

NPDES Permit Routine Sediment Monitoring in 2019: Ediz Hook - Port Angeles Net-Pens. Final Report

Net-pen Site

Ediz Hook Port Angeles Harbor

NPDES Permit Number

WA-004089-4

PREPARED FOR:

Washington State Department of Ecology

and

Cooke Aquaculture Pacific
P.O. Box 669
Anacortes, WA 98221

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PREPARED BY:

J.E. Jack Rensel, Ph.D.
Rensel Associates Aquatic Sciences Consultants
Arlington, Washington 98223

FIELD SAMPLING ASSISTANCE BY:

Gravity Marine Services
32617 SE 44th St.
Fall City, Washington 98024



Table of Contents

1. EXECUTIVE SUMMARY	1
2. INTRODUCTION	1
3. NPDES NAME DESIGNATION AND SAMPLING DATES	3
4. NET PEN CORNER LOCATIONS	4
5. PERFORMANCE STANDARDS: SEDIMENT ZINC	4
6. SUMMARY OF METHODS	5
7. SAMPLING STATION LOCATIONS	9
8. QUALITATIVE CHARACTERISTICS OF GRAB SAMPLES.....	10
9. SEDIMENT GRAIN SIZE & TOTAL ORGANIC CARBON RESULTS	13
10. SEDIMENT ZINC RESULTS	16
11. UNDERWATER VIDEO	17
12. DISSOLVED OXYGEN SUMMARY	19
13. PROJECT QUALITY CONTROL AND QUALITY ASSURANCE	20
14. QAQC SUMMARY	23
15. LITERATURE CITED.....	24
16. LIST OF APPENDICES.....	25

List of Figures

Figure 1. Vicinity Map showing general location of Port Angeles net pen sites and the nearest land of Ediz Hook shoreline.	2
Figure 2. Left: Full sized ponar sampler with weights. Right: Custom-built stainless-steel Van Veen style grab sampler and frame used in this 2019 survey after the full-sized Ponar grab sampler was damaged during sampling.	6
Figure 3. Sampling station locations, to approximate scale.	9

List of Tables

Table 1. NPDES site name, number, name abbreviation and type of monitoring conducted.	1
Table 2. NPDES net-pen site names, numbers and codes used for brevity in this report.....	3
Table 3. Sampling dates and tasks performed during this study.....	3
Table 4. Net Pen Corner GPS coordinates.	4
Table 5. Location and depth of sampling stations during sampling.	10
Table 6. Grab fullness, smell, visible sulfur reducing bacteria, apparent redox potential depth (RPD) and color for each sampling station and replicate grab.	11
Table 7. Total organic carbon and sediment grain size results and statistical summary.	15
Table 8. Replicate sediment zinc (Zn) concentrations with mean and standard deviation from samples collected during 2018 monitoring in Deepwater Bay.....	16
Table 9. Summary of underwater video quality and Observations	18
Table 10. Dissolved oxygen measurements required by the NPDES permit.	19
Table 11. Duplicate analysis of sediment total organic carbon samples.....	22
Table 12. Quality Control Check and Blanks for TOC.	22
Table 13. Duplicate analysis of sediment grain size (silt and clay only) samples.	23
Table 14. Duplicate analysis of sediment zinc samples.	23

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1. EXECUTIVE SUMMARY

National Pollution Discharge Elimination System (NPDES) monitoring at the Ediz Hook – Port Angeles Harbor net pen facility for the Department of Ecology (herein, Ecology) and Cooke Aquaculture Pacific was completed in late July 2019. Remaining fish in the cages had been harvested in April 2019. Sediment total organic carbon, grain size and zinc samples collected and analyzed by an analytical laboratory as required by the 2010 permit and in accordance with the 2010 Sampling and Analysis Plan. Methodology has been improved since that time and accordingly updates are summarized in this report.

Underwater videos of the sea bottom and qualitative observations were like prior monitoring events at this location in the past with no unusual conditions or overt indicators of eutrophication such as the *Beggiatoa* sp. sulfur-reducing bacteria. Spot prawns (*Pandalus platyceros*) remained the most common macrofauna observed on the seabottom with densities varying from none to many visible at any one time in the camera's field of view. Qualitative observations from underwater videos were restricted by turbidity as has been the case since routine sampling began in the mid-1980s at this location. The seabottom is mostly silt and clay within Port Angeles Harbor near the cages but becomes gradually sandier in areas to the east from near the Coast Guard station. The one shallower station near Ediz Hook had the best imagery as usual.

Sampling was completed successfully at all locations, although a grab sampler was damaged at one very deep location. At this location on the south end of the western net pen array a backup grab sampler was used to complete sampling by shifting the location of the grab sampler a few meters to the west. It is possible that the grab sampler encountered anchor chain. Underwater video did not indicate any unusual conditions or debris, but the sea bottom is composed of soft sediment and an anchor chain could have been below the surface.

Analysis of laboratory quality assessment and quality control indicated acceptable results. The sampling results were within allowable performance standards for net pen perimeter stations around the sediment impact zone. No further sampling is required or recommended given the results of this survey.

2. INTRODUCTION

This report documents the results of net-pen NPDES closure sampling results in summer 2019 conducted for the Washington Department of Ecology (herein: "Ecology") and Cooke Aquaculture Pacific, the net-pen permit holder, for the two sets of floating salmon net pens in Port Angeles Harbor as designated in Table 1.

Table 1. NPDES site name, number, name abbreviation and type of monitoring conducted.

NPDES Site Name	NPDES Number	Site Abbreviation Code	Type of Monitoring
Ediz Hood Port Angeles Harbor	WA-004089-4	PA	Site Closure

Closure monitoring is required in NPDES permits when fish culture is no longer practiced ensuring that the permitted area is returned to background conditions. A difficulty with this is that most Puget Sound fish farms have been in place for decades, prior to routine monitoring or baseline data collection. The net pens in Port Angeles Harbor have operated since the early 1980s with different owners periodically but the same manager over the past 30 years.

The first formal monitoring was voluntarily conducted by Sea Farms Norway in 1985 (Milner-Rensel 1986). Facility configuration changed extensively in the 1990s from east to west of a single large set of cages to north to south orientation of two sets of cages shown in Figure 1. The reorientation at that time occurred to improve water motion through the cages and to facilitate aerobic assimilation on the sea bottom.

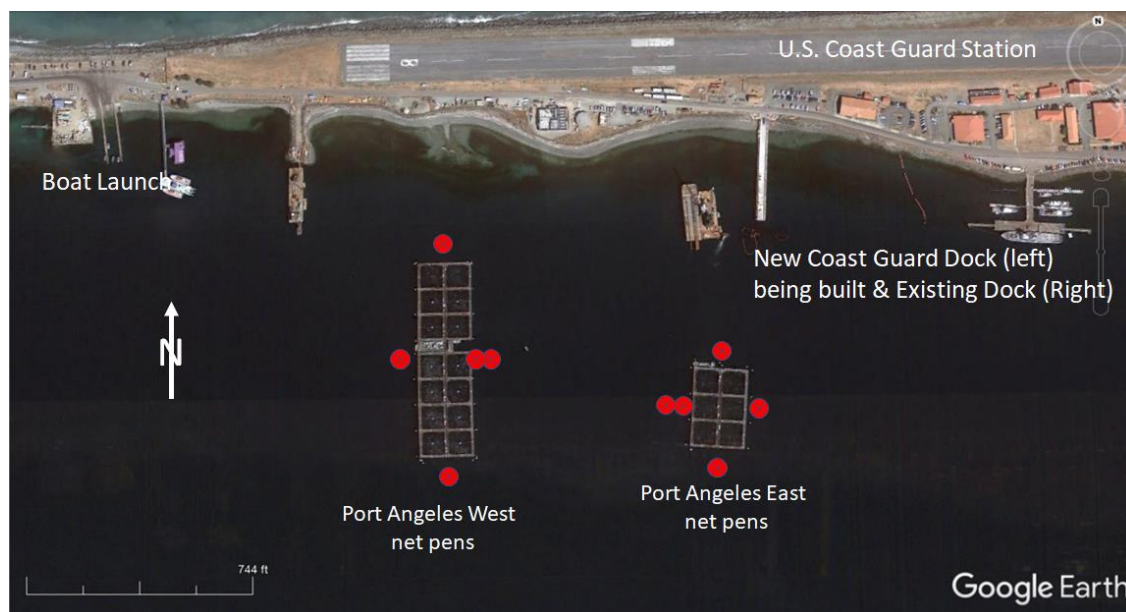


Figure 1. Vicinity Map showing general location of Port Angeles net pen sites and the nearest land of Ediz Hook shoreline.

Figure 1 is based on aerial photography as of July 30, 2017 showing the two sets of cages referred to as Port Angeles East (six cage group, abbreviated as PAE) and Port Angeles West (14 cage group, abbreviated as PAW). The red dots indicate the approximate location of required sampling stations with two stations on one side of each cage array. At each array, one station is for information only (50' distance) and the others are for regulatory performance assessment (100' distance).

There is extensive published and technical literature about Port Angeles Harbor, its physics, biology, human impacts and uses that is not reviewed here as this is a data report about net pen monitoring. Yet it is important to note that the most of the sediments of Port Angeles Harbor have been adversely affected by long-lasting perturbations such as log rafting, saw mills, plywood manufacturing, pulp and paper production, marine shipping and transport, boat building, bulk fuel facilities, marinas, and pleasure or commercial fishing boat moorage and maintenance occurred in or near the harbor (Ecology 2012). Within the inner harbor sediment

TOC and sulfide levels were extremely high at the time of that report and likely have not improved as of this writing as tree bark and wood fiber contains TOC that is refractory to oxidation. Large areas of the nearshore areas of Port Angeles Harbor were once log rafting sites (SAIC 1999). It is not clear if the net pen site was occupied by log rafts, but the Ecology sponsored report from 1999 did not have sampling stations nearby the existing net pen site. WDNR aerial photographs from 1997 and 1994 clearly show log rafting to the east of the launch ramp on Ediz Spit. Fallout from such log rafts are therefore likely in the area occupied by the existing net pens and decomposition of conifer tree bark and fiber and take many decades. Also in recent net pen monitoring, easily visible wood fibers were visible in some of the samples (Rensel 2018).

The structure of the closure sampling reported here was prearranged within the 2010 NPDES permit issued by the Washington Department of Ecology. The facility location has been monitored several times since then with guidance of a sampling and analysis plan first prepared in 2007 and amended slightly in 2010 (Rensel 2010) and reviewed by Department of Ecology staff. The present study and report represent the final sampling under the 2007-2010 SAP and the 2010 permit.

The 2010 sampling and analysis plan includes specifications for grab sampling of surficial sediment total organic carbon (TOC), grain size and zinc as well as underwater video recording of the sea bottom for each grab sampling station. Additionally, sampling of dissolved oxygen near the cages and at a single reference location is required.

3. NPDES NAME DESIGNATION AND SAMPLING DATES

Site nomenclature, NPDES number and location code used in reporting are shown in Table 2.

Table 2. NPDES net-pen site names, numbers and codes used for brevity in this report.

NPDES Site Name	NPDES Number	This Report Location Codes
Port Angeles Harbor Net Pens	WA-004089-4	PAW and PAE

Table 3 indicates the four sampling days and associated sampling activity conducted.

Table 3. Sampling dates and tasks performed during this study.

Sampling Net-pen Location Name	Sampling Dates
PAW and PAE perimeter stations grab sampling: TOC, grain size, zinc	23-24 July 2019
Drop video camera underwater monitoring of grab sampling stations	23-24 July 2019
Dissolved oxygen monitoring	24 July 2019

A Department of Ecology staff member (Laurie Niewolny) was on board the sampling vessel during the morning of the second day to observe sampling while some of the video and grab sampling stations were occupied. Two experienced Gravity Marine, Inc. staff operated the vessel and grab sample winch and two grab sampling specialists including the author acting as chief scientist were present.

4. NET PEN CORNER LOCATIONS

Table 4 presents the four corner GPS coordinates for both net pen arrays at the Ediz Hood - Port Angeles Harbor net pens that remained in place during this monitoring survey.

Table 4. Net Pen Corner GPS coordinates.

Site and Corner	Date and Time	Latitude	Longitude
PAE-NE	7/23/2019 17:13	N48.13848	W123.41778
PAE-SE	7/23/2019 17:14	N48.13778	W123.41795
PAE-SW	7/23/2019 17:15	N48.13784	W123.41867
PAE-NW	7/23/2019 17:17	N48.13857	W123.41851
PAW-SE	7/23/2019 17:24	N48.13770	W123.42173
PAW-SW	7/23/2019 17:25	N48.13771	W123.42246
PAW-NW	7/23/2019 17:28	N48.13949	W123.42248
PAW-NE	7/23/2019 17:29	N48.13951	W123.42171

5. PERFORMANCE STANDARDS: SEDIMENT ZINC

Sediment Zinc Standard: maximum of 410 mg/kg

Within the Department of Ecology regulations and WAC rules the applicable sediment zinc standard is a maximum concentration of 410 mg kg⁻¹. Sample results have not been adjusted for TOC content as the pertinent permit for net pens does not specify that it be done. Whether it is done or not is inconsequential as there never has been a violation of this standard in any of the net-pen sediment samples. Results are mostly an order of magnitude or less than the maximum allowable concentration.

The zinc standard “corresponds to a sediment quality that will result in no adverse effects, including no acute or chronic adverse effects on biological resources and no significant health risk to humans” (Washington Administrative Code: WAC 173-204).

Copper was monitored at Puget Sound net pens in the past when antifoulant was used on net pens to prevent biofouling. That is no longer practiced, but copper concentrations in sediments near net pens have never exceeded the regulatory limits and have been also routinely much less than maximum allowable concentrations. Zinc is a heavy metal and element that in a concentrated form is harmful to plant and animal life. But it is also an essential trace element for humans and other animals and many people are deficient in dietary zinc. It is an added constituent in fish feed in trace amounts and is also occurs naturally in sea water and ocean

sediments. It also has never exceeded the performance standard at any Puget Sound net pen facility.

If an elevated concentration is detected in our sampling, the responsible laboratory will re-digest the remaining homogenized sample replicate or for retesting of a single or multiple replicate of any subject station. That has happened a few times in the past for single replicate and without exception the re-analysis shows much lower zinc concentrations suggesting that the zinc is concentrated and possibly associated with galvanized metal. Zinc is also a common byproduct of our modern society from non-point run off and point sources like domestic sewers and may occur at higher concentrations in industrial areas harbors and waterways. Zinc tends to bind with sediments rich in silt and clay.

6. SUMMARY OF METHODS

Procedures and protocols were generally the same in 2019 as prior sampling years since 2010 in accordance with the sampling and analysis plan produced at that time (Rensel 2010). This section is a general summary of the methods. A new plan has been prepared for future monitoring of Puget Sound commercial net pens and is in final review by the Department of Ecology. The following constitutes a summary of updated methods used during in 2019 to amend that shown in the 2010 plan.

Benthic Sampling

A specialized, jet-drive sampling vessel with high resolution GPS, depth sounder and power winch-davit was positioned and maintained within a few centimeters of the target station as described in other prior recent net pen monitoring events (e.g., Rensel 2019).

Routine NPDES sampling commences by measuring distance from the outside edge of the net-pen SIZ by using a measuring calibrated line tied to the nearest cage located midway on all four sides of the rectangular net pen structure. When the davit of the sampling vessel was judged to be the appropriate distance along a perpendicular line from the net pen perimeter, a GPS waypoint was collected and stored on the sampling vessel's on-board computer. The measuring line is removed, and the vessel's operator maintains the location of the grab sampling davit sheave by using the rotary nozzles of the boat engine's jet drives or a 360-degree prop driven trolling assembly while referring to the computer display around the established waypoint. An effort is made to sample in wind and wave exposed stations during calm wind periods to minimize drift off station and minimize health and safety risks to crew.

