type of sand.

The material produced at the Ft. Pierce site is mined by a dragline excavator (**Figure A.18**). The dragline bucket dumps material into piles, and a front end loader transports the material to the processing plant. The processing plant first removes larger material using vibrating screens with spray bars. The sand is then fed into dewatering screws that remove remaining fines due to their weir-like effect. The resulting sand is placed onto a conveyor and stacked in piles from which it is loaded into a truck via front end loaders.

Figure A.18: Stewart Ft. Pierce mine with a dragline excavator (left) and the processing plant (right).

A.5 Sand Sample Processing Method and Results

The samples, 30 in total, were processed using mechanical sieve analysis conducted in accordance with American Society for Testing and Materials Standard Materials Designation D422-63 for particle size analysis of soils (ASTM, 2007). This method included the quantitative determination of the distribution of sand size particles. For sediment finer than the No. 230 sieve (4.0 phi), the ASTM Standard Test Method Designation D1140-00 was followed (ASTM, 2006). Mechanical sieving was accomplished using calibrated sieves with a gradation of half phi intervals. Additional sieves representing key ASTM sediment classification boundaries were included to meet Florida Department of Environmental Protection (FDEP) standards. Weights retained on each sieve were recorded cumulatively. Moist, dry and washed Munsell colors were also recorded during each stage of the sieve analysis under full spectrum lighting conditions.

Carbonate content was determined by percent weight for each sieved sample using the Construction Materials Engineering Council (CMEC) accredited testing method CPEHAT09. This method was adopted from the acid leaching methodology described in Twenhofel and Tyler (1941).

Following laboratory analysis, grain size data were entered into the gINT® software program, which computes the mean and median grain size, sorting, and silt/clay percentages for each sample using the moment method (Folk, 1974). A granularmetric report and a grain size distribution curve were compiled for each sample (**Section A.7)**.

Granularmetric reports and grain size distribution curves were prepared by Coastal Planning and Engineering, Inc. staff geologist in 2011. Laboratory analysis results of the 30 processed samples collected from the fourteen mines revealed 14 samples that met the sediment quality guidelines set forth in this report (**Table A.1, Section 3.1**)[10]. Since the cost of sand material at the construction jobsite is most influenced by the haul distance and the corresponding fuel costs, the table is sorted by vehicle distance from mine location to a central Broward County offload point. The Palm Ave. beach access and staging area (**Section 4.2)** was selected due to its central location of Segment II. Distances were determined using Google Earth Directions.

[10] The Stewart Ft. Pierce sample has a slightly lower moist Munsell *Value* (6) than recommended in the sediment quality guidelines (≥ 7). Stewart Ft. Pierce is included in the list of samples that fell within the range of the sediment quality guidelines because the sample's Munsell Value is only slightly outside the color range and all other sediment characteristics are well within the specified ranges.

Table A.1: Sand samples (14 total) analyzed from 30 upland sources for beach fill on Broward County's Segment II. Sediment samples that were considered appropriate based on established criteria for placement on the beach are in blue.

Company	Mine	Sample	Distance (mi)	Mean (mm)	Color (moist)	Sorting (φ)	% Fines (230)	% Gravel (4)	% Carb.	Price ($/cy)
Stewart Mining Industries	Ft. Pierce	Ft. Pierce*	110	0.46	2.5Y-6/2*	1.19	1.17	0	31	10
Stewart Mining Industries	Immokalee	Beach Sand	114	0.35	2.5Y-8/1	0.90	0.46	0	0	10
Stewart Mining Industries	Immokalee	Beach Sand #2	114	0.57	2.5Y-8/1	1.01	0.88	0	0	10
Vulcan Materials	Witherspoon	Witherspoon	114	0.59	2.5Y-8/1	0.61	0.22	0	0	12
E.R. Jahna	Ortona	Beach Sand C**	115	0.46	10YR-7/1	0.79	0.11	0	0.5	11
E.R. Jahna	Ortona	Mason	115	0.24	2.5Y-7/2	0.67	0.62	0	0	8
Cemex	Palmdale	FDOT Concrete	115	0.48	2.5Y-7/1	0.84	0.87	0.15	1	13
Cemex	Palmdale	Mason	115	0.32	2.5Y-5/3	0.74	1.61	0	0	4
Henry Fischer & Sons	17th St. SW	17th St. SW	120	0.36	2.5Y-5/3	0.65	0.42	0	0	17
Henry Fischer & Sons	Ranch Road Lake	Ranch Road	124	0.48	5Y-6/2	1.39	2.59	1.92	38	-
Florida Shell and Fill	Better Roads	3/16 Beach Sand	150	0.26	5Y-8/2	1.05	0.91	0	13	7
JJJ Enterprises	Farabee	Coarse Beach	153	0.18	5Y-7/3	1.21	3.77	0	14	10
JJJ Enterprises	Farabee	Fine Beach	153	0.14	5Y-8/1	0.60	2.72	0	4	8
Cemex	Lake Wales	FDOT Concrete	176	0.47	5Y-8/3	0.84	0.14	0	0	13
Cemex	Lake Wales	Commercial Concrete	176	0.30	5Y-8/3	0.80	0.3	0	1	12
Cemex	Lake Wales	Mason	176	0.27	5Y-8/2	0.64	0.23	0	0	9
CC Calhoun	Pit #1	White Sand	183	0.33	5Y-8/1	0.41	0.22	0	0	8
Cemex	Davenport	DEP Filter	206	0.62	2.5Y-8/2	0.71	0.24	0	2	30
Cemex	Davenport	Concrete	206	0.40	2.5Y-8/1	0.85	0.40	0	0	12
Cemex	Davenport	Commercial Concrete	206	0.42	2.5Y-8/1	0.90	0.37	0	0	11
Cemex	Davenport	Top Dressing	206	0.3	5Y-8/1	0.44	0.12	0	0	12
Cemex	Davenport	Mason	206	0.27	5Y-8/1	0.62	0.24	0	0	9
Cemex	Davenport	#7	206	0.17	5Y-8/1	0.48	0.31	0	0	4

Company	Mine	Sample	Distance (mi)	Mean (mm)	Color (moist)	Sorting (φ)	% Fines (230)	% Gravel (4)	% Carb.	Price ($/cy)
E.R. Jahna	Green Bay	Beach Sand C	213	0.43	2.5Y-8/1	0.92	0.75	0	0	13
E.R. Jahna	Green Bay	FDOT	213	0.41	5Y-8/1	0.79	0.16	0	0	12
E.R. Jahna	Green Bay	2nd Tailings	213	0.26	5Y-8/1	0.58	0.16	0	0	8
E.R. Jahna	Green Bay	Mason	213	0.18	2.5Y-8/1	0.41	0.47	0	0	8
Vulcan Materials	Keuka	301T Concrete	316	0.41	2.5Y-8/4	0.84	0.30	0	0	13
Vulcan Materials	Keuka	315 Conveyor	316	0.36	5Y-8/3	0.63	0.20	0	0	13
Vulcan Materials	Keuka	315	316	0.25	2.5Y-7/4	0.41	0.45	0	0	13

* The Stewart Ft. Pierce sample has a slightly lower moist Munsell *Value* (6) than recommended in the sediment quality guidelines (≥ 7). Stewart Ft. Pierce is included in the list of samples that fell within sediment quality guidelines because the sample's Munsell *Value* is only slightly darker than the color guideline and all other sediment characteristics are well within the sediment quality guidelines.

** The Jahna Ortona Beach Sand C sediment data was obtained directly from construction sediment samples collected as part of the recently completed truck-haul project in Hollywood Beach (CSI, 2012).

Fourteen samples are all finer (less than) than the sediment quality guideline mean grain size range, 0.35-0.65 mm, and should not be considered for Broward County beaches. These samples are: Cemex Palmdale Mason, Jahna Ortona Mason, Florida Shell and Fill 3/16 Beach Sand, JJJ Enterprises Farabee Coarse Beach and Fine Beach, Cemex Lake Wales Commercial Concrete and Mason, Cemex Davenport Top Dressing – Mason – and #7, Jahan Green Bay 2nd Tailings and Mason, and Vulcan Materials Keuka 315. No samples were larger than the maximum mean grain size of 0.65 mm.

Silt in excess of the 2% sediment quality guideline limit was found in three samples: Fischer Ranch Road Lake Ranch Road, JJJ Enterprises Farabee Coarse Beach, and JJJ Enterprises Farabee Fine Beach. The JJJ Enterprises' sand samples are both less than 0.19 mm and should not be considered for Broward County beaches. The Fischer Ranch Road Lake mine recently completed a beach project in Indian River County with fill that had silt contents less than 2%. The Fischer Ranch Road sand, however, also has a Munsell color *Value* darker than the sediment quality guidelines so it is not a recommended source Broward County should consider.

No samples exceeded the gravel content limit of 5%. Only two samples retained material larger than the #4 sieve: Cemex Palmdale FDOT Concrete (0.15%) and Fischer Ranch Road Lake Ranch Road (1.92%).

There were four samples that had moist Munsell *Values* less than 7: Stewart Ft. Pierce, Cemex Palmdale Mason, Fischer 17th St. SW, and Fischer Ranch Road. The Stewart Ft. Pierce sand fulfills all other sediment quality guidelines and has a moist Munsell *Value* of 6, but a dry

Value of 7. Stewart Ft. Pierce should be considered as a possible upland sand source and tested further if selected. The Cemex Palmdale Mason sand has a moist Munsell *Value* of 5 and also has a mean grain size finer than the sediment quality guidelines, so it is not a recommended source that Broward County should consider. The Fischer 17th St. SW sand fulfills all other sediment quality guidelines and has a moist Munsell *Value* of 5, but a dry *Value* of 6 and a washed *Value* of 8. The relatively low moist Munsell *Value* is likely due to the mine not being active when the sample was taken. There appeared to be topsoil mixed with the sample that would not be included in sand provided to the County. Fischer 17th St. SW could be considered as a possible upland sand source if testing while the mine is active showed compliance with the color guidelines, but with the current un-active state of the mine and a sample that has a moist Munsell *Value* of 5, the source is considered too dark for Broward County beaches and is therefore not recommended. The Fischer Ranch Road sand has a moist Munsell *Value* of 6 and also has a fines content greater than the sediment quality guidelines, so it is not a recommended source that Broward County should consider.

It is also noted that the Cemex Palmdale sample is representative of sediments from that mine which are commonly a little darker in color than the other noted sources. It is understood that, often, sand from the Palmdale mine is tested for color and when the material color does not meet a particular specification, the material is washed/scrubbed with a sodium hydroxide solution (50% NaOH in water). It is expected that sand from the Palmdale mine may need to be treated in this manner if used as a source along the Segment II beaches. It is not clear how this process will impact the material costs. Also, it is not clear if there would be regulatory issues related to concerns about the effect of the sand treatment may have upon the marine environment. Likewise, the Cemex Davenport mine will also apply chemicals to their sand if the material does not meet color requirements. It is unclear whether the Davenport samples collected, all with moist Munsell *Values* of 8,were treated by chemicals during the processing of the material.

Carbonate content is not addressed in the sediment quality guidelines. Nonetheless, two samples returned relatively high carbonate values: Stewart Ft. Pierce (31%) and Fischer Ranch Road (38%). While relatively high compared to other upland sources, the aforementioned samples have lower carbonate contents than the native beach (51.6% for 2011 study, 55.8% for 1999 study).

Table A.3 lists the recommendations for Broward County upland sand sources. There are three categories: *recommended*, *recommended with reservations*, and *not recommended*. The *recommended* sand sources meet the sediment quality guidelines (**Table A.2)** and are located within a viable trucking distance to Broward County beaches (within 135 miles[11]). Sources that

[11] See **Figure 7.1** and accompanying discussion in **Section 7.0** for assessment of reasonable trucking distance to Broward County beaches.

are *recommended with reservations* are sand sources that may be suitable for Broward County beaches, but other parameters need to be scrutinized before selection. *Not recommended* sources either did not meet the sediment quality guidelines or were determined to be too far from Broward County without direct rail capability.

Table A.3: Summary of suitability of the various upland sediments considered for the Broward County Segment II project.

Company	Mine	Sample	Status	Issues
Stewart Mining Industries	Immokalee	Beach Sand	Recommended	
Stewart Mining Industries	Immokalee	Beach Sand #2	Recommended	
Vulcan Materials	Witherspoon	Witherspoon	Recommended	
E.R. Jahna	Ortona	Beach Sand C	Recommended	
Stewart Mining Industries	Ft. Pierce	Ft. Pierce	Recommended with Reservations	Slightly darker color
Cemex	Palmdale	FDOT Concrete	Recommended with Reservations	Slightly darker color - Chemical application
Cemex	Davenport	Concrete	Recommended with Reservations	Trucking distance too far - Rail option available Chemical application
Cemex	Davenport	Commercial Concrete	Recommended with Reservations	Trucking distance too far - Rail option available Chemical application
Henry Fischer & Sons	17^{th} St. SW	17^{th} St. SW	Not Recommended	Color
Henry Fischer & Sons	Ranch Road Lake	Ranch Road	Not Recommended	Color and Fines
E.R. Jahna	Ortona	Mason	Not Recommended	Grain Size
Cemex	Palmdale	Mason	Not Recommended	Grain Size and Color
Florida Shell and Fill	Better Roads	3/16 Beach Sand	Not Recommended	Grain Size and Distance
JJJ Enterprises	Farabee	Coarse Beach	Not Recommended	Grain Size, Fines, Distance
JJJ Enterprises	Farabee	Fine Beach	Not Recommended	Grain Size, Fines, Distance
Cemex	Lake Wales	FDOT Concrete	Not Recommended	Distance
Cemex	Lake Wales	Commercial Concrete	Not Recommended	Grain Size and Distance
Cemex	Lake Wales	Mason	Not Recommended	Grain Size and Distance
CC Calhoun	Pit #1	White Sand	Not Recommended	Grain Size, Quality, Distance
Cemex	Davenport	DEP Filter	Not Recommended	Cost and Distance
Cemex	Davenport	Top Dressing	Not Recommended	Grain Size and Distance
Cemex	Davenport	Mason	Not Recommended	Grain Size and Distance
Cemex	Davenport	#7	Not Recommended	Grain Size and Distance
E.R. Jahna	Green Bay	Beach Sand C	Not Recommended	Distance
E.R. Jahna	Green Bay	FDOT	Not Recommended	Distance
E.R. Jahna	Green Bay	2nd Tailings	Not Recommended	Grain Size and Distance
E.R. Jahna	Green Bay	Mason	Not Recommended	Grain Size and Distance
Vulcan Materials	Keuka	301T Concrete	Not Recommended	Distance
Vulcan Materials	Keuka	315 Conveyor	Not Recommended	Distance
Vulcan Materials	Keuka	315	Not Recommended	Grain Size and Distance

A.6 Discussion

Each mine operator stressed that lead time is extremely important and Broward County could realize a cost savings if the operator(s) knew six months to one year in advance that sand was needed. The extra time allows the mine to meet the quantities that will be required during the short installation windows allowed by the permitting agencies. Since the beach nourishment industry is a small portion of the mines' business, they do not want to jeopardize business relationships with long-term continuous customers to meet the demand of a one-time project. Additional time allows for the mines to prepare accordingly and will result in more mines bidding on projects. If a short timeline is required, then multiple mines will likely be needed to produce large quantities.

Broward County upland sand could be customized depending on the source pit and the type of processing plant. The samples obtained in this study are sediments that some pits designed to be FDEP-approvable beach sand or the type of sand utilized for another industry (e.g., concrete). Some processing plants have the ability to separate sand by grain sizes and remix the classified sediments to the client's specifications. There are essentially two types of borrow pit processing plants: top-bottom plants and classifying plants. The top-bottom plants remove the coarse and fine grains, leaving only grains above and below a specified threshold largely determined by screens and dewatering screws. The classifying plants (Table A.3) take an additional step of separating the sand into multiple grain sizes. This allows the plants to provide a final product which meet strict FDOT regulations for concrete and road material. The same can be done for Broward County as long as the mine can locate other users for the omitted material.

Table A.3: Classification plants

Company	**Mine**
Stewart Mining Industries	Immokalee
Vulcan Materials	Witherspoon
Cemex	Palmdale
E.R. Jahna	Ortona
Cemex	Davenport
E.R. Jahna	Green Bay
Vulcan Materials	Keuka

Classification plants also have the ability to make more homogeneous final products. When analyzing the raw material mined from an upland sand source pit, the distribution of sediment grain sizes is large (poorly sorted). When observed on a histogram, the distribution has large tails that account for the fine and large grains. Top-bottom plants essentially remove the fine and large grains for their final product. Additionally, these plants can narrow the gradation generating a more homogenous, well sorted, final product.

Two plants (Cemex Palmdale and Cemex Davenport) apply chemicals to their sand if the material does not meet color requirements; this treatment essentially bleaches the sand product.. Determination of how chemicals applied to sediment affect the marine and nearshore coastal environment is beyond the scope of this study, however as the application of chemicals to essentially bleach sand may have unknown potential effects to Broward County beaches this aspect should be researched further.

Two plants (Cemex Davenport and Vulcan Keuka) located beyond a reasonable trucking distance have rail capabilities. The Cemex Davenport site possesses a fully functional rail line in which material can be directly loaded into rail cars. Rail capability at the site could make this a feasible and cost-effective option. Uncertainties with rail transport may, however, impact the ultimate feasibility of this approach for the for the Broward County Segment II project. As the Vulcan Keuka plant has not used their rail facilities for a while and would require major restoration to allow for functional rail transport, this option is not considered at the present time.

At the time of this study, most mines provided similar costs for their sand. In general, costs range between \$8 and \$13 dollars per cubic yard. One sand type was quoted to be \$30 per cubic yards from the Cemex Davenport mine. This sand, however, is a special DEP Filter specification that will not be required for the Segment II beach project. The mines provided costs based on current prices and the assumption that approximately 200,000 cubic yards (~270,000 tons) would be purchased. Transportation costs are not included in the unit cost. Costs from Fischer Ranch Road Lake were not available during this study. Ultimately, sand costs at the time of the project may vary depending on timing and volume. Higher volumes and longer time requirement for producing the sand will yield lower prices. Multi-year contracts are preferred by the mines and can also decrease sand source costs.

Appendix B:

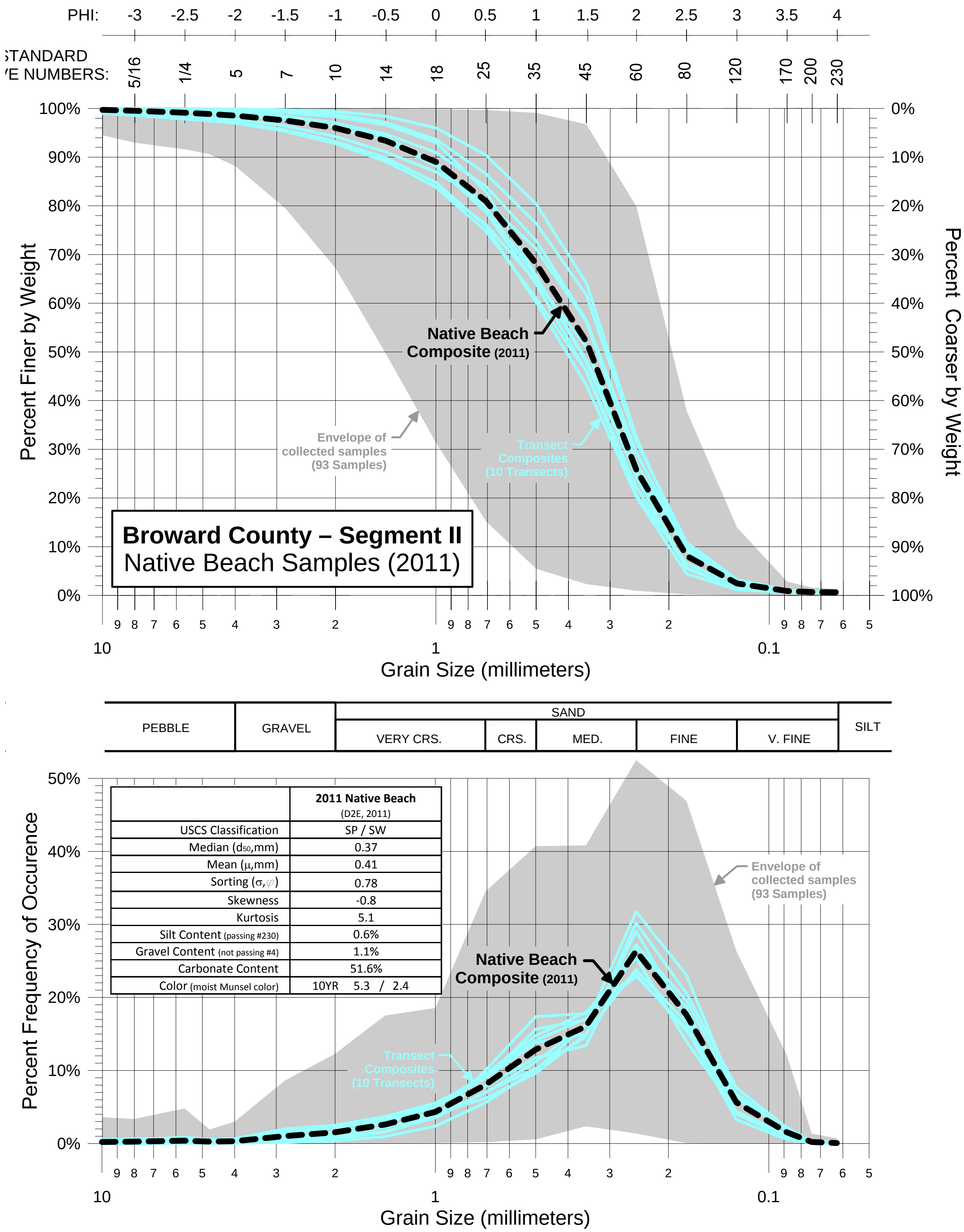
Sediment Quality Guidelines

Knowledge of the sediment characteristics of the beach requiring nourishment allows definition of acceptable quality characteristics for the project's sand source. Matching the nourishment sand to the pre-project native beach sand preserves the beach's integrity, appearance, physical stability, equilibrium shape, and suitability as habitat. Specific sediment characteristics of interest include mean grain size, sorting, silt content, gravel content, carbonate content, and moist Munsell color. The Segment II beaches generally contain a mixture of silica and calcium carbonate sand with negligible organic content. The typical mean grain size ranges between 0.2 and 0.7 mm. The larger grain sizes in this range consist primarily of shell fragments. The beaches typically have low silt content (on the order of 1%) and appear light yellow or light gray in color with a slight tan or orange cast to it (predominantly moist Munsell *Value* 5 – 7 and *Chroma* 1 – 3).

Table B.1 displays typical sediment characteristics from two native beach studies of the Segment II native beach: (1) from samples collected in 1999 as part of the Broward County General Reevaluation Report (USACE, 2003), and (2) from samples collected in 2011 by Coastal Planning and Engineering, Inc. and analyzed in the laboratory by Down-to-Earth Geotechnical Consulting, Inc. (D2E, 2011). **Figure B.1** displays the composite grain size distribution (GSD) curve for samples collected as part of the 2011 study. A composite GSD curve for the 1999 study was unavailable. Geotechnical data from the 2011 study will be utilized in this report.

Table B.1: Sediment characteristics of the Broward County – Segment II native beach.

