TECHNICAL MEMORANDUM

Biosparge Implementation Work Plan for UPRR Mosier Derailment

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This technical memorandum (TM) presents the work plan for implementation of a biosparge treatment system, to address benzene, toluene, ethylbenzene, and xylene (BTEX) impacts associated with the Union Pacific Railroad (UPRR) train derailment in Mosier, Oregon (Site).

The work plan for field implementation includes details and assumptions for installation, testing, operation and monitoring of the biosparge system.

1.0 Background, Objectives and Technical Approach

1.1 Site Location and Background

The derailment location is along the UPRR tracks in the town of Mosier, OR. Approximately 3,000 tons of impacted soil, to depths ranging from 8 to 22 feet below ground surface (bgs) were excavated and transported to Wasco County Landfill for disposal. Two extraction wells and four monitoring wells were installed near the derailment location (see Figure 1 for locations). Depth to water ranges from 22 feet bgs at EW-1 to 6 feet bgs at MW-4. The ground surface slopes to the east and northeast, with MW-4 being located in a low area. Groundwater flow direction, based on potentiometric surface evaluation, is to the east-northeast. Seasonal wetlands are located in the park area north of the rail line and are approximated on Figure 1.

1.2 Treatment Area Definition and Objectives

Groundwater sampling indicates BTEX impacts focused near MW-4. Based on the data, a biosparge system is proposed to be implemented in the vicinity, and downgradient, of MW-4 to reduce concentrations in that area and reduce the mass flux. It should be noted that the dense vegetation, wetlands, and deep ravines in that area constrain where and how many wells can be installed. The proposed well layout is included in Figure 1. The well layout is anticipated to have an adequate zone of influence to maximize treatment across the impacted area. Wells are spaced on approximately 20 foot centers and aligned to provide for shared trenches during compressed air supply line routing to minimize impacts to vegetation.

The objectives for biosparge implementation are as follows:

- Reduce contaminant concentrations in the groundwater to levels where natural attenuation processes will further reduce BTEX levels towards ultimately achieving the applicable standards.
- Reduce contaminant mass flux towards the north and northeast

1.3 Technical Approach

A range of remedial technologies were evaluated to determine the most effective technology for the Mosier site. Based on the anticipated effectiveness and ready implementability, biosparging was selected as the approach for installation. Biosparging is a remedial method that involves injecting compressed air or oxygen into the groundwater through a well or wells, at a low flow rate, to promote aerobic biodegradation of the various constituents of concern (COC). Biosparging is a well demonstrated method for addressing petroleum contaminants (US EPA, 2004, *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites*; US EPA, 2006, *In Situ and Ex Situ Biodegradation Technologies for Remediation of Contaminated Sites*).

2.0 Groundwater Biosparge Implementation

This section presents the implementation elements for the biosparge system.

2.1 Mobilization and Site Preparation

This task will consist of the mobilization of personnel, equipment, subcontractors, and materials to the site to implement biosparge system installation field activities. All personnel will be required to review and sign the health and safety plan (HSP), documenting an understanding of the safety protocols prior to any field activity. The installation contractor will be provided with project requirements to allow for installation in accordance with direction from UPRR.

Following mobilization to the site and prior to beginning intrusive work, site setup activities will be completed. The operation and location of all field equipment and lay-down areas will be coordinated with the property owners in order to minimize impacts. Sanitary facilities, laydown areas, waste storage areas, and decontamination areas will also be established.

2.2 Utility Location

Prior to commencing well installation and trenching, the Oregon One Call Utility Coordinating Service will be contacted to locate public underground utilities. In addition, an independent utility verification survey will be performed to confirm the absence of underground utilities at the trenching and drilling locations. In areas where utilities are identified within five feet of a trenching or drilling area, the utility will be exposed by hand digging or use of an air knife/vacuum unit before conducting intrusive activities.

2.3 Groundwater Monitoring Wells

Up to four new monitoring wells will be installed in the vicinity of MW-4. Wells will be installed to monitor the performance of select biosparge wells. The monitoring wells will be placed at 10 feet and 20 feet from two of the biosparge wells to confirm the radius of influence. In addition, the wells will be used as performance monitoring wells during the operation of the biosparge system.