The sea bottom at every sampling station was first inspected and recorded using a cabled underwater video camera with surface display. A priority during sampling was to inspect for the presence of obstructions or debris that could possibly interfere with sampling or jeopardize recovery of the sampler. The seabottom in this part of Port Angeles Harbor is composed mostly of silt and clay with very little or no coarse material like small gravel. The principal investigator was on deck and supervised each sampling attempt.

After the sampling is completed the videos are then inspected carefully for the presence of *Beggiatoa* sp. sulfur reducing bacteria that is visible even in turbid waters as a bright white

surface film that is spread all over the affected area in severe cases to just some small patches in early stages of impact. If this is seen during a field survey, the duration and spatial extent of the video survey would be increased. The presence of *Beggiatoa* has been extremely rare at net pen sites in Puget Sound over the past decade due to improvements in site configuration, depth and current velocity as well as reduced feed loss because of routine use of underwater camera feed detection equipment, better food conversion ratio and diets of the fish. The frequency of routine monitoring has also increased that allows for more timely feedback to the fish farmers about conditions near each site.

Figure 2. Left: Full sized ponar sampler with weights. Right: Custom-built stainless-steel Van Veen style grab sampler and frame used in this 2019 survey after the full-sized Ponar grab sampler was damaged during sampling.



For this present survey we initially used a full-sized Ponar Grab sampler (Figure 2 left). But midway through sampling something entangled that grab sampler at the deep (south) end of PAW net pens structure. The grab sampler was trapped on the bottom for some time while we worked to remove it. The problem occurred despite inspection of the seabottom first. As a result of this, we shifted sampling to a custom-made stainless-steel Van Veen style grab sampler with full opening top on both sides with a 0.073 m² jaw opening (Figure 2 right). The sampler was built by Gravity Marine Resources and was used to collect grain size and sediment chemistry samples during prior grab sampling events for Cooke Aquaculture Pacific.

The degree of sampler fullness and surface disturbance or leakage from the grab sampler was evaluated collectively to decide whether to accept or reject each grab, as per Puget Sound Estuary Protocol requirements (WA Department of Ecology, USEPA, and Puget Sound Water Quality Authority 2015). All grab samples were inspected for the presence of *Beggiatoa sp.* If a specific grab was judged acceptable, and after siphoning off trapped surface water, sample

characteristics such as surface color, visible biota, presence of rock, gravel, shell, shell hash, and other material was recorded and a photograph was taken of the sample surface, one on each side of grab sampler. The photographs are not a required NPDES permit task and were not included with this report for this site as they were essentially the same and very nondescript as has always been the case at the Port Angeles Harbor net pen sites. The grab sample fullness depth was measured in the center of the sample with a stainless-steel ruler and recorded.

A core was then taken of the upper two (2) cm of sample and at least one of the deck crew held the sample up close to smell the bottom side of the core for the presence of sulfur. If there was any doubt, a second staff member, usually the principal investigator would also smell the core to decide. The core was discharged by shaking into a pre-numbered Whirl Pac bag, mixed by hand and then sealed and placed in a cooler with ice within a plastic container with only other replicates from the sampling station occupied at that time.

A stainless-steel spoon was used to remove about 150 to 200 grams of the top two cm of the grab sample and placed in a pre-numbered Ziplock freezer bag for storage with ice in another cooler. When this was completed the deck crew then probed the sample to further depth looking for the presence of an apparent redox potential discontinuity (aRPD) layer interface and recording information as it was acquired. The excess sample was then discharged overboard, and the grab sampler cleaned and readied for the next deployment.

For TOC and zinc samples, the top 2 cm of each core was separated from the main core, placed in sterile Whirl-Pak bag containers that were pre-labeled in two locations. The samples were mixed by hand inside the bags before closing. The sample containers were placed on ice in coolers immediately after sealing and frozen later the same day until analyzed at an Ecology-certified laboratory. Sediments collected for grain size analysis were placed in pre-labeled zip lock freezer bags, stored in a cooler with ice and refrigerated later the same day for later transport the certified analytical laboratory.

Chain of custody data sheets were provided to the Ecology-certified analytical laboratory involved to accompany sample shipment. IEH Laboratories of Seattle, WA conducted the laboratory analyses. Laboratory director Dr. Damien Gadomski was directly involved in all aspects of sample preparation, analysis and reporting.

Sediment samples for TOC and zinc analysis were homogenized in the field within the sample containers (i.e., within the Whirl Pac containers) and separately before analysis in the laboratory. At the laboratory, TOC samples were carefully and slowly treated with weak acid to remove inorganic carbonates before analysis. There was little or no shell or shell hash in the Port Angeles sampling stations. Analysis of total organic carbon and sediment grain size (sieve only) was conducted using standard procedures as reported on the laboratories' data sheets. Chain of custody forms were given to each laboratory to document the sample numbers, dates and company contacts and the laboratory provided written, signed documentation of all the samples with attendant quality control analyses reporting.

Station Positioning

In addition to measuring distance from the pens with a field measuring line, DGPS locations were taken at all stations using a survey-grade heading and GPS recording system. The sampling

vessel owned by Gravity Marine Consultants (RV Cayuse, see the following link for photos and specifications: <https://gravitymarine.com/news/vessel/rv-cayuse>) The sampling vessel was outfitted with a Trimble SPS461 modular GPS heading receiver with a WAAS correction package. The Trimble SPS461 collects satellite and ground corrections to provide a DGPS horizontal position accuracy of 25 cm. The dual-antenna heading receiver also has an accuracy of 0.09-degrees for vessel heading and course calculations.

Navigation and vessel positioning are performed using the Hypack 2016a survey software which combines positioning with vessel dimensions, A-frame point location, and heading data. GPS and heading data are fed from the SPS461 receiver via serial connection, and input into the vessel's survey computer. The Hypack navigation software monitors the heading and position data real time. Vessel specifications are input into the Hypack software to both accurately reflect the dimensions of the vessel, the center of rotation, and the inclusion of an offset tracking point to collect corrected GPS data over the data acquisition point. This allows the navigation software to reflect in real-time both the heading of the vessel and the course over ground. Offsets are used to correct GPS data from the location of the installed antenna to the location of the acquired sample. The vessel operator can use the vessel's 360-degree engine jet nozzle to fine tune the location or a 360-degree trolling motor can be mounted and operated when conditions are suitable to maintain positioning. Station locations were digitally recorded at least once to the on-board computer during sampling. The above-mentioned DGPS unit was routinely monitored to ensure the differential corrections were being received by the DGPS system.

Underwater video

Underwater video at each sampling station identified in the sampling location section was collected by lowering a Ninja2 color video drop camera equipped with internal LED lights near the bottom for a minimum of 15 to 30 seconds of recording and greater than 100 meters of cable. The 2010 NPDES net pen permit requires the camera to bottom distance to be 3 to 7 feet but in over 30 years of sampling at the Port Angeles net pens under all conditions encountered, nothing has been visible at those distances all but the north side and shallow stations. This was documented in 2002, 2007, 2010, 2011, 2012, 2013, 2015 and 2017 NPDES net-pen sampling events. No editing was done of the sea bottom videos and videos that accompany this report are to be provided to Ecology via an FTP or cloud computing storage link.

Statistical Analysis

Statistical procedures included a transformation of the individual replicate data points for total organic carbon using a Department of Ecology rule involving data arcsine transformation. This procedure is outlined by Zar (2010) and others involves transforming the raw data by the formula: $\arcsin \sqrt{(\text{TOC}\%/100)}$, where the value after arcsine is the quantity square root. This was calculated as part of the Excel 2016 software package, by devising a formula. This type of transformation is often done to normalize proportional or percentage data which in turn facilitates use of the student's "t" parametric test.

A computer program (Statistix for Windows v9) was used to calculate t test results of the transformed TOC values compared to a transformed trigger value. These results were

compared to tabular values of t with alpha of 0.05, one-tailed (greater than, not two-tailed, see PSDDA 1996) to determine if TOC values exceeded critical values from either the NPDES rule or the site-specific baseline values, the latter taking precedence if available. This is the same procedure that has been conducted for many years of net-pen data analysis as reported to the Department of Ecology.

7. SAMPLING STATION LOCATIONS

The 2010 NPDES permit for Puget Sound net pens specifically identifies five stations to be sampled surrounding each separate net pen array. Four of the five stations are located exactly 100 feet from the net pen perimeter at the edge of the permit designated sediment impact zone as shown in Figure 3 with depth and GPS coordinates shown in Table 5.

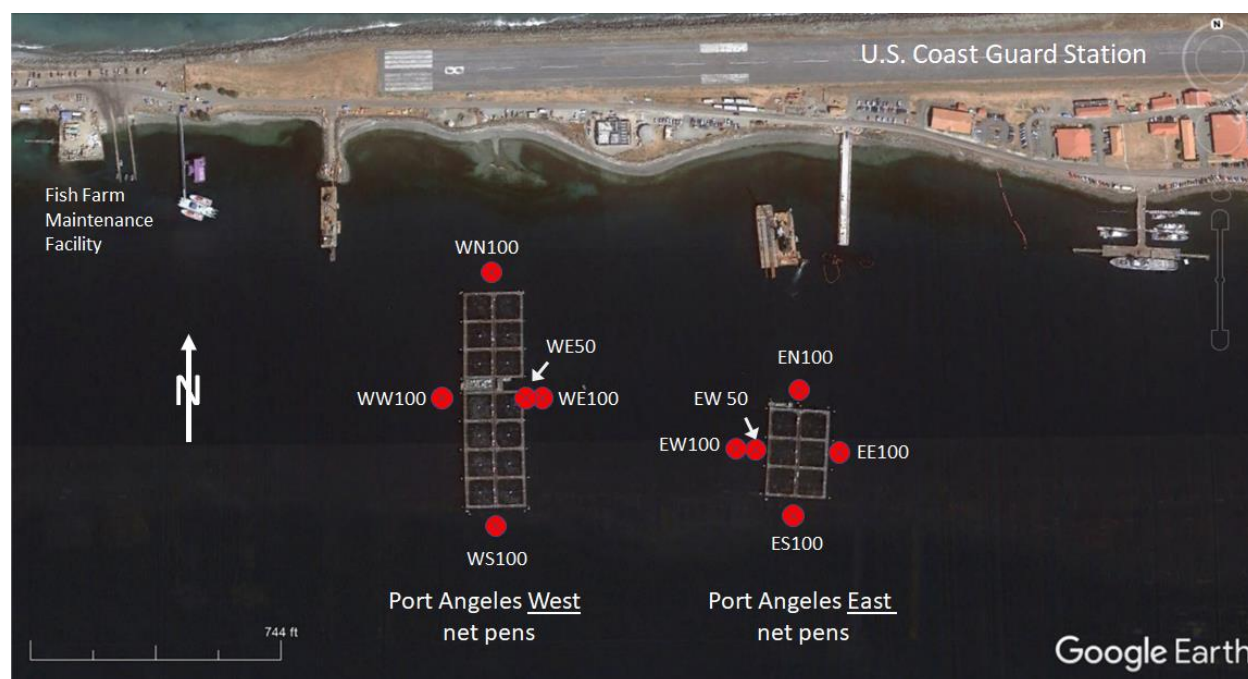


Figure 3. Sampling station locations, to approximate scale.

Additionally, a fifth station is to be in the dominant flow direction at 50' distance. This station is not a regulatory performance evaluation station but rather for information as it is within the allowable sediment impact zone (SIZ) although having such a zone does not mean that there necessarily are adverse effects. Table 5 includes the location of a water column reference station where one grab sample and core were collected, but the latter was not a permit requirement. One additional station 200 m west of the PA West cages was also monitored with a single grab sample for TOC and sediment grain size. In Figure 3 it would be located approximately at the location of the north direction arrow on the left side of the figure.

Generally, the tidal current flows east and west through these cages parallel to Ediz Spit and perpendicular to the long axes of the cages. But there is no definitive information regarding which of the directions should be considered strongest. As a conservative measure, I have routinely sampled on the west side of PAE and the east side of PAW as the two sides are

nearest each other. Hence if there are cumulative effects of interaction between the two cage facilities, these locations would be more affected. During this 2019 survey all 10 stations were successfully sampled with five replicates each, resulting in 50 individual samples that were submitted to the analytical laboratory plus the one voluntary reference sample mentioned above.

Table 5. Location and depth of sampling stations during sampling.

Station	Latitude	Longitude	Depth (ft.)
WW100	48.13871164 N	123.42285624 W	175'
WS100	48.13740501 N	123.42212704 W	190'
WS100*	48.13742025 N	123.42226005 W	190'
WE50	48.13869950 N	123.42150269 W	172'
WE100	48.13870450 N	123.42130075 W	172'
WN100	48.13979147 N	123.42207347 W	84'
EW100	48.13821144 N	123.41901289 W	191'
EW50	48.13819811 N	123.41880667 W	190'
REF1	48.13890145 N	123.42511594 W	175'
EE100	48.13810388 N	123.41746676 W	118'
EN100	48.13880106 N	123.41797605 W	135'
ES100	48.13751374 N	123.41840530 W	187'

The WS100 station has two location shown in Table 5. This was due to the need to alter the location slightly to the west to avoid the object(s) on the sea bottom that damaged one of the grab samplers. The relocated position is shown with the asterisk. The relocation was to the west of the initial location. This is not a downstream end of the cage and this alteration is highly unlikely to introduce any bias into the measurements of TOC, grain size or zinc as the area is extremely deep and has in the past always produced acceptable results.

8. QUALITATIVE CHARACTERISTICS OF GRAB SAMPLES

The qualitative nature of the grab samples in all the NPDES monitoring surveys I conduct are important. The results are useful as a check on stations that had unusually high or low sediment TOC results from one or more replicate samples. The appearance, color, smell and other characteristics can be compared among replications and stations to verify if the recorded quantitative results.

Table 6 summarizes general observation made during sampling of the photographs taken of the surface of the seabottom retained within the grab sampler.

Table 6. Grab fullness, smell, visible sulfur reducing bacteria, apparent redox potential depth (RPD) and color for each sampling station and replicate grab.