	Broward County Native Segment II Sediments (1999)	**Broward County** Native Segment II Sediments (2011)
Mean Grain Size (mm)	0.31	0.41
Sorting (φ)	0.77	0.78
Silt Content (passing #230 sieve)	1.5%	0.6%
Gravel Content (not passing #4 sieve)	1.4%	1.1%
Color (moist Munsell color)	Nearly white to gray that has a slight tan or orange cast to it. (no Munsell color was asssigned as part of the 1999 study)	10YR 5.3 / 2.4
Carbonate Content	55.8%	51.6%
Source	Data from SEA, May 1999 (USACE GRR, 2003 - Appendix E)	Collected by CPE, May/June 2011 Analyzed by D2E, August 2011



	2011 Native Beach (D2E, 2011)
USCS Classification	SP / SW
Median (d_{50},mm)	0.37
Mean (μ,mm)	0.41
Sorting (σ,φ)	0.78
Skewness	-0.8
Kurtosis	5.1
Silt Content (passing #230)	0.6%
Gravel Content (not passing #4)	1.1%
Carbonate Content	51.6%
Color (moist Munsel color)	10YR 5.3 / 2.4

Figure B.1: Sediment grain size distribution data for native beach sediments samples in 2011. The figure includes the envelope created from all available data, composite grain size curves for each transect, and a representative composite grain size curve for all samples collected.

A proposed sediment quality guideline was developed from the native beach sediment statistics and information from proposed/completed truck-haul beach fill projects in the Southeast. **Table B.2** displays these specifications assembled from various projects (FDEP website). It is noted that the representative Segment II sediments fall within the ranges of the various specifications.

Table B.2: Sediment quality guidelines from other Southeast Florida projects.

	Hallandale Beach Interim Beach Renourishment Project	**Hollywood** Interim Beach Renourishment Project	**Hillsboro Beach** Truck Haul Renourishment Project	**Miami** Truck Haul Nourishment	**Town of Palm Beach** Phipps FEMA Project and Reach 8	**Town of Palm Beach** South End Palm Beach Restoration
Mean Grain Size (mm)	0.45 - 0.65 (Bch Sed Anal) 0.35 - 0.65 (Sed. QA/QC)	0.45 - 0.65	0.45 - 0.65	0.30 - 0.55	0.35 - 0.55	-
Sorting (φ)	none specified	none specified	none specified	none specified	none specified	none specified
Silt Content (passing #230 sieve)	< 2%	< 2%	< 2%	< 5%	< 1.5%	< 2%
Gravel Content (not passing #4 sieve)	< 5%	< 5%	< 5%	< 5%	< 2%	< 5%
Color (allowable moist Munsell color Value)	Value: 6 or lighter (6 or higher)	Value: 6 or lighter (6 or higher)	Value: 6 or lighter (6 or higher)	Hue of: 2.5-10YR or 2.5-5Y Chroma: 3 or lighter (3 or lower) Value: 6 or lighter (6 or higher)	Value: 7 or lighter (7 or higher)	Value: 7 or lighter (7 or higher)
Source	Beach Sediment Analysis (Nov 24, 2009) Sediment QA/QC (Jan 6, 2010)	Beach Sediment Analysis (Oct 30, 2009) Sediment QA/QC (Jul 20, 2010)	Sediment QA/QC (approved May 23, 2008)	Specifications (effective date Dec 4, 2002) Sediment QA/QC (approved Aug 26, 2009)	Sediment QA/QC (approved Dec 12, 2009)	Sediment QA/QC (Sep 28, 2010)

Table B.3 displays the sediment quality guidelines proposed for a sand source used as beach fill along the Broward County – Segment II shoreline. Critical values for the analyzed samples are mean grain size, silt content, gravel content, and color. The sediment quality guidelines take into account native (existing) beach sediment conditions and are values which may reasonably be attained given what is known about potential sand sources.

Table B.3: Proposed sediment quality guidelines for the Segment II project.

Sediment Parameter	Compliance Value
Mean Grain Size (mm)	0.35 - 0.65
Silt Content (passing #230 sieve)	< 2%
Gravel Content (not passing #4 sieve)	< 5%
Color (allowable moist Munsell color Value)	≥ 7

It is noted that *gravel content* is specified in **Table B.3**. Specifically, this value is the percentage of material (by weight) that is greater than the #4 sieve (4.76 mm). The specification, percentage of material greater than the #4 sieve, does not directly address the mineralogical carbonate content. Following FDEP guidance outline in the QC/QA Plan template for upland sources, "shell content is used as the indicator of fine gravel content for the implementation of QC/QA procedures."

The mineralogical carbonate content is not directly addressed by the sediment quality guidelines. However, the proposed material shall be composed of quartz and/or calcium carbonate with no more than five percent sand of other mineralogical composition.

The sorting or gradation of the proposed material is also not directly addressed in the sediment quality guidelines. However, a specified gradation can include just the smallest and/or largest particles to guard against overly fine or coarse material, respectively. This is also addressed by the silt and gravel content.

Appendix C:

Granularmetric Report and Grain Size Distribution Curves for Upland Sand Mines Samples

Granularmetric Report

Depths and elevations based on measured values

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
ph (561) 391-8102
fax (561) 391-9116

Project Name:	Upland Sand Sources
Sample Name:	17th St SW
Analysis Date:	05-11-11
Analyzed By:	JR

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-5/3 Dry - 2.5Y-6/2 Washed - 2.5Y-8/1	Henry Fischer & Sons

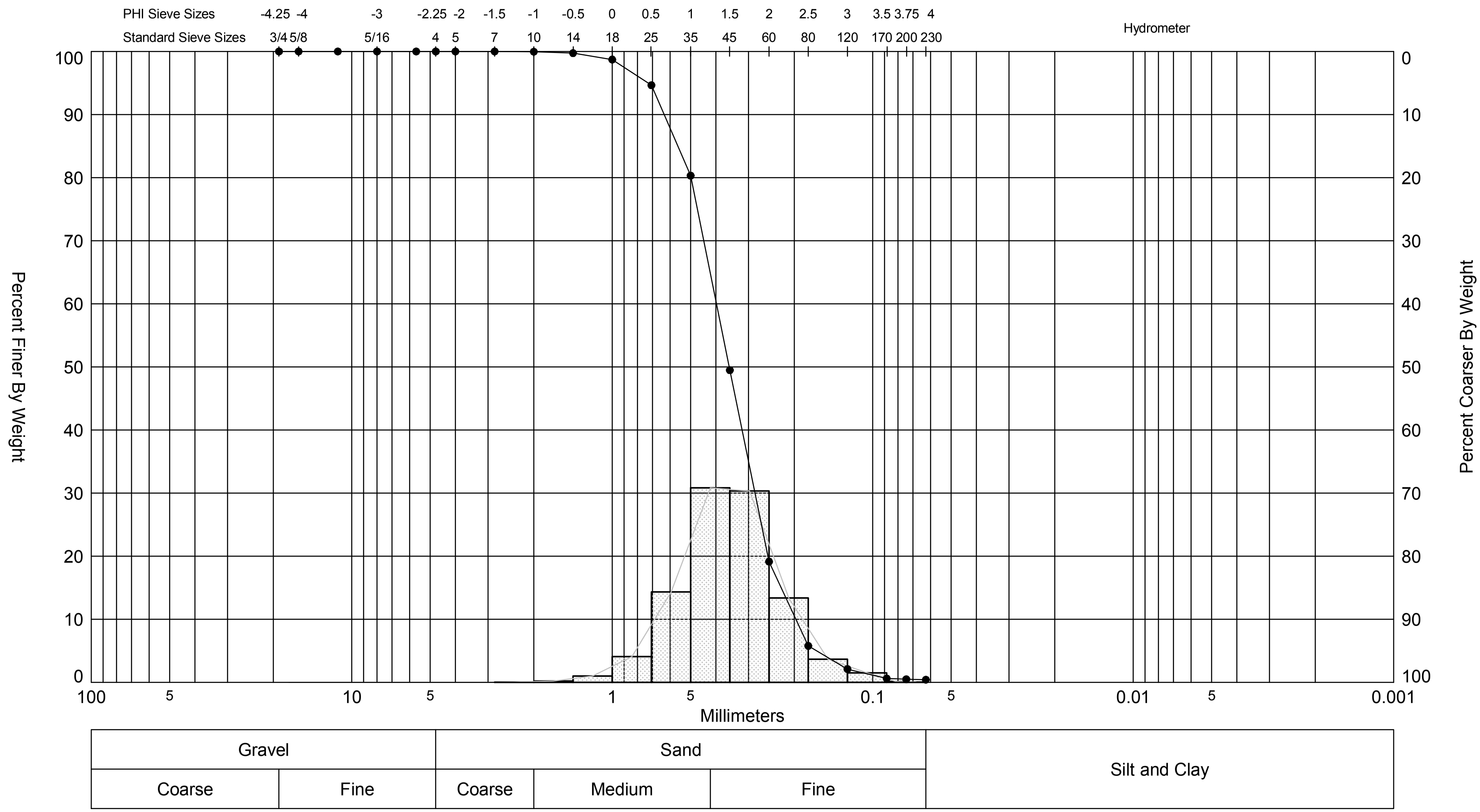
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
113.86	113.40	0.01	0.00	#200 - 0.48 #230 - 0.42		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.05	0.04	0.05	0.04
14	-0.50	1.41	0.25	0.22	0.30	0.26
18	0.00	1.00	1.16	1.02	1.46	1.28
25	0.50	0.71	4.63	4.07	6.09	5.35
35	1.00	0.50	16.32	14.33	22.41	19.68
45	1.50	0.35	35.11	30.84	57.52	50.52
60	2.00	0.25	34.55	30.34	92.07	80.86
80	2.50	0.18	15.21	13.36	107.28	94.22
120	3.00	0.13	4.19	3.68	111.47	97.90
170	3.50	0.09	1.70	1.49	113.17	99.39
200	3.75	0.07	0.15	0.13	113.32	99.52
230	4.00	0.06	0.07	0.06	113.39	99.58

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.61	2.12	1.90	1.49	1.09	0.87	0.46

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.49	0.36	0.65	0.03	3.7



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
17th St SW	—●—		SP	#200 - 0.48 #230 - 0.42		0	1.49	1.49	0.03	3.7	0.65

Comments: Henry Fischer & Sons

Depths and elevations based on measured values

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
ph (561) 391-8102
fax (561) 391-9116

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report

Depths and elevations based on measured values

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
ph (561) 391-8102
fax (561) 391-9116

Project Name: Upland Sand Sources

Sample Name: 3/16 Beach Sand

Analysis Date: 06-29-11

Analyzed By: JR

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 5Y-8/2 Dry - 5Y-8/1 Washed - 5Y-8/1	Better Roads, Florida Shell and Fill Co.

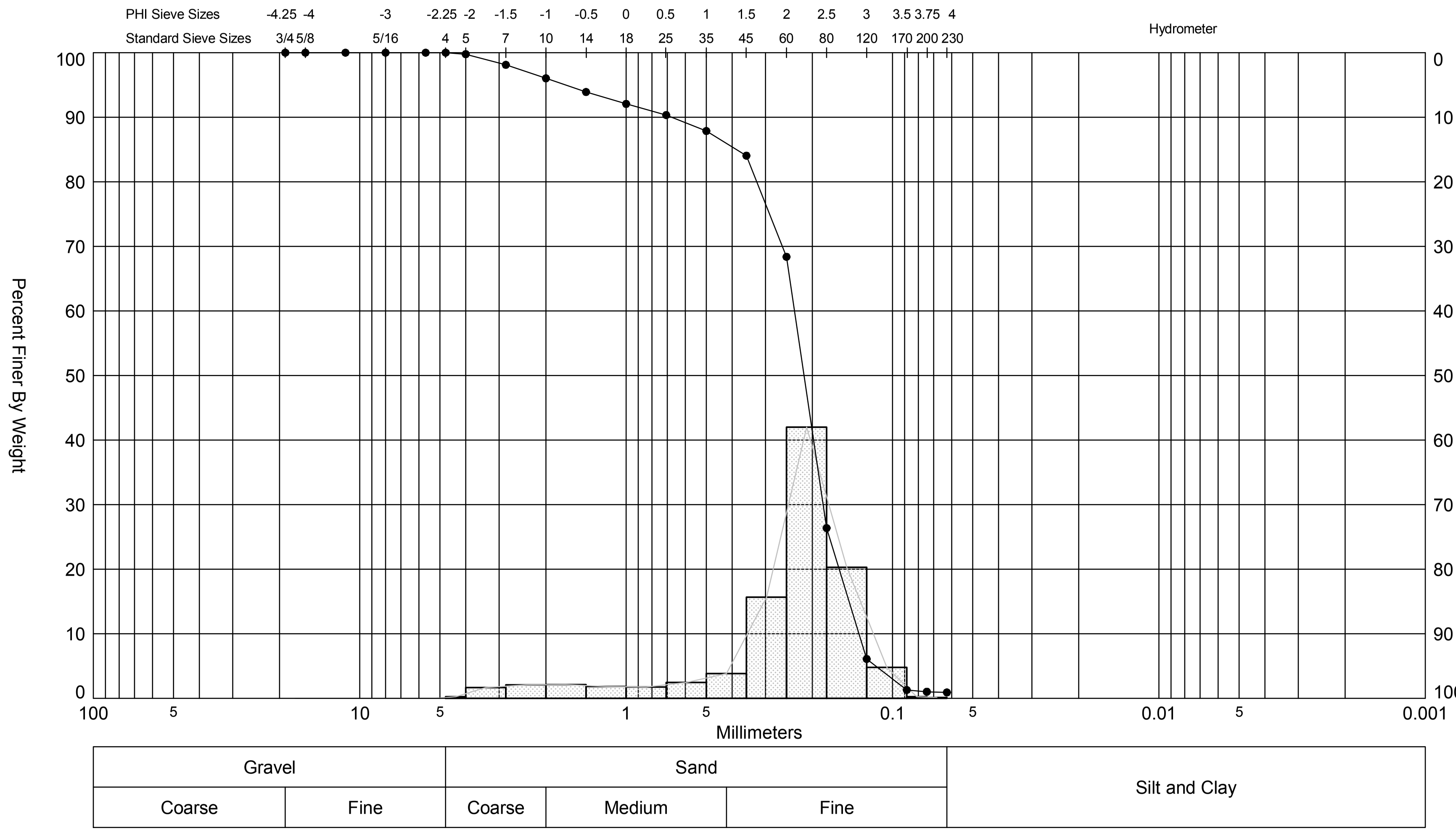
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
121.52	120.53	0.06	0.06	#200 - 1.02 #230 - 0.91		13	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.28	0.23	0.28	0.23
7	-1.50	2.83	2.00	1.65	2.28	1.88
10	-1.00	2.00	2.54	2.09	4.82	3.97
14	-0.50	1.41	2.58	2.12	7.40	6.09
18	0.00	1.00	2.24	1.84	9.64	7.93
25	0.50	0.71	2.10	1.73	11.74	9.66
35	1.00	0.50	3.00	2.47	14.74	12.13
45	1.50	0.35	4.64	3.82	19.38	15.95
60	2.00	0.25	19.04	15.67	38.42	31.62
80	2.50	0.18	51.05	42.01	89.47	73.63
120	3.00	0.13	24.64	20.28	114.11	93.91
170	3.50	0.09	5.83	4.80	119.94	98.71
200	3.75	0.07	0.33	0.27	120.27	98.98
230	4.00	0.06	0.13	0.11	120.40	99.09

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.11	2.76	2.53	2.22	1.79	1.50	-0.76

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.96	0.26	1.05	-1.92	6.63



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
3/16 Beach Sand	—●—		SW	#200 - 1.02 #230 - 0.91		13	2.22	1.96	-1.92	6.63	1.05

Comments: Better Roads, Florida Shell and Fill Co.

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Coastal Planning & Engineering
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Granularmetric Report

Depths and elevations based on measured values

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
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fax (561) 391-9116

Project Name:	Upland Sand Sources
Sample Name:	Beach Sand
Analysis Date:	05-11-11
Analyzed By:	JR

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 2.5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Stewart Mining Industries, Immokalee

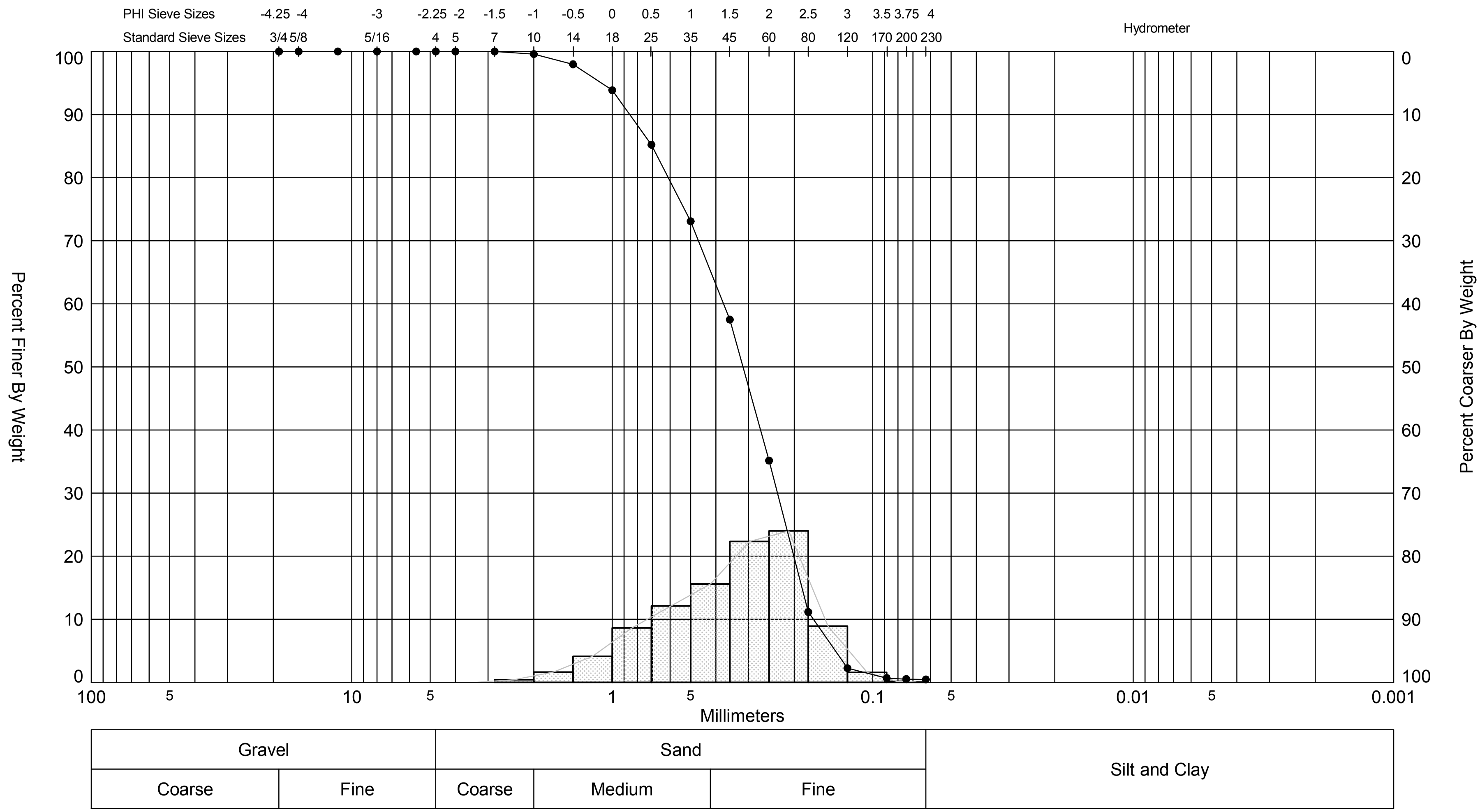
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
121.41	120.95	0.02	0.06	#200 - 0.52 #230 - 0.46		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.50	0.41	0.50	0.41
14	-0.50	1.41	1.97	1.62	2.47	2.03
18	0.00	1.00	4.99	4.11	7.46	6.14
25	0.50	0.71	10.49	8.64	17.95	14.78
35	1.00	0.50	14.73	12.13	32.68	26.91
45	1.50	0.35	18.93	15.59	51.61	42.50
60	2.00	0.25	27.14	22.35	78.75	64.85
80	2.50	0.18	29.14	24.00	107.89	88.85
120	3.00	0.13	10.80	8.90	118.69	97.75
170	3.50	0.09	1.91	1.57	120.60	99.32
200	3.75	0.07	0.19	0.16	120.79	99.48
230	4.00	0.06	0.07	0.06	120.86	99.54

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.85	2.40	2.21	1.67	0.92	0.55	-0.14

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.52	0.35	0.9	-0.53	2.83



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Beach Sand	—●—		SW	#200 - 0.52 #230 - 0.46		0	1.67	1.52	-0.53	2.83	0.9

Comments: Stewart Mining Industries, Immokalee

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Beach Sand #2

Analysis Date: 08-30-11

Analyzed By: LC

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
ph (561) 391-8102
fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 2.5Y-7/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	Steward Mining Industries, Immokalee

