FINAL

2015 (Year 2) Monitoring Report

Custom Plywood Interim Remedial Action Conservation Measures and Monitoring

Anacortes, WA

Prepared for
Washington State Department of Ecology

May 11, 2016
17800-51

HARTCROWSER

FINAL

2015 (Year 2) Monitoring Report

Custom Plywood Interim Remedial Action Conservation Measures and Monitoring

Anacortes, WA

Prepared for

Washington State Department of Ecology

May 11, 2016
17800-51

Prepared by

Hart Crowser, Inc.

Emily Duncanson
Environmental Scientist

Jessica Blanchette
Marine Biologist

Jason Stutes
Marine Ecologist

Maria Sandercock
Marine Biologist

Contents

TABLES

FIGURES

PHOTOGRAPHS

APPENDIX A

Wetland, Backshore, and Upland Buffer Vegetation Photographs

APPENDIX B

Technical Memoranda by Coast and Harbor Engineering – Former Custom Plywood Mill Cleanup Project (1) Physical Monitoring Procedures and (2) Qualitative Spit and Jetty Condition

FINAL

2015 (Year 2) Monitoring Report

Custom Plywood Interim Remedial Action Conservation Measures and Monitoring

Anacortes, Washington

EXECUTIVE SUMMARY

Custom Plywood is a Washington Department of Ecology (Ecology) Toxics Cleanup Program project site under an agreed order with the property owner. Located on Fidalgo Bay in Anacortes, Washington, Custom Plywood has progressed through a series of phases in an overall remedial cleanup action. Phase II, in-water cleanup activities, was completed in 2013. As part of the verifying the performance of design elements and complying with regulatory permit conditions specific to this project, this Conservation Measures and Monitoring report summarizes performance of various design elements compared to success criteria previously agreed upon by Ecology and other federal and state regulatory agencies (Hart Crowser 2012a). This report summarizes the results of Year 2 monitoring following the Phase II interim remedial actions.

Ecology and other agencies established a series of monitoring criteria to compare relative performance of the remedial actions and to evaluate the success of the project from a natural resources perspective. Table 1 and the text below provide a summary of these tasks and indicators for success. The performance categories included physical monitoring of the restored beach, epibenthic zooplankton sampling, documenting nearshore fish species, monitoring for forage fish spawning activity and egg survival, determining the effectiveness of eelgrass transplants, and monitoring the wetland and backshore vegetation. As seen in Table 1, all six categories have met their Year 2 success criteria.

Table 1 – 2015 Performance Status of Monitoring Components

Monitoring Component	Status of Success Criteria	Monitoring Year
Physical monitoring of the restored beach	Meeting criteria	Year 1
Epibenthic zooplankton	Meeting criteria	Year 2
Nearshore fish	Meeting criteria	Year 2
Forage fish spawning	Meeting criteria	Year 2
Eelgrass transplants	Meeting criteria	Year 1
Upland buffer	Meeting criteria	Year 4
Wetland and backshore vegetation	Meeting criteria	Year 2

The success criterion for the restored beach was for beach elevation profiles to change by no more than +/−1.5 feet by Year 5. This criterion was largely met during Year 2. Monitoring data found only minor changes in beach profiles below +6 feet mean lower low water (MLLW), but some localized changes exceeded this criteria in beach profile elevations above +6 feet MLLW, a result of erosion from the upland site. These changes are likely a result of the constructed beach profiles approaching dynamic equilibrium as anticipated.

Epibenthic zooplankton success was evaluated by comparing plankton densities on the restored beach to densities at the reference beach. Current densities on the restored beach were comparable to those from the reference beach. Enhanced densities may have been due to increased colonization of macrovegetation, which provides algae and detritus that support zooplankton production. Decreased presence of juvenile salmonids on the restored beaches may also have contributed to the results by allowing the epibenthic zooplankton populations to thrive.

Nearshore fish surveys focused on juvenile salmonid use of the restored beach compared to that on the reference beach. This criterion was met in 2015. Juvenile salmonid use of the restored beach was found to be greater than on the reference site, although catch was lower than in Year 1 monitoring.

Success criterion for forage fish was dependent on at least 50 percent of the substrate composition along the upper beach being suitable for forage fish spawning in any given year. This criterion was met in 2015, with forage fish spawning documented at all survey sites of the enhanced beach area during the Year 2 monitoring period. Increased egg survival was also documented since the replacement of beach substrate in 2013.

Eelgrass transplant success was defined as no temporal loss of eelgrass productivity over time. This was measured by the density of eelgrass, multiplied by the area of shoots in the transplant areas, and adjusted for changes in the reference bed. This density was then compared to eelgrass decline in the project vicinity. After one year, transplants showed signs of recruitment success with planting units exceeding transplant densities and coalescing into larger patches. This prompted a change in the survey methodology to begin examining densities via quadrat as opposed to counting planting units. Average density within the transplant area was 9.7 shoots per square meter (m^2), approximately 30 percent of the density surveyed in the reference area. Based on this survey, it is assumed that a greater number of shoots are present than were planted. Thus the success criteria of greater than 50 percent recruitment of the original plantings has been met in 2015.

Upland buffer, wetland, and backshore vegetation success is based on a combination of plant survival and cover criteria. There were no applicable criteria established to evaluate the upland buffer during this year's monitoring. However, the wetland and backshore criteria in the planted area during Year 2 were: (1) 30 percent or greater areal coverage of native vegetation; (2) 80 percent survival; and (3) less than 10 percent total cover of invasive plant species. Based on the data collected in 2015, all criteria were met for the wetland and backshore areas. Low numbers of non-natives were observed within all areas of the site.

1.0 INTRODUCTION AND OBJECTIVES

The Washington Department of Ecology (Ecology) Toxics Cleanup Program (TCP) completed Phase II of the interim remedial actions at the Custom Plywood site located on Fidalgo Bay in Anacortes, Washington, in 2013. The biological evaluation (BE; Hart Crowser 2011a) that was prepared for the remediation concluded that the project was not likely to adversely affect species listed under the Endangered Species Act (ESA). Short-term construction activities would cause temporary effects, but long-term effects to ESA-listed species, designated critical habitat, and essential fish habitat would be positive. These determinations of effects depended on the implementation of several proposed conservation measures designed to offset the temporary, unavoidable losses and disturbances to marine functions that would result from project remedial activities and restoration. Ecology prepared a Conservation Measures and Monitoring Plan (CMMP; Hart Crowser 2012a) to propose appropriate conservation measures to offset the temporary but unavoidable adverse impacts to important marine resources, especially those habitats for salmonids listed under ESA. The restoration actions described in the CMMP were expected to provide several benefits that would exceed the anticipated adverse impacts of the project.

The following restoration were actions completed during the Custom Plywood Interim Remedial Action remedial cleanup.

- Expanded and restored the shallow water migratory corridor and rearing habitat for juvenile salmonids at all tidal elevations by removing contaminated sediment as well as in-water and overwater structures.
- Excavated/dredged contaminated sediments covering 7.1 acres (1.8 acres in the shoreline cleanup zone/intertidal zone and 5.3 acres of subtidal zone) and backfilled with clean sediment.
- Removed 1,465 creosote-treated piles, derelict structures (bulkhead, L-shaped pier, and smaller concrete structures), and debris (concrete, metal, and brick) over an area of 13,500 square feet (sf).
- Enhanced approximately 1,770 linear feet of shoreline habitat between elevations of –5 and +8.5 feet MLLW with suitable substrates and/or grading to allow forage fish spawning. Areas that received these enhancements were the main shoreline of the property, the inner portion of the protective spit, the existing jetty, and a pocket beach located immediately north of the Custom Plywood site.
- Protected eelgrass to the extent possible and enhanced and expanded eelgrass beds through advanced plantings (2,000+ sf), to achieve no net long-term loss of eelgrass.
- Increased backshore function by planting native riparian vegetation above the upper beach and along the ordinary high water (OHW) line of the main shoreline, a total area of approximately 5,440 sf (0.1 acres).
- Compensated for unavoidable wetland losses that resulted from site remediation activities by hydrologically connecting a consolidated wetland mitigation area to Fidalgo Bay; this provided

juvenile salmonid access to approximately 12,000 sf of wetland and pocket estuary habitats surrounded by a vegetated buffer ranging from 50 to 75 feet wide.

The majority of these habitat enhancements occurred from July 15 to December 23, 2013, as part of construction activities for the Phase II Interim Remedial action. The shoreline protection features, such as the extension of the jetty and the installation of a protective spit, were completed within this window. Phase II also involved the placement of improved beach substrate for forage fish spawning and for use by juvenile salmonids, shorebirds, waterfowl, and other aquatic species at the site. In late October 2013, approximately 22,000 dunegrass plants were planted along the property shoreline to provide erosion control and backshore habitat as well as along the protective spit. The wetland mitigation complex was constructed during the Phase I Interim Action (July 22, 2011, to October 31, 2011) but it was not breached until Phase II, following the completion of the in-water excavation and dredging. In addition to cutting the breach, larger, heavier material was added to completely cover the sloped sides of the breach to withstand wave propagation from the south and prevent potential erosion. The channel of the breach was excavated to a depth that completely drains the pocket estuary within the wetland at low tide with the intention of preventing fish from being stranded in shallow, isolated water.

The CMMP laid out a 10-year monitoring program to assess the effectiveness of conservation measures implemented during design and construction. This Year 2 Monitoring Report is intended to provide the monitoring results of the restored beach substrate, epibenthic production, juvenile salmonid use, forage fish spawning, wetland and backshore vegetation function, and the advanced eelgrass transplant effort to satisfy the requirements associated with Nationwide Permit No. NWS-2012-868.

2.0 PROJECT LOCATION

The project is located in Anacortes, Washington, in Section 30 of Township 35 North, Range 2 East (Figure 1). The project area, approximately 23 acres in size, includes the area between approximately OHW and –6 feet MLLW and areas north of the site at the existing jetty owned by the City of Anacortes.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and

Figure 1 – Vicinity map

3.0 MONITORING SCHEDULE AND METHODS

3.1 Monitoring Schedule

The final in-water construction and subsequent as-built completed in December 2013 represents Year 0 of the monitoring timeline. Year 1 monitoring was conducted during 2014. Hart Crowser began Year 2 monitoring in January 2015 with a forage fish monitoring survey and another survey event in May. We conducted forage fish monitoring twice monthly from July through October and then twice in December. We monitored for epibenthic zooplankton and nearshore fish in May and June. Monitoring for the advanced eelgrass planting effort was conducted in late May. We performed physical and wetland monitoring in September and began Year 2 reporting in December 2015. Table 2 summarizes Hart Crowser's Year 2 monitoring and reporting schedule.

Table 2 – Monitoring and Reporting Schedule for Year 2 (2015)

Monitoring Event	Year 2 (2015) Monitoring Events											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Physical Monitoring									×			
Epibenthic Zooplankton and Nearshore Fish					×	×						
Forage Fish Survey for Sand Lances and Surf Smelt	×				×		××	××	××	××		××
Eelgrass Advanced Planting Monitoring												
Wetland Monitoring									×			
Year 2 Reporting												×

3.2 Physical Monitoring of Restored Beach

Coast and Harbor Engineering (CHE) conducted the physical monitoring of the restored beach in accordance with the monitoring approach described in the CMMP Work Plan (Hart Crowser 2014). They conducted an as-built survey in mid-December 2013, immediately following completion of the beach construction. They then monitored the restored beach habitat on August 28, 2015, by surveying nine beach profiles (Figure 2) from near the edge of adjacent eelgrass beds (or water's edge at the time of the survey) to +15 feet MLLW to determine the degree of substrate sorting, recruitment, and migration. The team noted beach features such as changes in slope or substrate and located them on each transect. They collected hand core samples of substrate at four locations on six of the eight transects to determine the depth and grain size composition of the surficial substrate. In Year 2 (2015) the team compared relative changes to the photopoints established during Year 1 (2014), documenting physical changes in the appearance of the restored beaches (both foreshore and backshore), accumulations of large woody debris (LWD), and the development of riparian vegetation. Results are discussed in a technical memorandum presented in Appendix B.

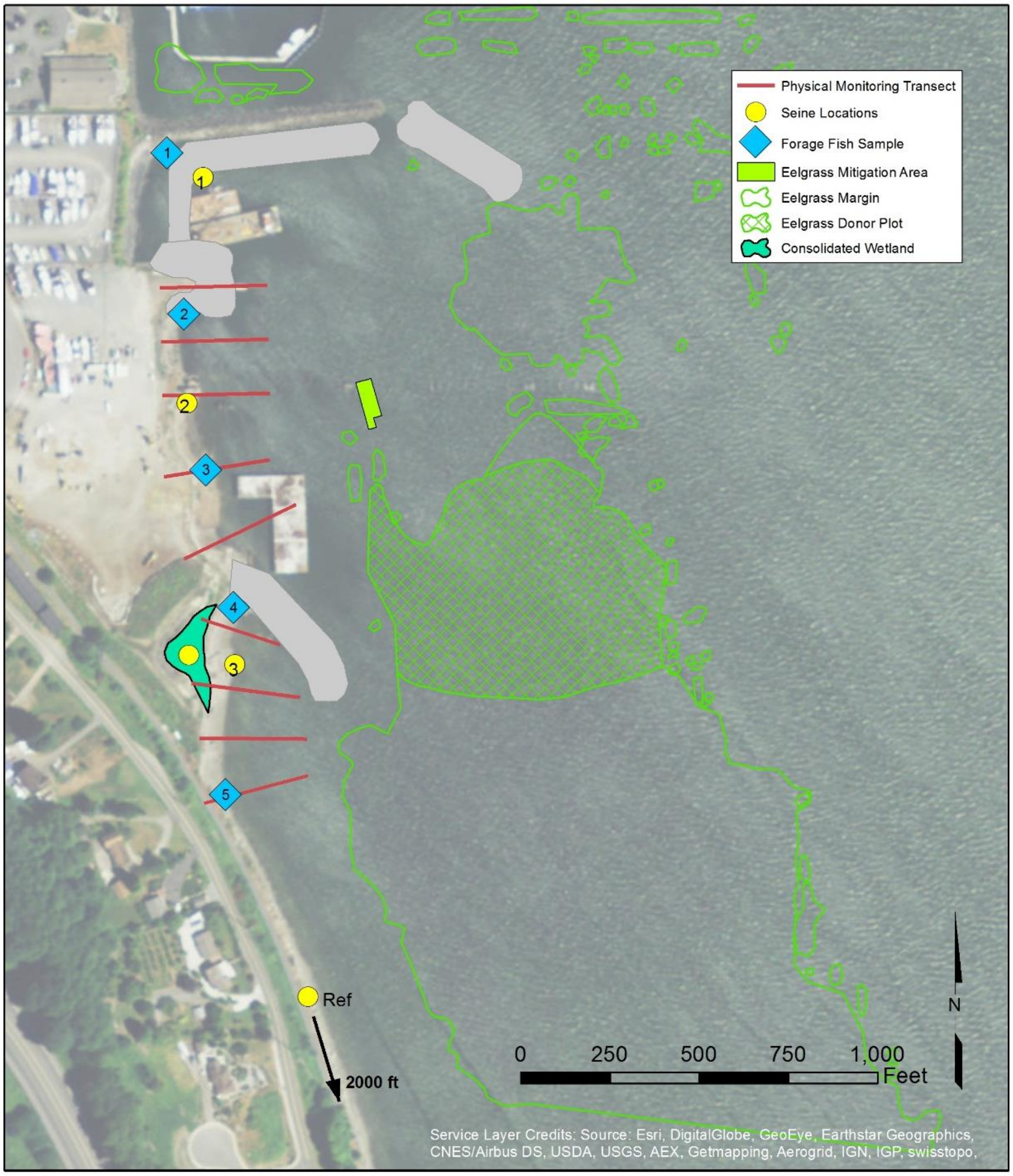


Figure 2 – Sampling locations

3.3 Epibenthic Zooplankton

Epibenthic zooplankton are a sediment-associated prey group important to juvenile salmonids. To gain insight into habitat function of the restored shoreline after restoration, quantitatively sampled epibenthic biota within the project area and at an unaltered reference site. We sampled four transects (one in the reference area and three in the project area; Figure 2) at two elevations (+4 and +6 feet MLLW) within the intertidal zone. Of the three transects within the project area, EB-1 was located along the south side of riprap jetty located on the northernmost section of the restored beach; EB-2 was located in the middle of the restored beach; and EB-3 was located at the outlet of a constructed pocket estuary. The reference site, located approximately 0.5 kilometers to the south of the project area, represented a more natural beach; little human alteration was present except for a walking path located behind vegetation in the upland. Sampling was conducted during two periods (May 13–15 and June 13–14) in the spring to coincide with juvenile salmonid sampling.

Samples were collected using a hand-held, battery-powered epibenthic zooplankton sampler (Simenstad et al. 1991) (Figure 3). The sampler, composed of a cylinder with 0.125-millimeter (mm) mesh screen ports was lowered through the water to enclose the benthic boundary layer over a surface area of 0.02 square meters (m^2). Once in place, the pump discharges water enclosed in the cylinder through a 0.250-mm sieve. The material deposited on the sieve was then collected and preserved in 10 percent buffered formalin for laboratory sorting and identification. Three replicate samples were collected at each elevation sampled along each transect.

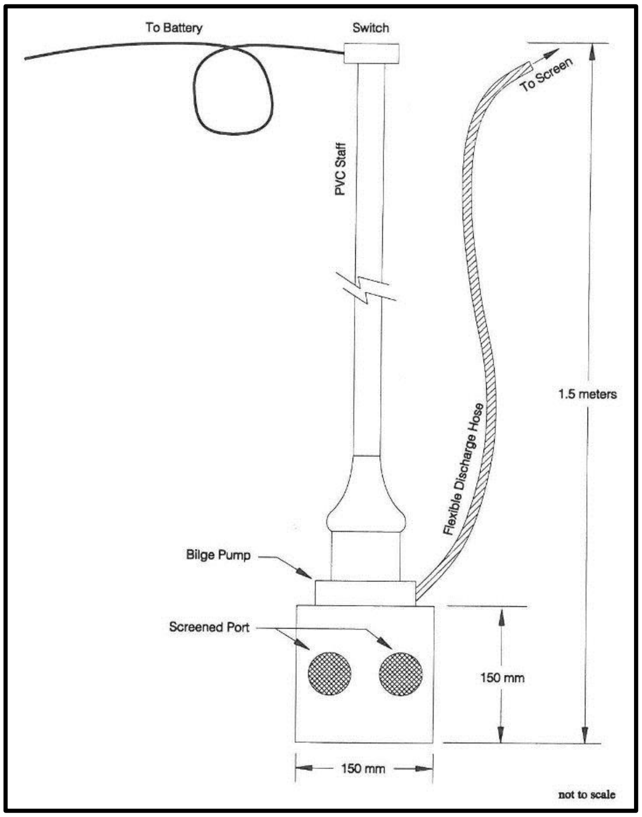


Figure 3 – Epibenthic zooplankton sampler

In the lab, samples were sorted and epibenthic organisms were identified to the lowest practicable taxonomic level. For each sampling event, data were analyzed using 2-way analysis of variance (ANOVA) to determine if there were differences in species richness, total epibiota abundance, or potential salmonid prey abundance as a function of elevation and treatment (restored vs. reference beach). Statistical differences, could be an indication of differences in habitat quality and prey resources for those species that forage in this habitat, such as juvenile salmonids.

3.4 Nearshore Fish

To determine use of the nearshore study area by juvenile salmonids and resident marine species, field teams collected nearshore fish samples using a standard 120-foot floating beach seine. The seine measured 120 feet long, 10 feet deep at the bag, and 3 feet deep at the end of the wings. The wings were 60 feet long with 0.375-inch bar mesh. The bag was 0.125-inch (bar) woven nylon mesh and measured 7.5 feet long by 10 feet deep. This net design was developed to capture smaller, surface-oriented fish, especially juvenile salmonids, in shoreline areas.

Beach seine sets were conducted at four sites—three on the restored beach and one reference site on a "natural" beach to the immediate south of the study area (Figure 2). Seining took place on May 4 and June 4, 2015, during the typical juvenile salmonid outmigratory period in Puget Sound. Additional beach seine sets were conducted in the pocket estuary adjacent to Site 3 using a 30-foot beach seine.

Beach seine methods employed during the sampling period were similar to those used in juvenile salmon studies within many estuaries in the Pacific Northwest. Exact location of beach seine sampling at each site depended on tidal elevations and currents. Two seine sets were deployed at each site. For the 120-foot seine, field personnel stood on the beach holding one end of a 100-foot haul line while the skiff containing the net backed out, perpendicular to the beach. When the end of the towline was reached, the skiff turned 90 degrees and the seine was deployed parallel to the beach in the direction of the current. After net deployment, the boat returned to the beach while releasing the second 100-foot towline. Field crew then hand-retrieved the seine to the beach (Photograph 1). Similar methods were employed for the 30-foot seine, except that instead of using a skiff, the net was walked out by personnel in waders. Beach seining at most sites was performed at higher tides so that samples would be taken from the newly constructed beach surface rather than from the lower sand flats.

Photograph 1 – Field team collecting nearshore fish samples using a standard 120-foot floating beach seine

Upon retrieval of the seine, fish and invertebrates were removed from the net and placed in a bucket of ambient water. Lengths of most fish were measured and recorded in the field; however, when large numbers of the same species were captured, a representative subsample (at least 20 fish) was measured. Fork lengths were measured on species with homocercal (notched) caudal fins (tails), and total length was measured for all other species (Photograph 2). Fish from the first set were released back into the bay away from where the second set was going to be captured. Selected fish and all invertebrates from both sets at a given site were retained in a single container and preserved in 10 percent formalin for laboratory identification and enumeration.

To determine the degree of use of the restored beach by juvenile salmonids and other fish species, we calculated total catch and catch per unit effort (CPUE; defined as number of fish per set). CPUE was determined for each site, for each treatment (restored versus reference), and for all sites combined during the two sampling periods. The pocket estuary was excluded from the both the overall and restored beach CPUE, as the estuary habitat was unique among both the restored and reference sites. We examined the results for differences between the reference and newly constructed beaches with respect to utilization by the local fish assemblage.

Photograph 2 – Field personnel measuring fish length

3.5 Forage Fish Spawn

A field biologist collected beach substrate samples on the restored beach and at an adjacent reference be ach to evaluate the potential use of the study area by spawning surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes hexapterus*). Surveys were conducted in accordance with Washington Department of Fish and Wildlife (WDFW) protocols (Moulton and Penttila 2001) by a biologist certified by WDFW for conducting such surveys.

In accordance with WDFW protocols, the study area was divided into four 100-foot transects in areas of suitable spawning substrates between +5 feet MLLW and mean higher high water (MHHW), capturing the full extent of the restored shoreline (Figure 2). The sites were numbered as Sites 1 to 4, from north to south. One transect was also established on a reference beach, as the southernmost Site 5 in Figure 2. During the survey, subsamples within the upper 1 to 2 inches of beach substrate were collected at spaced intervals within each transect and composited for laboratory analysis. Substrate was targeted if eggs were visible on the beach; otherwise, subsamples were spaced evenly to capture the full transect.

In the laboratory, composited beach samples were condensed with screens and winnowed to separate and remove forage fish eggs from the beach substrate. Winnowed samples were examined under a dissecting microscope to further search for eggs, identify species, and identify developmental stages. Data from these surveys indicate the presence and condition of forage fish eggs for comparing the restored beaches to the reference beach.

Forage fish surveys were staggered through the year to capture spawning events during different seasons. Surf smelt spawn year-round, but are predominately summer spawners in Fidalgo Bay, spawning during nighttime high tides. Sand lance in Puget Sound spawn only in the winter, between November and February, at varying high tides depending on weather conditions. Herring spawn subtidally on submerged vegetation between late winter and early spring.

A paired survey consists of two site visits separated by two weeks, to track development of eggs present. A single site survey was conducted in May 2015. Paired surveys were conducted in late June and early July, August, September, October, and December.

3.6 Advanced Eelgrass Transplant Monitoring

Advanced eelgrass transplanting occurred on June 23 and 24, 2014. Further explanation of the methods used as part of the transplant effort can be found in the Year 1 report (Hart Crowser 2015). The goals of the planting were to facilitate colonization of eelgrass into newly remediated areas that could support eelgrass habitat but currently do not and to mitigate for any eelgrass that was potentially impacted during construction activities. By transplanting eelgrass into the advanced planting area, we expect accelerated expansion of eelgrass habitat. See Figure 2 for advanced planting and eelgrass donor areas.

This report documents the one-year-post-transplant survey conducted on July 23, 2015. The purpose of the survey was to evaluate the planted eelgrass to ensure no net long-term loss. Monitoring transects were established by marking transplant plot corners collected via GPS coordinates during the prior year onto buoys. Divers were to swim parallel transects along the long axis of the plot counting planting units (PUs). At random intervals a diver would count the shoots associated with a given planting unit. Once we began swimming transects, it became clear that many of the PUs had coalesced into larger patches. We then adopted a survey protocol of determining density within the transplant area using randomly placed quadrats. We verified that the perimeter of the transplant area was similar or greater than the original transplant plot. For the purposes of this survey, we conservatively assume that the transplant area is the same as the original transplant area. This will be more rigorously determined in future surveys using georeferenced video. Density data taken within the transplant area will then be compared to the counts at the reference area to determine if the transplant area is approaching natural population densities.

We noted macroalgae, eelgrass, benthic substrates, and habitats, as well as large invertebrate fauna and fish visible during the survey. We used handheld video to document qualitative indicators of eelgrass health and survival.

3.7 Wetland, Backshore, and Upland Buffer Vegetation

Prior to Phase I remedial activities, the site contained five poorly functioning wetlands (Wetlands A through E) totaling 11,910 square feet (sf). Wetlands A (120 sf), B (124 sf), and D (9,910 sf) were freshwater depressional wetlands, and Wetlands C (367 sf) and E (1,389 sf) were estuarine wetlands. Wetlands A, B, C, and D, totaling 10,521 sf, were permanently removed during the Phase I upland remediation. Wetland E, a federally regulated wetland, was removed in Phase II of the project (2013). To mitigate the loss of wetland areas during the upland portion of remedial actions, one 12,000-square-foot, consolidated estuarine wetland complex was constructed on the southern portion of the property and was established as part of the overall cleanup action during Phase I construction. The wetland mitigation area consists of estuarine wetland, backshore dunegrass habitat (backshore), and associated upland buffer (which included dunegrass plantings) that is approximately 50 to 75 feet wide landward of MHHW. The upland buffer was created and planted with appropriate native vegetation during the Phase I construction in 2011. During Phase II construction in 2013, a protective temporary berm was constructed seaward of the wetland area to prevent potentially contaminated sediment from entering the created wetland. Also during Phase II, pickleweed from Wetland E was transplanted into the created wetland with the goal of establishing it there. The protective berm was breached in 2014 at the end of the Phase II Interim Action, restoring tidal exchange. The final wetland mitigation area totals approximately 12,000 square feet of estuarine and tidal unconsolidated bed wetland. This area was confirmed in the As-Built Verification Report (Hart Crowser 2012b). Within the wetland complex, there are currently two zones for monitoring: upland buffer (trees, shrubs and groundcover [e.g., dunegrass]) and estuarine wetland.

The upland buffer was monitored in 2012 (Hart Crowser 2013) following its completion during Phase I construction in 2011 (Hart Crowser 2011b). The report documented the restoration efforts to be largely successful with most of the trees, shrubs, and herbaceous vegetation healthy and growing well.

This Year 2 report addresses the upland buffer area monitored in 2012 as well as the areas created during 2013. The upland buffer (within the estuarine wetland complex) was monitored as Year 4 under the SEA program and assessed as to whether the site meets the success criteria for Year 4. The estuarine wetland and backshore along the berm, beach, and spit were monitored as Year 2 in 2015. Table 3 (attached) shows the monitoring schedules for these elements. The vegetation monitoring period for the Custom site is 10 years, beginning with 2014 as Year 1 and monitoring through 2023 (see Table 3).

The Year 1 (2014) monitoring of the backshore and wetland areas and the Year 3 (2014) monitoring of the upland buffer deviated from the sampling design that was developed in 2012 (Hart Crowser 2011b). For further information on the methods used during the Year 1 monitoring see the Hart Crowser (2015) Year 1 CMMP report.

The Year 2 monitoring followed the sampling design that was developed in 2012 using the transect sampling method for monitoring of the upland buffer, backshore, and estuarine wetland areas. These methods are described further below and are referenced in Hart Crowser 2011b.

We sampled the restored plant communities along 11 permanent vegetation transects (T1 through T11). T1, T2, T3, and T4 correspond to the upland buffer area; T5, T6, and T7 correspond to the wetland area and stormwater swale; T8 and T9 correspond to the berm outside the pocket estuary; and T10 and T11 correspond to the backshore along the restored beach (Figure 4). A tape measure was extended along each vegetation transect to locate the sample plots. T1 and T2 were 200 feet long; T3, T4, T5, T6, T8, T9, and T10 were 100 feet long; and T7 was 75 feet long. The transect locations are identified on Figure 4 to ensure the same locations are monitored each year.

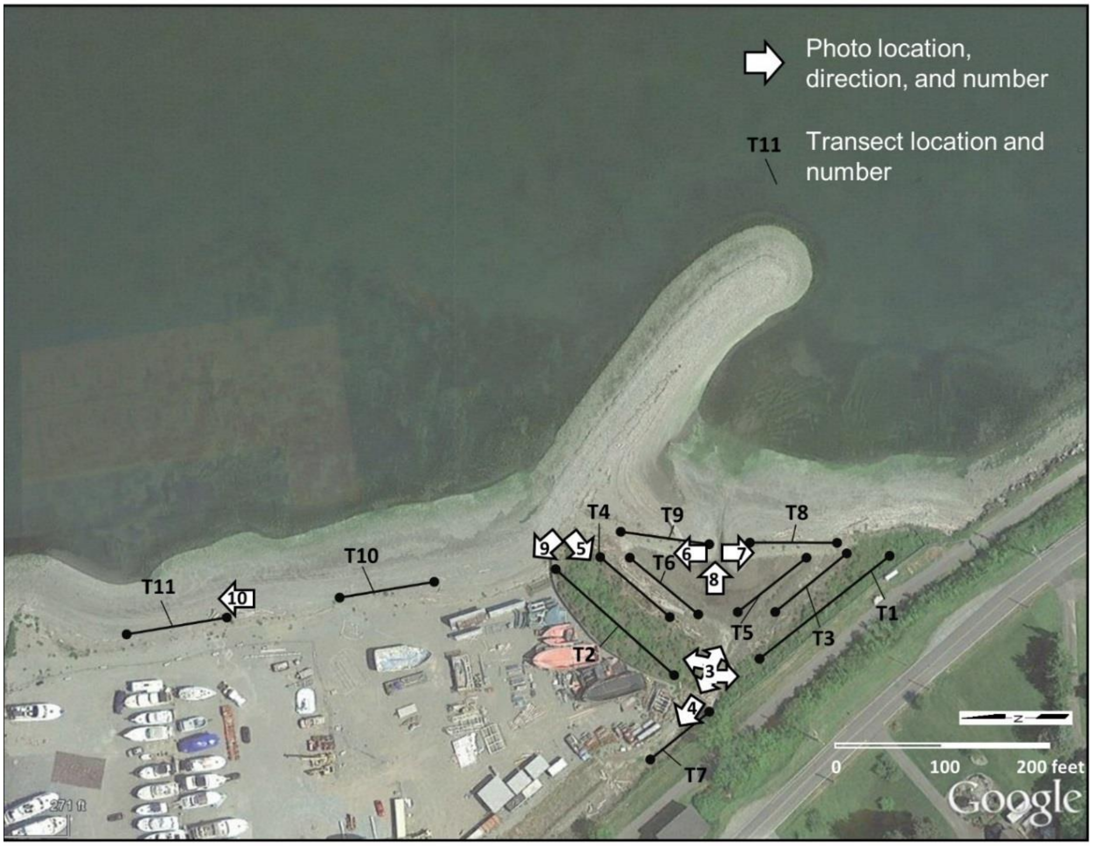


Figure 4 – Upland buffer, backshore, and wetland vegetation plots

Within each transect, we established three to eight permanent quadrats to estimate areal cover of native plants. We used a random number generator to eliminate bias in the placement of sample plots along each transect. Sample plots for all vegetation consisted of a circular quadrat (1-meter radius).

We visually estimated the percent cover of individual plant species within each quadrat. Data collection consisted of absolute percent cover of native species that had been installed, absolute percent cover of other native and non-native, non-invasive volunteer species, and absolute percent cover of invasive species. Species coverage values were summed to determine the total areal coverage in each plot. After calculating an average percent cover of the plots along each transect, we estimated the mean of the average percent cover for the transects of each plant community type (wetland, backshore, and upland buffer).

We visually inspected the mitigation plantings along each transect were also visually inspected to determine the health and vigor of the plants within the mitigation areas. Stressed and dying/dead trees were recorded. Installed plant survival was calculated by dividing the area of installed living plants by the current area of initially installed plants.

As part of the monitoring, we recorded our qualitative observations of vegetation and wildlife during qualitative data collection. We observed wildlife use by birds and small mammals, and recorded species present during the monitoring event.

4.0 RESULTS

4.1 Physical Monitoring of Restored Beach

Monitoring of the substrate and profile of the beach restoration project was conducted on August 28, 2015. Detailed methods and results of the monitoring are provided in the Technical Memorandum provided in Appendix B and briefly summarized here. The data collected during this Year 2 monitoring effort was compared to the Year 1 post-construction baseline conditions collected in 2014. The Year 2 survey found minor changes in beach profiles below +6 ft MLLW between 2014 and 2015 and some localized changes in beach profile elevations that exceeded the year-to-year criterion of “no greater than +/- 1.5 feet vertical change” above +6 ft MLLW. These localized changes, documented within the data, were due to erosion and are likely a result of the constructed beach profiles adjusting to the dynamic equilibrium beach profile. It appears that the 2015 profiles have reached a stage of dynamic equilibrium due to wave impact, and no further significant adjustment of the beach profiles is expected.

We qualitatively evaluated the spit and jetty as part of the beach substrate and profile monitoring. The field observations of the spit indicated that the composition of the slopes appeared the same as the condition immediately after construction (predominantly gravel and cobble with mild slopes). The spit itself is in good and stable condition; the structural integrity of the spit has not been compromised. Minor changes to the spit configuration occurred in the areas where sand material (for vegetation growth) was placed. Most of this sand material has eroded from the upper part of the spit, part of which has accumulated on the lee (interior) side of the spit.

The structural integrity of the jetty appeared similar to the condition immediately after construction. No noticeable displacement of stones or indication of instability of the jetty was observed. The top of the jetty on the east side was lower than the top of jetty on the west side. This sloping jetty top is consistent with the condition of the jetty immediately after construction, as documented in the post-construction surveys. The fish mix placed on the lee (interior) of the jetty has remained reasonably stable. As expected, some localized, minor adjustment of the armor stone toe of the jetty has occurred during the first year of post-construction monitoring; however, these minor adjustments have no impact on the structural integrity of the new jetty.

The fish passage has maintained its shape and provided tidal flow between the original jetty and the new jetty extension. It appears that the cross-sectional dimensions of the fish passage are similar to the dimensions achieved upon completion of construction. However, the surface material of fish passage has been subjected to some change. Voids in the armor stone layer of the fish passage have been partially filled with fine sediments such as silt, sand, and gravel. Filling of the voids in the fish passage armor stone layer may continue until rock interstices achieve a certain stage of equilibrium with tidal flow dynamics. However, filling of voids in the rock will not change the dimensions of the fish passage cross-sectional area.

The beach has likely achieved a state of dynamic equilibrium, meaning that some small changes in the beach profile, specifically along the upper beach, will occur. Some examples of possible beach changes are: erosion following winter storms, accumulation of sediments along the beach, or scarp formations during periods of elevated tides (i.e., during El Niño). However, we do not expect any long-term erosional trends in the project area.

4.2 Epibenthic Zooplankton

The restored beach face between +6 feet and +4 feet MLLW is composed of graded gravels and medium to fine sands has sorted into distinct bands as a result of tidal and wave action. Beach material at the reference is similar to that at the restored beach but also includes larger cobble and boulders. The larger boulder material at the reference is likely riprap from the original rail system that historically followed the shoreline. Organic content of the sediments, though evolving, would be considered low for the restored beach since placement of the material occurred recently in fall 2013. Grain size analysis indicates higher fines content near site EB-3, closest to the installed jetty, and may indicate a source of organics or reduced physical forcing. Qualitative beach sediment characteristics were similar in both the May and June 2015 sampling periods.

4.2.1 Assemblages and Relative Abundance

A detailed analysis was performed on several data strata using two-way analysis of variance (ANOVA), including total epibenthic biota density, crustacean density, and species richness for each sampling period. Crustacean density was analyzed separately because crustaceans (especially copepods) are known to be important prey items for juvenile salmonids (Simenstad et al. 1980; Simenstad et al. 1982). We analyzed for differences by treatment (restored sites vs. reference site) and by tidal height (+4 vs. +6 feet MLLW).

We also calculated Shannon’s diversity index and evenness index. Whereas species richness is simply the number of different species present, diversity takes abundance and evenness of the community into account. Evenness is how close in number each species in the community is, and provides information on whether the community is dominated by a few taxa.