Station	Rep.	Sample No.	Grab fullness cm	Sulfur Smell	Visible Beggiatoa Sp.	aRPD present	Surface/2cm deep Color	Comments
WW100	1	1	8	Slight	no	no	gray over black	
WW100	2	2	10	Slight	no	no		
WW100	3	3	9	Slight	no	no		
WW100	4	4	10	Slight	no	no		
WW100	5	5	8	Slight	no	no		
WE100	1	6	10	Slight	no	no	gray over black	
WE100	2	7	10	Slight	no	no		
WE100	3	8	11	Slight	no	no		
WE100	4	9	11	Slight	no	no		
WE100	5	10	10	Slight	no	no		
WE50	1	11	11	moderate	no	no	gray over black	
WE50	2	12	12	moderate	no	no		
WE50	3	13	11	moderate	no	no		
WE50	4	14	10	moderate	no	no		
WE50	5	15	11	moderate	no	no		
EW100	1	16	9	Slight	no	no	More gray over black	
EW100	2	17	8	Slight	no	no		
EW100	3	18	9	Slight	no	no		
EW100	4	19	9	Slight	no	no		
EW100	5	20	7	Slight	no	no		
EW50	1	21	7	none	no	1 cm	surface gray and lighter than other locations, black below	A few mussel shells
EW50	2	22	7	none	no	1 cm		
EW50	3	23	8	none	no	1 cm		
EW50	4	24	8	none	no	1 cm		
EW50	5	25	8	none	no	1 cm		
WS100	1	26	8	none	no	no	gray	
WS100	2	27	15	none	no	no		
WS100	3	28	15	none	no	no		
WS100	4	29	15	none	no	no		
WS100	5	30	15	none	no	no		
WN100	1	31	10	none	no	1 cm	gray	
WN100	2	32	11	none	no	0.5 cm		
WN100	3	33	9	slight	no	0.5 cm		
WN100	4	34	11	none	no	2.5 cm		
WN100	5	35	13	none	no	0.5 cm		

Station	Rep.	Sample No.	Grab fullness cm	Sulfur Smell	Visible <i>Beggiatoa</i> Sp.	aRPD present	Surface/2cm deep Color	Comments
EE100	1	36	15	none	no	2 cm	gray over black	
EE100	2	37	15	none	no	2 cm		
EE100	3	38	15	none	no	2 cm		
EE100	4	39	15	none	no	2 cm		
EE100	5	40	15	none	no	2 cm		
EN100	1	41	10	none	no	6 cm	medium to dark grey, variable among replicates	
EN100	2	42	12	none	no	6 cm		
EN100	3	43	10	none	no	6 cm		
EN100	4	44	8	none	no	6 cm		
EN100	5	45	8	none	no	6 cm		
ES100	1	46	15	none	no	no	gray	Tubicolous and errantia polychaetes
ES100	2	47	15	none	no	no		
ES100	3	48	15	none	no	no		
ES100	4	49	15	none	no	no		
ES100	5	50	15	none	no	no		

- **Olfactory Results:** Five of the ten sampling stations had no sulfur smell from the cores. Three stations had slight sulfur smell for all replicates. One station had one of the five replicates with a slight sulfur smell. One station, WE50 had moderate sulfur smell from all replicate cores; it is an information station only, not a station where the regulatory limits for sediment TOC or zinc apply.

The human olfactory detection level of hydrogen sulfide ranges from 10 to 50 parts per billion or lower in some cases Toombs et al. (2010). So even a trace of hydrogen sulfide is highly detectable when we held the cores up to smell them while cupping them in our hands. Every sample was sensed by one of the deck hands and then the principal investigator if there was any possible detection of sulfur smell.

- **Sulfur Reducing Mats:** No stations exhibited signs of *Beggiatoa* spp. bacterial mats on the surface of the sea floor, either in videos or on the retrieved grab sample surfaces. When present these are easily detected as discussed above. Also, no sea bottoms seen in the video were emitting visible bubbles of methane or other gases.
- **Apparent Redox Potential Zone depth (aRPD):** One station (WE50) indicated an aRPD of 1 cm deep where the sediment was darker than the top 1 cm layer. See Rensel (2019) for a discussion of the use of this metric regarding research published by Gerwing et al. (2018). That work *suggested* that the aRPD depth is not an analytical method to evaluate sediment pore water dissolved oxygen or Eh (reduction/oxidation) conditions. Nor is it suggested that black sediment indicates anoxia, or that RPD depth is indicative of actual RPD depth. Nevertheless, in this case this observation correlated with the only station to have

moderate sulfur smell and relatively high TOC concentration. Again, this station is within the permit allowed sediment impact zone.

- **Grab Sample surface color:** all stations indicated normal, grey colored sediment surface color.
- **Other Grab Sample Inspection Observations:** Fragment of mussel shell were noted at station WE50. Several tubicolous and errantia (i.e., tube-dwelling and free living) segmented polychaete worms were observed at ES100.

9. SEDIMENT GRAIN SIZE & TOTAL ORGANIC CARBON RESULTS

Data Presentation

Table 7 presents detailed results of silt/clay and TOC replicate samples derived from the laboratory reports copied into the attached Appendix. Five replicates were collected at every station specified in the sampling and analysis plan as per the NPDES permit requirements, as previously discussed.

Sediment Grain Size

Seven out of 10 stations between 50 to 80% fines, two stations had > 80% fines and one station in relatively shallow water and nearer Ediz Hook was in the 20 to 50% category regarding the four sediment fines categories used to assess sediment TOC performance of net pens. In general, the percent fines were like prior sampling events that were judged acceptable based on QAQC assessments.

The highest mean sediment fines concentrations in these 2019 samples occurred at PAWE50 and PAW100 with very similar results of approximately 84% for both with minimal among replicate standard deviation. For comparison, for the 2015 sampling (Rensel 2016) the mean of the same to stations was 79.2%, a 5.8% relative change but well within precision limits the laboratory method. As discussed below in relation to the TOC results, a small change can constitute a significant difference in regulatory results, however, as the standards have abrupt step boundaries that may greatly affect outcomes with very small differences of percent fines.

The lowest sediment fines occurred at PAWN100 that is the shallow end of the larger of the two facilities where mean fines averaged 25.6% (SD 4.7%) in these 2019 results. Yet in 2015 the seabottom at that same sampling station averaged only 3.2% and only three samples could be acquired due to extensive shell and shell hash. Deeper stations have not had this kind of interannual variability.

Sediment TOC

Table 7 includes all data used to assess sediments fines and TOC as well as the results of statistical testing summaries for TOC as required by the subject NPDES permit.

All of the 100' sediment impact zone perimeter stations had TOC concentrations less than the limits cited in the NPDES permit for the station-specific percent fines category. All but one of these perimeter stations were well within the requirements except WN100 that nominally exceeded the result, but the statistical t test indicated a non-significant difference due to

variability. This station has previously had issues with wood fiber in the core samples that was visible upon inspection in the laboratory. I expect this to continue as Port Angeles Harbor has large areas with excessive wood fiber present, as noted by Ecology (2012).

One of the two 50' distant stations, WE50, statistically exceeded the TOC limit with a mean value of 3.09%. The silt and clay concentration at this station was just slightly higher (at 84.2%) than the 80% break point between regulatory classes of TOC, so the regulatory criterion declined abruptly from 3.2% to 2.6%. However, this 50' distant station is defined in the permit to be used for information only as it is within the allowed sediment impact zone. Accordingly, no action is required with respect to TOC results for this station, as well as all other stations.

Table 7. Total organic carbon and sediment grain size results and statistical summary.

Site and Station Number→	PAWW100	PAWE100	PAWE50	PAEW100	PAEW50	PAWS100	PAWN100	PAEE100	PAEN100	PAES100
Raw TOC Replicate Values (decimal)										
replicate 1	2.40	2.79	3.02	2.95	2.47	2.88	2.96	1.68	2.36	2.46
replicate 2	2.31	1.64	3.32	1.68	2.79	2.57	1.70	2.18	1.92	1.89
replicate 3	2.77	2.96	2.91	2.39	2.09	2.46	1.38	1.92	1.67	1.87
replicate 4	2.69	2.27	2.60	3.37	2.35	2.32	1.98	1.80	1.49	1.83
replicate 5	2.52	3.29	3.60	2.55	1.92	2.22	3.04	2.64	3.10	2.41
Arcsin Transformed TOC (decimal)										
replicate 1	8.92	9.61	10.01	9.89	9.04	9.77	9.91	7.45	8.84	9.03
replicate 2	8.74	7.35	10.50	7.45	9.62	9.22	7.48	8.49	7.97	7.90
replicate 3	9.58	9.90	9.82	8.89	8.30	9.02	6.73	7.97	7.42	7.86
replicate 4	9.43	8.67	9.28	10.57	8.82	8.75	8.08	7.71	7.02	7.76
replicate 5	9.14	10.45	10.94	9.18	7.96	8.57	10.05	9.35	10.14	8.93
Silt-Clay (decimal)										
replicate 1	0.792	0.877	0.860	0.681	0.593	0.763	0.284	0.564	0.663	0.545
replicate 2	0.770	0.861	0.859	0.667	0.659	0.755	0.259	0.598	0.597	0.596
replicate 3	0.769	0.843	0.838	0.603	0.626	0.772	0.193	0.559	0.672	0.616
replicate 4	0.782	0.836	0.811	0.627	0.617	0.795	0.228	0.577	0.538	0.537
replicate 5	0.746	0.817	0.840	0.647	0.582	0.707	0.314	0.605	0.657	0.581
Mean silt-clay (decimal)	0.772	0.847	0.842	0.645	0.615	0.759	0.256	0.581	0.625	0.575
SD	0.017	0.023	0.020	0.031	0.030	0.032	0.047	0.020	0.057	0.034
Appropriate TOC trigger (percent)	3.2%	2.6%	2.6%	3.2%	3.2%	3.2%	1.7%	3.2%	3.2%	3.2%
Observed mean TOC (percent)	2.54	2.59	3.09	2.59	2.32	2.49	2.21	2.04	2.11	2.09
Observed St. Dev. TOC	0.19	0.65	0.38	0.63	0.34	0.26	0.75	0.38	0.64	0.32
Arcsin transformation, mean TOC	9.16	9.20	10.11	9.20	8.75	9.07	8.45	8.19	8.28	8.30
Arcsin transformation, trigger level	10.30	10.30	9.28	10.30	10.30	10.30	7.49	10.30	10.30	10.30
Calculated t, transformed data	-7.32	-2.03	2.91	-2.10	-5.37	-5.93	1.45	-6.26	-3.63	-7.14
Critical t, alpha = 0.05, 1 tailed	2.132	2.132	2.132	2.132	2.132	2.132	2.132	2.132	2.132	2.132
Calculated exceeds critical level?	No	No	NA	No	NA	No	No	No	No	No
Additional action required?	No	No	NA	No	NA	No	No	No	No	No

10. SEDIMENT ZINC RESULTS

Individual replicate and sampling station average sediment zinc results were all much less than regulatory requirements at all sampling stations as shown below in Table 8. The applicable sediment zinc performance standard is 410 mg kg⁻¹ dry weight.

Table 8. Replicate sediment zinc (Zn) concentrations with mean and standard deviation from samples collected during 2019 monitoring at Ediz Hook – Port Angeles Harbor net pens.

Sample ID	Station	Total Solids	Water	Zinc	Mean Zn	SD Zn
		(%)	(%)	(mg/kg Dry Weight)	(mg/kg)	(mg/kg)
1	WW100	43.4%	56.6%	78.6		
2	WW100	44.6%	55.4%	120.0		
3	WW100	42.8%	57.2%	84.5		
4	WW100	39.6%	60.4%	85.1		
5	WW100	47.5%	52.5%	88.1	91.2	16.4
6	WE100	41.2%	58.8%	87.7		
7	WE100	42.0%	58.0%	77.0		
8	WE100	41.5%	58.5%	79.0		
9	WE100	44.8%	55.2%	71.8		
10	WE100	39.5%	60.5%	79.0	78.9	5.7
11	WE50	45.5%	54.5%	75.5		
12	WE50	45.4%	54.6%	74.6		
13	WE50	40.2%	59.8%	79.1		
14	WE50	44.7%	55.3%	72.0		
15	WE50	44.6%	55.4%	87.3	77.7	5.9
16	EW100	55.3%	44.7%	101		
17	EW100	53.7%	46.3%	162		
18	EW100	55.1%	44.9%	70.5		
19	EW100	54.6%	45.4%	74.7		
20	EW100	56.2%	43.8%	83.0	98.3	37.5
21	EW50	55.8%	44.2%	62.4		
22	EW50	57.7%	42.3%	70.1		
23	EW50	52.4%	47.6%	80.9		
24	EW50	51.9%	48.1%	72.7		
25	EW50	58.1%	41.9%	72.2	71.7	6.6
26	WS100	53.0%	47.0%	67.1		
27	WS100	52.2%	47.8%	70.3		
28	WS100	54.0%	46.0%	76.0		

Sample ID	Station	Total Solids	Water	Zinc	Mean Zn	SD Zn
29	WS100	54.5%	45.5%	68.7		
30	WS100	51.8%	48.2%	69.0	70.2	3.4
31	WN100	64.9%	35.1%	81.4		
32	WN100	67.6%	32.4%	74.5		
33	WN100	71.9%	28.1%	60.5		
34	WN100	66.9%	33.1%	104		
35	WN100	63.9%	36.1%	89.1	82.0	16.3
36	EE100	62.1%	37.9%	59.4		
37	EE100	59.6%	40.4%	60.7		
38	EE100	60.3%	39.7%	62.5		
39	EE100	59.3%	40.7%	63.3		
40	EE100	56.9%	43.1%	66.8	62.5	2.8
41	EN100	56.9%	43.1%	97.6		
42	EN100	60.6%	39.4%	86.0		
43	EN100	63.1%	36.9%	78.3		
44	EN100	65.9%	34.1%	69.8		
45	EN100	59.2%	40.8%	73.6	81.0	11.0
46	ES100	61.8%	38.2%	64.6		
47	ES100	61.1%	38.9%	61.9		
48	ES100	62.0%	38.0%	57.5		
49	ES100	63.2%	36.8%	66.9		
50	ES100	59.2%	40.8%	65.4	63.2	3.7
REF1	NA	40.0%	60.0%	67.5		

11. UNDERWATER VIDEO

Underwater videos in Port Angeles Harbor are always affected by very high levels of suspended particles and turbidity regardless of the time of year, tidal series stage or weather factors. Only one station (WN100) is relatively shallow and the other stations are entirely dark without the camera lights but the suspended matter in the deep layer results in excessive light backscatter that compromises the imagery.

The 2010 NPDES permit requires the use of a scale indicator to be suspended below the camera, but this is not feasible as an attachment such as that only serves to stir up the bottom with its very fine and flocculant sediments. A new NPDES Permit takes effect in year 2020 requires both a scale and maintenance of camera position 3 to 7 feet about the sea bottom.

For this monitoring in 2019, underwater videos were collected at five of the sampling stations on the morning of 23 July 2019 beginning at 10:20 AM at the commencement of the Port Angeles Harbor monitoring. The remainder were recorded the following day commencing at 14:02 hours, as the day was relatively calm. This partitioning of effort was performed to avoid

strong westerly winds on that were blowing on the first day could interfere with all aspects of the monitoring. Winds increased on the first day increased throughout the afternoon, a common phenomenon in the area, particularly in the spring and summer. Sampling continued but was restricted to locations that were sheltered from waves by the net pen structures.

On the first day we used an aluminum frame for positioning the camera 3 feet above the bottom. This is the minimal distance required in the new NPDES permits taking effect in 2020. The second day the frame was not used to lower the camera closer to the bottom as on the first day we were unable to see anything whatsoever at three feet above the bottom, including the frame. A Department of Ecology staff member was on board to see this as it occurred.

As usual at this location, we had to be with approximately one foot of the bottom to see the substrate or any organisms. Also, as usual at this site, the primary observations were that there are variable numbers of spot prawns, *Pandalus platyceros* present ranging from low density to high density (i.e., 6 or more in a single small area visible at once with the video camera). Otherwise the videos show a relatively featureless mud bottom below the photic zone and dark except when the video camera lights are utilized. The one exception is the northern station of the western cage assembly, i.e., WN100 that is about ½ the depth of the other stations. No *Beggiatoa* sp. sulfur reducing bacteria were observed with the video camera or on the surfaces of the grab samples when inspected.

The underwater video results were used to produce a list of each station's qualitative characteristics, shown below as Table 9.

Table 9. Summary of underwater video quality and Observations

Time	Sampling Station	Quality of Imagery	Observations
10:20	WW100	Nothing visible due to backscatter of suspended matter. Camera at 3 ft above bottom on aluminum frame.	NA
10:33	WS100	Same as above	NA
10:50	WE50	Same as above	NA
10:58	WE100	Same as above	NA
11:10	WE-100 2nd try	Camera without aluminum frame suspended at about 1 foot above bottom	Another attempt at the same location as above but closer to the bottom without the aluminum frame this time showing spot prawns but otherwise featureless conditions.

