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Jefferson County Department of Community Development
621 Sheridan Street
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Attention: David Johnson

Subject: Letter Report
Thorndyke Resource
Marine Water Quality
Jefferson County, Washington
File No. 12060-001-01

The purpose of this letter is to form a bridge between the GeoEngineers, Inc. (GeoEngineers) Draft Data Gap Analysis for Marine Water Quality Element Pit-to-Pier (2008) and the 2014 Draft Environmental Impact Statement (DEIS) text. Since much of the detail and information relating to marine water quality is very technical in nature, and the goal of the DEIS is to be understandable by the general public, this letter will cover the technical elements of the discussion and the EIS will be a simplified summary.

WATER QUALITY

Existing Conditions

The shape, bathymetry and water circulation of Hood Canal are typical of a fjord-type estuary. Hood Canal is a long and thin embayment of Puget Sound with deep waters in the central and southern sections (330-575 feet [ft] / 100-175 meters [m]) and shallow sills at the mouth (180 ft / 55m) (near Port Ludlow) and at South Point (50m) (~3.5 miles southwest of the Hood Canal bridge) (Paulson 1993). The project site sits approximately within the central portion of the Canal. Landward of the Great Bend, depths are less than 50m (Paulson 1993). Flows in Hood Canal are typical of an estuary with saltier water flowing into Hood Canal at depth and lighter, less salty water flowing out of Hood Canal at the surface. The sills prevent the free flow of seawater into the central basin allowing only periodic renewal of bottom waters by strong flows (intrusions) from the Strait of Juan de Fuca (Paulson 1993).

Baseline marine water quality of Hood Canal could potentially be impacted by project-related activities associated with both the construction and the operation and maintenance of the conveyor and the pier facilities and vessel traffic to and from the completed pier structure. Existing marine water quality at the site is expected to be good, with respect to metals, oils, grease and other organic pollutants. The site area is relatively undeveloped and no obvious sources of contaminants are present in the nearby region. It appears unlikely that water temperatures in the nearshore areas increase substantially in the summer, with the exception of isolated tidepools.

Marine water quality issues considered pertinent to the project are organized into five primary elements as follows:

- Dissolved Oxygen;
- Turbidity;
- Metals/Organotins;
- Petroleum Hydrocarbons; and
- Nutrients/Bacteria and Exotic Species.

References of existing studies, documents and other related information are cited throughout with a complete citation provided in the references section.

DISSOLVED OXYGEN

Even though surface currents are strong in Hood Canal, there is little advective transport (e.g., movement of nutrients and oxygen via currents) and little vertical mixing (Paulson 1993). These circulation patterns can result in vertical stratification creating a pattern of increased nitrogen and phosphorus and decreased oxygen at depth (especially in the central and southern portions of Hood Canal) (Newton 2008, Paulson 1993). The Washington State Aquatic Life Dissolved Oxygen (DO) Criteria for Marine Waters of extraordinary quality is 7.0 mg/L ([milligrams per liter] lowest 1-day minimum) (WAC 173-201A-210). Minimum oxygen concentrations of 1-2 mg/L have been observed in Hood Canal since the early 1990s (Newton 2008). Low levels of DO in Hood Canal are a concern for the health and survival of aquatic life. Fish kills have been documented in Hood Canal since the 1920s (Newton 2008). The unique circulation and lack of frequent flushing in Hood Canal contributes to the low DO problem as do loadings of nitrogen and carbon. Phytoplankton growth in Hood Canal is limited by nitrogen, so algal growth is particularly sensitive to inputs of this nutrient (Newton 2008). The increased growth of algae leads to an increase in organic matter sinking to deeper waters where decomposers break this organic matter down, using up oxygen in the process (Newton 2008, Paulson 1993). Minimum oxygen concentrations of 1-2 mg/L have been measured in southern Hood Canal since the early 1990s (Newton 2008).

Marine water quality information in the vicinity of the proposed project was researched to provide a general basis from which to establish a baseline of water quality. With the exception of DO, it appears that marine water quality in the vicinity of the project is extraordinary. Hood Canal marine waters are rated by the Washington State Department of Ecology (Ecology) as having extraordinary quality for aquatic life uses (WAC 173-201A-612, Ecology 2006). Extraordinary quality aquatic life uses are described as: salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; and crustaceans, and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning (WAC 173-201A-610, Ecology 2006). Marine waters designated as having extraordinary quality for aquatic life uses have stricter water quality standards for turbidity, DO, pH, and temperature (WAC 173-201A-210, Ecology 2006).

The Thorndyke Resource Operations Complex Central Conveyor and Pier Project Biological Evaluation (Pentec 2003) states that background water quality samples have not been collected in the vicinity of the project area but that because the area is relatively undeveloped, marine water quality is expected to be excellent. Since then others have collected water quality samples in the vicinity of the proposed pier. The Washington State Department of Ecology Puget Sound Assessment and Monitoring Program (PSAMP) has collected water quality samples at two stations near the project site (PSAMP 2008a, HCB006/008 – King Spit, Bangor Naval Reserve and PGA001 – Port Gamble-Inner Harbor). Water quality parameters measured include temperature, dissolved oxygen, fecal coliform, salinity, ammonia, nitrate, nitrite, phosphorus, pH, Secchi depth, and light transmission (PSAMP 2008a). In addition, in early 2008, the Port Gamble S'Klallam Tribe in Kingston, Washington started a marine water monitoring program near the Hood Canal Bridge (Rose 2008). In Hood Canal near the mouth of Dabob Bay oxygen concentrations ranged from approximately 7 to 12 mg/L in the surface waters and 4 to 6 mg/L in bottom waters (Khangaonkar et al. 2012).

Four sites in Hood Canal in the vicinity of the project site have been listed on Ecology's 303(d) List of impaired waters for dissolved oxygen (Ecology 2012, Listing IDs: 38380, 38384, 66181 and 66193). See 303(d) Water Quality Listings, Figure 2.

In 1996 and 1998, marine waters in Thorndyke Bay and Squamish Harbor met the Washington State water quality standards for fecal coliform (Ecology 2012).

TURBIDITY

Turbidity is a measure of the amount of suspended particles in the water column. Washington State defines turbidity as "the clarity of water expressed as nephelometric turbidity units (NTU) and measured with a calibrated turbidimeter" (WAC 173-201A-020, Ecology 2006). Other measures of the amount of suspended material in the water column are percent light transmission using a transmissometer, total suspended solids (a measure of the mass, in milligrams, of dissolved and particulate matter in a liter of water) and Secchi depth (the depth, in meters, to which a black and white disk is still visible from the surface of the water). Turbidity is typically thought of as a measure of suspended inorganic or organic particles, however the ability of the water to transmit light can also be impacted by the amount of phytoplankton (unicellular algae in the water column) and zooplankton (small animals in the water column) in the water.