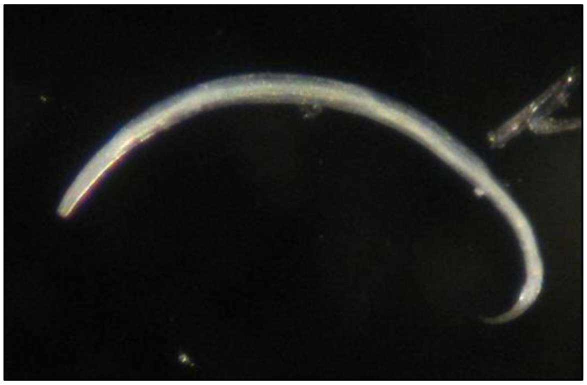
4.2.2 May 2015

For total biota, no significant difference was found between the +4 and +6 feet MLLW sampling depths, between reference and restored groups, or with an interaction between depth and treatment level (Table 4). However, there was a significant interaction ($p<0.05$) between tidal elevation and individual sites, meaning that the effect of tidal elevation on biota density depends on the site in question. While the difference between sites was not statistically significant ($p=0.083$), the differences between EB-1 and EB-3 and between EB-1 and the reference site within the +6 feet MLLW sampling events could be considered ecologically significant. For crustaceans, there was no significant difference in density across treatment or depth, with no significant interaction. However, as with total epibenthic fauna, there was a significant interaction between elevation and site ($p<0.001$). It appears that the reference site at +4 feet MLLW is significantly different (in crustacean density) from the other sites, and at +6 feet MLLW, the restored site EB-1 differs from the other sites. For species richness, there was a significant interaction between elevation and site ($p<0.05$). At +4 feet MLLW, all sites were indistinguishable in species richness, but at +6 feet MLLW, EB-1 and the reference site were similar to each other and differed from EB-2 and EB-3. Epibenthic biota in May (Table 5, attached) were overall dominated by nematodes (38 percent of total biota quantified; Photograph 3) and copepods (27 percent; Photograph 4) but differences in species assemblage were apparent by site and elevation. EB-1 at +4 feet MLLW was dominated mostly by copepods and nematodes (37 percent each), with the next most common organism being eggs (9 percent) and barnacle nauplii (4 percent; Photograph 5). In the Year 1 report (Hart Crowser 2015), eggs were grouped and analyzed with annelid larvae; due to their increased presence and proportion of the total biota population and their unknown taxonomy, eggs are analyzed as a separate taxa for 2015. EB-1 at +6 feet MLLW was dominated by barnacle nauplii (30 percent), copepods (24 percent), and nematodes (17 percent). EB-2 was dominated at both elevations by nematodes (51 percent at +4 feet; 89 percent at +6 feet MLLW), although annelids were common at +4 feet (17 percent; Photograph 6) and copepods were the next most common at +6 feet MLLW (6 percent). EB-3 was dominated by copepods at +4 feet elevations (51 percent) and nematodes at +6 feet MLLW (39 percent) with copepod as the next most common (26 percent), followed by barnacle nauplii and eggs (14 percent for both). The reference site at +4 MLLW was dominated by copepods (38 percent), but nematodes were commonly found (28 percent) as well as ostracods (13 percent). The reference site at +6 MLLW was also dominated by barnacle nauplii (26 percent) and co-dominate with copepods (25 percent), with other common organisms being annelids (15 percent) and nematodes (13 percent).

Table 4 – Two-way ANOVA Results for (A) May and (B) June Zooplankton in 2015

A. May Data		B. June Data	
Treatment (reference/restored)	**P**	**Treatment (reference/restored)**	**P**
Total Epibenthic Biota (#/m^2)	0.77	Total Epibenthic Biota (#/m2)	0.10
Total Crustaceans (#/m^2)	0.36	Total Crustaceans (#/m2)	0.21
Species Richness	0.25	Species Richness	0.33
Depth (shallow/deep)	**P**	**Depth (shallow/deep)**	**P**
Total Epibenthic Biota (#/m^2)	0.77	Total Epibenthic Biota (#/m^2)	0.43
Total Crustaceans (#/m^2)	0.83	Total Crustaceans (#/m^2)	0.36
Species Richness	0.62	Species Richness	0.16
Treatment x Depth	**P**	**Treatment x Depth**	**P**
Total Epibenthic Biota (#/m^2)	0.13	Total Epibenthic Biota (#/m2)	0.22
Total Crustaceans (#/m^2)	0.15	Total Crustaceans (#/m2)	0.28
Species Richness	0.62	Species Richness	0.60

Note:
No results were statistically significant



Photograph 3 – Nematode

Photograph 4 – Two varieties of copepod (crustaceans)

Photograph 5 – Barnacle nauplii (a crustacean)

Photograph 6 – Polychaete trochophore (an annelid)

Total epibenthic fauna density in May did not differ significantly by elevation or treatment but there were some significant differences by site ($p<0.05$). The site with highest epibenthic fauna density was site EB-1 at +6 feet MLLW and the lowest was EB-3 at +6 feet MLLW. Overall, the +6 feet MLLW samples had greater epibenthic fauna density than the +4 feet MLLW samples, and the restored sites had greater density than the reference site. Consequently, the +6 feet MLLW restored samples had the highest epibenthic fauna density. However, the +4 feet MLLW reference samples had the lowest fauna density (Figure 5, attached; Table 6, attached). This pattern appears to be largely driven by the presence or absence of crustaceans.

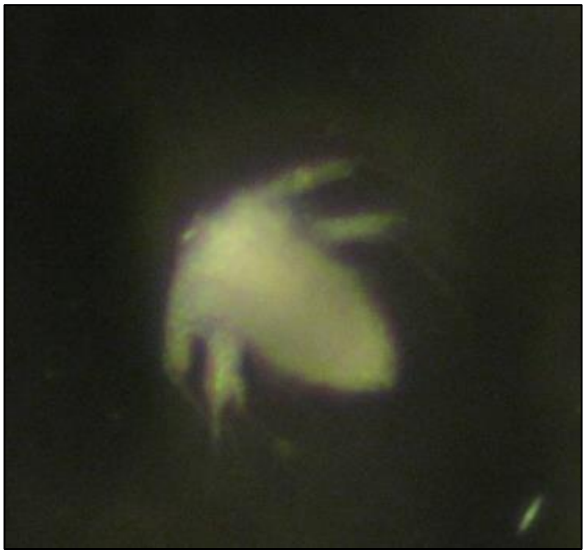
Crustacean density differed depending on the site and elevation of each site but did not differ significantly when grouped by treatment (i.e. all restored sites were grouped). The majority of the crustaceans found were copepods, although at +6 feet MLLW there was also a notable number of barnacles. Generally, the +6 feet MLLW samples had higher crustacean density than those at +4 feet MLLW, and the reference site had higher density than the restored sites (Figure 6; Table 6). The site with the highest crustacean density was EB-1 at +6 feet MLLW and the lowest was the nematode-dominated EB-2 at +4 feet MLLW.

Species richness was not significantly different by elevation or by treatment when sites were grouped, but there was a significant interaction between elevation and individual sites (Table 4). Species richness was greater in +4 feet MLLW samples than in +6 feet MLLW samples (Figure 7). Interestingly, community evenness was often higher in +6 feet MLLW samples than in +4 feet MLLW samples, with the exception of EB-2 at +6 feet MLLW. As a result, diversity did not display any clear pattern by elevation or treatment. However, average diversity in the restored areas at +4 feet MLLW was higher than in the reference site (Table 6). Diversity was highest at EB-1 +4 feet MLLW, and lowest at EB-3 +4 feet MLLW.

4.2.3 June 2015

For total biota, no significant difference was found between reference and restored areas (Table 4). However, there was a peripherally significant difference (p=0.1) where the +4 feet MLLW restored sites averaged higher zooplankton densities. There were statistically significant differences (p<0.05) between elevations and sites and, as in May, a significant interaction between site and tidal elevation. Tukey's honest significant difference (HSD) analysis revealed that the site most likely driving this result was EB-3 with over 3 times the density of epibenthic biota when compared to reference sites. For crustacean density, there was no significant difference across elevation or treatment when grouping the sites into treatment categories of "restored" or "reference." However, there were statistically significant differences in elevation and site when the restored sites were analyzed separately. There was also a statistically significant interaction between elevation and site (p<0.05). These results were driven by an abnormally large density of epibenthic crustaceans at EB-3, mainly at the +4 feet elevation.

Epibenthic biota in June were dominated by copepods (24 percent of total biota quantified), crustacean nauplii (21 percent; Photograph 7), and annelids (22 percent; Table 5, attached). EB-1 at +4 feet MLLW was dominated by annelid larvae (36 percent), though copepods, crustacean nauplii and nematodes were also common (21 percent, 12 percent and 12 percent, respectively). EB-1 at +6 feet MLLW was dominated by annelid larvae (50 percent), with other common organisms including copepods, crustacean nauplii, and Platyhelminthes (16 percent, 12 percent, and 12 percent, respectively). EB-2 was dominated at +4 feet MLLW by barnacles (31 percent) and annelid larvae (28 percent) with an abundance of copepods (16 percent) and crustacean nauplii (13 percent). At +6 feet MLLW, nematodes were the dominant organism at EB-2 (34 percent), and other common organisms included crustacean nauplii, copepods, and barnacles (20 percent, 19 percent, and 15 percent, respectively). EB-3 was dominated by crustacean nauplii at +4 feet MLLW (40 percent) and copepods were the next most common organism (26 percent). When tides reached an elevation of +6 feet MLLW, EB-3 was dominated by copepods (45 percent); barnacles and nematodes were also common (11 percent and 17 percent, respectively). Reference sites were dominated by crustacean nauplii at +4 feet MLLW (33 percent); other commonly found organisms include copepods (22 percent), annelid larvae (17 percent), and eggs (14 percent). At +6 feet MLLW, the reference site was dominated by copepods (29 percent) with the co-dominant crustacean nauplii (25 percent) and, again, eggs were common (19 percent).



Photograph 7 – Crustacean nauplii

As in May, total epibenthic fauna density did not differ significantly by elevation or treatment, but there were statistically significant differences between sites ($p<0.05$; Table 4). There was also a significant interaction term between elevation and site. It seems that total populations were consistently high at site EB-1 across depths but EB-3 had markedly higher total density at the +4 feet elevation. The +4 feet MLLW samples had greater epibenthic fauna density than the +6 feet MLLW samples and the restored sites had greater density than the reference site. Consequently, the +4 feet MLLW restored samples had the highest epibenthic fauna density. However, the +4 feet MLLW reference samples had the least fauna density (Figure 5; Table 6). This pattern appears to be largely driven by crustaceans.

Total crustacean density did not differ significantly by depth when sites were grouped by treatment, but sites were significantly different and were different depending on the sampling depth (Table 6). The main driver of the interaction term is site EB-3; at +4 feet MLLW, site EB-3 had nearly seven times the density of EB-2 and twice that of EB-1, but at +6 feet MLLW EB-3 was one third the density of EB-1 and had nearly the same density as EB-2. The +4 feet MLLW samples had a drastically higher density of crustaceans than the +6 feet MLLW samples and the restored areas had a higher density of crustaceans than the references sites. The +4 feet MLLW restored site in June was significantly higher in crustacean density than the other treatment groups, primarily dominated by nauplii and copepods, with a notable abundance of barnacles and cladocera. The main components of June crustacean populations were nauplii and copepods (Figure 6; Table 5).

There were no statistically significant differences in richness across elevation or treatment and no interaction (Table 4). However, when sites were analyzed outside of “restored” or “reference” groups, there was a difference ($p<0.05$) in elevation and site but no interaction. In general, restored sites had greater species richness than reference sites (25 vs. 18; Figure 7). The site with the lowest richness was EB-2, though EB-3 was very similar (Table 6). No clear pattern emerged in either Shannon’s diversity index or evenness index, though both indices seem similar to those in May at each treatment level with the exception of EB-2. In site EB-2, both diversity and evenness rose to levels comparable to the other sites in June (Table 6). Overall, restored diversity and evenness were higher than those of the reference site and this result was mostly driven by the crustacean group.

4.2.4 Year-to-Year Trends

Inter-annual comparisons reveal changes in total biota and crustacean density in both restored and reference sites at +6 feet MLLW sampling events. In all sites at all depths there was in increase in mean density for both epibenthic fauna and crustaceans (Figure 8). For total zooplankton, there was not a significant difference between 2014 and 2015 densities at +4 feet MLLW in May or June. However, there were significant increases in density in both months at +6 feet MLLW ($p<0.05$; Table 7).When analyzing crustaceans specifically, there were no detectable differences between 2014 and 2015 densities in May and June at the +4 feet MLLW (Figure 9). However, at +6 feet MLLW, there was a statistically significant increase ($p<0.05$) in density in June and a very nearly significant ($p=0.06$) increase in May (Table 7). In June, both treatment groups increased in crustacean density at +6 feet MLLW but at +4 feet MLLW the reference site had slightly lower crustacean densities than the previous year. Species richness increased in all treatment levels and elevations in both months (Figure 10).

4.3 Nearshore Fish

In total, 19 species of fish were captured and identified in beach seine sets—19 species at sites on the restored beach, three species in the pocket estuary, and nine species at the adjacent reference beach site. Overall, fish were more abundant in June relative to May (CPUE of 857.3 fish/set in June and 671.1 fish/set in May). In both May and June, CPUE for all fish was greater at the reference site (Table 8). However, if shiner perch (*Cymatogaster aggregata*) are excluded (which drive up the CPUE at all sites), CPUE was higher at the restored sites in May (120.7 fish/set vs. 63.5 fish/set) and comparable among sites in June (386.5 fish/set at restored sites and 321.5 fish/set at the reference site). In May, Site 1 had a much lower catch than the other restored sites (36.5 fish/set vs. ~270 fish/set). The opposite was observed in June when Site 1 had the highest catch at (649 fish/set) among the restored sites (with 414.5 fish/set at Site 2 and 307.5 fish/set at Site 3).

4.3.1 Year-to-Year Trends

Overall, more fish species were captured in 2015 than in 2014 (19 species in 2015 versus 17 species in 2014; Table 8). However, CPUE in 2015 was about half of that in 2014 (total CPUE = 1735.1 fish/set in 2014 and = 762.6 fish/set in 2015). If shiner perch are excluded, the ratio is similar (565.5 fish/set in 2014 vs. 240.0 fish/set in 2015). This result was largely driven by reduced catch of surf smelt at Site 3 and the reference site.

4.3.2 Salmonids

Juvenile salmon abundance in May was higher relative to June (CPUE for all sites = 1.25 fish/set vs. 0.6 fish/set, respectively), although abundance during both time periods was low. In May, three chum (*Oncorhynchus keta)* and six pink salmon (*O. gorbuscha)* were captured at Sites 1 and 2 (no salmon were caught at the reference). In June four Chinook (hatchery; *O. tshawytscha*) and one chum salmon were caught at Sites 2 and 3. Again, no salmon were captured at the reference site.

Length frequency data for pinks and chum in May show typical clusters of young-of-the-year fish, with most between 40 and 60 millimeters (mm) (Figure 11). In June, the single chum salmon captured was larger, at 73 mm. Juvenile Chinook were also found in June, in low abundance, and only at restored sites (Figure 12). Of those caught, most were between 70 and 90 mm, and were likely young-of-the-year ocean-type migrants. After emergence from redds, these ocean-type migrants typically spend 90 days or less in freshwater before outmigrating to the marine nearshore. One larger chinook—105 mm in length—was also captured in June. This was likely a yearling stream-type migrant, which spend at least one year after emergence rearing in freshwater before migrating to the ocean, generally in the spring.

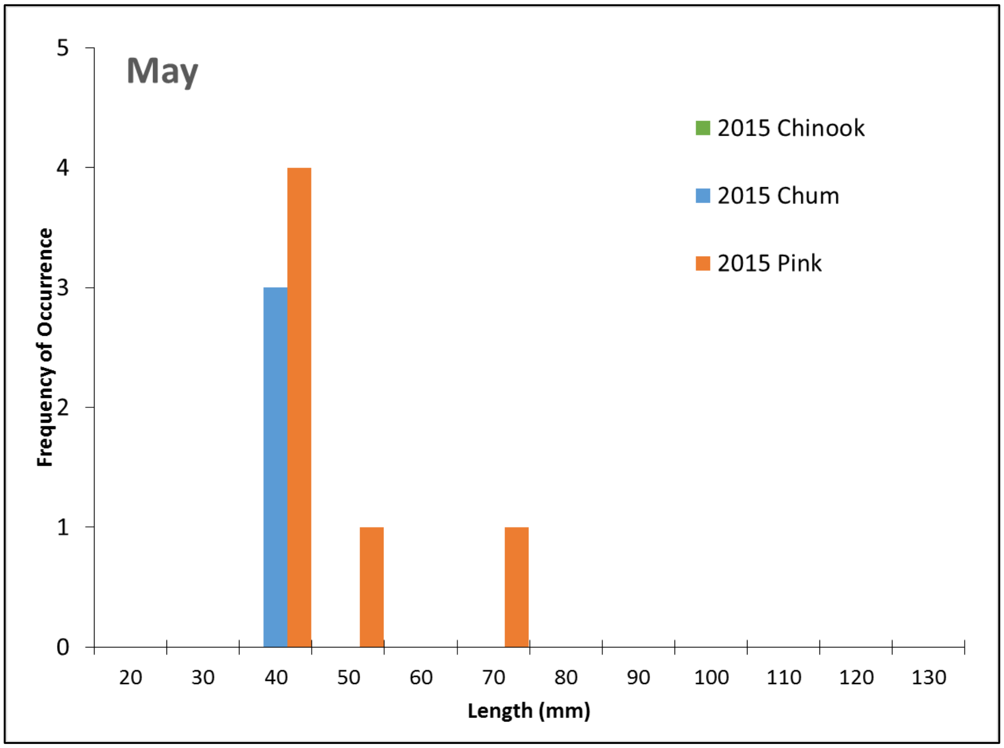


*Figure 11 – Size distribution of juvenile salmon species (*Oncorhyncus spp.*) at restored and reference sites, May 2015*

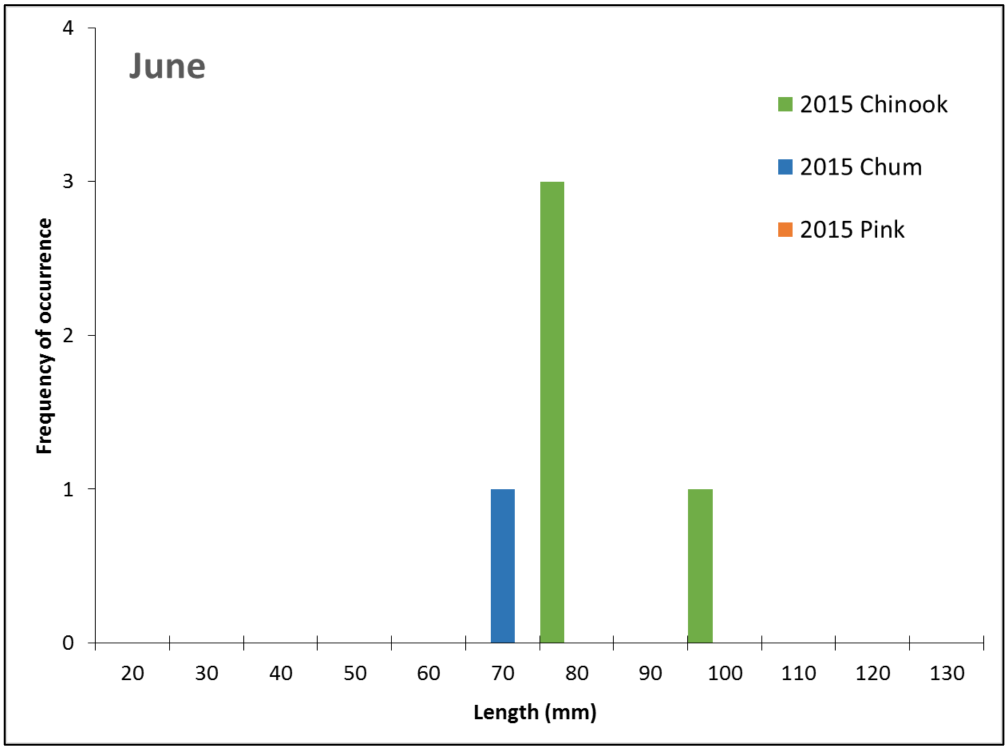


*Figure 12 – Size distribution of juvenile salmon species (*Oncorhyncus spp.*) at restored and reference sites, June 2015*

Year-to-Year Trends

Total salmonid abundance was considerably lower during 2015 monitoring activities relative to 2014 sampling (41.2 fish/net in 2014 and 0.9 fish/net in 2015). No sockeye (*O. nerka*) or coho salmon (*O. kisutch*) were captured during 2015 monitoring activities, whereas they were captured in 2014 at low levels. Considerably fewer chinook, chum, and pink salmon were captured in 2015 than in 2014. Of the salmonids caught, all were within the range of lengths observed in 2014 (i.e., no individuals were considerably larger or smaller than fish of the same species caught in 2014 [Figure 13]).

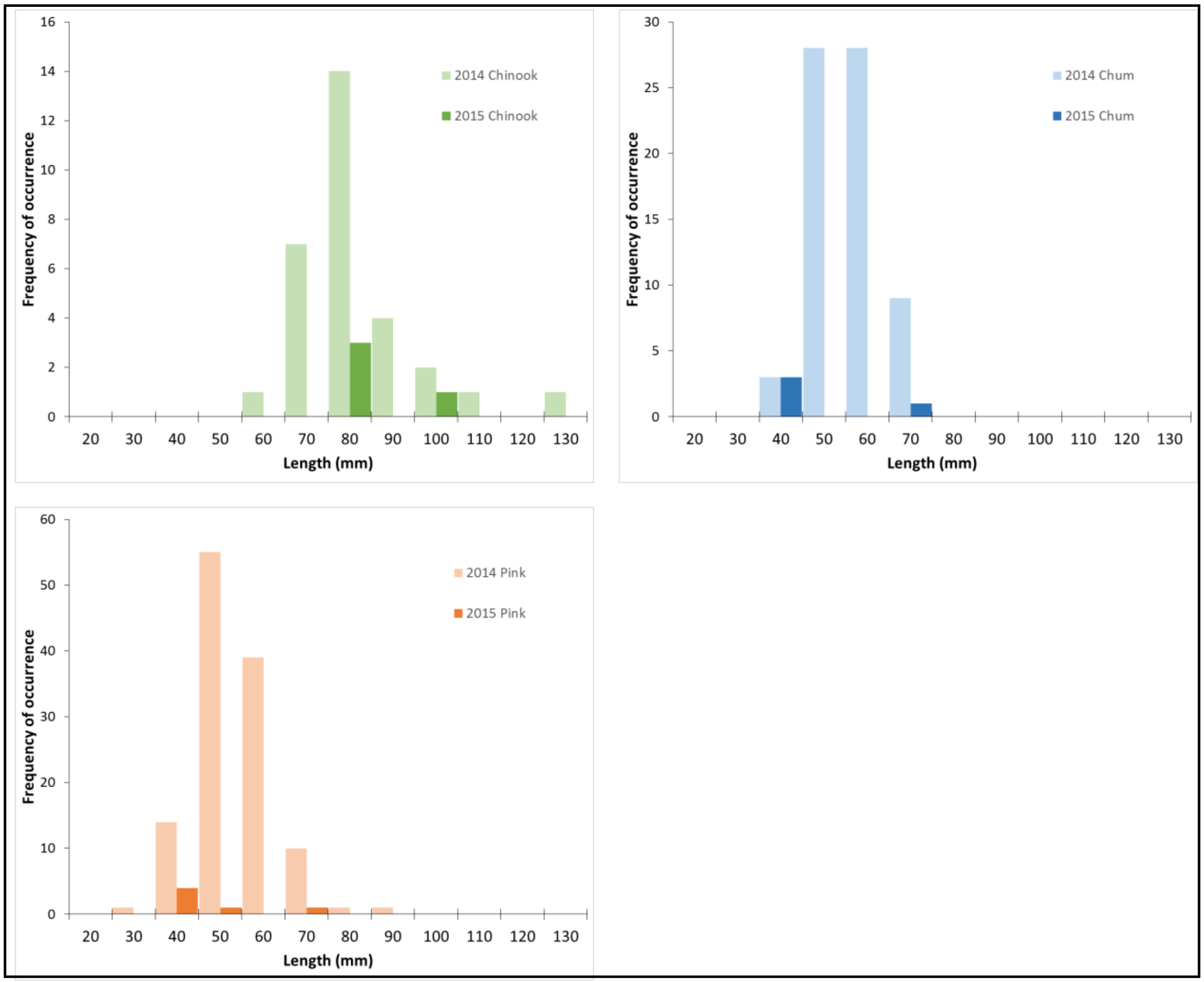


Figure 13 – Comparison of juvenile salmonid lengths observed in 2014 and 2015 (for species caught in both years)

4.3.3 Marine Resident Fish Species

4.3.3.1 Nearshore Beach Habitats

The species composition of marine fish is presented in Table 8. In May, the most abundant non-salmonid species were shiner perch (*Cymatogaster aggregata*), surf smelt (*Hypomesus pretiosus,*), and Pacific staghorn sculpin (*Leptocottus armatus*), representing 84 percent, 11 percent and 3 percent of total catch, respectively (Table 8). Thirteen other non-salmonid species occurred in May, but in relatively low abundance (less than 5 fish/set). Surf smelt were caught at a much higher rate at the restored beach relative to the reference beach (97.2 fish/set versus 2.5 fish/set). The opposite was true for shiner perch (2,047 fish/set at the reference versus 70.5 fish/set at restored sites) and Pacific staghorn sculpin (59 fish/set at the reference site and 5.2 fish/set at restored sites). Many of the other species caught at the restored site in low abundances were not caught at the reference site. Total number of species at the restored sites was 19 and averaged 9.67/site while the number of species collected at the reference site was 5.

In June, the most abundant species were shiner perch, surf smelt, and threespine stickleback (*Gasterosteus aculeatus,*), representing 57 percent, 22 percent and 11 percent of total catch, respectively. Snake prickleback (*Lumpenus sagitta,*), and Pacific staghorn sculpin (were found in moderate abundances (Table 8). Six other non-salmonid species occurred in June, but in relatively low abundance (less than five fish/set). As in May, shiner perch and Pacific staghorn sculpin were much more abundant at the reference beach than at the restored beach (Table 8). Snake prickleback were also more abundant at the reference. Conversely, surf smelt and threespine stickleback were two to three times as abundant at the restored sites than at the reference beach. Most other species were only caught at the restored sites (Table 8). Total number of species caught at the restored sites was 13 and averaged 8.67 per site, while 7 species were caught at the reference site.

4.3.3.2 Pocket Estuary

In May, two species were caught in the pocket estuary: Pacific staghorn sculpin (22.5 fish/set) and shiner perch (7.0 fish/set). In June, three species were caught: Pacific staghorn sculpin (3.5 fish/set), shiner perch (19.5 fish/set), and surf smelt (3.0 fish/set). Pacific staghorn sculpin caught in the pocket estuary were smaller than specimens caught at the beach sites. In May specimens ranged from 20 to 70 mm in the pocket estuary and 40–120 mm at the beach sites, suggesting the sculpins that use the pocket estuary are younger than those that use the beach sites. A similar trend was not observed for shiner perch or surf smelt.

4.3.3.3 Year-to-Year Trends

Catch for shiner perch, surf smelt, and pacific herring was considerably less in 2015 than in 2014, particularly at Site 3 and the reference beach (Table 9). Surf smelt catch at Sites 1 and 2 was actually higher in 2015, but not by enough to offset the large reductions in catch at Site 3 and the reference. Conversely, catch for pacific staghorn sculpin and threespine stickleback increased considerably from 2014 to 2015. Other species were caught in low numbers and catch was similar between years.

4.3.3.4 Water Quality Parameters

Water quality parameters are shown in Table 10. Temperatures were higher at every site in June compared to May. Conversely, turbidity was lower at every site (except Site 2) in June compared to May. The coolest site in both May and June was Site 2, which also had the lowest turbidity in both months. The reference site was the warmest in both months, and also had the highest turbidity. In June, the pocket estuary had a similar turbidity to Site 3, which is located on the beach by the pocket estuary's outlet. The pocket estuary was warmer, however, than Site 3, likely because it is shallower and warms faster in the sun.

Table 10 – Temperature and Turbidity at Sample Sites in May and June 2015

Site		Temperature (° C)	Turbidity (NTU)
May	BS-1	15.2	5.3
	BS-2	14.0	0.0
	BS-3	14.8	8.9
	BS-Ref	16.6	9.6
	Pocket Estuary[1]	-	-
June	BS-1	16.0	1.8
	BS-2	14.4	0.4
	BS-3	15.5	1.2
	BS-Ref	17.2	3.7
	Pocket Estuary	16.4	1.7

Note

[1] Data not collected at pocket estuary in May.

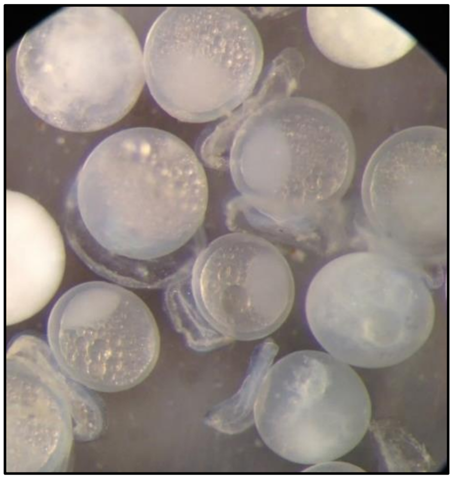
4.4 Forage Fish

During the Year 2 forage fish monitoring, the site was surveyed 11 times from January 28 to December 17. The final Year 1 forage fish survey was not reported due to the timing of the report submission; therefore, the December 30, 2014, results are included here. This December survey as well as the survey conducted on January 28, 2015, were meant to investigate potential spawning for surf smelt and sand lance during winter months. Forage fish surveys did not begin again until May, where a single trip was made to monitor the presence of early summer surf smelt spawning. These were followed by paired surveys in late June and early July through October that monitored the condition of eggs and tracked egg development for surf smelt. Specific times and dates for the surveys varied across the year and largely depended on the tide being below +5 feet (MLLW). Despite near year-round sampling, only surf smelt eggs were encountered at the site (both on the restored beach and reference beach). Egg presence and developmental stages are summarized in Table 11.

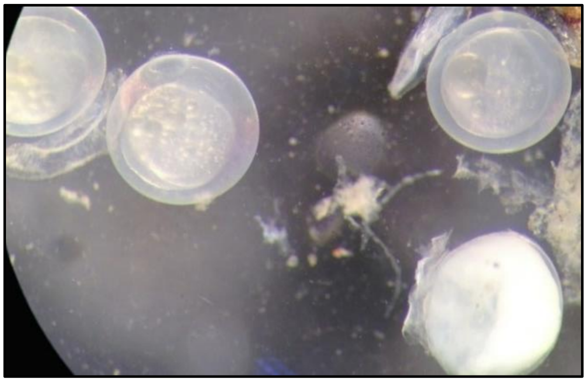
Table 11 – 2015 Summary of Surf Smelt Egg Presence and Development

Date	Sites With Eggs Found	Relative amount of Eggs	Egg Condition	Egg Development
December 29, 2014	Site 2 only	Very low: 4 eggs	Decent: 50% viable	1 day old
January 28	Site 2 only	Very low: 2 eggs	Good: 100% viable	Approximately 8 hours old
May 4	All 5 sites, fewest at Site 5	Many: hundreds	Poor: all dead	Recent spawn
June 4	All 5 sites; fewest at Site 4	Many: hundreds	Mostly poor	Two stages, some recently spawned
July 14	All 5 sites; fewest at Site 4	Many: hundreds (>400 eggs)	Decent: most were dead 0–30% were viable eggs	Recent spawn, less than 2 days
August 12	Sites 1, 2, 3, and 4; none at Site 5	Many: hundreds at Sites 1 (80 eggs), 2 (>400 eggs), and 3 (250 eggs), less than 10 eggs were at Site 4 and no eggs at Site 5	All were dead or open	Unable to discern developmental stage with all eggs being opaque and/or open
August 27	Sites 1, 2, 3, and 4; none at Site 5	Many: 20 to 60 eggs per site, exception of Site 5 which had no eggs	Poor: most were dead	Sites 1 and 2 had 50% viable eggs which ranged in development from several days to over 2 weeks. Sites 3 and 4 had only 20% viable eggs and were several days post spawn.
September 10	Sites 1,2, 3, and 4; none at Site 5	Moderate: 50 to 200 eggs at Sites 1, 2, 3, and 4	Predominantly non-viable	Eggs ranged from 1 to 4 days to several weeks old
September 22	Sites 2, 3, and 4; none at Site 5	Variable: Site 2 had 2 eggs, Site 3 had 100 eggs, Site 4 had 50 eggs	Decent: 100% dead at Site 2, 30% dead at Site 3, and 50% dead at Site 4	5–8 hours to several days post-spawn
October 7	Sites 2, 3, and 4; none at Site 1 and 5	Low: 1 egg Site 2, 50 eggs Site 3, 10 eggs at Site 4	Predominantly non-viable	Eggs ranged from 1 to 4 days, Sites 2 and 4 had larval fish present as well
October 23	Sites 1, 2, and 3; none at Sites 1 and 5	Varied: 10 at Site 1, 200 eggs at Site 2, and 4 eggs at Site 3	Poor: predominantly non-viable, 85-100% of eggs	Several weeks with some hatched viable larval fish swimming in dish
December 17	Site 2 only	Very low; only 1 egg found	Good	5–8 hours post-spawn

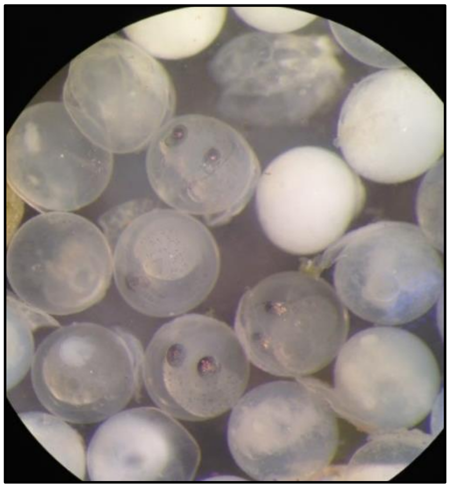
Weather conditions during surveys varied, offering a variety of temperature exposure and climate conditions to surf smelt eggs deposited on the beach. Eggs were found at different stages of development both within individual sites and between sites during a single survey. Examples of stages of development for eggs in viable condition are shown in the following photographs (Photographs 8–10). Viable eggs are relatively translucent, with discernable developmental stages visible, including blastula and early larval stages with eye-spots. Non-viable eggs are opaque white, with dented or broken shells. Most of the eggs in the photos are in excellent or good condition, with only a few dead eggs.



Photograph 8 – Eggs at 5 to 8 hours of development (recent spawn), with blastula formed on the yolk. There are two eggs in poor condition (non-viable), but most are in good condition.



Photograph 9 – Eggs at 1 to 2 days of development, with gastrula, advanced embryo, or early larval development around the yolk. There is one non-viable egg.



Photograph 10 – Eggs at 2 weeks of development, with advanced larvae, dark eye spots, and close to hatching. There are a few non-viable eggs, but most are in good condition.

4.5 Advanced Eelgrass Transplant Monitoring

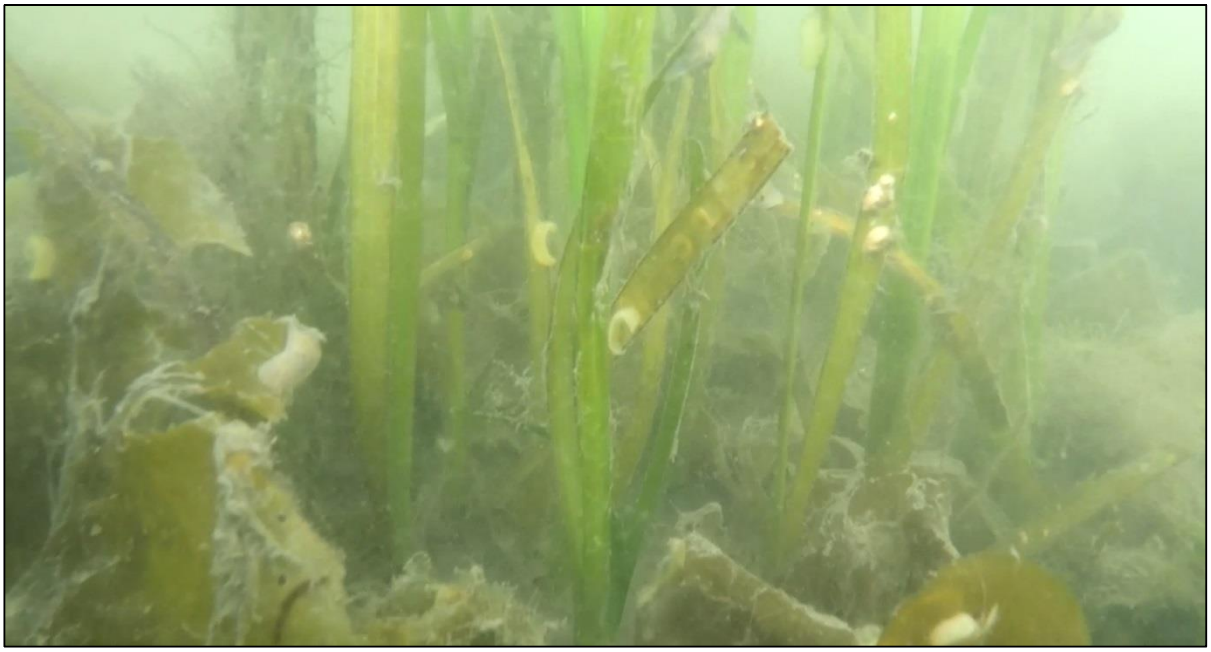
In 2014, 330 PU's were placed to cover an area of 2,915 sf. This is a density of approximately 3.7 shoots/m^2 or 0.33 shoots/sf. PU's were planted using a 3-foot-center modular PVC grid system. The transplant area is composed of two swaths approximately 15 feet wide. The intent was to construct a rectangle 30 feet wide by 120 feet long. Once both swaths were completed, residual PU's were constructed from contingency eelgrass harvested and added to the shoreward (west) swath, extending it for several feet. This means that the west side of the rectangle extends slightly further north. The shape of the planting area and the location at the site is shown on Figure 14.

Figure 14 – Location of eelgrass mitigation area

Typically, individual planting units are still discernable one year after eelgrass transplanting. However, at the time of this survey, the plants had undergone extensive growth over the first year and, as a result, the individual planting units were no longer identifiable, the plants having begun to coalesce. The Year 1 post-transplant monitoring survey of the planted area indicated no net loss of eelgrass PU's and an increase in density from the initial planting as plants were beginning to fill in between originally installed planting units (Photograph 11). The density of eelgrass in the transplant area was 9.7 shoots/m^2 which is a 160 percent increase over the initial transplant density. Despite this large increase, transplant density is only 30 percent of the reference density (32.0 shoots/m^2) and the differences between the mean densities was significant ($p<0.001$).