Time	Sampling Station	Quality of Imagery	Observations
11:14	WN100	Shallower location than all others over a sea bottom with some sand mixed in so clearer imagery.	Numerous white <i>Metridium senile</i> anemones on an anchor line, a small flat fish observed, sediments with a small percentage of shell hash, clam siphon holes prevalent.
14:02	EN100	Same as above	Several Pandalid shrimp, probably <i>P. platyceros</i> , spot prawns. At time 2.15 a small (approx. 1 x 2 feet) scrap of large mesh netting observed resting on the sediment. Cooke Aquaculture was notified, and staff has removed it.
14:18	EW50	Periods of relatively clear visibility but with mostly moderate backscatter	Numerous spot prawns, some are juveniles with a few unidentified small shapes on the bottom that appear biological in origin.
14:25	EW100	Periods of relatively clear visibility but with moderate backscatter	Very numerous spot prawns, some are juveniles
14:35	ES100	Same as above	Mostly featureless smooth sea bottom with a few unidentified small shapes on the bottom that appear to be biological in origin
14:43	EE100	Generally poor quality due to great depth and darkness plus extensive backscatter from suspended matter being transported by the tide. A few moments of clarity occasionally.	Mostly featureless smooth sea bottom with some small pieces of seaweed

12. DISSOLVED OXYGEN SUMMARY

Table 10 includes dissolved oxygen measurements at permit-specified depths that were collected during this survey. As previously stated, no fish were in the net pens at the time of this survey and the results were similar to previous surveys.

Table 10. Dissolved oxygen measurements required by the NPDES permit.

Station Code	Starting Time	Dissolved Oxygen mg/L
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	24 July 2019	1m	6m	1m Above Bottom
WW100	17:08	8.23	8.24	4.00
WN100	17:14	8.41	8.51	8.22
WE100	17:18	8.46	8.39	4.03
WE50	17:20	8.20	8.29	4.36
WS100	17:25	8.39	8.39	4.49
EW100	17:29	8.42	8.38	4.51
EW50	17:31	8.47	8.42	4.40
EN100	10:33	9.20	8.97	4.48
EE100	17:37	8.67	8.57	3.81
ES100	17:42	8.40	8.37	4.17
REFERENCE 1	17:49	8.60	8.50	4.30

13. PROJECT QUALITY CONTROL AND QUALITY ASSURANCE

The objective of quality assurance/quality control procedures is to provide useful data of known and acceptable quality. **QA/QC** is the combination of **quality assurance**, the process or set of processes used to measure and assure the quality of a product and **quality control**, a procedure or set of procedures intended to ensure that a product or service adheres to a defined set of quality criteria or meets the requirements of a specific project.

Several basic points describe data quality. The accuracy of a procedure is determined by how close, on average, its result is to the actual value. Precision describes the variability of results from a replicated procedure. With high precision, the results of a procedure will be nearly the same for any number of replications, whether the results are accurate. Data and results can be considered complete if they satisfy the sampling and analysis plan guidelines and goals for describing the environment. Detection of bias - the systematic or persistent distortion of a measurement process which causes error in one direction. Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value in quality control checks. Representativeness describes how well the data reflect actual site or regional conditions. Useful comparability of data, between years and sites, requires consistent use of standardized methods.

The analytical laboratory utilized for this project provided internal laboratory data QA/QC analysis for sediment total organic carbon, sediment grain size analysis and sediment zinc. I further examine their data herein looking for patterns and possible discrepancies by examining within station sample replicate variation, expected values compared to prior historical results

and the range of normally occurring results both from background or baseline conditions and from net pen affected conditions where other observations such as visual appearance, smell, redox potential discontinuity layer depth (if present) and occurrence of indicator macroinfauna that are known to populate sediments receiving excessive amounts of total organic carbon.

The following components are examined herein:

Accuracy. Method accuracy is determined quantitatively using spike recovery results and qualitatively using positive (QC check sample) and negative (blank) controls. Matrix spikes determine the method performance for each batch of samples and whether the sample matrix interferes with the method, while QC check samples provide an independent verification of accurate laboratory standard calibration. See the laboratory data report at the end of this report for results.

Precision. The precision of the TOC, metals and particle size laboratory duplicate analyses were determined by analyzing sample splits in the laboratory. It is not appropriate for TOC, in particular, to compare field duplicates because there is great spatial variability in TOC content that arises from difference in large organic particles that may or may not be sampled from immediately adjacent surfaces of sediment in the same sample. Estimates of field replicate precision are interesting, but it is not reasonable to expect low variance because samples are taken from separate grab samples that may vary in their location of collection on the bottom due to even minor differences in grab sampler line angle when sampling. Precision is expressed as relative percent difference (RPD) as calculated by the spreadsheet use of Equation 1 on the raw data. We do not use laboratory calculated values but will compare them to our calculated values as another means to detect possible analytical mistakes.

Equation 1: Precision Calculation

$$RPD = 2 * [A - B] / A + B * (100)$$

Where:

- RPD is the relative percent difference between duplicate sample measurements.
- A and B are the results for the duplicate determinations.
- [A-B] is the absolute value difference between the determinations

Sediment Total Organic Carbon QAQC

Three laboratory splits (duplicates) were assessed for TOC (Table 11) that constitute 6.0% of the total number of TOC samples analyzed.

RPD for these samples ranged from 10.1% to 18.2% and averaged 14.2%. The range and mean were slightly higher than other recent NPDES reporting projects for net pens but within limits established in a new sampling and analysis plan nearing completion at the time of this writing.

Table 11. Duplicate analysis of sediment total organic carbon samples.

TOC Sample ID	TOC 1	TOC 11	TOC 30	Mean	SD
Original Sample TOC %	2.40	0.74	0.60	1.25	1.55
Duplicate Sample TOC%	2.17	0.64	0.72	1.18	0.86
Relative Percent Difference	10.1%	14.4%	18.2%	14.2%	0.04

Table 12 indicated quality control checks, also known as percent recovery of laboratory standards of known concentration varied from 92.8 to 102.4% with an average of 98.8%. Blank method checks were all less than 0.01

Table 12. Quality Control Check and Blanks for TOC.

TOC SAMPLE ID	TOC 1	TOC 11	TOC 30	Mean	SD
TOC% FOUND	3.11	3.43	3.39	3.31	0.17
TOC% TRUE	3.35	3.35	3.35	3.35	0.00
RECOVERY %	92.8%	102.4%	101.2%	98.8%	0.05
BLANK	<0.01	<0.01	<0.01	<0.01	NA

Sediment Grain Size QAQC

RPD of silt and clay in the particle size distribution duplicate analysis was elevated compared to prior NPDES reports for Deepwater Bay. Normally the mean value is less than 10% but in this case two very high samples (GS40 and GS80) forced the average to a much higher than normal value of 38.1.

Examination of the data in Table 13 indicate that two of the six duplicates had high RPD values, one was moderate and three were low. The first five duplicates were from transect stations and all but one (GS80 = station 16) were from the western, coarse sea bottom side. The sixth was from a perimeter station (S1W100) and had a low and acceptable RPD of 3.6%. I cannot discern a pattern of high versus low RPD for these sample duplicates. It may be due to the prevalent shell and shell hash that was so common in the surficial layers of these cores, the correlation is not exact among stations with high and low RPD except that the only soft bottom station (GS 118) was among the more acceptable results.

Table 13. Duplicate analysis of sediment grain size (silt and clay only) samples.

Grain Size Sample ID	GS 20	GS 40	GS 45	Mean	SD
Original Sample Silt/Clay %	64.66	60.48	91.64	72.26	16.91
Duplicate Sample Silt/Clay%	64.39	62.47	92.31	73.06	16.70
Relative Percent Difference	0.4	3.2	0.7	1.5	1.5

Sediment Zinc QAQC

Table 14 presents the duplicate analysis for zinc samples and total solids that is the dry weight method used to prepare the samples for metals and other analytical tests. The mean RPD for total solids duplicate analysis was very low (0.3%) and sediment zinc RPD was an acceptable 4.7%.

Table 14. Duplicate analysis of sediment zinc samples.

	Total Solids (%)					Zinc (mg/kg)			
Solids or Zinc Sample ID	20	40	Mean	SD		38	batch	Mean	SD
Original Sample	56.2%	56.9%				62.5	24.0		
Duplicate Sample	54.9%	58.0%				58.3	23.4		
Relative Percent Difference	2.3%	1.9%	2.1%	0.3%		7.0%	2.5%	4.7%	3.1%

14. QAQC SUMMARY

Completeness. The developed data set is complete as stated in the sample and analysis plan and meets the goals of the study. Samples were collected and assayed for TOC, sediment grain size and zinc for all 51 samples at ten required stations and one sample at a voluntary reference station. No samples were lost or mishandled in the collection, storage, transport or analysis phases of this project.

Representativeness. The sampling was representative of the season (mid-summer) in which the data are required by permit to be collected and the time period when the best quality sampling of sediments and underwater video can be obtained. No unusual conditions or weather occurred during the sampling period, except for strong winds the afternoon of the first sampling day, but this is typical for the subject sampling area in summer. The data set is therefore considered to be representative.

Comparability. Sediment samples and dissolved oxygen measurements were collected within the specific category and parameter, analyzed using identical protocols and standard methods discussed in the sampling and analysis plan for this project which represent the most

appropriate methodology. The same analyst entered the laboratory data into spreadsheets, double checked the entries on a separate day and inspected results for unreasonable entries or outcomes. Statistical tests were conducted twice for the results using a statistical software program known to be valid and error free. Moreover, the same principal investigator conducted this survey as those in the recent past. Therefore, these data may be compared to similarly collected data in the future or the recent past. Comparisons made among samples within the data set are therefore also valid, but not expected to be identical in outcome as site and station-specific habitat characteristics can vary considerably over small spatial and temporal scales.

Sediment samples and dissolved oxygen measurements were collected and analyzed using standard methods discussed in the sampling and analysis plan for this project and in updated methodology section of this report. They represent the most appropriate methodology for this situation. Therefore, these data may be compared to similarly collected data except for dissolved oxygen that rapidly changes within minutes as variable water parcels flow through the site. Moreover, the cages had no fish and no aeration was being practiced as it often is during summer at the subject location.

IEH Analytical Laboratories of Seattle provided all the laboratory analyses for this project and has used the same methodologies in recent years after improving all laboratory equipment about 9 years ago.

Each replicate grab sample that was judged in the field to be of adequate volume and have suitable grab sampler closure to prevent washout had a unique and matching sample number assigned in order to easily compare results among stations and to performance metrics. Upon receipt at Rensel Associates, the laboratory data files were checked for completeness, average results and the possibility of extremely low or high results. The laboratory retained frozen samples for TOC and zinc in the appropriate storage conditions until advised that technical analysis is completed and that the samples may be discarded. The report appendices include the original reported raw data and accompanying QAQC data from the laboratory.

As a result of these survey results, no follow up sampling for exceedance monitoring is required.

15. LITERATURE CITED

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16. LIST OF APPENDICES

A. Chain of Custody for sediment analyses

B. Statistical Analyses

C. IEH Analytical Laboratory Reports (TOC, Grain Size and Zinc)

Appendix A. Chain of Custody for sediment analyses of TOC, grain size and zinc

Chain of Custody		Hand delivered to IEH Laboratories of Seattle, WA			
July 23-24 2019 Port Angeles Harbor Closure Sampling , Corrected					
Rensel Associates Aquatic Sciences		Samples submitted: 25 July 2019			
Technical Questions: 360-631-6538					
Invoice: Cooke Aquaculture Pacific. P.O. Box PO Box 669, Anacortes WA 98221 (360) 391-2409					
Sample Number	Station Name	Replicate No.	TOC & Zinc (whirl pac number)	Sediment Grain Size Sieve Only	Station Name Comment
1	WW100	1	1	1	
2	WW100	2	2	2	
3	WW100	3	3	3	
4	WW100	4	4	4	
5	WW100	5	5	5	
6	WE100	1	6	6	
7	WE100	2	7	7	
8	WE100	3	8	8	
9	WE100	4	9	9	
10	WE100	5	10	10	
11	WE50	1	11	11	
12	WE50	2	12	12	
13	WE50	3	13	13	
14	WE50	4	14	14	
15	WE50	5	15	15	
16	EW100	1	16	16	
17	EW100	2	17	17	
18	EW100	3	18	18	
19	EW100	4	19	19	
20	EW100	5	20	20	
21	EW50	1	21	21	
22	EW50	2	22	22	
23	EW50	3	23	23	
24	EW50	4	24	24	
25	EW50	5	25	25	
26	WS100	1	26	26	
27	WS100	2	27	27	
28	WS100	3	28	28	
29	WS100	4	29	29	
30	WS100	5	30	30	
31	WW100	1	31	31	Mislabeled
32	WW100	2	32	32	Mislabeled
33	WW100	3	33	33	Mislabeled
34	WW100	4	34	34	Mislabeled
35	WW100	5	35	35	Mislabeled
31	WN100	1	31	31	Corrected
32	WN100	2	32	32	Corrected
33	WN100	3	33	33	Corrected
34	WN100	4	34	34	Corrected
35	WN100	5	35	35	Corrected
36	EE100	1	36	36	
37	EE100	2	37	37	
38	EE100	3	38	38	
39	EE100	4	39	39	
40	EE100	5	40	40	
41	EN100	1	41	41	
42	EN100	2	42	42	
43	EN100	3	43	43	
44	EN100	4	44	44	
45	EN100	5	45	45	
46	SE100	1	46	46	
47	SE100	2	47	47	
48	SE100	3	48	48	
49	SE100	4	49	49	
50	SE100	5	50	50	
REF1	REF1	1	REF1	REF1	
Total N of Samples: 51 each					

Appendix B. Statistical Program Output for each sampling station

1) Statistix 9.0 Port Angeles Harbor WW100 11/18/2019, 1:34:34 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	9.1620	0.1555	-7.32	4	0.9991	8.8305
Cases Included 5 Missing Cases 0						

2) Statistix 9.0

WE100, 11/18/2019, 1:42:52 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	9.1960	0.5442	-2.03	4	0.9438	8.0358
Cases Included 5 Missing Cases 0						

3 Statistix 9.0

WE50, 11/18/2019, 1:20:50 PM

One-Sample T Test

Null Hypothesis: $\mu = 9.28$

Alternative Hyp: $\mu > 9.28$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	10.110	0.2850	2.91	4	0.0218	9.5025
Cases Included 5 Missing Cases 0						

4) Statistix 9.0

EW100, 11/18/2019, 3:36:41 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	9.1960	0.5250	-2.10	4	0.9483	8.0768
Cases Included 5 Missing Cases 0						

5) Statistix 9.0

EW50, 11/18/2019, 1:23:22 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	8.7480	0.2892	-5.37	4	0.9971	8.1315
Cases Included 5 Missing Cases 0						

6) Statistix 9.0

WS100, 11/18/2019, 3:43:37 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	9.0660	0.2082	-5.93	4	0.9980	8.6221
Cases Included 5 Missing Cases 0						

7) Statistix 9.0

WN100, 11/18/2019, 9:20:26 AM

One-Sample T Test

Null Hypothesis: $\mu = 7.49$

Alternative Hyp: $\mu > 7.49$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	8.4500	0.6606	1.45	4	0.1099	7.0417
Cases Included 5 Missing Cases 0						

8) Statistix 9.0

EE100, 11/18/2019, 3:54:39 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower
						Bound
V001	8.1940	0.3363	-6.26	4	0.9983	7.4771
Cases Included 5 Missing Cases 0						

9) Statistix 9.0

EN100, 11/18/2019, 3:56:31 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$

Alternative Hyp: $\mu > 10.3$

95% Lower

Variable	Mean	SE	T	DF	P	Bound
V001	8.2780	0.5566	-3.63	4	0.9889	7.0914

Cases Included 5 Missing Cases 0

10) Statistix 9.0

ES100, 11/18/2019, 3:58:09 PM

One-Sample T Test

Null Hypothesis: $\mu = 10.3$


Alternative Hyp: $\mu > 10.3$

Variable	Mean	SE	T	DF	P	95% Lower Bound
V001	8.2960	0.2806	-7.14	4	0.9990	7.6978

Cases Included 5 Missing Cases 0

	Station	T value	T criteria	P	Result
1	WW100	-7.32	10.30	0.99	NS
2	WE100	-2.03	10.30	0.94	NS
3	WE50	2.91	9.28	0.02	S
4	EW100	-2.10	10.30	0.95	NS
5	EW50	-5.37	10.30	0.99	NS
6	WS100	-5.93	10.30	0.99	NS
7	WN100	1.45	7.49	0.11	NS
8	EE100	-6.26	10.30	0.99	NS
9	EN100	-3.63	10.30	0.99	NS
10	ES100	-7.14	10.30	0.99	NS

Appendix C. IEH Analytical Laboratory Reports.

