NW Natural Gas Company

Revised Wastewater Pilot Plant Testing Plan

(Second Revision in Response to DEQ June 23, 2009 Comments)

June 2009

Sevenson Environmental Services, Inc.

NW Natural
Wastewater Pilot Plant Testing Plan
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Pilot Plant Process Design—NW Natural Site

The proposed treatment process is largely designed to remove iron and manganese, cyanide, heavy metals, VOCs and SVOCs. The pilot plant will be situated inside a secondary containment area containing crushed stone over a 40-mil liner, with berms around the entire pilot site to contain wastewater, residual, or chemical spills. The facility will be operated under a site-specific Health and Safety Plan (HASP), submitted under separate cover. The site-specific HASP will address spill prevention and countermeasures to be taken and emergency contacts in the event of a spill.

The NW Natural pilot plant is designed to operate at an average daily flow rate of 50 gpm (18,000 gals/day), 6 hours per day, allowing one hour for startup and one hour for shutdown each day over a 5-day week. Treated effluent from the Siltronic pilot plant (15 gpm) will be blended into the NW Natural pilot plant for discharge to the current POTW.

All backwash water will be recirculated to the influent equalization tanks for re-treatment. All plant residuals (bag filters, sedimentation tank solids, and spent carbon) will be properly disposed of to a permitted facility.

Sevenson has included its wastewater treatment pilot plant design and materials balance in Appendix A. This mass balance will be expanded upon completion of the pilot plant with data taken during the runs. The expanded mass balance will be incorporated into the final design data. The proposed process flow diagram for the pilot plant is included in Appendix B.

Influent Wells Location

The NW Natural pilot plant will draw from two or more wells on the NW Natural Site: MW-1-55 and PW-1-80 as shown on Figure 1. It is anticipated that the well pumps will operate constantly to replenish the influent equalization tanks of the pilot plant. Figures 2 and 3 show the expected flow from MW-1-55 and PW-1-80, respectively. The pumping capacity of well MW-1-55 will be measured before the pilot test. If the yield from well MW-1-55 is inadequate to supply sufficient water for the pilot test, an additional well or

wells in the northern area of the Site will be identified before the pilot test begins. Each well pump will pump into a separate 21,000-gallon equalization tank. The well pump flows, which are continuous, have been sized to allow for continuous pilot plant operation during the operating week.

Influent Equalization Tanks

Waters from both wells will be pumped into two 21,000-gallon frac tanks. Besides well water, the equalization tanks will also receive spent backwash water from the downstream GAC vessels. The tanks will be air-tight, with a vapor-phase carbon system on top of one of the tanks to handle off-gases (volatile organic compounds and air) that may be released from the tanks.

The tanks are designed to permit settling of solids and flotation of light solids and oil. Periodically, the operator will employ a “sludge judge” in each tank to monitor the buildup of DNAPL in the bottom of the equalization tanks. The “sludge judge” is a clear plastic tube approximately 8 feet with a foot valve on the bottom to allow the operator to determine the sludge buildup, if any, in each tank. Accumulated solids and floatables in the tanks will be periodically removed as required using a trash pump.

In the full-scale design, it is planned to utilize a dedicated DNAPL tank which will receive DNAPL directly from the process wells, thus greatly reducing the DNAPL accumulating in the equalization tanks in the full-scale system.

Clarifier Feed Pumps

Two 100-gpm clarifier feed pumps will be provided, one per equalization tank. The pumps are oversized to provide the capability to “loop” the flow through an in-line aerator to facilitate iron removal prior to sedimentation. The pumps also have variable-frequency drives to allow for pumping different flow ratios from each well to the pilot plant.

Sodium Hydroxide Feed Pumps

Two sodium hydroxide feed pumps, pH meters and controllers will be installed on the influent equalization tanks to increase the influent pH to approximately 8.5. The rates of iron and manganese oxidation are both greatly accelerated at higher pH.