Monitoring wells will be installed using a truck mounted Sonic drill rig. A stainless-steel sampling probe will be advanced in 5-ft pushes until refusal. For each 5 foot section, the sampler will be withdrawn from the borehole, the cuttings emptied into a liner and the top and bottom labeled with the depth of collection, and the liner then cut longitudinally to allow access to the soil core. Continuous soil cores will be collected and logged. Soil cuttings will be screened in the field using a photoionization detector (PID). Once the desired depth for the well is reached, the well casing string will be lowered into the hole and the annular space filled. Monitoring wells will be constructed of new, pre-cleaned, 2-inch-diameter Schedule 40 PVC blank pipe with 10 ft of 0.01-inch slotted well screen. The screen will be placed such that the screen straddles the seasonal low water elevation. Therefore, screened interval depths will vary with location depending on local depth to water.

Once the well casing is suspended in the borehole, the temporary casing will be gradually withdrawn as clean silica sand (supplier certified to be free of contaminants, inert, hard, well rounded, and free from roots, trash and other deleterious material) is poured into the annular space. The sand pack will be extended a minimum of 6 inches above the monitoring well screen. Once the sand pack is installed, bentonite chips will be placed over the sand pack to a depth of 3 ft bgs and concrete hydrated to fill the balance of the annular space. A surface protective casing will be set into the concrete. The monitoring wells will be finished using a flush mount or riser pipe design and fitted with expandable locking plugs and locks that are keyed alike. Three bollards will be installed to protect the well riser pipe. If flush mount completions are installed a single bollard will be installed to mark the well location.

2.4 Biosparge Well Installation

Five vertical biosparge wells will be installed by via Sonic drilling methods. Wells will be installed on 20 foot centers in a row north of MW-4, as far north as is possible before being constrained by the terrain. The location of the wells may be adjusted in the field based on obstacles encountered in the park. Soil cuttings will be logged and screened in the field using a photoionization detector (PID).

The desired depth for biosparge wells will be determined in the field by the project engineer and will vary by location. Biosparge wells will be constructed of new, pre-cleaned, 2-inch-diameter Schedule 40 PVC blank pipe with 3-ft of 0.01-inch slotted well screen. The top 5 feet of the well casing will be constructed of 2 inch threaded galvanized piping to allow connection to the biosparge piping. Biosparge well screens will be placed at the base of the aquifer directly above the bedrock/refusal or at a depth of 25 feet bgs, whichever is encountered first. Typical biosparge well construction details are shown in Figure 2.

Once the well casing is suspended in the borehole, the temporary casing will be gradually withdrawn and the annulus seal filled with filter pack material. The filter pack material will be clean, bagged silica sand (supplier certified to be free of contaminants, inert, hard, well rounded, and free from roots, trash and other deleterious material). The filter pack will be placed from the bottom of the borehole and extend up the annulus a minimum of 6 inches above the top of the screen. The filter pack will be tagged continuously to ensure proper placement.

Following filter pack tagging, a bentonite seal will be placed above the filter pack. The 100 percent sodium bentonite seal will consist of 3/8 inch-diameter dry bentonite pellets or chips and will be a minimum of 3 feet thick. Bentonite will be placed in 2 foot lifts and properly hydrated before the next lift is placed. The bentonite seal will be allowed to set for a minimum of 1 hour prior to grouting. Concrete will be used to fill the balance of the annular space. Wells will be completed in a below grade vault that is large enough to allow connection to the system piping.

2.5 Trenching

Trenches will be constructed for the air supply piping to the biosparge wells. Detectable marking tape will be included in the trenches to facilitate future location of the piping. Directional boring will be required to run the piping under the railroad tracks.

Main trenches will be extended from the biosparge equipment location to the treatment area. Upon reaching the treatment area, lateral trenches will extend to each of the well locations, carrying an individual biosparge line.

The trenches will be routed to avoid impact with existing utilities as identified during the topographical and utility survey to be conducted at the site.

Soil removed from the trench excavation is anticipated to be uncontaminated but will be screened with a PID during excavation. Clean soil may be either used as trench backfill above the pipe zone and/or spread out on site in areas designated by UPRR. Any impacted soil will be properly disposed off-site. All areas disturbed during construction will be restored to their original surface.