	IEH ANALYTICAL LABORATORIES LABORATORY & CONSULTING SERVICES 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103 PHONE: (206) 632-2715 FAX: (206) 632-2417																																																																																																										
CASE FILE NUMBER: REN010-13B PAGE 1 REPORT DATE: 10/23/19 DATE SAMPLED: 07/23-24/19 DATE RECEIVED: 07/25/19 FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT SAMPLES FROM JACK RENSEL, RENSEL ASSOCIATES																																																																																																											
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IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: REN010-13B PAGE 2
REPORT DATE: 01/19/20
DATE SAMPLED: 07/23-24/19 DATE RECEIVED: 07/25/19
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT
SAMPLES FROM JACK RENSEL, RENSEL ASSOCIATES

QA/QC DATA

QC PARAMETER	TOC (%)	TOC (%)	TOC (%)
METHOD	EPA 9060	EPA 9060	EPA 9060
DATE ANALYZED	10/21/19	10/22/19	10/23/19
DETECTION LIMIT	0.01	0.01	0.01
DUPLICATE			
SAMPLE ID	1	11	30
ORIGINAL	2.40	3.02	2.96
DUPLICATE	2.17	3.22	3.53
RPD	10.37%	6.25%	17.57%
SPIKE SAMPLE			
SAMPLE ID			
ORIGINAL			
SPIKED SAMPLE			
SPIKE ADDED			
% RECOVERY	NA	NA	NA
QC CHECK (mg/L)			
FOUND	3.11	3.43	3.39
TRUE	3.35	3.35	3.35
% RECOVERY	92.84%	102.39%	101.19%
BLANK	<0.01	<0.01	<0.01

RPD = RELATIVE PERCENT DIFFERENCE.

NA = NOT APPLICABLE OR NOT AVAILABLE.

NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.

OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski, PhD
Laboratory Manager



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: REN010-13A PAGE 1
REPORT DATE: 10/22/19
DATE SAMPLED: 07/23-24/19 DATE RECEIVED: 07/25/19
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT
SAMPLES FROM JACK RENSEL

CASE NARRATIVE

Fifty one sediment samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on the subsequent page.

SAMPLE DATA - DRY WEIGHT BASIS

SAMPLE ID	TOTAL SOLIDS (%)	WATER (%)	ZINC (mg/kg)
1	43.4%	56.6%	78.6
2	44.6%	55.4%	120
3	42.8%	57.2%	84.5
4	39.6%	60.4%	85.1
5	47.5%	52.5%	88.1
6	41.2%	58.8%	87.7
7	42.0%	58.0%	77.0
8	41.5%	58.5%	79.0
9	44.8%	55.2%	71.8
10	39.5%	60.5%	79.0
11	45.5%	54.5%	75.5
12	45.4%	54.6%	74.6
13	40.2%	59.8%	79.1
14	44.7%	55.3%	72.0
15	44.6%	55.4%	87.3
16	55.3%	44.7%	101
17	53.7%	46.3%	162
18	55.1%	44.9%	70.5
19	54.6%	45.4%	74.7
20	56.2%	43.8%	83.0
21	55.8%	44.2%	62.4
22	57.7%	42.3%	70.1
23	52.4%	47.6%	80.9
24	51.9%	48.1%	72.7
25	58.1%	41.9%	72.2
26	53.0%	47.0%	67.1
27	52.2%	47.8%	70.3
28	54.0%	46.0%	76.0
29	54.5%	45.5%	68.7
30	51.8%	48.2%	69.0
31	64.9%	35.1%	81.4
32	67.6%	32.4%	74.5
33	71.9%	28.1%	60.5
34	66.9%	33.1%	104
35	63.9%	36.1%	89.1
36	62.1%	37.9%	59.4
37	59.6%	40.4%	60.7
38	60.3%	39.7%	62.5
39	59.3%	40.7%	63.3
40	56.9%	43.1%	66.8
41	56.9%	43.1%	97.6
42	60.6%	39.4%	86.0
43	63.1%	36.9%	78.3
44	65.9%	34.1%	69.8
45	59.2%	40.8%	73.6
46	61.8%	38.2%	64.6
47	61.1%	38.9%	61.9
48	62.0%	38.0%	57.5
49	63.2%	36.8%	66.9
50	59.2%	40.8%	65.4
REF1	40.0%	60.0%	67.5



IEH ANALYTICAL LABORATORIES
LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: REN010-13A PAGE 2
REPORT DATE: 01/19/20
DATE SAMPLED: 07/23-24/19 DATE RECEIVED: 07/25/19
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON SEDIMENT
SAMPLES FROM JACK RENSEL

QA/QC DATA

QC PARAMETER	TOTAL SOLIDS (%)	TOTAL SOLIDS (%)	ZINC (mg/kg)	ZINC (mg/kg)
METHOD	EPA 160.3	EPA 160.3	EPA 6010	EPA 6010
DATE ANALYZED	10/12/19	10/12/19	07/31/19	08/05/19
DETECTION LIMIT	1.00	1.00	0.100	0.100
DUPLICATE				
SAMPLE ID	20	40	38	BATCH
ORIGINAL	56.2%	56.9%	62.5	24.0
DUPLICATE	54.9%	58.0%	58.3	23.4
RPD	2.46%	1.91%	6.90%	2.53%
SPIKE SAMPLE				
SAMPLE ID				
ORIGINAL				
SPIKED SAMPLE				
SPIKE ADDED				
% RECOVERY	NA	NA	NA	NA
QC CHECK (mg/L)				
FOUND			0.464	0.475
TRUE			0.500	0.500
% RECOVERY	NA	NA	92.80%	95.00%
BLANK	NA	NA	<0.100	<0.100

RPD = RELATIVE PERCENT DIFFERENCE.

NA = NOT APPLICABLE OR NOT AVAILABLE.

NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.

OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski, PhD
Laboratory Manager



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PHONE: (206) 632-2715 FAX: (206) 632-2417

ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A1

ANALYST: OAA

CLIENT SAMPLE ID: 1

TOTAL WET WEIGHT (g) 80.38
TOTAL DRY WEIGHT (g) 34.87

PERCENT SOLIDS @ 105C 43.38%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 1

SIEVE FRACTION

BEAKER TARE: 112.17
TOTAL DRY WT (g) 120.24
SAMPLE WT (g) 8.06

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.16	0.46%	99.54%	Shells
10	2.00	0.63	1.80%	97.73%	Shells
20	0.850	0.70	1.99%	95.74%	Fine Sells
40	0.425	0.53	1.51%	94.24%	
60	0.250	0.70	1.99%	92.24%	
140	0.106	2.25	6.46%	85.78%	
200	0.075	2.31	6.62%	79.17%	
<200	<0.075	0.90	2.59%		
TOTAL WT		8.17			
RECOVERY (%)		101.28%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.27% % SAND 18.57% % CLAY/SILT 79.17% MEAN (mm) 0.0981

% SOLIDS 43.38% % WATER 56.62%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A2

ANALYST: OAA

CLIENT SAMPLE ID: 2

TOTAL WET WEIGHT (g) 81.24
TOTAL DRY WEIGHT (g) 36.20

PERCENT SOLIDS @ 105C 44.56%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 2

SIEVE FRACTION

BEAKER TARE: 111.39
TOTAL DRY WT (g) 120.67
SAMPLE WT (g) 9.28

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.06	0.17%	99.83%	Shells
10	2.00	1.05	2.89%	96.94%	Shells
20	0.850	0.78	2.14%	94.80%	Fine Sells
40	0.425	0.52	1.44%	93.35%	Fine Sells
60	0.250	0.69	1.91%	91.45%	
140	0.106	2.59	7.16%	84.29%	
200	0.075	2.63	7.26%	77.03%	
<200	<0.075	0.94	2.60%		
TOTAL WT		9.26			
RECOVERY (%)		99.71%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 3.06% % SAND 19.91% % CLAY/SILT 77.03% MEAN (mm) 0.1080

% SOLIDS 44.56% % WATER 55.44%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A3

ANALYST: OAA

CLIENT SAMPLE ID: 3

TOTAL WET WEIGHT (g) 80.05
TOTAL DRY WEIGHT (g) 34.23

PERCENT SOLIDS @ 105C 42.76%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 3

SIEVE FRACTION

BEAKER TARE: 118.11
TOTAL DRY WT (g) 126.78
SAMPLE WT (g) 8.67

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.23	0.67%	99.33%	Shells
10	2.00	0.67	1.96%	97.37%	Shells
20	0.850	0.87	2.53%	94.84%	Fine Shells
40	0.425	0.54	1.57%	93.27%	Fine Shells
60	0.250	0.71	2.07%	91.20%	
140	0.106	2.48	7.25%	83.95%	
200	0.075	2.42	7.06%	76.89%	
<200	<0.075	0.68	1.99%		
TOTAL WT		8.59			
RECOVERY (%)		99.12%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.63% % SAND 20.48% % CLAY/SILT 76.89% MEAN (mm) 0.1173

% SOLIDS 42.76% % WATER 57.24%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A4

ANALYST: OAA

CLIENT SAMPLE ID: 4

TOTAL WET WEIGHT (g) 81.62
TOTAL DRY WEIGHT (g) 32.30

PERCENT SOLIDS @ 105C 39.57%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 4

SIEVE FRACTION

BEAKER TARE: 114.87
TOTAL DRY WT (g) 122.85
SAMPLE WT (g) 7.98

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.92	2.85%	97.15%	
10	2.00	0.78	2.41%	94.73%	
20	0.850	0.60	1.85%	92.89%	
40	0.425	0.34	1.05%	91.84%	
60	0.250	0.51	1.59%	90.25%	
140	0.106	1.92	5.94%	84.32%	
200	0.075	1.97	6.11%	78.21%	
<200	<0.075	0.85	2.63%		
TOTAL WT		7.89			
RECOVERY (%)		98.83%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 5.27% % SAND 16.52% % CLAY/SILT 78.21% MEAN (mm) 0.2189

% SOLIDS 39.57% % WATER 60.43%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A5

ANALYST: OAA

CLIENT SAMPLE ID: 5

TOTAL WET WEIGHT (g) 80.70
TOTAL DRY WEIGHT (g) 38.31

PERCENT SOLIDS @ 105C 47.48%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 5

SIEVE FRACTION

BEAKER TARE: 112.74
TOTAL DRY WT (g) 123.45
SAMPLE WT (g) 10.71

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.50	1.30%	98.70%	Shells
10	2.00	1.49	3.88%	94.82%	Shells
20	0.850	1.02	2.65%	92.17%	Fine Shells
40	0.425	0.61	1.59%	90.58%	Fine Shells
60	0.250	0.72	1.87%	88.71%	
140	0.106	2.69	7.02%	81.68%	
200	0.075	2.72	7.10%	74.58%	
<200	<0.075	0.91	2.38%		
TOTAL WT		10.65			
RECOVERY (%)		99.40%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 5.18% % SAND 20.24% % CLAY/SILT 74.58% MEAN (mm) 0.1861

% SOLIDS 47.48% % WATER 52.52%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A6

ANALYST: OAA

CLIENT SAMPLE ID: 6

TOTAL WET WEIGHT (g) 80.96
TOTAL DRY WEIGHT (g) 33.36

PERCENT SOLIDS @ 105C 41.20%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 6

SIEVE FRACTION

BEAKER TARE: 111.70
TOTAL DRY WT (g) 116.37
SAMPLE WT (g) 4.67

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.09	0.28%	99.72%	Shells
10	2.00	0.14	0.43%	99.30%	Shells
20	0.850	0.21	0.63%	98.67%	Fine Shells
40	0.425	0.21	0.64%	98.03%	
60	0.250	0.35	1.06%	96.97%	
140	0.106	1.26	3.79%	93.18%	
200	0.075	1.82	5.45%	87.74%	
<200	<0.075	0.48	1.45%		
TOTAL WT		4.58			
RECOVERY (%)		98.07%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.70% % SAND 11.56% % CLAY/SILT 87.74% MEAN (mm) 0.0404

% SOLIDS 41.20% % WATER 58.80%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A7

ANALYST: OAA

CLIENT SAMPLE ID: 7

TOTAL WET WEIGHT (g) 81.21
TOTAL DRY WEIGHT (g) 34.11

PERCENT SOLIDS @ 105C 42.00%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 7

SIEVE FRACTION

BEAKER TARE: 112.56
TOTAL DRY WT (g) 118.40
SAMPLE WT (g) 5.84

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.13	0.38%	99.62%	Shells
20	0.850	0.20	0.60%	99.02%	Fine Shells
40	0.425	0.29	0.86%	98.16%	
60	0.250	0.36	1.04%	97.12%	
140	0.106	1.52	4.45%	92.67%	
200	0.075	2.25	6.59%	86.08%	
<200	<0.075	0.94	2.75%		
TOTAL WT		5.69			
RECOVERY (%)		97.35%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.38% % SAND 13.54% % CLAY/SILT 86.08% MEAN (mm) 0.0286

% SOLIDS 42.00% % WATER 58.00%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/19/2019

LAB SAMPLE ID: REN01013A8

ANALYST: OAA

CLIENT SAMPLE ID: 8

TOTAL WET WEIGHT (g) 81.27
TOTAL DRY WEIGHT (g) 33.70

PERCENT SOLIDS @ 105C 41.47%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 8

SIEVE FRACTION

BEAKER TARE: 117.37
TOTAL DRY WT (g) 123.72
SAMPLE WT (g) 6.36

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.11	0.34%	99.66%	Shells
10	2.00	0.05	0.16%	99.51%	Shells
20	0.850	0.34	1.01%	98.50%	Fine Shells
40	0.425	0.35	1.04%	97.46%	Fine Shells
60	0.250	0.47	1.40%	96.06%	
140	0.106	1.65	4.90%	91.15%	
200	0.075	2.32	6.87%	84.28%	
<200	<0.075	1.10	3.26%		
TOTAL WT		6.40			
RECOVERY (%)		100.61%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.49% % SAND 15.23% % CLAY/SILT 84.28% MEAN (mm) 0.0459

% SOLIDS 41.47% % WATER 58.53%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013A9