Turbidity is measured as an indicator of water quality because the ability of the water column to transmit light can impact photosynthesis for phytoplankton and submerged vascular plants and algae (Thom et al. 1996). In addition, suspended sediments can impact fish and invertebrates by affecting behavior and interfering with gill ventilation, by covering benthic organisms or by stirring up contaminants in the bottom sediments, increasing exposure for organisms (Simenstad et al. 1999).

The two draft Thorndyke Resource Biological Evaluations (BEs) state that short term impacts on turbidity are anticipated from pier construction and boat prop wash (Hart Crowser 2013, Pentec 2003). It was assumed that tidal fluctuations and tidal currents would mitigate for temporary impacts on water quality through dilution and advection (Hart Crowser 2013, Pentec 2003). The BEs also state that no long-term direct or indirect effects to marine water quality are anticipated from the project (Hart Crowser 2013, Pentec 2003). One study reporting observed levels of suspended materials from dredging events was cited and it was stated that levels from boat prop wash at the project site would be much lower (Hart Crowser 2013). No supporting documentation or quantitative analyses for this statement were provided.

The action at the project site that could have potential long-term impacts on turbidity is boat traffic and the resulting prop wash. Propellers of tug boats create currents known as prop wash. These currents can disturb bottom sediments and stir them up into suspension in the water column increasing turbidity (Ebbesmeyer et al. 1995, Hamill et al. 1998). Prop wash may disturb project site sediments when tug boats are entering and exiting the pier area. The amount of sediment resuspension and the time it takes for those particles to settle depends in part on the sediment grain size at the site that will be disturbed. On September 26 2008, GeoEngineers collected three surface sediment samples (0 to 10 inches) from three locations with 10-foot increments of depth (10 feet mean lower low water (MLLW), 20 feet MLLW and 30 feet MLLW) in the vicinity of the proposed aggregate loading facility. As shown on Figure 3, sieve analysis indicates that the samples were composed primarily of medium to fine sand. It is likely that sediment grain size in Thorndyke Bay is smaller than at the pier site due to different source materials. Thorndyke Bay receives inputs of fine material from Thorndyke Creek, while the pier site receives inputs of sand from sloughing of adjacent bluffs.

As part of an evaluation of longshore sediment transport and shoreline processes (Anchor 2003) the potential for vessel propeller wash to scour shoreline bed sediments at the Project pier site was investigated using a PROPWASH model (Blaauw and van de Kaa 1978, Verhey 1983). The model estimated that a maximum of 3.5 and 19 inches of bottom scour would occur for water depths of 50 and 40 feet respectively at a horizontal distance of 150 feet from the propeller. Because it was assumed that tug boats are likely to work in 50 feet of water or greater these results were interpreted as indicating minimal scour (Anchor 2003). Potential problems with the modeling approach and assumptions made for the PROPWASH model include:

- Actual water depths at a horizontal distance of 150 feet from tugboat propellers may be less than 50 feet if tugs are perpendicular to the shore and facing away from the shore. This tug configuration, while potentially physically possible will be precluded from operations as described in the Standards of Care (yet to be prepared) for the vessel traffic study. Figure 9 of the Longshore Sediment Transport and Shoreline Processes report (Anchor 2003) shows that the pier is 150 feet (horizontal distance) from the propellers of tugs numbered 2 and 3. The site plan in the BE shows that the leading edge of the breasting dolphin of the pier is at approximately 50 feet MLLW (Hart Crowser 2013). These depths and assumptions should be rechecked during final design to not under-estimate scour velocities.
- Increased velocities that occur at the sediment surface were not modeled in the PROWASH model (Simpson 2008). This omission could potentially under-estimate scour velocities.
- Tugs with 5000 horsepower (Hp) were assumed, however tugs with 3000Hp are more likely to be used at this site due to cost and availability (Simpson 2008). The difference could potentially over-estimate scour velocities.

The PROPWASH study indicated a potential maximum scour depth of 19 inches (for water 40 feet deep at a horizontal distance of 150 feet from the propeller) (Anchor 2003). The depth used in the PROPWASH study was the depth from the propeller to the sediment surface. This was calculated by subtracting the propeller shaft depth from the total depth. Anchor assumed a propeller shaft depth of 15 to 16 feet below the water line (Anchor 2003). The BE states that the largest tugs to be used will have a 25-foot draft and the largest ships will have a 45-foot draft (Hart Crowser 2013). The relationship between draft and propeller depth for the specific tugs and ships to be used is unknown, however the above assumption of a 15- to 16-foot propeller depth should be evaluated as designs and operating procedures advance. Other major factors influencing prop wash are whether the boat propeller is pointing right at the shore, whether the barge is between the tug and shore, or whether any object or operating procedure reduces the force or directs the fast currents wash away from the shore. Sediment grain size of disturbed sediments was estimated as fine sand but grain size is only known definitively and quantitatively to a depth of ten inches. Scour velocities were potentially over-estimated if grain size is larger or under estimated if grain size is smaller as a result of this data gap. The proposed orientation of tugs in Figure 9 of the Longshore Sediment Transport and Shoreline Processes report (Anchor 2003) would result in less scour and therefore less potential turbidity effects than if tugs operated in more shallow water (especially if propellers were oriented towards shore). In order to ensure that this assumption remains true for day-to-day operations of the pier site, a requirement for tugs to operate as depicted in Figure 9 (or another arrangement demonstrated to have even smaller scour velocities) should be written into the Standards of Care (yet to be prepared) for the vessel traffic study.

After eight years of operation large ships, in addition to tugs, are expected to work at the pier. An assumption made in the Longshore Sediment Transport and Shoreline Processes report (Anchor 2003, page 29) is that vessels are not expected to dock under their own power, but will have tug assist. In order to ensure that this assumption is true for day-to-day operations at the pier site, a requirement for no use of ship bow thrusters at the pier should be written into the Standards of Care (yet to be prepared) for the vessel traffic study.

In addition, because the PROPWASH model study was intended to investigate shoreline scour and not turbidity of marine waters, the model did not provide estimates of turbidity levels for comparison with marine water quality criteria. Analysis of sediment grain size below ten inches during future geotechnical explorations would be useful in determining potential impacts to turbidity from prop wash that may disturb sediments at depths greater than 10 inches, however Coast and Harbor scientists expressed confidence in the assumption that sediment grain size would be the same or larger below 10 inches depth due to the source material (sloughing of adjacent bluffs).

