9-36 Shaft-Related Materials

9-36.1 Shaft Casing

9-36.1(1) Permanent Casing

Permanent casing shall be of steel base metal conforming to ASTM A 36.

9-36.1(2) Temporary Casing

Temporary casing shall be a smooth wall structure of steel base metal, except where corrugated metal pipe is shown in the Plans as an acceptable alternative material.

9-36.2 Shaft Slurry

9-36.2(1) Mineral Slurry

Mineral slurry shall conform to the following requirements:

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API 13B-1, Section 1	63 to 75
Viscosity (seconds/quart)	Marsh Funnel and Cup API 13b-1, Section 2.2	26 to 50
PH	Glass Electrode, pH Meter, or pH Paper	8 to 11
Sand Content (percent)	Sand API 13B-1, Section 5	
Prior to final cleaning		4.0 max.
Immediately prior to placing concrete		4.0 max.

Use of mineral slurry in salt water installations will not be allowed.

Slurry temperature shall be at least 40F when tested.

9-36.2(2) Synthetic Slurry

Synthetic slurries shall be used in conformance with the manufacturer's recommendations and shall conform to the quality control plan specified in Section 6-19.3(2)B, item 4. The synthetic slurry shall conform to the following requirements:

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API 13B-1, Section 1	64 max.
Viscosity (seconds/quart)	Marsh Funnel and Cup API 13b-1, Section 2.2	32 to 135
PH	Glass Electrode, pH Meter, or pH Paper	6 to 11.5
Sand Content (percent)	Sand API 13B-1, Section 5	
prior to final cleaning		1.0 max.
immediately prior to placing concrete		1.0 max.

If the product is not listed on the Qualified Products List, the Contractor shall submit a Request for Approval of Materials Source (RAM) form with the following information:

- Test data showing conformance to the properties in the table above, and
- Documentation showing that the synthetic slurry (with load-tested additives) has been approved by the California Department of Transportation (Caltrans).

9-36.2(3) Water Slurry

Water without site soils may be used as slurry when casing is used for the entire length of the drilled hole. Water slurry without full length casing may only be used with the approval of the Engineer.

Water slurry shall conform to the following requirements:

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API 13B-1, Section 1	65 max.
Sand Content (percent)	Sand API 13B-1, Section 5	1.0 max.

Use of water slurry in salt water installations will not be allowed.

Slurry temperature shall be at least 40ºF when tested.

9-36.3 Steel Reinforcing Bar Centralizers

Steel reinforcing bar centralizers shall be steel, conforming to the details shown in the Plans. The Contractor may propose the use of alternative steel reinforcing bar devices as part of the shaft installation narrative as specified in Section 6-19.3(2)B, item 9, subject to the Engineer's review and approval of such devices.

9-36.4 CSL Access Tubes and Caps

Access tubes for crosshole sonic log testing shall be steel pipe of 0.145 inches minimum wall thickness and at least 1½ inch inside diameter.

The access tubes shall have a round, regular inside diameter free of defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage of 1.3-inch maximum diameter source and receiver probes used for the crosshole sonic log tests. The access tubes shall be watertight and free from corrosion, with clean internal and external faces to ensure a good bond between the concrete and the access tubes.

The access tubes shall be fitted with watertight threaded PVC caps on the bottom, and shall be fitted with watertight PVC caps, secured in position by means as approved by the Engineer, on the top.

9-36.5 Grout for CSL Access Tubes

Grout for filling the access tubes at the completion of the crosshole sonic log tests shall be a homogeneous mixture of neat cement grout and potable water, conforming to Section 9-20.3(4), except that the maximum water/cement ratio shall be 0.45.

Department of Ecology Guidance:
Disposal of Synthetic Polymer Slurry Waste from Shaft Drilling Operations

Scope:

The Washington State Department of Ecology (Ecology) developed this document to provide guidance to the Washington State Department of Transportation (WSDOT) and its contractors on appropriate methods of managing liquid waste from large diameter drilling operations at WSDOT project sites. The document focuses on the disposal of liquid wastes generated at projects using synthetic polymer slurries as a drilled shaft stabilizing fluid. This document does NOT address disposal or reuse of solid or semi-solid material from shaft drilling operations. Ecology's Waste2Resources Program will develop separate guidance regarding the proper disposal or reuse of solids from drilling projects.

Purpose:

Ecology developed this guidance to identify procedures and practices used to prepare synthetic polymer slurry waste from deep shaft drilling operations for disposal through a publicly owned domestic wastewater treatment facility (POTW). These guidelines are basic recommendations, designed to ensure that a short-term discharge of the liquid waste presents minimal risk to the receiving POTW and to the environment.

It is Ecology's opinion that the denatured waste polymer slurry is acceptable for disposal through POTWs in Washington with limitations. The pretreated waste must meet certain qualitative standards for viscosity, pH, and settleable solids. Since each POTW owner is responsible for protecting the integrity of their treatment system, acceptance of this waste is at the sole discretion of the local wastewater treatment authority. This guidance does not alter the authority of the local treatment system owners and operators to refuse discharge of the waste to their systems or to set standards that may be more restrictive than the standards recommended in this document.