ANALYST: OAA

CLIENT SAMPLE ID: 9

TOTAL WET WEIGHT (g) 78.84
TOTAL DRY WEIGHT (g) 35.31

PERCENT SOLIDS @ 105C 44.79%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 9

SIEVE FRACTION

BEAKER TARE: 117.41
TOTAL DRY WT (g) 124.34
SAMPLE WT (g) 6.93

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.06	0.16%	99.84%	Shells
10	2.00	0.19	0.53%	99.31%	Shells
20	0.850	0.37	1.04%	98.27%	Fine Shells
40	0.425	0.32	0.89%	97.37%	
60	0.250	0.44	1.23%	96.14%	
140	0.106	1.73	4.90%	91.23%	
200	0.075	2.68	7.59%	83.65%	
<200	<0.075	1.03	2.92%		
TOTAL WT		6.81			
RECOVERY (%)		98.22%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.69% % SAND 15.67% % CLAY/SILT 83.65% MEAN (mm) 0.0447

% SOLIDS 44.79% % WATER 55.21%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B0

ANALYST: OAA

CLIENT SAMPLE ID: 10

TOTAL WET WEIGHT (g) 79.76
TOTAL DRY WEIGHT (g) 31.51

PERCENT SOLIDS @ 105C 39.51%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 10

SIEVE FRACTION

BEAKER TARE: 112.08
TOTAL DRY WT (g) 118.77
SAMPLE WT (g) 6.70

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.62	1.97%	98.03%	Shells
10	2.00	0.17	0.55%	97.48%	Shells
20	0.850	0.35	1.11%	96.37%	Fine Shells
40	0.425	0.34	1.08%	95.28%	
60	0.250	0.45	1.42%	93.87%	
140	0.106	1.63	5.18%	88.69%	
200	0.075	2.20	6.97%	81.72%	
<200	<0.075	0.93	2.94%		
TOTAL WT		6.69			
RECOVERY (%)		99.88%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.52% % SAND 15.76% % CLAY/SILT 81.72% MEAN (mm) 0.1330

% SOLIDS 39.51% % WATER 60.49%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B1

ANALYST: OAA

CLIENT SAMPLE ID: 11

TOTAL WET WEIGHT (g) 80.15
TOTAL DRY WEIGHT (g) 36.48

PERCENT SOLIDS @ 105C 45.52%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 11

SIEVE FRACTION

BEAKER TARE: 119.15
TOTAL DRY WT (g) 125.04
SAMPLE WT (g) 5.89

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.01	0.02%	99.98%	Shells
10	2.00	0.13	0.34%	99.64%	Fine Shells
20	0.850	0.13	0.36%	99.27%	
40	0.425	0.21	0.58%	98.69%	
60	0.250	0.39	1.06%	97.64%	
140	0.106	1.79	4.92%	92.72%	
200	0.075	2.44	6.67%	86.05%	
<200	<0.075	0.70	1.91%		
TOTAL WT		5.79			
RECOVERY (%)		98.27%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.36% % SAND 13.59% % CLAY/SILT 86.05% MEAN (mm) 0.0263

% SOLIDS 45.52% % WATER 54.48%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B2

ANALYST: OAA

CLIENT SAMPLE ID: 12

TOTAL WET WEIGHT (g) 78.97
TOTAL DRY WEIGHT (g) 35.88

PERCENT SOLIDS @ 105C 45.43%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 12

SIEVE FRACTION

BEAKER TARE: 112.65
TOTAL DRY WT (g) 118.63
SAMPLE WT (g) 5.99

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.01	0.02%	99.98%	
10	2.00	0.10	0.28%	99.70%	Shells
20	0.850	0.17	0.46%	99.23%	Fine Shells
40	0.425	0.25	0.71%	98.53%	
60	0.250	0.39	1.08%	97.45%	
140	0.106	1.67	4.67%	92.78%	
200	0.075	2.47	6.87%	85.91%	
<200	<0.075	0.89	2.48%		
TOTAL WT		5.95			
RECOVERY (%)		99.33%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.30% % SAND 13.79% % CLAY/SILT 85.91% MEAN (mm) 0.0264

% SOLIDS 45.43% % WATER 54.57%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B3

ANALYST: OAA

CLIENT SAMPLE ID: 13

TOTAL WET WEIGHT (g) 79.59
TOTAL DRY WEIGHT (g) 32.01

PERCENT SOLIDS @ 105C 40.22%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 13

SIEVE FRACTION

BEAKER TARE:	113.91
TOTAL DRY WT (g)	120.45
SAMPLE WT (g)	6.54

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.06	0.18%	99.82%	Shells
10	2.00	0.11	0.34%	99.48%	Shells
20	0.850	0.13	0.40%	99.08%	Fine Shells
40	0.425	0.26	0.81%	98.28%	
60	0.250	0.40	1.24%	97.04%	
140	0.106	1.80	5.62%	91.42%	
200	0.075	2.43	7.58%	83.84%	
<200	<0.075	1.28	4.01%		
TOTAL WT		6.46			
RECOVERY (%)		98.73%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.52% % SAND 15.64% % CLAY/SILT 83.84% MEAN (mm) 0.0369

% SOLIDS 40.22% % WATER 59.78%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B4

ANALYST: OAA

CLIENT SAMPLE ID: 14

TOTAL WET WEIGHT (g) 80.50
TOTAL DRY WEIGHT (g) 35.98

PERCENT SOLIDS @ 105C 44.70%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 14

SIEVE FRACTION

BEAKER TARE: 118.67
TOTAL DRY WT (g) 126.78
SAMPLE WT (g) 8.11

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.49	1.35%	98.65%	Shells
10	2.00	0.01	0.02%	98.63%	
20	0.850	0.20	0.56%	98.07%	Fine Shells
40	0.425	0.38	1.05%	97.02%	
60	0.250	0.45	1.26%	95.76%	
140	0.106	2.18	6.05%	89.71%	
200	0.075	3.11	8.63%	81.08%	
<200	<0.075	1.29	3.57%		
TOTAL WT		8.09			
RECOVERY (%)		99.80%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.37% % SAND 17.55% % CLAY/SILT 81.08% MEAN (mm) 0.0899

% SOLIDS 44.70% % WATER 55.30%



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PHONE: (206) 632-2715 FAX: (206) 632-2417

ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B5

ANALYST: OAA

CLIENT SAMPLE ID: 15

TOTAL WET WEIGHT (g) 79.93
TOTAL DRY WEIGHT (g) 35.66

PERCENT SOLIDS @ 105C 44.61%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 15

SIEVE FRACTION

BEAKER TARE: 112.11
TOTAL DRY WT (g) 119.13
SAMPLE WT (g) 7.03

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.33	0.91%	99.09%	Shells
10	2.00	0.03	0.09%	99.00%	Fine Shells
20	0.850	0.17	0.47%	98.53%	Fine Shells
40	0.425	0.33	0.92%	97.61%	
60	0.250	0.34	0.96%	96.65%	
140	0.106	1.84	5.15%	91.50%	
200	0.075	2.66	7.47%	84.04%	
<200	<0.075	1.33	3.73%		
TOTAL WT		7.02			
RECOVERY (%)		99.91%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.00% % SAND 14.96% % CLAY/SILT 84.04% MEAN (mm) 0.0665

% SOLIDS 44.61% % WATER 55.39%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B6

ANALYST: OAA

CLIENT SAMPLE ID: 16

TOTAL WET WEIGHT (g) 84.22
TOTAL DRY WEIGHT (g) 46.54

PERCENT SOLIDS @ 105C 55.26%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 16

SIEVE FRACTION

BEAKER TARE: 111.93
TOTAL DRY WT (g) 128.63
SAMPLE WT (g) 16.70

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.22	0.47%	99.53%	
20	0.850	0.44	0.95%	98.58%	
40	0.425	0.62	1.33%	97.24%	
60	0.250	0.92	1.97%	95.27%	
140	0.106	7.32	15.72%	79.55%	
200	0.075	5.33	11.46%	68.09%	
<200	<0.075	1.78	3.83%		
TOTAL WT		16.63			
RECOVERY (%)		99.63%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.47% % SAND 31.44% % CLAY/SILT 68.09% MEAN (mm) 0.0534

% SOLIDS 55.26% % WATER 44.74%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B7

ANALYST: OAA

CLIENT SAMPLE ID: 17

TOTAL WET WEIGHT (g) 78.55
TOTAL DRY WEIGHT (g) 42.18

PERCENT SOLIDS @ 105C 53.70%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 17

SIEVE FRACTION

BEAKER TARE:	112.06
TOTAL DRY WT (g)	127.50
SAMPLE WT (g)	15.43

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.06	0.15%	99.85%	
10	2.00	0.04	0.09%	99.76%	
20	0.850	0.14	0.32%	99.44%	Shells
40	0.425	0.39	0.93%	98.50%	Fine Shells
60	0.250	0.75	1.78%	96.73%	
140	0.106	6.82	16.17%	80.56%	
200	0.075	5.83	13.81%	66.75%	
<200	<0.075	1.52	3.61%		
TOTAL WT		15.55			
RECOVERY (%)		100.75%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.24% % SAND 33.01% % CLAY/SILT 66.75% MEAN (mm) 0.0476

% SOLIDS 53.70% % WATER 46.30%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B8

ANALYST: OAA

CLIENT SAMPLE ID: 18

TOTAL WET WEIGHT (g) 80.77
TOTAL DRY WEIGHT (g) 44.53

PERCENT SOLIDS @ 105C 55.13%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 18

SIEVE FRACTION

BEAKER TARE: 118.97
TOTAL DRY WT (g) 137.84
SAMPLE WT (g) 18.86

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.07	0.17%	99.83%	Shells
20	0.850	0.28	0.62%	99.22%	Fine Shells
40	0.425	0.41	0.92%	98.30%	
60	0.250	0.92	2.07%	96.22%	
140	0.106	9.95	22.35%	73.88%	
200	0.075	6.05	13.59%	60.29%	
<200	<0.075	1.27	2.85%		
TOTAL WT		18.95			
RECOVERY (%)		100.46%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.17% % SAND 39.55% % CLAY/SILT 60.29% MEAN (mm) 0.0515

% SOLIDS 55.13% % WATER 44.87%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013B9

ANALYST: OAA

CLIENT SAMPLE ID: 19

TOTAL WET WEIGHT (g) 81.08
TOTAL DRY WEIGHT (g) 44.30

PERCENT SOLIDS @ 105C 54.63%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 19

SIEVE FRACTION

BEAKER TARE: 112.79
TOTAL DRY WT (g) 130.27
SAMPLE WT (g) 17.49

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.07	0.17%	99.83%	Shells
10	2.00	0.38	0.86%	98.98%	Shells
20	0.850	0.72	1.62%	97.36%	Fine Shells
40	0.425	0.71	1.61%	95.75%	Fine Shells
60	0.250	1.10	2.47%	93.28%	
140	0.106	7.90	17.83%	75.44%	
200	0.075	5.66	12.78%	62.67%	
<200	<0.075	1.09	2.46%		
TOTAL WT		17.62			
RECOVERY (%)		100.79%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.02% % SAND 36.31% % CLAY/SILT 62.67% MEAN (mm) 0.0803

% SOLIDS 54.63% % WATER 45.37%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013C0

ANALYST: OAA

CLIENT SAMPLE ID: 20

TOTAL WET WEIGHT (g) 80.31
TOTAL DRY WEIGHT (g) 45.15

PERCENT SOLIDS @ 105C 56.22%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 20

SIEVE FRACTION

BEAKER TARE:	113.05
TOTAL DRY WT (g)	130.15
SAMPLE WT (g)	17.10

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.04	0.08%	99.92%	Shells
10	2.00	0.21	0.45%	99.47%	Shells
20	0.850	0.57	1.25%	98.22%	Fine Shells
40	0.425	0.53	1.18%	97.04%	
60	0.250	1.06	2.34%	94.70%	
140	0.106	7.72	17.10%	77.60%	
200	0.075	5.85	12.95%	64.66%	
<200	<0.075	1.10	2.43%		
TOTAL WT		17.05			
RECOVERY (%)		99.75%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.53% % SAND 34.81% % CLAY/SILT 64.66% MEAN (mm) 0.0621

% SOLIDS 56.22% % WATER 43.78%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013C0 DUP

ANALYST: OAA

CLIENT SAMPLE ID: 20 DUP

TOTAL WET WEIGHT (g) 80.84
TOTAL DRY WEIGHT (g) 44.35

PERCENT SOLIDS @ 105C 54.86%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 20 DUP

SIEVE FRACTION

BEAKER TARE:	118.96
TOTAL DRY WT (g)	135.87
SAMPLE WT (g)	16.91

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.20	0.46%	99.54%	Shells
20	0.850	0.45	1.01%	98.53%	Fine Shells
40	0.425	0.51	1.14%	97.39%	
60	0.250	1.04	2.34%	95.05%	
140	0.106	7.85	17.69%	77.36%	
200	0.075	5.75	12.97%	64.39%	
<200	<0.075	1.16	2.62%		
TOTAL WT		16.95			
RECOVERY (%)		100.24%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.46% % SAND 35.16% % CLAY/SILT 64.39% MEAN (mm) 0.0569

% SOLIDS 54.86% % WATER 45.14%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013C1

ANALYST: OAA

CLIENT SAMPLE ID: 21

TOTAL WET WEIGHT (g) 80.40
TOTAL DRY WEIGHT (g) 44.83

PERCENT SOLIDS @ 105C 55.76%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 21

SIEVE FRACTION

BEAKER TARE:	114.80
TOTAL DRY WT (g)	134.20
SAMPLE WT (g)	19.40

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.54	1.21%	98.79%	Shells
10	2.00	0.48	1.08%	97.71%	Shells
20	0.850	0.61	1.36%	96.35%	Fine Shells
40	0.425	0.64	1.43%	94.92%	
60	0.250	1.28	2.85%	92.07%	
140	0.106	8.84	19.72%	72.35%	
200	0.075	5.85	13.05%	59.30%	
<200	<0.075	1.12	2.49%		
TOTAL WT		19.36			
RECOVERY (%)		99.80%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.29% % SAND 38.41% % CLAY/SILT 59.30% MEAN (mm) 0.1345

% SOLIDS 55.76% % WATER 44.24%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013C2

ANALYST: OAA

CLIENT SAMPLE ID: 22

TOTAL WET WEIGHT (g) 80.88
TOTAL DRY WEIGHT (g) 46.67

PERCENT SOLIDS @ 105C 57.71%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 22

SIEVE FRACTION

BEAKER TARE:	119.05
TOTAL DRY WT (g)	136.14
SAMPLE WT (g)	17.09

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.06	0.12%	99.88%	Shells
20	0.850	0.39	0.83%	99.05%	Fine Shells
40	0.425	0.55	1.18%	97.88%	Fine Shells
60	0.250	0.96	2.05%	95.83%	
140	0.106	8.12	17.40%	78.43%	
200	0.075	5.84	12.51%	65.93%	
<200	<0.075	1.15	2.46%		
TOTAL WT		17.05			
RECOVERY (%)		99.76%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.12% % SAND 33.95% % CLAY/SILT 65.93% MEAN (mm) 0.0474

% SOLIDS 57.71% % WATER 42.29%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/21/2019

LAB SAMPLE ID: REN01013C3

ANALYST: OAA

CLIENT SAMPLE ID: 23

TOTAL WET WEIGHT (g) 79.67
TOTAL DRY WEIGHT (g) 41.72

PERCENT SOLIDS @ 105C 52.36%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 23