A Final Environmental Impact Statement for the Glacier Northwest Gravel Mine stated that prop wash could affect nearshore organisms by stirring up bottom sediments thus increasing turbidity (Jones and Stokes 2000). It was stated that suspended sediments from prop wash could impact an adjacent eelgrass patch and other marine plant communities at the site (Jones and Stokes 2000). A Final Environmental Impact Statement and BE by the Port of Everett for their Satellite Rail/Barge Transfer Facility stated that construction activities (e.g., pile driving in the harbor) would create temporary increases in turbidity (Pentec 2004, Port of Everett 2004). Prop wash from tugs was not evaluated as a potential project action that could impact turbidity of marine waters, however it was stated that scour from prop wash would not affect eelgrass because "…tug propellers will always be the length of the barge and the length of the tug away (250 feet or more) from existing eelgrass and in water depths exceeding 50 feet." (Port of Everett 2004).

It is likely that some prop wash will occur at the site, especially during vessel departure when the most engine power will be needed to move a fully loaded vessel. The total amount of sediment resuspension over the life-time of the project will depend in part on the depth that tugs and ships operate in and their orientation to the shore (propellers create the greatest disturbance/turbulence at a given point away from the propeller), the sediment grain size (up to the depth of expected scour), sediment transport and deposition processes, speed and size of the vessel, duration of the propeller activity, and characteristics of the propeller(s) (e.g., size and angle). In addition, the number of ship visits is important information for evaluating the length of time that turbidity levels may be elevated. A memo evaluating the potential for vessel induced turbidity in Rozelle Bay, Australia cited several studies indicating that silt (sediment particles approximately 2-50 micrometers [µm]) would not be resuspended from the bottom if boat propellers were 3-5m above bottom sediments (Patterson Britton and Partners 2006, Hill and Beachler 2002). The studies did not indicate if large transport vessels (e.g., tugs and barges) were used in the studies.

In order to accurately evaluate the potential for the project to impact turbidity, existing conditions at the site (e.g., sediment grain size below 10 inches and existing water column turbidity levels) may need to be characterized or, at a minimum, estimated using data from nearby undeveloped sites. The characterization of coastal processes conducted by Coast and Harbor Engineering (2008) seems to indicate that the large sediment grain size will allow rapid settling of disturbed particles and that tidal currents (maximum flows of 0.55 meters per second [m/s] or 1.8 feet per second [ft/s]) at the site will carry away and dilute small suspended particles thereby minimizing long-term impacts on turbidity. The Longshore Sediment Transport and Shoreline Processes report indicates that the pier will be used up to 300 days per year with a maximum of six barges per day (average of 3 barges a day) (Anchor 2003). Depending on size, barges will take from one to eight hours to load. If sediments at the pier site are resuspended during tug-assisted placement of barges there is still not enough information to determine what resulting turbidity levels will be and how long they will last. With up to six barge visits per day, water quality criteria for turbidity at the site could be exceeded often and potentially for extended periods of time. It would be helpful if future analyses of prop wash would include estimates of turbidity levels and a measure of duration for when those levels would be above water quality criteria for Hood Canal.

METALS/ORGANOTINS

The hulls of ships are typically coated in paints containing biocides (e.g., tributyltin and copper thiocyonate) which slowly leach out from the paint and prevent the growth of organisms (Sandberg et al. 2007). Tributyltin (TBT) is an organo-metal compound that is toxic to aquatic life (EPA 2004). It is an endocrine-disrupting chemical that causes reproductive effects in aquatic organisms (EPA 2004, Fent 1996). Mollusks are particularly sensitive to tributyltin (EPA 2004). Imposex (irreversible masculinization of the female snail reproductive tract) was observed in 38 to 67 percent of female whelks in shipping channels near Portland, Maine (Sommer et al. 2000). Copper is an essential micronutrient with background concentrations in marine waters of 0.5 to 6 nanometers (nM) (Millero and Sohn 1992). Copper is toxic to aquatic life at elevated concentrations (EPA 2007). These biocides leach into the water, adsorb to particles and settle to the bottom (Clark et al. 1988, Laughlin and Linden 1987). Because copper is an essential nutrient, organisms have mechanisms to excrete it making it less persistent in the environment (Campbell et al 1988). Tributyltin breaks down slowly and tends to bioaccumulate in organisms and biomagnify up the food chain. Over time, tributyltin could accumulate at the site unless water currents, sediment scour or burial remove it from the system. The use of antifouling paints is considered necessary because marine invertebrates colonize ship hulls reducing the streamlining of the vessel and potentially damaging the hull. Antifouling paints can serve to protect local marine resources by reducing the introduction of non-native species from ship hulls. A study of commercial ships in Hamburg, Germany found that ship hulls contained 49 percent non-native species (Gollasch S. 2006).

Through the National Pollutant Discharge Elimination System (NPDES) permit program, Washington State limits discharges of copper from shipyard dry docks on Puget Sound (Showalter and Savarese 2005). In addition, Washington State has established surface water (freshwater and marine) criteria for copper (WAC 173-201A-240, Ecology 2006). The U.S. Environmental Protection Agency (EPA) has established water quality criteria for tributyltin (EPA 2004) and copper (EPA 2007) and regulates the sale of antifouling paints containing organotin compounds (Showalter and Savarese 2005). Washington State has not established water quality criteria for tributyltin.

Studies conducted as part of the Thorndyke Resource Operations Complex Central Conveyor and Pier Project did not address potential impacts to water quality from antifouling paints (FHM 2006, Anchor 2003, Hart Crowser 2013). Potential effects of boat antifouling paints were not addressed in the Final Environmental Impact Statement for Maury Island Glacier Northwest Gravel Mine (Jones and Stokes 2000) or the Port of Everett Final Environmental Impact Statement for the Proposed Satellite Rail/Barge Transfer Facility (Port of Everett 2004). In general, sites where concentrations of anti-fouling paint biocides in sediment or water are an issue with regard to exceeding toxicity thresholds include heavy shipping lanes, busy ports and harbors or marinas (Schottle and Brown 2007, Seligman et al. 2004, Strand and Jacobsen 2000). Several studies provide methods of estimating leaching rates from ships hulls (Sandberg et al. 2007).