Figure 1: Location of NW Natural Wells for Pilot Plant

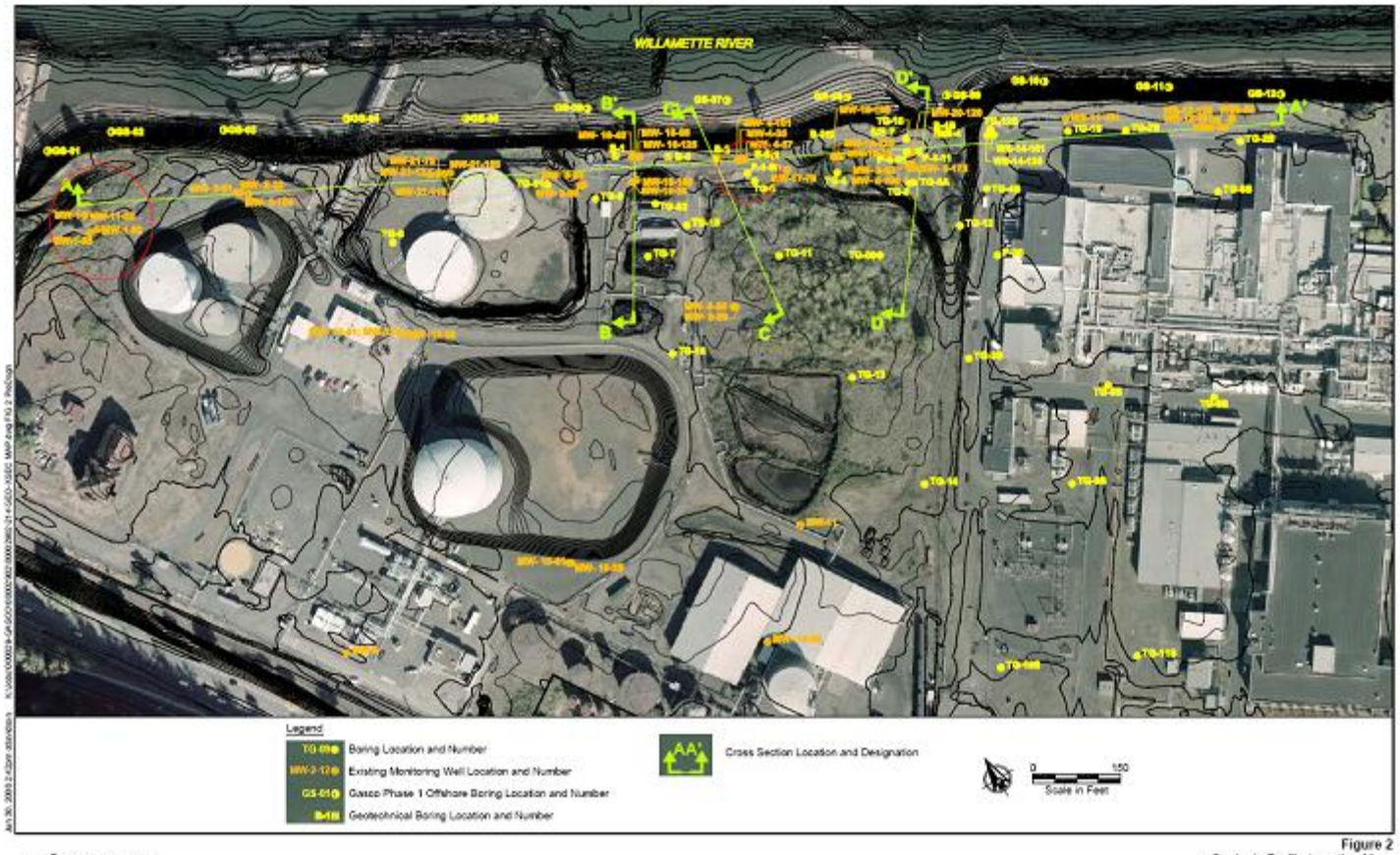


Figure 2: Well Flow Calculations