Due to concerns with increased potential of slug loading at smaller plants, facilities operating with daily average flows of 0.5 million gallons per day (MGD, or 500,000 gallons per day) or less must seek concurrence from their regional Ecology office prior to accepting the waste. To minimize the potential release of untreated wastes, sewer agencies operating combined sewer systems must not allow discharge of the waste into the combined portions of their collection system during wet weather periods when combined sewer overflows are likely to occur.

Waste Polymer Treatment and Disposal Process Overview:

The following provides an overview of the steps contractors and the local treatment authorities will generally take to prepare for a short-term discharge of treated waste polymer from a construction site. These steps represent a "typical" process common to most wastewater treatment authorities in the state. However, this list is not intended to be an exclusive list of procedures. Interactions between contractors and local treatment authorities will vary between jurisdictions.

1. *Pre-construction:* Contractor must contact local wastewater treatment authority before starting construction to start negotiating a short-term agreement to discharge wastewater to local treatment system. The local treatment authority will provide the contractor with specific conditions, limitations, testing requirements and fee schedules for the discharge. This guidance document includes model language that Ecology recommends local treatment

authorities include in their agreements. However, each treatment authority has the discretion to choose which portions of the model language, if any, are appropriate for their systems. Ecology also expects the local treatment authorities to modify the suggested language or add conditions to their agreements that they believe are appropriate to protect their treatment systems.

2. *During Construction:* To minimize delays between the end of construction and disposal, the contractor must work with local treatment system staff during construction to finalize logistical details for on-site treatment and disposal. Details will include, but are not limited to, identifying an appropriate discharge location, establishing site-specific list of equipment and methods contractor will use to treat and pump waste, developing a testing schedule for the pre-treated waste and establishing a communication list for both parties to use. The local treatment authority may choose to record logistical details in the short term discharge agreement or will track the details in other documents available to the contractor.

3. *Post-construction, on-site treatment:* Once shaft construction is complete, the contractor will consolidate used polymer into process storage tanks for treatment with hypochlorite. The contractor must also notify the local treatment authority contacts at this time to let them know that project is nearly ready to begin discharging waste. If not already completed, the contractor and local treatment authority must complete and sign the short-term discharge agreement for the waste.

   To treat the waste, the contractor will add hypochlorite to the storage tanks to break down the polymer's chemical structure. The contractor may use either dry calcium hypochlorite at a minimum ratio of 15 pounds per 10,000 gallons, or liquid sodium hypochlorite (10-12% concentration) in a minimum ratio of 6-8 gallons per 10,000 gallons of waste. The contractor must use mechanical mixing to ensure complete treatment of each tank of polymer waste. One polymer manufacturer (Cetco) recommends using pumps to circulate the waste during treatment to ensure complete mixing; this method has support from two of Washington's largest treatment authorities (King County and City of Tacoma). The contractor may use other methods of mixing if they can demonstrate to the local treatment authority that the proposed method results in complete mixing of the entire tank contents. The contractor must continue to mix the waste until the viscosity of the fluid measures in the range of 26-30 seconds per quart (sec/qt) in a Marsh Funnel Viscosity [1]test. The contractor may increase the amount of hypochlorite used if waste viscosity is higher than the acceptable range after initial minimum dosing. After viscosity of the complete tank meets the target range, the contractor will halt mixing and allow the tank to sit for a minimum of 24 hours so any residual solids disturbed by mixing can settle.

   Once the contractor has completed treatment, the local treatment authority will verify that the waste meets acceptable standards for discharge. The contractor must demonstrate using a testing acceptable to the treatment authority that the waste liquid viscosity is within the range of 26-30 sec/qt., complies with a settleable solids standard of 7.0 ml/L, and pH is within the range of 5.0 to 11.0. The contractor must also present results from all other testing required

[1] Viscosity determined in the field using Marsh Funnel Viscosity testing protocols established in American Petroleum Institute's Standard 13b-1, Section 2.2 or ASTM Standard D6910.

by the local treatment authority in the short term discharge agreement. Additional testing will be based on the specific needs of the individual treatment plant. Examples of additional testing parameters could include: turbidity and/or total suspended solids, total dissolved solids, ammonia, total kjeldahl nitrogen (TKN), total hardness, sodium concentration, or site-specific priority pollutant testing for metals or other toxins (priority pollutant testing may be required when construction site has known or suspected contamination).