PETROLEUM HYDROCARBONS

Actions at the project site listed as having a probable likelihood to affect marine water quality with respect to levels of petroleum hydrocarbons are oil and fuel spills or leaks from vessels entering and leaving Hood Canal and the pier loading facility. Petroleum-derived diesel is composed of approximately 75 percent saturated hydrocarbons (e.g., paraffins including n-, iso-, and cycloparaffins), and 25 percent aromatic hydrocarbons (including polycyclic aromatic hydrocarbons [PAHs] such as benzo[a]pyrene and chrysene)) (ASTDR 1995). PAHs are the most potentially toxic fraction of diesel fuel (EPA 2008). PAHs are a group of greater than 100 chemicals formed from chemical processes in natural crude oil and coal deposits and during incomplete burning of oil and gas, coal, garbage, and other organic substances (ATSDR 1996). Most PAHs have low solubility in water and therefore are commonly found associated with suspended or bottom sediments (ATSDR 1996). Understanding the toxicity of PAHs to aquatic life is difficult because PAHs exist as complex mixtures of many different compounds (EPA 2008). Effects of PAHs on benthic invertebrates include inhibited reproduction, delayed emergence and mortality (EPA 2008). Fish exposed to PAHs exhibited fin erosion, liver abnormalities, cataracts, and reduced immune function (ATSDR 1996). EPA regulates PAHs in marine waters through the establishment of water quality criteria for individual PAHs (EPA 2008).

The Thorndyke Resource BE states that fuel spills during construction and operation of the conveyor are possible (Hart Crowser 2013, Pentec 2003). Short term increases in concentrations of petroleum hydrocarbons can be expected if fuel spills or leaks occur. The Thorndyke Resource BE also indicates that because fueling of vessels will not occur at the site the volume of the spill(s) will be limited to that contained in the vessel and therefore “potential impacts to water quality from small spills or leaks are possible, but are unlikely to have long-term impact” (Hart Crowser 2013, Pentec 2003).

The Port of Everett Final Environmental Impact Statement for the Proposed Satellite Rail/Barge Transfer Facility (Port of Everett 2004) and the Port of Everett Rail/Barge Transfer Facility Biological Evaluation (Pentec 2004) acknowledge the potential for fuel spills to occur and concludes that these spills would only have temporary effects on marine water quality. At the time of the Port of Everett reports, existing water quality at the proposed Everett transfer facility site was already impacted by groundwater contamination and commercial vessel use (Port of Everett 2004). Additional information from the Final Environmental Impact Statement for Maury Island Glacier Northwest Gravel Mine indicates that “Normal operations of the vessels do not result in significant spillage of petroleum products. As with any boat, tugs would release oil and diesel into the water from their exhausts. The small amounts would disperse quickly. Currents would move and dilute such inputs and any one area is unlikely to be impacted repeatedly.” (Jones and Stokes 2000).

Although diesel fuel would likely be the primary petroleum product spilled from boats and other related equipment, understanding the fate of an oil spill in the marine environment (especially the saturated and aromatic hydrocarbon components) can help inform the fate of diesel in that environment. Within ten minutes of oil spilling into marine waters, the oil will disperse quickly into a 1 centimeter (cm) film (Stanislav 1999). The film continues to spread until it is thinner than 1 millimeter (mm). In the first few days after a spill, the light and volatile components of the oil transform into the gaseous phase and water soluble components of the oil dissolve into the water (Stanislav 1999). If an oil spill occurs close to shore it can soak into shoreline and intertidal sediments where it can persist for years depending on sediment composition and exposure to waves and weathering (Sauer et al. 1998).

The risk of boat accidents and the resulting nature of the spills has not been studied. Future studies, or analysis, assumed to be required as part of the National Environmental Policy Act (NEPA) process will help to estimate the potential frequency and magnitude of fuel spills from barge and ship/barge traffic coming and going from the pier. The fate and transport of fuels, once they enter into marine waters in the vicinity of the project site has not yet been evaluated.

NUTRIENTS/BACTERIA AND EXOTIC SPECIES

The 1992 Clean Vessel Act (US Code 1992) identifies untreated vessel sewage discharges as “a substantial contributor to localized degradation of water quality in the United States.” Compared to sewage treatment plant discharges, the concentrated waste in boat holding tanks can have as much as 1000 times the amount of bacteria in the same volume of sewage (Kitsap County 2005). Gray water also contains high levels of bacteria as well as nutrients and organic matter that stimulate growth of aquatic algae and create a demand for oxygen (Kitsap County 2005). The State of Washington prohibits the discharge of any “…organic or inorganic matter that shall cause or tend to cause pollution of such waters according to the determination of the department, as provided for in this chapter.” (RCW 1987). Discharge of sewage or gray water by boats at the project site are unlikely to impact levels of fecal coliform, nutrients and organic matter in marine waters near the pier site due to the anticipated low frequency of these discharges. The Thorndyke Resource BE states that “plumes of (potentially discharged) gray water are expected to disperse quickly in the substantial currents present in this portion of the canal, and no short-term acute or chronic effects on biota are likely” (Hart Crowser, 2013). No supporting documentation or quantitative analyses for this statement were provided.

The Final Environmental Impact Statements for the Port of Everett Proposed Satellite Rail/Barge Transfer Facility and Maury Island Glacier Northwest Gravel Mine did not address potential impacts from discharges of sewage or gray water (Jones and Stokes 2000, Port of Everett 2004).

The characterization of coastal processes currently being conducted by Coast and Harbor Engineering (2008) seems to indicate that tidal currents (maximum flows of 0.55 m/s or 1.8 ft/s) at the site will carry away and dilute discharges of sewage or gray water thereby minimizing long-term impacts on levels of nutrient and bacteria at the site.

Ballast water is not likely to be a significant source of nutrients or harmful bacteria like *Escherichia coli*, however ballast water from international or out-of-state vessels can potentially contain exotic species of marine organisms which may include the larvae of fish and benthic invertebrates. Large vessels can carry more than 200,000 cubic meters of ballast water and hundreds of millions of live organisms (Foss et al. 2007). The State of Washington prohibits the discharge of ballast water from vessels unless there has been an open sea exchange of water or the ballast water is treated to ensure removal of 95 percent of zooplankton organisms and 99 percent of phytoplankton and bacteria (WAC 2001, RCW 2000). Potential illegal discharges of untreated ballast water from foreign vessels at the site would likely negatively impact the marine ecosystem of Hood Canal if any exotic species were to become established.