2.6 Piping

Piping to the air sparging wells will be either by common manifold line or using individual lines to each well. The decision to use a manifold or individual lines along with piping diameters and materials will be determined by the project engineer prior to installation, based on costs and logistics of each option.

3.0 Biosparge System

This section details the design assumptions for implementation of the biosparge system and components.

3.1 Injection Pressure and Flow Rate Design

Air injection flow rates were selected based on achieving 20 standard cubic feet per minute (scfm) per well and a minimum pressure of 5 pounds per square inch gauge (psig) above the static head pressure of the groundwater table. This is expected to produce at least a 10-foot radius of oxygen influence in the saturated zone.

Based on a screen submergence of 20 feet of water, the expected wellhead pressure required to initiate biosparging is less than 13 psig. Blower discharge pressures will account for the required wellhead pressure and applicable frictional piping losses.

3.2 Zone of Influence

It is assumed that the radius of influence will extend radially approximately 10 feet from the center of each well. Monitoring wells will be installed at various distances (10 and 20 feet) from the AS wells to confirm the radius of influence (ROI) through dissolved oxygen and water level measurements.

3.3 System Details

A skid- or trailer-mounted biosparge system will be used to provide compressed air to the biosparge wells. The system will be placed near the City of Mosier waste water treatment plant. The biosparge system will be capable of a minimum of 20 psig and 100 cubic feet per minute.

The biosparge system will include the following:

- One heat exchanger capable of reducing the compressor outlet air temperature to a maximum temperature of 140 degrees Fahrenheit.
- Airflow meters, pressure gauges, and temperature gauges.

Process equipment, including piping, instrumentation, controls, and enclosure will be pre-assembled and tested before delivery to the site.

3.4 Electrical

An electrical connection from the WWTP will be used to provide electrical service to the biosparge system. Electrical infrastructure and available service will be documented during the site utility survey.

3.5 Instrumentation and Controls

One SCADA programmable logic controller (PLC) with a human-machine interface (HMI) will provide monitoring of system operation. Due to the simplicity of the biosparging system, instrumentation and controls will be kept to a minimum.

The design will include the options to operate the well field in either an intermittent ("pulsed") mode or in a continuous mode. Initial operation of the system will be in continuous mode. Pulsed operation can be initiated if enhanced lateral propagation of air is required.

4.0 Biosparge Operation

Startup testing of the biosparge system will be conducted over a two-day period to confirm the radius of influence and establish the steady-state operating point. The radius of influence is generally defined as the distance from the AS well at which dissolved oxygen changes are noted in the groundwater.

The system will be tested in the same manner as it is expected to be operated. Dissolved oxygen and water level measurements will be taken at all wells. The system will be turned on with all wells operational. Flow and pressure measurements will be collected. The following day, a second set of groundwater parameters will be collected to evaluate the effectiveness of the system at equilibrium.

Results of the startup testing will be used to finalize system operating parameters.

5.0 Operation Maintenance and Monitoring

Monitoring and maintenance activities associated with the biosparge system will include requirements from the manufacturer's equipment maintenance schedule. Additional O&M activities may include:

- Troubleshooting system errors and/or alarm conditions
- Monitoring and recording system runtime
- Monitoring and recording system output temperature
- Monitoring and recording system pressures and flow rates
- Inspecting, cleaning and/or replacing air filters
- Inspecting and/or replacing compressor oil, oil filters, and oil separators
- Inspecting, cleaning, and/or replacing air/water and air/oil filter elements
- Verifying operation of butterfly valves, pressure regulators, and flow rate indicators/transmitters
- Verifying operation of automatic condensate drains
- Monitoring and recording subsurface pressures and VOC emissions at outlying monitoring wells.

5.1 Groundwater Monitoring

Following installation and development, both biosparge and monitoring wells will be sampled to develop a baseline concentration. Monitoring wells will again be tested following the completion of biosparge field testing activities. Monthly groundwater monitoring results will also be used for optimization of the remedial system. Operational optimization may include increased air pressure or flow rates, or installation of additional biosparge wells.