4. *Discharging Waste to POTW:* After the local treatment authority staff verify that the waste meets acceptable discharge standards, the contractor may start discharging the waste to the location specified in the short term discharge agreement. The contractor must use pump equipment that will not exceed the discharge flow rate listed in the short term agreement and must ensure that the pump's intake will not pull in settled solids from the bottom of the storage tanks. Ecology recommends the following operational conditions in the model discharge agreement: limit discharge only to the hours when treatment plant is staffed, limit discharge to a maximum of one 20,000 gallon storage tank per day, contractor must monitor the discharge for high turbidity (sign of solids being taken up by pump) or high viscosity (sign of incomplete treatment). The contractor must immediately stop discharging and notify the treatment plant staff if the pump begins to draw in settled solids or if there is evidence of layers of untreated polymer waste in the tank. The contractor must also immediately comply with any directives from the treatment plant staff to cease discharging. If a spill occurs during the discharge, the contractor must immediately cease the discharge, contain and clean up the spill, and notify the local treatment authority and Ecology.

   The contractor must handle all residual solids in the storage tanks according to local solid waste regulations and may not discharge residual solids to the wastewater treatment plant. Ecology acknowledges that some entrainment of solids may occur as the liquid level reaches the bottom of the storage tanks. The contactors must take reasonable measures to minimize the discharge of solids, including stopping pumping before reaching the bottom of the tank. Discharging large concentrations of solids to the treatment plant is a violation of the short term agreement with the local authority and may be subject to penalties as allowed in local sewer ordinances. If a discharge of residual solids contribute to an effluent violation at the POTW, the contractor could be liable for additional state or federal penalties as allowed by the Clean Water Act.

<u>Model Short-term Discharge Agreement Language:</u>

While each discharge scenario will require a unique agreement with site-specific conditions, Ecology recommends the following model language be included in agreements between local treatment authorities and the contractor:

1. Contractor will limit the discharge period to normal treatment plant operating hours to ensure both contractor and plant staff are available to address problems that might arise immediately.

2. Contractor will limit discharge flow rate to the lowest rate determined by the following calculations:

    a. 10% of the average flow rate for the collection system drainage basin into which the waste is discharged;

   b. 5% of the average daily flow into the treatment plant for the time of year the discharge occurs;
   c. maximum rate of 50 gallons per minute.

3. Contractor will restrict the discharge volume to no more than one storage (storage) tank per day; approximately 20,000 gallons.

4. Contractor must establish pumping procedures that minimize disturbing the sludge layer at the bottom of the storage tanks. Contractor must take all reasonable steps to avoid discharging sludge to the treatment plant.

5. The contractor must immediately cease discharge upon either verbal or written request from the treatment plant staff.

6. Contractor must handle the discharge in a manner that prevents accidental release into any surface water or stormwater collection system. Release of slurry materials to any Waters of the State is expressly prohibited in the construction stormwater general permit and is considered a violation of RCW 90.48.080. If an accidental release to surface water or stormwater occurs, the contractor must take immediate steps to cease the discharge and contain the spill. The contractor must also notify the local treatment authority and Ecology of the spill within 24 hours of the incident.

<u>Ecology Regional Office Phone Numbers:</u>

Northwest Region - 1-425-649-7000
(Island, King, Kitsap, San Juan, Skagit, Snohomish, and Whatcom counties)

Southwest Region - 1-360-407-6300
(Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, and Wahkiakum counties)

Central Region - 1-509-575-2490
(Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, and Yakima counties)

Eastern Region - 1-509-329-3400
(Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, and Whitman counties)

Technical Summary: Synthetic Polymer Slurry Waste from Shaft Drilling Operations Using WSDOT Standard Specifications

Background:

In an average year, WSDOT constructs about 150 large-diameter drilled shafts to support bridge foundations and retaining walls associated with transportation projects. Shafts are generally uncased, 30 to 200 feet deep, and 2 to10 feet in diameter. Drilling contractors use a process known as "slurry drilling" to excavate shafts on sites with wet and unstable geological formations. The process uses thousands of gallons of a slurry liquid to stabilize the shaft walls. Depending on the site geology, drilling contractors will either use water as the base slurry liquid or they will use fluids containing synthetic polymers. Ecology's disposal guidance pertains only to systems using synthetic polymer drilling fluids.

Two synthetic slurry systems are currently approved by WSDOT for use in drilled shaft construction in the state: CETCO's Shore Pac Polymer Slurry and KB International's SlurryPro. The Shore Pac system uses a sodium acrylate-acrylamide copolymer to form the base slurry fluid. SlurryPro is classified as a vinyl polymer. In addition to the base polymer fluid, each system may include additives that improve drilling performance or aid in shaft wall stability. Attachment 1 includes a summary of potential additives for both approved systems. Both slurry systems typically produce between 60,000 and120,000 gallons of polymer-based slurry waste for each project, depending on the size of the shafts drilled.

Shaft drilling contractors use a closed-loop process to recover and reuse the polymer slurry on a project until all required shafts are drilled. The process uses several storage tanks connected in series to contain the active slurry during drilling. After completing the last shaft the contractors will contain the slurry in the storage tanks until disposal.