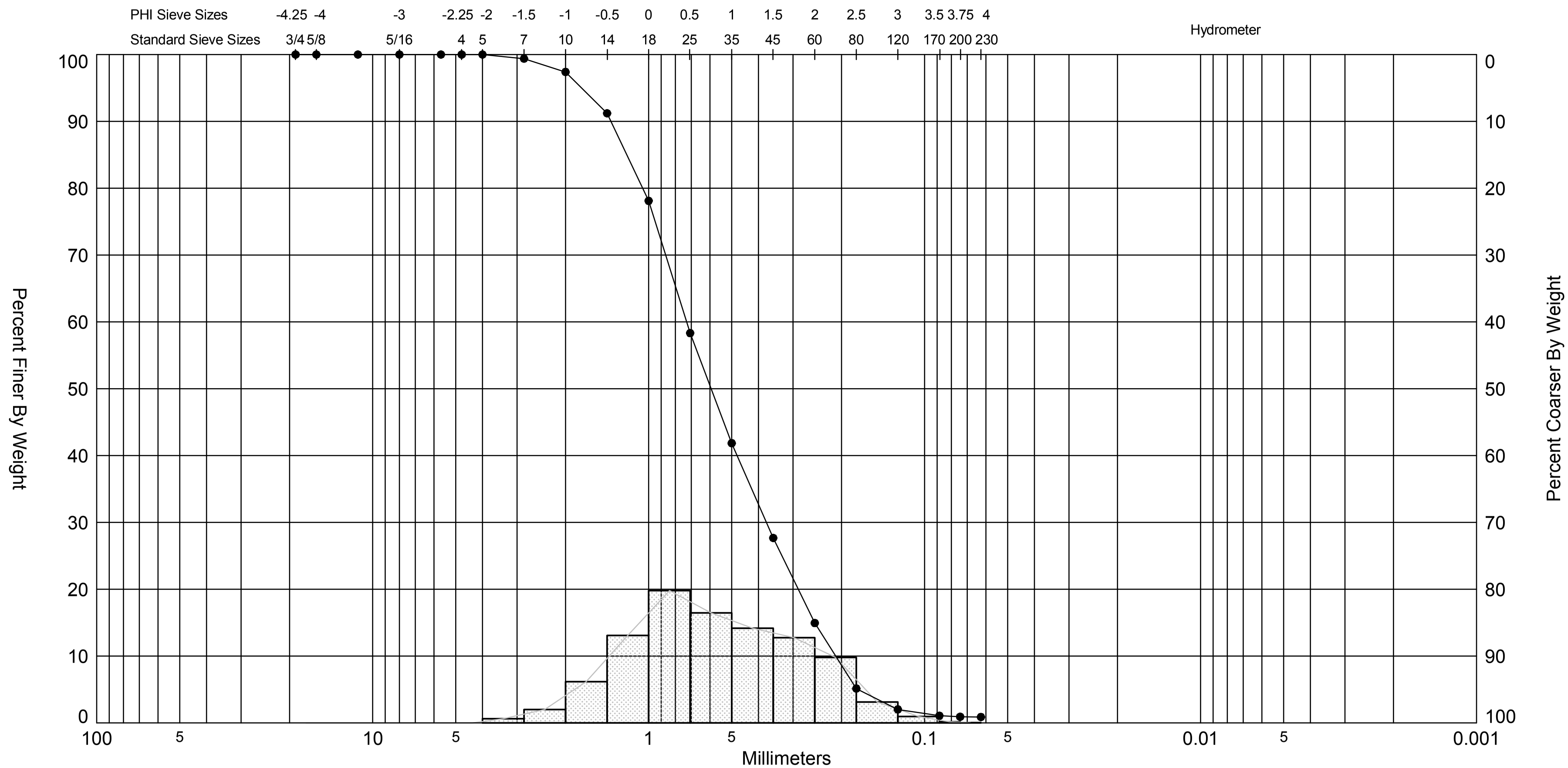
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
118.41	117.50	0.02	0.09	#200 - 0.92 #230 - 0.88		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.72	0.61	0.72	0.61
10	-1.00	2.00	2.37	2.00	3.09	2.61
14	-0.50	1.41	7.32	6.18	10.41	8.79
18	0.00	1.00	15.51	13.10	25.92	21.89
25	0.50	0.71	23.43	19.79	49.35	41.68
35	1.00	0.50	19.50	16.47	68.85	58.15
45	1.50	0.35	16.79	14.18	85.64	72.33
60	2.00	0.25	15.07	12.73	100.71	85.06
80	2.50	0.18	11.61	9.80	112.32	94.86
120	3.00	0.13	3.70	3.12	116.02	97.98
170	3.50	0.09	1.12	0.95	117.14	98.93
200	3.75	0.07	0.18	0.15	117.32	99.08
230	4.00	0.06	0.05	0.04	117.37	99.12

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.52	1.96	1.60	0.75	0.08	-0.22	-0.81

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	0.81	0.57	1.01	0.12	2.49



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Beach Sand #2	—●—		SW	#200 - 0.92 #230 - 0.88		0	0.75	0.81	0.12	2.49	1.01

Comments: Steward Mining Industries, Immokalee

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	08-30-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources
Sample Name: Davenport-#7
Analysis Date: 05-10-11
Analyzed By: JR

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Cemex

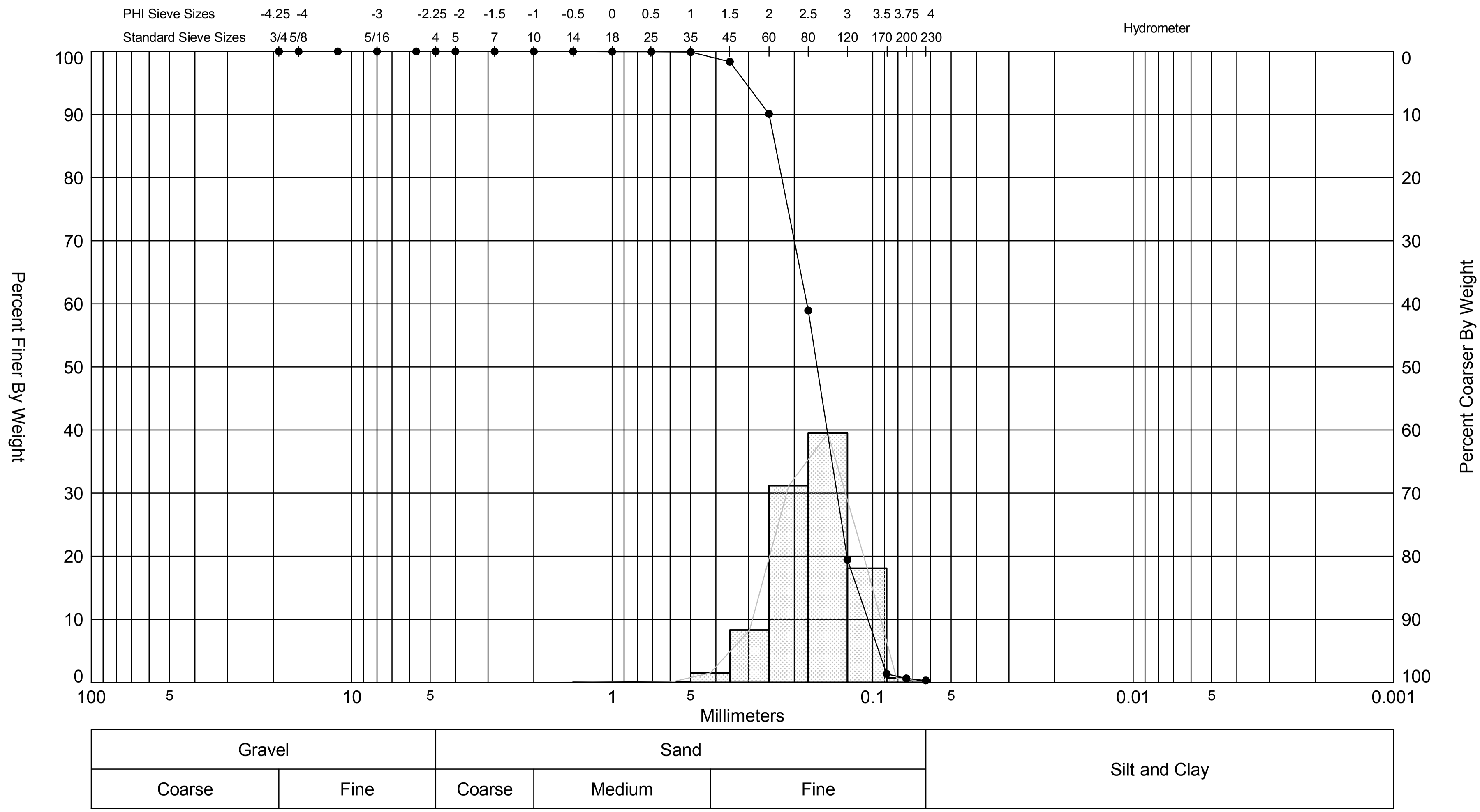
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
125.97	125.72	0.11	0.02	#200 - 0.62 #230 - 0.31		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.00	0.00	0.00	0.00
18	0.00	1.00	0.04	0.03	0.04	0.03
25	0.50	0.71	0.01	0.01	0.05	0.04
35	1.00	0.50	0.08	0.06	0.13	0.10
45	1.50	0.35	1.92	1.52	2.05	1.62
60	2.00	0.25	10.43	8.28	12.48	9.90
80	2.50	0.18	39.25	31.16	51.73	41.06
120	3.00	0.13	49.76	39.50	101.49	80.56
170	3.50	0.09	22.80	18.10	124.29	98.66
200	3.75	0.07	0.91	0.72	125.20	99.38
230	4.00	0.06	0.39	0.31	125.59	99.69

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.40	3.10	2.93	2.61	2.24	2.10	1.70

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.59	0.17	0.48	-0.36	3.34



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Davenport-#7	——●——		SP	#200 - 0.62 #230 - 0.31		0	2.61	2.59	-0.36	3.34	0.48

Comments: Cemex

Depths and elevations based on measured values

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Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report Depths and elevations based on measured values	Coastal Planning & Engineering 2481 NW Boca Raton Blvd, Boca Raton FL 33431 ph (561) 391-8102 fax (561) 391-9116
Project Name: Upland Sand Sources	
Sample Name: Davenport-Concrete	
Analysis Date: 05-10-11	
Analyzed By: JR	

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Cemex

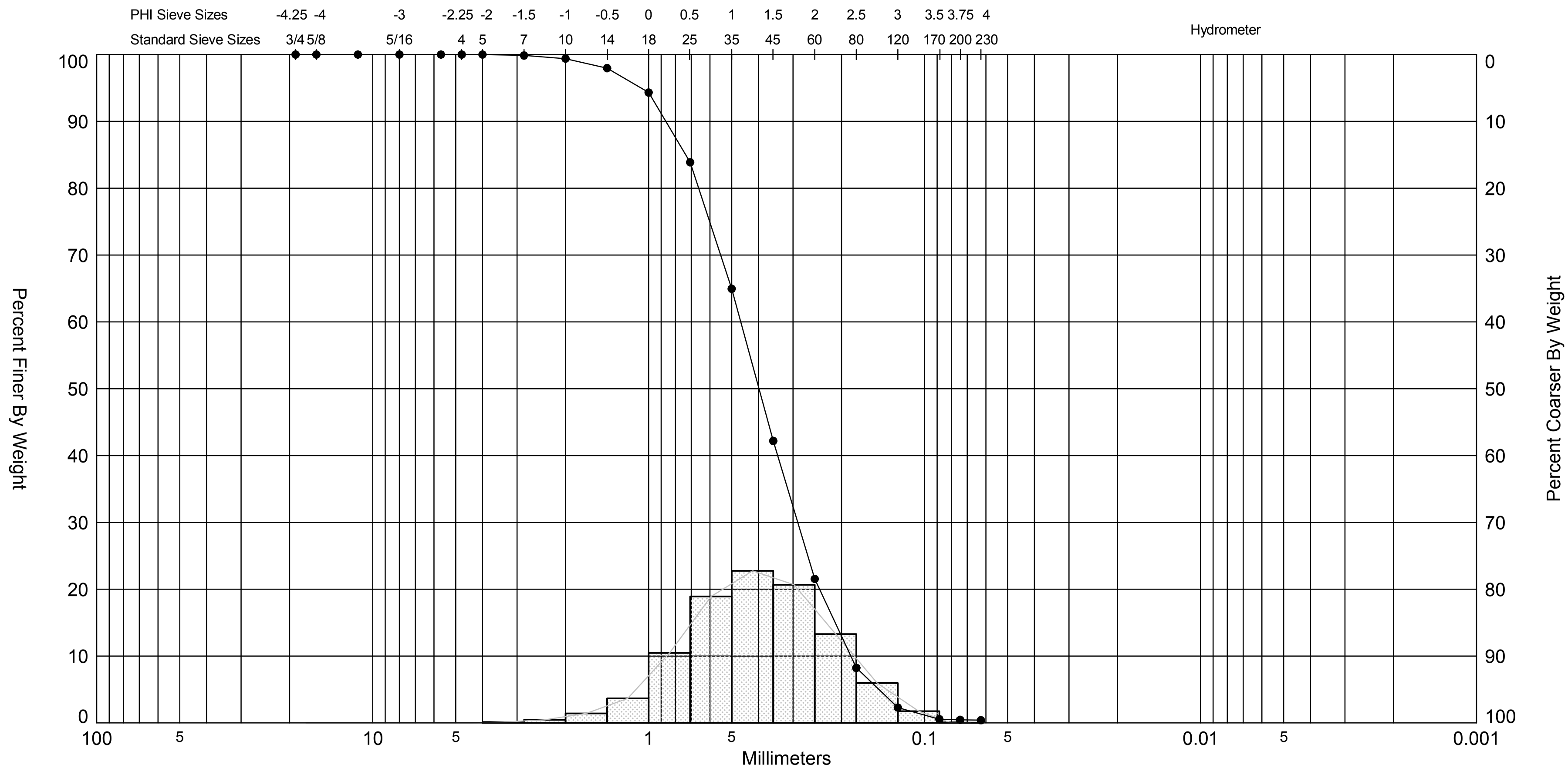
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
131.31	131.17	0.11	0.21	#200 - 0.45 #230 - 0.40		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.18	0.14	0.18	0.14
10	-1.00	2.00	0.62	0.47	0.80	0.61
14	-0.50	1.41	1.86	1.42	2.66	2.03
18	0.00	1.00	4.79	3.65	7.45	5.68
25	0.50	0.71	13.71	10.44	21.16	16.12
35	1.00	0.50	24.86	18.93	46.02	35.05
45	1.50	0.35	29.89	22.76	75.91	57.81
60	2.00	0.25	27.12	20.65	103.03	78.46
80	2.50	0.18	17.48	13.31	120.51	91.77
120	3.00	0.13	7.80	5.94	128.31	97.71
170	3.50	0.09	2.28	1.74	130.59	99.45
200	3.75	0.07	0.13	0.10	130.72	99.55
230	4.00	0.06	0.06	0.05	130.78	99.60

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.77	2.21	1.92	1.33	0.73	0.49	-0.09

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.32	0.40	0.85	-0.16	3.05



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Davenport-Concrete	—●—		SP	#200 - 0.45 #230 - 0.40		0	1.33	1.32	-0.16	3.05	0.85

Comments: Cemex

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Davenport-Comm. Con.

Analysis Date: 06-29-11

Analyzed By: LC

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 2.5Y-8/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	CEMEX Davenport-Commercial Concrete

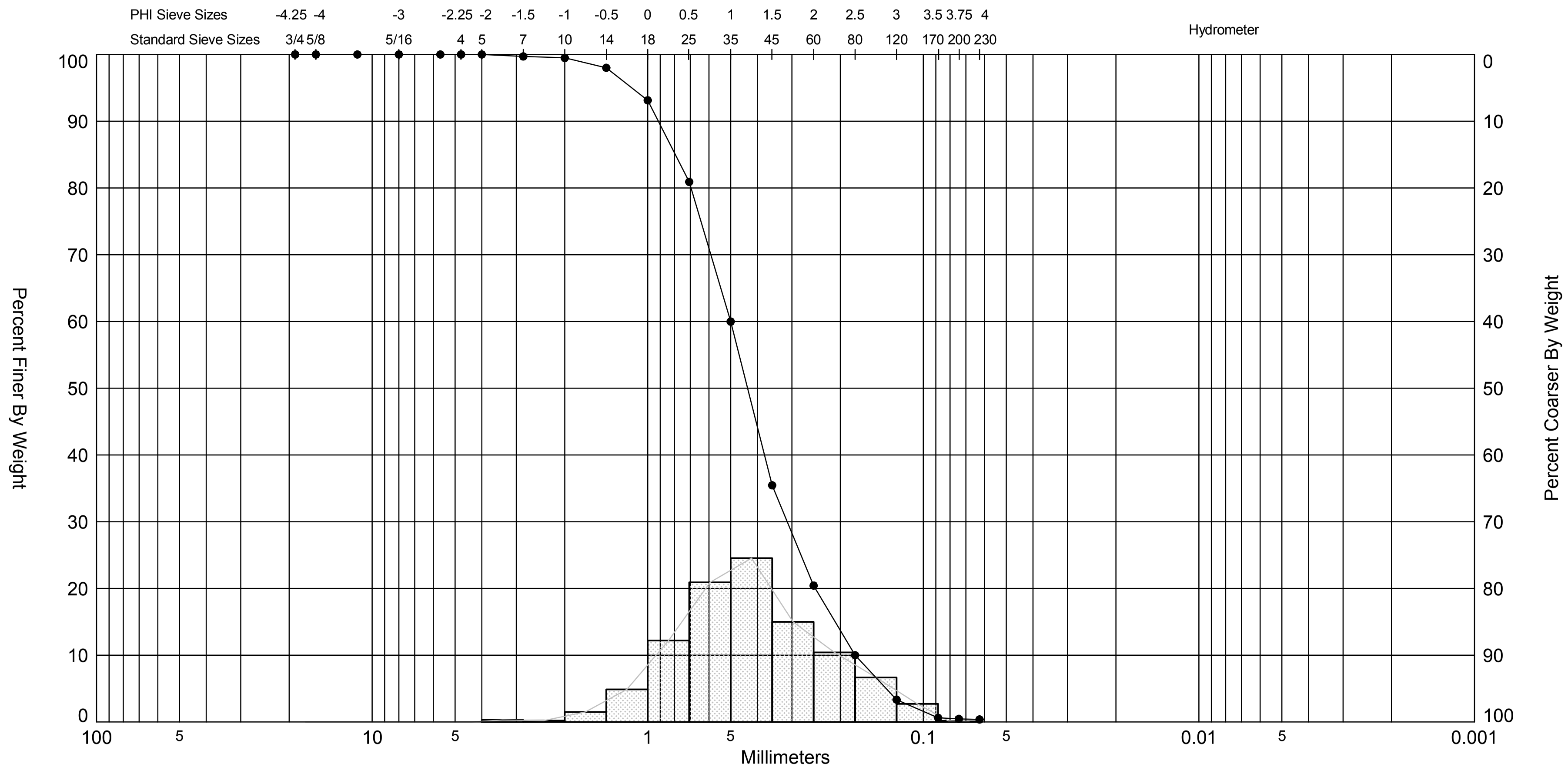
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
128.26	128.05	0.03	0.19	#200 - 0.45 #230 - 0.37		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.38	0.30	0.38	0.30
10	-1.00	2.00	0.28	0.22	0.66	0.52
14	-0.50	1.41	1.90	1.48	2.56	2.00
18	0.00	1.00	6.24	4.87	8.80	6.87
25	0.50	0.71	15.67	12.22	24.47	19.09
35	1.00	0.50	26.84	20.93	51.31	40.02
45	1.50	0.35	31.46	24.53	82.77	64.55
60	2.00	0.25	19.26	15.02	102.03	79.57
80	2.50	0.18	13.38	10.43	115.41	90.00
120	3.00	0.13	8.56	6.67	123.97	96.67
170	3.50	0.09	3.49	2.72	127.46	99.39
200	3.75	0.07	0.21	0.16	127.67	99.55
230	4.00	0.06	0.10	0.08	127.77	99.63

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.87	2.21	1.85	1.20	0.64	0.37	-0.19

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.25	0.42	0.9	0.09	3



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Davenport-Comm. Con.	—●—		SW	#200 - 0.45 #230 - 0.37		0	1.2	1.25	0.09	3	0.9

Comments: CEMEX Davenport-Commercial Concrete

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	Coastal Planning & Engineering 2481 NW Boca Raton Blvd, Boca Raton FL 33431 ph (561) 391-8102 fax (561) 391-9116
Sample Name: Davenport-DEP Filter	
Analysis Date: 05-10-11	
Analyzed By: JR	

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/2 Dry - 2.5Y-8/1 Washed - 5Y-8/1	Cemex

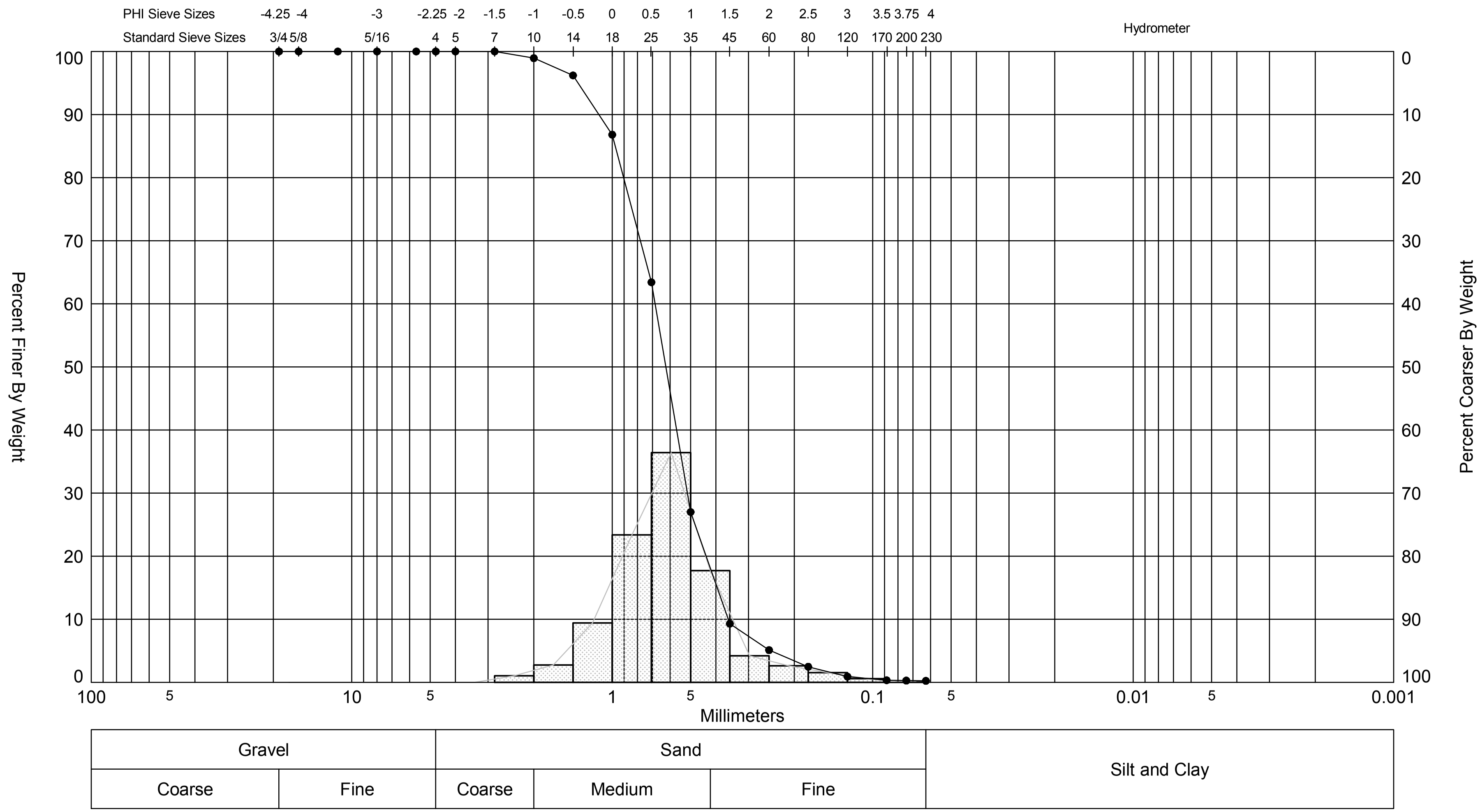
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
123.28	123.06	0.01	0.06	#200 - 0.28 #230 - 0.24		2	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	1.31	1.06	1.31	1.06
14	-0.50	1.41	3.36	2.73	4.67	3.79
18	0.00	1.00	11.59	9.40	16.26	13.19
25	0.50	0.71	28.83	23.39	45.09	36.58
35	1.00	0.50	44.90	36.42	89.99	73.00
45	1.50	0.35	21.82	17.70	111.81	90.70
60	2.00	0.25	5.17	4.19	116.98	94.89
80	2.50	0.18	3.25	2.64	120.23	97.53
120	3.00	0.13	1.92	1.56	122.15	99.09
170	3.50	0.09	0.71	0.58	122.86	99.67
200	3.75	0.07	0.06	0.05	122.92	99.72
230	4.00	0.06	0.05	0.04	122.97	99.76

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.02	1.31	1.06	0.68	0.25	0.06	-0.44

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	0.69	0.62	0.71	0.49	4.61



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Davenport-DEP Filter	——●——		SP	#200 - 0.28 #230 - 0.24		2	0.68	0.69	0.49	4.61	0.71