Within the transplant area, there was scattered kelp (*Saccharinna latissima*) that was likely drift (Photograph 12). Epiphyte loads were minimal and mostly bryozoans, hydroids, and egg masses from small gastropods (e.g., bubble snail). Hooded nudibranchs (*Melibe leonine*) were noted in the canopies of denser patches. Shoots appeared healthy with new growth (both leaves and new emergent shoots) spreading laterally. Clam shells and shell remnants were noted on the sediment surface. This area was backfilled a year earlier, indicating that infauna have been recruiting aggressively. Organic fines were noted on the sediment surface along with siphon holes from larger clams. Several medium-sized Dungeness crabs (*Metacarcinus magister*) were sighted transiting between eelgrass patches.

Photograph 11 – Increase in density of eelgrass shoots within newly transplanted area



Photograph 12 – Epiphyte growth and larval eggs on eelgrass shoots within newly transplanted area

4.6 Wetland, Backshore, and Upland Buffer Vegetation

The wetland complex was surveyed on September 29, 2015, by a Hart Crowser wetland biologist. As described earlier, the upland buffer, including a zone of dunegrass within the wetland complex, was established in 2011, and Year 4 monitoring was conducted for these areas in 2015. The estuarine wetland and the backshore habitat along the berm, beach, and spit were established in 2013/2014 and Year 2 monitoring was conducted in these areas on the September 20, 2015. During the Year 2 monitoring, Hart Crowser used the transect plot method (described in Hart Crowser 2011b) to sample along 11 permanent vegetation transects (T1 through T11). T1, T2, T3, and T4 correspond to the upland buffer areas; T5, T6, and 7 correspond to the wetland area and stormwater swale; T8 and T9 correspond to the berm on the bay side of the pocket estuary; and T10 and T11 assess the backshore along the restored beach (Figure 4). Percent cover of each species within each circular quadrat (1-m radius) was recorded. Also, photos were taken from the 11 photographic points shown at the locations on Figure 4. These representative photos are provided in Appendix A. Some of the 2015 photos are shown in comparison to the 2014 monitoring photos to illustrate change over time.

Success criteria for the upland buffer were developed for monitoring Years 1, 2, 3, 5, 7, and 10; however, no specific Year 4 success criteria were established for the upland buffer within the wetland complex (see Section 6.0, Success Criteria). However, we compared the data collected to the success criteria from previous monitoring years and whether the buffer was on a trajectory towards meeting the Year 5 criterion. The total average percent cover for the native tree, shrub, and ground species for all plots was determined to be 32 percent; however, the percent cover ranged from 20 to 44 for each transect. The average is just slightly above the Year 2 criterion of 30 percent cover but does not meet the Year 3 criterion of 40 percent cover. These low percent cover values are likely a result of three years of stress within the upland buffer due to tent caterpillar invasions and an exceptionally dry summer in 2015. Tent caterpillars can be seen in Photograph 13. Average invasive percent cover ranged from 0 to 8 percent in the upland buffer, which is below the range of the “10 percent or less” success criterion. Invasive weeds were present at T1 only and consisted primarily of bindweed (*Convolvulus sp.*). Bindweed was present along the fence bordering the upland buffer area and was wrapped around many species within this area (Photographs 13 and 14).

Photograph 13 – Bindweed and tent caterpillars within south end of upland buffer area

Photograph 14 – Bindweed along fence and vegetation within south end of upland buffer area

Table 12 summarizes Year 2 monitoring results including those for the hydrologic and wetland area monitoring. Information was collected to determine if the vegetation within the estuarine wetland meets the Year 2 success criteria of 30 percent native cover or greater. Wetland vegetation had expanded its range in Year 2. Additionally, dunegrass expanded into wetland areas in T5 and T6. Therefore, the average cover for all wetland vegetation that was present within T3 and T4 and all vegetation found in T5, T6, and T7, is 40 percent, which exceeds the Year 2 success criteria. Total areal coverage of invasives along the wetland transects was 2 percent, well below the Year 2 success criterion of 10 percent cover or less. Invasive white clover (*Trifolium repens*) was the only invasive measured and present only at T6. Within the estuarine wetland, we saw 0 percent mortality of the replanted pickleweed (*Salicornia virginica*, the only installed plant within the wetland) meeting the success criteria of 80 percent survival or greater for Year 2. We observed expansion of the pickleweed from its planted area within the wetland complex into the stormwater swale and at the entrance of the wetland breach (Figure 15). Tidal inundation was observed covering the estuarine wetland marsh areas diurnally up to the MHHW mark as seen in Photograph 15. Therefore, the estuarine species expanded into the dunegrass areas of T3 and T4. Observations during 2015 indicated that one quarter to one eighth of the wetland is permanently inundated, depending on the tide levels. These inundated areas potentially provide resting habitat for juvenile salmonids.

Table 12 – Summary of 2015 (Year 2) Monitoring Results for Wetland and Hydrology Compared with Success Criteria

Criterion	Year 2 Success Criteria (% cover)	Total Average Cover (%)	Success Criteria Met?
Total areal cover of native wetland plants	30	40	Yes
Total areal cover of invasive weeds	0 to 10	2	Yes
Survival of installed plants (pickleweed)	80	100	Yes
Hydrology	Tidal inundation in wetland area to the MHHW mark (100%)	Yes	Yes

Figure 15 – Estuarine wetland and mudflat vegetation within the wetland mitigation area

Photograph 15 – Tidal inundation within wetland mitigation area

Table 13 summarizes Year 2 monitoring results for the backshore areas along the berm, beach, and spit. Information was collected to determine if the vegetation within the backshore meets the Year 2 success criteria of 30 percent native cover or greater. The total average cover for all backshore transects was 30 percent for Year 2, and therefore meets the success criteria. We collected survival information in the backshore and observed 15 percent mortality of planted species; therefore, the site meets the criteria of 80 percent or greater survival. The average areal coverage of invasive weeds within the backshore was 2 percent, exceeding the success criteria of less than 10 percent.

Table 13 – Summary of 2015 (Year 2) Monitoring Results for Backshore along Beach, Berm, and Spit Compared with Success Criteria

Criterion	Year 2 Success Criteria (% cover)	Total Average Cover (%)	Success Criteria Met?
Total areal cover of native plants	30	30	Yes
Survival of installed plants	80	85	Yes
Total areal cover of invasive weeds	0 to 10	2	Yes

Table 14 (attached) shows the total average percent cover along each transect location. Two of the four backshore transects met the 30 percent or greater total percent native cover. Transect 8 (T8, along the south berm) had 8 percent total average cover of wetland emergent vegetation along with 10 percent dunegrass. Transect 9 (T9, along the north berm) measured only dunegrass areal coverage at 32 percent. The predominant cover along T10 and T11 was dunegrass (29 and 49 percent, respectively); coverage of other non-native vegetation ranged from 13 to 3 percent.

Areas that contained estuarine vegetation were mapped on the site using global positioning system (GPS). Then, through geographic information system (GIS) software, we calculated that approximately 79 percent (9,530 square feet) of the 12,000-sf wetland is vegetated with estuarine plants, and 7,605 sf are an unconsolidated bed wetland (mudflat). This area is shown on Figure 12. Expanded tidal inundation over the past year has allowed estuarine plants to move up into the upland buffer (T3 and T4) and well into the stormwater swale. There is great potential for additional growth in future years if conditions continue on the same trend (Photographs 16 and 17).

Photograph 16 – Estuarine vegetation extending into the stormwater swale

Photograph 17 – Estuarine vegetation along T5

Non-native cover at the site was very low overall; with a more detailed estimate of non-native cover along each transect provided in Table 14 (attached). There were no non-native species observed within the estuarine wetland. Non-native vegetation cover within the upland buffer ranged from 0 to 26 percent. Non-native species observed within the buffer included grass species (*Poa sp.* and *Festuca sp.*), cranesbills (*Geranium sp.*), bindweed, common tansy (*Tanacetum vulgare),* and dandelion (*Taraxicum officinale*), of which, bindweed and common tansy are considered invasive species. As mentioned above, non-native and invasive vegetation was predominantly located within the south end of the upland buffer consisting primarily of bindweed, which was grown thick along the fenceline and was observed wrapped on many trees and shrubs. Additional non-natives such as Himalayan blackberry and fennel were present adjacent and at the entrance of the stormwater swale (Photograph 18). Non-native species in the backshore habitat primarily included white clover and wormwood (*Artemisia sp*.). Hart Crowser recommends removing non-natives in early spring so that these species do not spread further. Since there is relatively little non-native cover, early and thorough management will be very effective at keeping the non-native cover low, preventing future spreading of these species.

Photograph 18 – Himalayan blackberry and other non-natives present at entrance of stormwater swale

5.0 DISCUSSION

5.1 Epibenthic Zooplankton

The restored areas of Custom Plywood were similar in total biota, crustacean density, and species richness and diversity when compared to those same metrics of the unrestored reference site. The total epibenthic zooplankton densities in restored areas were statistically indistinguishable from the reference site in both sampling months when restored sites were grouped together. Nematodes contributed disproportionately to the epibenthic fauna density in May. Although nematode density actually increased slightly in June (7,604 individuals [#]/m^2 in May; 7,629 #/m^2 in June), crustacea (mostly nauplii and copepods) increased dramatically from May to June; annelid densities increased as well, but to a lesser extent. Crustaceans were the main driver of the trends seen between sites, treatment levels, and tidal elevation. When grouped by treatment, crustacean densities in the restored areas were comparable to those of the reference site in both May and June. While there were differences in specific sites, the restored sites were all either significantly greater than or comparable to the densities of the reference site in both months. Statistically significant differences between sites in both total biota and crustaceans were primarily due to anomalous factors in site EB-3. In May, the difference between EB-3 and the other sites may be ecologically significant (p=0.083). This is congruent with findings in June, when EB-3 stood out as having a significantly higher density than the other sites at +4 feet MLLW and is comparable to the other sites at +6 feet MLLW. EB-3 displayed a similar pattern for crustaceans, as expected, since crustaceans largely drive the pattern seen across sites. Also of note, the highest density of eggs relative to the other sites (analyzed with annelid larvae in 2014) was found in Site EB-3 and the reference site. Site EB-3 is distinct as a habitat that supports a crustacean-dominated population and fluctuates in total abundance depending on time and tidal elevation. The installed jetty just north of the EB-3 sampling site acts as a pocket beach with protection from wave action and a depository for fine sediment and organic material, possibly providing nutrients to encourage zooplankton growth. In addition to the jetty there is a brackish marsh in close proximity to EB-3 that is a direct depositor of run off into the EB-3 area.

Species richness overall increased from 2014. Site EB-1 had the highest scores for Shannon’s diversity and evenness Indices in both May and June as well as at each sampling depth. Site EB-1 is located directly south of a large rip-rap jetty. The majority of the population of EB-1 was crustaceans (mostly copepods and nauplii) and nematodes in May; in June the dominant species were crustaceans (mostly copepods) and annelids. It appears that the overall abundance in site EB-1 fluctuates depending on the depth and month but in June density seemed steady across sampling depths in quantities greater than those of the reference site. The lowest diversity and evenness scores were found in EB-2 in May, primarily due to a combination of an absence of crustacea and an abundance of nematodes. In June, EB-3 had the lowest diversity and evenness for the opposite reason; crustacea (mainly nauplii and copepods) overwhelmingly dominated the other taxa. This increase in richness and in crustacea found from May to June is also reflected in year-to-year trends.

There was a noticeable increase in total epibenthic zooplankton density from 2014 to 2015 in all treatment levels and depths. There was also a marked increase in crustacean density from 2014 to 2015 with the exception of the reference site at +4 feet MLLW and the restored sites in May at +4 feet MLLW, where there was a very slight decrease in crustaceans. This marked increase in crustacean density in 2015 could be due to a reduction in overall predation pressure. As discussed in the above section pertaining to salmonids, total catch per unit effort (CPUE) decreased immensely from 2014 (41.2 fish/net in 2014 and 0.9 fish/net in 2015). Salmonids and their prey items (primarily crustaceans and, to a lesser extent, annelids) tend to have an inverse relationship (Koenings and Kyle 1997); thus, reduced predation coupled with a more mature restored beach face (Scatolini and Zedler 1996) is the likely explanation for increased epibenthic zooplankton numbers in 2015.

5.2 Nearshore Fish

Catch rates and composition of non-salmonid species in the study area and reference beach were similar and typical of nearshore areas of Puget Sound (Fresh 2006). The large numbers of shiner perch is typical of protected areas when nearshore waters begin to warm in the late spring and into the summer.

Nearshore beach seine sampling during spring 2015 showed different, and somewhat atypical, outmigration patterns for juvenile salmonids from 2014. The drop in pink salmon catch is to be expected given their 2-year life cycle in which juveniles outmigrate during even years. Although the timing of our sampling coincided with peak migration for coho and sockeye (between late April and mid-May; Weitkamp et al. 1995), no individuals of either species were caught. Some Chinook were captured, but at much lower levels than in 2014. However, similar or lower numbers were captured at the reference site, suggesting that lower numbers were the result of overall lower juvenile salmon abundance during the sampling period.

This is consistent with sampling efforts conducted by the Samish Tribe in 2015, who also sampled nearshore fish in Fidalgo Bay throughout the spring and summer. Similar to our efforts, they did not catch juvenile coho or sockeye salmon and caught only one juvenile Chinook salmon. They did catch two juvenile pink salmon and 16 juvenile chum salmon. Reports from other fisheries scientists in the area indicate that juvenile salmon were caught earlier in the season this year than in past years, suggesting an earlier outmigration (Todd Woodard, Samish Tribe, personal communication). This could be one explanation for the lower number of juvenile salmon caught this May and June compared to last year.

The distribution observed in non-salmonids may also be the result of different water temperatures at the two areas. As in 2014, in both May and June, water temperature was higher at the reference sites relative to restored sites by 1 to 2° C (Table 10). Since salmonids generally require cooler temperatures (10 to 15° C), they may be more abundant at the restored beach, using the area as a temperature refuge. Other marine resident species, shiner perch in particular, prefer warmer temperatures and were likely more abundant at the reference site for this reason.

Catch rates as Sites 2 and 3 were similar in both May and June and were considerably higher than Site 1 in May but considerably lower than Site 1 in June. This trend was not apparent in 2014 and likely the result of natural variation of the fish community along the restored beach. While CPUE at the reference site was substantially higher than at the restored sites, this was largely due to high catch of shiner perch and to a lesser extent Pacific staghorn scuplin and snake prickleback. Most other species were captured at higher rates at the restored sites.

Overall, total CPUE in 2015 was about half that in 2014. The only species that saw increased catch in 2015 were Pacific staghorn sculpin and threespine stickleback. Climatically, 2015 was an unusual year with extremely low snowpack and warmer temperatures in spring than are typical; these factors could affect fish densities and composition within the nearshore.

In conclusion, 2015 data show that the CPUE of juvenile salmonids on the restored beach in the study area was greater than that of the adjacent unmodified reference beach. The restored beach also outperformed the reference beach in terms of the number of salmonid species observed. The data also show that the distribution of non-salmonid species on the restored beach can differ substantially from the adjacent reference site, with higher species richness and evenness at the restored sites. Sampling data indicate that the restored beach is providing suitable nearshore marine habitat for migrating and rearing salmonids.

5.3 Forage Fish

Surf smelt eggs were the only forage fish species found during beach spawning surveys at the Custom Plywood site. Spawning of Pacific sand lance have been documented at other locations in Fidalgo Bay, but have not been found at the Custom Plywood site or the reference beach during either the Year 1 or Year 2 monitoring periods. In Fidalgo Bay, herring spawn subtidally on submerged aquatic vegetation, primarily eelgrass (*Zostera marina*; Dayv Lowry, WDFW, personal communication), mostly along the western shore near the restored beach. Adult Pacific herring were found at each of the beach seine sampling locations on the restored and reference beach.

The Year 1 (2014) report did not include the final 2014 forage fish survey, conducted on December 30, 2014, due to deadline restrictions, and therefore is included in this Year 2 report. This winter survey found only two eggs, located at Site 2. Year 2 (2015) surveys began in January and found only 4 eggs on site, two of which were viable at 1 day old and the remaining two dead. Year 1 surveys did not include a January sampling date due to the timing of the contract award; therefore, a comparison between January events cannot be made at this time. The Year 1 and Year 2 spring surveys were conducted on different dates and had varied results. The Year 1 (2014) monitoring found very few eggs in April (less than 10), and none were viable. In contrast, the May 2015 survey found hundreds of eggs at all five sites. Year 2 surveys continued to find hundreds of eggs from this May event into mid-August at most of the sites, after which egg counts dropped to between 20 and 100. During this May to mid-August period, eggs were consistently found at Sites 1, 2, and 3, with eggs less present at Sites 4 and 5. Fewer eggs at Site 4 is consistent with survey results from Year 1 during this same period. Beginning with the August 27, 2015, survey and continuing into the late October survey, relatively lower numbers of eggs were found at all sites. Year 1 surveys found variable numbers of eggs during this same period, with eggs ranging to hundreds in late August and early September, to thousands in mid-September, and then dropping for both October surveys. From late August to late October 2015, there were no eggs found at Site 5 (reference, un-restored beach) during this time. This differs with the Year 1 survey results which found eggs on Site 5 during these same months in 2014. The December 17, 2015, survey found only one surf smelt egg located at Site 2.

As in Year 1, fewer eggs were typically found at Site 4. This survey location is on the inside edge of the south side of the constructed spit, facing the pocket estuary. Possible reasons for poor spawning at Site 4 include shoreline topography; finer, more organic, rich substrate; freshwater runoff from the estuary; increased frequency of egg predators (e.g., amphipods); or an increase in predatory birds that frequent the estuary. More silts and fine particles were noted in several of the Site 4 samples, including the presence of small worms. During the Year 1 surveys, eggs were found consistently at

Site 5, which is the reference or unrestored beach, although their quality was variable. During Year 2, eggs were only found at Site 5 during three survey events (May, June, and early July). High organic content, amphipods, and barnacle shell hash were documented in Site 5 samples. The coarse cobble and large gravel material at the unrestored beach is challenging substrate for successful spawning to occur; however, several Year 1 surveys indicated healthy condition of eggs spawned at this location. This was not evident in Year 2 surveys.

Egg survival was monitored as the presence of fully developed eggs. Surf smelt eggs reach full development in about two weeks, at which point they hatch into planktonic larvae, and move into the pelagic zone. Larval fish were found in both October 2015 sampling events. Larval fish were also found in several surveys during 2014. As was found in Year 1, the condition of eggs at the four sites on the restored beach varied during individual surveys and no single site had better egg survival or relative egg abundance between surveys. In contrast with Year 1, the 2015 surveys of Site 5 indicated fewer spawning events and egg survival compared to the four sites on the restored beach.

Year 2 again found that surf smelt were making full use of the restored beach and were spawning at varied locations for each spawning event but seemed to favor Sites 1, 2, and 3, with Year 2 surveys consistently documenting higher numbers of eggs at Site 2. Low to no eggs were found at Site 4 and Site 5 (reference or unrestored beach). Surf smelt are likely opportunistic when spawning, finding refuge along the shoreline during nighttime high tides. Precise locations for spawning may vary based on tidal currents, the presence of predators, or storm events. There were often eggs in different stages of development found during individual surveys, suggesting multiple overlapping spawning events throughout the summer months. Having a large area of suitable habitat along the restored beach increases the likelihood for successful spawning and survival for surf smelt in Fidalgo Bay.

This suitable spawning habitat can be critical to egg survey during the hot summer months. Surf smelt can experience up to 100 percent mortality without proper shading or substrate (Rossell and Dinnel 2007). The substrate of mixed sand and pebble deposited along the restored beach has increased survival of eggs from the summer 2013, when fish were spawning on exposed boulder and contaminated material. The loose material now on the beach allows the eggs to become mixed in under the top layer, preventing desiccation and direct exposure to sunlight. Continued monitoring into 2016 should show increased spawning and better egg viability of the restored beach, as beach material continues sorting, ultimately reaching a steady state.

5.4 Advanced Eelgrass Transplant Monitoring

Based on the survey results (both qualitative and quantitative), the eelgrass present in the transplant area appeared to be functioning at a high level. Original PU’s showed marked expansion with coalescence into larger patches which was unexpected recruitment for one year of growth. In the eelgrass community we are seeing recruitment and use by several invertebrate species ranging from motile crabs to sessile bivalves. When compared to a reference area at a similar depth in an established eelgrass bed outside of the remediation site (i.e., uncontaminated), eelgrass density at the reference area is still quite a bit (70 percent) higher. Based on year-over-year surveys of the reference area, 2015 represented an “average” year for eelgrass with densities. Should average conditions continue, we expect further recruitment in subsequent surveys, leading to expansion well beyond the boundaries of the original transplant area.

5.5 Wetland, Backshore, and Upland Buffer Vegetation

For the most part, the plants within the wetland and backshore along the berm are healthy and growing, particularly the pickleweed within the wetland and dunegrass in the buffer of the wetland complex. The pickleweed that was transplanted in 2013 took about a year to establish, and is now growing well within the areas where tidal inundation is diurnal including within the stormwater swale. Where inundation is longer in duration, the pickleweed was not growing well or had died out. The wetland vegetation composition will recalibrate over time to the salinity and water levels within the wetland. Other low salt marsh wetland vegetation, such as saltgrass and fat hen (*Atriplex sp.*), established in these areas and are growing well. Large storms during high tides has brought additional woody debris into the wetland and even up into the stormwater swale (Photograph 19) that is beneficial to the biota within the wetland and stormwater regulation within that area.

Photograph 19 – Woody debris now present within the stomwater swale

Conditions and external factors within the upland buffer have been challenging since 2011 and are likely reasons why the buffer is not meeting the wetland Year 3 success criterion. The upland buffer has been adversely affected by an invasion of tent caterpillars in 2013, 2014, and (to a lesser extent) 2015, and a severely dry spring and summer in 2015. Tent caterpillars ate a substantial number of leaves, primarily on rose and currant species, but also on a few other species within the buffer, with the worst impacts seen in 2013. Ecology and Hart Crowser were aware of the tent caterpillars in 2013 and had the property owner, Bud Lemieux, start an eradication maintenance program at that time, based on a maintenance memorandum from Hart Crowser. While the growth of rose and currant species were set back in 2013, they survived and showed growth in 2014 despite another caterpillar invasion that year. More caterpillars were eradicated in the summers of 2014 and 2015, with Bud Lemieux continuing to respond to the problem. During the Year 2 monitoring, we saw many stressed or dead conifers within the upland buffer area. These trees were healthy during the Year 1 monitoring but the extreme drought during the summer of 2015 appears to have negatively impacted these species.

The backshore along the beach and berm (along the wetland) were planted with dunegrass in 2013, which grew well and established following its installation. However, heavy winter wind and wave action caused some of the backshore to erode away along with the plants. The original site design allowed for some natural sorting of the beach material due to tides and wave actions. The most stable backshore areas were those where large woody debris had either been placed or washed up during storms. During 2014, the backshore along the beach was the most disturbed, due to direct wave action, and resulted in some non-native species growth within the center and northern parts of the backshore. During 2015, the backshore along the beach appears to be beginning to stabilize and dunegrass is growing well within the areas where it successfully established since planting (Photographs 20 and 21). Once the backshore is more stable, we recommend removal of non-natives within the backshore, and potential replanting, so that dunegrass can continue to expand within this area. Placement of large woody debris may also be considered to stabilize the sand in the backshore along the beach.

The Year 1 report (Hart Crowser 2015) included the dunegrass installed along the spit as part of the backshore zone. The Year 1 survey was conducted approximately nine months following the plants installation; at that point, the plants were doing relatively well. However, heavy wind and wave action during high tides since that Year 1 survey has washed away both the dunegrass and sand originally placed along the spit, which was observed during this Year 2 monitoring event. Since it was installed after the original design process, it was never intended or incorporated as part of the permanent backshore area. As a result, there are no formal monitoring or maintenance requirements for this vegetation. Since this dunegrass is likely not going to reestablish, it is not recommended that this area be replanted.

Photographs 20 and 21 – Dunegrass and non-native vegetation within the backshore along beach

Percent survival within the wetland exceeded the Year 2 goal with significant expansion of estuarine vegetation within the wetland complex. Survival within the backshore exceeded the 80 percent success criteria for Year 2. The 2016 monitoring will assess three years post-construction and will inform the success of the site going forward.

6.0 ADAPTIVE MANAGEMENT FOR UPLAND BUFFER

Adaptive management is an iterative process by which restoration measures or management actions are systematically evaluated and subsequently modified in response to new information. Based on our surveys to date (through Year 4), the upland buffer only slightly exceeds the Year 3 success criterion of 40 percent cover and is not on track to meet the Year 5 success criterion of 50 percent cover, thus requiring adaptive management (Hart Crowser 2011b). Hart Crowser staff will contact the appropriate regulatory agencies to discuss next steps and corrective actions needed to ensure that the upland buffer can begin to meet established performance criteria. These steps will be agreed upon and implemented within one year. We will establish contingency measures and evaluate them during each monitoring event to help ensure that any proposed adaptive management steps are systematically evaluated to maintain success.

7.0 SUCCESS CRITERIA

The success criteria for the beach restoration are provided in the CMMP (Hart Crowser 2012a) and are italicized below. Evaluation of each monitoring component and its success at meeting these criteria is discussed in this section.

7.1 Restored Beach

The success criterion for the restored beach is as follows:

- *Beach profiles will not change by more than +/–1.5 feet by Year 5.*

This criterion was largely met during Year 2. Monitoring data found only minor changes in beach profiles below +6 feet MLLW. Year 2 surveys did find some localized changes in beach profile elevations exceeding this criteria above +6 feet MLLW. These exceedances are a result of erosion from the upland site. These changes are likely a result of the constructed beach profiles adjusting to the dynamic equilibrium beach profile.

7.2 Epibenthic Zooplankton

The success criterion for epibenthic zooplankton is as follows:

- *Epibenthic zooplankton densities on restored beach (CPUE) comparable to or greater than that on the unrestored reference beach in any given year.*

This criterion was met in 2015. Epibenthic zooplankton densities of the restored sites were statistically comparable to the reference beach in both May and June. Any restored site with significant differences from the reference site had greater zooplankton densities than the reference beach.

7.3 Nearshore Fish

The success criterion for nearshore fish is as follows:

- *Juvenile salmonids use on restored beach CPUE comparable to or greater than that on the unrestored reference beach.*

This criterion was met in 2015. Juvenile salmonid use of the restored beach was found to be greater than in the reference site over the two-month spring sampling period. Three salmonid species were observed at the restored beach and no salmonid species were observed at the reference beach.

7.4 Forage Fish

The success criterion for forage fish is as follows:

- *Substrate composition along the upper beach will be suitable for forage fish spawning over a minimum of 50 percent of the beach area enhanced in any given year.*

This criterion was again met in 2015. Forage fish spawning occurred on a majority of the enhanced beach area during the Year 2 monitoring period with spawning documented on all survey sites. Increased egg survival was also documented since the replacement of beach substrate in 2013.

7.5 Advanced Eelgrass Transplants

The success criteria of the proposed eelgrass transplants are as follows:

- *No temporal loss of eelgrass productivity. Specifically, the density multiplied by the area of eelgrass shoots in the transplant areas must equal or exceed any declines in eelgrass in the project vicinity, adjusted for changes in the reference bed.*

- *By 2015 monitoring, we expect 50 percent or greater colonization to have occurred, with total recovery of the 2,915 sf at a similar density to a reference bed expected by 2019 (Year 5). Should this not be met, additional and similar types of effort will be carried out using the same procedures detailed above unless study results or conditions suggest that a modified approach will achieve greater success.*

These criteria were met this year. The eelgrass within the transplanted area has maintained the 2,915-sf area and increased in density since original installation. While we have not yet met the full 2019 criteria with respect to similar eelgrass shoot density to the reference area, there is nothing at this time to indicate that this criteria will not be met by 2019.

7.6 Wetland, Backshore, and Upland Buffer Vegetation

The criteria for wetland and buffer vegetation success is based on a combination of criteria for survival and cover as listed below.

Goal 1: Restore Wetland Areas through Installation of Native Vegetation Success Criteria

Survival of planted native vegetation would be monitored for two years.

- Year 1: 90 percent survival of installed plants visually estimated
- Year 2: 80 percent survival of installed plants visually estimated

Areal coverage of native shrubs and emergent vegetation would be a minimum of 80 percent after 10 years.

- Year 1: 20 percent cover
- Year 2: 30 percent cover
- Year 3: 40 percent cover
- Year 5: 50 percent cover
- Year 7: 60 percent cover
- Year 10: 80 percent cover

Goal 2: Restore Buffer Areas through Installation of Native Vegetation Success Criteria

Survival of planted native vegetation would be monitored for two years.

- Year 1: 90 percent survival of installed plants
- Year 2: 80 percent survival of installed plants

Areal coverage of native tree, shrub, and groundcover species would be a minimum of 80 percent after 10 years.

- Year 1: 20 percent cover
- Year 2: 30 percent cover
- Year 3: 40 percent cover
- Year 5: 50 percent cover
- Year 7: 60 percent cover
- Year 10: 80 percent cover

Goal 3: Control Invasive Plant Species within the Wetland and Buffer Areas

Invasive plant areal coverage would be less than 10 percent after 10 years.

- Years 1 through 10: 10 percent or less coverage of invasive plants

Goal 4: Provide Adequate Hydrologic Connection for Restored Wetland

Visual observation of tidal inundation during a normal tidal cycle each year.

- Years 1 through 10: 100 percent coverage of marsh mitigation area by tidal waters at tidal elevation of approximately MHHW

Documented coverage (in square feet) of emergent estuarine plant species using a global positioning system during Years 1, 5, and 10.

- Years 1, 5, and 10: 12,000 sf or greater cover of native estuarine plant species
- A total of 12,000 sf or more of wetland would be maintained throughout the 10-year monitoring period

The wetland area is meeting nearly all of the success criteria. The upland buffer did not have specific criteria for Year 4 monitoring; however, by comparing the data collected to the existing criteria, it appears that the area is slightly above the Year 2 criterion of 30 percent cover yet is still below the Year 3 criterion of 40 percent cover. These low percent cover values are likely a result of three years of stress within the upland buffer due to tent caterpillar invasions and an exceptionally dry summer in 2015. The upland buffer is meeting the year-to-year criteria of less than 10 percent invasives. Hart Crowser recommends continued observations for and removal of the bindweed and other non-natives so that the buffer vegetation can successfully develop over time. While not essential, Hart Crowser also recommends monitoring the stressed conifers in the buffer and replacement should recruitment of other tree species not be observed. We observed 100 percent coverage of marsh mitigation area by tidal waters at tidal elevation of approximately MHHW, meeting the hydrologic connection goal of the site design. The estuarine vegetation totaled 9,530 square feet within the restored wetland; growth within this area will likely continue and hopefully meet the Year 5 goal of 12,000 square feet in 2017.

8.0 REFERENCES

Fresh, K. L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by the Seattle District, US Army Corps of Engineers, Seattle, Washington.

Hart Crowser 2011a. Draft Biological Evaluation, Custom Plywood Interim Action Phase II, Anacortes, Washington. Prepared by Hart Crowser under Discretion and Contract with Washington State Department of Ecology under Agreement with GBH Investments, LLC. August 15, 2011. Prepared for Washington State Department of Ecology Toxics Cleanup Program. August 5, 2011.

Hart Crowser 2011b. Memorandum re: Appendix B-1 – Conceptual Wetland Mitigation Plan for the Custom Plywood Interim Remedial Action. Prepared for Washington State Department of Ecology, Olympia, Washington, by Hart Crowser, Edmonds, Washington. September 9, 2011.

Hart Crowser 2012a. Draft Final Conservation Measures and Monitoring Plan, Custom Plywood Interim Action Phase II, Anacortes, Washington. Prepared by Hart Crowser under Discretion and Contract with Washington State Department of Ecology under Agreement with GBH Investments, LLC. August 15, 2012.

Hart Crowser 2012b. As-Built Verification Report, Wetland Mitigation Area, Custom Plywood Interim Remedial Action – Phase I, Anacortes, Washington. May 15, 2012.

Hart Crowser 2013. 2012 (Year 1) Monitoring Report, Wetland Mitigation Area, Custom Plywood Interim Remedial Action. Anacortes, Washington. Prepared by Hart Crowser under Discretion and

Contract with Washington State Department of Ecology under Agreement with GBH Investments, LLC. January 31, 2013.

Hart Crowser 2014. Final Conservation Measures and Monitoring Work Plan, Custom Plywood Interim Action Phase II, Anacortes, Washington. Prepared by Hart Crowser under Discretion and Contract with Washington State Department of Ecology under Agreement with GBH Investments, LLC. May 20, 2014.

Hart Crowser 2015. Year 1 Monitoring Report, Custom Plywood Interim Remedial Action Conservation Measures and Monitoring, Custom Plywood, Anacortes, Washington. Prepared by Hart Crowser under Discretion and Contract with Washington State Department of Ecology under Agreement with GBH Investments, LLC. June 2, 2015.

Koenings, J.P. and G.B. Kyle 1997. Consequences to Juvenile Sockeye Salmon and the Zooplankton Community Resulting from Intense Predation. Alaska Fishery Research Bulletin Vol. 4(2): pp 120-135. Alaska Department of Fish and Game.

Moulton, L.L. and D.E. Penttila 2001. Field Manual for Sampling Forage Fish Spawn in Intertidal Shore Regions. San Juan County Forage Fish Assessment Project. MJM Research. Lopez Island, Washington. Washington Department of Fish and Wildlife, La Conner, Washington.

Rossell, L. and P. Dinnel 2007. Temperature and Shading Effects on Surf Smelt, *Hypomesus pretiosus*, Egg Survival. Puget Sound Georgia Basin 2007 Conference Proceedings.

Scatolini, S.R. and J.B. Zedler 1996. Epibenthic invertebrates of natural and constructed marshes of San Diego Bay. Wetlands Vol. 16: pp. 24–37.

Simenstad, C.A., W.J. Kinney, B.S. Miller, and T. Petr 1980. Epibenthic Zooplankton Assemblages at Selected Sites along the Strait of Juan de Fuca. NOAA Environmental Research Lab., Boulder, CO (USA). Marine Ecosystems Analysis Program.

Simenstad, C.A., E.O. Salo, B.R. Melteff, and R.A. Neve 1982. Foraging Success as a Determinant of Estuarine and Nearshore Carrying Capacity of Juvenile Chum Salmon (*Oncorhynchus keta*) in Hood Canal, Washington. Alaska University, Fairbanks (USA). Alaska Sea Grant Program.

Simenstad, C.A., C.D. Tanner, R.M. Thom, and L.L. Conquest 1991. Puget Sound Estuary Program: Estuarine Habitat Assessment Protocol. EPA 910/9-91-037. Prepared for US Environmental Protection Agency, Region 10, Seattle, Washington. Final Report.

Weitkamp, L.A, T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R. S. Waples 1995. Status review of coho salmon from Washington, Oregon, and California. NOAA Tech. Memorandum. NMFS-NWFSC-24. US Dept. of Commerce. 258p.