The 1992 Clean Vessel Act (US Code, 1992) identifies untreated vessel sewage discharges as "a substantial contributor to localized degradation of water quality in the United States." Gray water also contains high levels of bacteria as well as nutrients and organic matter that stimulate growth of aquatic algae and create a demand for oxygen (Kitsap County, 2005). The State of Washington prohibits the discharge of any "…organic or inorganic matter that shall cause or tend to cause pollution of such waters according to the determination of the department, as provided for in this chapter." (RCW, 1987).

Discharge of sewage or gray water by boats at the project site are unlikely to impact levels of fecal coliform, nutrients and organic matter in marine waters near the pier site due to the anticipated low frequency of these discharges.

A summary of water quality issues, sources, likelihood of impacts has been prepared in a tabular form. This material is carried forward in to the DEIS.

TABLE 1. WATER QUALITY ISSUES

Water Quality Parameter	Potential Causes/ Sources[1]	Likelihood of Incident/Action Occurrng[2]	Likelihood of Potential Impact[3]	Supporting Literature/Studies
Turbidity	Prop wash due to intermittent and ongoing boat/barge traffic.	**Likely** – Prop wash from tugs has a high probability of occurring during routine docking, undocking and loading in the vicinity of the pier.	**0 to 10 inches Unlikely** - Because the sediment grain size down to 10 inches depth in the area of the proposed conveyor and pier loading facility is medium to fine sand particles, disturbed sediments will settle to the bottom quickly and should not create damaging levels of turbidity. Glacially consolidated soils in this area would also make propwash a lot less likely. **Deeper than 10 inches Unlikely** - The presence of fine particles that could be resuspended from sediments below 10 inches are unlikely. Modelling of prop wash combined with the barge/tug layout makes deeper sediment disturbance unlikely.	Anchor 2003; Coast and Harbor 2008, GeoEngineers 2008
	Increased stormwater runoff from pier facility and conveyor in the nearshore area.	**Unlikely** – Stormwater runoff from new impervious surfaces as a result of the pier loading facility, conveyor and associated structures has a high probability of occurring but it will be captured and treated before flowing over the slope into a diffuser discharge system.	**Unlikely** – Quantitative data on frequency and magnitude of occurrence of stormwater runoff is needed to determine that potential impact is unlikely.	[1]Coast and Harbor 2008
	Incidental spills of gravel from the conveyor and pier structure.	**Likely** – Small incidental spills of sand and gravel from the conveyor and pier structure will likely occur at a low frequency.	**Unlikely** – the structurally enclosed conveyor and containment systems that will be used on the barges and ships will reduce the potential for spills. In addition the percent fines content of the sand and gravel is low (2-6%) reducing the likelihood of exceeding turbidity criteria if a spill occurs.	Hart Crowser 2013
	Temporary pier and nearshore conveyor construction activities	**Likely** – Temporary construction activities have a high probability of occurring with all marine (in-water) construction projects.	**Likely** – Short-term sediment disturbance will occur during construction of the conveyor piers and associated pile support structures.	Pentec 2003; Jones and Stokes 2000; Coast and Harbor 2008

Water Quality Parameter	Potential Causes/ Sources[1]	Likelihood of Incident/Action Occurrng[2]	Likelihood of Potential Impact[3]	Supporting Literature/Studies
Metals/ Organotins	Leaching of metals and tributyltin from coatings on boats/barges that are in direct contact with the water column.	**Likely** – Almost all marine vessel hulls in contact with the water are coated with anti-fouling paints containing various levels of metals/organo-metals designed to prevent growth of marine organisms. Tributyltin has historically been used for this but is slowly being replaced by other metals (lead, copper) because of its high toxicity to marine organisms and persistence in the marine environment.	**Unlikely** – Leaching of some metals/organo-metals from vessel hulls will occur, however in general, only heavy shipping sites (shipping lanes, busy ports and harbors or marinas) seem to be areas of concern with regard to exceeding toxicity thresholds of metals and organotins in sediment or water.	Sandberg et al. 2007; Schottle and Brown 2007; Seligman et al. 2004; Strand and Jacobsen 2000
Petroleum Hydrocarbons	Oil and gasoline/diesel spills due to accidents.	**Unlikely** – The probability of a catastrophic spill as a result of boat or barge collisions and/or accidents is low.	**Short-term impacts likely, long-term impacts unlikely** – An agency-approved spill prevention and response plan, to be developed prior to construction, will outline measures to prevent accidents and spills and provisions for rapid containment and cleanup of a spill.	Hart Crowser 2013
	Incidental oil and gasoline/diesel leaks and contaminated rainwater runoff from boats/barges.	**Likely** – Incidental oil/grease and gasoline/diesel coming from precipitation runoff from boat/barge surfaces or small leaks or spills has a high probability of occurring.	**Unlikely** – On-going incidental inputs of PAHs from up to six barges or ships a day will occur, however operating procedures such as rapid clean-up of oil, gasoline, and diesel on the pier and vessels and repair of leaks, in addition to implementation of BMPs will reduce the quantity of inputs. The likely rate of loading is anticipated to be low enough that the receiving environment can evaporate, dilute, metabolize, and assimilate the PAHs.	Hart Crowser 2013
	Increased discharge of petroleum or exhaust products from idling automobile traffic on Hood Canal Bridge during bridge closures for barge/boat traffic.	**Unlikely** – Barge/boats will disrupt automobile traffic on the Hood Canal Bridge very infrequently when compared to the total amount of time the bridge is open to traffic.	**Unlikely** – Automobile traffic will release insignificant levels of oil/grease if idling on the Hood Canal Bridge as a result of barge/boats passing through the Canal.	Heath 2011

Water Quality Parameter	Potential Causes/ Sources[1]	Likelihood of Incident/Action Occurrng[2]	Likelihood of Potential Impact[3]	Supporting Literature/Studies
Nutrients, Bacteria, and Exotic species	Release of gray water (sewage) from vessels with resulting inputs of nitrogen/ phosphorus and bacteria into Hood Canal.	**Likely but low frequency**– Only treated sewage or gray water may be discharged within 3 miles of shore. Accidental releases of untreated gray water/sewage may occur but are expected to be unlikely.	**Unlikely** – Restrictions on the discharge of sewage and gray water and tidal currents at the site will minimize risk of localized nutrient or bacteria pollution problems.	Pentec 2003; WAC 2001; RCW 2000; Foss et al. 2007; 33 USC § 1322
	Discharges of untreated ballast water introducing exotic species to Hood Canal.	**Exotic Species, Unlikely** – It is illegal to discharge untreated ballast water in Washington State.	**Exotic Species, Unlikely** – International or out-of-state vessels are unlikely to illegally discharge untreated ballast water. All vessels of 300 gross tons and greater, except military vessels, must file a ballast water reporting form 24 hours prior to entering state waters. Vessels operating locally should not contain exotic species. Illegal discharges would harm the ecosystem of Puget Sound but they are unlikely.	RCW 2000; 33 CFR Part 151; 46 CFR Part 162
Dissolved Oxygen	Release of gray water (sewage) from vessels with resulting inputs of nitrogen and phosphorus into Hood Canal which is already limited for dissolved oxygen (DO) concentrations.	**Likely but low frequency**– Only treated sewage or gray water may be discharged within 3 miles of shore. Accidental releases of untreated gray water/sewage may occur but are expected to be unlikely.	**Unlikely** – Low frequency of discharges, restrictions on the discharge of sewage/gray water and tidal currents at the site will minimize risk of locally elevated nutrient levels and concentrations of organic matter that could lead to oxygen depletion.	Pentec 2003; WAC 2001; RCW 2000; Foss et al. 2007; 33 USC § 1322