and Equalization Volume for NW Natural MW-1-55

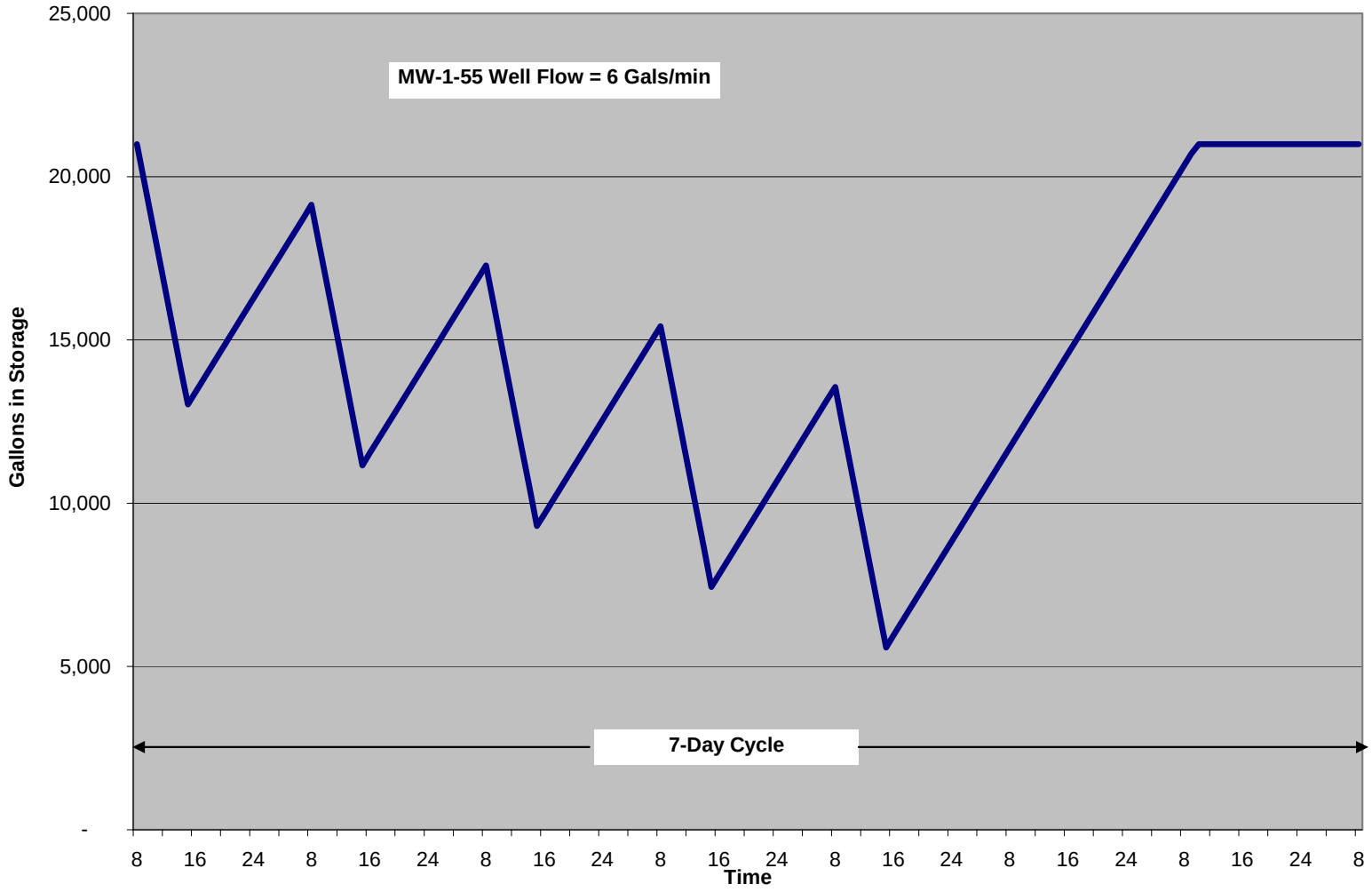
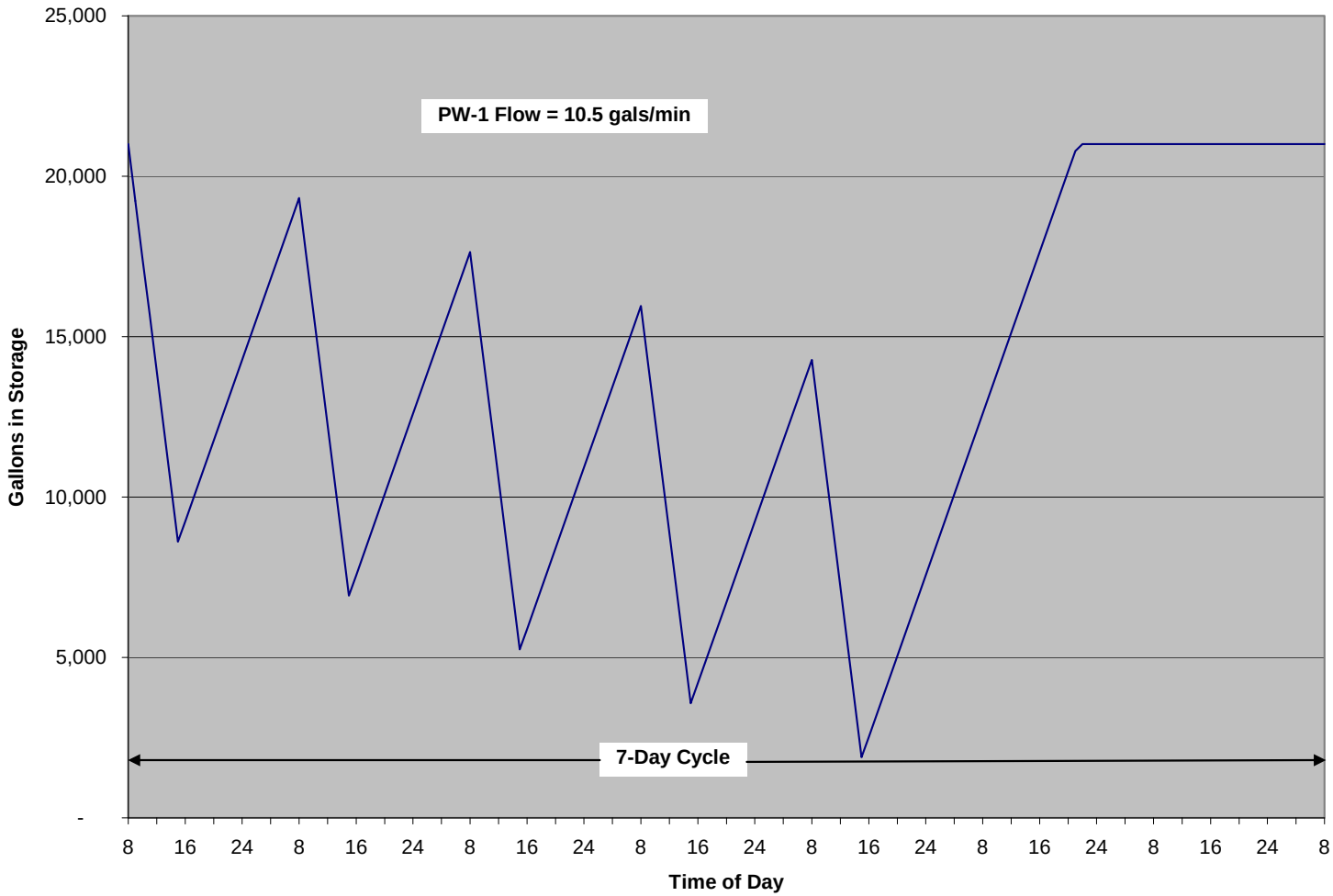