Comments: Cemex

Depths and elevations based on measured values

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Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report

Depths and elevations based on measured values

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fax (561) 391-9116

Project Name: Upland Sand Sources
Sample Name: Davenport-Mason
Analysis Date: 05-10-11
Analyzed By: JR

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Cemex

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
111.39	111.18	0.02	0.04	#200 - 0.30 #230 - 0.24		0	

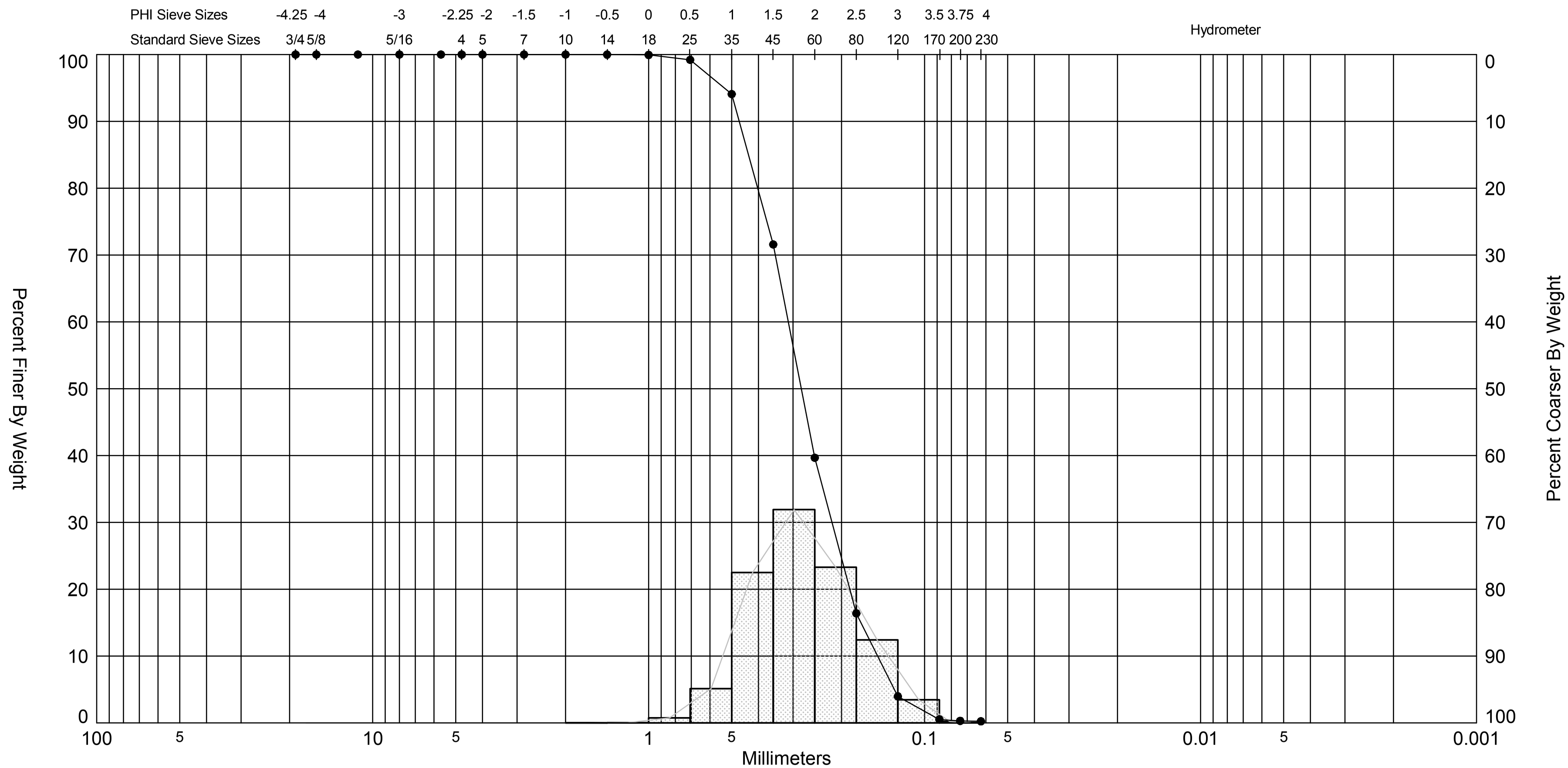
Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.01	0.01	0.01	0.01
18	0.00	1.00	0.06	0.05	0.07	0.06
25	0.50	0.71	0.81	0.73	0.88	0.79
35	1.00	0.50	5.71	5.13	6.59	5.92
45	1.50	0.35	25.06	22.50	31.65	28.42
60	2.00	0.25	35.55	31.91	67.20	60.33
80	2.50	0.18	25.93	23.28	93.13	83.61
120	3.00	0.13	13.83	12.42	106.96	96.03
170	3.50	0.09	3.84	3.45	110.80	99.48
200	3.75	0.07	0.24	0.22	111.04	99.70
230	4.00	0.06	0.07	0.06	111.11	99.76

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.96	2.52	2.32	1.84	1.42	1.22	0.91

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.87	0.27	0.62	0.16	2.83

GRANULARMETRIC REPORT BROWARD_UPLAND_SAND_SOURCES.GPJ JPBRAZIL.GDT 8/31/11



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Davenport-Mason	—●—		SP	#200 - 0.30 #230 - 0.24		0	1.84	1.87	0.16	2.83	0.62

Comments: Cemex

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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SIEVE ANALYSIS BROWARD_UPLAND_SAND_SOURCES.GPJ JPBRAZIL.GDT 8/31/11

Granularmetric Report

Depths and elevations based on measured values

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fax (561) 391-9116

Project Name: Upland Sand Sources
Sample Name: Dvpt-Top Dressing
Analysis Date: 05-10-11
Analyzed By: JR

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Cemex-Davenport

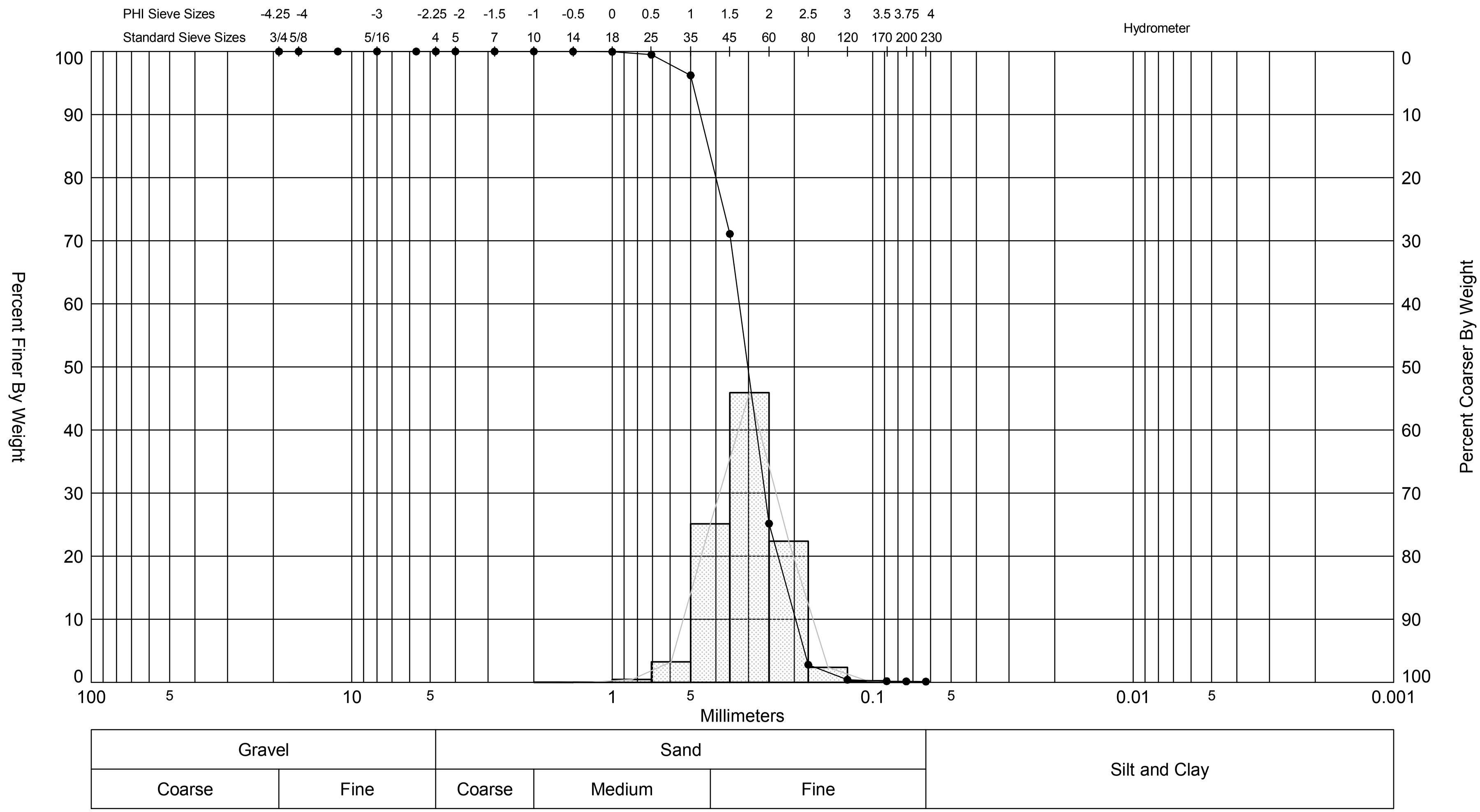
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
109.15	109.05	0.00	0.04	#200 - 0.15 #230 - 0.12		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.01	0.01	0.01	0.01
18	0.00	1.00	0.04	0.04	0.05	0.05
25	0.50	0.71	0.50	0.46	0.55	0.51
35	1.00	0.50	3.57	3.27	4.12	3.78
45	1.50	0.35	27.44	25.14	31.56	28.92
60	2.00	0.25	50.12	45.92	81.68	74.84
80	2.50	0.18	24.42	22.37	106.10	97.21
120	3.00	0.13	2.60	2.38	108.70	99.59
170	3.50	0.09	0.25	0.23	108.95	99.82
200	3.75	0.07	0.03	0.03	108.98	99.85
230	4.00	0.06	0.03	0.03	109.01	99.88

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.45	2.20	2.00	1.73	1.42	1.24	1.02

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.72	0.30	0.44	-0.06	3.65



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Dvpt-Top Dressing	——•——		SP	#200 - 0.15 #230 - 0.12		0	1.73	1.72	-0.06	3.65	0.44

Comments: Cemex-Davenport

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Farabee Coarse Beach	
Analysis Date: 06-29-11	
Analyzed By: LC	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 5Y-7/3 Dry - 2.5Y-8/2 Washed - 2.5Y-8/1	JJJ Enterprises

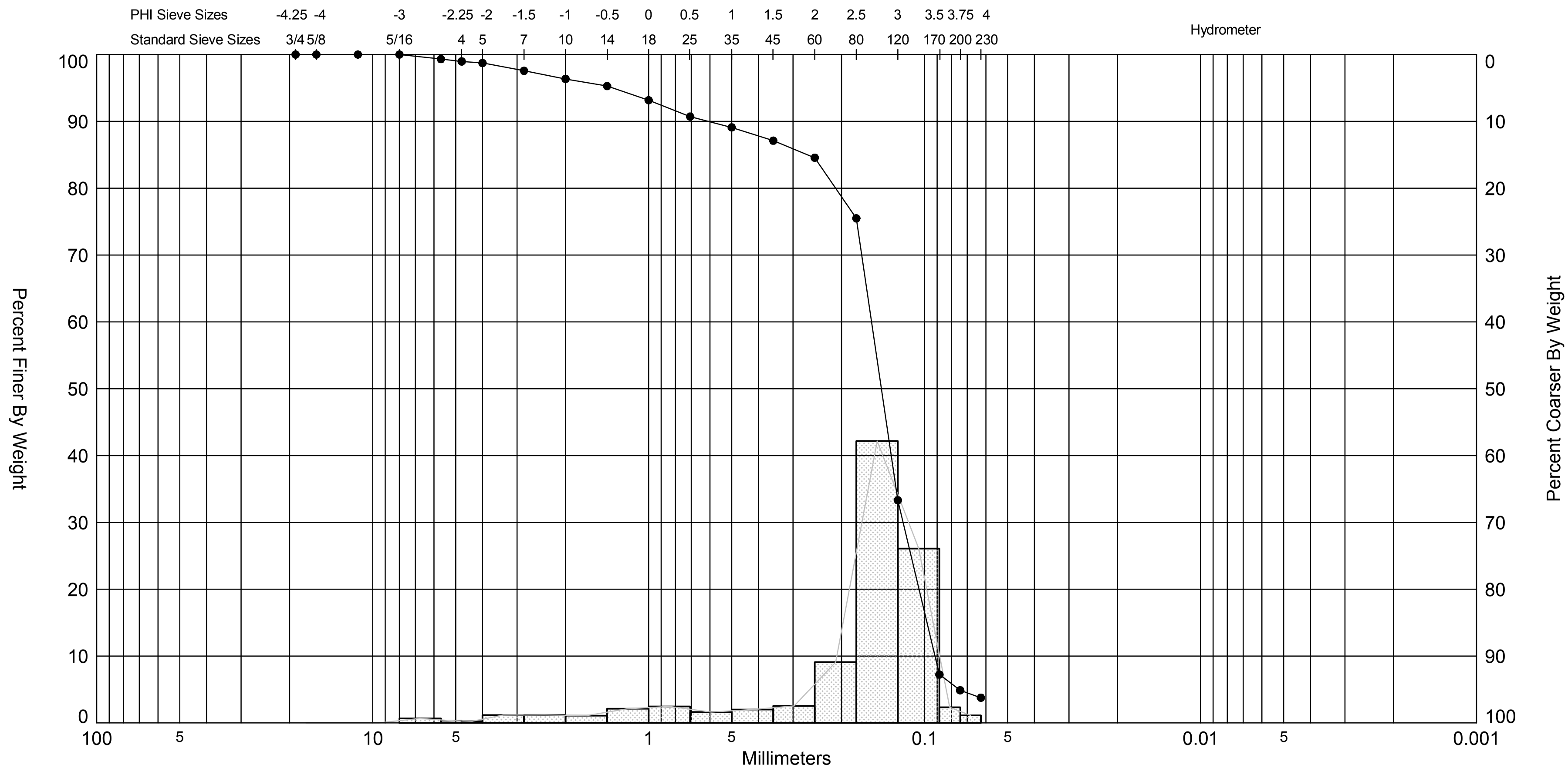
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
105.72	102.22	0.33	0.16	#200 - 4.88 #230 - 3.77		14	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.72	0.68	0.72	0.68
4	-2.25	4.76	0.37	0.35	1.09	1.03
5	-2.00	4.00	0.25	0.24	1.34	1.27
7	-1.50	2.83	1.23	1.16	2.57	2.43
10	-1.00	2.00	1.29	1.22	3.86	3.65
14	-0.50	1.41	1.13	1.07	4.99	4.72
18	0.00	1.00	2.23	2.11	7.22	6.83
25	0.50	0.71	2.59	2.45	9.81	9.28
35	1.00	0.50	1.71	1.62	11.52	10.90
45	1.50	0.35	2.10	1.99	13.62	12.89
60	2.00	0.25	2.70	2.55	16.32	15.44
80	2.50	0.18	9.59	9.07	25.91	24.51
120	3.00	0.13	44.59	42.18	70.50	66.69
170	3.50	0.09	27.57	26.08	98.07	92.77
200	3.75	0.07	2.48	2.35	100.55	95.12
230	4.00	0.06	1.17	1.11	101.72	96.23

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.74	3.33	3.16	2.80	2.51	2.03	-0.43

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.44	0.18	1.21	-2.28	8.03



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Farabee Coarse Beach	—●—		SW	#200 - 4.88 #230 - 3.77		14	2.8	2.44	-2.28	8.03	1.21

Comments: JJJ Enterprises

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Farabee Fine Beach	
Analysis Date: 06-29-11	
Analyzed By: LC	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	JJJ Enterprises

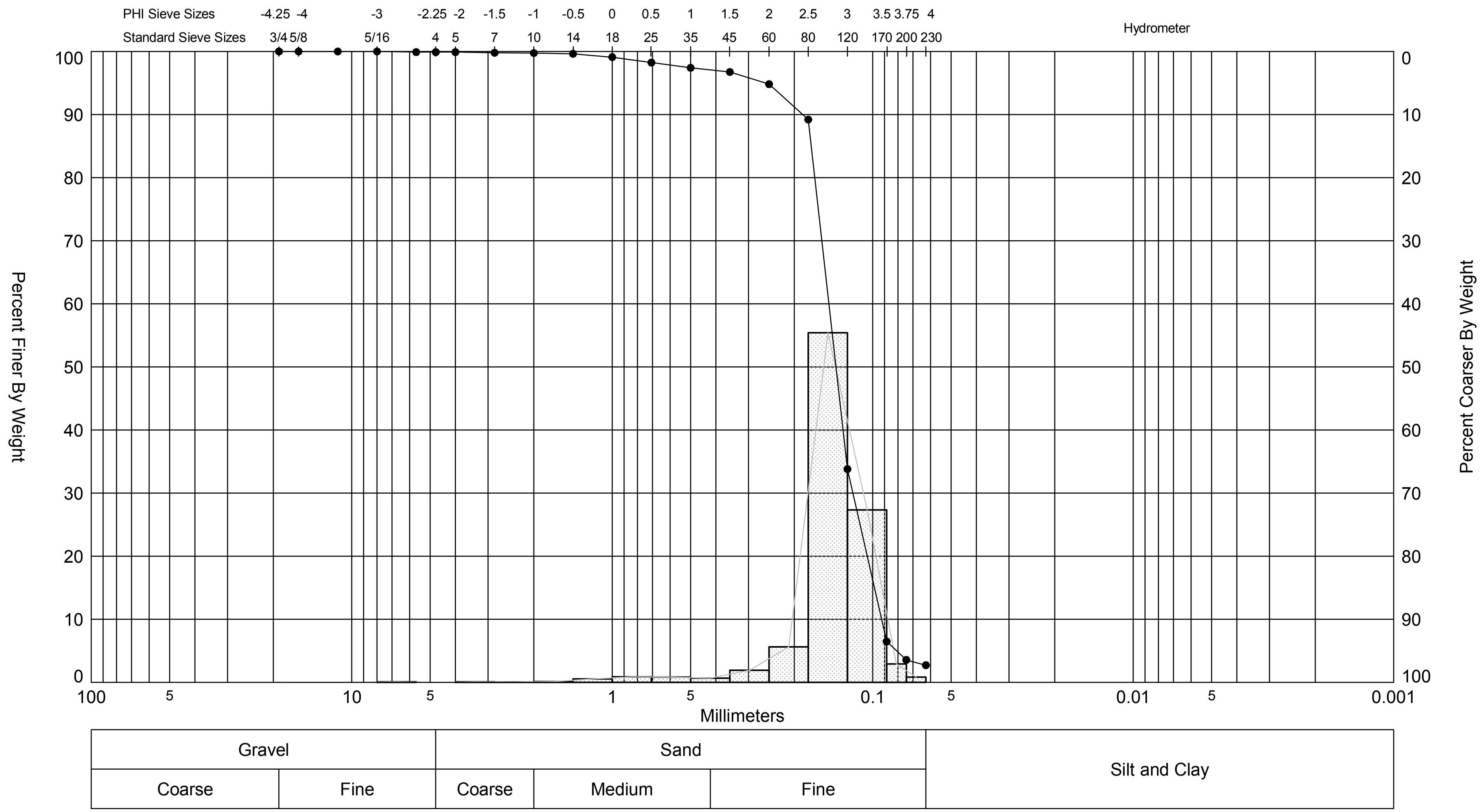
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
124.85	122.10	0.51	0.10	#200 - 3.56 #230 - 2.72		4	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.12	0.10	0.12	0.10
4	-2.25	4.76	0.00	0.00	0.12	0.10
5	-2.00	4.00	0.00	0.00	0.12	0.10
7	-1.50	2.83	0.13	0.10	0.25	0.20
10	-1.00	2.00	0.06	0.05	0.31	0.25
14	-0.50	1.41	0.15	0.12	0.46	0.37
18	0.00	1.00	0.66	0.53	1.12	0.90
25	0.50	0.71	1.08	0.87	2.20	1.77
35	1.00	0.50	1.03	0.82	3.23	2.59
45	1.50	0.35	0.82	0.66	4.05	3.25
60	2.00	0.25	2.41	1.93	6.46	5.18
80	2.50	0.18	7.01	5.61	13.47	10.79
120	3.00	0.13	69.18	55.41	82.65	66.20
170	3.50	0.09	34.11	27.32	116.76	93.52
200	3.75	0.07	3.65	2.92	120.41	96.44
230	4.00	0.06	1.05	0.84	121.46	97.28

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.63	3.33	3.16	2.85	2.63	2.55	1.95

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.8	0.14	0.6	-3.33	21.17



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Farabee Fine Beach	—●—		SP	#200 - 3.56 #230 - 2.72		4	2.85	2.8	-3.33	21.17	0.6

Comments: JJJ Enterprises

Depths and elevations based on measured values

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Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Ft. Pierce	
Analysis Date: 05-11-11	
Analyzed By: JR	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 2.5Y-6/2 Dry - 2.5Y-7/1 Washed - 2.5Y-7/1	Stewart Mining Industries