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables\Reports\Year 2 CMM\20160511\Year 2 CMM Report_20160511.docx

TABLES

Table 3 – Schedule for Reporting and Annual Monitoring for Wetland Mitigation Area

Monitoring Element	Year												
	2011 (Year 0)	2012 (Year 1)	2013 (Year 2)	2014 (Year 3)	2015 (Year 4)	2016 (Year 5)	2017 (Year 6)	2018 (Year 7)	2019 (Year 8)	2020 (Year 9)	2021 (Year 10)	2022 (Year 11)	2023 (Year 12)
Upland Buffer Monitoring	✓	✓	✓	✓	✓	○	○	○	○	○	○	○	○
Backshore in Wetland Complex Monitoring	✓	✓	✓	✓	✓	○	○	○	○	○	○	○	○
Hydrology Monitoring	N/A	N/A	N/A	✓ (Year 1)	✓ (Year 2)	○ (Year 3)	○ (Year 4)	○ (Year 5)	○ (Year 6)	○ (Year 7)	○ (Year 8)	○ (Year 9)	○ (Year 10)
Wetland and Backshore along Beach Vegetation Monitoring	N/A	N/A	N/A	✓ Year 1	✓ (Year 2)	○ (Year 3)	○ (Year 4)	○ (Year 5)	○ (Year 6)	○ (Year 7)	○ (Year 8)	○ (Year 9)	○ (Year 10)
Annual Monitoring Report (by December 31)	✓	✓	X	✓	✓	○	○	○	○	○	○	○	○

Notes:

✓ - completed to date
○ - scheduled for completion
X – Not completed

Table 5 – Relative Composition of the Epibenthic Zooplankton Community in Reference and Restored Sites at Two Tidal Elevations, May and June 2015

	+4				+6				
MAY	**EB-1**	**EB-2**	**EB-3**	**EB-Ref**	**EB-1**	**EB-2**	**EB-3**	**EB-Ref**	**Total**
Annelid	0.7%	16.6%	8.5%	2.7%	8.2%	2.6%	2.7%	15.3%	7.2%
Arthropod									
Mite	0.0%	0.0%	2.2%	0.4%	1.1%	0.0%	0.6%	1.1%	0.7%
Crustacea									
Amphipod	0.6%	0.1%	0.9%	0.0%	0.0%	0.0%	1.1%	0.8%	0.4%
Total Barnacle	4.2%	9.9%	3.2%	9.3%	33.0%	0.8%	15.1%	28.1%	13.0%
Cyprid	0.3%	0.3%	0.7%	0.1%	2.6%	0.0%	0.9%	1.9%	0.8%
Nauplii	3.9%	9.6%	2.5%	9.2%	30.4%	0.8%	14.2%	26.3%	12.1%
Cladocera	0.0%	0.2%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.1%
Copepod	37.0%	8.3%	51.4%	38.0%	24.2%	5.6%	26.2%	24.7%	26.9%
Cumacean	0.4%	0.0%	0.2%	0.1%	0.0%	0.0%	0.0%	0.2%	0.1%
Euphausiid	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Gammarid	0.1%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.1%
Isopod	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.4%	0.1%
Mysid	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Ostracod	0.0%	0.0%	0.2%	12.8%	0.0%	0.0%	0.3%	2.4%	2.0%
Unidentified Crustacea									
Nauplii	1.5%	0.0%	0.2%	0.4%	2.6%	0.0%	0.6%	1.2%	0.8%
Juvenile (Zoea)	0.0%	4.2%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.6%
Dinoflagellate	3.3%	0.0%	0.0%	0.6%	0.9%	0.0%	0.0%	0.5%	0.7%
Eggs	8.8%	0.4%	0.5%	4.3%	1.7%	0.7%	14.1%	9.1%	5.0%
Foraminifera	0.0%	0.1%	0.2%	0.0%	0.2%	0.0%	0.3%	0.2%	0.1%
Mollusc									
Bivalve	0.0%	6.8%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.9%
Gastropod	0.4%	0.0%	0.4%	1.0%	0.7%	0.6%	0.0%	1.8%	0.6%
Unidentified spp.	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Nematode	36.6%	50.8%	31.1%	27.9%	17.3%	88.8%	38.9%	13.3%	38.1%
Platyhelminthes	0.3%	0.0%	0.0%	0.0%	0.1%	0.5%	0.0%	0.0%	0.1%
Tunicata									
Larvacea	3.4%	2.6%	0.7%	0.0%	9.5%	0.0%	0.0%	0.7%	2.1%
Unidentified	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Unidentified spp.	0.0%	0.0%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.2%

	+4				+6				
JUNE	**EB-1**	**EB-2**	**EB-3**	**EB-Ref**	**EB-1**	**EB-2**	**EB-3**	**EB-Ref**	**Total**
Annelid	36.1%	28.2%	3.6%	16.9%	50.3%	9.0%	16.5%	11.5%	21.5%
Arthropod									
Collembola	0.1%	0.0%	0.3%	0.0%	0.0%	0.1%	0.3%	0.0%	0.1%
Mite	0.5%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.3%	0.1%
Crustacea									
Amphipod	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Barnacle	1.9%	31.1%	7.0%	4.1%	3.3%	15.1%	10.9%	3.8%	9.6%
Cyprid	1.3%	1.8%	0.2%	0.6%	1.5%	0.3%	0.4%	0.7%	0.8%
Nauplii	0.6%	29.3%	6.8%	3.6%	1.7%	14.8%	10.6%	3.1%	8.8%
Cladocera	1.4%	1.5%	8.8%	0.4%	1.3%	0.4%	1.3%	0.3%	1.9%
Copepod	21.0%	16.1%	26.0%	22.0%	15.9%	19.1%	45.3%	28.7%	24.3%
Cumacean	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Gammarid	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Isopod	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Ostracod	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%
Unidentified Crustacea									
Nauplii	12.1%	13.1%	39.5%	32.9%	11.8%	20.0%	17.1%	25.1%	21.4%
Juvenile (Zoea)	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%
Dinoflagellate	0.5%	0.3%	4.8%	4.7%	0.3%	0.0%	0.1%	3.4%	1.8%
Eggs	2.5%	0.0%	0.0%	13.7%	2.5%	0.0%	0.0%	19.0%	4.7%
Foraminifera	0.2%	0.1%	0.0%	0.1%	0.0%	0.3%	0.2%	0.1%	0.1%
Mollusc									
Bivalve	0.3%	0.2%	4.0%	0.9%	0.4%	0.0%	0.6%	0.1%	0.8%
Gastropod	0.5%	0.3%	0.2%	0.0%	0.1%	0.0%	0.2%	0.1%	0.2%
Nematode	12.2%	8.8%	1.4%	1.8%	2.0%	33.5%	5.3%	5.5%	8.8%
Platyhelminthes	10.2%	0.1%	2.9%	0.2%	11.5%	0.3%	0.0%	0.3%	3.2%
Tunicata									
Larvacea	0.4%	0.2%	1.5%	2.1%	0.5%	2.0%	2.0%	1.7%	1.3%

Table 6 – Epibenthic Zooplankton Density and Diversity in Reference and Restored Sites at Two Tidal Elevations, May and June 2015

	EB-1		EB-2		EB-3		Restored Total		Reference	
Month	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**
MAY										
Mean Epibenthic Zooplankton (#/m^2)	10916.67	45066.67	18966.67	25066.67	12800.00	9300.00	14227.78	26477.78	22700.00	14166.67
Mean Crustacean Zooplankton (#/m^2)	4883.33	27100.00	1133.33	1500.00	6566.67	4033.33	4194.44	10877.78	13666.67	8666.67
Shannon's Diversity Index	1.88	1.93	1.25	0.51	1.44	1.50	1.96	2.04	1.80	2.18
Shannon's Evenness Index	0.66	0.71	0.52	0.25	0.55	0.65	0.61	0.69	0.67	0.77
Species Richness	17.00	15.00	11.00	8.00	14.00	10.00	25.00	19.00	15.00	17.00
JUNE										
Total Epibenthic Zooplankton (#/m^2)	181600.00	171033.33	58333.33	57600.00	395333.30	62200.00	211755.60	96944.44	45700.00	71366.67
Total Crustacean Zooplankton (#/m^2)	65633.33	54933.33	36066.67	31200.00	329400.00	46733.33	143700.00	44288.89	27666.67	35633.33
Shannon's Diversity Index	1.96	1.84	1.74	1.67	1.67	1.60	2.13	2.18	1.92	2.00
Shannon's Evenness Index	0.66	0.65	0.68	0.67	0.63	0.62	0.68	0.71	0.68	0.72
Species Richness	20.00	17.00	13.00	12.00	14.00	13.00	23.00	21.00	17.00	16.00

Table 7 – Inter-Annual Comparison of Epibenthic Zooplankton Densities by Treatment and Tidal Elevation

	2014				2015				2014 vs 2015	
	Restored		Reference		Restored		Reference		P-Values	
Month	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**	**+4'**	**+6'**
MAY										
Mean Epibenthic Zooplankton (#/m^2)	10967	4000	32333	2383	14228	26478	22700	14167	0.45	**0.007**
Mean Crustacean Zooplankton (#/m^2)	4778	3139	16089	1233	4194	10878	13667	8667	0.36	*0.06*
JUNE										
Mean Epibenthic Zooplankton (#/m^2)	18011	6622	44200	19333	211756	96944	45700	71367	*0.08*	**0.002**
Mean Crustacean Zooplankton (#/m^2)	11278	3733	29733	16800	143700	44289	27667	35633	0.19	**<0.001**

Note:

Bold values indicate significant differences ($p \leq 0.05$) of total density between years; *italicized* values indicate possible ecologically important differences.

Table 8 – Beach Seine CPUE for May and June 2015

Species		Station													
		BS-1		BS-2		BS-3		Total Restored		BS-Ref		Grand Total		Pocket Estuary	
		May	June	May	June	May	June	May	June	May	June	May	June	May	June
Salmonids	Chinook salmon, juvenile	-	-	-	1.0	-	1.0	-	0.7	-	-	-	0.5	-	-
	Chum salmon, juvenile	0.5	-	1.0	-	-	0.5	0.5	0.2	-	-	0.4	0.1	-	-
	Pink salmon, juvenile	1.0	-	2.0	-	-	-	1.0	-	-	-	0.8	-	-	-
	Salmonid (unid'd)	0.5	-	-	-	-	-	0.2	-	-	-	0.1	-	-	-
Forage Fish	Pacific herring	0.5	0.5	-	-	-	-	0.2	0.2	-	-	0.1	0.1	-	-
	Sand lance	0.5	-	-	-	-	-	0.2	-	-	-	0.1	-	-	-
	Surf smelt	10.0	265.5	126.5	248.5	155.0	146.0	97.2	220.0	2.5	76.5	73.5	184.9	-	6.0
Other Fish	Bay pipefish	0.5	-	1.0	1.0	-	-	0.5	0.3	-	-	0.4	0.3	-	-
	Buffalo sculpin	0.5	-	0.5	-	-	-	0.3	-	-	-	0.3	-	-	-
	Crescent gunnel	1.0	-	14.0	-	1.5	-	5.5	-	1.5	-	4.5	-	-	-
	Kelp greenling	0.5	-	-	-	-	-	0.2	-	-	-	0.1	-	-	-
	Pacific staghorn sculpin	2.5	2.5	4.0	3.5	9.0	10.0	5.2	5.3	59.0	66.0	18.6	21.4	22.5	7.0
	Penpoint gunnel	-	-	2.0	-	-	-	0.7	-	-	-	0.5	-	-	-
	Rock sole	-	0.5	-	-	-	-	-	0.2	0.5	-	0.1	0.1	-	-
	Saddleback gunnel	-	0.5	-	1.0	-	1.0	-	0.8	-	1.0	-	0.9	-	-
	Sculpin (unid'd)	4.5	-	-	-	-	-	1.5	-	-	-	1.1	-	-	-
	Shiner perch	11.5	1.0	102.0	78.0	98.0	133.5	70.5	70.8	2047.0	1709.5	564.6	485.4	7.0	39.0
	Snake prickleback	2.5	80.0	0.5	0.5	3.0	4.5	2.0	28.3	-	176.0	1.5	65.3	-	-
	Starry flounder	-	0.5	-	-	-	-	-	0.2	-	0.5	-	0.3	-	-
	Threespine stickleback	-	296.0	17.0	81.0	0.5	11.0	5.8	129.3	-	1.5	4.4	97.4	-	-
	Tidepool sculpin	-	3.0	-	-	-	-	-	1.0	-	-	-	0.8	-	-
Total juvenile salmonids:		**2.0**	**-**	**3.0**	**1.0**	**-**	**1.5**	**1.7**	**0.8**	**-**	**-**	**1.3**	**0.6**	**-**	**-**
Total (excluding shiner perch)		**24.5**	**649.0**	**168.5**	**336.5**	**169.0**	**174.0**	**120.7**	**386.5**	**63.5**	**321.5**	**106.4**	**371.9**	**22.5**	**6.5**
Grand Total:		**36.5**	**650.0**	**270.5**	**414.5**	**267.0**	**307.5**	**191.3**	**457.3**	**2110.5**	**2031.0**	**671.1**	**857.3**	**29.5**	**52.0**
# Reps:		**2**	**2**	**2**	**2**	**2**	**2**	**6**	**6**	**2**	**2**	**8**	**8**	**2**	**1**

Table 9 – Beach Seine CPUE for 2014 and 2015 Sampling Seasons

		Station													
		BS-1		BS-2		BS-3		Total Restored		Reference		Total		Pocket Estuary	
Species		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Salmonids	Chinook	0.5	-	6.3	0.5	1.6	0.5	2.8	0.3	-	-	2.1	0.3	-	-
	Chum	2.3	0.3	4.5	0.5	10.3	0.3	5.7	0.3	3.0	-	5.0	0.3	-	-
	Coho	-	-	2.8	-	0.5	-	1.1	-	-	-	0.8	-	-	-
	Pink	4.8	0.5	27.5	1.0	85.3	-	39.2	0.5	15.3	-	33.2	0.4	-	-
	Sockeye	-	-	0.3	-	0.3	-	0.2	-	-	-	0.1	-	-	-
	Unidentified salmonid	-	0.3	-	-	-	-	-	0.1	-	-	-	0.1	-	-
Forage Fish	Pacific herring	23.8	0.5	8.0	-	28.8	-	20.2	0.2	19.5	-	20.0	0.1	-	-
	Sand lance	-	0.3	-	-	-	-	-	0.1	1.3	-	0.3	0.1	-	-
	Surf smelt	6.8	137.8	55.5	187.5	928.3	150.5	330.2	158.6	721.1	39.5	427.9	128.8	-	2.0
Other Fish	Bay pipefish	-	0.3	-	1.0	-	-	-	0.4	-	-	-	0.3	-	-
	Buffalo sculpin	-	0.3	0.3	0.3	-	-	0.1	0.2	-	-	0.1	0.1	-	-
	Crescent gunnel	0.3	2.0	1.3	8.3	2.8	2.3	1.4	4.2	-	3.5	1.1	4.0	-	-
	Kelp greenling	0.3	0.3	-	-	-	-	0.1	0.1	-	-	0.1	0.1	-	-
	Pacific staghorn sculpin	5.0	2.5	6.3	3.8	0.8	9.5	4.0	5.3	5.2	62.5	4.3	19.6	2.5	17.3
	Padded sculpin	-	-	-	-	-	-	-	-	0.5	-	0.1	-	-	-
	Penpoint gunnel	-	-	-	1.0	-	-	-	0.3	-	-	-	0.3	-	-
	Rock sole	-	0.3	-	-	-	-	-	0.1	-	0.3	-	0.1	-	-
	Saddleback gunnel	-	0.3	-	0.5	-	0.5	-	0.4	-	0.5	-	0.4	-	-
	Sculpin (unid'd)	3.0	1.8	-	-	-	-	1.0	0.6	-	-	0.8	0.4	1.0	-
	Shiner perch	11.5	6.3	394.8	90.0	221.7	115.8	209.3	70.7	4050.5	1878.3	1169.6	522.6	100.5	17.7
	Snake prickleback	38.0	41.3	99.5	0.5	20.4	3.8	52.6	15.2	50.6	88.0	52.1	33.4	-	-
	Starry flounder	-	0.3	-	-	-	-	-	0.1	-	0.3	-	0.1	-	-
	Threespine stickleback	4.3	148.0	27.8	49.0	13.4	5.8	15.1	67.6	24.1	0.8	17.4	50.9	-	-
	Tidepool sculpin	-	1.5	-	-	-	-	-	0.5	-	-	-	0.4	-	-
	Tubesnout	-	-	0.3	-	0.5	-	0.3	-	-	-	0.2	-	-	-
Total Juvenile Salmonids:		**7.5**	**0.8**	**41.3**	**2.0**	**97.8**	**0.8**	**48.9**	**1.2**	**18.3**		**41.2**	**0.9**		
Grand Total:		**100.3**	**344.3**	**634.8**	**343.8**	**1314.3**	**288.8**	**683.1**	**325.6**	**4891.0**	**2073.5**	**1735.1**	**762.6**	**104.0**	**37.0**
# Reps:		**4**	**4**	**4**	**4**	**4**	**4**	**12**	**12**	**4**	**4**	**16**	**16**	**4**	**4**

Table 14 – Vegetation Monitoring Data Sheet
Custom Plywood Wetland Mitigation Area, Anacortes, Washington

Site: Custom Plywood Interim Remedial Action
Investigator: D. Hennessey and E. Duncanson
Project Number: 17800-51
Date: 9/29/2015
Transects: T1 and T2 (200 feet) T3, T4, T5, T6, T8, T9,T10, and T11 (100 feet), and T7 (75 feet)
Sample Plots: 8 (T1), 7 (T2), 4 (T3, T4, T5, T6, T8, T9, T10, and T11), and 3 (T7) per transect
Sample Plot Size: 1-meter-square quadrat

Plant Species installed in Phase I		Estimated Percent Cover for Sample Plots at Each Transect																																																	
		T1 (200')								T2 (200')							T3 (100')				T4 (100')				T5 (200')				T6 (100')				T7 (75')			T8 (100')				T9 (100')				T10 (100')				T11 (100')			
Scientific Name	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Upland Buffer (native)																																																			
Acer macrophyllum	Big-leaf maple																																																		
Acer circinatum	Vine maple							5																																											
*Almus rubra**	Alder																																																		
Arctorstaphylos uva-ursi	Kinnikinnick			25			25		15																																										
Fragaria chiloensis	Coastal strawberry			10		35	3	3	5	15	3	5	20			4																																			
Gaulheria shallon	Salal																																																		
Holodiscus discolor	Oceanspray							5				15																																							
Leymus mollis	Dunegrass																5	10	25	40	30	40	35	15																											
Pseudotsuga menziesii	Douglas fir																																																		
Pinus contorta	Shore pine					40									5																																				
Populus balsamifera	Black cottonwood			1		5																																													
*Populus papyrifera**	Birch																																																		
Ribes sanguineum	Red-flowering currant		15		60				15																																										
Rosa nutkana	Nootka rose	2						5		10	2					2																																			
Rubus parviflorus	Thimbleberry			5			25							80																																					
Sambucus racemosa	Red elderberry																																																		
*Spiraea douglasii**	Hardhack																																																		
Symphoricarpos albus	Snowberry	50											38	3	40																																				
Total Percent Cover per Sample Plot (Native Trees, Shrubs and Herbaceous Vegetation)		52	15	41	60	80	53	18	35	25	5	20	58	83	45	6	5	10	25	40	30	40	35	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average Cover Per Transect		**44**								**35**							**20**				**30**				**0**				**0**				**0**			**0**				**0**				**0**				**0**			
Wetland Emergents (native)																																																			
Salacornia virginica	Pickleweed																95	30		15				8											10																
*Cakile edentula**	American searocket																																																		
*Distichlis spicata**	Saltgrass																						10												7																
*Deschampsia cespitosa**	Tufted hairgrass																																																		
*Spergularia sp.**	Sand spurry																																																2	
*Atriplex patula**	Spear saltbush																	5	40	35	5		15	10				7					90	60	25		12		15												
Leymus mollis	Dunegrass																								40	30	25	25	17	40	25	55																			
Plantago macrocarpa	Seashore plantain																																	5				3													
Total Cover per Sample Plot (Native Emergents)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	35	40	50	5	0	25	18	40	30	25	32	17	40	25	55	90	65	42	0	12	3	15	0	0	0	0	0	0	0	0	0	0	2	0
Average Cover Per Transect		**0**								**0**							**55**				**12**				**32**				**34**				**66**			**8**				**0**				**0**				**0.5**			
Backshore along Berm and Beach (native)																																																			
Installed Vegetation (Dunegrass), Phase II (2013/2014)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	9	10	48	25	20	34	30	20	25	40	15	60	45	75
Average Cover Per Transect		**0**								**0**							**0**				**0**				**0**				**0**				**0**			**10**				**32**				**29**				**49**			
Invasive Weeds																																																			
Convolvulus sp	Bindweed	5	5	5	20	6	7																																												
Cirsium arvense	Canada thistle																																																		
Senecio jacobaea	Tansy ragwort			2	5		1	3																																											
Phalaris arundinacea	Reed canarygrass							5																																											
Trifolium repens	White clover																													20	10															7					25
Total Cover per Sample Plot (Invasive Weeds)		5	5	7	25	6	8	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	25
Average Cover Per Transect		**8**								**0**							**0**				**0**				**0**				**8**				**0**			**0**				**0**				**2**				**6**			
Other Non-Native Plants																																																			
Agrostis stolonifera	Creeping bentgrass																																																		
Tanacetum vulgare	Common tansy																																																		
Matricaria discoidea	Pineapple weed																																																		
	Moss																																																		
Poa sp.	Bluegrass	20	85			2	5	25	15		40																																								
Festuca sp.	Grasses		15	2																																															
Taraxicum officinale	Dandelion		2	20				3		3					1																														2						
Eastwoodi elegans	Yellow aster																																											2							
Geranium sp.	Cranesbills				15					5						1																																			
Artemisia sp.	Wormwood																																									1		8	6	30	5	3	8		
Unidentified grasses/herbs											10																	1																							
Bare ground																																																			
Total Cover per Sample Plot (Native and Non-native Plants)		20	102	22	15	2	5	28	15	8	50	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	10	8	30	5	3	8	0	0
Average Cover Per Transect		**26**								**9**							**0**				**0**				**0**				**0**				**0**			**0**				**0**				**13**				**3**			

Note
* Volunteer plant species

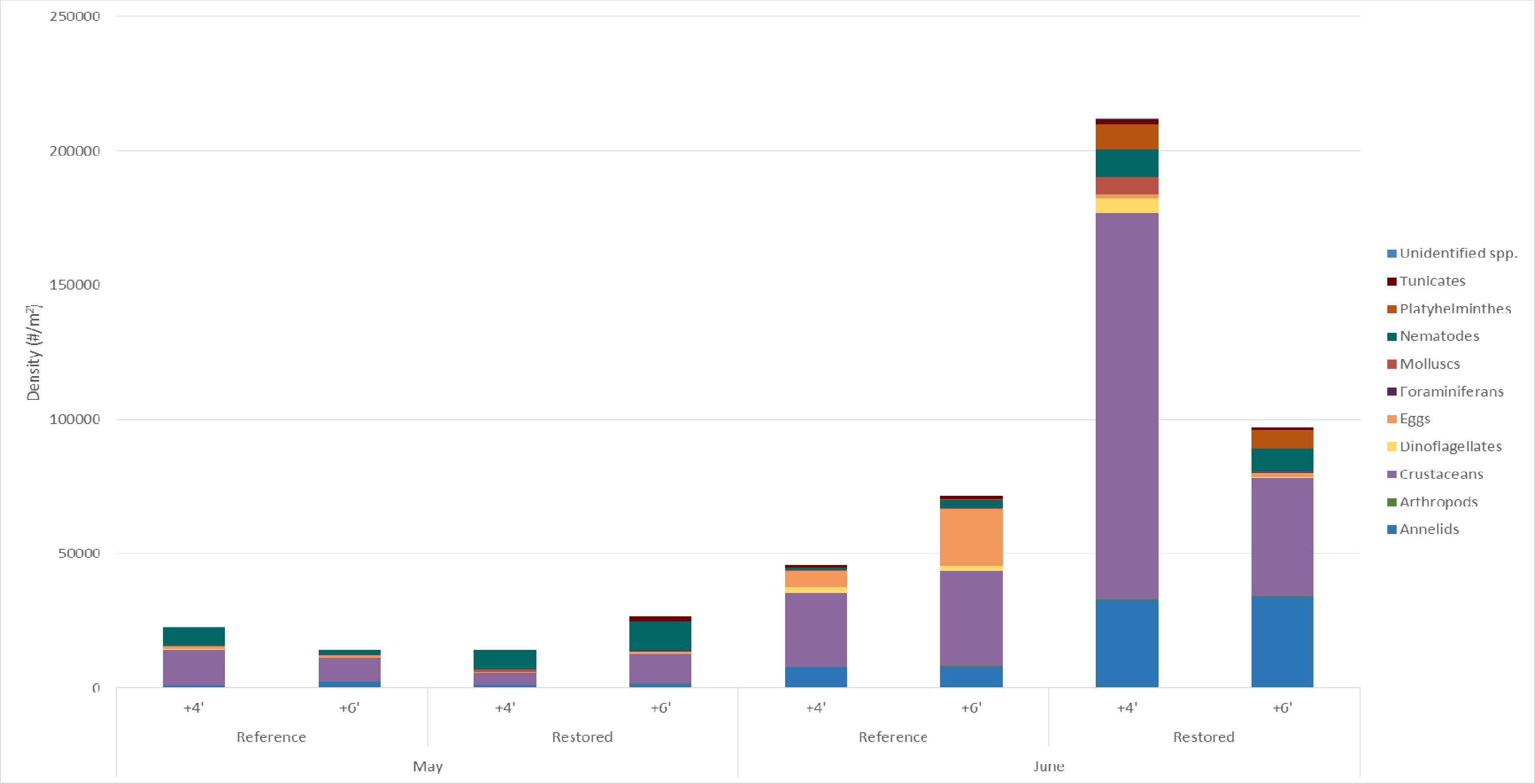
Table 14 – Vegetation Monitoring Data Sheet (cont'd)

Average Percent Cover Per Transect												
Type	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**	**Total Average Cover**
Buffer Vegetation (T1, T2, T3, T4)	44	35	20	30	0	0	0	0	0	0	0	**32**
Wetland Vegetation (T3, T4, T5, T6, T7)*	0	0	55	12	32	34	66	8	0	0	1	**40**
Backshore Vegetation (T8, T9, T10, T11)	0	0	0	0	0	0	0	10	32	29	49	**30**
Invasive Vegetation	8	0	0	0	0	8	0	0	0	2	6	**2**
Other Native and Non-Native Vegetation	26	9	0	0	0	0	0	0	0	13	3	**5**
Total Estimated Native Plant Coverage	**44**	**35**	**75**	**42**	**32**	**34**	**66**	**18**	**32**	**29**	**49**	**34**

Note:

* Total average cover for wetland vegetation includes T3 and T4; see section 4.6 for discussion.

FIGURES



Custom Plywood
Anacortes, Washington

Mean Density of Total Epibenthic Zooplankton in Reference and Restored Sites at Two Tidal Elevations, May and June 2015

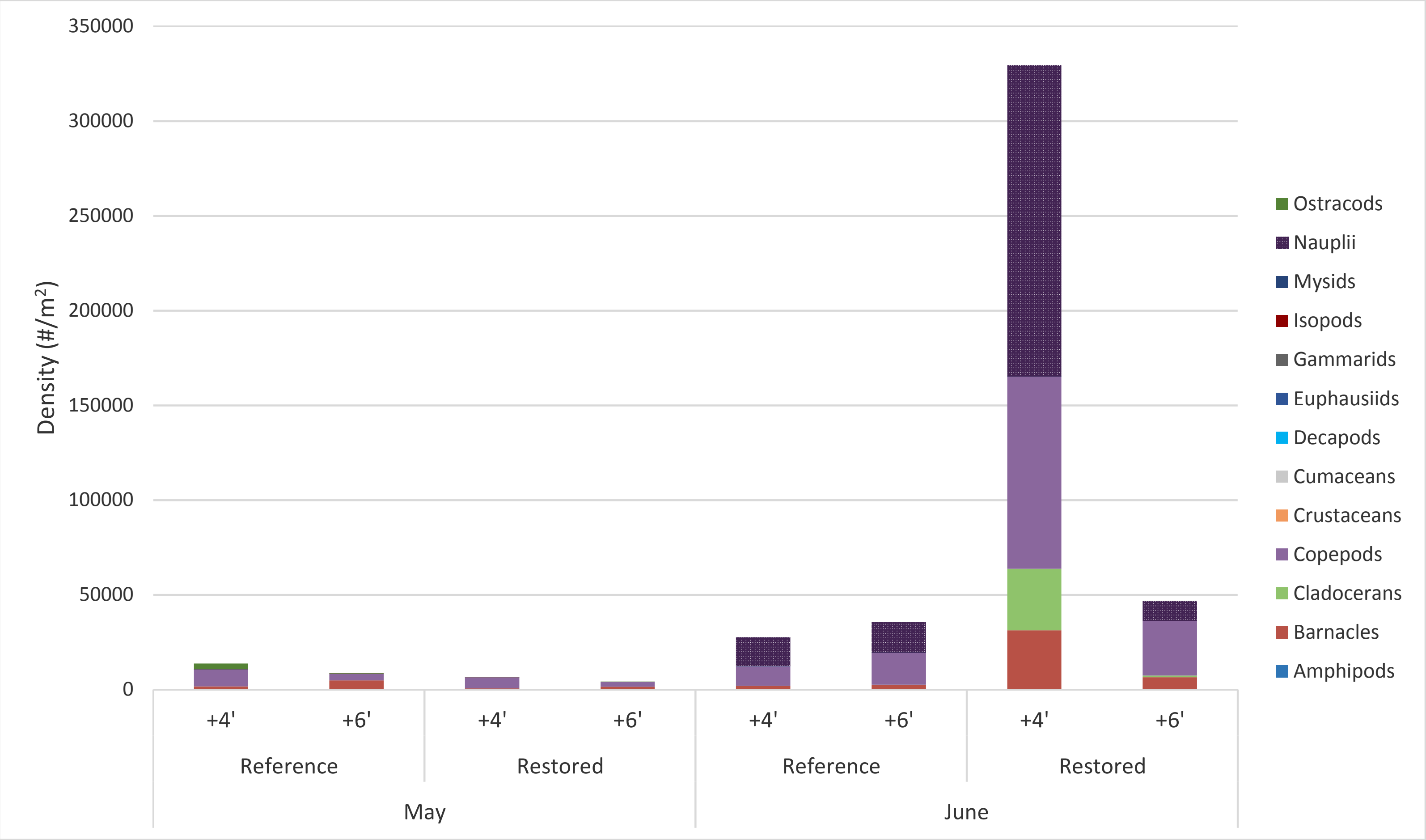
17800-51 12/11

HARTCROWSER

Figure

5

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables In-Basket\Figures\Figures4-9_Zooplankton.xls



Custom Plywood
Anacortes, Washington

Mean Density of Total Crustacean Zooplankton in Reference and Restored Sites at Two Tidal Elevations, May and June 2015

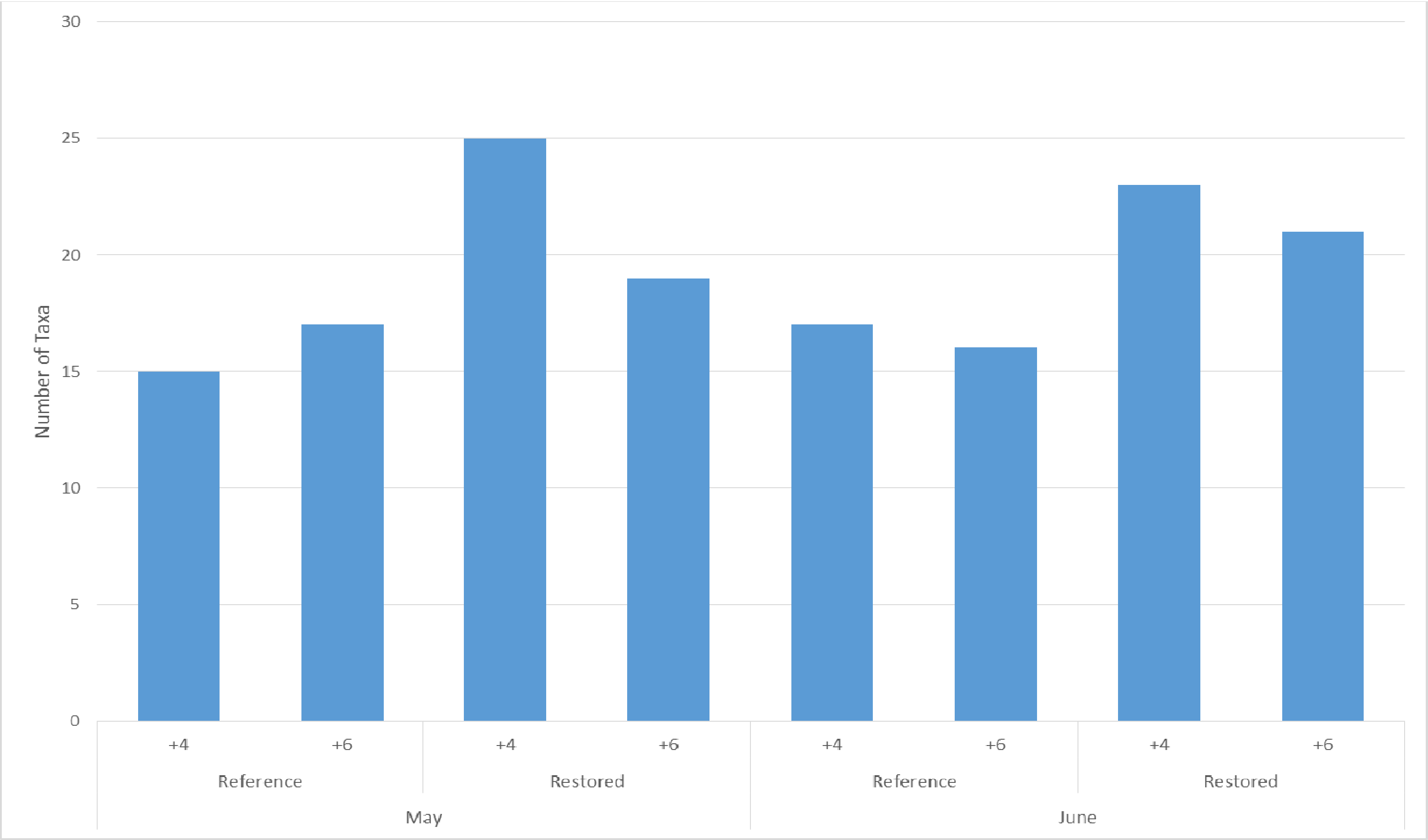
17800-51 12/11

HARTCROWSER

Figure
6

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables In-Basket\Figures\Figures4-9_Zooplankton.xls

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables In-Basket\Figures\Figures4-9_Zooplankton.xls



Custom Plywood
Anacortes, Washington

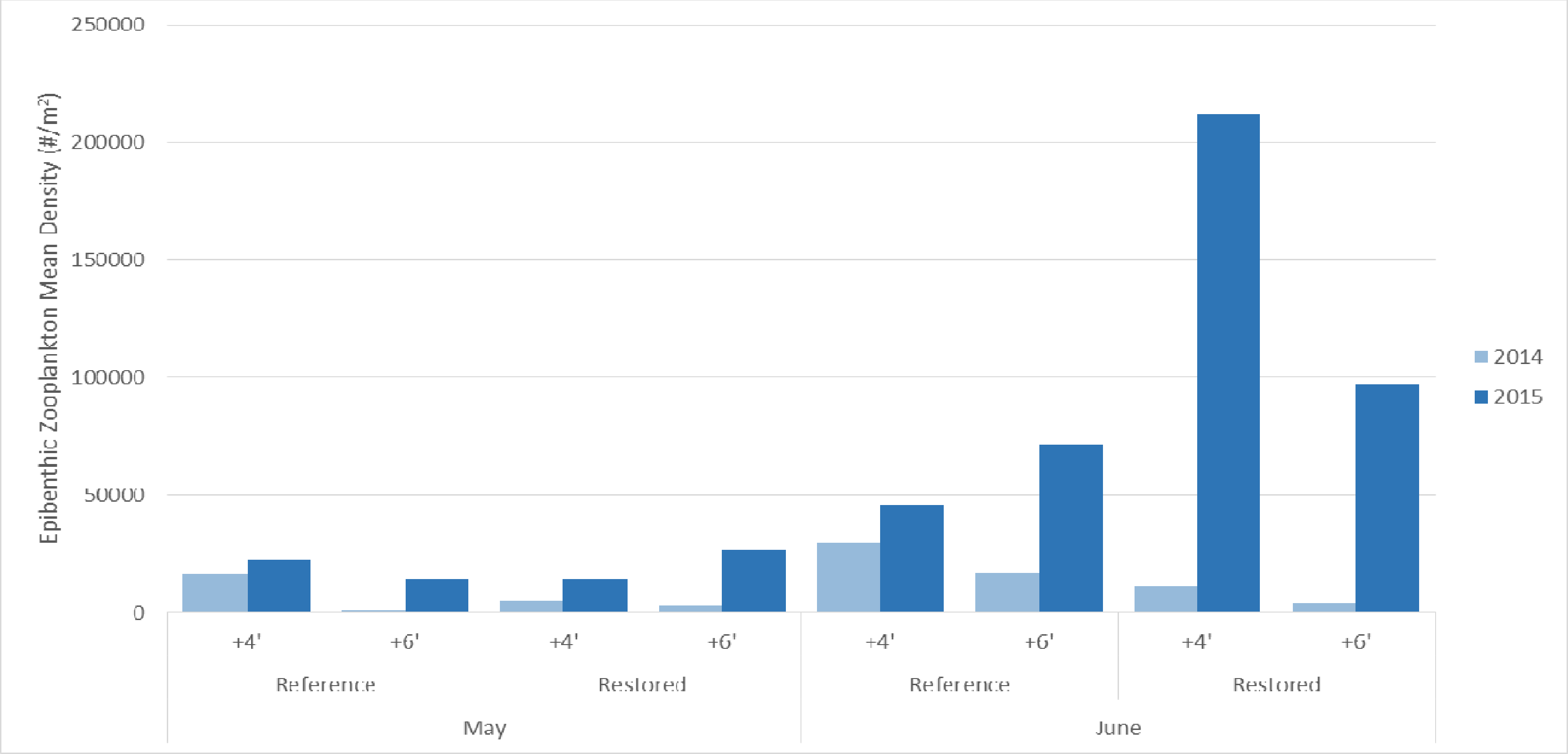
Epibenthic Zooplankton Taxa Richness in Reference and Restored Sites at Two Tidal Elevations, May and June 2015

17800-51 12/11

HARTCROWSER

Figure

7



Custom Plywood
Anacortes, Washington

Inter-annual Comparison of Total Epibenthic Zooplankton in Reference and Restored Sites at Two Tidal Elevations, May and June 2014 and 2015