Drilling operations produce two dominant waste streams: solid waste comprised of drilling spoils, and liquid waste comprised of spent polymer slurry. The liquid waste, which is the focus of this document, is a highly viscous combination of the base polymer, additives and water. While the base polymers are generally non-toxic substances that are often used in water and wastewater treatment systems, the liquid waste from drilling operations meets the broad definition of "pollutant" as defined in Chapter 90.48.020 of the Revised Code of Washington (RCW). State law defines pollutant as a "contaminant, or other alteration of the physical, chemical or biological properties, of any waters of the state". Chapter 90.48.080 RCW prohibits the discharge of pollutants to "waters of the state," which includes all freshwater and marine water bodies, groundwater, wetlands and stormwater systems that discharge to state waters. Contractors may, however, enter into agreements with local wastewater treatment authorities for treatment and disposal of the waste through a POTW.

Waste Characterization and Treatability

The physical and chemical characteristics of the waste slurry render it unacceptable for direct discharge into domestic sewer systems without preliminary treatment by the drilling contractor. According to product literature for the two slurry products approved for use in Washington, typical Marsh Funnel Viscosity of an operating slurry drilling system range between 50 sec/qt to 150 sec/qt (typical Marsh Funnel Viscosity of water is approximately 26 sec/qt). Domestic wastewater collection and treatment systems are not designed to handle high viscosity liquids. The high viscosity of the slurry mixture can prevent the waste from flowing properly through sewer collection systems and contribute to system overflows due to pump fouling and blockages.

High concentrations of polymers can also disrupt normal treatment operations at POTWs, leading to plant upsets. Although POTWs often use similar polymers to enhance their treatment process, they do so using low concentrations that are added at a controlled rate into specific stages of the process. Uncontrolled slug-loading of polymers at the front end of the plant can cause a variety of problems in the mechanical and biological systems of the plant that will result in decreased treatment efficiency. Because of the risks to the treatment system from high concentrations of acrylamide and vinyl polymers, the drilling contractor must pre-treat the waste polymer mixture with a strong oxidizer. The pretreatment process decreases viscosity and breaks down the base polymer chemical structure to forms that are more easily removed in the POTW's biological processes. A pretreatment strategy most commonly recommended by the slurry manufacturers is to oxidize the waste polymer with hypochlorite.

At Ecology's request, WSDOT coordinated testing of denatured polymer slurry waste from projects located in Tacoma and Monroe. The first round of testing, completed in April 2011, provided limited, preliminary data on waste generated at the US 2/SR 522 Interchange Widening Project in Monroe. The project used SlurryPro as the polymer system. The second round of testing, completed in August 2011, provided detailed analysis of conventional and priority pollutants in wastes generated at the I5-Portland Avenue to Port of Tacoma HOV expansion project in Tacoma. This project used both approved slurry systems (SlurryPro and ShorePac). The pollutant testing done at each site did not attempt to identify the source of pollutants. The test goals were to identify whether typical wastes from projects using polymer slurry systems contained pollutants of concern and, if so, whether the concentrations exceeded acceptable levels for treatment at a POTW.

The test results indicate that the waste is acceptable for disposal through a POTW when properly pretreated with hypochlorite. The results identified detectable levels of several priority pollutant metals. However, metals concentrations are lower than the local limits established by many municipalities in Washington. Test results also indicated that the waste exhibits low to moderate chemical oxygen demand, has moderate to high concentrations of total suspended solids (TSS), moderately high pH, and contains high concentration of chloroform. Attachment 2 summarizes the results of testing coordinated by WSDOT.

Ecology acknowledges that the chloroform in the pretreated waste, as shown in Attachment 2, exceed benchmark levels established by King County. In addition, TSS concentrations are higher than levels typically found in domestic wastewater. Ecology believes that the dilution provided by limiting flow based on condition #2 in the Model Agreement will mitigate concerns with high concentrations of chloroform and TSS. However, each local treatment authority has the discretion to require additional treatment to decrease chloroform and TSS concentrations prior to discharge to their systems.

<u>Preliminary Treatment by Contractor</u>

Drilling contractors must treat the waste slurry on site to make it acceptable for disposal through a POTW. This preliminary treatment typically uses hypochlorite to oxidize the base polymer molecule. Oxidation decreases the fluid viscosity and breaks down the coagulating properties of the polymer. Once properly denatured, the waste liquid viscosity will decrease to approximately 26-30 sec/qt, which is a typical range for water. While testing shows that the denatured liquid contains detectable levels of many priority metals and some volatile organic pollutants, the concentrations are at levels acceptable for further treatment at a POTW.

Slurry pretreatment uses hypochlorite to chemically break down the base polymer molecules. Contractors may use either a dry, granular calcium hypochlorite product or concentrated liquid sodium hypochlorite (10%-12% solution). Treatment with a dry hypochlorite product typically requires 15 pounds of dry product per 10,000 gallons of waste polymer. Treatment with liquid hypochlorite typically requires 6-8 gallons of concentrated solution per 10,000 gallons of waste liquid slurry. The contractor may use household liquid chlorine bleach, which contains approximately 5% hypochlorite, but will need to use double the volume to achieve complete treatment. Regardless of the form of hypochlorite used in the pretreatment process, the contractor must ensure the chemical delivery method provides even distribution throughout the entire storage tank.