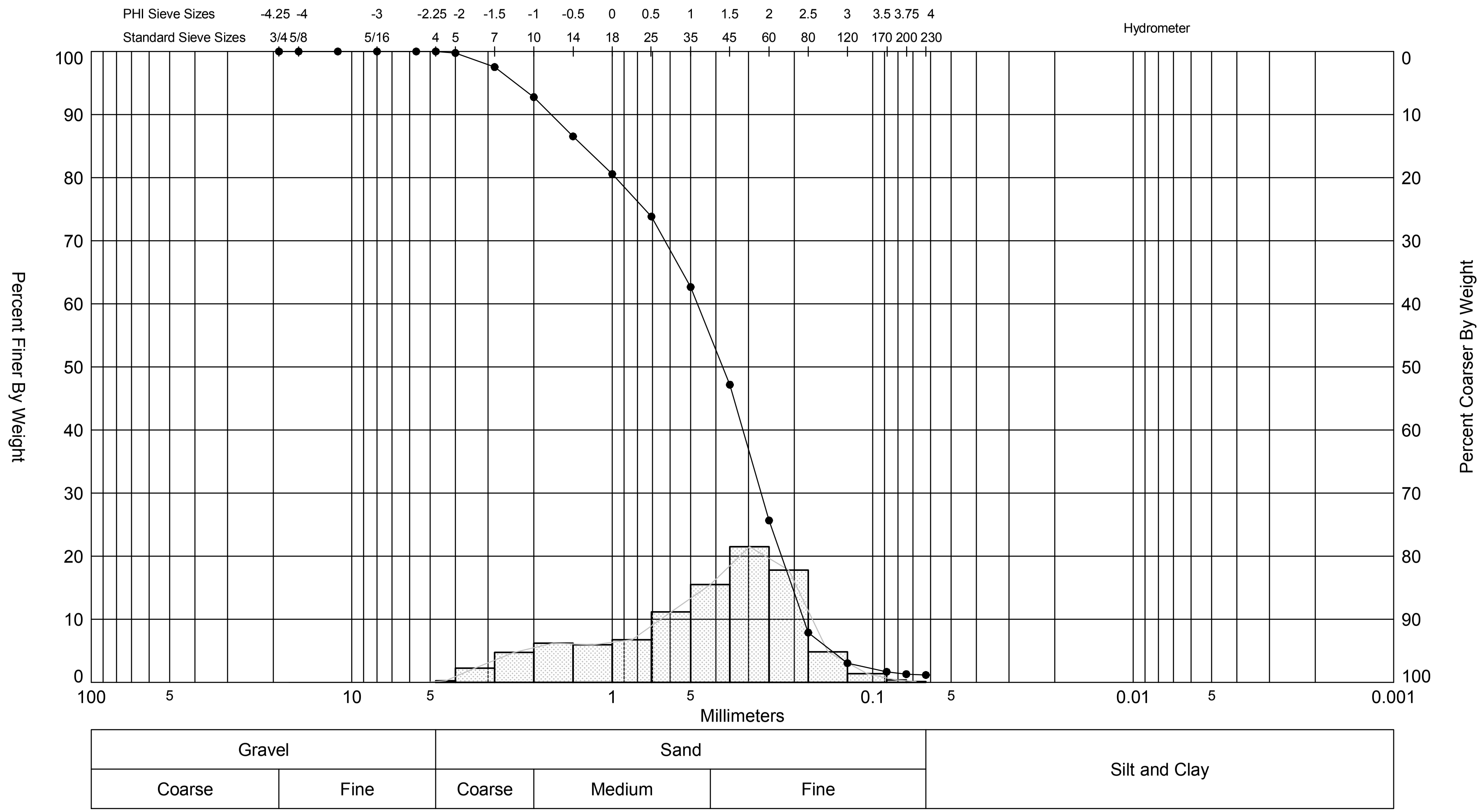
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
111.33	110.50	0.42	0.06	#200 - 1.30 #230 - 1.17		31	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.27	0.24	0.27	0.24
7	-1.50	2.83	2.48	2.23	2.75	2.47
10	-1.00	2.00	5.31	4.77	8.06	7.24
14	-0.50	1.41	6.92	6.22	14.98	13.46
18	0.00	1.00	6.65	5.97	21.63	19.43
25	0.50	0.71	7.50	6.74	29.13	26.17
35	1.00	0.50	12.43	11.17	41.56	37.34
45	1.50	0.35	17.23	15.48	58.79	52.82
60	2.00	0.25	23.96	21.52	82.75	74.34
80	2.50	0.18	19.80	17.78	102.55	92.12
120	3.00	0.13	5.39	4.84	107.94	96.96
170	3.50	0.09	1.52	1.37	109.46	98.33
200	3.75	0.07	0.41	0.37	109.87	98.70
230	4.00	0.06	0.14	0.13	110.01	98.83

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.80	2.27	2.02	1.41	0.41	-0.29	-1.23

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.11	0.46	1.19	-0.65	2.7



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Ft. Pierce	—●—		SW	#200 - 1.30 #230 - 1.17		31	1.41	1.11	-0.65	2.7	1.19

Comments: Stewart Mining Industries

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

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Project Name: Upland Sand Sources			
Sample Name: GB-2nd Tailings			
Analysis Date: 06-29-11			
Analyzed By: JR			
Easting (ft):	Northing (ft):	Coordinate System: Florida State Plane East	Elevation (ft):
USCS: SP	Munsell: Wet - 5Y-8/1, Dry - 5Y-8/1, Washed - 5Y-8/1	Comments: Jahna Green Bay - Second Tailings	

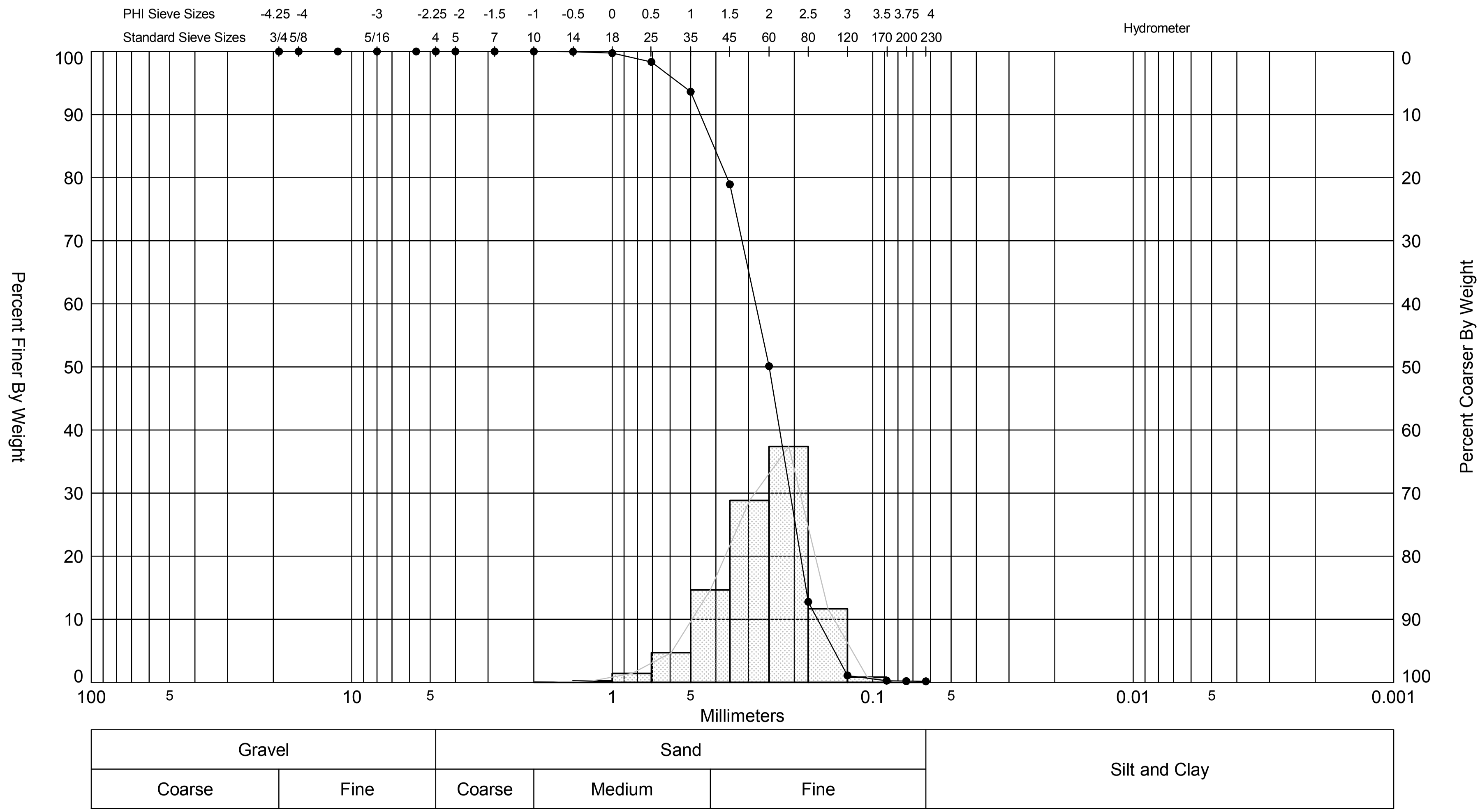
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
117.54	117.37	0.02	0.01	#200 - 0.19 #230 - 0.16		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.04	0.03	0.04	0.03
18	0.00	1.00	0.27	0.23	0.31	0.26
25	0.50	0.71	1.65	1.40	1.96	1.66
35	1.00	0.50	5.55	4.72	7.51	6.38
45	1.50	0.35	17.25	14.68	24.76	21.06
60	2.00	0.25	33.87	28.82	58.63	49.88
80	2.50	0.18	43.91	37.36	102.54	87.24
120	3.00	0.13	13.70	11.66	116.24	98.90
170	3.50	0.09	0.97	0.83	117.21	99.73
200	3.75	0.07	0.09	0.08	117.30	99.81
230	4.00	0.06	0.04	0.03	117.34	99.84

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.83	2.46	2.34	2.00	1.57	1.33	0.85

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.92	0.26	0.58	-0.59	3.6



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
GB-2nd Tailings	——●——		SP	#200 - 0.19 #230 - 0.16		0	2	1.92	-0.59	3.6	0.58

Comments: Jahna Green Bay - Second Tailings

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

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Project Name: Upland Sand Sources
Sample Name: GB-Beach Sand C
Analysis Date: 07-01-11
Analyzed By: TD

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 2.5Y-8/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	Jahna Green Bay

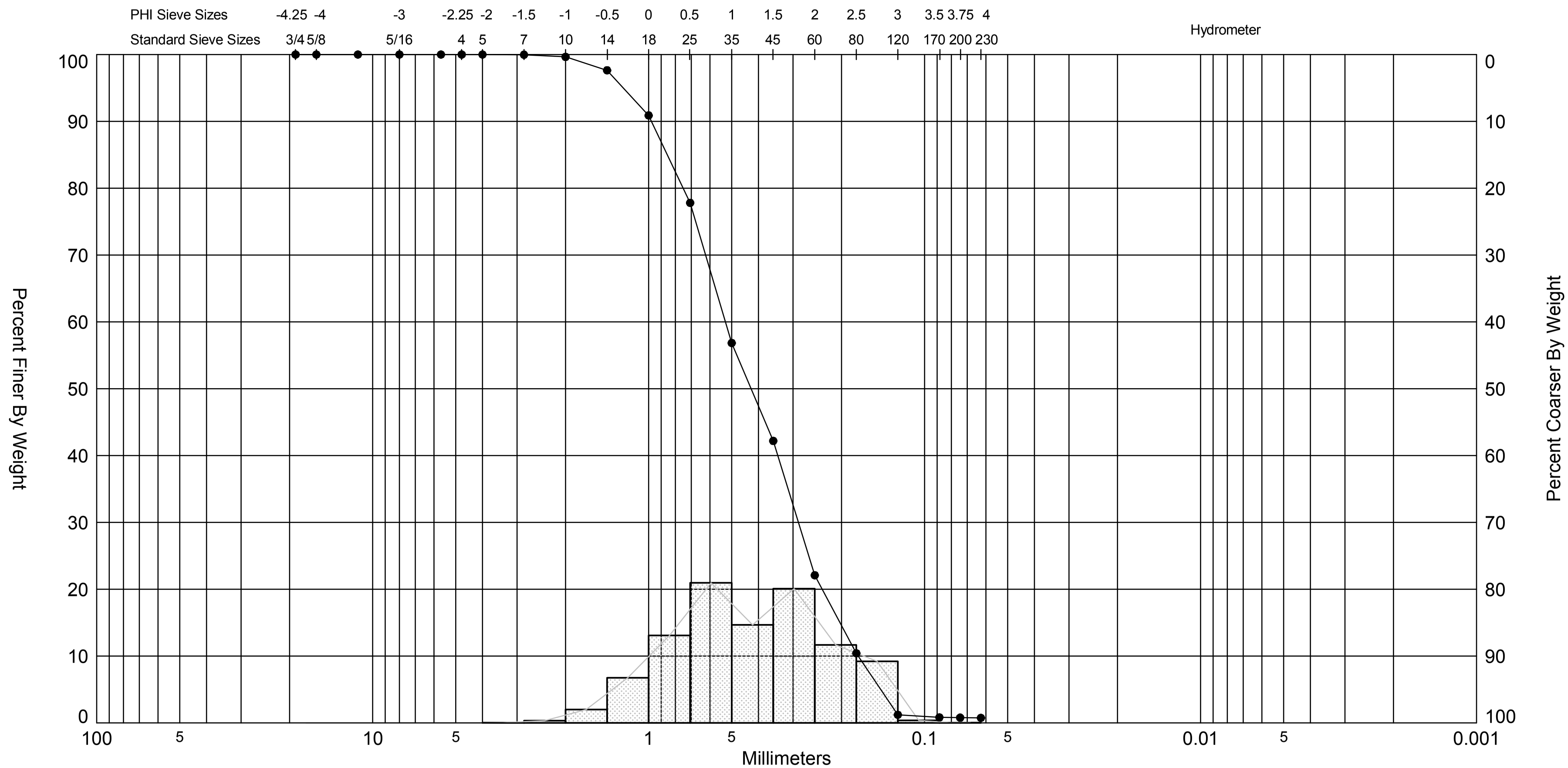
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
114.44	113.86	0.02	0.22	#200 - 0.78 #230 - 0.75		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.04	0.03	0.04	0.03
10	-1.00	2.00	0.37	0.32	0.41	0.35
14	-0.50	1.41	2.30	2.01	2.71	2.36
18	0.00	1.00	7.73	6.75	10.44	9.11
25	0.50	0.71	14.97	13.08	25.41	22.19
35	1.00	0.50	24.00	20.97	49.41	43.16
45	1.50	0.35	16.76	14.65	66.17	57.81
60	2.00	0.25	23.00	20.10	89.17	77.91
80	2.50	0.18	13.35	11.67	102.52	89.58
120	3.00	0.13	10.54	9.21	113.06	98.79
170	3.50	0.09	0.45	0.39	113.51	99.18
200	3.75	0.07	0.05	0.04	113.56	99.22
230	4.00	0.06	0.03	0.03	113.59	99.25

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.79	2.26	1.93	1.23	0.57	0.26	-0.30

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.23	0.43	0.92	-0.07	2.35



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
GB-Beach Sand C	—●—		SW	#200 - 0.78 #230 - 0.75		0	1.23	1.23	-0.07	2.35	0.92

Comments: Jahna Green Bay

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	07-01-11
Analyzed By:	TD
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Green Bay-FDOT	
Analysis Date: 06-29-11	
Analyzed By: JR	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	Jahna Green Bay - FDOT (aka Beach Sand D)

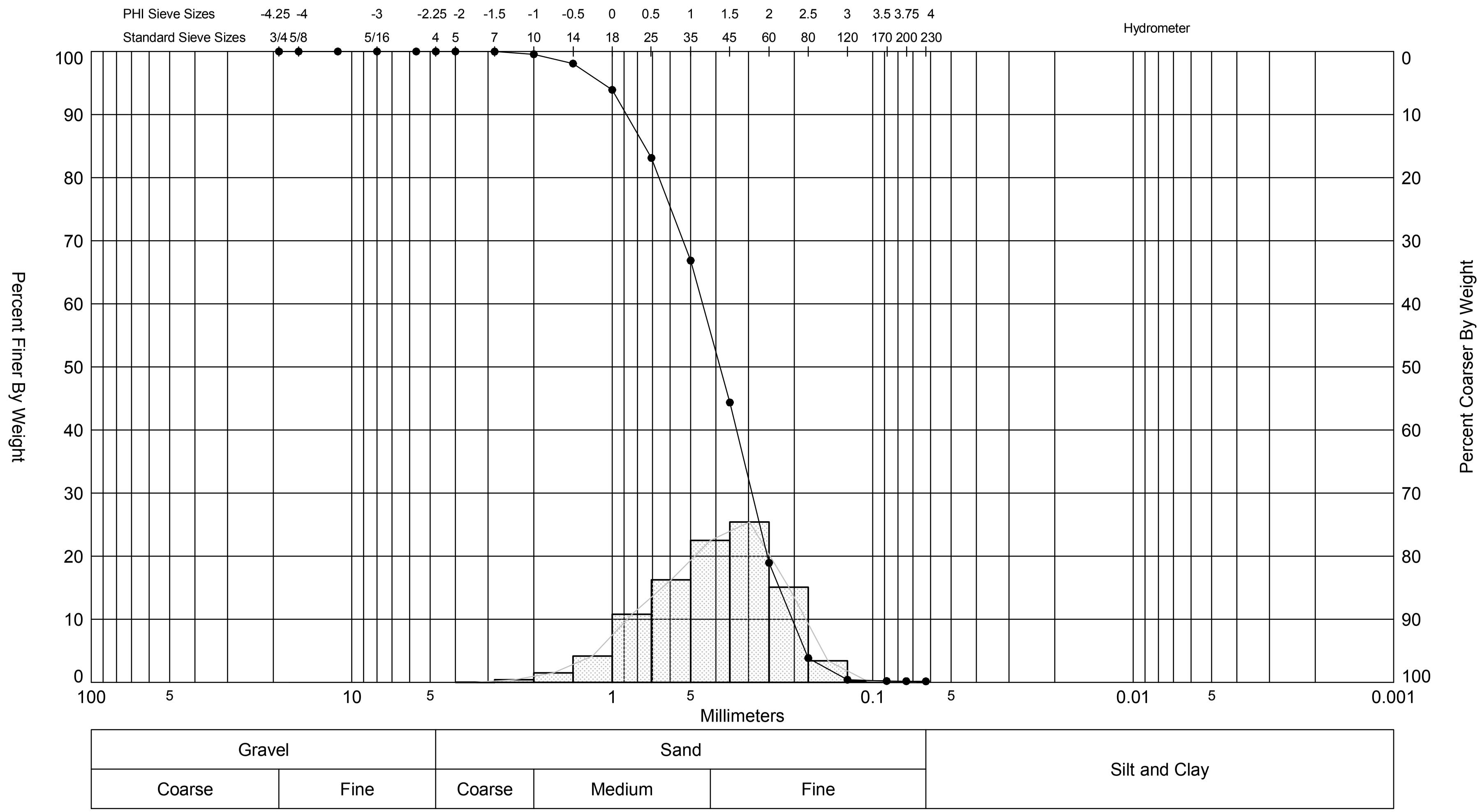
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
131.15	130.96	0.00	0.04	#200 - 0.18 #230 - 0.16		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.03	0.02	0.03	0.02
10	-1.00	2.00	0.55	0.42	0.58	0.44
14	-0.50	1.41	1.94	1.48	2.52	1.92
18	0.00	1.00	5.45	4.16	7.97	6.08
25	0.50	0.71	14.16	10.80	22.13	16.88
35	1.00	0.50	21.32	16.26	43.45	33.14
45	1.50	0.35	29.51	22.50	72.96	55.64
60	2.00	0.25	33.32	25.41	106.28	81.05
80	2.50	0.18	19.80	15.10	126.08	96.15
120	3.00	0.13	4.50	3.43	130.58	99.58
170	3.50	0.09	0.27	0.21	130.85	99.79
200	3.75	0.07	0.04	0.03	130.89	99.82
230	4.00	0.06	0.02	0.02	130.91	99.84

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.46	2.10	1.88	1.37	0.75	0.46	-0.13

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.29	0.41	0.79	-0.43	2.93



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Green Bay-FDOT	──●──		SP	#200 - 0.18 #230 - 0.16		0	1.37	1.29	-0.43	2.93	0.79

Comments: Jahna Green Bay - FDOT (aka Beach Sand D)

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources
Sample Name: Green Bay-Mason
Analysis Date: 06-29-11
Analyzed By: LC

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ph (561) 391-8102
fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	Jahna Green Bay - mason sand (aka beach sand-m)

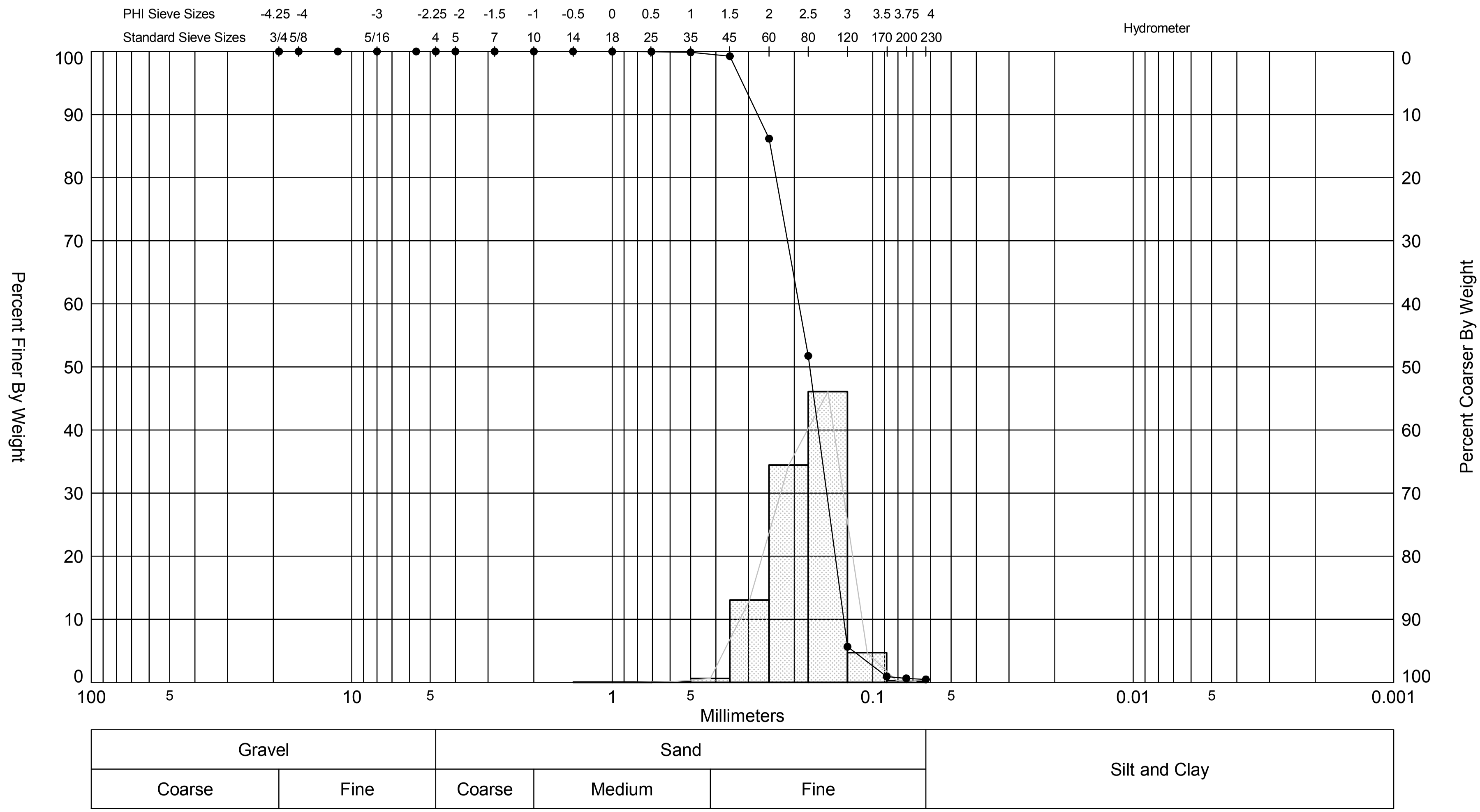
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
110.35	109.97	0.06	0.07	#200 - 0.63 #230 - 0.47		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.00	0.00	0.00	0.00
18	0.00	1.00	0.01	0.01	0.01	0.01
25	0.50	0.71	0.02	0.02	0.03	0.03
35	1.00	0.50	0.11	0.10	0.14	0.13
45	1.50	0.35	0.68	0.62	0.82	0.75
60	2.00	0.25	14.41	13.06	15.23	13.81
80	2.50	0.18	38.01	34.44	53.24	48.25
120	3.00	0.13	50.87	46.10	104.11	94.35
170	3.50	0.09	5.21	4.72	109.32	99.07
200	3.75	0.07	0.33	0.30	109.65	99.37
230	4.00	0.06	0.18	0.16	109.83	99.53

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.07	2.89	2.79	2.52	2.16	2.03	1.66

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.46	0.18	0.41	-0.38	3.4



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Green Bay-Mason	——●——		SP	#200 - 0.63 #230 - 0.47		0	2.52	2.46	-0.38	3.4	0.41

Comments: Jahna Green Bay - mason sand (aka beach sand-m)

Depths and elevations based on measured values

Coastal Planning & Engineering
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fax (561) 391-9116

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Keuka-301T Concrete	
Analysis Date: 05-11-11	
Analyzed By: JR	

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ph (561) 391-8102
fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/4 Dry - 2.5Y-8/3 Washed - 2.5Y-8/2	Vulcan Materials Co.