Figure 3: Well Flow Calculation and Equalization Volume for NW Natural PW-1



Recirculation Loop and In- Line Aeration

Two in-line aerators (eductors) will be installed on the recirculation lines from the clarifier feed pumps to the Influent Equalization Tanks. The eductors will draw air into the recirculation lines to assist in iron and manganese oxidation.

Polymer Addition

A polymer addition system will be installed to feed polymer to the wastewater prior to introduction into the downstream inclined-plate clarifier to facilitate settling. The polymer will be mixed in line with a 2-inch static mixer, and paced off the flow meters.

Inclined-Plate Clarifier (IPC)

An inclined-plate clarifier (IPC) will receive the flow from the equalization tanks and remove the oxidized iron and manganese. In addition, heavy metals will be removed via iron co-precipitation in the clarifier. Settled sludge will be removed and stored for dewatering that will be conducted in a filter press as necessary during the pilot operation. The resulting filter cake will be stored in a proper container within the containment area and properly disposed of prior to pilot plant demobilization.

IPC Effluent Tank

A 2,500-gallon effluent tank will be positioned at the outlet of the IPC to receive the flow by gravity. This tank will serve as the pump tank for the filter feed pump. The tank will also receive the treated flow from the Siltronic Pilot Plant.

Filter Feed Pump

Following the IPC will be a single 75-gpm electric centrifugal pump. This pump will be manually controlled, using the level in the IPC Effluent Tank. The flow rate will be adjusted with the use of a variable-frequency drive.

The Filter Feed Pump will pump the combined flows through the cyanide destruct tank, the bag filters, and the granular activated carbon (GAC) vessels, before discharging into the effluent /backwash storage tanks.

Hydrogen Peroxide Feed System

A hydrogen peroxide feed pump, oxidation-reduction potential (ORP) indicator and controller will deliver 50% hydrogen peroxide solution to an in-line static mixer to thoroughly mix the wastewater and hydrogen peroxide. The feed pump will take suction from a chemical tote, containing approximately 260 gallons. The peroxide dosage will be paced off the ORP set point.

Sodium Hydroxide Feed System

A sodium hydroxide feed pump, pH meter and controller will be installed on the cyanide destruct tank to increase the wastewater pH to approximately 10.0. The feed pump will take suction from a chemical tote, containing approximately 260 gallons. The rates of cyanide oxidation and any iron and manganese are greatly accelerated at higher pH.

Cyanide Destruct Reactor

A separate reactor tank will be used for cyanide destruction. The tank will be sized for a minimum detention time of 120 minutes, based upon the results in the treatability tests.

Sulfuric Acid Feed System

A sulfuric acid feed pump, pH meter and controller will be installed on the pipe from the cyanide destruct tank to reduce the wastewater pH to approximately 8.5. The feed pump will take suction from a drum, containing approximately 20 gallons. The acid will be injected upstream of a 2-inch in-line static mixer.

Primary Bag Filters

Two pressure bag filters will be provided to remove remaining particulates from the wastewater prior to the GAC units. The bag filters will be set up to operate in series to filter iron and other solids prior to introduction into the GAC vessels. Each bag filter has a capacity of 100 gpm.

The upstream and downstream filters will be fitted with 10-micron and 5-micron bags, respectively. The vessels are fitted with inlet and outlet pressure gauges. The bags will be changed at an appropriate pressure differential.

Granular Activated Carbon Vessels

The waste stream then flows through two, 6-foot diameter Granular Activated Carbon (GAC) vessels, piped in series, with differential pressure measured across each vessel. The GAC units will remove volatile organics and semi-volatile organics in the effluent from the filter units. Seventeen hundred pounds of carbon will be loaded into each vessel.

The sizing of the system is intended to produce breakthrough on the lead carbon vessel within the pilot plant study period to better determine carbon life in the full-scale system. The sizing has also been designed to remove all organics in the lag vessel after breakthrough in the lead vessel. Breakthrough will be determined by daily sampling of total organic carbon between the columns. After breakthrough, total organic carbon will be monitored from the lag column. No pilot work will continue if the lag vessel becomes exhausted.

The GAC filters will be provided with backwashing capability to allow continuous operation. The amount of carbon in each vessel has been calculated to give the process water the correct amount of contact time at a maximum flow rate of 65 gallons per minute.