Proper pretreatment requires complete mixing of the hypochlorite and waste slurry. Without adequate mixing, the liquid will develop stratified layers of treated fluid on top of untreated polymer. Cetco's "Drilling and Mixing Guide" for the Shore PAC polymer system identifies using pumps to circulate the waste polymer and hypochlorite mixture as the preferred method to ensure complete mixing. The contractor may consider using other mechanical mixing techniques, such as propeller or paddle mixers or air agitation, to provide mixing energy. However the contractor must demonstrate to the local treatment authority that their proposed alternate method will provide complete mixing of the tank's contents. After mixing, each storage tank must sit undisturbed for at least 24-hours to allow any suspended residual solids to resettle.

At project completion, the storage tanks containing the waste polymer will also contain a layer of settled solids or sludge. This sludge layer is not an acceptable material for discharge to a POTW. The contractor must handle the sludge in a manner consistent with local solid waste regulations and with guidance being developed by Ecology's Waste2Resources Program.

<u>Disposal Process</u>

Disposal of treated waste slurry liquid to a POTW will require formal agreement between the contractor and the local wastewater treatment authority in advance of release to the POTW. <u>Early coordination with the local treatment authority is imperative to ensure timely disposal at the end of the project</u>. Ideally, contractors will contact the local treatment authority during the project bidding to identify local policies and constraints that may impact disposal of these waste streams at the end of construction. Contractors must also coordinate closely with the local treatment authority to negotiate the logistics of discharging the treated slurry waste and to coordinate any testing required by the treatment authority. The contractor must comply with all local restrictions and fee requirements imposed by the treatment authority. Contractors may not discharge wastes into any sewage collection system or any other portion of a sewage treatment system without having signed authorization for the discharge from the local treatment authority. Contractors may never discharge these wastes to stormwater collection or treatment system.

Ecology may provide technical assistance regarding slurry waste disposal to local treatment authorities upon request. However, the local treatment authority will retain all rights and responsibilities to control the acceptance of wastes for discharge to their collection systems and treatment plants. Also, since contractors will discharge this waste under temporary agreements for a limited amount of time, Ecology will not require the contractor to apply for a State Waste Discharge Permit for the disposal of industrial wastes to a POTW.

The treatment plant manager or other designated operators from the POTW receiving the waste slurry for disposal will evaluate the pretreated waste and determine if it is sufficiently treated for discharge into their system. Contractors must demonstrate to plant staff that the Marsh Funnel Viscosity of the treated liquid is within the range of 26-30 sec/qt (typical range for water). Contractors must also demonstrate using testing acceptable to the treatment authority that the waste liquid complies with a settleable solids standard of 7.0 ml/L and pH is within an acceptable range of 5.0 to 11.0. Facilities using UV light disinfection systems may also require testing of the fluid's turbidity or may perform other tests necessary to evaluate whether the waste could impact their disinfection system. **[NOTE: Ecology has identified the preceding testing as the minimum level of testing effort contractors can expect from local**

treatment authorities. The local authorities may, at their discretion, require additional testing they deem reasonable to verify that the waste meets local standards and is acceptable for their treatment system.]

The local treatment authority will work with the contractor to determine the best method of discharging the waste to the POTW or associated system. Discharge methods may include pumping the waste into the collection system at a convenient access point or using a tanker to transport the waste to the treatment plant (if plant has capability to accept hauled wastes). The local treatment authority will incorporate the acceptable discharge methods and specific limitations into the short-term discharge agreement with the contractor.

<u>Conclusion</u>

Ecology provides this guidance for use by WSDOT drilling contractors and for local wastewater treatment authorities in Washington. Based on test results from projects using the two WSDOT-approved synthetic polymer slurry systems, the waste liquid from drilling operations may be acceptable for disposal at POTWs, when properly pretreated. The local authority has the discretion whether to follow this guidance, and should consider site-specific issues that may not be covered in this guidance. This guidance is intended to provide technical assistance to both contractors and the local authorities. Questions regarding this guidance should be directed to the Water Quality Program at the regional Ecology office closest to the project site.

Attachment 1:
Description of WSDOT-Approved Polymer Slurry Products

Table 1: Summary of CETCO Products		
Product	**General Description**	**Use**
SHOREPAC	Copolymer of sodium acrylate and acrylamide	Base polymer slurry.
ACCU-VIS	Copolymer of sodium acrylate and acrylamide in mineral oil	Boosts viscosity of slurry to improve fluid loss control, bit lubrication and shale stabilization/inhibition.
SODA ASH	Sodium Carbonate	Controls make-up water pH to maintain desired range of 8-10 in the slurry system.
CAUSTIC SODA	Sodium Hydroxide	Used when drilling in acidic soils to control slurry pH to maintain the desired range of 8-10.
INSTA-CLEAR	Blend of Clay, Inorganic Salt, and Organic Polymer	Flocculent designed to remove high levels of suspended solids from the slurry system. Also used to decrease slurry pH and can be used in place of hypochlorite for denaturing slurry prior to disposal.
MACRO-FILL	Acrylamide Polymer	Highly-absorbent material added to slurry to seal fractures and permeable formations in shaft walls. Used to solidify and stabilize shaft walls and prevent fluid loss in porous soils.
SAND SEALANT/ MULTI-SEAL	Proprietary mixture of Bentonite and inert fibrous materials	Stabilization of shaft walls drilled in unconsolidated, highly-permeable formations such as in saturated cobble, gravel and sand formations.
STONE STOP	Dry, granular Bentonite	Seals large fractures in shaft walls to prevent slurry fluid loss.