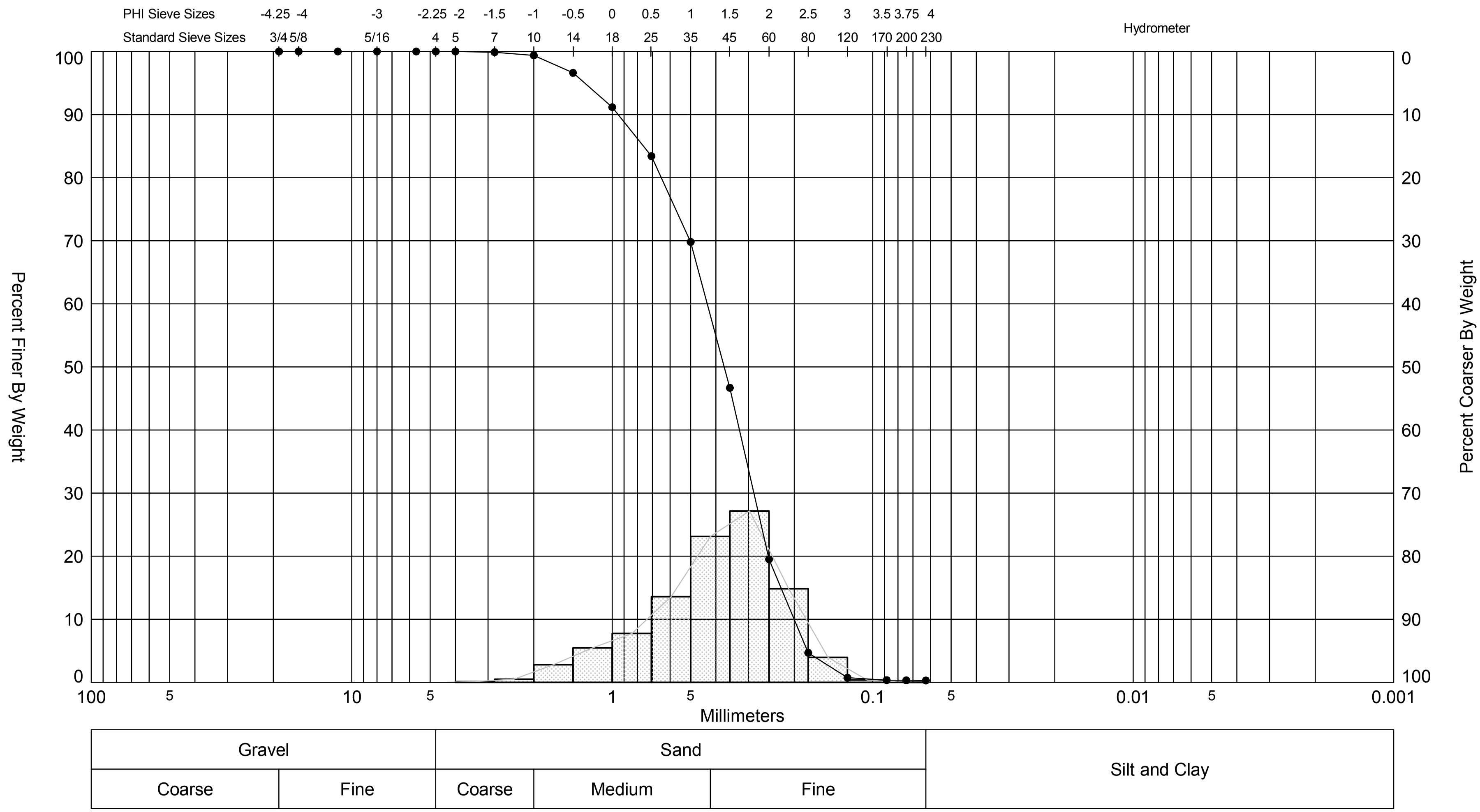
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
117.97	117.63	0.00	0.02	#200 - 0.32 #230 - 0.30		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.13	0.11	0.13	0.11
10	-1.00	2.00	0.59	0.50	0.72	0.61
14	-0.50	1.41	3.28	2.78	4.00	3.39
18	0.00	1.00	6.42	5.44	10.42	8.83
25	0.50	0.71	9.15	7.76	19.57	16.59
35	1.00	0.50	16.04	13.60	35.61	30.19
45	1.50	0.35	27.29	23.13	62.90	53.32
60	2.00	0.25	32.06	27.18	94.96	80.50
80	2.50	0.18	17.48	14.82	112.44	95.32
120	3.00	0.13	4.66	3.95	117.10	99.27
170	3.50	0.09	0.45	0.38	117.55	99.65
200	3.75	0.07	0.04	0.03	117.59	99.68
230	4.00	0.06	0.02	0.02	117.61	99.70

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.49	2.12	1.90	1.43	0.81	0.46	-0.35

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.3	0.41	0.84	-0.62	3.2



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Keuka-301T Concrete	—●—		SP	#200 - 0.32 #230 - 0.30		0	1.43	1.3	-0.62	3.2	0.84

Comments: Vulcan Materials Co.

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources
Sample Name: Keuka-315
Analysis Date: 05-11-11
Analyzed By: JR

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-7/4 Dry - 2.5Y-8/3 Washed - 2.5Y-8/2	Vulcan Materials Co.

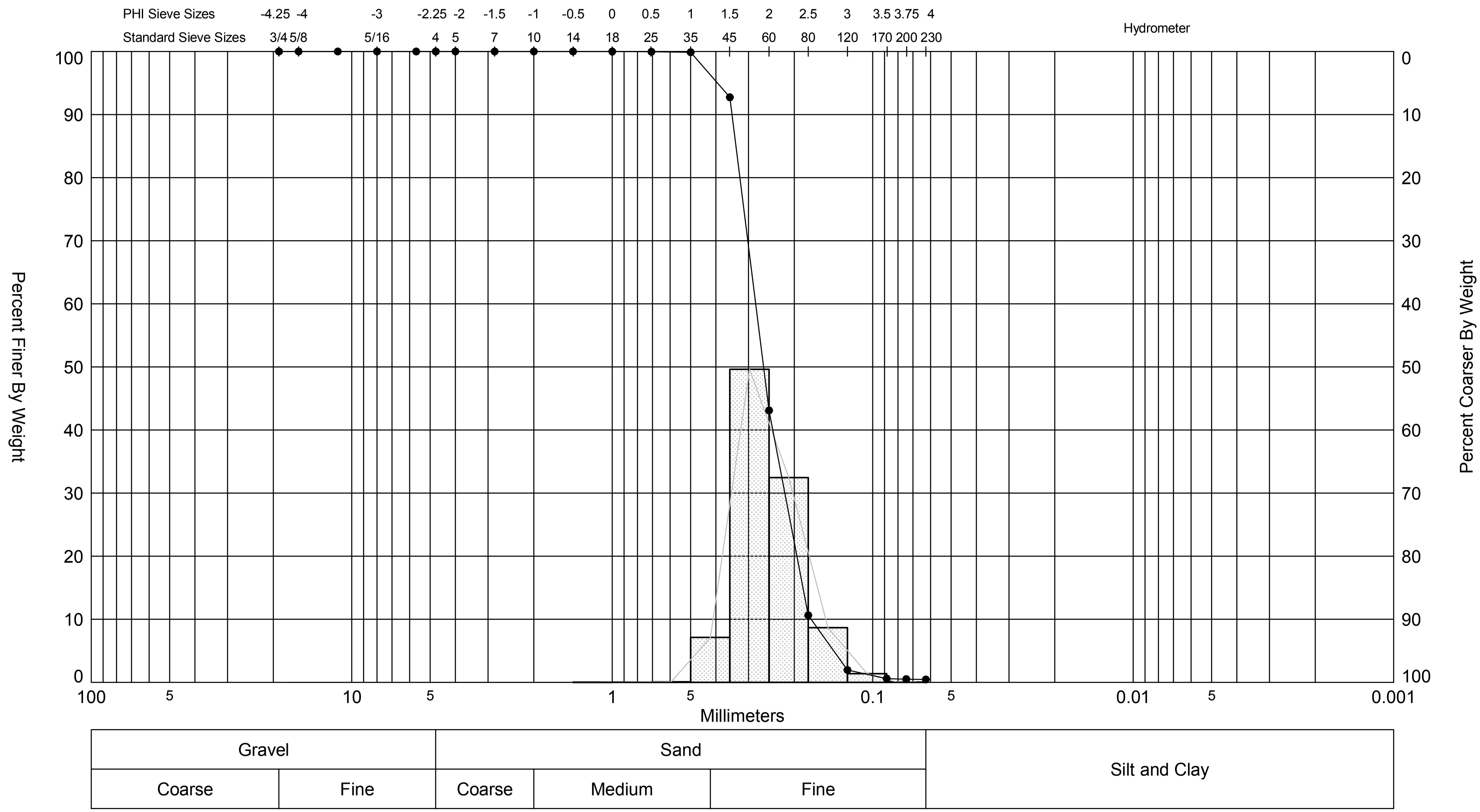
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
101.32	100.88	0.00	0.02	#200 - 0.51 #230 - 0.45		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.00	0.00	0.00	0.00
18	0.00	1.00	0.01	0.01	0.01	0.01
25	0.50	0.71	0.03	0.03	0.04	0.04
35	1.00	0.50	0.08	0.08	0.12	0.12
45	1.50	0.35	7.23	7.14	7.35	7.26
60	2.00	0.25	50.30	49.64	57.65	56.90
80	2.50	0.18	32.90	32.47	90.55	89.37
120	3.00	0.13	8.78	8.67	99.33	98.04
170	3.50	0.09	1.38	1.36	100.71	99.40
200	3.75	0.07	0.09	0.09	100.80	99.49
230	4.00	0.06	0.06	0.06	100.86	99.55

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.82	2.42	2.28	1.93	1.68	1.59	1.34

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.99	0.25	0.41	0.59	3.84



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Keuka-315	—●—		SP	#200 - 0.51 #230 - 0.45		0	1.93	1.99	0.59	3.84	0.41

Comments: Vulcan Materials Co.

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Keuka-315 Conveyor

Analysis Date: 05-11-11

Analyzed By: JR

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/3 Dry - 2.5-8/2 Washed - 5Y-8/1	Vulcan Materials Co.

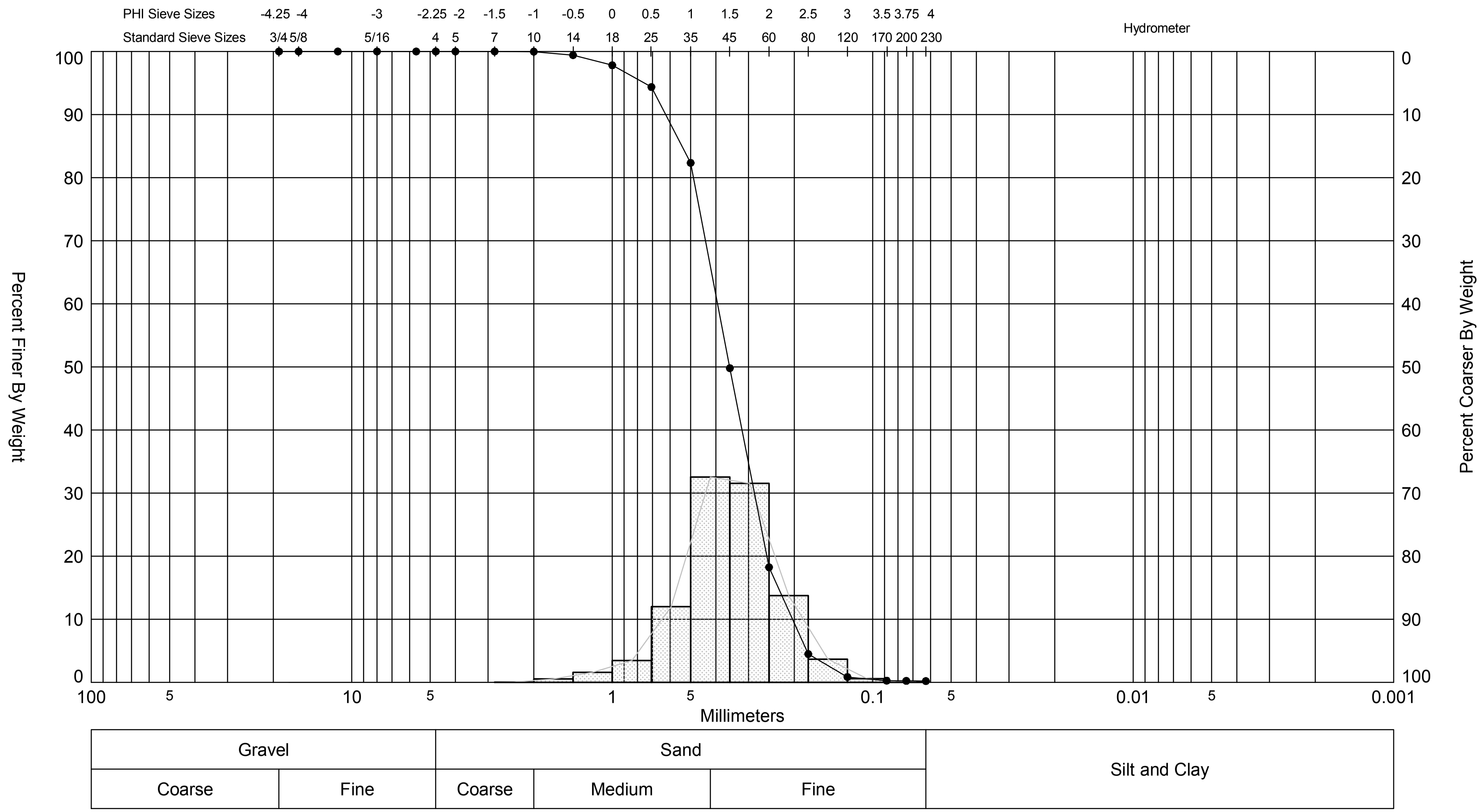
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
117.58	117.37	0.01	0.00	#200 - 0.23 #230 - 0.20		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.04	0.03	0.04	0.03
14	-0.50	1.41	0.65	0.55	0.69	0.58
18	0.00	1.00	1.88	1.60	2.57	2.18
25	0.50	0.71	4.07	3.46	6.64	5.64
35	1.00	0.50	14.13	12.02	20.77	17.66
45	1.50	0.35	38.26	32.54	59.03	50.20
60	2.00	0.25	37.11	31.56	96.14	81.76
80	2.50	0.18	16.17	13.75	112.31	95.51
120	3.00	0.13	4.29	3.65	116.60	99.16
170	3.50	0.09	0.67	0.57	117.27	99.73
200	3.75	0.07	0.05	0.04	117.32	99.77
230	4.00	0.06	0.04	0.03	117.36	99.80

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.48	2.08	1.89	1.50	1.11	0.93	0.41

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.48	0.36	0.63	-0.34	4.03



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Keuka-315 Conveyor	—●—		SP	#200 - 0.23 #230 - 0.20		0	1.5	1.48	-0.34	4.03	0.63

Comments: Vulcan Materials Co.

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	Coastal Planning & Engineering 2481 NW Boca Raton Blvd, Boca Raton FL 33431 ph (561) 391-8102 fax (561) 391-9116
Sample Name: Lake Wales-Comm. Con.	
Analysis Date: 05-10-11	
Analyzed By: JR	

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/3 Dry - 2.5Y-8/2 Washed - 2.5Y-8/2	Cemex Lake Wales Commercial Concrete

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
105.24	105.07	0.03	0.10	#200 - 0.34 #230 - 0.30		1	

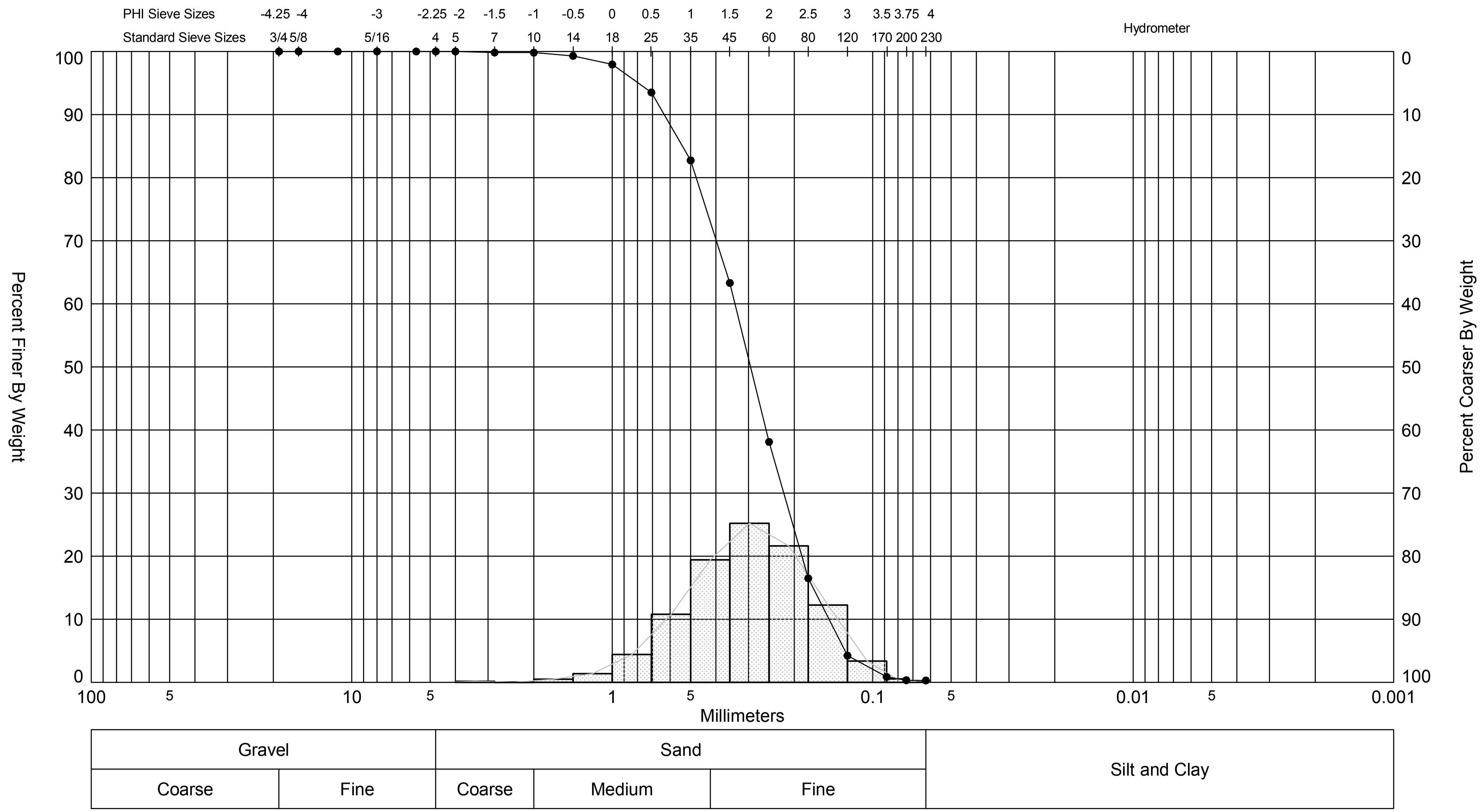
Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.18	0.17	0.18	0.17
10	-1.00	2.00	0.01	0.01	0.19	0.18
14	-0.50	1.41	0.55	0.52	0.74	0.70
18	0.00	1.00	1.43	1.36	2.17	2.06
25	0.50	0.71	4.66	4.43	6.83	6.49
35	1.00	0.50	11.35	10.78	18.18	17.27
45	1.50	0.35	20.44	19.42	38.62	36.69
60	2.00	0.25	26.52	25.20	65.14	61.89
80	2.50	0.18	22.74	21.61	87.88	83.50
120	3.00	0.13	12.91	12.27	100.79	95.77
170	3.50	0.09	3.54	3.36	104.33	99.13
200	3.75	0.07	0.56	0.53	104.89	99.66
230	4.00	0.06	0.04	0.04	104.93	99.70

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.97	2.52	2.30	1.76	1.20	0.94	0.33

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.72	0.30	0.8	-0.39	3.41

GRANULARMETRIC REPORT BROWARD_UPLAND_SAND_SOURCES.GPJ JPBRAZIL.GDT 8/31/11



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Lake Wales-Comm. Con.			SP	#200 - 0.34 #230 - 0.30		1	1.76	1.72	-0.39	3.41	0.8

Comments: Cemex Lake Wales Commercial Concrete

Depths and elevations based on measured values

Coastal Planning & Engineering
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fax (561) 391-9116

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

SIEVE ANALYSIS BROWARD_UPLAND_SAND_SOURCES.GPJ JPBRAZIL.GDT 8/31/11

Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Lake Wales-FDOT Con.