Effluent/Backwash Storage Tank

After the GAC vessels, the treated wastewater will be discharged into two 21,000-gallon effluent/backwash storage tanks. These tanks will serve as “batch holding tanks” during the start up phase of the operation, and will be utilized as clean water holding tanks for backwash water.

Effluent/Backwash Pumps

Two electric centrifugal pumps will be provided, each with a capacity of 350 gpm, to allow for a suitable backwash rate for the GAC vessels, and to discharge to the approved discharge point.

Flow Meter Rate/Totalizer

All treated wastewater discharged from the plant will pass through a 2-inch flow meter and totalizer.

In addition, a backwash flow meter will be installed on the backwash line.

Effluent Bag Filters

A final filtration step will be accomplished using two bag filters arranged in parallel. The filters are intended to remove any carbon fines and adsorbed organics escaping the GAC vessels.

The bag filters will be equipped with 0.5-micron bags. The vessels are fitted with inlet and outlet pressure gauges. The bags will be changed at an appropriate pressure differential.

Residual Disposal

All residuals from the pilot treatment plant: settled solids, GAC media, and spent bag filters will be properly disposed of.

Hoses

Two-inch hose will be used for the conveyance of the process water between the process tankage in the pilot plant. Hose is used instead of hard piping because they provide a degree of flexibility and shock absorption that is critical in the field. The proposed hose is a hard rubber 150-psi suction type hose with a spiral wound steel reinforcement running through its length.

Pilot Plant Process Design—Siltronic Site

The proposed treatment process is largely designed to remove iron and manganese, cyanide, heavy metals, and chlorinated solvents including vinyl chloride. The pilot plant will be situated inside a secondary containment area containing crushed stone over a 40-mil liner, with berms around the entire pilot site to contain wastewater, residual, or chemical spills. The facility will be operated under a site-specific Health and Safety Plan (HASP), submitted under separate cover. The site-specific HASP will address spill prevention and countermeasures to be taken and emergency contacts in the event of a spill.

The Siltronic pilot plant is designed to operate at an average daily flow rate of 15 gpm (5,400 gals/day), 6 hours per day, allowing one hour for startup and one hour for shutdown each day over a 5-day week. Treated effluent from the Siltronic pilot plant will be blended into the NW Natural pilot plant at the Clarifier Effluent Tank, for further treatment and discharge to the current POTW.

All plant residuals (disposable bag filters containing solids and sedimentation tank solids) will be treated as a listed F002 waste and will be properly disposed of to a permitted facility. Prior to disposal, the residuals will be stored in a closed container located within the containment zone.

Sevenson has included its wastewater treatment pilot plant design and materials balance for the Siltronic site in Appendix A. This mass balance will be expanded upon completion of the pilot plant with data taken during the runs. The expanded mass balance will be incorporated into the final design data. The proposed process flow diagram for the pilot plant is included in Appendix B.

Influent Well(s) Location

The pilot plant will draw from selected well(s) on the Siltronic site. It is anticipated that the well pump(s) will operate constantly to replenish the influent equalization tank of the

pilot plant. Figure 4 shows the total expected flow from the Siltronic site. Each well pump will pump into a 21,000-gallon equalization tank.

The well pump flows, which are continuous, have been sized to allow for continuous pilot plant operation during the operating week.

Influent Equalization Tank

Waters from the Siltronic well(s) will be pumped into a single 21,000-gallon frac tank. The tank will be air-tight, with a vapor-phase carbon system on top of the tank to handle off-gases (volatile organic compounds and air) that may be released from the tank.

The tank is designed to permit settling of solids and flotation of light solids and oil. The accumulated solids and floatables in the tanks will be periodically removed as required using a trash pump. Plant influent characteristics will be sampled from this tank.

Clarifier Feed Pump

One 30-gpm clarifier feed pump will be provided. The pump is oversized to provide the capability to "loop" the flow through an in-line aerator to facilitate iron removal prior to sedimentation. The pump will also have a variable-frequency drive to allow for pumping different flows to the pilot plant.