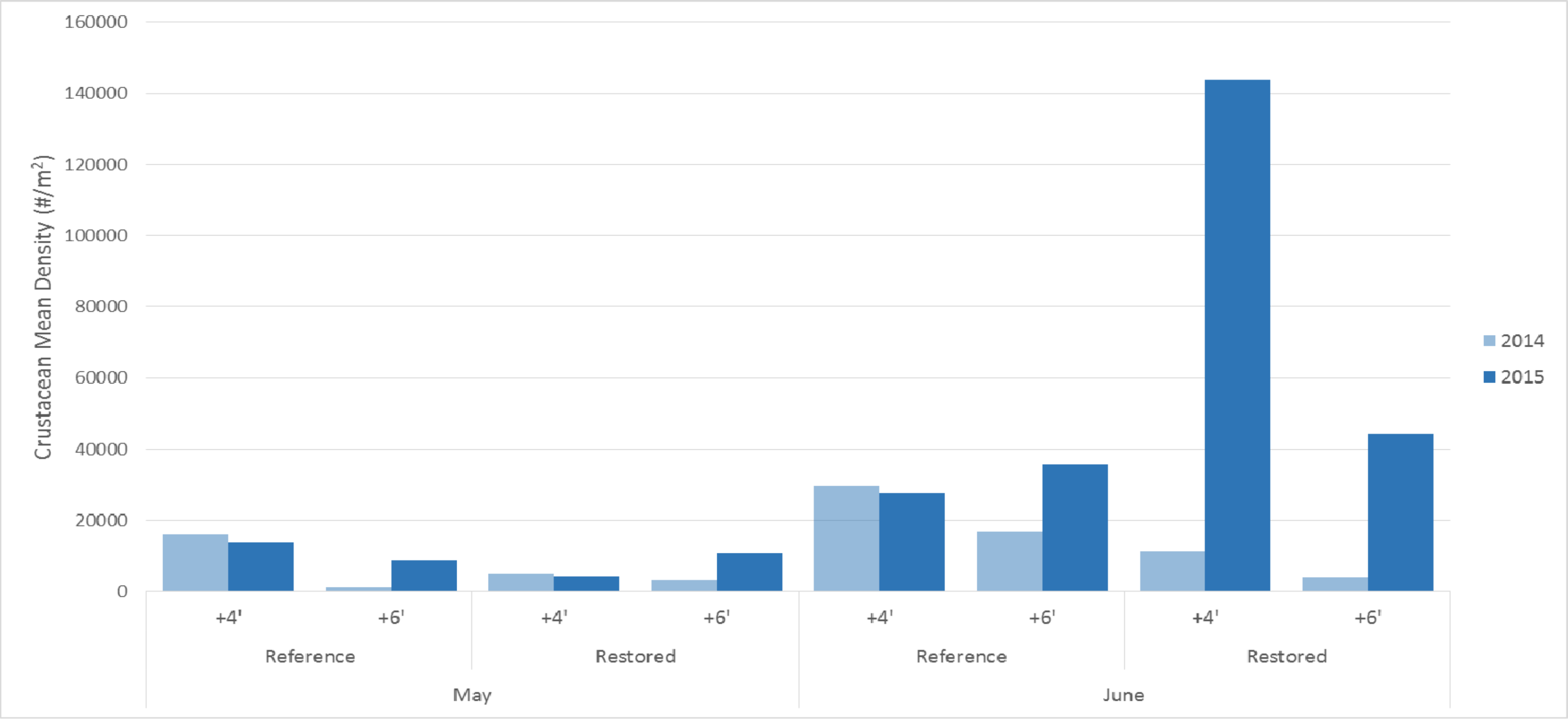
17800-51 12/11

HARTCROWSER

Figure

8

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables In-Basket\Figures\Figures4-9_Zooplankton.xls



Custom Plywood
Anacortes, Washington

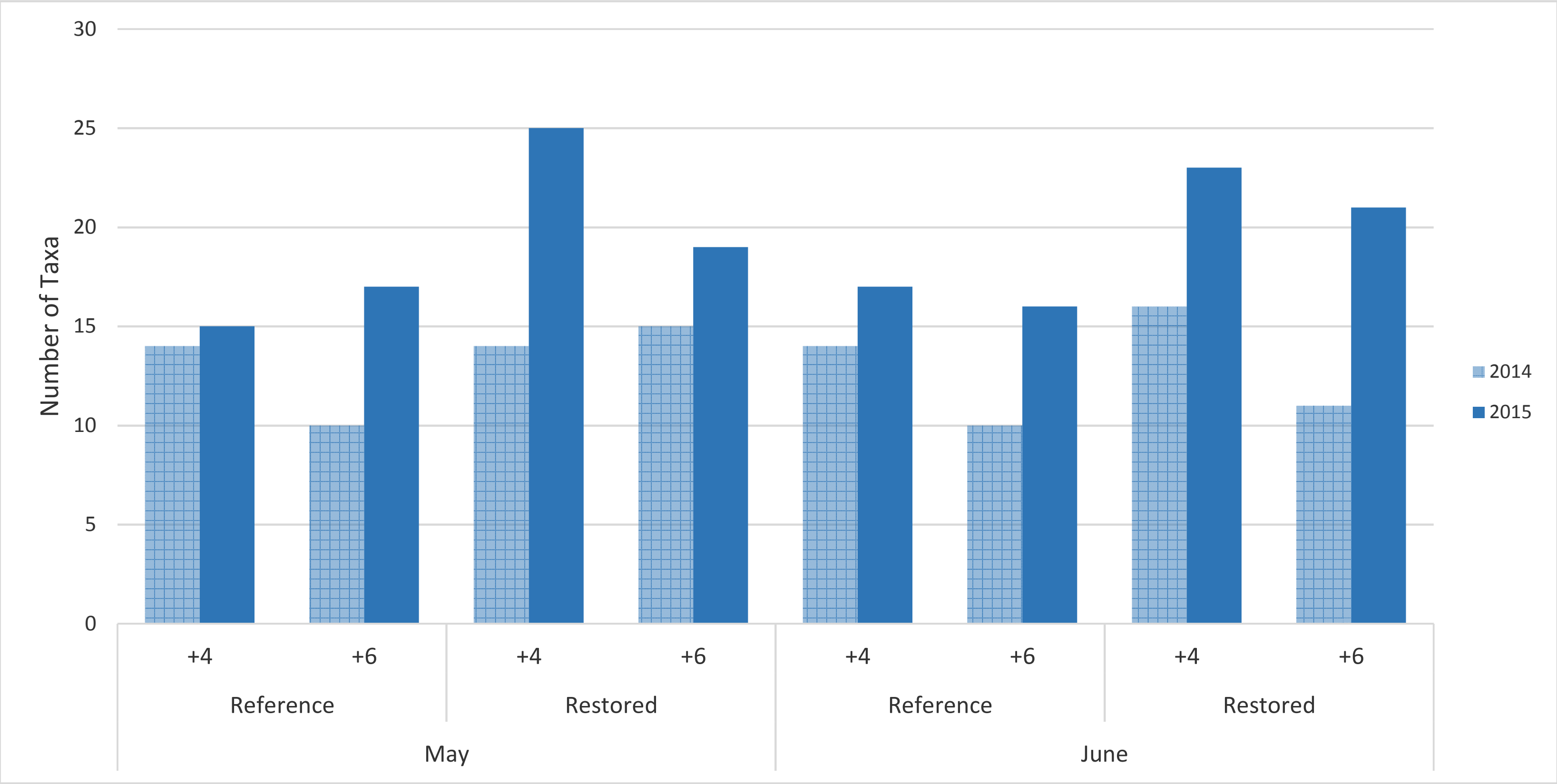
Inter-annual Comparison of Crustaceans in Reference and Restored Sites at Two Tidal Elevations, May and June 2014 and 2015

17800-51 12/11

HARTCROWSER

Figure

9



Custom Plywood
Anacortes, Washington

Inter-annual Comparison of Species Richness in Reference and Restored Sites at Two Tidal Elevations, May and June 2014 and 2015

17800-51 12/11

HARTCROWSER

Figure

10

R:\NOTEBOOKS\1780051_Custom Plywood Permitting Support Ph2\Deliverables In-Basket\Figures\Figures4-9_Zooplankton.xls

APPENDIX A

Wetland, Backshore, and Upland Buffer Vegetation Photographs

Photograph A-1 – Photo point 1 buffer on south side of estuary looking northwest

Photograph A-2 – Photo point 2 wetland on south side of estuary looking northwest

Photograph A-3 – Photo point 3 buffer on south side of wetland looking south

Photograph A-4 – Photo point 3 on north side of wetland looking northwest

Photograph A-5 – Photo point 3 of north side of wetland looking north

Photograph A-6 – Photo point 3 of wetland at drainage swale looking west

Photograph A-7 – Photo point 4 drainage swale, Year 1 (top) and Year 2 (bottom)

Photograph A-8 – Photo point 5 of buffer looking northwest, Year 1 (top) and Year 2 (bottom)

Photograph A-9 – Photo point 6 of berm on bay side of estuary looking north, Year 1 (top) and Year 2 (bottom)

Photograph A-10 – Photo point 7 of berm on bay side of estuary looking south, Year 1 (top) and Year 2 (bottom)

Photograph A-11 – Photo point 8 of channel between bay and estuary looking east, Year 1 (top) and Year 2 (bottom)

Photograph A-12 – Photo point 9 of backshore near pocket estuary looking north, Year 1 (top) and Year 2 (bottom)

Photograph A-13 – Photo point 10 of backshore in middle of restored beach looking north

APPENDIX B
Technical Memoranda
by Coast and Harbor Engineering

Former Custom Plywood Mill Cleanup Project
(1) Physical Monitoring Procedures and
(2) Qualitative Spit and Jetty Condition

COAST & HARBOR
ENGINEERING
A Division of Hatch Mott MacDonald

Technical Memorandum – Final Draft

Former Custom Plywood Mill Cleanup Project 2014-2015 Physical Monitoring

1. Introduction

This technical memorandum summarizes the results of physical monitoring at the Former Custom Plywood Mill Cleanup Project, as part of the Conservation Measures and Monitoring Plan (CMMP) conducted by Coast & Harbor Engineering (CHE), a division of Hatch Mott MacDonald, during the 2014-2015 measurement and observation cycle.

Monitoring at the project site included two physical monitoring events: (1) Baseline physical monitoring conducted on September 24, 2014 following construction, (2) Subsequent physical monitoring conducted on August 28, 2015. As defined by the CMMP, the Former Custom Plywood Mill Cleanup Project physical monitoring program included collection, processing, and review of three types of data: (1) topographic survey data, (2) sediment sampling and grain size analysis, and (3) ground photography at select photo points.

The results and observations of the first cycle of physical monitoring events are presented and summarized within the following subsections of this technical memorandum:

Topographic Surveys: During the September 24, 2014 and August 28, 2015 physical monitoring events , CHE performed beach elevation topographic surveying using RTK-GPS equipment along the length of eight (8) beach monitoring transects orientated perpendicular to the shoreline, two (2) spit monitoring transects, and one (1) Jetty extension monitoring transect. Coordinates of the monitoring transects are tabulated within CHE's previously developed technical memorandum (CHE 2014). During the physical monitoring events, CHE collected the coordinates (i.e., Easting, Northing, and Elevation) of 361 total points. Accumulated topographic survey data included a combination of points measured along the beach transects, sediment sampling points, photo points, spit transect points, and points along the new jetty extension. All survey data is included with Appendix A and on the accompanying CD in ASCII format. The approximate location of the monitoring transects for surveying are shown in plan view in Figure 1. An example beach survey profile plotted along Transect 6 is shown in Figure 2. All transect profile data developed from AutoCAD-generated TIN surfaces are included within Appendix B.

Figure 1. Plan view of project site showing transect locations along beach, spit, and new jetty extension structures

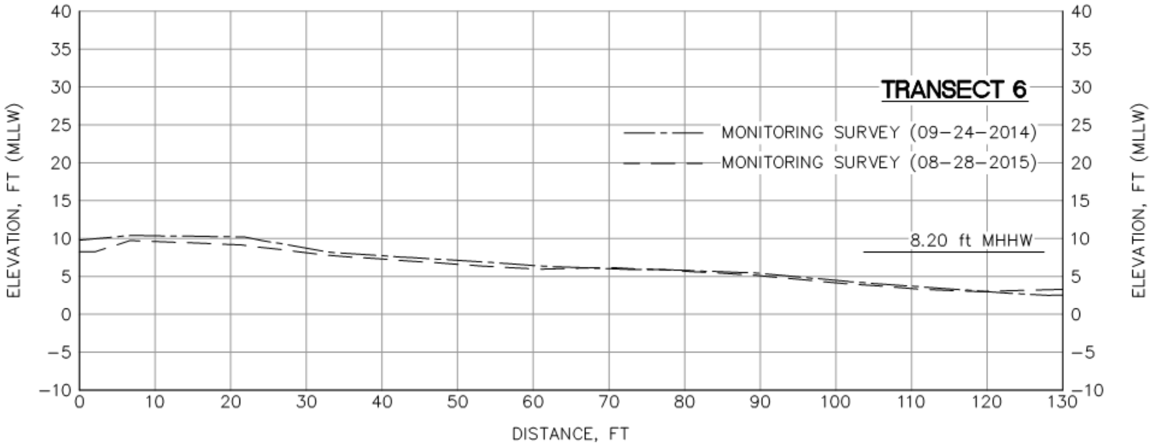


Figure 2. Example profile of beach Transect 6 for the physical monitoring events conducted on 9-24-2014 and 8-28-2015

__Sediment Sampling__: Sediment samples were collected at four (4) locations along each of the beach transects (excluding Transect 1 and 8). Each sediment sample collected was labeled with the corresponding transect number and a profile location number, ranging from 1-4, where 1 means that the sediment sample was taken at the landward side of the transect and 4 means that the sediment sample was taken at the seaward side of the transect. All samples were analyzed (by Hart Crowser) for size gradation. Analysis results are included within Appendix C. Example gradations of Transect 6 are shown in Figure 3a through 3d for both physical monitoring events**.**

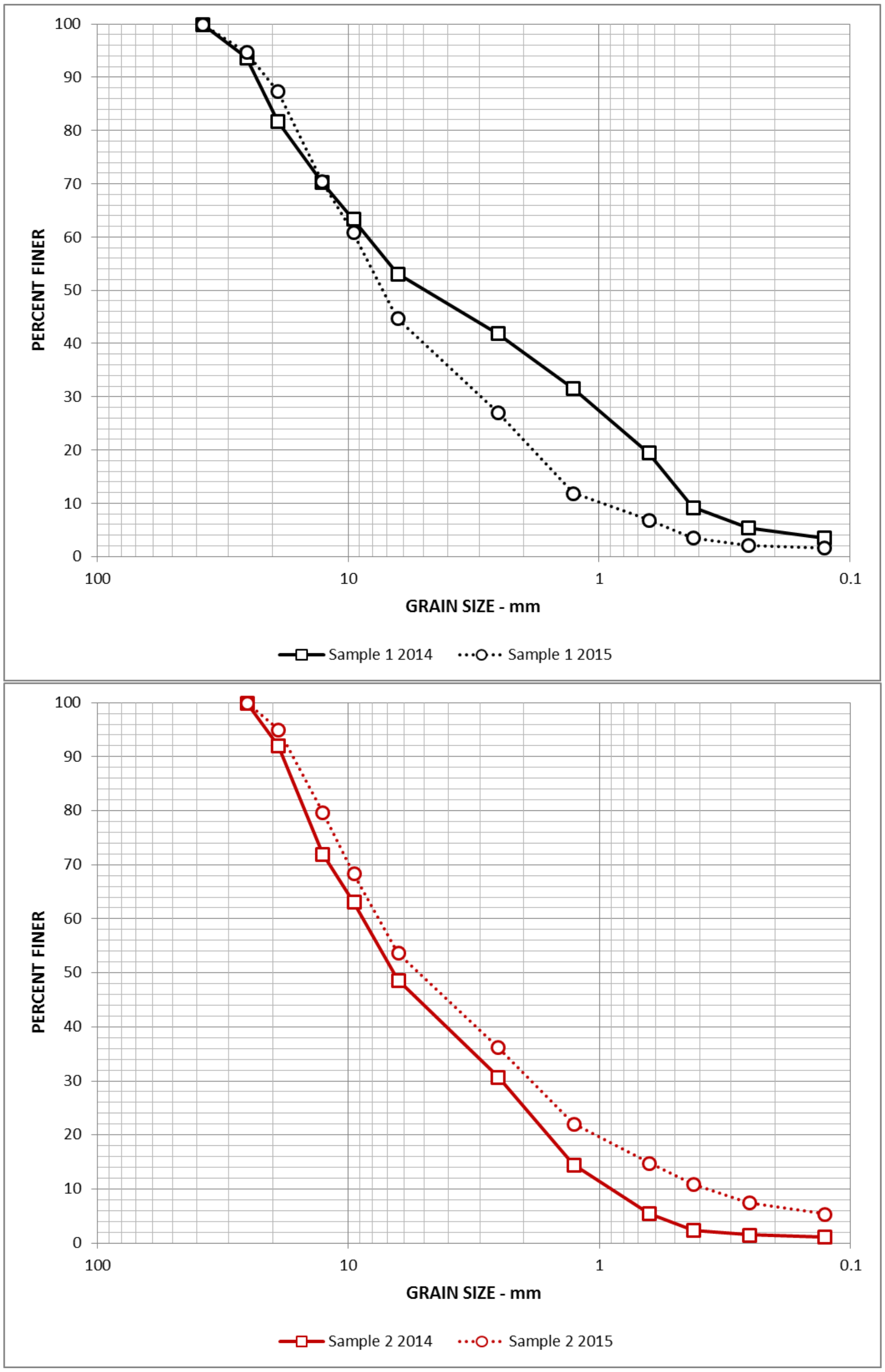


Figure 3a, b. Example sediment gradation curves for sample locations 1 and 2 along beach Transect 6

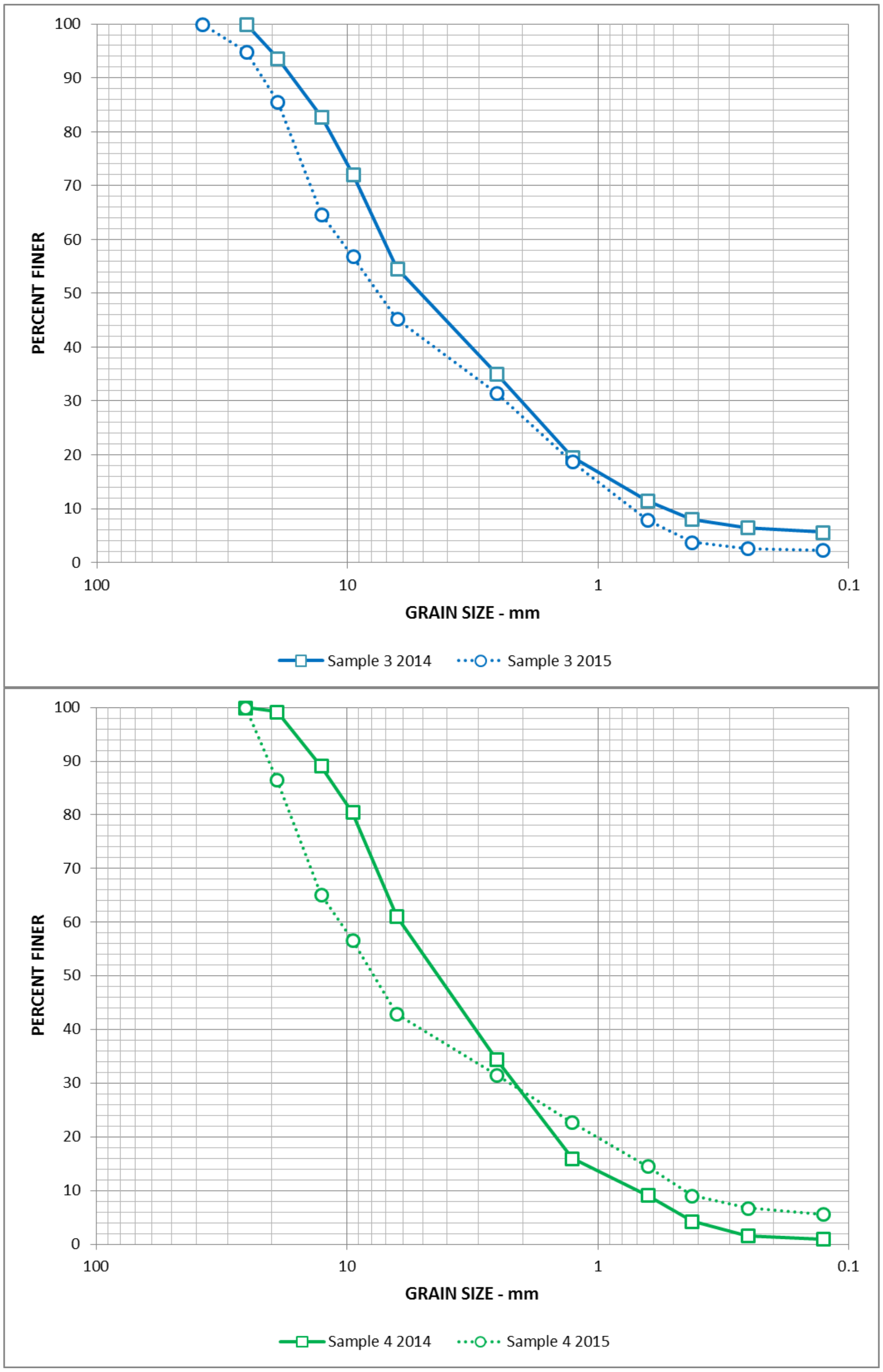


Figure 3c, d. Example sediment gradation curves for sample locations 3 and 4 along beach Transect 6

Ground Photography: Photographs of the beach, spit feature and offshore structures (New Jetty extension and fish passage) were taken during both monitoring events and are included within the CD that accompanies this physical monitoring report. Seven photo points were established at the project site. The purpose of the photo points was to visually document site conditions including habitat, sediments, constructed features, and qualitative features from fixed locations for comparison between physical monitoring events. Photographs taken at the photo points for both monitoring events are shown in Figures 4a through 4g.

Figure 4a. Photo Point 1 (galvanized fence post at south end of site) looking north along shoreline

Figure 4b. Photo Point 3a (west end of spit) looking south along shoreline

Figure 4c. Photo Point 3b (west end of spit) looking north along shoreline

Figure 4d. Photo Point 4a (headland feature) looking south along shoreline

Figure 4e. Photo Point 4b (headland feature) looking north along shoreline

Figure 4f. Photo Point 2 (east end of spit) looking west along spit feature toward shoreline

Figure 4g. Photo Point 7 (east end of new jetty) looking west along new Jetty

More details on content and methodology of the CHE monitoring program are summarized in CHE's technical memorandum entitled *"Former Custom Plywood Cleanup Project Physical Monitoring Procedures"* (CHE 2014). Based upon compilation, processing, and review of the data from the physical monitoring and observations (Cycle 1),the conditions along the three design elements of the Former Custom Plywood Cleanup project (i.e.beach, spit, and new jetty extension) are evaluated and summarized in the following subsections.

2. Beach Evaluation Summary

- Minor or no change in beach transect profiles were observed below approximate elevation +6 ft MLLW[1].
- Localized changes in beach profile elevations were observed at some transects (Ex. Transects 2, 4, and 5) at elevations above approximately +6 ft MLLW. The observed changes at these transects predominately indicate a localized lowering of the beach profile. In general, changes in the upper slope of the monitoring transects are relatively small and for the most part do not exceed 1.5 ft in elevation change (excluding a few localized areas). The observed localized changes of beach elevations are likely a result of the constructed beach profiles adjusting to the dynamic equilibrium beach profile.
- It appears that all or most of the beach transects have reached a stage of dynamic equilibrium due to wave impact, and no further measurable adjustment of beach profiles is expected.
- In general, the type of sediment along the beach area has not changed since construction was completed. At some locations along the beach observation transects, beach sediment characteristics (i.e. grain size distribution) were slightly modified upon adjustment to local wave impact and tide conditions. The median sediment size (D50) slightly decreased (became finer) in the upper portion of the slope (landward end of the transects) for beach Transects 2, 3, 4, 5, and 7. The maximum reduction in median sediment size was observed at Transect 5, sample location 1.
- In the lower portion of the slope (seaward end of the transects) for beach Transects 3, 4, 5, 6, and 7 the median sediment size generally increased (became coarser) due to natural sorting. The maximum increase in median sediment size was observed at Transect 7, sample location 3. Sediment grainsize sorting and adjustment to local wave impact and tide conditions is a natural phenomenon that was originally accounted for by the project design criteria.
- In summary, the constructed beach along the project site has performed to its physical function with regard to the project design criteria and design specifications.

---

[1] Please note that Mean Tide Level (MTL) at the project is equal to +5.0 ft MLLW. Therefore, no change in beach elevation occurred at MTL and below for beach Transects 1 through 8 based upon the topographic survey data collected.

3. Spit Evaluation Summary

- No detrimental and/or unexpected changes to the spit configuration were observed during the monitoring cycle. The portion of the spit feature built from gravel and cobble materials (as stipulated by the design) has been in stable condition with no detectable changes to the cross-sectional configuration. Some changes in the spit (near the crest of the structure) occurred in the areas where sand material (for vegetation growth) was placed[2]. Most of this sand material has eroded from the upper part of the spit, most of which has accumulated on the lee (interior) side of the spit.
- The spit material and all slopes (inner and outer) are in stable condition and are in relative equilibrium with hydrodynamic conditions (i.e. waves and currents).
- The median sediment size at some locations along the spit has slightly increased (became coarser) upon natural sorting of sediment due to wave and tide impacts.
- It appears that the spit was constructed and has performed with regard to the design criteria developed during the design process.

4. Jetty Evaluation Summary

- No detectable changes to the jetty extension are observed based upon the results of the physical monitoring surveys. For example, no significant changes to the new jetty extension crest elevations were measured[3].
- As expected, some localized and minor adjustment of the armor stone toe of the jetty has occurred during the first year of post-construction monitoring. However, these minor adjustments do not jeopardize the structural integrity of the new jetty extension.
- It appears that the cross-sectional dimensions of the fish passage are similar to the dimensions achieved upon completion of construction. The surface material of fish passage has been subjected to some change. Voids in the armor stone layer of the fish passage have been partially filled with fine sediments such as silt, sand, and gravel. Filling of the voids in the fish passage armor stone layer may continue until rock interstices achieve a certain stage of equilibrium with tidal flow dynamics. Filling of voids in the rock will not change the dimensions of the fish passage cross-sectional area.
- It appears that the new jetty structure and the fish passage feature were constructed and have performed with regard to the design criteria developed during the design process.
- Fish mix placed on the lee (interior) of the jetty has remained reasonably stable.

---

[2] Please note that this material was not designed to withstand any wave impact.

[3] Please note that CHE topographic survey was not intended to determine settlement of the new jetty extension. A professional topographic survey would be required to address jetty settlement.

5. References

CHE 2014. Former Custom Plywood Mill Cleanup Project Physical Monitoring Procedures-December 2014 Technical Memorandum. Technical Memorandum prepared for Hart Crowser by Coast & Harbor Engineering, a division of Hatch Mott MacDonald, Edmonds, Washington, December 14, 2014.