Analysis Date: 05-10-11

Analyzed By: JR

Coastal Planning & Engineering
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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/3 Dry - 2.5Y-8/2 Washed - 2.5Y-8/2	Cemex Lake Wales-FDOT Concrete

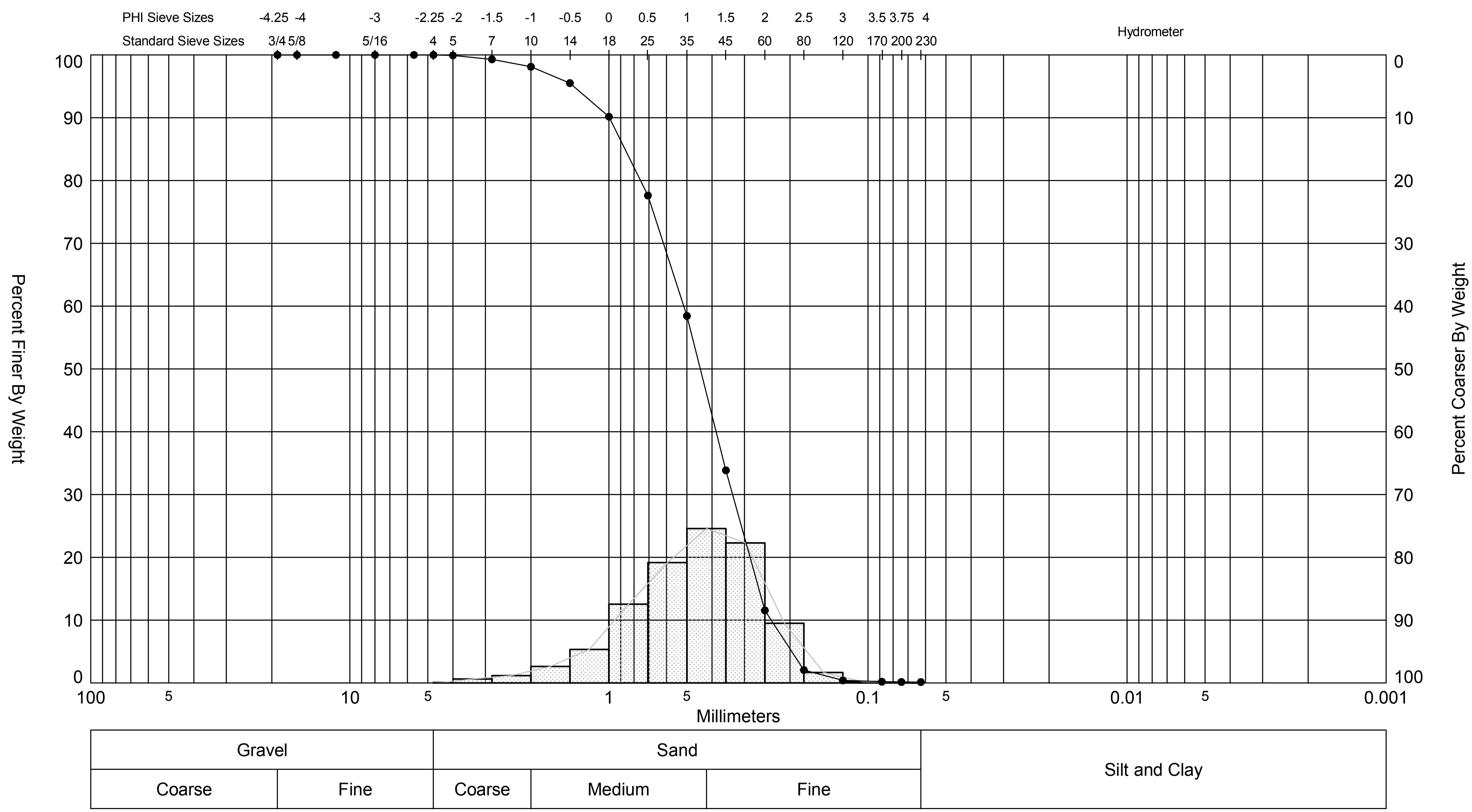
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
111.54	111.44	0.01	0.04	#200 - 0.15 #230 - 0.14		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.09	0.08	0.09	0.08
7	-1.50	2.83	0.69	0.62	0.78	0.70
10	-1.00	2.00	1.32	1.18	2.10	1.88
14	-0.50	1.41	2.91	2.61	5.01	4.49
18	0.00	1.00	5.96	5.34	10.97	9.83
25	0.50	0.71	14.01	12.56	24.98	22.39
35	1.00	0.50	21.38	19.17	46.36	41.56
45	1.50	0.35	27.43	24.59	73.79	66.15
60	2.00	0.25	24.87	22.30	98.66	88.45
80	2.50	0.18	10.60	9.50	109.26	97.95
120	3.00	0.13	1.84	1.65	111.10	99.60
170	3.50	0.09	0.23	0.21	111.33	99.81
200	3.75	0.07	0.04	0.04	111.37	99.85
230	4.00	0.06	0.01	0.01	111.38	99.86

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.34	1.90	1.70	1.17	0.57	0.25	-0.45

Moment	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
Statistics	1.08	0.47	0.84	-0.6	3.54



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Lake Wales-FDOT Con.	──●──		SP	#200 - 0.15 #230 - 0.14		0	1.17	1.08	-0.6	3.54	0.84

Comments: Cemex Lake Wales-FDOT Concrete

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	Coastal Planning & Engineering 2481 NW Boca Raton Blvd, Boca Raton FL 33431 ph (561) 391-8102 fax (561) 391-9116
Sample Name: Lake Wales-Mason	
Analysis Date: 05-10-11	
Analyzed By: JR	

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/2 Dry - 5Y-8/2 Washed - 5Y-8/2	Cemex

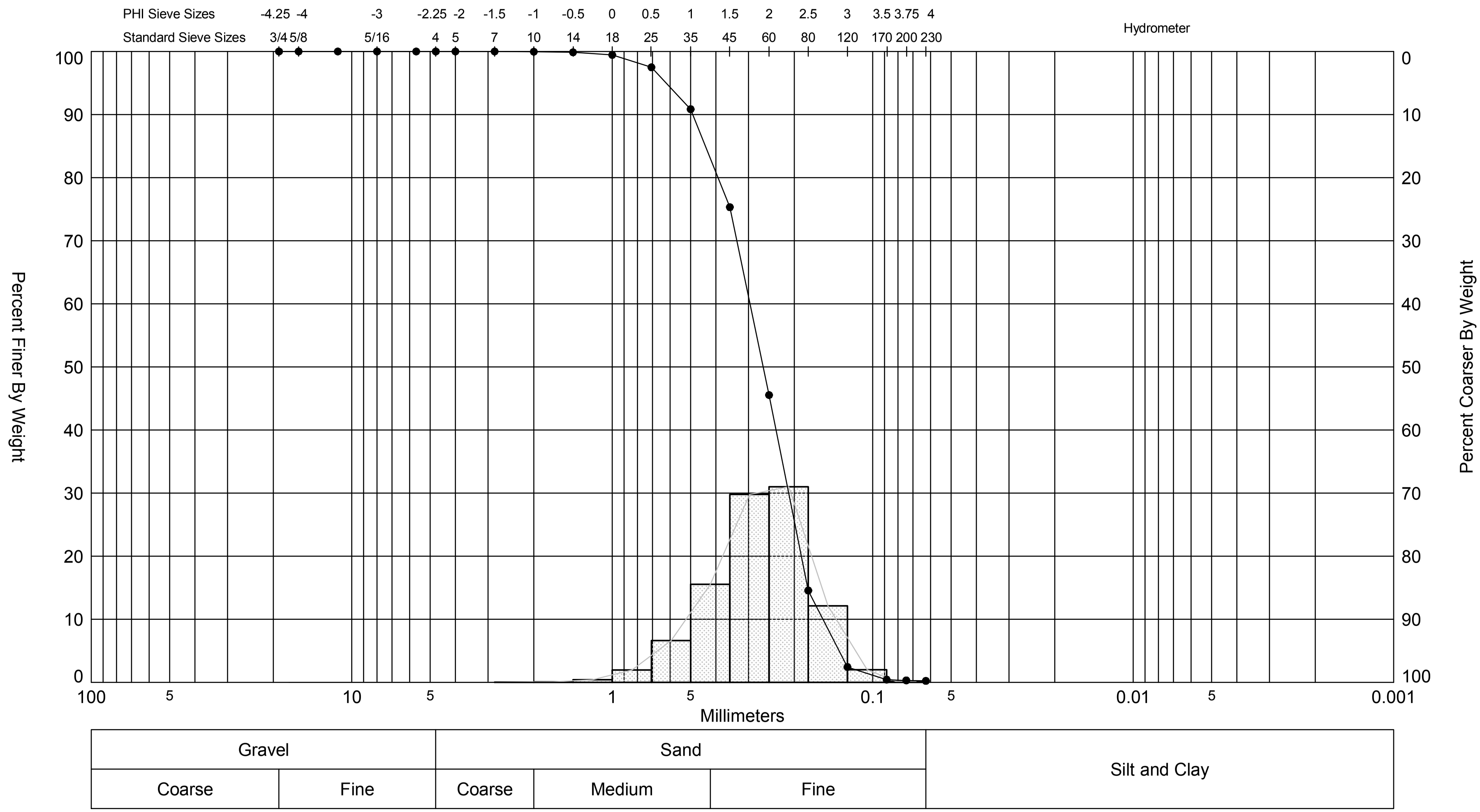
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
103.05	102.81	0.01	0.01	#200 - 0.31 #230 - 0.23		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.04	0.04	0.04	0.04
14	-0.50	1.41	0.09	0.09	0.13	0.13
18	0.00	1.00	0.43	0.42	0.56	0.55
25	0.50	0.71	2.02	1.96	2.58	2.51
35	1.00	0.50	6.84	6.64	9.42	9.15
45	1.50	0.35	16.00	15.53	25.42	24.68
60	2.00	0.25	30.69	29.78	56.11	54.46
80	2.50	0.18	31.92	30.98	88.03	85.44
120	3.00	0.13	12.50	12.13	100.53	97.57
170	3.50	0.09	2.06	2.00	102.59	99.57
200	3.75	0.07	0.12	0.12	102.71	99.69
230	4.00	0.06	0.08	0.08	102.79	99.77

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.89	2.48	2.33	1.93	1.51	1.22	0.69

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.88	0.27	0.64	-0.47	3.56



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Lake Wales-Mason	——●——		SP	#200 - 0.31 #230 - 0.23		0	1.93	1.88	-0.47	3.56	0.64

Comments: Cemex

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Ortona-Beach Sand C	
Analysis Date: 06-29-11	
Analyzed By: LC	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	Jahna

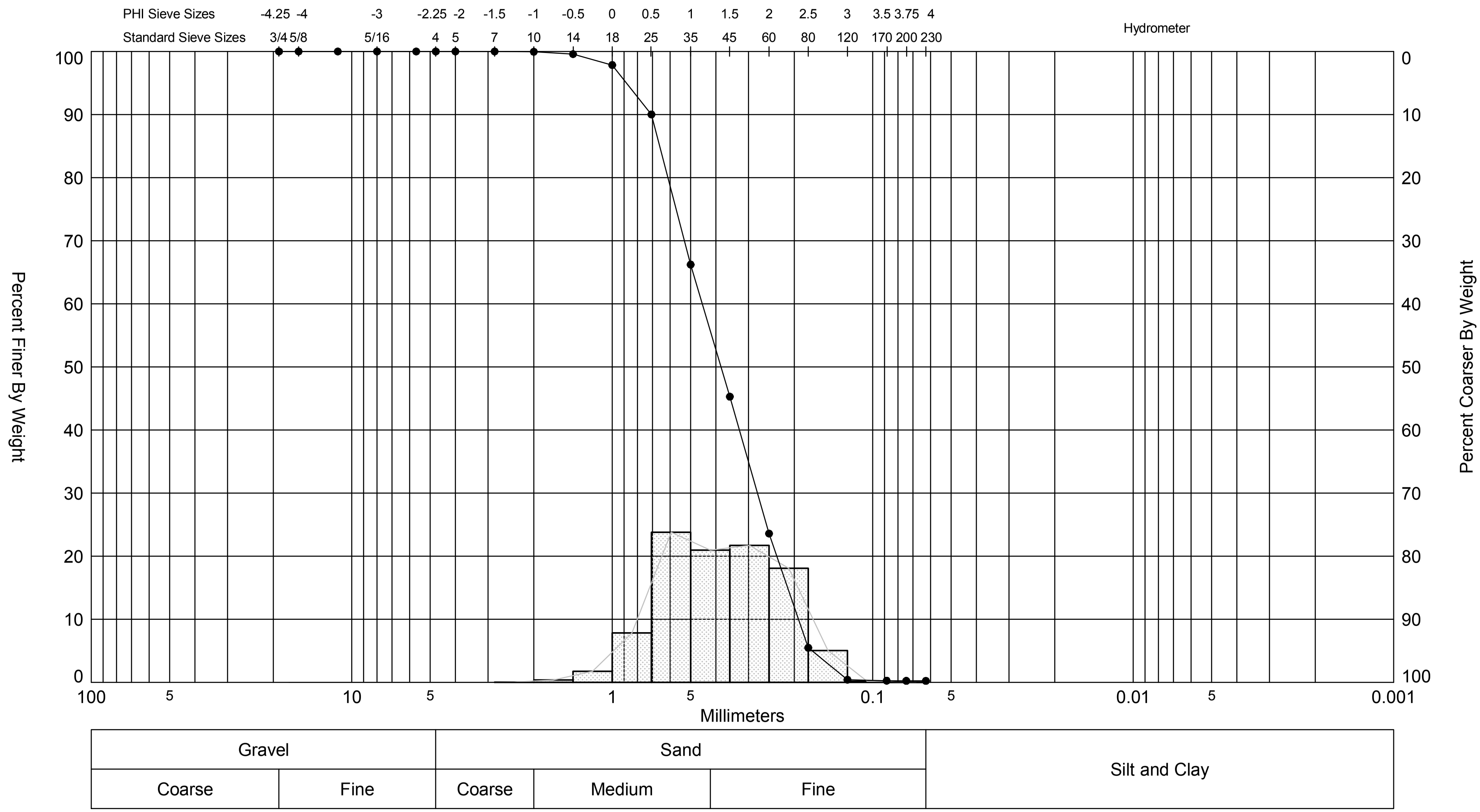
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
150.13	150.00	0.02	0.14	#200 - 0.24 #230 - 0.23		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.07	0.05	0.07	0.05
14	-0.50	1.41	0.55	0.37	0.62	0.42
18	0.00	1.00	2.60	1.73	3.22	2.15
25	0.50	0.71	11.75	7.83	14.97	9.98
35	1.00	0.50	35.73	23.80	50.70	33.78
45	1.50	0.35	31.44	20.94	82.14	54.72
60	2.00	0.25	32.58	21.70	114.72	76.42
80	2.50	0.18	27.17	18.10	141.89	94.52
120	3.00	0.13	7.60	5.06	149.49	99.58
170	3.50	0.09	0.24	0.16	149.73	99.74
200	3.75	0.07	0.03	0.02	149.76	99.76
230	4.00	0.06	0.01	0.01	149.77	99.77

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.55	2.21	1.97	1.39	0.82	0.63	0.18

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.39	0.38	0.73	-0.08	2.46



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Ortona-Beach Sand C	—●—		SP	#200 - 0.24 #230 - 0.23		0	1.39	1.39	-0.08	2.46	0.73

Comments: Jahna

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Ortona-Mason	
Analysis Date: 06-29-11	
Analyzed By: LC	

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Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-7/2 Dry - 2.5Y-7/2 Washed - 2.5Y-8/2	Jahna Ortona

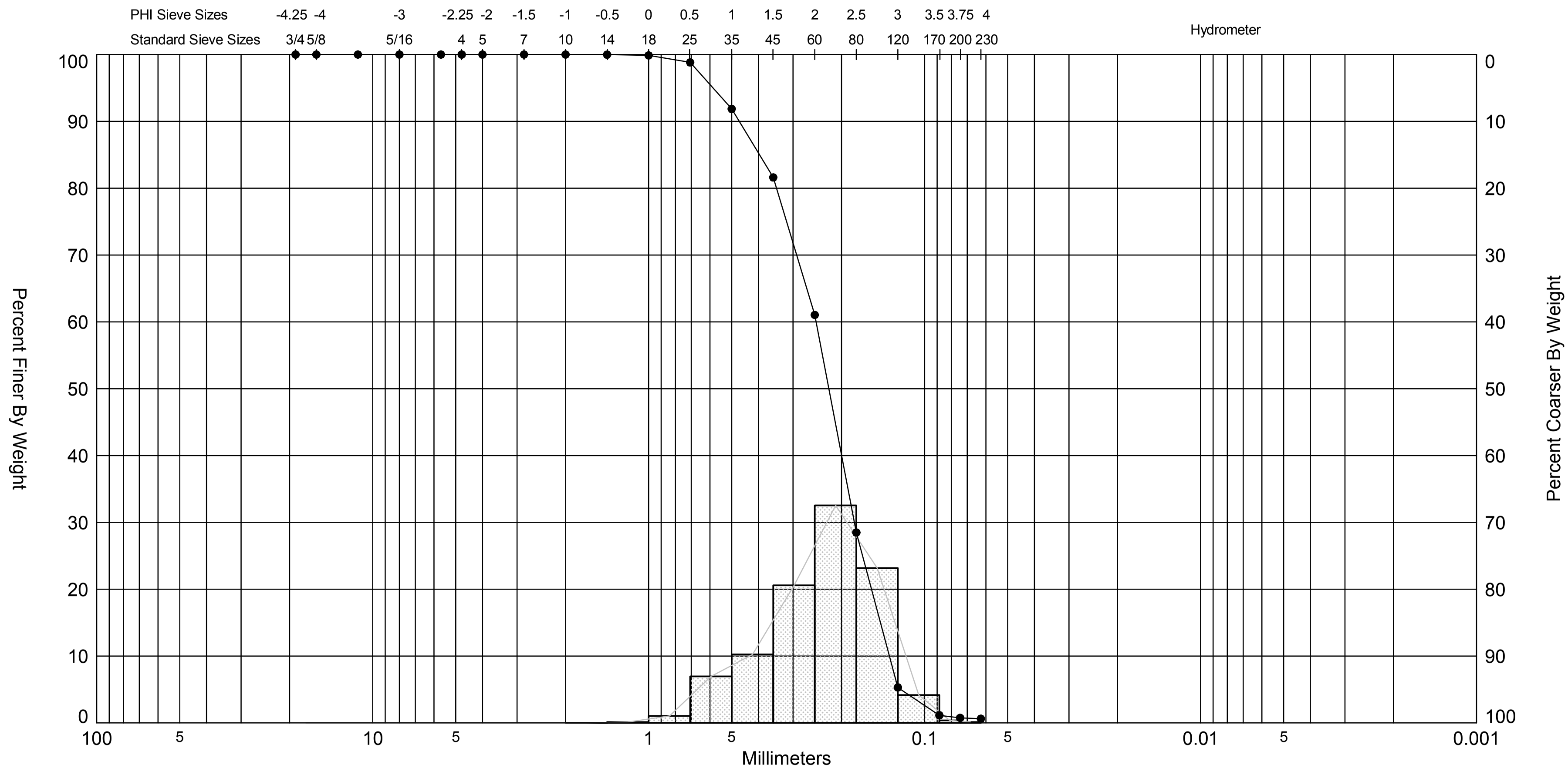
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
119.70	119.06	0.06	0.03	#200 - 0.75 #230 - 0.62		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.02	0.02	0.02	0.02
18	0.00	1.00	0.13	0.11	0.15	0.13
25	0.50	0.71	1.26	1.05	1.41	1.18
35	1.00	0.50	8.33	6.96	9.74	8.14
45	1.50	0.35	12.27	10.25	22.01	18.39
60	2.00	0.25	24.62	20.57	46.63	38.96
80	2.50	0.18	38.98	32.56	85.61	71.52
120	3.00	0.13	27.73	23.17	113.34	94.69
170	3.50	0.09	4.99	4.17	118.33	98.86
200	3.75	0.07	0.47	0.39	118.80	99.25
230	4.00	0.06	0.16	0.13	118.96	99.38

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.04	2.77	2.58	2.17	1.66	1.38	0.77

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	2.08	0.24	0.67	-0.51	3



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Ortona-Mason	—●—		SP	#200 - 0.75 #230 - 0.62		0	2.17	2.08	-0.51	3	0.67

Comments: Jahna Ortona

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Palmdale-FDOT Con.

Analysis Date: 05-11-11

Analyzed By: JR

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-7/1 Dry - 2.5Y-7/1 Washed - 5Y-8/1	Cemex Palmdale-FDOT Concrete

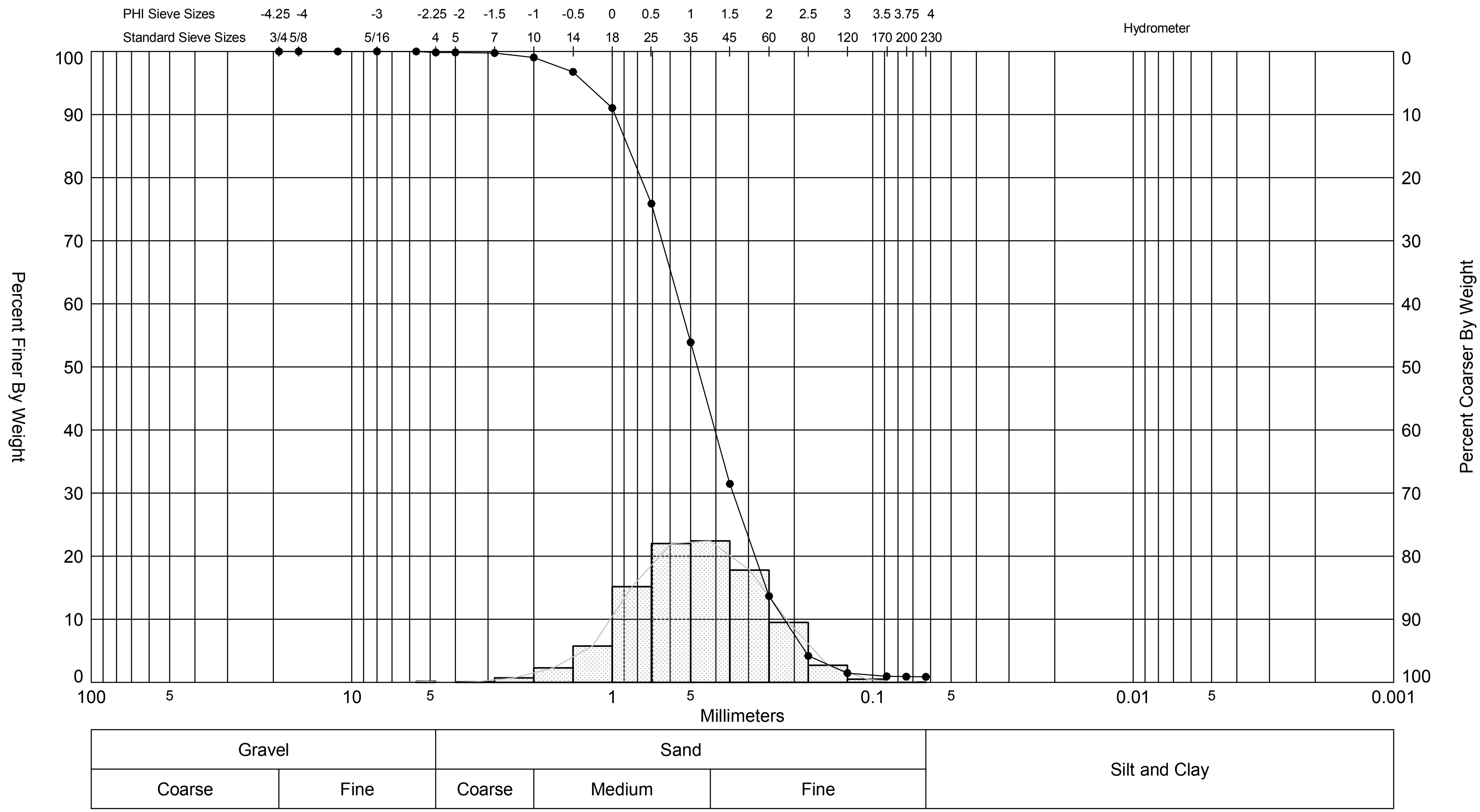
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
117.53	116.61	0.01	0.09	#200 - 0.90 #230 - 0.87		1	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.18	0.15	0.18	0.15
5	-2.00	4.00	0.00	0.00	0.18	0.15
7	-1.50	2.83	0.10	0.09	0.28	0.24
10	-1.00	2.00	0.83	0.71	1.11	0.95
14	-0.50	1.41	2.68	2.28	3.79	3.23
18	0.00	1.00	6.73	5.73	10.52	8.96
25	0.50	0.71	17.82	15.16	28.34	24.12
35	1.00	0.50	25.83	21.98	54.17	46.10
45	1.50	0.35	26.36	22.43	80.53	68.53
60	2.00	0.25	20.92	17.80	101.45	86.33
80	2.50	0.18	11.14	9.48	112.59	95.81
120	3.00	0.13	3.20	2.72	115.79	98.53
170	3.50	0.09	0.61	0.52	116.40	99.05
200	3.75	0.07	0.06	0.05	116.46	99.10
230	4.00	0.06	0.04	0.03	116.50	99.13