Table 2: Summary of KB International Products		
Product	**General Description**	**Use**
SlurryPro CDP	Proprietary vinyl polymer with urea	Base polymer slurry.
SlurryPro LA-1-D	synthetic polymer	Reacts with base slurry to create a polymer film/synthetic membrane at the shaft wall.
ProTek 100-CP	Potassium hydroxide	Controls slurry system pH to maintain desired operating pH of 11-12; reconditions base polymers during operation.
WeightIt	Blend of alkaline salts	Increases slurry density to mildly enhance and assist the base slurry's soil stabilization effects.
KobbleBlok	Proprietary granular polymer material	Granules rapidly swell to form various size deformable globules that plug porous zones in shaft walls in soils dominated by cobbles and gravels.
InstaFreeze	Proprietary blend of alkaline salts and sodium hydroxide	Increases slurry stabilization performance in low cohesion soils.

Attachment 2:
Summary of Slurry Waste Chemical Analysis

Table 3provides a summary of results from laboratory analyses for conventional, non-conventional, and priority pollutant parameters, conducted on samples of pretreated polymer slurry waste. Data presented in Table 3 include results of limited testing of waste generated at the US 2/SR 522 Interchange Widening Project in Monroe and from expanded testing of waste from the I5-Portland Avenue to Port of Tacoma HOV expansion project in Tacoma.

Testing at the Tacoma sites, conducted in August 2011, provided detailed analysis of wastes from projects using the two WSDOT-approved polymer systems: Slurry Pro from KB International and ShorePac from CETCO. Analytical work for the Tacoma sites was completed by OnSite Environmental (Washington State Lab Accreditation #C591-11) under contract with WSDOT and was based on testing guidance developed in cooperation with Ecology. AmTest Laboratories of Kirkland (#C554-11) and Pace Analytical Services of Minneapolis (#C486-11) provided limited sub-contracted analytical services for the Tacoma sites. Due to time constraints with the Monroe project, Ecology requested a limited battery of tests to include priority metals, volatile organics, PCBs and conventional parameters. Analytical work for the project was completed in April 2011 by AmTest Laboratories and by the City of Monroe's Wastewater Treatment Plant lab (#M749-11).

Table 3: Summary of Analytical Results			
Analytes	**Tacoma, Slurry Pro**	**Tacoma, ShorePac**	**Monroe, SR 522 Project**
Chemical Oxygen Demand	110 mg/L	140 mg/L	*Not Tested*
Total Suspended Solids	620 mg/L	220 mg/L	*Not Tested*
pH	9.3	9.7	7.65
Settleable Solids	Non Detect	Non Detect	*Not Tested*
Total Phenols	0.12 mg/L	0.044mg/L	.023 mg/L
Total Cyanide	<0.005 mg/L	<0.005 mg/L	<0.005 mg/L
Cyanide (Weak Acid Dissociable)	<0.005 mg/L	<0.005 mg/L	
TPH-D, light oils	.55 mg/L	Non Detect	*Not Tested*
TPH-D, Heavy oils	0.41 mg/L	0.41 mg/L	*Not Tested*
TPH-G	590 ug/L	720 ug/L	*Not Tested*
Priority pollutant metals			
Hexavalent Chromium	Non Detect	Non Detect	*Not Tested*
Antimony	1.7 ug/L	2.2 ug/L	1.27 ug/L
Arsenic	15.0 ug/L	8.2 ug/L	9.41 ug/L
Beryllium	0.66 ug/L	Non Detect	<0.05 ug/L
Cadmium	0.24 ug/L	Non Detect	0.41 ug/L
Chromium	84.0 ug/L	26.0 ug/L	14.5 ug/L
Copper	66.0 ug/L	36.0 ug/L	25.3 ug/L
Lead	29.0 ug/L	6.7 ug/L	2.21 ug/L
Mercury	0.075 ug/L	0.053 ug/L	.00508 ug/L
Nickel	28.0 ug/L	9.1 ug/L	20.9 ug/L