APPENDIX A

Topographic Survey Data

```
#0256 Former Custom Plywood Cleanup
#Monitoring survey by Joel Darnell,P.E. & John Dawson, EIT
#Datum: NAVD88 ft, System: WA State Plane North, NAD83 ft.
#Unit connected to GLONAS satellite network and WSRN: PRSNVRSRTCM3
#Data below are raw and unprocessed
1211926.46,549434.63,6.50,ref,HRMS:0.056,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:10:38:11
1211952.96,549442.14,3.21,pnt,HRMS:0.056,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:10:38:43
1211945.75,549438.61,4.00,pnt,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:10:38:54
1211936.08,549435.99,5.24,pnt,HRMS:0.058,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:39:09
1211935.19,549438.32,5.29,pnt,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:39:32
1211916.67,549432.86,13.49,pnt,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.500
,HDOP:0.800,VDOP:1.300,DATE:09-24-2014,TIME:10:40:13
1211912.07,549432.13,13.30,pnt,HRMS:0.063,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.500
,HDOP:0.800,VDOP:1.300,DATE:09-24-2014,TIME:10:40:26
1211901.39,549429.79,12.92,pnt,HRMS:0.049,VRMS:0.082,STATUS:FIXED,SATS:11,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:10:40:40
1211891.93,549547.75,12.41,pnt,HRMS:0.058,VRMS:0.082,STATUS:FLOAT,SATS:13,PDOP:1.500
,HDOP:0.800,VDOP:1.300,DATE:09-24-2014,TIME:10:42:19
1211895.65,549547.44,11.86,pnt,HRMS:0.049,VRMS:0.062,STATUS:FIXED,SATS:16,PDOP:1.300
,HDOP:0.600,VDOP:1.200,DATE:09-24-2014,TIME:10:52:42
1211905.55,549547.59,8.83,pnt,HRMS:0.056,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:53:07
1211917.46,549546.55,6.90,pnt,HRMS:0.049,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:53:24
1211930.55,549546.36,5.37,pnt,HRMS:0.042,VRMS:0.056,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:53:43
1211944.05,549546.11,3.85,pnt,HRMS:0.053,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:54:01
1211959.38,549545.06,2.27,pnt,HRMS:0.079,VRMS:0.115,STATUS:FLOAT,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:10:54:18
1211890.58,549647.09,9.42,pnt,HRMS:0.065,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:02:22
1211902.21,549645.51,9.68,pnt,HRMS:0.049,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:02:51
1211916.50,549643.36,8.07,pnt,HRMS:0.065,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:03:12
1211931.81,549640.40,7.04,pnt,HRMS:0.056,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:03:27
1211945.57,549638.40,5.60,pnt,HRMS:0.054,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:03:45
1211958.71,549636.56,4.11,pnt,HRMS:0.060,VRMS:0.072,STATUS:FIXED,SATS:16,PDOP:1.200,
HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:11:04:03
1211970.66,549634.65,2.79,pnt,HRMS:0.068,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:04:24
1211975.26,549633.95,2.39,pnt,HRMS:0.072,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:04:47
1211899.85,549766.42,9.90,pnt,HRMS:0.051,VRMS:0.059,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:06:24
1211913.98,549761.43,9.70,pnt,HRMS:0.058,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:06:47
1211923.03,549757.80,7.70,pnt,HRMS:0.051,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:07:08
1211933.56,549753.82,7.03,pnt,HRMS:0.058,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:07:33
1211946.03,549749.61,6.23,pnt,HRMS:0.051,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:08:00
1211956.95,549740.54,5.59,pnt,HRMS:0.065,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:08:21
```

```
1211960.81,549744.28,5.55,pnt,HRMS:0.060,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:08:39
1211965.11,549743.08,5.46,pnt,HRMS:0.060,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:08:52
1211976.39,549739.19,4.98,pnt,HRMS:0.056,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:09:08
1211989.28,549734.31,3.80,pnt,HRMS:0.060,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:09:27
1212000.95,549730.52,2.92,pnt,HRMS:0.051,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:09:45
1212010.66,549727.02,2.19,pnt,HRMS:0.091,VRMS:0.112,STATUS:FLOAT,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:10:05
1212014.23,549725.62,1.97,pnt,HRMS:0.075,VRMS:0.085,STATUS:FLOAT,SATS:13,PDOP:1.200,
HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:10:39
1211877.21,549886.11,11.58,pnt,HRMS:0.049,VRMS:0.056,STATUS:FIXED,SATS:14,PDOP:1.400
,HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:11:13:48
1211885.68,549888.57,10.01,pnt,HRMS:0.056,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.400
,HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:11:14:16
1211889.68,549891.82,8.67,pnt,HRMS:0.065,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:14:29
1211899.21,549895.52,8.31,pnt,HRMS:0.060,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:14:59
1211910.27,549900.74,7.79,pnt,HRMS:0.058,VRMS:0.066,STATUS:FIXED,SATS:15,PDOP:1.400,
HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:11:15:25
1211914.47,549902.68,7.72,pnt,HRMS:0.054,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:15:40
1211916.27,549903.31,8.00,pnt,HRMS:0.058,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:15:54
1211924.82,549907.39,7.37,pnt,HRMS:0.058,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:16:14
1211936.59,549912.73,5.83,pnt,HRMS:0.056,VRMS:0.066,STATUS:FIXED,SATS:13,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:16:30
1211949.71,549918.74,4.26,pnt,HRMS:0.073,VRMS:0.079,STATUS:FIXED,SATS:15,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:11:16:47
1211961.58,549924.50,3.06,pnt,HRMS:0.075,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:17:00
1211973.23,549929.49,1.88,pnt,HRMS:0.066,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:17:22
1211869.36,550037.84,10.56,pnt,HRMS:0.056,VRMS:0.066,STATUS:FIXED,SATS:12,PDOP:1.400
,HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:21:26
1211872.78,550037.61,11.33,pnt,HRMS:0.058,VRMS:0.062,STATUS:FIXED,SATS:12,PDOP:1.400
,HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:21:55
1211877.75,550038.24,11.03,pnt,HRMS:0.061,VRMS:0.066,STATUS:FIXED,SATS:12,PDOP:1.400
,HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:22:11
1211885.21,550039.78,7.98,pnt,HRMS:0.073,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:22:32
1211889.92,550040.99,8.74,pnt,HRMS:0.063,VRMS:0.066,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:22:57
1211898.49,550042.69,8.55,pnt,HRMS:0.061,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.300,
HDOP:0.900,VDOP:0.900,DATE:09-24-2014,TIME:11:23:12
1211910.79,550043.38,6.97,pnt,HRMS:0.056,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.300,
HDOP:0.900,VDOP:0.900,DATE:09-24-2014,TIME:11:23:26
1211923.63,550044.59,5.44,pnt,HRMS:0.061,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:23:39
1211937.20,550047.61,3.92,pnt,HRMS:0.058,VRMS:0.062,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:23:57
1211949.14,550048.83,2.72,pnt,HRMS:0.075,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:24:14
1211958.14,550050.77,1.83,pnt,HRMS:0.070,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:24:32
1211850.67,550183.08,10.80,pnt,HRMS:0.061,VRMS:0.066,STATUS:FIXED,SATS:13,PDOP:1.200
,HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:25:49
1211854.68,550183.30,11.72,pnt,HRMS:0.056,VRMS:0.059,STATUS:FIXED,SATS:14,PDOP:1.100
```

```
,HDOP:0.700,VDOP:0.800,DATE:09-24-2014,TIME:11:25:59
1211859.84,550183.25,11.50,pnt,HRMS:0.066,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.300
,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:26:09
1211862.79,550183.60,10.46,pnt,HRMS:0.077,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:26:30
1211870.28,550183.54,9.74,pnt,HRMS:0.066,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:26:51
1211873.84,550183.34,9.98,pnt,HRMS:0.058,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.100,
HDOP:0.800,VDOP:0.800,DATE:09-24-2014,TIME:11:27:07
1211877.99,550183.47,9.39,pnt,HRMS:0.066,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:27:22
1211879.93,550183.51,8.73,pnt,HRMS:0.066,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:27:36
1211890.98,550183.53,7.13,pnt,HRMS:0.058,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:27:53
1211902.26,550183.39,5.93,pnt,HRMS:0.101,VRMS:0.125,STATUS:FLOAT,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:28:08
1211914.71,550183.62,4.70,pnt,HRMS:0.058,VRMS:0.059,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:28:32
1211928.90,550183.53,3.31,pnt,HRMS:0.066,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:28:53
1211942.47,550183.51,2.12,pnt,HRMS:0.077,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:29:20
1211928.47,550183.22,3.37,t3-1,HRMS:0.112,VRMS:0.141,STATUS:FLOAT,SATS:15,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:29:58
1211896.74,550182.92,6.54,t3-2,HRMS:0.484,VRMS:0.587,STATUS:FLOAT,SATS:13,PDOP:1.300
,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:31:21
1211887.62,550183.44,7.46,t3-3,HRMS:0.420,VRMS:0.466,STATUS:FLOAT,SATS:12,PDOP:1.400
,HDOP:1.000,VDOP:1.000,DATE:09-24-2014,TIME:11:32:37
1211876.84,550183.24,11.50,t3-4,HRMS:0.590,VRMS:0.643,STATUS:FLOAT,SATS:12,PDOP:1.40
0,HDOP:1.000,VDOP:1.000,DATE:09-24-2014,TIME:11:35:37
1211838.59,550283.51,15.25,pnt,HRMS:0.359,VRMS:0.299,STATUS:FLOAT,SATS:11,PDOP:1.800
,HDOP:1.100,VDOP:1.400,DATE:09-24-2014,TIME:11:37:50
1211841.86,550283.22,15.73,pnt,HRMS:0.494,VRMS:0.531,STATUS:FLOAT,SATS:14,PDOP:1.300
,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:38:05
1211846.82,550283.57,15.63,pnt,HRMS:0.426,VRMS:0.469,STATUS:FLOAT,SATS:11,PDOP:1.800
,HDOP:1.100,VDOP:1.400,DATE:09-24-2014,TIME:11:38:19
1211852.31,550283.32,14.08,pnt,HRMS:0.545,VRMS:0.751,STATUS:FLOAT,SATS:11,PDOP:1.800
,HDOP:1.100,VDOP:1.400,DATE:09-24-2014,TIME:11:38:40
1211855.90,550283.52,11.68,t2-4,HRMS:0.467,VRMS:0.607,STATUS:FLOAT,SATS:15,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:11:39:14
1211866.70,550283.44,9.68,pnt,HRMS:0.539,VRMS:0.630,STATUS:FLOAT,SATS:11,PDOP:1.600,
HDOP:1.000,VDOP:1.200,DATE:09-24-2014,TIME:11:39:43
1211866.29,550283.76,10.05,t2-3,HRMS:0.379,VRMS:0.351,STATUS:FLOAT,SATS:11,PDOP:1.60
0,HDOP:1.000,VDOP:1.200,DATE:09-24-2014,TIME:11:40:28
1211875.38,550283.47,5.90,pnt,HRMS:0.066,VRMS:0.069,STATUS:FIXED,SATS:11,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:40:52
1211885.29,550283.42,4.49,pnt,HRMS:0.061,VRMS:0.066,STATUS:FIXED,SATS:13,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:09-24-2014,TIME:11:41:10
1211894.66,550283.48,3.10,pnt,HRMS:0.064,VRMS:0.066,STATUS:FIXED,SATS:11,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:41:36
1211894.65,550283.45,3.07,t2-1,HRMS:0.066,VRMS:0.062,STATUS:FIXED,SATS:11,PDOP:1.400
,HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:41:47
1211901.39,550283.49,1.91,pnt,HRMS:0.068,VRMS:0.066,STATUS:FIXED,SATS:11,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:42:08
1211877.18,550283.32,5.64,t2-2,HRMS:0.056,VRMS:0.056,STATUS:FIXED,SATS:11,PDOP:1.400
,HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:42:36
1211869.67,550283.41,6.86,pnt,HRMS:0.121,VRMS:0.135,STATUS:FLOAT,SATS:11,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:43:02
1211860.29,550283.33,8.34,pnt,HRMS:0.121,VRMS:0.135,STATUS:FLOAT,SATS:11,PDOP:1.400,
HDOP:0.900,VDOP:1.100,DATE:09-24-2014,TIME:11:43:25
1211941.84,550383.35,1.47,pnt,HRMS:0.064,VRMS:0.056,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:45:21
```

```
1211935.33,550383.40,2.57,pnt,HRMS:0.061,VRMS:0.056,STATUS:FIXED,SATS:15,PDOP:1.100,
HDOP:0.700,VDOP:0.800,DATE:09-24-2014,TIME:11:45:37
1211926.33,550383.44,3.87,pnt,HRMS:0.056,VRMS:0.056,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:45:55
1211916.58,550383.54,4.98,pnt,HRMS:0.066,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:46:10
1211907.39,550383.57,6.35,pnt,HRMS:0.061,VRMS:0.059,STATUS:FIXED,SATS:15,PDOP:1.100,
HDOP:0.700,VDOP:0.800,DATE:09-24-2014,TIME:11:46:27
1211897.28,550383.46,7.80,pnt,HRMS:0.056,VRMS:0.052,STATUS:FIXED,SATS:13,PDOP:1.200,
HDOP:0.800,VDOP:0.900,DATE:09-24-2014,TIME:11:46:44
1211893.18,550383.76,8.57,pnt,HRMS:0.061,VRMS:0.056,STATUS:FIXED,SATS:15,PDOP:1.100,
HDOP:0.700,VDOP:0.800,DATE:09-24-2014,TIME:11:47:04
1211891.78,550385.90,10.09,photo,HRMS:0.056,VRMS:0.056,STATUS:FIXED,SATS:12,PDOP:1.3
00,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:47:25
1211890.62,550383.40,10.20,pnt,HRMS:0.058,VRMS:0.059,STATUS:FIXED,SATS:12,PDOP:1.300
,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:47:42
1211880.98,550383.45,10.60,pnt,HRMS:0.450,VRMS:0.456,STATUS:FLOAT,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:11:48:00
1211864.08,550383.57,10.45,pnt,HRMS:0.056,VRMS:0.056,STATUS:FIXED,SATS:12,PDOP:1.300
,HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:48:30
1211881.57,550383.53,9.84,pnt,HRMS:0.117,VRMS:0.128,STATUS:FLOAT,SATS:12,PDOP:1.300,
HDOP:0.800,VDOP:1.000,DATE:09-24-2014,TIME:11:48:51
1211841.67,550383.61,10.60,pnt,HRMS:0.100,VRMS:0.121,STATUS:FLOAT,SATS:14,PDOP:1.100
,HDOP:0.700,VDOP:0.800,DATE:09-24-2014,TIME:11:49:22
1212259.32,550698.66,7.32,photo,HRMS:0.723,VRMS:0.886,STATUS:FLOAT,SATS:12,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:09-24-2014,TIME:11:56:13
1212302.30,550669.52,19.22,pnttop,HRMS:0.237,VRMS:0.220,STATUS:FLOAT,SATS:14,PDOP:1.
300,HDOP:0.600,VDOP:1.200,DATE:09-24-2014,TIME:12:09:43
1212301.58,550666.46,19.53,pnttop,HRMS:0.217,VRMS:0.207,STATUS:FLOAT,SATS:14,PDOP:1.
300,HDOP:0.600,VDOP:1.200,DATE:09-24-2014,TIME:12:09:58
1212463.94,550582.05,14.71,pnttop,HRMS:0.073,VRMS:0.079,STATUS:FIXED,SATS:16,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:15:21
1212412.21,550610.19,14.80,pnttop,HRMS:0.068,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:15:41
1212384.57,550625.75,14.92,pnttop,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:15:55
1212360.49,550639.07,15.33,pnttop,HRMS:0.068,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:16:06
1212354.40,550641.33,15.49,cntl,HRMS:0.061,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:16:21
1212311.77,550665.91,15.92,nail,HRMS:0.068,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:16:49
1212412.21,550610.19,14.76,cntl,HRMS:0.061,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:17:20
1212358.09,550645.71,15.33,topedge,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1
.200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:17:59
1212352.50,550638.02,15.04,topedge,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1
.200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:18:10
1212410.60,550607.07,14.82,topedge,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:16,PDOP:1
.200,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:18:29
1212414.65,550616.27,14.49,topedge,HRMS:0.061,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1
.200,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:18:37
1212465.04,550588.06,14.61,topedge,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1
.200,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:18:55
1212461.30,550579.75,14.40,topedge,HRMS:0.068,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1
.200,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:19:03
1212427.58,550603.85,14.57,top,HRMS:0.061,VRMS:0.079,STATUS:FIXED,SATS:16,PDOP:1.200
,HDOP:0.600,VDOP:1.000,DATE:09-24-2014,TIME:12:19:19
1212381.77,550627.82,15.02,top,HRMS:0.064,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:19:33
1212332.32,550654.26,15.49,top,HRMS:0.066,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:19:58
1212334.31,550657.79,15.39,top,HRMS:0.061,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.200
```

```
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:03
1212329.43,550648.76,15.14,top,HRMS:0.061,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:10
1212318.12,550661.90,15.44,top,HRMS:0.068,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:18
1212314.48,550658.17,15.57,top,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:24
1212319.87,550665.08,15.40,top,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:30
1212304.07,550671.64,15.62,top,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.200
,HDOP:0.700,VDOP:1.000,DATE:09-24-2014,TIME:12:20:38
1211895.52,550285.98,2.38,photo,HRMS:0.261,VRMS:0.364,STATUS:FLOAT,SATS:14,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:09-24-2014,TIME:12:31:08
1211946.20,550048.60,2.43,t4-1,HRMS:0.104,VRMS:0.125,STATUS:FLOAT,SATS:13,PDOP:1.400
,HDOP:0.700,VDOP:1.200,DATE:09-24-2014,TIME:12:34:23
1211930.21,550047.23,4.14,t4-2,HRMS:0.052,VRMS:0.059,STATUS:FIXED,SATS:13,PDOP:1.400
,HDOP:0.700,VDOP:1.200,DATE:09-24-2014,TIME:12:35:02
1211913.34,550044.93,6.03,t4-3,HRMS:0.062,VRMS:0.066,STATUS:FIXED,SATS:13,PDOP:1.400
,HDOP:0.700,VDOP:1.200,DATE:09-24-2014,TIME:12:35:24
1211897.53,550042.94,7.97,t4-4,HRMS:0.055,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.400
,HDOP:0.700,VDOP:1.200,DATE:09-24-2014,TIME:12:35:46
1211961.91,549924.76,4.50,t5-1,HRMS:0.064,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:40:12
1211941.16,549915.45,6.93,t5-2,HRMS:0.055,VRMS:0.069,STATUS:FIXED,SATS:15,PDOP:1.500
,HDOP:0.700,VDOP:1.300,DATE:09-24-2014,TIME:12:40:41
1211921.98,549906.24,9.48,t5-3,HRMS:0.101,VRMS:0.161,STATUS:FLOAT,SATS:13,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:41:10
1211906.87,549899.74,9.74,t5-4,HRMS:0.080,VRMS:0.118,STATUS:FLOAT,SATS:13,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:41:40
1212114.41,549717.92,8.80,pnt,HRMS:0.090,VRMS:0.141,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:46:31
1212118.18,549721.81,8.41,pnt,HRMS:0.073,VRMS:0.105,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:46:47
1212123.66,549728.65,6.83,pnt,HRMS:0.064,VRMS:0.082,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:47:13
1212131.87,549737.48,5.32,pnt,HRMS:0.064,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:47:31
1212141.18,549748.96,2.90,pnt,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:47:54
1212145.31,549753.27,1.79,pnt,HRMS:0.066,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:48:08
1212111.35,549714.52,10.12,pnt,HRMS:0.064,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:48:46
1212108.98,549711.91,10.16,pnt,HRMS:0.055,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.600
,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:49:01
1212106.70,549708.65,7.77,pnt,HRMS:0.050,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:49:19
1212101.20,549703.24,5.99,pnt,HRMS:0.059,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:49:32
1212101.44,549703.07,6.08,pnt,HRMS:0.062,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:49:40
1212096.26,549697.27,4.46,pnt,HRMS:0.052,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:49:58
1212089.81,549689.64,1.75,pnt,HRMS:0.076,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:50:20
1212153.43,549644.38,8.87,photo,HRMS:0.055,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.60
0,HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:51:12
1212151.71,549644.07,8.50,pnt,HRMS:0.056,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:51:31
1212156.29,549632.71,6.12,pnt,HRMS:0.475,VRMS:0.666,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:51:55
1212159.61,549624.07,3.86,pnt,HRMS:0.488,VRMS:0.659,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:52:15
```

```
1212163.99,549615.34,2.55,pnt,HRMS:0.636,VRMS:0.817,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:52:31
1212167.22,549606.76,1.75,pnt,HRMS:0.547,VRMS:0.659,STATUS:FLOAT,SATS:14,PDOP:1.600,
HDOP:0.800,VDOP:1.400,DATE:09-24-2014,TIME:12:52:47
1212148.06,549653.57,9.37,pnt,HRMS:0.441,VRMS:0.469,STATUS:FLOAT,SATS:14,PDOP:1.700,
HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:53:30
1212142.94,549666.26,9.71,pnt,HRMS:0.320,VRMS:0.328,STATUS:FLOAT,SATS:14,PDOP:1.700,
HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:53:46
1212136.92,549678.79,9.68,pnt,HRMS:0.510,VRMS:0.505,STATUS:FLOAT,SATS:14,PDOP:1.700,
HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:54:00
1212131.16,549693.21,9.57,pnt,HRMS:0.555,VRMS:0.528,STATUS:FLOAT,SATS:14,PDOP:1.700,
HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:54:15
1212129.44,549697.96,10.55,pnt,HRMS:0.071,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.700
,HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:54:40
1212097.19,549708.71,6.45,s1-1,HRMS:0.062,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.700
,HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:55:22
1211938.24,549849.87,9.35,photo,HRMS:0.059,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.70
0,HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:12:56:51
1211998.05,549731.93,3.14,t6-1,HRMS:0.064,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:12:58:17
1211978.07,549738.95,4.93,t6-2,HRMS:0.109,VRMS:0.190,STATUS:FLOAT,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:12:58:44
1211950.76,549748.24,5.86,t6-3,HRMS:0.109,VRMS:0.180,STATUS:FLOAT,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:12:59:09
1211924.49,549757.45,7.68,t6-4,HRMS:0.087,VRMS:0.148,STATUS:FLOAT,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:12:59:42
1211964.43,549635.82,3.48,t7-1,HRMS:0.059,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:02:04
1211948.53,549638.31,5.33,t7-2,HRMS:0.055,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:02:32
1211933.16,549640.54,6.96,t7-3,HRMS:0.055,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:02:59
1211915.27,549643.04,8.33,t7-4,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.800
,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:03:23
1211881.00,549710.31,6.37,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:04:41
1211883.37,549714.21,6.19,channel,HRMS:0.059,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:04:53
1211884.54,549718.69,6.62,channel,HRMS:0.059,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:05:03
1211896.48,549716.40,6.30,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:15,PDOP:1.
600,HDOP:0.700,VDOP:1.400,DATE:09-24-2014,TIME:13:05:15
1211895.80,549714.33,5.91,channel,HRMS:0.047,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:05:24
1211895.17,549712.72,6.28,channel,HRMS:0.052,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:05:33
1211910.58,549713.30,6.14,channel,HRMS:0.059,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:05:46
1211910.10,549711.08,5.47,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:05:53
1211908.98,549708.59,5.98,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:02
1211929.08,549710.56,5.80,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:17
1211927.86,549706.59,5.25,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:26
1211927.68,549701.86,5.96,channel,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:35
1211936.68,549710.39,5.92,channel,HRMS:0.047,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:49
1211937.10,549708.94,5.81,channel,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:06:58
1211937.56,549707.19,5.90,channel,HRMS:0.055,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.
```

```
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:07:06
1211943.95,549716.18,5.97,channel,HRMS:0.049,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:07:16
1211954.93,549730.91,5.69,channel,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:07:28
1211964.37,549744.46,5.11,channel,HRMS:0.059,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:07:38
1211989.53,549761.68,4.29,channel,HRMS:0.052,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:07:51
1212001.02,549759.80,4.01,channel,HRMS:0.096,VRMS:0.164,STATUS:FLOAT,SATS:13,PDOP:1.
800,HDOP:0.800,VDOP:1.600,DATE:09-24-2014,TIME:13:08:00
1212007.47,549741.13,3.03,channel,HRMS:0.059,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.
700,HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:13:08:14
1211899.07,549527.94,12.72,photo,HRMS:0.052,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.7
00,HDOP:0.800,VDOP:1.500,DATE:09-24-2014,TIME:13:09:38
```

```
#0256 Former Custom Plywood Cleanup
#Monitoring survey by John Dawson,P.E. & Gregory Clunies
#Datum: NAVD88 ft, System: WA State Plane North, NAD83 ft.
#Unit connected to GLONAS satellite network and WSRN: PRSNVRSRTCM3
#Data below are raw and unprocessed
1211899.80,549528.91,12.89,photo-2,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:11,PDOP:2
.000,HDOP:0.900,VDOP:1.800,DATE:08-28-2015,TIME:08:06:23
1212034.76,549543.49,-0.83,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:12:48
1212026.32,549543.36,-0.69,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:13:14
1212019.02,549543.35,-0.46,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:13:37
1212012.55,549543.49,-0.40,pnt-2,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.5
00,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:08:14:05
1212003.84,549544.08,-0.21,pnt-2,HRMS:0.061,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:14:21
1211994.70,549544.14,-0.01,pnt-2,HRMS:0.054,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.5
00,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:08:14:48
1211987.48,549544.55,0.42,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:15:04
1211978.52,549544.85,0.98,pnt-2,HRMS:0.058,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:15:25
1211970.15,549545.33,1.72,pnt-2,HRMS:0.058,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:15:50
1211962.68,549545.68,2.49,pnt-2,HRMS:0.047,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:16:16
1211959.11,549545.82,2.95,pnt-2,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:16:55
1211952.07,549546.05,3.60,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:17:20
1211944.26,549546.18,4.32,pnt-2,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:17:44
1211937.46,549546.21,4.90,pnt-2,HRMS:0.051,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:18:03
1211929.94,549546.21,5.72,pnt-2,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:18:32
1211923.59,549546.55,6.44,pnt-2,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:18:58
1211916.43,549546.71,7.62,pnt-2,HRMS:0.049,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:19:20
1211910.28,549547.15,8.22,pnt-2,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:19:50
1211905.60,549547.33,9.20,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:08:20:20
1211902.19,549547.38,10.13,pnt-2,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:20:53
1211900.59,549547.16,11.72,pnt-2,HRMS:0.060,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:21:18
1211895.10,549547.74,12.16,pnt-2,HRMS:0.060,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:21:44
1211891.18,549548.01,11.78,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:22:05
1211887.00,549548.13,12.09,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.5
00,HDOP:0.800,VDOP:1.300,DATE:08-28-2015,TIME:08:22:22
1211938.87,549849.99,9.20,photo-2,HRMS:0.189,VRMS:0.213,STATUS:FIXED,SATS:14,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:08:24:48
1212304.11,550671.56,15.17,pnt-2,HRMS:0.049,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:08:39:13
1212301.70,550666.43,13.75,pnt-2,HRMS:0.065,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:40:44
1212302.37,550669.69,15.08,pnt-2,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:41:09
```

```
1212311.66,550666.22,15.53,pnt-2,HRMS:0.065,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:41:48
1212320.17,550664.78,14.73,pnt-2,HRMS:0.065,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:42:16
1212318.07,550662.03,15.03,pnt-2,HRMS:0.060,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:42:38
1212314.50,550658.65,14.74,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:43:06
1212332.66,550654.65,15.13,pnt-2,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:43:44
1212334.33,550657.82,14.96,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:44:04
1212329.27,550648.52,14.82,pnt-2,HRMS:0.053,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:44:47
1212354.51,550641.49,15.10,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:08:45:47
1212352.18,550638.30,14.64,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:13,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:08:46:17
1212357.71,550645.63,15.03,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:46:43
1212360.93,550639.01,15.01,pnt-2,HRMS:0.067,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:47:37
1212385.27,550625.16,14.47,pnt-2,HRMS:0.067,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:48:21
1212381.52,550628.76,14.73,pnt-2,HRMS:0.065,VRMS:0.089,STATUS:FIXED,SATS:16,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:48:40
1212414.12,550616.24,14.17,pnt-2,HRMS:0.088,VRMS:0.105,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:49:23
1212412.29,550610.38,14.45,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:49:52
1212410.99,550607.87,14.38,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:50:21
1212427.96,550604.47,14.11,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:51:14
1212464.36,550582.69,14.12,pnt-2,HRMS:0.053,VRMS:0.082,STATUS:FIXED,SATS:16,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:52:20
1212464.29,550587.91,14.05,pnt-2,HRMS:0.053,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:52:41
1212461.63,550579.98,13.75,pnt-2,HRMS:0.049,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:53:10
1212464.13,550582.29,14.28,pnt-2,HRMS:0.058,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:08:53:59
1211842.64,550536.27,-1.85,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:00:33
1211824.97,550533.52,0.29,pnt-2,HRMS:0.067,VRMS:0.089,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:09:01:15
1211815.72,550532.23,1.58,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.50
0,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:09:01:40
1211809.23,550531.79,2.85,pnt-2,HRMS:0.063,VRMS:0.079,STATUS:FIXED,SATS:11,PDOP:1.60
0,HDOP:0.700,VDOP:1.400,DATE:08-28-2015,TIME:09:02:04
1211889.17,550387.62,9.35,photo-2,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:12,PDOP:1.
500,HDOP:0.700,VDOP:1.300,DATE:08-28-2015,TIME:09:04:03
1211842.45,550384.27,11.00,pnt-2,HRMS:0.049,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:06:09
1211865.68,550384.32,10.82,pnt-2,HRMS:0.060,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:06:44
1211880.82,550383.68,9.81,pnt-2,HRMS:0.049,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:07:47
1211881.00,550382.94,9.87,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:15,PDOP:1.30
0,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:08:04
1211894.46,550383.45,7.65,pnt-2,HRMS:0.049,VRMS:0.069,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:09:04
1211903.80,550383.49,6.56,pnt-2,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.30
```

```
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:09:19
1211907.85,550383.80,6.07,pnt-2,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:15,PDOP:1.30
0,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:09:55
1211916.82,550383.82,5.08,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:10:13
1211926.67,550383.13,3.81,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:10:31
1211935.44,550382.93,2.57,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:10:53
1211942.31,550383.14,1.42,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:11:20
1211954.74,550383.27,-0.64,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:11:44
1211962.64,550383.08,-1.60,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:13,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:12:00
1211936.42,550283.46,-1.48,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.600,VDOP:1.300,DATE:08-28-2015,TIME:09:13:21
1211914.39,550283.55,-0.34,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:13:54
1211901.13,550283.29,2.19,pnt-2,HRMS:0.054,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:14:16
1211893.85,550283.54,3.26,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.600,VDOP:1.300,DATE:08-28-2015,TIME:09:14:44
1211885.12,550283.82,4.57,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:16:02
1211894.48,550283.27,3.36,t2-1.15,HRMS:0.044,VRMS:0.062,STATUS:FIXED,SATS:13,PDOP:1.
300,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:19:09
1211877.27,550283.65,5.64,t2-2.15,HRMS:0.056,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:21:27
1211868.96,550283.99,6.97,pnt-2,HRMS:0.051,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:24:19
1211866.44,550283.13,7.45,pnt-2,HRMS:0.167,VRMS:0.190,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:24:42
1211865.42,550282.31,7.54,t2-3.15,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:25:05
1211857.20,550283.62,8.81,pnt-2,HRMS:0.056,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:25:29
1211851.23,550283.56,9.47,pnt-2,HRMS:0.060,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:25:44
1211846.08,550283.26,9.99,pnt-2,HRMS:0.065,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:26:06
1211841.76,550283.08,10.41,pnt-2,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:16,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:26:26
1211835.93,550283.89,10.81,pnt-2,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:26:41
1211850.92,550183.10,10.64,pnt-2,HRMS:0.060,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:27:54
1211856.29,550183.72,11.62,pnt-2,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:28:14
1211859.20,550183.43,11.35,pnt-2,HRMS:0.060,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:28:40
1211863.67,550183.25,10.20,pnt-2,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:28:52
1211870.16,550183.68,9.09,pnt-2,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:29:18
1211874.29,550182.95,8.55,pnt-2,HRMS:0.140,VRMS:0.167,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:29:33
1211876.96,550183.30,8.41,t3-4.15,HRMS:0.058,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:30:13
1211881.55,550183.73,8.05,pnt-2,HRMS:0.072,VRMS:0.085,STATUS:FIXED,SATS:16,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:30:56
1211887.67,550183.15,7.23,t3-3.15,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:31:34
```

```
1211892.22,550183.76,6.67,pnt-2,HRMS:0.060,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:32:19
1211892.04,550183.41,6.65,pnt-2,HRMS:0.068,VRMS:0.092,STATUS:FIXED,SATS:16,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:32:59
1211896.98,550182.24,5.96,t4-2.15,HRMS:0.053,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:34:16
1211904.11,550183.50,5.10,pnt-2,HRMS:0.130,VRMS:0.154,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:34:36
1211914.57,550183.83,4.12,pnt-2,HRMS:0.066,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:34:47
1211929.34,550183.48,2.73,pnt-2,HRMS:0.068,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:35:10
1211929.36,550183.50,2.72,t3-1.15,HRMS:0.068,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.
200,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:35:29
1211942.91,550183.55,1.68,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.700,VDOP:1.000,DATE:08-28-2015,TIME:09:35:52
1211954.62,550183.57,0.88,pnt-2,HRMS:0.068,VRMS:0.098,STATUS:FIXED,SATS:14,PDOP:1.20
0,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:36:11
1211967.43,550183.53,0.29,pnt-2,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:36:26
1211981.04,550183.38,-0.27,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:16,PDOP:1.3
00,HDOP:0.600,VDOP:1.200,DATE:08-28-2015,TIME:09:36:42
1211996.88,550183.15,-1.14,pnt-2,HRMS:0.068,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:36:55
1212009.75,550183.45,-1.35,pnt-2,HRMS:0.066,VRMS:0.089,STATUS:FIXED,SATS:16,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:37:14
1212023.86,550183.21,-1.17,pnt-2,HRMS:0.066,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.2
00,HDOP:0.600,VDOP:1.000,DATE:08-28-2015,TIME:09:37:31
1212029.66,550183.32,-1.25,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:37:52
1211867.88,550038.39,10.29,pnt-2,HRMS:0.068,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:40:51
1211874.13,550039.29,10.17,pnt-2,HRMS:0.066,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:41:12
1211880.57,550039.92,9.21,pnt-2,HRMS:0.068,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:41:26
1211887.34,550041.35,8.33,pnt-2,HRMS:0.066,VRMS:0.092,STATUS:FIXED,SATS:16,PDOP:1.20
0,HDOP:0.700,VDOP:1.000,DATE:08-28-2015,TIME:09:41:41
1211896.46,550042.31,7.08,pnt-2,HRMS:0.064,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:41:54
1211897.27,550042.37,6.96,t4-4.15,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:42:35
1211905.39,550043.72,6.26,pnt-2,HRMS:0.061,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:42:56
1211910.89,550044.18,5.70,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:43:22
1211914.01,550044.58,5.44,t4-3,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.300
,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:43:49
1211922.39,550046.05,4.75,pnt-2,HRMS:0.064,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:44:15
1211929.84,550047.08,3.98,pnt-2,HRMS:0.119,VRMS:0.161,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:44:35
1211929.79,550047.09,4.15,t4-2.15,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:16,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:44:46
1211937.15,550047.92,3.41,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:45:25
1211945.71,550049.31,2.51,t4-1.15,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:13,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:45:52
1211950.31,550049.71,2.04,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:13,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:09:46:14
1211958.18,550050.89,1.32,pnt-2,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:46:37
1211967.43,550052.15,0.18,pnt-2,HRMS:0.055,VRMS:0.085,STATUS:FIXED,SATS:12,PDOP:1.40
```

```
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:46:54
1211975.24,550053.25,-0.46,pnt-2,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:12,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:47:10
1211985.44,550054.69,-1.20,pnt-2,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:47:23
1211989.18,550055.16,-1.45,pnt-2,HRMS:0.060,VRMS:0.082,STATUS:FIXED,SATS:12,PDOP:1.4
00,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:47:37
1211876.45,549885.66,11.18,pnt-2,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:12,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:49:55
1211884.83,549889.24,9.45,pnt-2,HRMS:0.061,VRMS:0.089,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:50:19
1211889.42,549891.31,8.84,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:50:39
1211898.75,549895.84,9.06,pnt-2,HRMS:0.047,VRMS:0.072,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:50:55
1211906.88,549899.58,8.43,pnt-2,HRMS:0.065,VRMS:0.085,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:51:14
1211906.90,549899.59,8.37,t5-4.15,HRMS:0.060,VRMS:0.075,STATUS:FIXED,SATS:12,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:51:33
1211909.61,549900.54,7.97,pnt-2,HRMS:0.049,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.700,VDOP:1.200,DATE:08-28-2015,TIME:09:52:05
1211915.50,549903.18,7.45,pnt-2,HRMS:0.049,VRMS:0.069,STATUS:FIXED,SATS:12,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:52:26
1211921.80,549906.18,6.52,t5-3.15,HRMS:0.056,VRMS:0.072,STATUS:FIXED,SATS:12,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:09:52:59
1211924.33,549907.52,6.38,pnt,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:08:03
1211931.51,549910.38,5.62,pnt,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:08:16
1211936.98,549913.23,5.01,pnt,HRMS:0.049,VRMS:0.079,STATUS:FIXED,SATS:16,PDOP:1.300,
HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:08:35
1211941.52,549915.18,4.52,t5-2.15,HRMS:0.049,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:09:00
1211949.43,549918.60,3.83,pnt-2,HRMS:0.079,VRMS:0.112,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:09:26
1211958.24,549923.01,2.78,pnt-2,HRMS:0.058,VRMS:0.089,STATUS:FIXED,SATS:16,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:09:50
1211961.85,549924.40,2.43,t5-1.15,HRMS:0.053,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.
300,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:10:14
1211970.36,549928.24,1.68,pnt-2,HRMS:0.042,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:10:40
1211973.37,549929.94,1.36,pnt-2,HRMS:0.044,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:10:54
1211983.59,549934.49,0.42,pnt-2,HRMS:0.049,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:11:09
1211991.72,549938.41,-0.33,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:11:23
1212001.94,549942.78,-0.19,pnt-2,HRMS:0.051,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:11:54
1212001.91,549942.91,-0.06,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:12:14
1212010.92,549947.14,-0.44,pnt-2,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:12:31
1212030.07,549956.02,-0.94,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:12:53
1212041.46,549961.04,-1.05,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:13:16
1212102.33,549704.23,8.37,pnt-2,HRMS:0.051,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:18:21
1212109.10,549711.87,8.01,pnt-2,HRMS:0.060,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:18:55
1212113.66,549716.98,7.44,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:19:10
```

```
1212118.19,549722.09,6.79,pnt-2,HRMS:0.079,VRMS:0.105,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.700,VDOP:1.100,DATE:08-28-2015,TIME:10:19:24
1212123.19,549728.05,5.95,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:19:39
1212129.71,549735.73,4.91,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:19:51
1212138.79,549745.95,3.26,pnt-2,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:20:07
1212145.99,549753.19,1.46,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:20:21
1212153.90,549762.95,-1.31,pnt-2,HRMS:0.049,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:20:39
1212096.31,549709.07,8.15,s1-1.15,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:22:16
1212102.49,549704.49,8.39,pnt-2,HRMS:0.060,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:22:43
1212096.67,549697.96,5.88,pnt-2,HRMS:0.046,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:23:06
1212090.12,549689.56,2.16,pnt-2,HRMS:0.046,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:23:31
1212085.04,549683.62,-0.40,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.4
00,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:23:58
1212171.60,549595.44,-1.20,pnt-2,HRMS:0.058,VRMS:0.092,STATUS:FIXED,SATS:14,PDOP:1.3
00,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:25:39
1212167.20,549607.23,1.73,pnt-2,HRMS:0.049,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:26:03
1212164.29,549614.68,3.26,pnt-2,HRMS:0.051,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:26:28
1212159.72,549625.06,5.61,pnt-2,HRMS:0.056,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:26:43
1212155.97,549633.53,6.90,pnt-2,HRMS:0.051,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:26:58
1212151.77,549644.38,7.45,pnt-2,HRMS:0.051,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:27:11
1212147.07,549655.28,7.74,pnt-2,HRMS:0.060,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:27:22
1212142.32,549666.57,7.94,pnt-2,HRMS:0.049,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:27:35
1212137.75,549678.10,7.68,pnt-2,HRMS:0.060,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:28:14
1212133.27,549688.02,7.61,pnt-2,HRMS:0.051,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:28:37
1212130.58,549693.87,7.63,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:28:53
1212130.21,549698.53,7.33,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:29:20
1212108.27,549710.70,8.19,pnt-2,HRMS:0.058,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:29:59
1211895.35,549768.01,7.76,pnt-2,HRMS:0.046,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:31:45
1211899.73,549766.43,9.23,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:32:03
1211913.54,549761.42,8.64,pnt-2,HRMS:0.051,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:32:39
1211924.88,549757.30,7.22,t6-4.15,HRMS:0.053,VRMS:0.072,STATUS:FIXED,SATS:15,PDOP:1.
200,HDOP:0.700,VDOP:1.000,DATE:08-28-2015,TIME:10:33:14
1211934.26,549754.07,6.55,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:15,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:33:35
1211943.38,549750.58,5.87,pnt-2,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.60
0,HDOP:0.900,VDOP:1.300,DATE:08-28-2015,TIME:10:33:51
1211946.88,549749.50,5.66,pnt-2,HRMS:0.046,VRMS:0.066,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:34:14
1211950.95,549748.45,5.44,t6-3.15,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.
```

```
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:34:49
1211958.82,549745.51,5.68,pnt-2,HRMS:0.046,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:35:19
1211967.73,549742.38,5.28,pnt-2,HRMS:0.046,VRMS:0.069,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:35:35
1211977.06,549738.60,4.60,pnt-2,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:35:59
1211977.63,549738.82,4.65,t6-2.15,HRMS:0.056,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:36:19
1211988.92,549734.85,3.54,pnt-2,HRMS:0.053,VRMS:0.075,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:36:36
1211999.88,549731.11,2.67,pnt-2,HRMS:0.042,VRMS:0.062,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:36:51
1211998.33,549731.43,2.80,t6-1.15,HRMS:0.051,VRMS:0.072,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:37:10
1212006.09,549728.58,2.50,pnt-2,HRMS:0.060,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:37:29
1211958.67,549710.87,4.65,channel-2015,HRMS:0.060,VRMS:0.089,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:38:34
1211951.07,549709.71,4.83,channel-2015,HRMS:0.060,VRMS:0.085,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:38:50
1211940.94,549707.17,5.15,channel-2015,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:39:00
1211930.91,549709.42,5.38,channel-2015,HRMS:0.065,VRMS:0.092,STATUS:FIXED,SATS:14,PD
OP:1.400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:39:10
1211919.44,549711.32,5.61,channel-2015,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:39:20
1211908.17,549713.01,5.37,channel-2015,HRMS:0.121,VRMS:0.167,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:39:33
1211899.44,549714.75,5.57,channel-2015,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PD
OP:1.400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:39:45
1211891.69,549715.83,5.70,channel-2015,HRMS:0.056,VRMS:0.082,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:39:54
1211883.21,549715.89,5.55,channel-2015,HRMS:0.056,VRMS:0.085,STATUS:FIXED,SATS:14,PD
OP:1.500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:40:11
1211877.77,549717.21,5.65,channel-2015,HRMS:0.060,VRMS:0.089,STATUS:FIXED,SATS:14,PD
OP:1.600,HDOP:0.900,VDOP:1.300,DATE:08-28-2015,TIME:10:40:25
1211890.97,549646.82,9.27,pnt-2,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:42:39
1211902.21,549645.26,9.20,pnt-2,HRMS:0.072,VRMS:0.098,STATUS:FIXED,SATS:14,PDOP:1.50
0,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:43:01
1211916.77,549643.22,7.34,t7-4.15,HRMS:0.070,VRMS:0.095,STATUS:FIXED,SATS:14,PDOP:1.
500,HDOP:0.900,VDOP:1.200,DATE:08-28-2015,TIME:10:43:43
1211933.49,549640.76,6.02,pnt-2,HRMS:0.063,VRMS:0.085,STATUS:FIXED,SATS:15,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:44:08
1211932.70,549640.81,5.98,t7-3.15,HRMS:0.058,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:45:50
1211945.40,549638.69,4.86,pnt-2,HRMS:0.058,VRMS:0.085,STATUS:FIXED,SATS:15,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:46:15
1211948.52,549638.45,4.43,t7-2.15,HRMS:0.058,VRMS:0.082,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:46:41
1211958.54,549636.88,3.51,pnt-2,HRMS:0.056,VRMS:0.085,STATUS:FIXED,SATS:14,PDOP:1.30
0,HDOP:0.800,VDOP:1.000,DATE:08-28-2015,TIME:10:47:18
1211964.38,549635.64,2.88,t7-1.15,HRMS:0.053,VRMS:0.079,STATUS:FIXED,SATS:14,PDOP:1.
400,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:47:55
1211971.53,549634.71,2.14,pnt-2,HRMS:0.065,VRMS:0.095,STATUS:FIXED,SATS:14,PDOP:1.40
0,HDOP:0.800,VDOP:1.100,DATE:08-28-2015,TIME:10:48:13
1211979.41,549633.53,1.13,pnt-2,HRMS:0.063,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.60
0,HDOP:1.000,VDOP:1.200,DATE:08-28-2015,TIME:10:48:25
1211986.11,549632.36,0.28,pnt-2,HRMS:0.058,VRMS:0.089,STATUS:FIXED,SATS:14,PDOP:1.60
0,HDOP:1.000,VDOP:1.200,DATE:08-28-2015,TIME:10:48:39
```