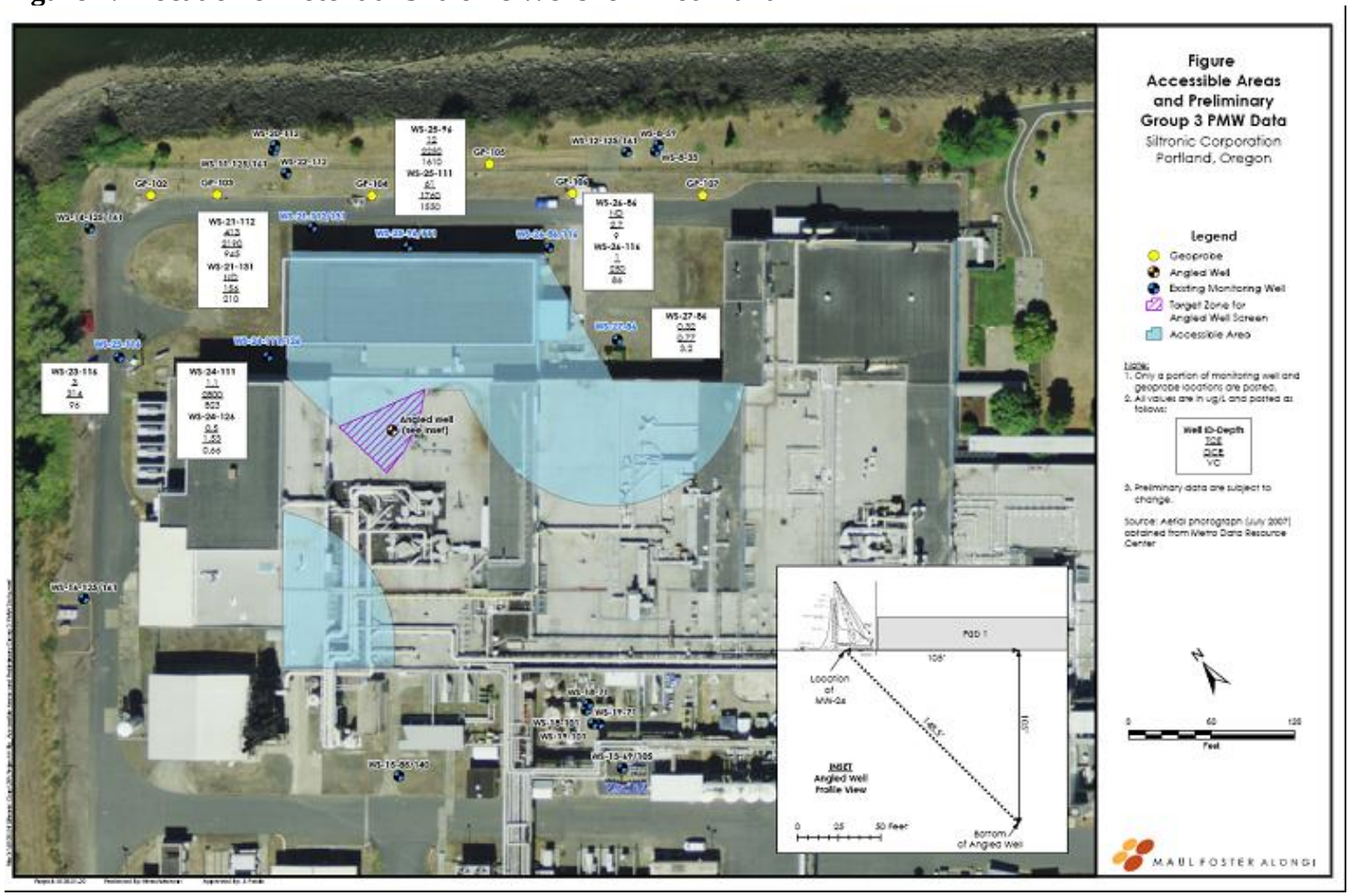
Flow Meter Rate/Totalizer

All treated wastewater discharged from the plant will pass through a 1-inch flow meter and totalizer.

Sodium Hydroxide Feed Pumps

A sodium hydroxide feed pump, pH meter and controller will be installed on the influent equalization tank to increase the influent pH to approximately 8.5. The rates of iron and manganese oxidation are both greatly accelerated at higher pH.

Figure 4: Location of Potential Siltronic Wells for Pilot Plant



Recirculation Loop and In- Line Aeration

An in-line aerator will be installed on the recirculation lines from the clarifier feed pumps to the Influent Equalization Tanks. The aerator will draw air into the recirculation line to assist in iron and manganese oxidation.

Polymer Addition

A polymer addition system will be installed to feed polymer to the wastewater prior to introduction into the downstream inclined-plate clarifier to facilitate settling. The polymer will be mixed in line with a 1-inch static mixer, and paced off the flow meter.

Inclined-Plate Clarifier (IPC)

An inclined-plate clarifier (IPC) will receive the flow from the equalization tanks and remove the oxidized iron and manganese. In addition, heavy metals will be removed via iron co-precipitation in the clarifier. Settled sludge will be removed and stored for dewatering once the full-scale plant is constructed.

IPC Effluent Tank

A 750-gallon effluent tank will be positioned at the outlet of the IPC to receive the flow by gravity. This tank will serve as the pump tank for the filter feed pump. The tank will also receive the treated flow from the Siltronic Pilot Plant.

Advanced Oxidation Feed Pump

Following the IPC will be a single 15-gpm electric centrifugal pump. This pump will be manually controlled, using the level in the IPC Effluent Tank. The flow rate will be adjusted with the use of a variable-frequency drive.

The Advanced Oxidation Pump will pump the wastewater flow through the advanced oxidation process, before discharging into the IPC Effluent Tank in the NW Natural Pilot Plant for further treatment.

Advanced Oxidation Process (AOP)

The advanced oxidation process (AOP) utilizes a combination of hydrogen peroxide and ultraviolet light to destroy the chlorinated organic solvents and cyanide in the Siltronic wastewater.