Table 3: Summary of Analytical Results			
Analytes	**Tacoma, Slurry Pro**	**Tacoma, ShorePac**	**Monroe, SR 522 Project**
Selenium	2.5 ug/L	1.9 ug/L	1.30 ug/L
Silver	0.33 ug/L	0.43 ug/L	0.21 ug/L
Zinc	170.0 ug/L	33.0 ug/L	17 ug/L
Volatile organic compounds			
Acetone	21 ug/L	14.0 ug/L	24.8 ug/L
2-Butanone	Non Detect	Non Detect	5.7 ug/L
Chloroform	300.0 ug/L	1200.0 ug/L	214 ug/L
Bromodichloromethane	0.76 ug/L	4.7 ug/L	Non Detect
Vinyl Chloride	0.75 ug/L	0.70 ug/L	Non Detect
Carbon Tetrachloride	0.54 ug/L	Non Detect	1.9 ug/L
Styrene	Non Detect	0.29 ug/L	Non Detect
1,2-Dichloroethane	Non Detect	Non Detect	1.7 ug/L
Methyl Isobutyl Ketone	Non Detect	Non Detect	11.2 ug/L
Carbon Disulfide	Non Detect	Non Detect	3.6 ug/L
Chloroethane	Non Detect	Non Detect	10.8 ug/L
Chloromethane	Non Detect	Non Detect	25 ug/l
Methylene Chloride	Non Detect	Non Detect	4.8 ug/L
Toluene	Non Detect	Non Detect	5.4 ug/L
Semivolatile organic compounds			*Not Tested*
Benzyl alcohol	Non Detect	0.51 ug/L	
bis(2-Ethylhexyl)phthalate	5.3 ug/L	2.9 ug/L	
Bis(2-Chloroethyl)ether	2.4 ug/L	Non Detect	
Butylbenzylphtalate	2.7 ug/L	Non Detect	
1,2-Dichlorobenzene	8.0 ug/L	Non Detect	
Organochlorine pesticides	Non Detect	Non Detect	*Not Tested*
PCBs	Non Detect	Non Detect	Non Detect
Chlorinated acid herbicides	Non Detect	Non Detect	*Not Tested*
Dioxin	Non Detect	Non Detect	*Not Tested*

6-19.GR6 Shafts

6-19.2.GR6 Materials

6-19.2(9-36.2(2)).GR6 Synthetic Slurry

(Section 9-36.2(2) is supplemented with the following)
Must use once preceding any of the following:

6-19.2(9-36.2(2)).OPT1.GB6 (Fresh Water For Synthetic Slurry)
(January 2, 2012)
Use in projects with shafts constructed in salt water when the geotechnical report specifies that the use of fresh water for synthetic slurry is feasible and when the Contracting Agency restricts the water for synthetic slurry to fresh water only. Include with **6-19.4.OPT3.GB6 and 6-19.5.OPT2.GB6.**

6-19.3.GR6 Construction Requirements

6-19.3(2).GR6 Submittals

6-19.3(2).INST1.GR6 (Section 6-19.3(2) is supplemented with the following)
Must use once preceding any of the following:

6-19.3(2).OPT1.GB6 (CSL Testing By Contractor)
(January 2, 2012)
Use in projects where CSL testing is to be provided by the Contractor. Include with **6-19.3(9)A.OPT1.GB6, 6-19.3(9)C.OPT1.GB6, 6-19.4.OPT2.GB6 and 6-19.5.OPT1.GB6.**

6-19.3(3).GR6 Shaft Excavation

6-19.3(3).INST1.GR6 (Section 6-19.3(3) is supplemented with the following)
Must use once preceding any of the following:

6-19.3(3).OPT1.GB6 (Variations In Bearing Layer Elevations)
(January 2, 2012)
Use in projects where shaft embedment to a minimum penetration into a bearing layer is required, and where the bearing layer elevation cannot be accurately specified with certainty. Include with **6-19.3(5).OPT1.GB6 and 6-19.4.OPT1.GB6.**

6-19.3(3)B.GR6 Temporary and Permanent Shaft Casing

6-19.3(3)B.INST1.GR6 (Section 6-19.3(3)B is supplemented with the following)
Must use once preceding any of the following:

6-19.3(3)B.OPT1.FB6 (Required Casing)
(January 2, 2012)

Use in projects where permanent and/or temporary casing is required. The first fill-in identifies the bridge and pier number or the wall name and station limits. The second fill-in specifies the casing type as permanent or temporary. The third fill-in specifies the bottom elevation of the casing. The fourth fill-in specifies the top and bottom elevation limits for concurrent casing placement with excavation. The fifth fill-in specifies the maximum dimension that excavation may precede the casing tip. The third, fourth and fifth fill-ins should be specified in the geotechnical report prepared for the project.
(5 fill-ins)

6-19.3(3)B.OPT2.GB6 (Rotating/Oscillating Method Required)
(January 2, 2012)
Use in projects where the geotechnical report for the project recommends, and the ADSC/WSDOT Shaft Task Force concurs, that site conditions dictate the use of the rotating/oscillating method for shaft excavation.

6-19.3(3)B4.GR6 **Temporary Telescoping Shaft Casing**

6-19.3(3)B4.INST1.GR6 (The second paragraph of Section 6-19.3(3)B4 is revised to read as follows)
Must use once preceding any of the following:

6-19.3(3)B4.OPT1.GB6 (Temp. Telescoping Casing Not Allowed At End Piers)
(January 2, 2012)
Use in projects where design conditions exist where the option of temporary telescoping casing for shafts at bridge end piers is not appropriate for the overall design behavior of the overall bridge.