APPENDIX B

Transect Profile Data

Figure 1. Location of Transects

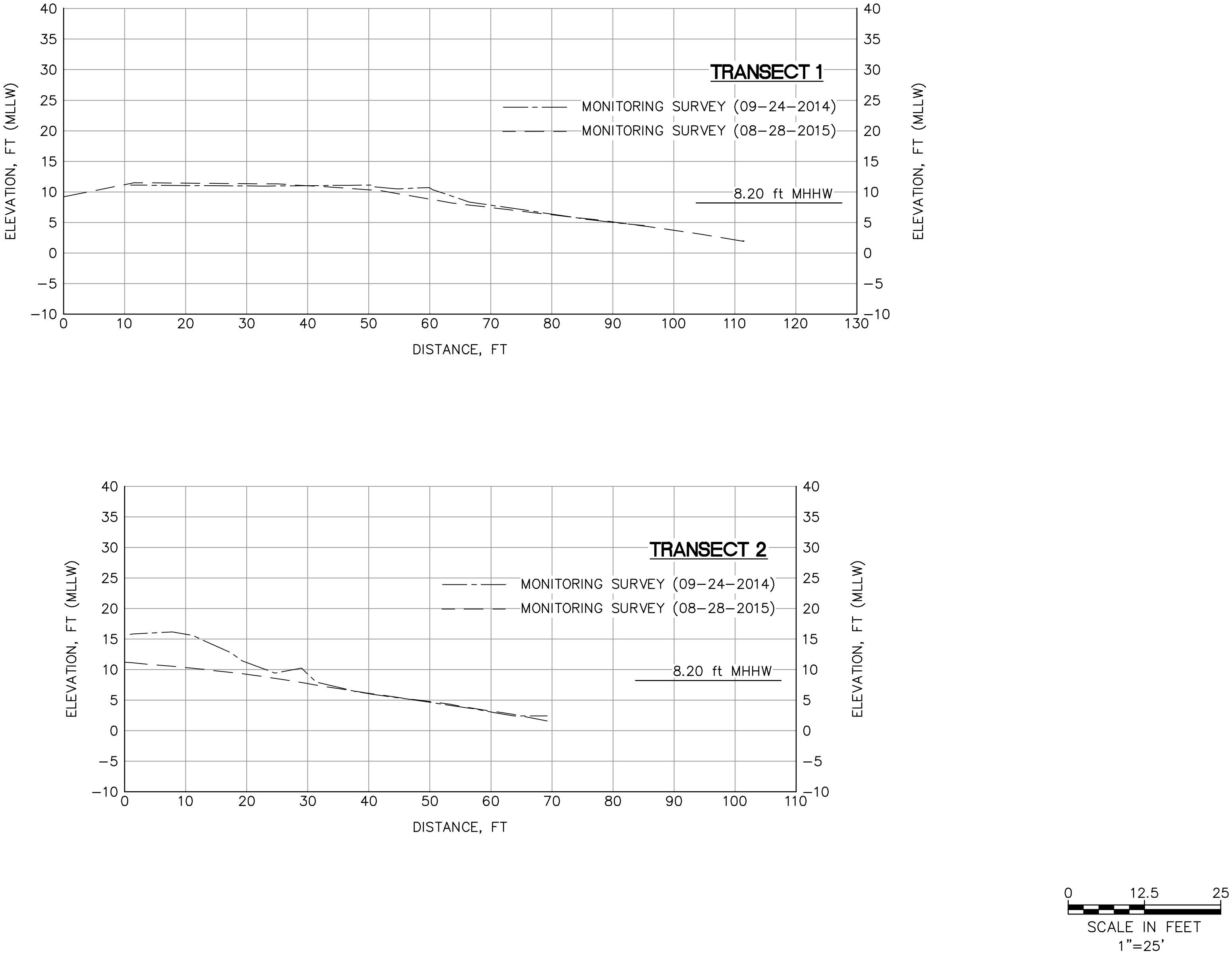


Figure 2. Cross-section profiles of monitoring transects

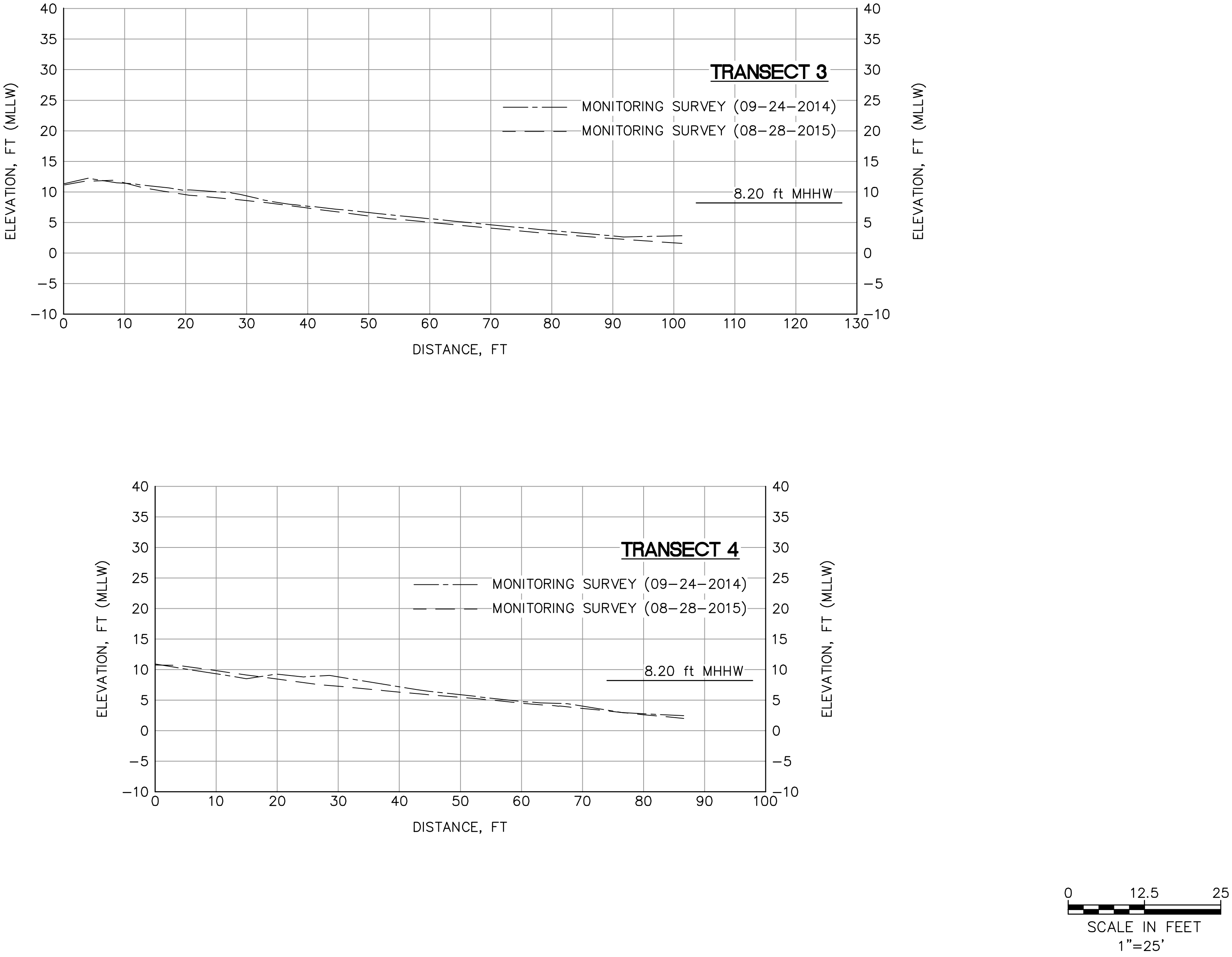
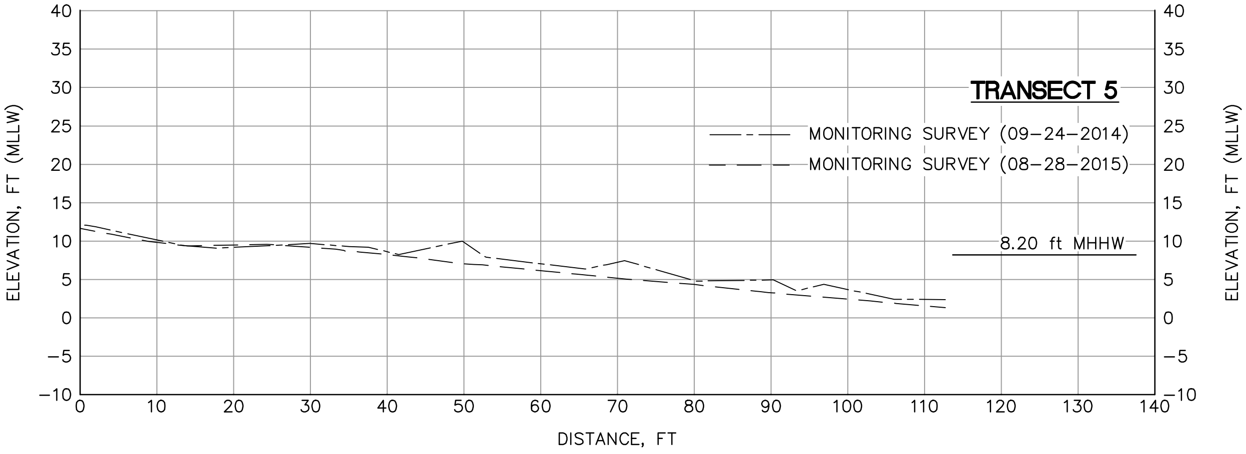
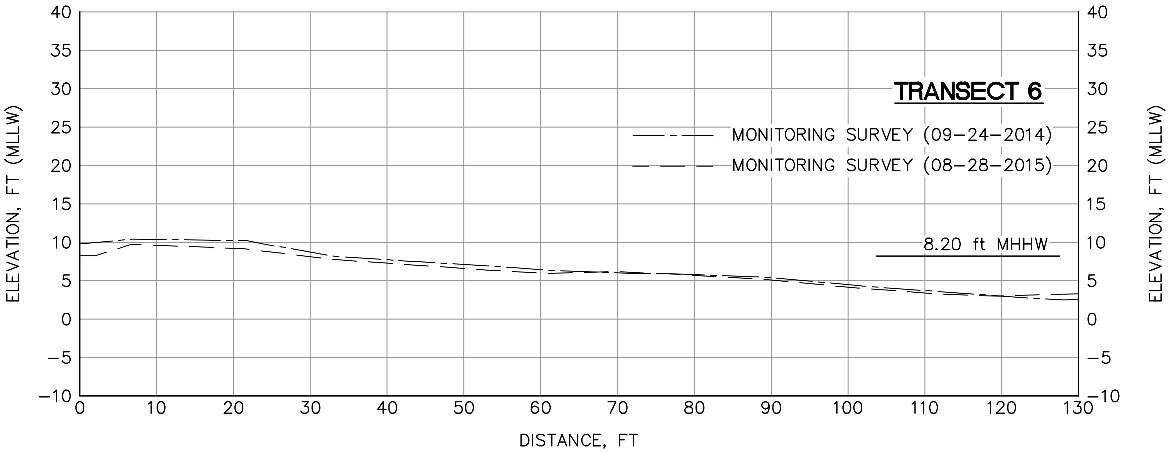


Figure 3. Cross-section profiles of monitoring transects





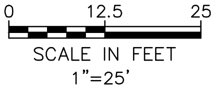


Figure 4. Cross-section profiles of monitoring transects

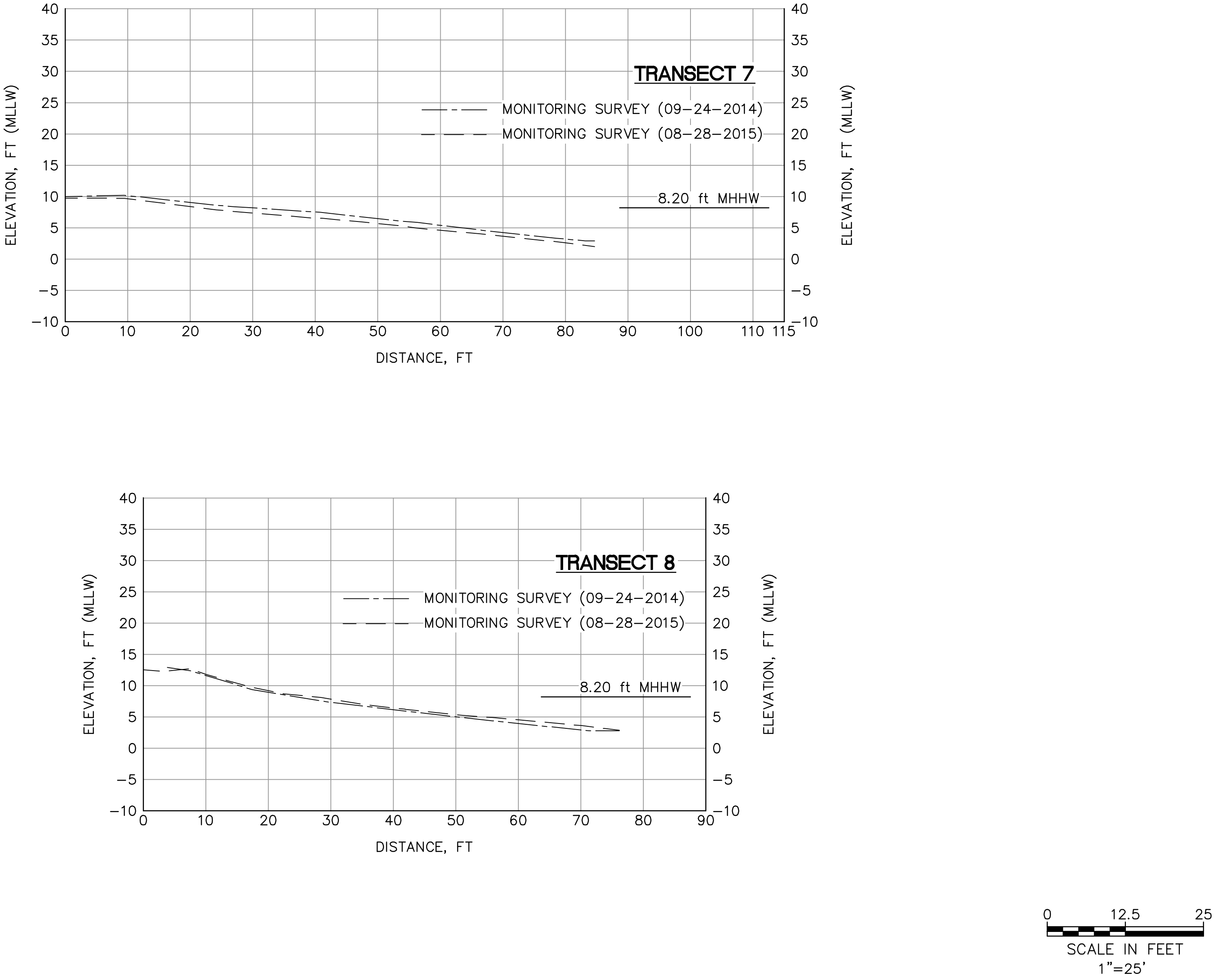


Figure 5. Cross-section profiles of monitoring transects

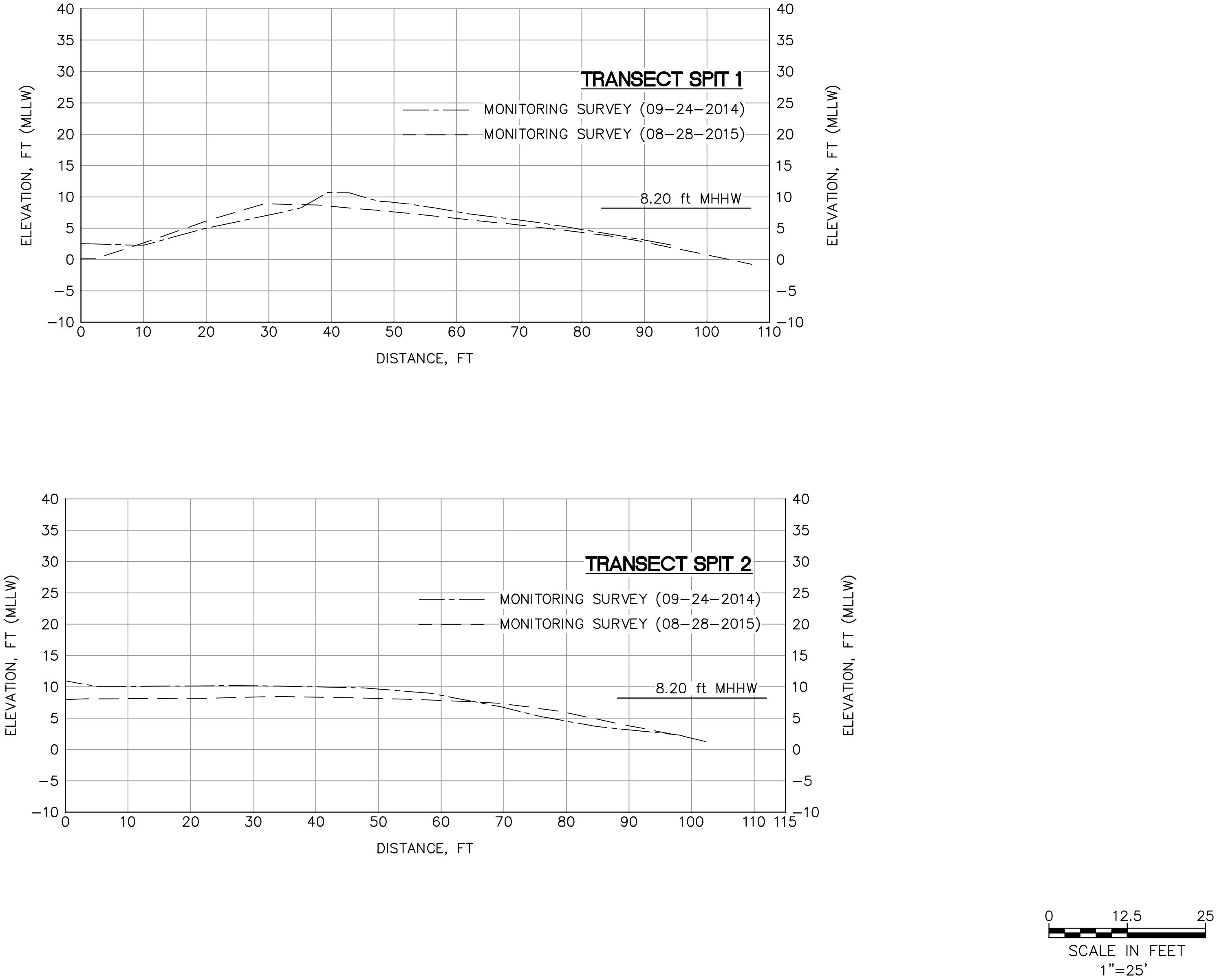
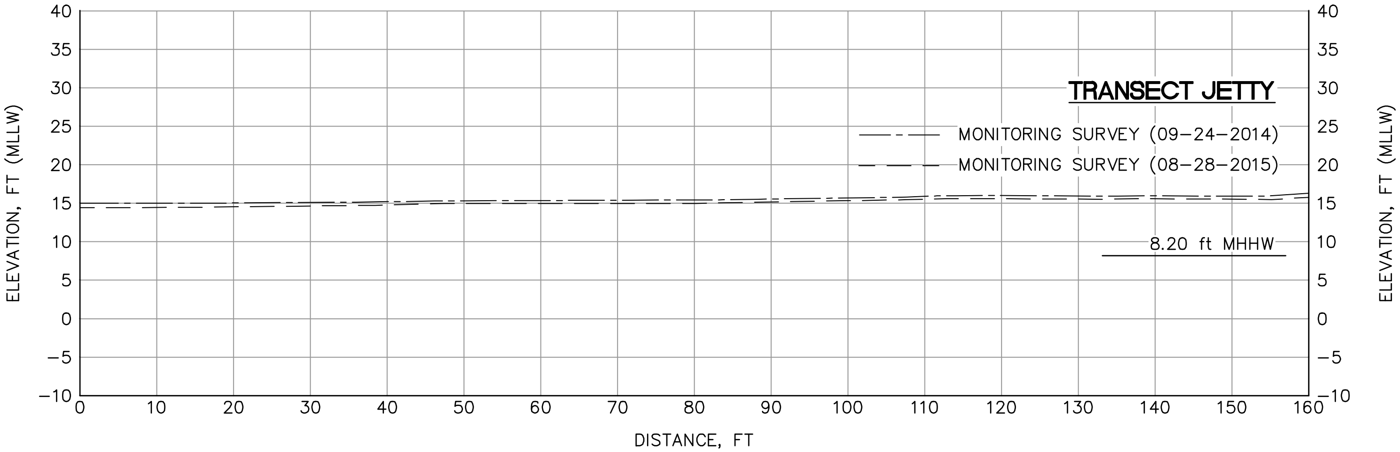


Figure 6. Cross-section profiles of monitoring transects



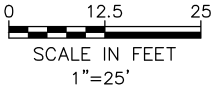
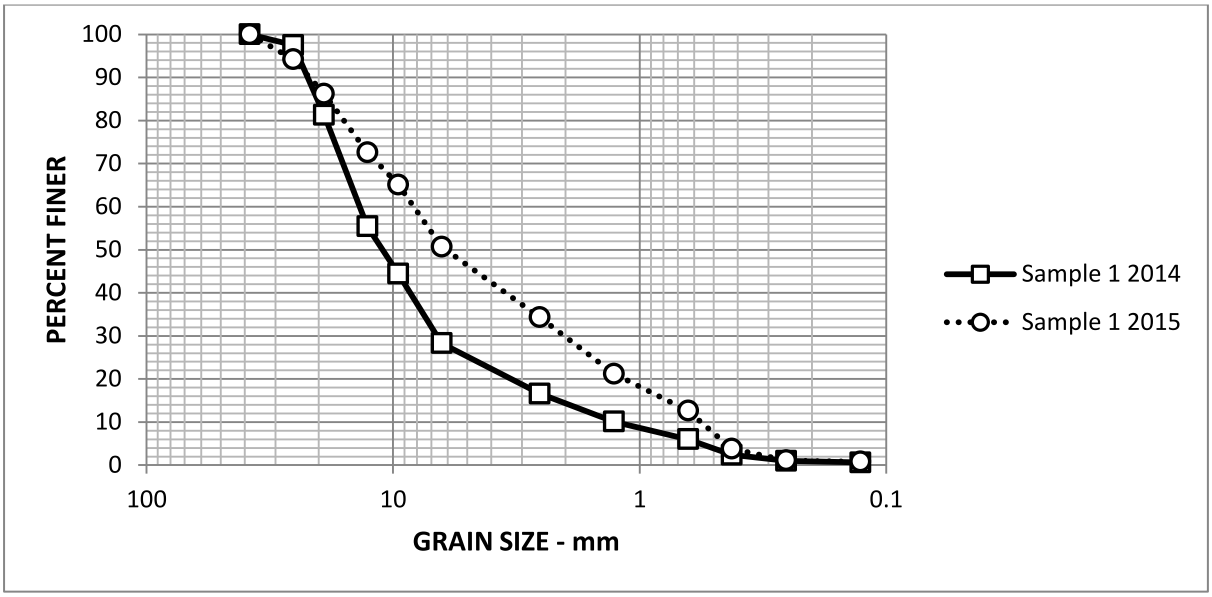


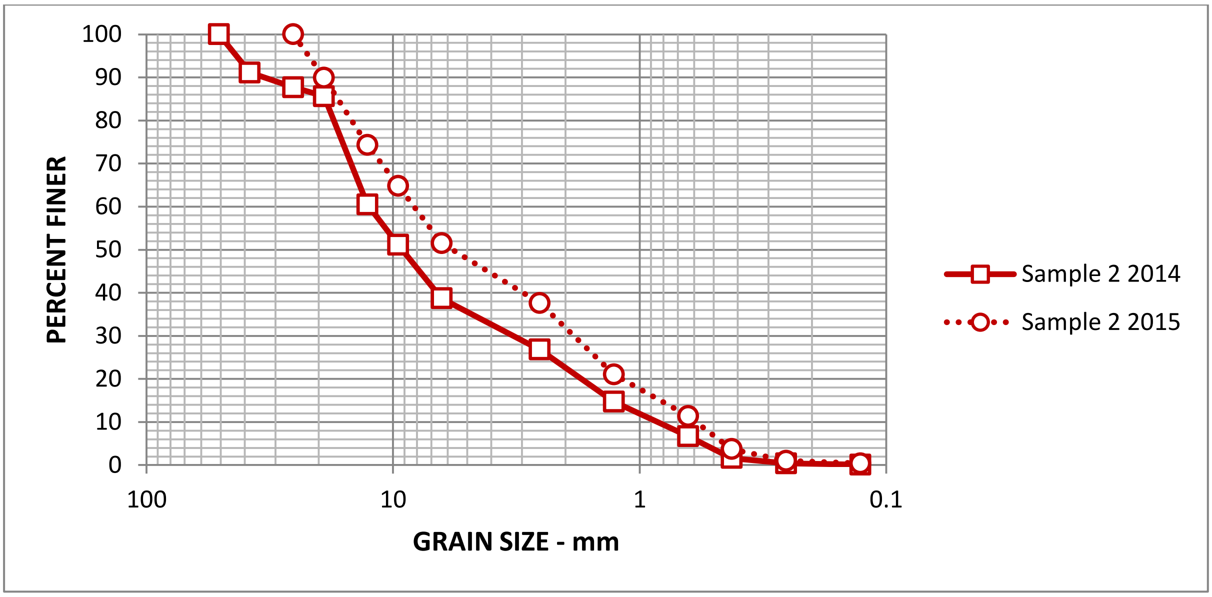
Figure 6. Cross-section profiles of monitoring transects

APPENDIX C

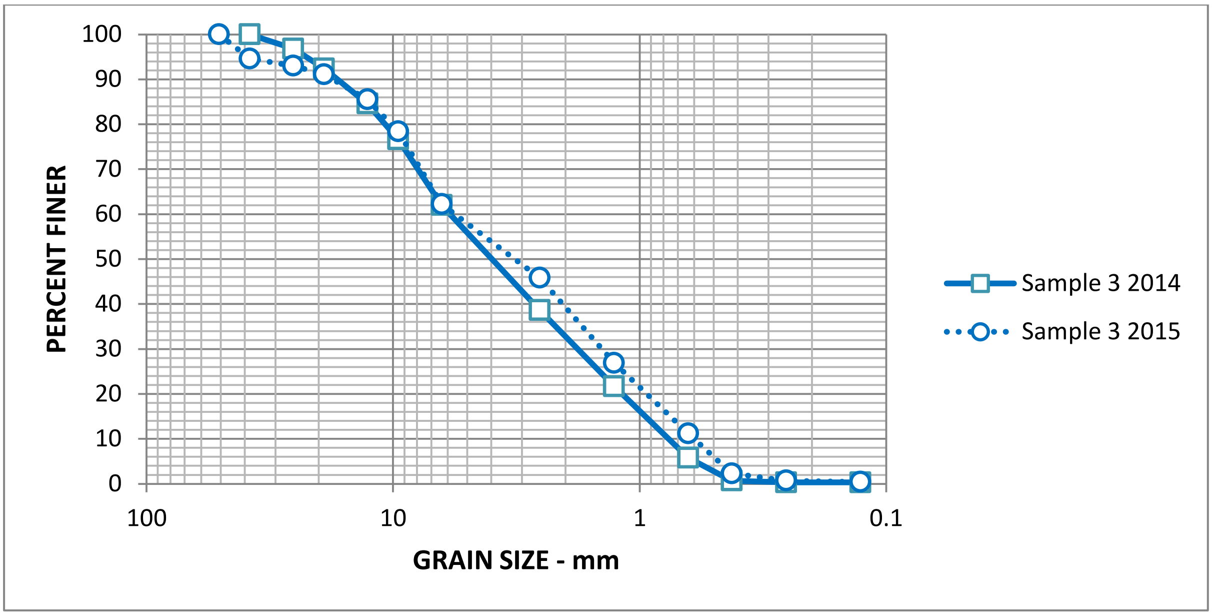
Sediment Grain Size Analysis Results

Transect 2

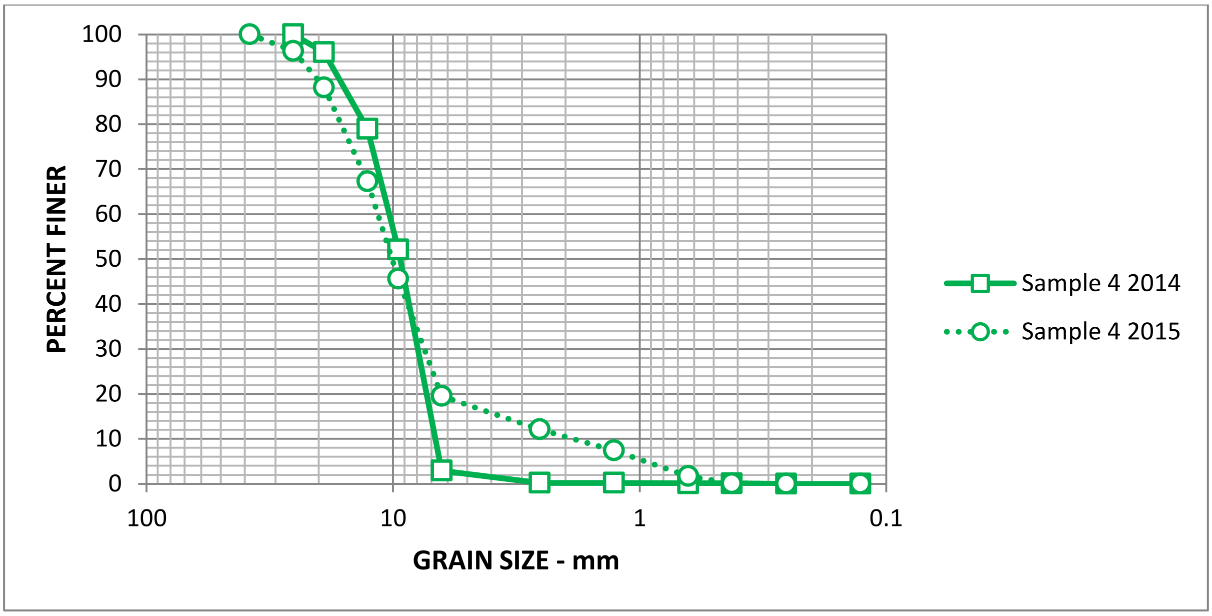

PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

Transect 2

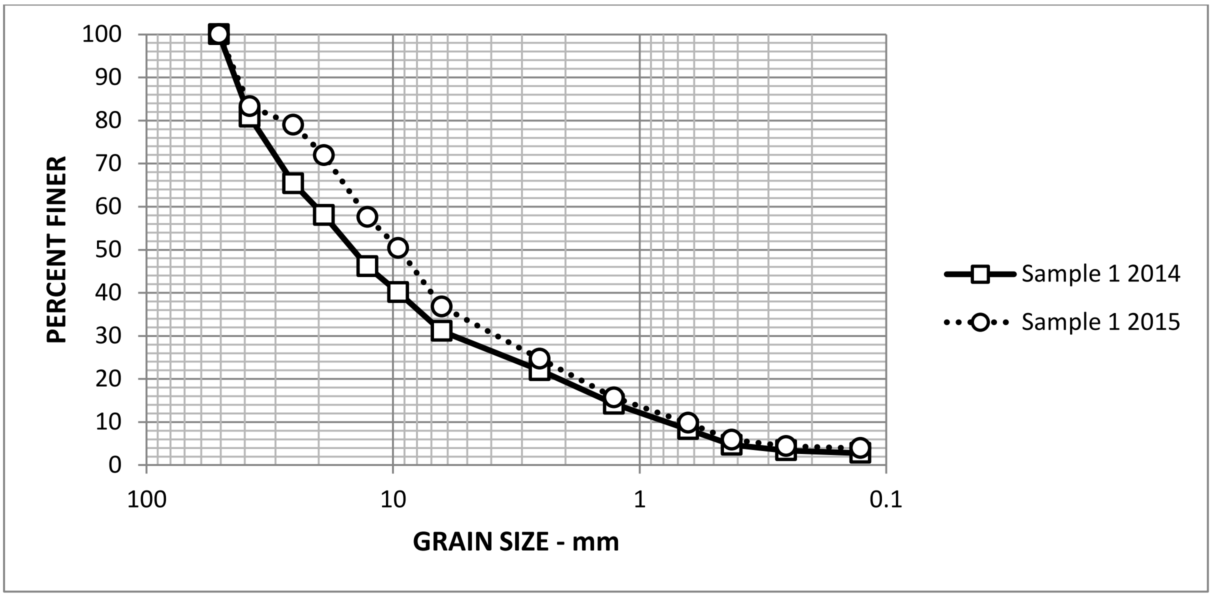


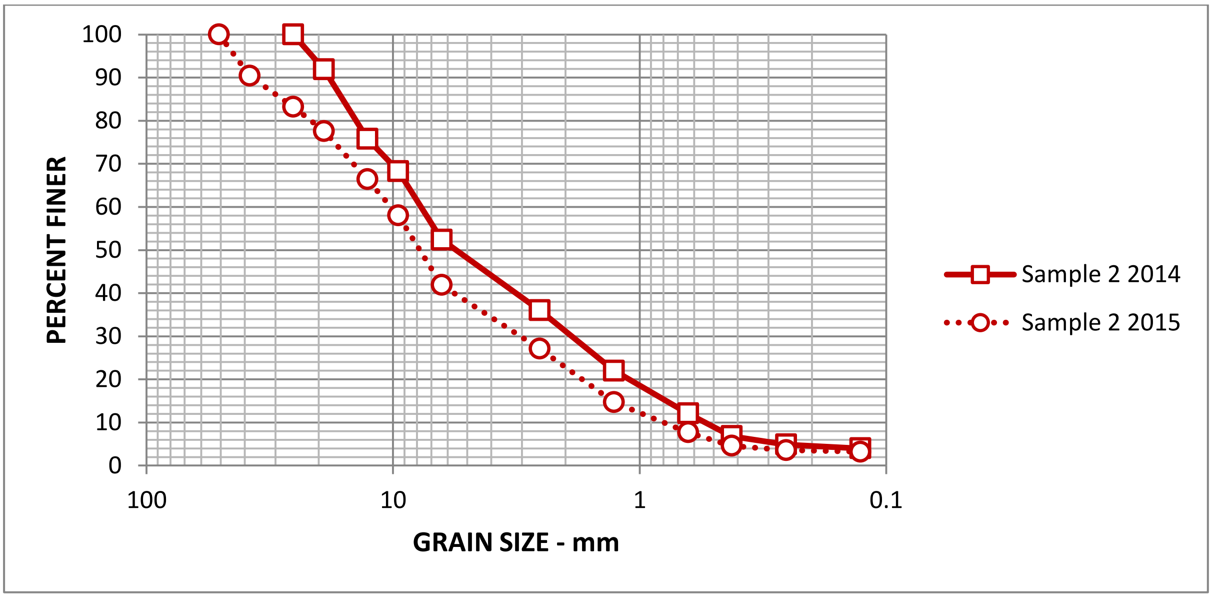
100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 3 2014
Sample 3 2015



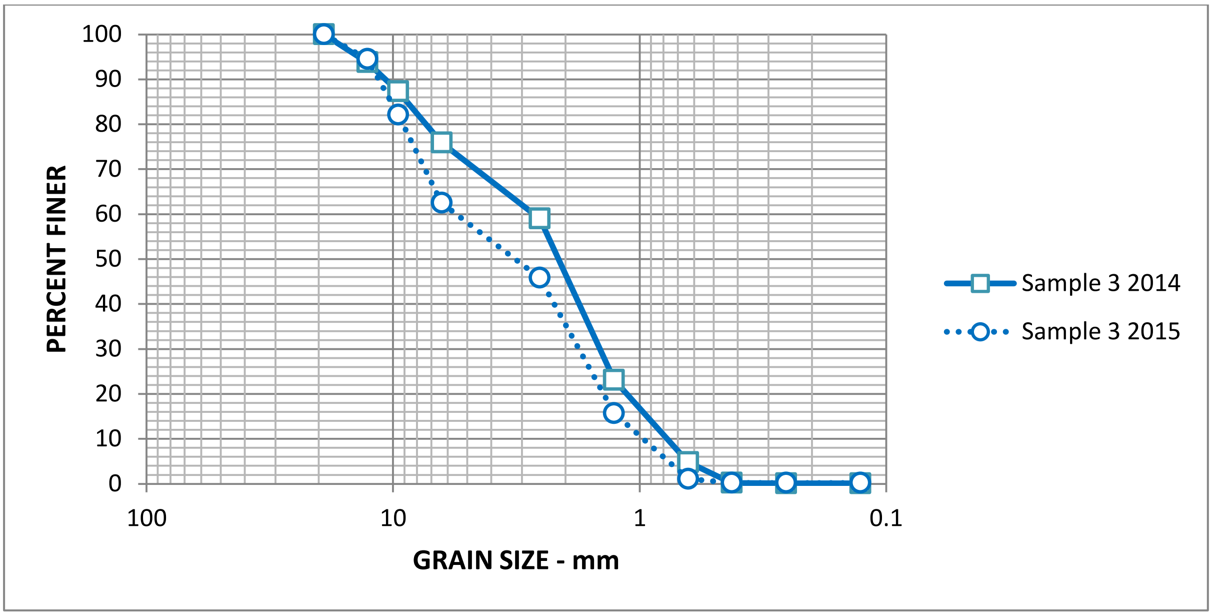
100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 4 2014
Sample 4 2015