A hydrogen peroxide feed pump, oxidation-reduction potential (ORP) indicator and controller will deliver 50% hydrogen peroxide solution to an in-line static mixer to thoroughly mix the wastewater and hydrogen peroxide. The wastewater-peroxide mixture will pass through an ultraviolet reactor to destroy the chlorinated solvents and most cyanide.

Effluent Storage Tank

After the AOP, the treated wastewater will be discharged into a single 18,000-gallon storage tank. This tank will serve as a "batch holding tank" during the start up phase of the operation, and will be used to cool the potentially hot liquid, before introducing the flow into the NW Natural Pilot Plant.

Also, the plant effluent characteristics will be sampled from this tank.

Effluent Pump

A 15-gpm electric centrifugal pump will be used to pump the effluent from the storage tank to the NW Natural Pilot Plant for ultimate discharge to the local POTW. The flow from the Siltronic pilot will be measured and totalized prior to final discharge to the NW Natural pilot plant.

Residual Disposal

All residuals from the pilot treatment plant: settled solids from the IPC, will be properly disposed of. The residuals will be stored in a closed container within the containment zone prior to disposal.

Hoses

Two-inch hose will be used for the conveyance of the process water between the process tankage in the pilot plant. The proposed hose is a hard rubber 150-psi suction type hose with a spiral wound steel reinforcement running through its length.

Sampling and Analysis Plan

General

This Sampling and Analysis Plan covers the pilot wastewater treatment plants at both the NW Natural and Siltronic sites and their effluent discharges. All samples to be taken will be grab samples.

Influent and effluent samples will be taken in accordance with the March 31, 2009 "Discharge Limitations and Monitoring Requirements for the NW Natural/Gasco Site" from Oregon Department of Environmental Quality (DEQ).

The NW Natural pilot treatment facilities have been designed to remove:

- Iron and manganese;
- Cyanide
- Heavy metals
- Volatile and semi-volatile organic compounds, particularly polyaromatic hydrocarbons

The Siltronic pilot treatment facilities have been designed to remove:

- Iron and manganese;
- Cyanide
- Heavy metals
- Volatile and semi-volatile organic compounds, particularly polyaromatic hydrocarbons, and
- Chlorinated solvents, particularly vinyl chloride.

Effluent Flow Routing

All flow from the NW Natural pilot wastewater treatment plant will be discharged to the local POTW. The effluent flow rate will be instantaneously measured and totalized. All flow from the Siltronic pilot plant will be initially stored in an 18,000-gallon storage tank before being pumped and ultimately discharged to the NW Natural pilot plant.

Sample Locations

Both plants will utilize influent equalization tanks and effluent storage tanks. Grab samples will be taken from these tanks. Weekly grab samples will also be taken on the influent from the wells upstream of the equalization tanks to determine the actual water quality from the individual wells. In addition, process samples will be obtained from individual processes to facilitate the design of the individual processes.

Monitoring Program

Table 1 is a summary of discharge limitations summarized from the March 31, 2009 memorandum from the Oregon DEQ, and amended in its June 23 e-mail from Mr. Dana Bayuk. Table 2 is the Oregon DEQ's monitoring requirements for the pilot plant and subsequent facilities. Besides the required permit tests, Sevenson will perform other tests on influent and process flows as required to control and monitor process performance.

Sevenson will collect samples and conduct the analyses for the following reasons:

- To satisfy the discharge reporting requirements of the regulatory agency.
- To form a rational basis for controlling the pilot treatment processes.
- To define the operational efficiency of the pilot plants.
- To develop a historical record of the conditions under which the plant has been operated, as an aid to the design of the full-scale plant.

Table 2 shows the Oregon DEQ's monitoring schedule that will be used for both pilot plant operations. Besides the required tests, Sevenson will perform other tests on internal process flows as required to control and monitor process performance, as shown in Tables 3 and 4 for NW Natural and Siltronic, respectively.

Also, any sludges or sludge cakes generated will be tested for total solids. Also, all treatment chemicals used will be tracked throughout the pilot test period for final design purposes.

Table 1: Discharge Limitations for NW Natural/Gasco Site[1]

Discharge Limitations		
Parameter	**Monthly Average**	**Daily Maximum**
Benzene	0.66 (µg/L)	1.1 (µg/L)
Benzo(a)Anthracene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Benzo(a)Pyrene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Benzo(b)Flouranthene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Benzo(k)Flouranthene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Copper	Not to exceed EPA Method 200.8 Quantitation Limit of 10 µg/L	17.7 (µg/L)
Chromium VI	Not to exceed EPA Method 218.6 Quantitation Limit of 10 µg/L	16 (µg/L)
Chrysene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Free Cyanide	Not to exceed ASTM Method 4282-02 Quantitation Limit of 10 µg/L	
Dibenzo(a,h)Anthracene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Indeno(1,2,3-Cd)Pyrene	Not to exceed EPA Method 625 Quantitation Limit of 1 µg/L	
Iron (Dissolved)	300.0 (µg/L)	520 (µg/L)
Manganese (Dissolved)	50.0 (µg/L)	86.6 (µg/L)
Mercury	Not to exceed EPA Method 245.7 Quantitation Limit of 0.01 µg/L	
Pentachlorophenol	Not to exceed EPA Method 625 Quantitation Limit of 2 µg/L	
pH	6.5 S.U.	8.5 S.U.
Temperature	7-day Avg. of the Daily Maximums Not to Exceed 68 ºF	

[1] Unless indicated as dissolved, total metal concentration will be tested. Effluent samples will be tested for both dissolved and total metals.