Notes:

[1] Impacts not addressed: potential long-term marine water quality impacts due to upland land use changes or activities within the Hood Canal watershed that may occur in the future if this project is approved.

[2] **Likely**: Sufficient existing information to conclude that activity or action has a high probability of occurring. **Unlikely**: Sufficient existing information to conclude that activity or action has a low probability of occurring. **Unknown**: Insufficient existing information to conclude that activity or action has a low probability or high probability of occurring.

[3] **Likely**: Sufficient existing information to conclude that impact from that activity or action is probable and therefore this potential impact should be evaluated in the EIS. **Unlikely**: Sufficient existing information to conclude that activity or action has a low probability of occurring and that impact is improbable OR that there is not precedent for addressing this impact for a project with this scale and scope and therefore this potential impact should not be evaluated in the EIS. **Unknown**: Insufficient existing information to determine likelihood of impact and therefore this impact should be evaluated in the EIS after collection of more data and/or information.

Construction Direct and Indirect Impact Analysis

Stormwater runoff from developed portions of the upland areas could increase discharges to the nearshore, which could affect water quality within the intertidal zone.

It is anticipated that a small amount of soil may be suspended in the water column during pile driving, barging and other construction activities because of the granular nature of the existing material. Turbidity may occur within the immediate vicinity of construction activities. However, local currents and tidal action are expected to quickly disperse the locally derived suspended sediment. Dissolved oxygen levels in marine waters are not anticipated to be significantly altered during construction.

Minor increases in turbidity could also result from propeller wash from ships conveying construction barges to and from the overwater conveyor during construction. Scouring impacts from propeller wash would be short-term, localized and have minor and temporary impacts on turbidity, shoreline processes or beach stability.

Fuel spillage during construction activities and operation of the conveyor is possible. Fueling of vessels will not occur on site, any spill or leak would be limited to that contained within the tug or ship (barges do not contain fuel). Best management practices (BMP) will be implemented in marine areas to minimize the risk of fuel spills and other potential sources of contamination. An agency-approved spill prevention and response plan including provisions for on-site containment equipment (including a boom) will be developed to govern any construction activities. Spill prevention and spill response procedures will be maintained throughout operation of the conveyor. Such spills or leaks are possible but unlikely to have any long-term impact on water quality.

Operations

Minor increases in turbidity could result from propeller wash from tugs escorting barges and ships to and from the pier. Results of the PROPWASH model show that scouring of bed sediment due to propeller wash may occur in waters shallower than 50 feet (Anchor, 2003). Once the site is operational, project tugs will generally operate in waters depths of 75 feet or greater. Assuming that propeller depth, boat orientation and other boat and operating specifics are the same as those modeled in the Anchor PROPWASH study, scouring impacts from propeller wash would likely be short-term, localized to the immediate area and have no significant adverse impact on turbidity, shoreline processes or beach stability (Anchor, 2003). Without significant scouring impacts, resulting turbidity will be minimal, transient, highly localized, subject to the composition of the substrate materials and tidal dispersion, and expected to fall within state turbidity criteria.

Sanitary facilities located at the end of the pier will be pumped out, maintained, contained and disposed at an upland facility. There will be no discharge of materials from sanitary facilities to the marine environment. BMPs will be implemented to install work practices to avoid spills and leaks. Similarly, adherence to BMPs as well as a Marine Operations Plan will minimize potential fuel and contaminant spills from tugs, barges and ships during loading operations.

Among other restrictions, rules require vessels involved in coastal trade to report and conduct ballast water exchange at least 50 miles offshore before being allowed to discharge ballast into waters of the state.

Mitigation Measures

Impacts from stormwater discharges from the anticipated cut area on the bluff will be evaluated and minimized/prevented through a geotechnical and civil engineering design. Stormwater will be likely captured and treated before flowing over the slope crest and routed to a vault with catch basins and a diffuser system before final discharge onto the nearshore.

The conveyor will be enclosed over the entire overwater route to minimize potential aggregate spills onto the intertidal and shallow subtidal zones.

Routine and site-specific BMPs will be implemented during project construction and operation. Specific measures will be determined during the final design and construction phases of the project. Proposed measures will include those associated with grading, soil management and erosion control; stormwater and wastewater management; spill prevention, control and recovery; solid waste management; concrete use; dust control and vegetation management, including control of non-indigenous species. Anticipated measures will be similar to those developed by King County, Ecology and the Washington State Department of Transportation (WSDOT) (King County, 2013; Ecology, 2012; WSDOT, 2011). The selected measures also will comply with requirements of Ecology's Section 401 Water Quality Certification issued for the project. A comprehensive description of proposed BMPs will be included in the forthcoming Construction Management and Mitigation Plan (CMMP).

Unavoidable Adverse Impacts

Aggregate or fuel spills could cause avoidance of the area by juvenile salmon, resident marine fish and marine mammals, but the conveyor design and implemented BMPs make any such impacts remote, temporary and of small scale.

Sincerely,
GeoEngineers, Inc.