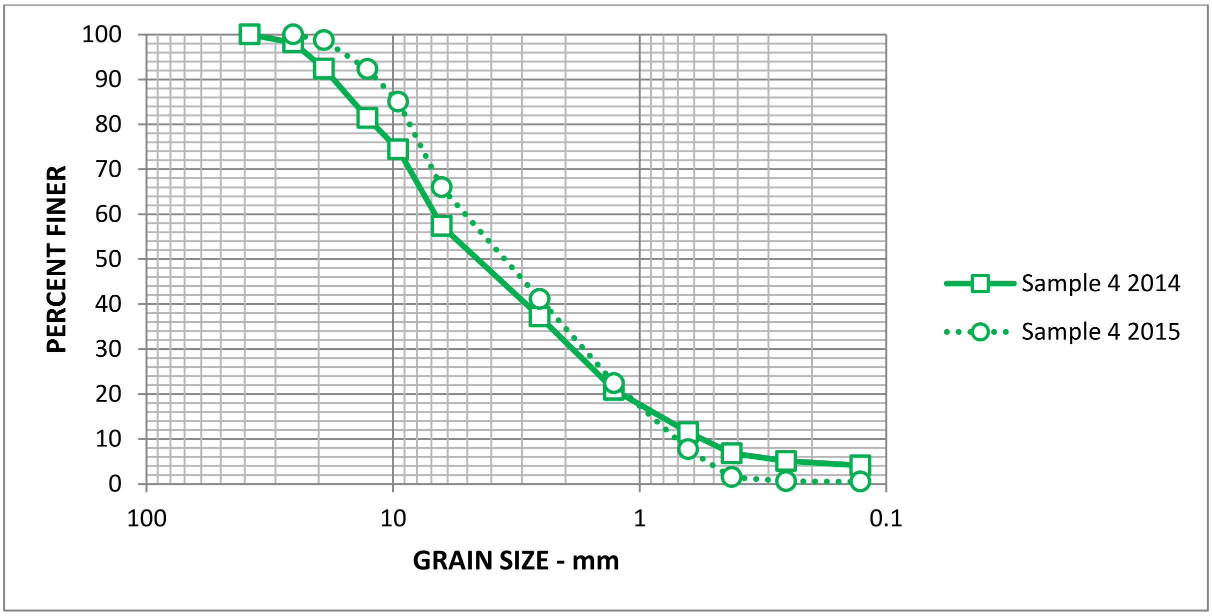
Transect 3


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015

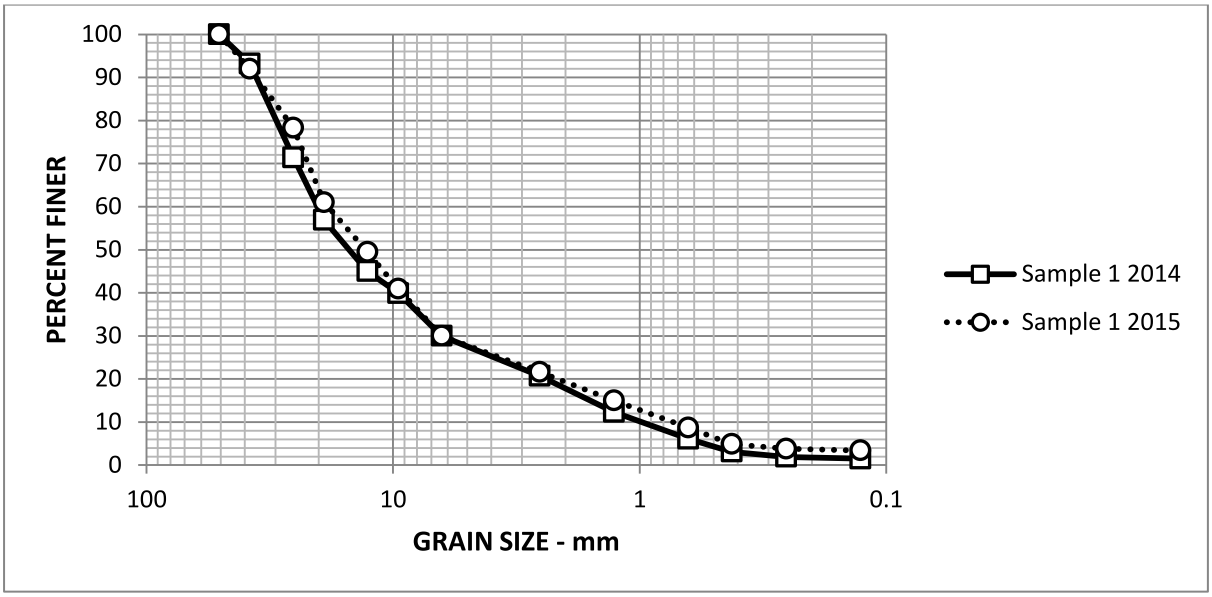

100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

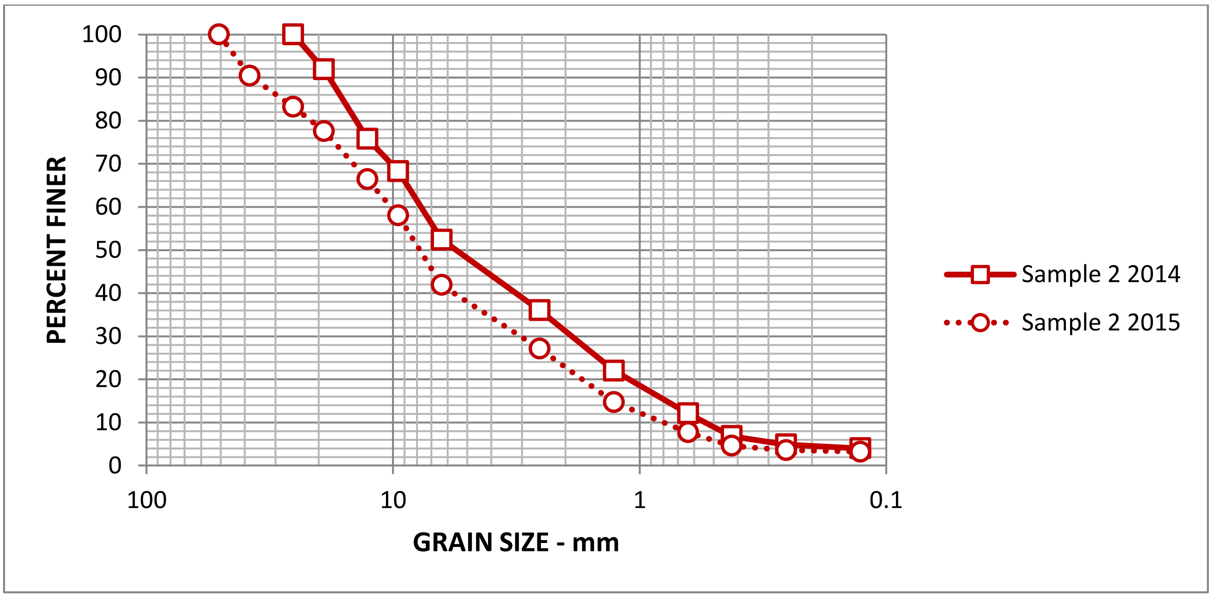
Transect 3


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 3 2014
Sample 3 2015

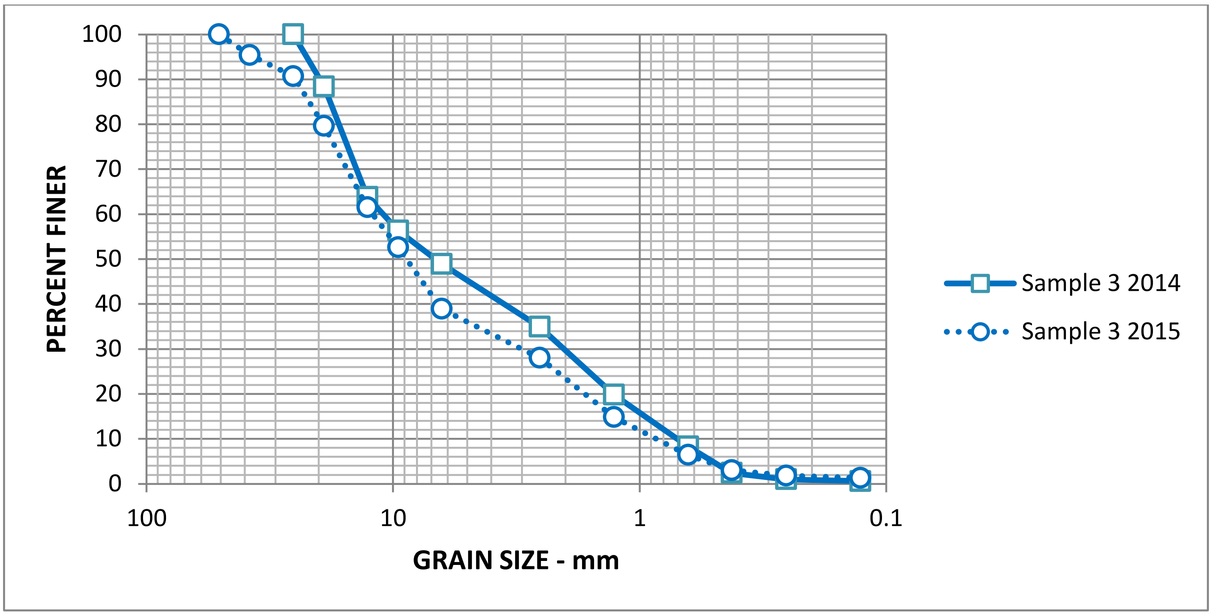

PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 4 2014
Sample 4 2015

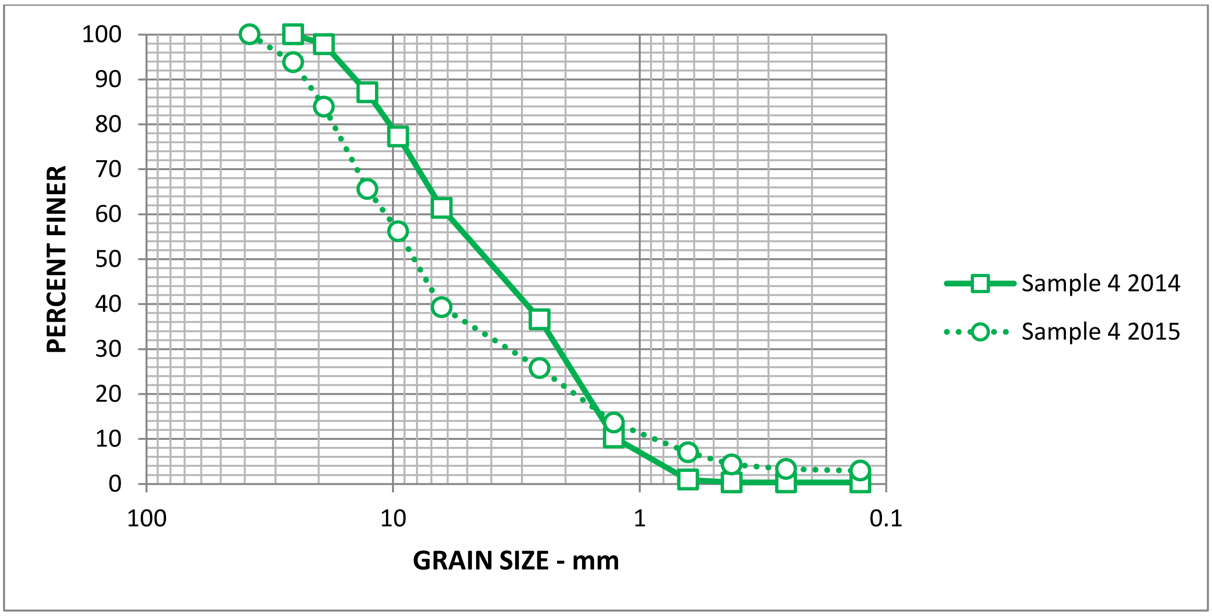
Transect 4


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

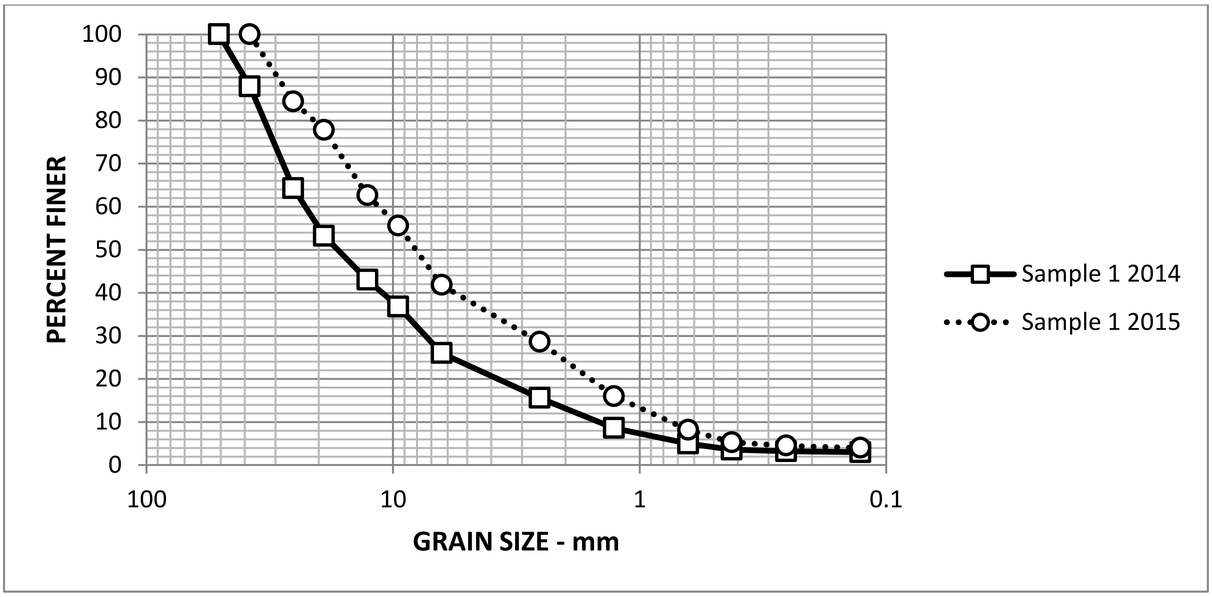
Transect 4

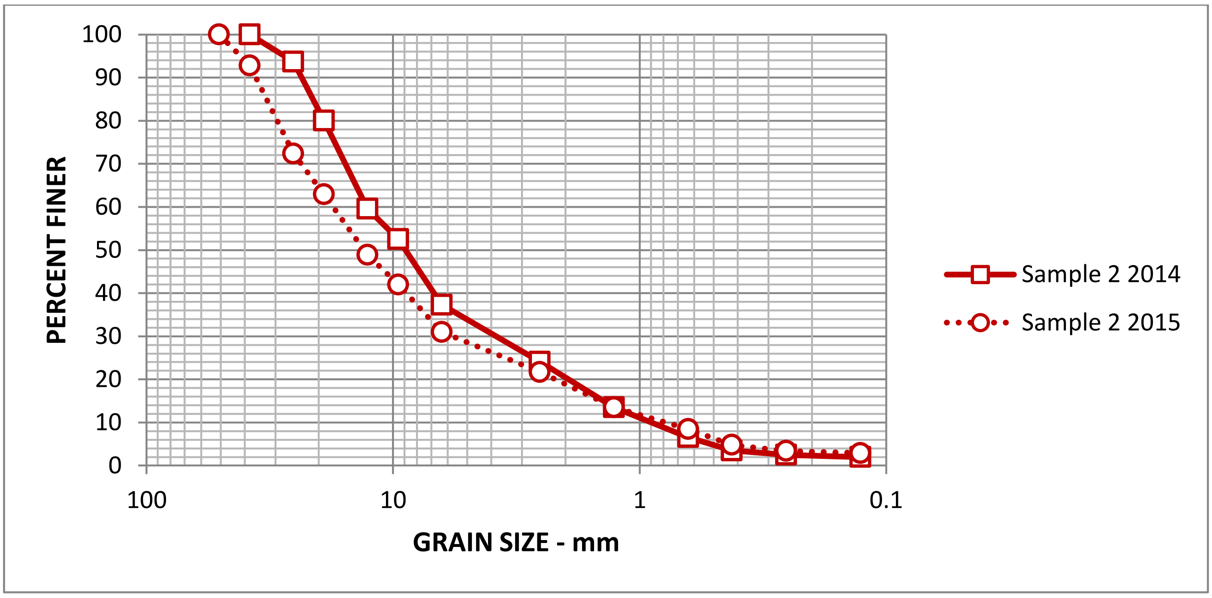




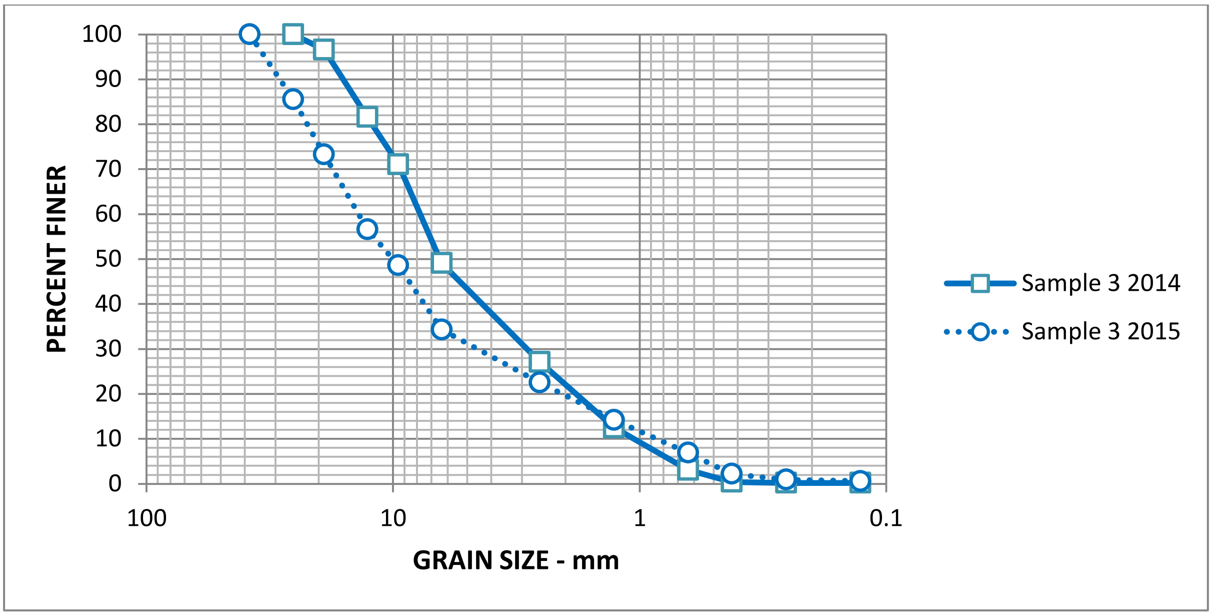
COAST & HARBOR ENGINEERING
A Division of Hatch Mott MacDonald

Transect 5

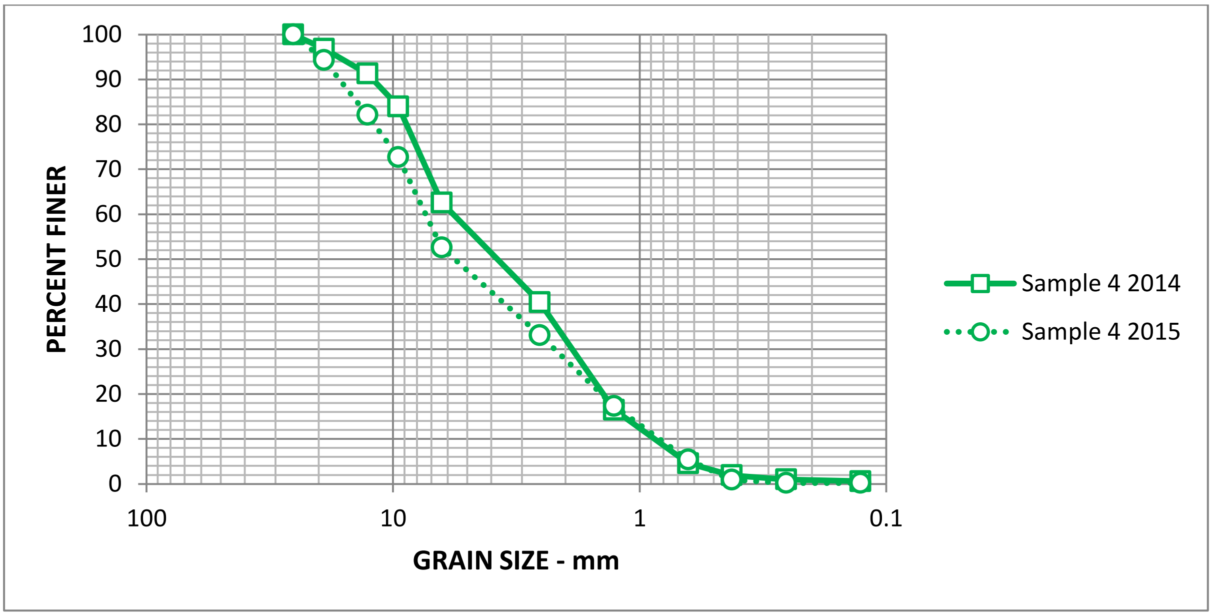

100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

Transect 5

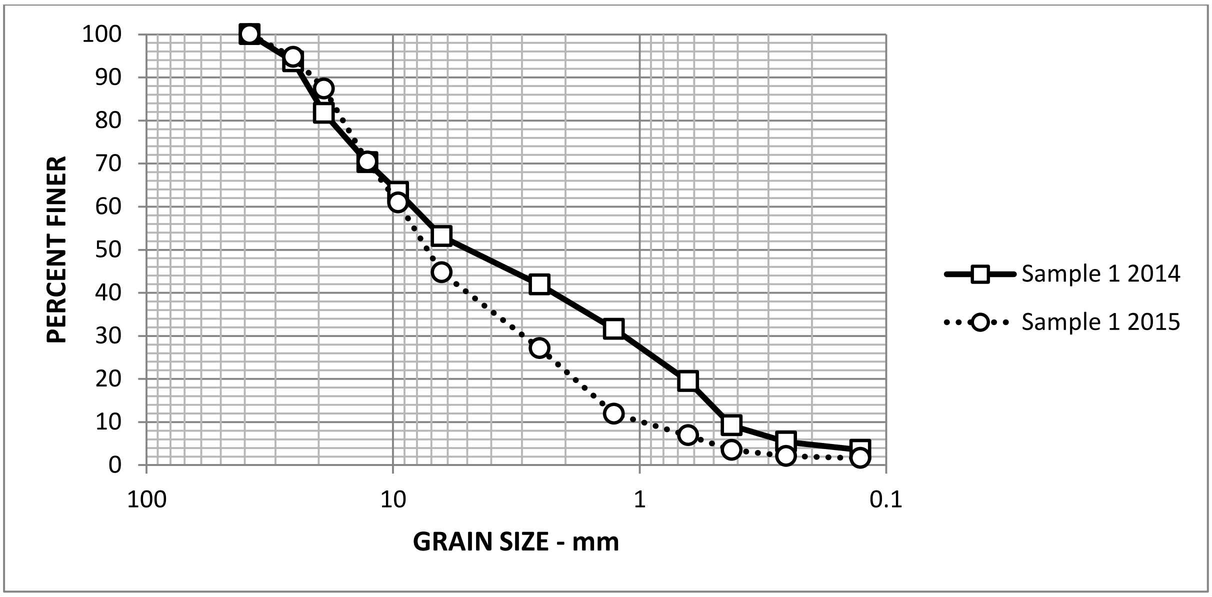


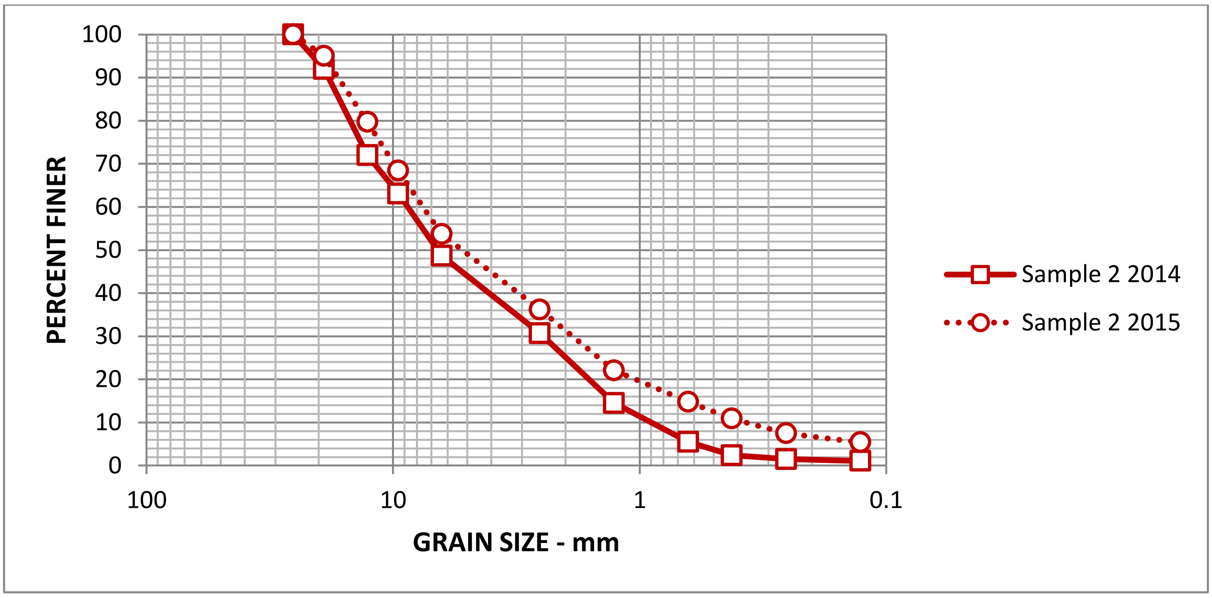
PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 3 2014
Sample 3 2015



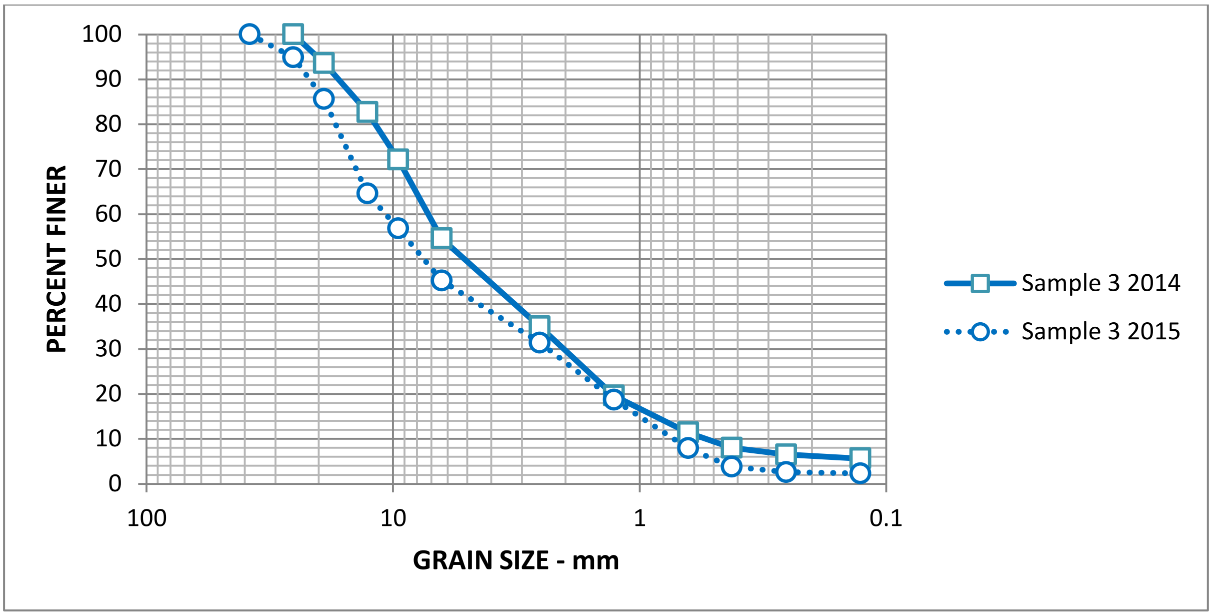
PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 4 2014
Sample 4 2015

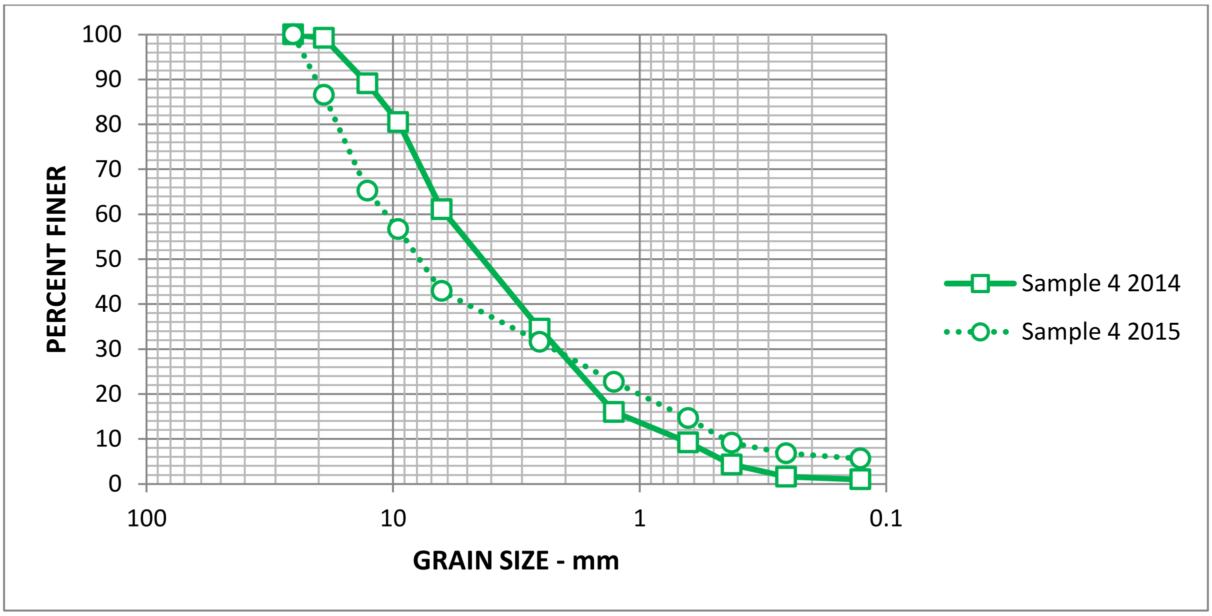
Transect 6


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015

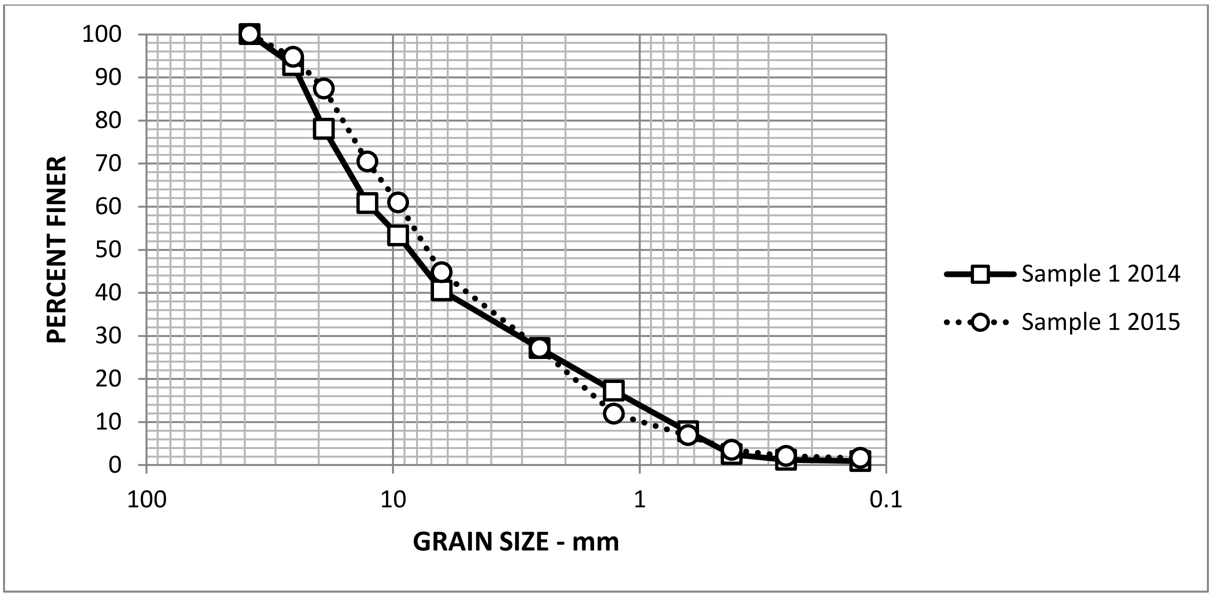

100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

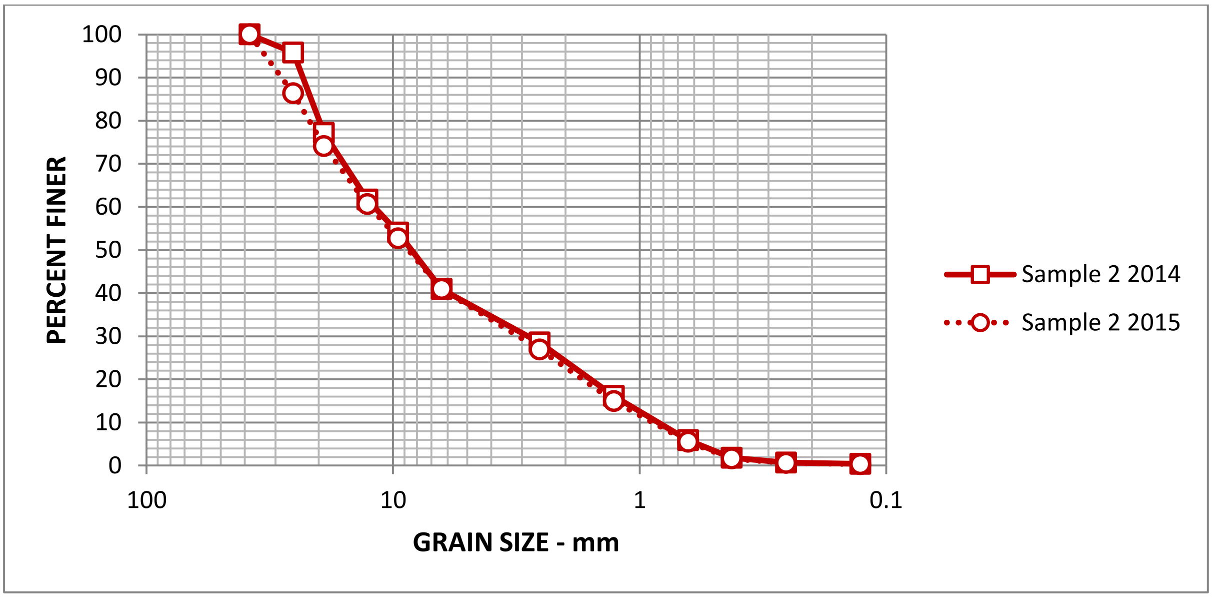
Transect 6


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 3 2014
Sample 3 2015

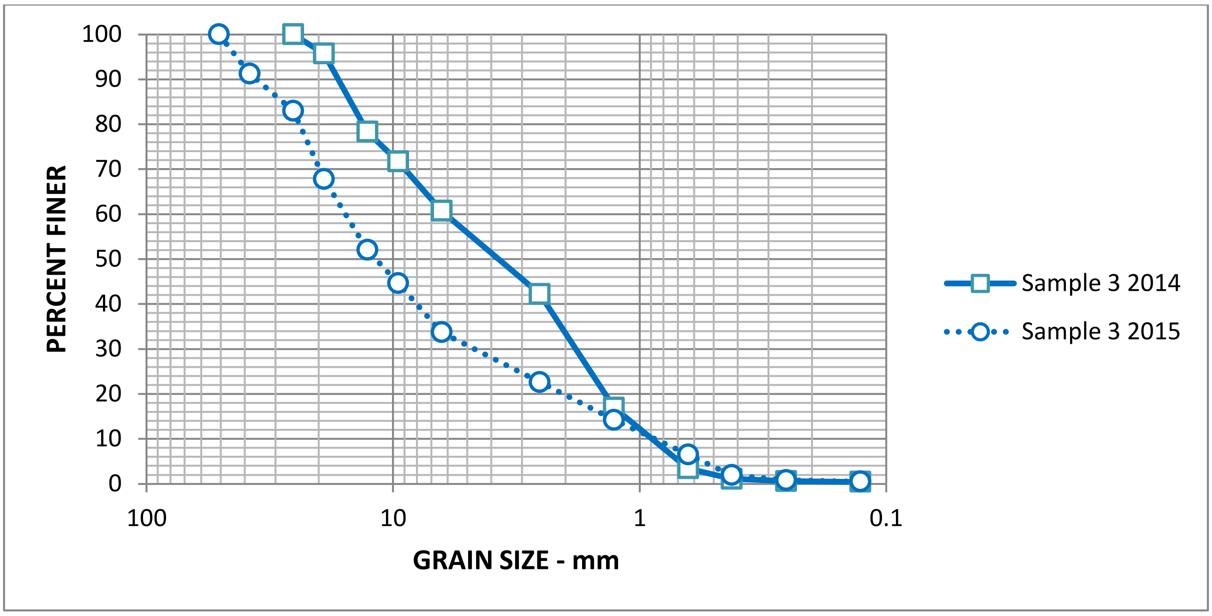

PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 4 2014
Sample 4 2015

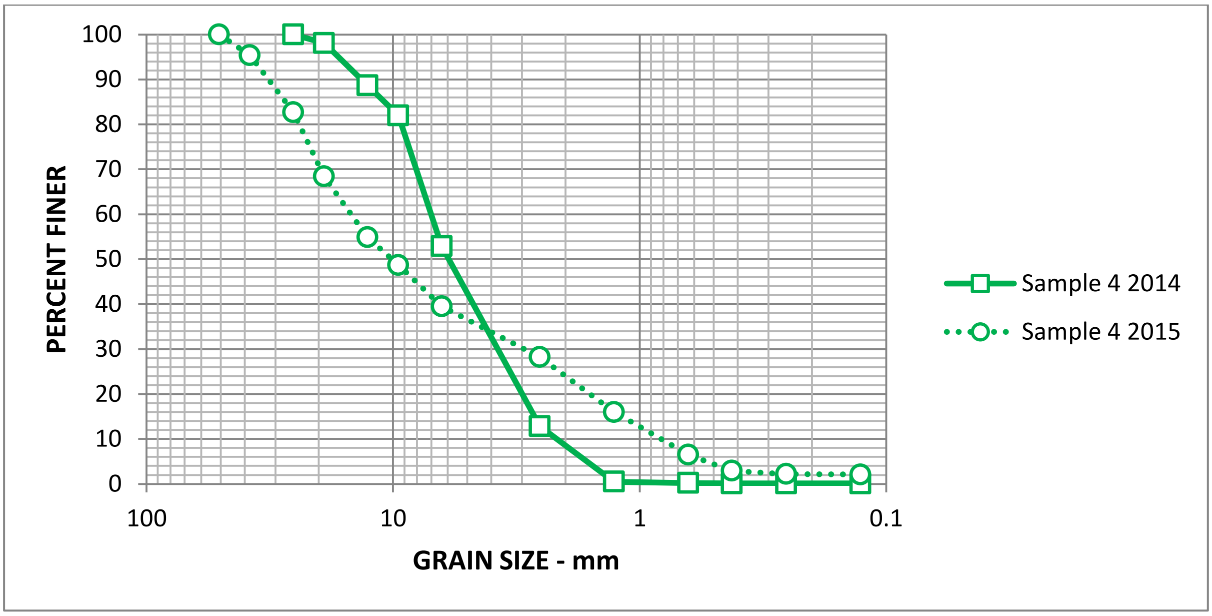
Transect 7


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015

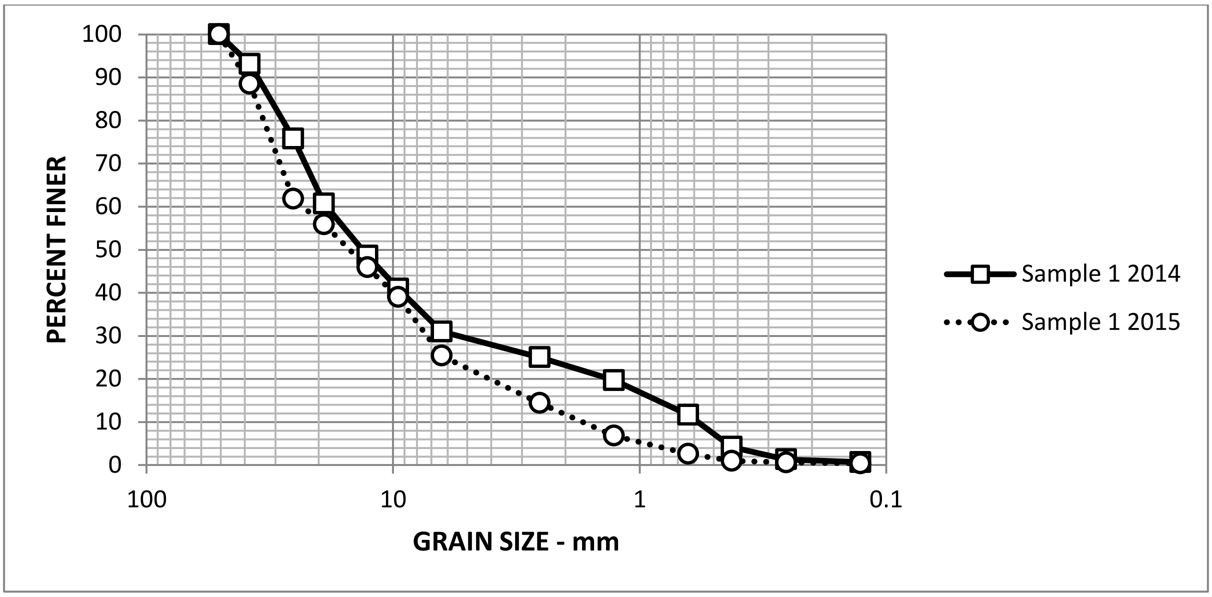

PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 2 2014
Sample 2 2015

Transect 7


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 3 2014
Sample 3 2015


PERCENT FINER
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
GRAIN SIZE - mm
Sample 4 2014
Sample 4 2015

Spit


100
90
80
70
60
50
40
30
20
10
0
PERCENT FINER
100
10
1
0.1
GRAIN SIZE - mm
Sample 1 2014
Sample 1 2015