SIEVE FRACTION

BEAKER TARE: 112.56
TOTAL DRY WT (g) 129.74
SAMPLE WT (g) 17.18

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.16	0.37%	99.63%	Shells
10	2.00	0.24	0.56%	99.06%	Shells
20	0.850	0.44	1.06%	98.00%	Fine Shells
40	0.425	0.56	1.35%	96.65%	
60	0.250	1.04	2.49%	94.16%	
140	0.106	7.94	19.02%	75.14%	
200	0.075	5.21	12.50%	62.65%	
<200	<0.075	1.43	3.43%		
TOTAL WT		17.01			
RECOVERY (%)		99.03%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.94% % SAND 36.42% % CLAY/SILT 62.65% MEAN (mm) 0.0796

% SOLIDS 52.36% % WATER 47.64%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C4

ANALYST: OAA

CLIENT SAMPLE ID: 24

TOTAL WET WEIGHT (g) 81.86
TOTAL DRY WEIGHT (g) 42.52

PERCENT SOLIDS @ 105C 51.94%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 24

SIEVE FRACTION

BEAKER TARE: 112.14
TOTAL DRY WT (g) 129.54
SAMPLE WT (g) 17.40

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.62	1.45%	98.55%	Shells
10	2.00	0.48	1.13%	97.41%	Shells
20	0.850	0.56	1.32%	96.09%	Fine Shells
40	0.425	0.67	1.57%	94.52%	
60	0.250	1.20	2.82%	91.70%	
140	0.106	7.66	18.02%	73.68%	
200	0.075	5.09	11.98%	61.70%	
<200	<0.075	1.13	2.65%		
TOTAL WT		17.41			
RECOVERY (%)		100.04%			

0.0

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.59% % SAND 35.71% % CLAY/SILT 61.70% MEAN (mm) 0.1447

% SOLIDS 51.94% % WATER 48.06%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C5

ANALYST: OAA

CLIENT SAMPLE ID: 25

TOTAL WET WEIGHT (g) 79.56
TOTAL DRY WEIGHT (g) 46.24

PERCENT SOLIDS @ 105C 58.12%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 25

SIEVE FRACTION

BEAKER TARE:	116.74
TOTAL DRY WT (g)	137.76
SAMPLE WT (g)	21.01

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.56	1.20%	98.80%	Shells
10	2.00	0.26	0.56%	98.24%	Shells
20	0.850	0.47	1.01%	97.23%	Fine Shells
40	0.425	0.58	1.25%	95.98%	Fine Shells
60	0.250	1.20	2.59%	93.39%	
140	0.106	10.04	21.71%	71.69%	
200	0.075	6.26	13.53%	58.16%	
<200	<0.075	1.32	2.85%		
TOTAL WT		20.66			
RECOVERY (%)		98.35%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.76% % SAND 40.08% % CLAY/SILT 58.16% MEAN (mm) 0.1217

% SOLIDS 58.12% % WATER 41.88%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C6

ANALYST: OAA

CLIENT SAMPLE ID: 26

TOTAL WET WEIGHT (g) 80.21
TOTAL DRY WEIGHT (g) 42.50

PERCENT SOLIDS @ 105C 52.99%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 26

SIEVE FRACTION

BEAKER TARE: 119.44
TOTAL DRY WT (g) 131.06
SAMPLE WT (g) 11.62

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.00	0.00%	100.00%	
20	0.850	0.08	0.19%	99.81%	Fine Shells
40	0.425	0.25	0.59%	99.22%	
60	0.250	1.38	3.24%	95.98%	
140	0.106	3.72	8.76%	87.22%	
200	0.075	4.63	10.89%	76.33%	
<200	<0.075	1.51	3.56%		
TOTAL WT		11.58			
RECOVERY (%)		99.66%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.00% % SAND 23.67% % CLAY/SILT 76.33% MEAN (mm) 0.0297

% SOLIDS 52.99% % WATER 47.01%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C7

ANALYST: OAA

CLIENT SAMPLE ID: 27

TOTAL WET WEIGHT (g) 81.86
TOTAL DRY WEIGHT (g) 42.74

PERCENT SOLIDS @ 105C 52.21%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 27

SIEVE FRACTION

BEAKER TARE: 113.01
TOTAL DRY WT (g) 124.81
SAMPLE WT (g) 11.80

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.04	0.08%	99.92%	Shells
20	0.850	0.06	0.15%	99.77%	Fine Shells
40	0.425	0.38	0.89%	98.88%	
60	0.250	1.77	4.14%	94.74%	
140	0.106	3.65	8.54%	86.20%	
200	0.075	4.57	10.69%	75.51%	
<200	<0.075	1.26	2.95%		
TOTAL WT		11.73			
RECOVERY (%)		99.42%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.08% % SAND 24.41% % CLAY/SILT 75.51% MEAN (mm) 0.0341

% SOLIDS 52.21% % WATER 47.79%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C8

ANALYST: OAA

CLIENT SAMPLE ID: 28

TOTAL WET WEIGHT (g) 80.37
TOTAL DRY WEIGHT (g) 43.43

PERCENT SOLIDS @ 105C 54.04%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 28

SIEVE FRACTION

BEAKER TARE:	119.09
TOTAL DRY WT (g)	130.67
SAMPLE WT (g)	11.58

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.07	0.15%	99.85%	Shells
20	0.850	0.13	0.29%	99.56%	Fine Shells
40	0.425	0.35	0.80%	98.76%	
60	0.250	1.01	2.32%	96.44%	
140	0.106	3.66	8.44%	88.00%	
200	0.075	4.68	10.79%	77.21%	
<200	<0.075	1.73	3.97%		
TOTAL WT		11.62			
RECOVERY (%)		100.34%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.15% % SAND 22.63% % CLAY/SILT 77.21% MEAN (mm) 0.0318

% SOLIDS 54.04% % WATER 45.96%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013C9

ANALYST: OAA

CLIENT SAMPLE ID: 29

TOTAL WET WEIGHT (g) 81.27
TOTAL DRY WEIGHT (g) 44.33

PERCENT SOLIDS @ 105C 54.54%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 29

SIEVE FRACTION

BEAKER TARE: 111.33
TOTAL DRY WT (g) 121.65
SAMPLE WT (g) 10.32

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.02	0.04%	99.96%	Shells
20	0.850	0.08	0.17%	99.79%	Fine Shells
40	0.425	0.21	0.46%	99.32%	
60	0.250	0.96	2.16%	97.17%	
140	0.106	3.12	7.03%	90.13%	
200	0.075	4.71	10.63%	79.50%	
<200	<0.075	1.13	2.55%		
TOTAL WT		10.22			
RECOVERY (%)		98.98%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.04% % SAND 20.46% % CLAY/SILT 79.50% MEAN (mm) 0.0251

% SOLIDS 54.54% % WATER 45.46%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D0

ANALYST: OAA

CLIENT SAMPLE ID: 30

TOTAL WET WEIGHT (g) 78.92
TOTAL DRY WEIGHT (g) 40.85

PERCENT SOLIDS @ 105C 51.76%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 30

SIEVE FRACTION

BEAKER TARE: 112.20
TOTAL DRY WT (g) 125.56
SAMPLE WT (g) 13.36

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.02	0.05%	99.95%	Shells
20	0.850	0.19	0.46%	99.50%	Fine Shells
40	0.425	0.53	1.30%	98.20%	
60	0.250	2.36	5.79%	92.41%	
140	0.106	4.05	9.92%	82.49%	
200	0.075	4.80	11.75%	70.74%	
<200	<0.075	1.40	3.42%		
TOTAL WT		13.35			
RECOVERY (%)		99.90%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.05% % SAND 29.21% % CLAY/SILT 70.74% MEAN (mm) 0.0441

% SOLIDS 51.76% % WATER 48.24%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D1

ANALYST: OAA

CLIENT SAMPLE ID: 31

TOTAL WET WEIGHT (g) 79.89
TOTAL DRY WEIGHT (g) 51.84

PERCENT SOLIDS @ 105C 64.89%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 31

SIEVE FRACTION

BEAKER TARE:	112.72
TOTAL DRY WT (g)	150.62
SAMPLE WT (g)	37.90

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	1.13	2.18%	97.82%	Shells
10	2.00	0.76	1.46%	96.36%	Shells
20	0.850	0.72	1.40%	94.97%	Fine Shells
40	0.425	0.97	1.87%	93.10%	
60	0.250	1.60	3.08%	90.02%	
140	0.106	26.75	51.61%	38.41%	
200	0.075	5.20	10.03%	28.38%	
<200	<0.075	1.22	2.36%		
TOTAL WT		38.35			
RECOVERY (%)		101.17%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 3.64% % SAND 67.98% % CLAY/SILT 28.38% MEAN (mm) 0.2223

% SOLIDS 64.89% % WATER 35.11%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D2

ANALYST: OAA

CLIENT SAMPLE ID: 32

TOTAL WET WEIGHT (g) 83.66
TOTAL DRY WEIGHT (g) 56.54

PERCENT SOLIDS @ 105C 67.58%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 32

SIEVE FRACTION

BEAKER TARE: 116.48
TOTAL DRY WT (g) 159.37
SAMPLE WT (g) 42.89

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.49	0.86%	99.14%	Shells
10	2.00	0.55	0.97%	98.17%	Shells
20	0.850	0.54	0.95%	97.22%	Fine Shells
40	0.425	0.79	1.39%	95.83%	
60	0.250	1.53	2.70%	93.13%	
140	0.106	32.57	57.60%	35.52%	
200	0.075	5.43	9.60%	25.92%	
<200	<0.075	1.14	2.01%		
TOTAL WT		43.02			
RECOVERY (%)		100.31%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.83% % SAND 72.25% % CLAY/SILT 25.92% MEAN (mm) 0.1493

% SOLIDS 67.58% % WATER 32.42%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D3

ANALYST: OAA

CLIENT SAMPLE ID: 33

TOTAL WET WEIGHT (g) 80.66
TOTAL DRY WEIGHT (g) 58.03

PERCENT SOLIDS @ 105C 71.94%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 33

SIEVE FRACTION

BEAKER TARE:	115.03
TOTAL DRY WT (g)	162.68
SAMPLE WT (g)	47.65

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.66	1.13%	98.87%	Shells
10	2.00	0.62	1.06%	97.81%	Shells
20	0.850	0.51	0.88%	96.93%	Fine Shells
40	0.425	0.68	1.16%	95.77%	
60	0.250	1.56	2.69%	93.08%	
140	0.106	37.79	65.12%	27.96%	
200	0.075	5.02	8.65%	19.30%	
<200	<0.075	1.06	1.83%		
TOTAL WT		47.89			
RECOVERY (%)		100.50%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 2.19% % SAND 78.50% % CLAY/SILT 19.30% MEAN (mm) 0.1696

% SOLIDS 71.94% % WATER 28.06%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D4

ANALYST: OAA

CLIENT SAMPLE ID: 34

TOTAL WET WEIGHT (g) 80.87
TOTAL DRY WEIGHT (g) 54.10

PERCENT SOLIDS @ 105C 66.90%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 34

SIEVE FRACTION

BEAKER TARE: 111.06
TOTAL DRY WT (g) 153.60
SAMPLE WT (g) 42.55

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.32	0.60%	99.40%	Wood Debris
10	2.00	0.22	0.41%	98.99%	Wood Debris, Shells
20	0.850	0.44	0.80%	98.19%	Wood Debris, Fine Shells
40	0.425	0.80	1.49%	96.70%	
60	0.250	1.70	3.15%	93.55%	
140	0.106	33.29	61.54%	32.02%	
200	0.075	5.01	9.26%	22.76%	
<200	<0.075	1.09	2.02%		
TOTAL WT		42.88			
RECOVERY (%)		100.78%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.01% % SAND 76.23% % CLAY/SILT 22.76% MEAN (mm) 0.1298

% SOLIDS 66.90% % WATER 33.10%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D5

ANALYST: OAA

CLIENT SAMPLE ID: 35

TOTAL WET WEIGHT (g) 79.81
TOTAL DRY WEIGHT (g) 50.97

PERCENT SOLIDS @ 105C 63.87%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 35

SIEVE FRACTION

BEAKER TARE:	119.42
TOTAL DRY WT (g)	155.94
SAMPLE WT (g)	36.53

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.36	0.70%	99.30%	Wood Debris, Shells
10	2.00	0.53	1.04%	98.26%	Wood Debris, Shells
20	0.850	0.88	1.73%	96.54%	Fine Wood Debris, Fine Shells
40	0.425	1.25	2.45%	94.08%	
60	0.250	1.95	3.82%	90.26%	
140	0.106	24.79	48.63%	41.63%	
200	0.075	5.21	10.22%	31.41%	
<200	<0.075	1.88	3.68%		
TOTAL WT		36.84			
RECOVERY (%)		100.85%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 1.74% % SAND 66.86% % CLAY/SILT 31.41% MEAN (mm) 0.1478

% SOLIDS 63.87% % WATER 36.13%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D6

ANALYST: OAA

CLIENT SAMPLE ID: 36

TOTAL WET WEIGHT (g) 78.88
TOTAL DRY WEIGHT (g) 48.99

PERCENT SOLIDS @ 105C 62.10%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 36

SIEVE FRACTION

BEAKER TARE: 112.17
TOTAL DRY WT (g) 134.83
SAMPLE WT (g) 22.67

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.02	0.04%	99.96%	Shells
10	2.00	0.13	0.27%	99.69%	Fine Shells
20	0.850	0.17	0.34%	99.35%	Fine Shells
40	0.425	0.37	0.75%	98.60%	
60	0.250	1.18	2.40%	96.20%	
140	0.106	12.34	25.18%	71.02%	
200	0.075	7.15	14.59%	56.43%	
<200	<0.075	1.31	2.67%		
TOTAL WT		22.65			
RECOVERY (%)		99.94%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.31% % SAND 43.26% % CLAY/SILT 56.43% MEAN (mm) 0.0570

% SOLIDS 62.10% % WATER 37.90%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/22/2019

LAB SAMPLE ID: REN01013D7

ANALYST: OAA

CLIENT SAMPLE ID: 37

TOTAL WET WEIGHT (g) 80.78
TOTAL DRY WEIGHT (g) 48.14

PERCENT SOLIDS @ 105C 59.59%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 37

SIEVE FRACTION

BEAKER TARE: 112.34
TOTAL DRY WT (g) 132.82
SAMPLE WT (g) 20.48

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.01	0.01%	99.99%	Shells
20	0.850	0.10	0.20%	99.78%	Fine Shells
40	0.425	0.38	0.78%	99.00%	Fine Shells
60	0.250	1.05	2.19%	96.81%	
140	0.106	11.02	22.88%	73.93%	
200	0.075	6.80	14.12%	59.81%	
<200	<0.075	0.95	1.98%		
TOTAL WT		20.30			
RECOVERY (%)		99.12%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.01% % SAND 40.18% % CLAY/SILT 59.81% MEAN (mm) 0.0457

% SOLIDS 59.59% % WATER 40.41%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013D8

ANALYST: OAA

CLIENT SAMPLE ID: 38

TOTAL WET WEIGHT (g) 82.95
TOTAL DRY WEIGHT (g) 50.01

PERCENT SOLIDS @ 105C 60.29%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 38

SIEVE FRACTION

BEAKER TARE: 116.27
TOTAL DRY WT (g) 139.86
SAMPLE WT (g) 23.59

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.02	0.04%	99.96%	Shells
20	0.850	0.27	0.54%	99.42%	Fine Shells
40	0.425	0.54	1.07%	98.35%	Fine Shells
60	0.250	1.37	2.74%	95.61%	
140	0.106	12.63	25.25%	70.37%	
200	0.075	7.25	14.50%	55.87%	
<200	<0.075	1.41	2.83%		
TOTAL WT		23.48			
RECOVERY (%)		99.56%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.04% % SAND 44.09% % CLAY/SILT 55.87% MEAN (mm) 0.0544