6-19.3(3)I.GR6 **Required Use of Slurry in Shaft Excavation**

6-19.3(3)I.INST1.GR6 (Section 6-19.3(3)I is supplemented with the following)
Must use once preceding any of the following:

6-19.3(3)I.OPT1.GB6 (Exception For Casing Sealed Against Influx Of Water Into Excavation)
(January 2, 2012)
Use in projects where the geotechnical conditions, as documented in the geotechnical report for the project, allow the possibility of performing shaft excavation in a cased hole beneath the water table level without the need for slurry to ensure the stability of the bottom of the excavation.

6-19.3(4).GR6 Slurry Installation Requirements

6-19.3(4)A.GR6 Slurry Technical Assistance

6-19.3(4)A.INST1.GR6 (Section 6-19.3(4)A is supplemented with the following)
Must use once preceding any of the following:

6-19.3(4)A.OPT1.FB6 (Slurry Manufacturer's Representative's Presence Required At Specific Shaft Sites)
(January 2, 2012)
Use in projects where the geotechnical conditions vary enough from one shaft site to another to affect how the slurry is used at each shaft site. The fill-in identifies the specific shaft locations where the presence of the slurry manufacturer's representative is required.
(1 fill-in)

6-19.3(5).GR6 Assembly and Placement of Reinforcing Steel

6-19.3(5).INST1.GR6 (Section 6-19.3(5) is supplemented with the following)
Must use once preceding any of the following:

6-19.3(5).OPT1.GB6 (Variations In Bearing Layer Elevations)
(January 2, 2012)
Use in projects where shaft embedment to a minimum penetration into a bearing layer is required, and where the bearing layer elevation cannot be accurately specified with certainty. Include with **6-19.3(3).OPT1.GB6 and 6-19.4.OPT1.GB6.**

6-19.3(7).GR6 Placing Concrete

6-19.3(7)D.GR6 Requirements for Placing Concrete Underwater

6-19.3(7)D.INST1.GR6 (Section 6-19.3(7)D is supplemented with the following)
Must use once preceding any of the following:

6-19.3(7)D.OPT1.GB6 (Tremie Allowed As An Alternative To Concrete Pump)
(January 2, 2012)
Use in projects where the construction site is at a remote location where it may be difficult to make arrangements to have a concrete pump at the site.

6-19.3(9).GR6 Nondestructive Testing of Shafts (Crosshole Sonic Log Testing)

6-19.3(9)A.GR6 **Schedule of CSL Testing**

6-19.3(9)A.INST1.GR6 (The first paragraph of Section 6-19.3(9)A is revised to read as follows)
Must use once preceding any of the following:

6-19.3(9)A.OPT1.GB6 (CSL Testing By Contractor)
(January 2, 2012)
Use in projects where CSL testing is to be provided by the Contractor. Include with **6-19.3(2).OPT1.GB6, 6-19.3(9)C.OPT1.GB6, 6-19.4.OPT2.GB6 and 6-19.5.OPT1.GB6.**

6-19.3(9)C.GR6 **Engineer's Final Acceptance of Shafts**

6-19.3(9)C.INST1.GR6 (Section 6-19.3(9)C is revised to read as follows)
Must use once preceding any of the following:

6-19.3(9)C.OPT1.GB6 (CSL Testing By Contractor)
(January 2, 2012)
Use in projects where CSL testing is to be provided by the Contractor. Include with **6-19.3(2).OPT1.GB6, 6-19.3(9)A.OPT1.GB6, 6-19.4.OPT2.GB6 and 6-19.5.OPT1.GB6.**

6-19.4.GR6 **Measurement**

6-19.4.INST1.GR6 (The ninth and tenth paragraphs of Section 6-19.4 are revised to read as follows)
Must use once preceding any of the following:

6-19.4.OPT1.GB6 (Variations In Bearing Layer Elevations)
(January 2, 2012)
Use in projects where shaft embedment to a minimum penetration into a bearing layer is required, and where the bearing layer elevation cannot be accurately specified with certainty. Include with **6-19.3(3).OPT1.GB6 and 6-19.3(5).OPT1.GB6.**

6-19.4.INST2.GR6 (Section 6-19.4 is supplemented with the following)
Must use once preceding any of the following:

6-19.4.OPT2.GB6 (CSL Testing By Contractor)
(January 2, 2012)
Use in projects where CSL testing is to be provided by the Contractor. Include with **6-19.3(2).OPT1.GB6, 6-19.3(9)A.OPT1.GB6, 6-19.3(9)C.OPT1.GB6 and 6-19.5.OPT1.GB6.**

6-19.4.OPT3.GB6 (Fresh Water For Synthetic Slurry)
(January 2, 2012)
Use in projects with shafts constructed in salt water when the geotechnical report specifies that the use of fresh