Fiona McNair
Aquatic Scientist

Lisa A. Berntsen
Principal

LEK:LAB:lc:leh

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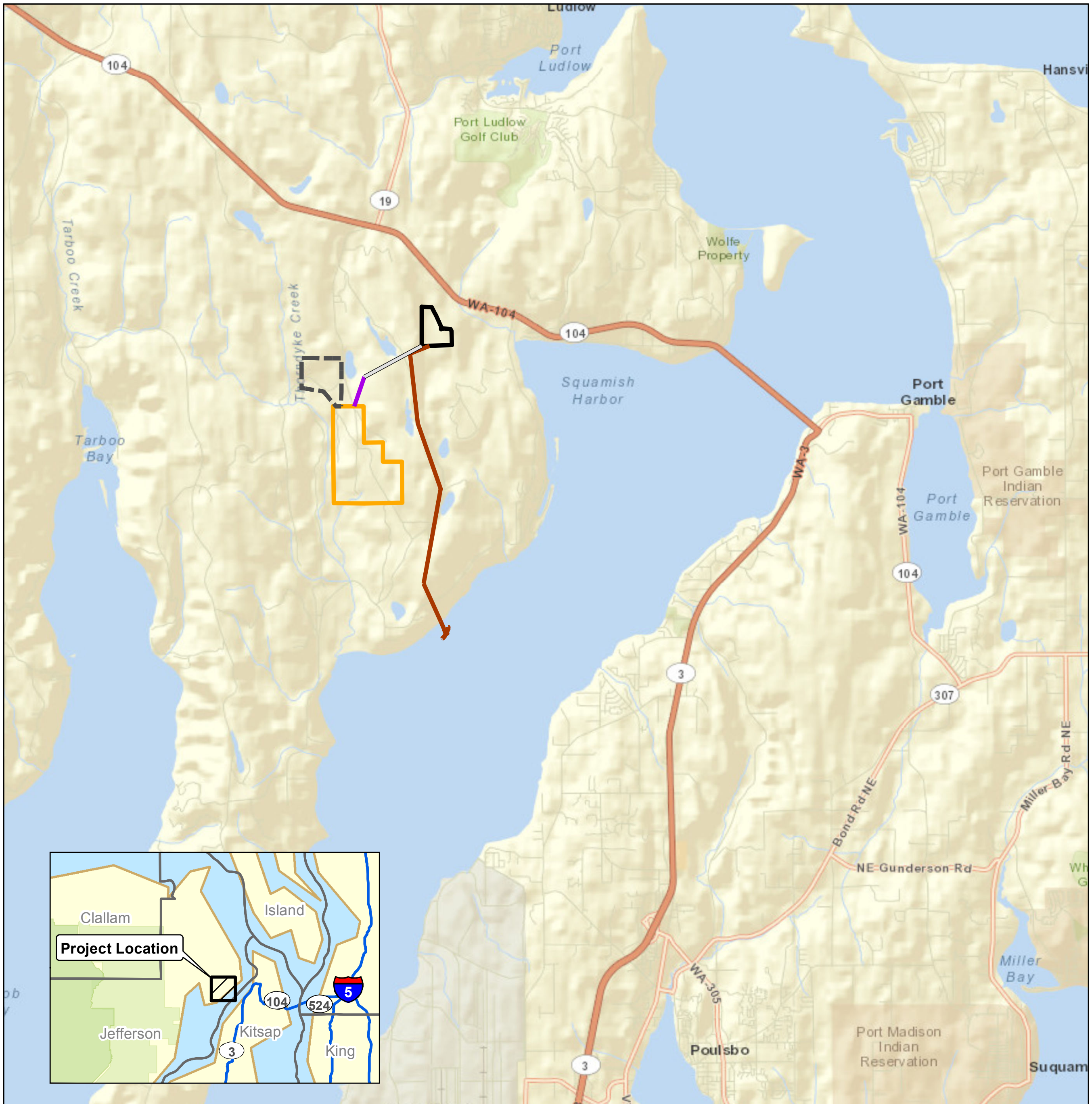
Attachments:

Figure 1. Vicinity Map

Figure 2. 303(d) Water Quality Listings Thorndyke Resource Project

Figure 3. Sieve Analysis

One copy submitted electronically



Little Wahl Conveyor
Central Conveyor
Wahl Conveyor
Meridian Extraction Area Boundary
Shine Operations Hub
Wahl Exraction Area

N
W E
S

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Miles

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Sources: ESRI Data & Maps, Street Maps 2008.
Base map from ESRI Data Online.
Projection: NAD 1983, UTM Zone 10 North.

Vicinity Map

Thorndyke Resource
Jefferson County, Washington

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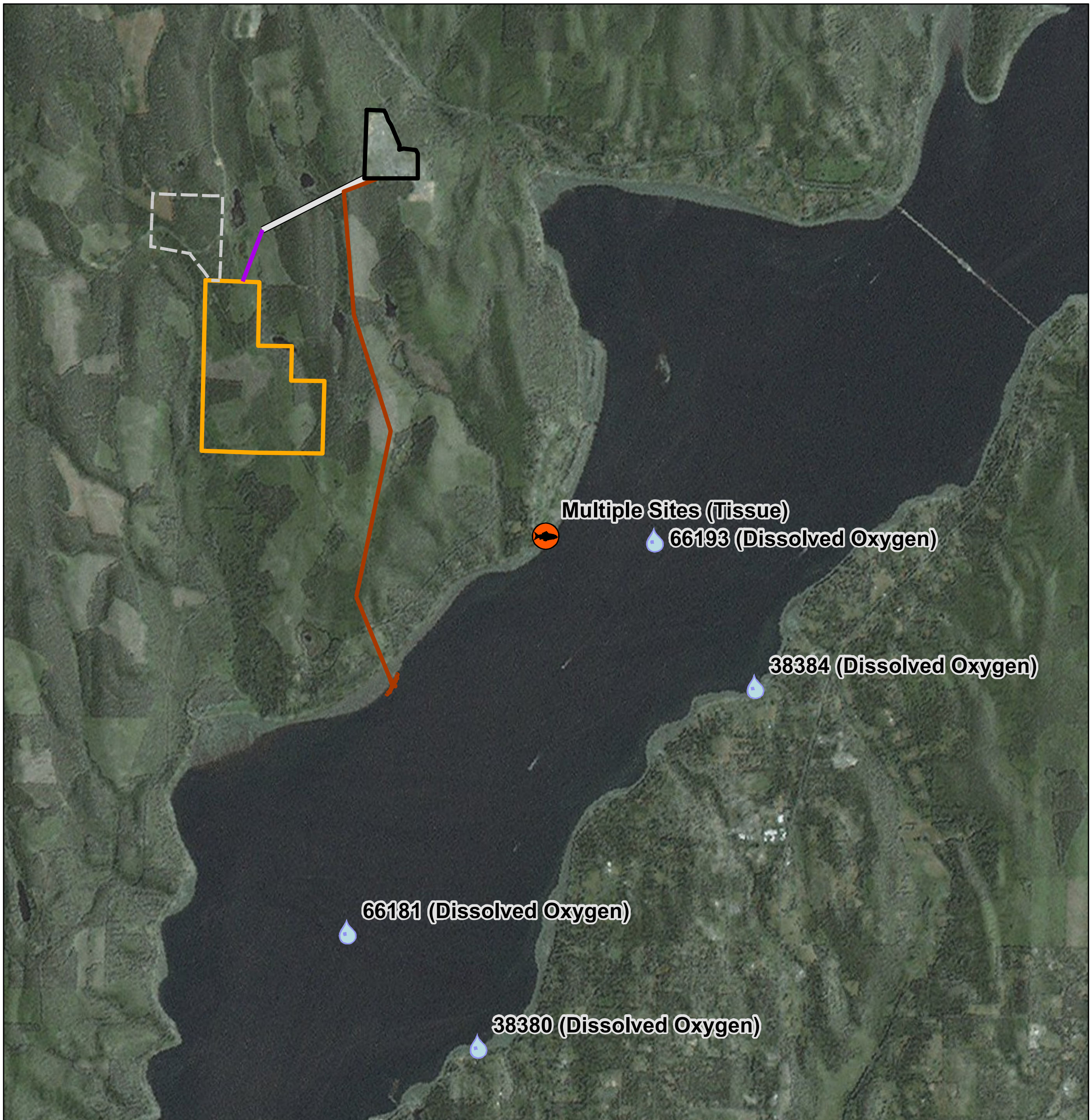
Figure 1