5.2 Air Monitoring

During initial startup of the biosparge system, air monitoring will be required to confirm volatiles are not being emitted to the atmosphere from the wells or at the soil surface. Monitoring will be conducted by using a PID at various ground-surface locations within the biosparge field. If volatiles are detected, 24-hour ambient air samples will be collected using Summa canisters and analyzed for VOCs using TO-15.

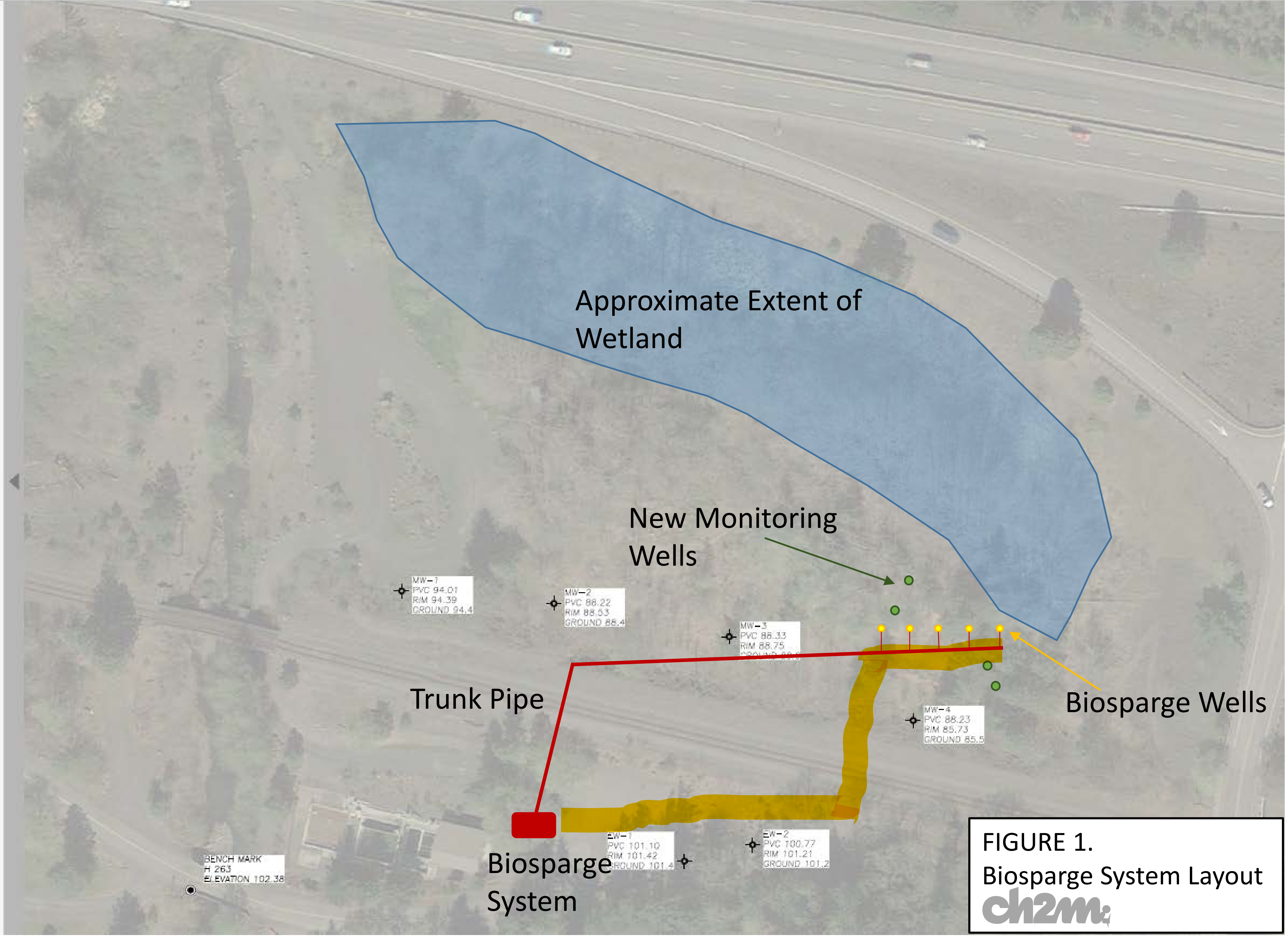

FIGURE 1.
Biosparge System Layout

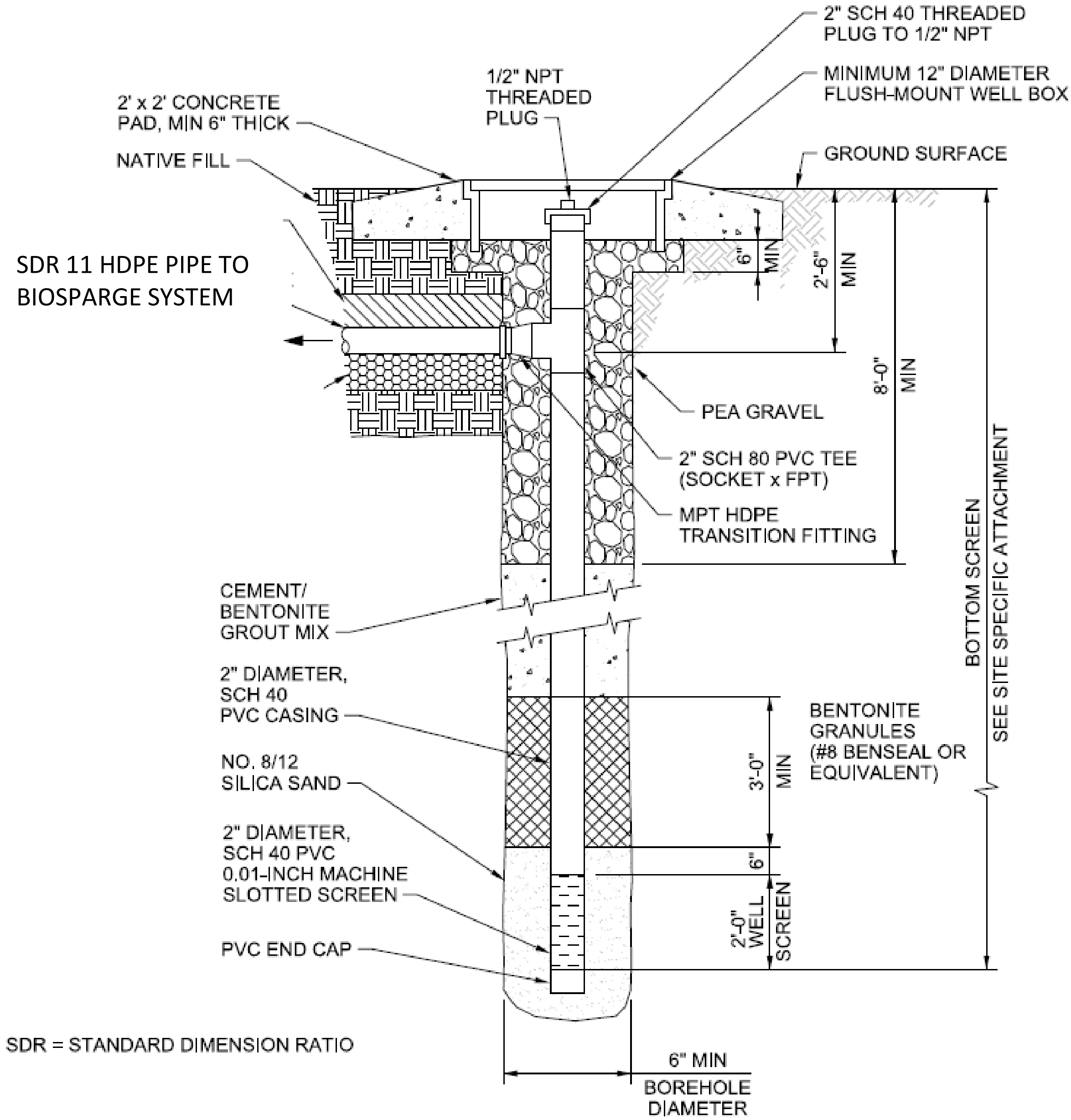

FIGURE 2. VERTICAL SPARGE WELL DETAIL
Union Pacific Railroad, Mosier, OR