% SOLIDS 60.29% % WATER 39.71%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013D9

ANALYST: OAA

CLIENT SAMPLE ID: 39

TOTAL WET WEIGHT (g) 79.91
TOTAL DRY WEIGHT (g) 47.38

PERCENT SOLIDS @ 105C 59.29%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 39

SIEVE FRACTION

BEAKER TARE: 119.32
TOTAL DRY WT (g) 141.26
SAMPLE WT (g) 21.94

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.04	0.09%	99.91%	Shells
20	0.850	0.40	0.85%	99.07%	Fine Shells
40	0.425	0.65	1.36%	97.70%	Fine Shells
60	0.250	1.36	2.86%	94.84%	
140	0.106	11.18	23.59%	71.26%	
200	0.075	6.40	13.51%	57.75%	
<200	<0.075	1.89	3.98%		
TOTAL WT		21.91			
RECOVERY (%)		99.85%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.09% % SAND 42.17% % CLAY/SILT 57.75% MEAN (mm) 0.0570

% SOLIDS 59.29% % WATER 40.71%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E0

ANALYST: OAA

CLIENT SAMPLE ID: 40

TOTAL WET WEIGHT (g) 80.78
TOTAL DRY WEIGHT (g) 46.00

PERCENT SOLIDS @ 105C 56.95%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 40

SIEVE FRACTION

BEAKER TARE: 112.68
TOTAL DRY WT (g) 132.69
SAMPLE WT (g) 20.01

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.02	0.04%	99.96%	Shells
20	0.850	0.08	0.16%	99.79%	Fine Shells
40	0.425	0.45	0.98%	98.82%	Fine Shells
60	0.250	1.01	2.18%	96.63%	
140	0.106	9.96	21.65%	74.98%	
200	0.075	6.67	14.51%	60.48%	
<200	<0.075	1.65	3.59%		
TOTAL WT		19.83			
RECOVERY (%)		99.14%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.04% % SAND 39.48% % CLAY/SILT 60.48% MEAN (mm) 0.0457

% SOLIDS 56.95% % WATER 43.05%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E0 DUP

ANALYST: OAA

CLIENT SAMPLE ID: 40 DUP

TOTAL WET WEIGHT (g) 81.84
TOTAL DRY WEIGHT (g) 47.51

PERCENT SOLIDS @ 105C 58.05%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 40 DUP

SIEVE FRACTION

BEAKER TARE: 117.04
TOTAL DRY WT (g) 136.25
SAMPLE WT (g) 19.21

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.08	0.16%	99.84%	Shells
20	0.850	0.22	0.46%	99.38%	Fine Shells
40	0.425	0.40	0.84%	98.54%	Fine Shells
60	0.250	1.05	2.21%	96.34%	
140	0.106	9.62	20.24%	76.10%	
200	0.075	6.47	13.63%	62.47%	
<200	<0.075	1.40	2.94%		
TOTAL WT		19.23			
RECOVERY (%)		100.08%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.16% % SAND 37.37% % CLAY/SILT 62.47% MEAN (mm) 0.0479

% SOLIDS 58.05% % WATER 41.95%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E1

ANALYST: OAA

CLIENT SAMPLE ID: 41

TOTAL WET WEIGHT (g) 80.21
TOTAL DRY WEIGHT (g) 45.61

PERCENT SOLIDS @ 105C 56.86%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 41

SIEVE FRACTION

BEAKER TARE: 112.87
TOTAL DRY WT (g) 129.63
SAMPLE WT (g) 16.77

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.18	0.39%	99.61%	Shells
20	0.850	0.28	0.61%	99.01%	Fine Shells
40	0.425	0.28	0.62%	98.39%	Fine Shells
60	0.250	1.71	3.76%	94.63%	
140	0.106	7.62	16.71%	77.92%	
200	0.075	5.31	11.65%	66.27%	
<200	<0.075	1.38	3.01%		
TOTAL WT		16.76			
RECOVERY (%)		99.96%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.39% % SAND 33.34% % CLAY/SILT 66.27% MEAN (mm) 0.0514

% SOLIDS 56.86% % WATER 43.14%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E2

ANALYST: OAA

CLIENT SAMPLE ID: 42

TOTAL WET WEIGHT (g) 80.03
TOTAL DRY WEIGHT (g) 48.47

PERCENT SOLIDS @ 105C 60.57%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 42

SIEVE FRACTION

BEAKER TARE: 111.54
TOTAL DRY WT (g) 132.66
SAMPLE WT (g) 21.13

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.16	0.32%	99.68%	Shells
10	2.00	0.07	0.15%	99.53%	Shells
20	0.850	0.20	0.41%	99.11%	Fine Shells
40	0.425	0.30	0.62%	98.49%	
60	0.250	1.02	2.10%	96.39%	
140	0.106	10.11	20.85%	75.54%	
200	0.075	7.69	15.86%	59.68%	
<200	<0.075	1.60	3.29%		
TOTAL WT		21.14			
RECOVERY (%)		100.06%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.47% % SAND 39.85% % CLAY/SILT 59.68% MEAN (mm) 0.0637

% SOLIDS 60.57% % WATER 39.43%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E3

ANALYST: OAA

CLIENT SAMPLE ID: 43

TOTAL WET WEIGHT (g) 80.65
TOTAL DRY WEIGHT (g) 50.91

PERCENT SOLIDS @ 105C 63.13%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 43

SIEVE FRACTION

BEAKER TARE: 111.54
TOTAL DRY WT (g) 135.34
SAMPLE WT (g) 23.80

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.01	0.02%	99.98%	Shells
20	0.850	0.23	0.45%	99.52%	Fine Shells
40	0.425	0.36	0.70%	98.82%	
60	0.250	1.09	2.14%	96.68%	
140	0.106	10.93	21.47%	75.21%	
200	0.075	9.18	18.04%	57.18%	
<200	<0.075	1.89	3.71%		
TOTAL WT		23.69			
RECOVERY (%)		99.54%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.02% % SAND 42.80% % CLAY/SILT 57.18% MEAN (mm) 0.0489

% SOLIDS 63.13% % WATER 36.87%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E4

ANALYST: OAA

CLIENT SAMPLE ID: 44

TOTAL WET WEIGHT (g) 80.19
TOTAL DRY WEIGHT (g) 52.84

PERCENT SOLIDS @ 105C 65.89%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 44

SIEVE FRACTION

BEAKER TARE: 119.14
TOTAL DRY WT (g) 146.29
SAMPLE WT (g) 27.14

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.24	0.45%	99.55%	Shells
10	2.00	0.02	0.04%	99.51%	Shells
20	0.850	0.25	0.47%	99.04%	Fine Shells
40	0.425	0.39	0.73%	98.31%	Fine Shells
60	0.250	0.74	1.41%	96.91%	
140	0.106	13.22	25.02%	71.89%	
200	0.075	9.55	18.07%	53.82%	
<200	<0.075	2.70	5.11%		
TOTAL WT		27.10			
RECOVERY (%)		99.85%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.49% % SAND 45.69% % CLAY/SILT 53.82% MEAN (mm) 0.0727

% SOLIDS 65.89% % WATER 34.11%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E5

ANALYST: OAA

CLIENT SAMPLE ID: 45

TOTAL WET WEIGHT (g) 80.53
TOTAL DRY WEIGHT (g) 47.66

PERCENT SOLIDS @ 105C 59.19%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 45

SIEVE FRACTION

BEAKER TARE: 119.31
TOTAL DRY WT (g) 136.86
SAMPLE WT (g) 17.55

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.27	0.56%	99.44%	Shells
10	2.00	0.03	0.07%	99.37%	Shells
20	0.850	0.13	0.27%	99.10%	Fine Shells
40	0.425	0.23	0.47%	98.63%	Fine Shells
60	0.250	0.96	2.01%	96.61%	
140	0.106	8.13	17.05%	79.57%	
200	0.075	6.59	13.83%	65.74%	
<200	<0.075	1.26	2.64%		
TOTAL WT		17.59			
RECOVERY (%)		100.20%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.63% % SAND 33.63% % CLAY/SILT 65.74% MEAN (mm) 0.0657

% SOLIDS 59.19% % WATER 40.81%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/219

LAB SAMPLE ID: REN01013E6

ANALYST: OAA

CLIENT SAMPLE ID: 46

TOTAL WET WEIGHT (g) 80.30
TOTAL DRY WEIGHT (g) 49.64

PERCENT SOLIDS @ 105C 61.82%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 46

SIEVE FRACTION

BEAKER TARE: 119.28
TOTAL DRY WT (g) 143.78
SAMPLE WT (g) 24.50

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.06	0.12%	99.88%	Shells
20	0.850	0.21	0.43%	99.45%	Fine Shells
40	0.425	0.30	0.61%	98.85%	
60	0.250	0.58	1.16%	97.68%	
140	0.106	12.83	25.85%	71.83%	
200	0.075	8.59	17.31%	54.52%	
<200	<0.075	1.83	3.68%		
TOTAL WT		24.40			
RECOVERY (%)		99.60%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.12% % SAND 45.36% % CLAY/SILT 54.52% MEAN (mm) 0.0519

% SOLIDS 61.82% % WATER 38.18%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E7

ANALYST: OAA

CLIENT SAMPLE ID: 47

TOTAL WET WEIGHT (g) 80.85
TOTAL DRY WEIGHT (g) 49.37

PERCENT SOLIDS @ 105C 61.06%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 47

SIEVE FRACTION

BEAKER TARE: 111.95
TOTAL DRY WT (g) 133.84
SAMPLE WT (g) 21.88

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.05	0.11%	99.89%	Shells
20	0.850	0.42	0.85%	99.04%	Fine Shells
40	0.425	0.37	0.74%	98.30%	
60	0.250	0.53	1.07%	97.22%	
140	0.106	10.70	21.67%	75.56%	
200	0.075	7.86	15.92%	59.64%	
<200	<0.075	1.86	3.76%		
TOTAL WT		21.78			
RECOVERY (%)		99.53%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.11% % SAND 40.25% % CLAY/SILT 59.64% MEAN (mm) 0.0502

% SOLIDS 61.06% % WATER 38.94%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E8

ANALYST: OAA

CLIENT SAMPLE ID: 48

TOTAL WET WEIGHT (g) 80.10
TOTAL DRY WEIGHT (g) 49.70

PERCENT SOLIDS @ 105C 62.05%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 48

SIEVE FRACTION

BEAKER TARE: 118.97
TOTAL DRY WT (g) 139.62
SAMPLE WT (g) 20.65

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.19	0.38%	99.62%	Shells
20	0.850	0.29	0.58%	99.04%	Fine Shells
40	0.425	0.24	0.48%	98.56%	
60	0.250	0.45	0.91%	97.65%	
140	0.106	10.07	20.26%	77.39%	
200	0.075	7.87	15.83%	61.56%	
<200	<0.075	1.35	2.71%		
TOTAL WT		20.45			
RECOVERY (%)		99.02%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.38% % SAND 38.06% % CLAY/SILT 61.56% MEAN (mm) 0.0502

% SOLIDS 62.05% % WATER 37.95%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013E9

ANALYST: OAA

CLIENT SAMPLE ID: 49

TOTAL WET WEIGHT (g) 80.67
TOTAL DRY WEIGHT (g) 51.02

PERCENT SOLIDS @ 105C 63.24%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 49

SIEVE FRACTION

BEAKER TARE: 112.68
TOTAL DRY WT (g) 138.25
SAMPLE WT (g) 25.57

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.03	0.05%	99.95%	Shells
20	0.850	0.20	0.40%	99.55%	
40	0.425	0.23	0.45%	99.09%	
60	0.250	0.53	1.03%	98.07%	
140	0.106	12.65	24.80%	73.27%	
200	0.075	9.99	19.58%	53.68%	
<200	<0.075	1.76	3.44%		
TOTAL WT		25.39			
RECOVERY (%)		99.29%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.05% % SAND 46.26% % CLAY/SILT 53.68% MEAN (mm) 0.0500

% SOLIDS 63.24% % WATER 36.76%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013F0

ANALYST: OAA

CLIENT SAMPLE ID: 50

TOTAL WET WEIGHT (g) 80.38
TOTAL DRY WEIGHT (g) 47.60

PERCENT SOLIDS @ 105C 59.22%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 50

SIEVE FRACTION

BEAKER TARE: 112.34
TOTAL DRY WT (g) 133.95
SAMPLE WT (g) 21.61

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.17	0.36%	99.64%	
20	0.850	0.12	0.25%	99.39%	
40	0.425	0.18	0.38%	99.01%	
60	0.250	0.86	1.81%	97.20%	
140	0.106	10.54	22.13%	75.07%	
200	0.075	8.06	16.93%	58.14%	
<200	<0.075	1.63	3.43%		
TOTAL WT		21.56			
RECOVERY (%)		99.75%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.36% % SAND 41.50% % CLAY/SILT 58.14% MEAN (mm) 0.0516

% SOLIDS 59.22% % WATER 40.78%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013F1

ANALYST: OAA

CLIENT SAMPLE ID: REF1

TOTAL WET WEIGHT (g) 80.92
TOTAL DRY WEIGHT (g) 32.34

PERCENT SOLIDS @ 105C 39.97%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 51

SIEVE FRACTION

BEAKER TARE: 112.73
TOTAL DRY WT (g) 116.69
SAMPLE WT (g) 3.96

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.00	0.00%	100.00%	
20	0.850	0.02	0.07%	99.93%	
40	0.425	0.07	0.22%	99.71%	
60	0.250	0.15	0.45%	99.25%	
140	0.106	0.86	2.65%	96.60%	
200	0.075	1.61	4.97%	91.64%	
<200	<0.075	1.18	3.66%		
TOTAL WT		3.89			
RECOVERY (%)		98.23%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.00% % SAND 0.36% % CLAY/SILT 91.64% MEAN (mm) 0.0092

% SOLIDS 39.97% % WATER 60.03%



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ASTM D422 PARTICLE SIZE

ANALYSIS DATE: 10/23/2019

LAB SAMPLE ID: REN01013F1 DUP

ANALYST: OAA

CLIENT SAMPLE ID: REF1 DUP

TOTAL WET WEIGHT (g) 80.35
TOTAL DRY WEIGHT (g) 32.46

PERCENT SOLIDS @ 105C 40.40%

SIEVE FRACTION - SAND GRAVEL

BEAKER # 52

SIEVE FRACTION

BEAKER TARE: 119.53
TOTAL DRY WT (g) 122.88
SAMPLE WT (g) 3.36

SIEVE SIZE	(mm)	(g)	(%)	% FINER	COMMENTS
0.375	9.50	0.00	0.00%	100.00%	
0.25	6.30	0.00	0.00%	100.00%	
4	4.75	0.00	0.00%	100.00%	
10	2.00	0.00	0.00%	100.00%	
20	0.850	0.02	0.06%	99.94%	
40	0.425	0.05	0.17%	99.77%	
60	0.250	0.13	0.40%	99.37%	
140	0.106	0.78	2.39%	96.97%	
200	0.075	1.51	4.66%	92.31%	
<200	<0.075	0.82	2.54%		
TOTAL WT		3.32			
RECOVERY (%)		98.78%			

PHYSICAL PROPERTIES

DISTRIBUTION % GRAVEL 0.00% % SAND 7.69% % CLAY/SILT 92.31% MEAN (mm) 0.0083

% SOLIDS 40.40% % WATER 59.60%