Office: PORT Path: P:\12\12060001_GIS\MXD\1206000101_F1_WaterQuality.mxd Map Revised: 05 February 2014 ccabrera



Little Wahl Conveyor
Central Conveyor
Wahl Conveyor
Meridian Extraction Area Boundary
Shine Operations Hub
Wahl Exraction Area

Impairment (303D)
Dissolved Oxygen
Tissue

N W E S

0 6,000
Feet

Data Source:
303D GIS data from Washington Department of Ecology,
Base Map from ESRI Data Online.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
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303(d) Water Quality Listings
Thorndyke Resource Project

Thorndyke Resource
Jefferson County, Washington

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Figure 2

Office: PORT Path: P:\12\12060001_GIS\MXD\1206000101_303D_WaterQualityb.mxd Map Revised: 10 February 2014 ccabrera

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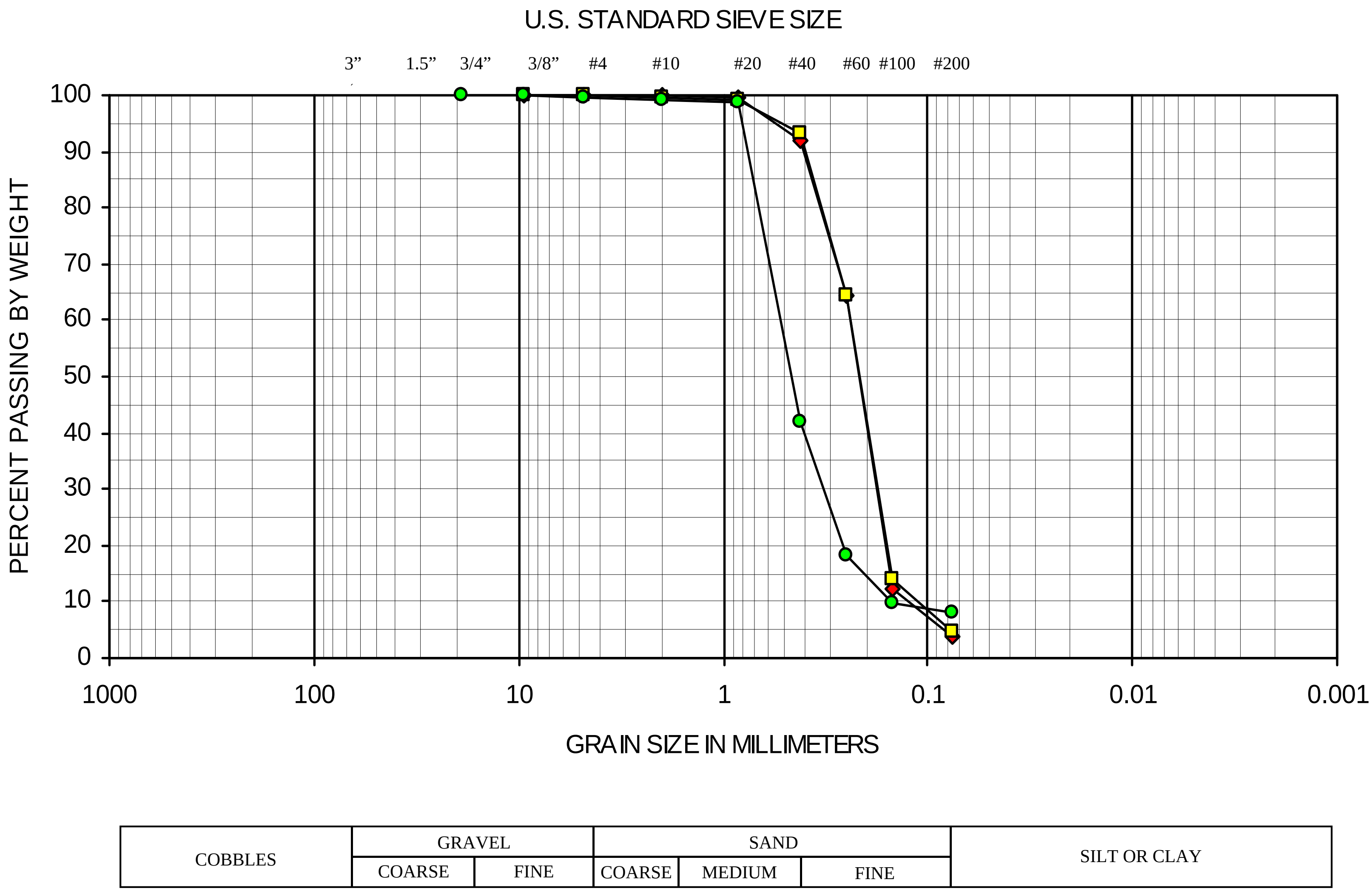
FIGURE 3

SIEVE ANALYSIS RESULTS



SYMBOL	EXPLORATION NUMBER	DEPTH (in)	MOISTURE (%)	SOIL CLASSIFICATION
Red diamond	N/A	10	37.9	Gray sand (SP)
Yellow square	N/A	20	54.3	Gray sand (SP)
Green circle	N/A	30	30.4	Gray sand with silt (SP-SM)