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.46	1.93	1.68	1.09	0.52	0.23	-0.35

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.07	0.48	0.84	-0.19	3.24



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Palmdale-FDOT Con.	——●——		SP	#200 - 0.90 #230 - 0.87		1	1.09	1.07	-0.19	3.24	0.84

Comments: Cemex Palmdale-FDOT Concrete

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources

Sample Name: Palmdale-Mason

Analysis Date: 05-19-11

Analyzed By: JR

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-5/3 Dry - 2.5Y-5/2 Washed - 5Y-8/1	Cemex

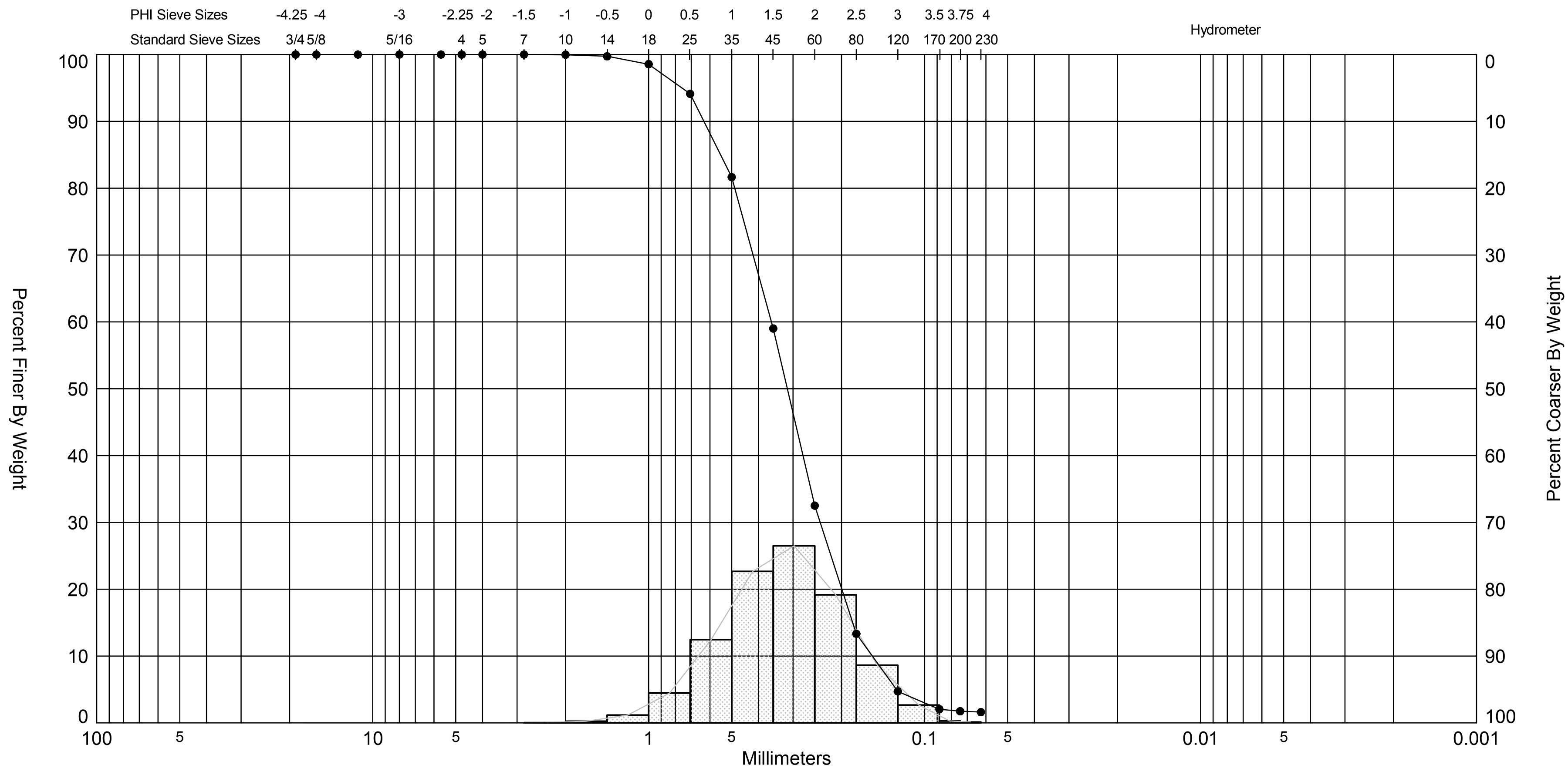
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
108.03	106.45	0.03	0.12	#200 - 1.74 #230 - 1.61		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.03	0.03	0.03	0.03
14	-0.50	1.41	0.26	0.24	0.29	0.27
18	0.00	1.00	1.26	1.17	1.55	1.44
25	0.50	0.71	4.80	4.44	6.35	5.88
35	1.00	0.50	13.46	12.46	19.81	18.34
45	1.50	0.35	24.47	22.65	44.28	40.99
60	2.00	0.25	28.64	26.51	72.92	67.50
80	2.50	0.18	20.71	19.17	93.63	86.67
120	3.00	0.13	9.30	8.61	102.93	95.28
170	3.50	0.09	2.88	2.67	105.81	97.95
200	3.75	0.07	0.34	0.31	106.15	98.26
230	4.00	0.06	0.14	0.13	106.29	98.39

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.98	2.43	2.20	1.67	1.15	0.91	0.40

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.64	0.32	0.74	-0.08	3.02



Gravel		Sand			Silt and Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Palmdale-Mason	—●—		SP	#200 - 1.74 #230 - 1.61		0	1.67	1.64	-0.08	3.02	0.74

Comments: Cemex

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-19-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: Ranch Road	
Analysis Date: 05-10-11	
Analyzed By: JR	

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SW	Wet - 5Y-6/2 Dry - 2.5Y-7/1 Washed - 2.5Y-7/1	Henry Fischer & Sons

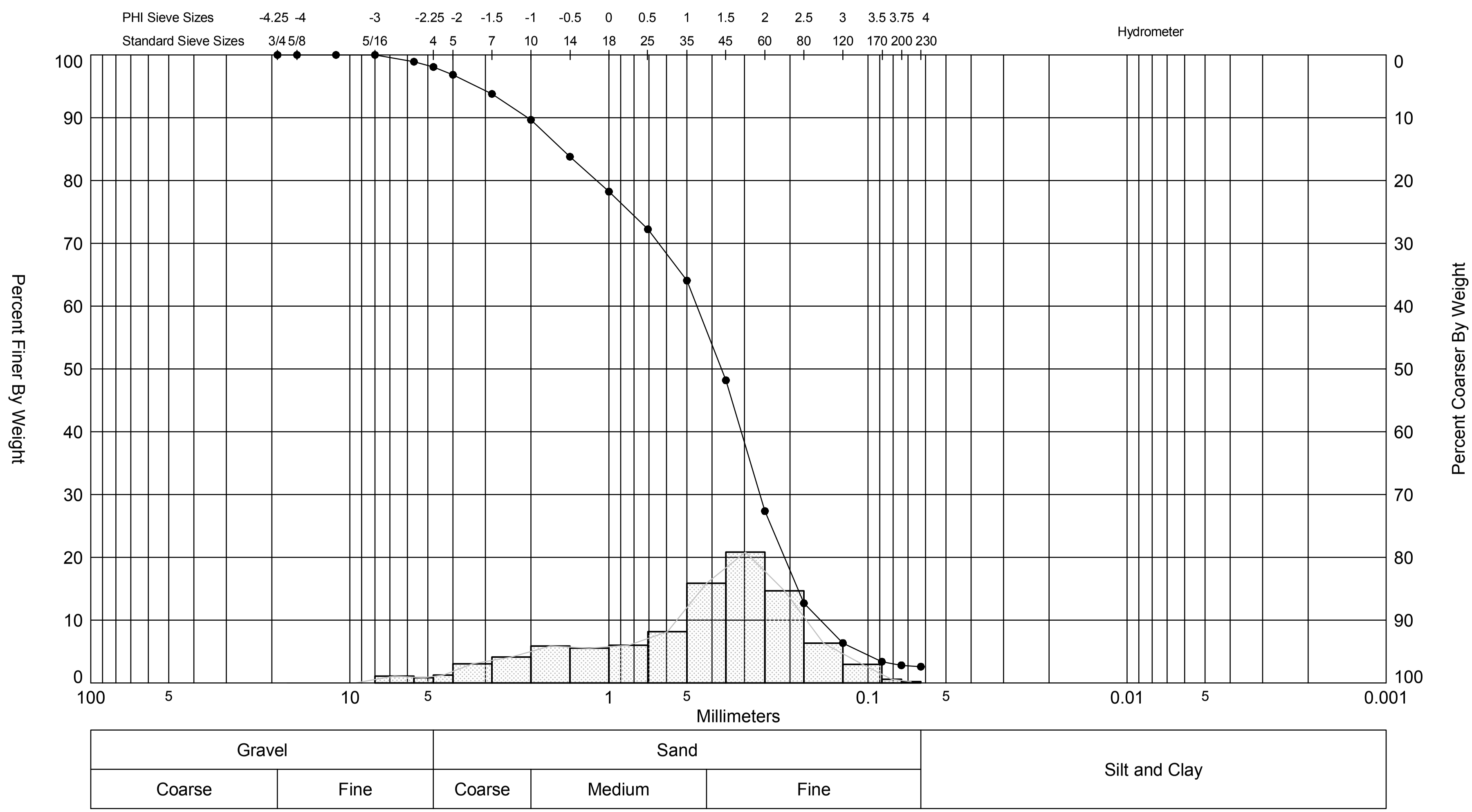
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
107.75	105.13	0.06	0.09	#200 - 2.81 #230 - 2.59		38	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	1.16	1.08	1.16	1.08
4	-2.25	4.76	0.91	0.84	2.07	1.92
5	-2.00	4.00	1.34	1.24	3.41	3.16
7	-1.50	2.83	3.29	3.05	6.70	6.21
10	-1.00	2.00	4.45	4.13	11.15	10.34
14	-0.50	1.41	6.33	5.87	17.48	16.21
18	0.00	1.00	5.99	5.56	23.47	21.77
25	0.50	0.71	6.47	6.00	29.94	27.77
35	1.00	0.50	8.79	8.16	38.73	35.93
45	1.50	0.35	17.11	15.88	55.84	51.81
60	2.00	0.25	22.44	20.83	78.28	72.64
80	2.50	0.18	15.81	14.67	94.09	87.31
120	3.00	0.13	6.83	6.34	100.92	93.65
170	3.50	0.09	3.20	2.97	104.12	96.62
200	3.75	0.07	0.61	0.57	104.73	97.19
230	4.00	0.06	0.24	0.22	104.97	97.41

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.23	2.39	2.08	1.44	0.27	-0.52	-1.70

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.06	0.48	1.39	-0.75	2.93



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Ranch Road	——●——		SW	#200 - 2.81 #230 - 2.59		38	1.44	1.06	-0.75	2.93	1.39

Comments: Henry Fischer & Sons

Depths and elevations based on measured values

Coastal Planning & Engineering
2481 NW Boca Raton Blvd, Boca Raton
FL 33431
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fax (561) 391-9116

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-10-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	
Sample Name: White Sand	
Analysis Date: 06-29-11	
Analyzed By: LC	

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fax (561) 391-9116

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 5Y-8/1 Dry - 5Y-8/1 Washed - 5Y-8/1	CC Calhoun, Pit #1

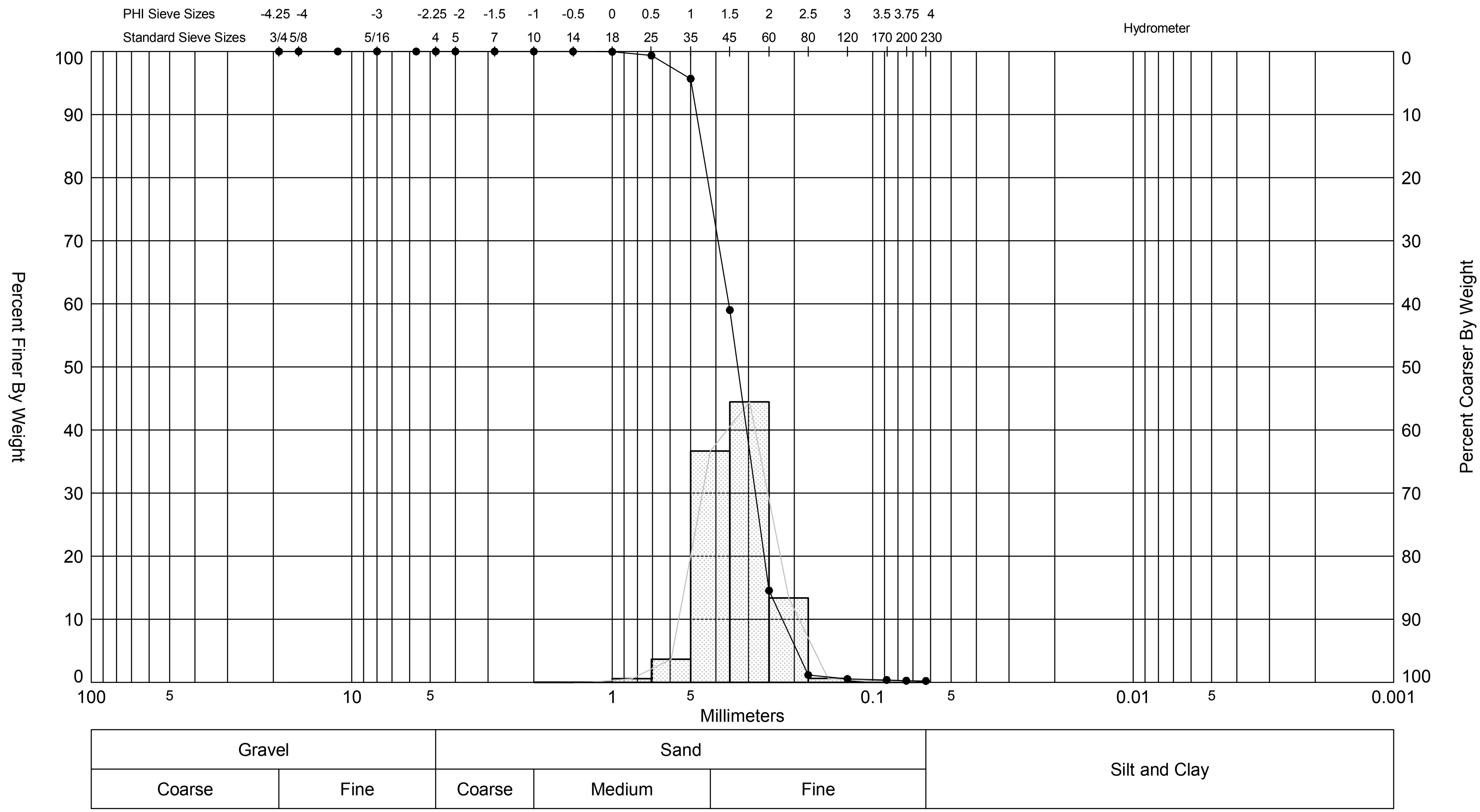
Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
112.41	112.24	0.00	0.07	#200 - 0.26 #230 - 0.22		0	

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.00	0.00	0.00	0.00
14	-0.50	1.41	0.01	0.01	0.01	0.01
18	0.00	1.00	0.04	0.04	0.05	0.05
25	0.50	0.71	0.66	0.59	0.71	0.64
35	1.00	0.50	4.14	3.68	4.85	4.32
45	1.50	0.35	41.22	36.67	46.07	40.99
60	2.00	0.25	49.98	44.46	96.05	85.45
80	2.50	0.18	15.04	13.38	111.09	98.83
120	3.00	0.13	0.71	0.63	111.80	99.46
170	3.50	0.09	0.18	0.16	111.98	99.62
200	3.75	0.07	0.14	0.12	112.12	99.74
230	4.00	0.06	0.04	0.04	112.16	99.78

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
2.36	1.98	1.88	1.60	1.28	1.16	1.01

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.6	0.33	0.41	0.2	4.44



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
White Sand	—●—		SP	#200 - 0.26 #230 - 0.22		0	1.6	1.6	0.2	4.44	0.41

Comments: CC Calhoun, Pit #1

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	06-29-11
Analyzed By:	LC
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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Granularmetric Report

Depths and elevations based on measured values

Project Name: Upland Sand Sources	Coastal Planning & Engineering 2481 NW Boca Raton Blvd, Boca Raton FL 33431 ph (561) 391-8102 fax (561) 391-9116
Sample Name: Witherspoon	
Analysis Date: 05-11-11	
Analyzed By: JR	

Easting (ft):	Northing (ft):	Coordinate System:	Elevation (ft):
		Florida State Plane East	

USCS:	Munsell:	Comments:
SP	Wet - 2.5Y-8/1 Dry - 2.5Y-8/1 Washed - 2.5Y-8/1	Vulcan

Dry Weight (g):	Wash Weight (g):	Pan Retained (g):	Sieve Loss (%):	Fines (%):	Organics (%):	Carbonates (%):	Shell Hash (%):
120.10	119.97	0.00	0.11	#200 - 0.23 #230 - 0.22		0	

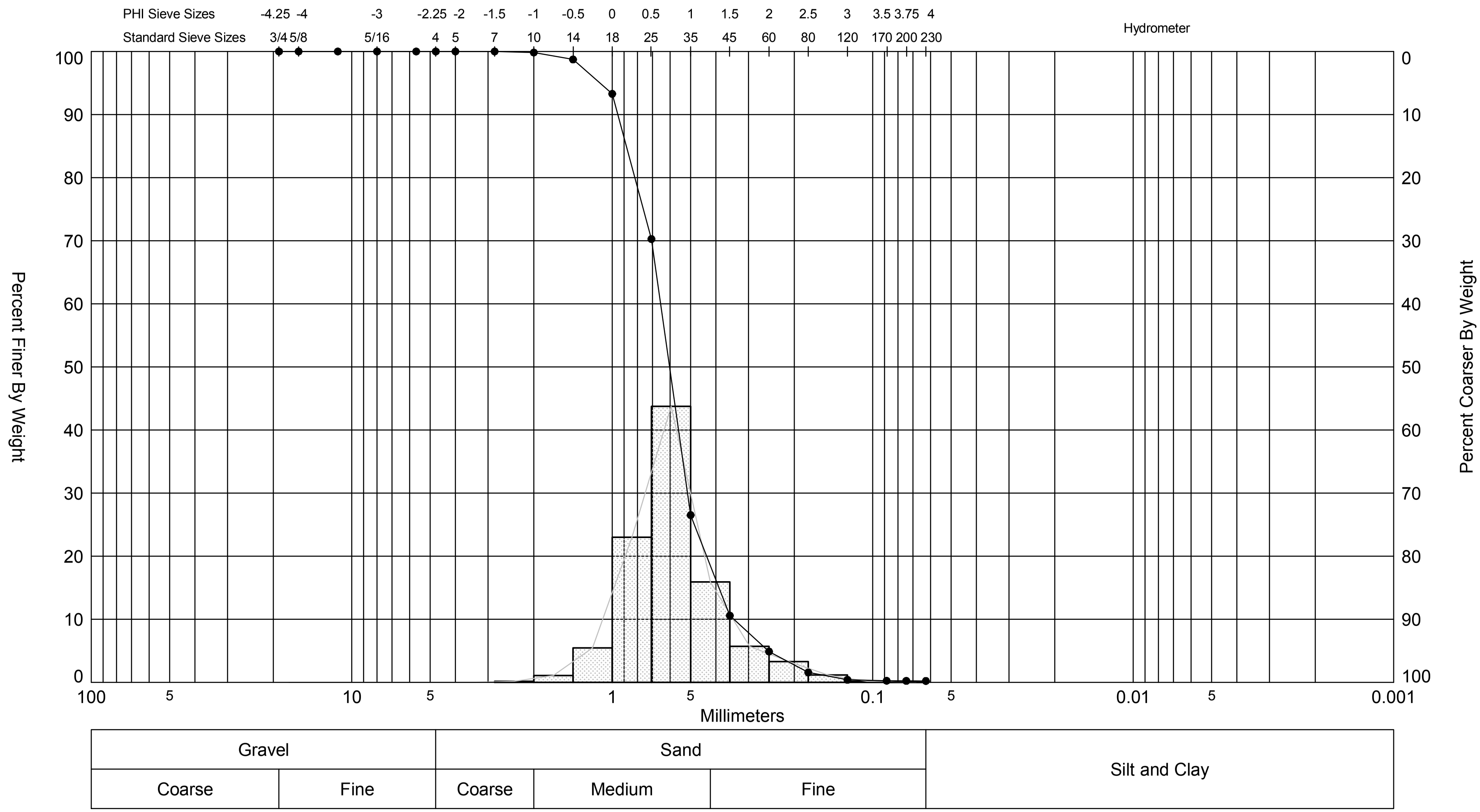
Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4"	-4.25	19.03	0.00	0.00	0.00	0.00
5/8"	-4.00	16.00	0.00	0.00	0.00	0.00
7/16"	-3.50	11.31	0.00	0.00	0.00	0.00
5/16"	-3.00	8.00	0.00	0.00	0.00	0.00
3.5	-2.50	5.66	0.00	0.00	0.00	0.00
4	-2.25	4.76	0.00	0.00	0.00	0.00
5	-2.00	4.00	0.00	0.00	0.00	0.00
7	-1.50	2.83	0.00	0.00	0.00	0.00
10	-1.00	2.00	0.21	0.17	0.21	0.17
14	-0.50	1.41	1.32	1.10	1.53	1.27
18	0.00	1.00	6.55	5.45	8.08	6.72
25	0.50	0.71	27.64	23.01	35.72	29.73
35	1.00	0.50	52.55	43.76	88.27	73.49
45	1.50	0.35	19.13	15.93	107.40	89.42
60	2.00	0.25	6.85	5.70	114.25	95.12
80	2.50	0.18	3.97	3.31	118.22	98.43
120	3.00	0.13	1.41	1.17	119.63	99.60
170	3.50	0.09	0.18	0.15	119.81	99.75
200	3.75	0.07	0.02	0.02	119.83	99.77
230	4.00	0.06	0.01	0.01	119.84	99.78

Shell Hash calculated from visual estimate of shell <4.75mm and >2.8mm.

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
1.99	1.33	1.05	0.73	0.40	0.20	-0.16

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	0.77	0.59	0.61	0.66	4.57

GRANULARMETRIC REPORT BROWARD_UPLAND_SAND_SOURCES.GPJ JPBRAZIL.GDT 8/31/11



Sample	Symbol	Elev. (ft)	USCS	% Fines	% Organics	% Carbonates	Median	Mean	Skew	Kurt	Sort
Witherspoon	—●—		SP	#200 - 0.23 #230 - 0.22		0	0.73	0.77	0.66	4.57	0.61

Comments: Vulcan

Depths and elevations based on measured values

Sample Information	
Project Name:	Upland Sand Sources
Analysis Date:	05-11-11
Analyzed By:	JR
Easting (X, ft):	
Northing (Y, ft):	
Horizontal System:	
Vertical System:	

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