Table 2: Oregon DEQ Monitoring Requirements for the NW Natural/Gasco Site

	Minimum Monitoring		
Parameter	**Minimum Frequency**		**Sample Type**
	During Pilot Study	**All Other Periods**	
Volume Discharged	Daily, when discharging	Daily, when discharging	Metering
Temperature	Daily, when discharging	Daily, when discharging	Recorder
Bioassay Testing	-	Annual	Grab
Outfall Pipe	-	Annual	Inspection
pH	Weekly, when discharging	Monthly, when discharging	Grab
Hardness	Weekly, when discharging	Monthly, when discharging	Grab
Free Cyanide	Weekly, when discharging	Monthly, when discharging	Grab
Total Cyanide	Weekly, when discharging	Monthly, when discharging	Grab
Available Cyanide	Weekly, when discharging	Monthly, when discharging	Grab
Weak-acid Dissociable Cyanide	Weekly, when discharging	Monthly, when discharging	Grab
PAHs			
Acenaphthylene	Weekly, when discharging	Monthly, when discharging	Grab
Acenaphthene	Weekly, when discharging	Monthly, when discharging	Grab
Anthracene	Weekly, when discharging	Monthly, when discharging	Grab
Benzo(a)Anthracene	Weekly, when discharging	Monthly, when discharging	Grab
Benzo(a)Pyrene	Weekly, when discharging	Monthly, when discharging	Grab
Benzo(b)Flouranthene	Weekly, when discharging	Monthly, when discharging	Grab
Benzo(k)Flouranthene	Weekly, when discharging	Monthly, when discharging	Grab
Carbazole	Weekly, when discharging	Monthly, when discharging	Grab
Chrysene	Weekly, when discharging	Monthly, when discharging	Grab
Dibenzo(a,h)Anthracene	Weekly, when discharging	Monthly, when discharging	Grab
Dibenzofuran	Weekly, when discharging	Monthly, when discharging	Grab
Flouranthene	Weekly, when discharging	Monthly, when discharging	Grab
Flourene	Weekly, when discharging	Monthly, when discharging	Grab
Indeno(1,2,3-Cd) Pyrene	Weekly, when discharging	Monthly, when discharging	Grab
2-Methlynaphthalene	Weekly, when discharging	Monthly, when discharging	Grab
Naphthalene	Weekly, when discharging	Monthly, when discharging	Grab
Pyrene	Weekly, when discharging	Monthly, when discharging	Grab

Table 2 (Cont'd): Oregon DEQ Monitoring Requirements for the NW Natural Site

Parameter	Minimum Monitoring Minimum Frequency		Sample Type
	During Pilot Study	All Other Periods	
Metals[2]			
Arsenic (organic)	Weekly, when discharging	Monthly, when discharging	Grab
Arsenic (inorganic)[3]	Weekly, when discharging	Monthly, when discharging	Grab
Cadmium	Weekly, when discharging	Monthly, when discharging	Grab
Chromium III	Weekly, when discharging	Monthly, when discharging	Grab
Chromium VI	Weekly, when discharging	Monthly, when discharging	Grab
Copper	Weekly, when discharging	Monthly, when discharging	Grab
Iron (dissolved)	Weekly, when discharging	Monthly, when discharging	Grab
Iron (total)	Weekly, when discharging	Monthly, when discharging	Grab
Lead	Weekly, when discharging	Monthly, when discharging	Grab
Manganese (dissolved)	Weekly, when discharging	Monthly, when discharging	Grab
Mercury	Weekly, when discharging	Monthly, when discharging	Grab
Nickel	Weekly, when discharging	Monthly, when discharging	Grab
Selenium	Weekly, when discharging	Monthly, when discharging	Grab
Silver	Weekly, when discharging	Monthly, when discharging	Grab

[2] Unless indicated as dissolved, total metal concentration will be tested. Effluent samples will be tested for both dissolved and total metal concentrations.
[3] Speciation to be conducted at least once during the pilot testing and monthly during initial full-scale operation

Table 2 (Cont'd): Oregon DEQ Monitoring Requirements for NW Natural Site

Minimum Monitoring (Continued)			
Parameter	**Minimum Frequency**		**Sample Type**
	During Pilot Study	**All Other Periods**	
VOCs			
Acetone	Weekly, when discharging	Monthly, when discharging	Grab
Benzene	Weekly, when discharging	Monthly, when discharging	Grab
2-Butanone	Weekly, when discharging	Monthly, when discharging	Grab
1,1-dichloroethene	Weekly, when discharging	Monthly, when discharging	Grab
cis-1,2-dichloroethene	Weekly, when discharging	Monthly, when discharging	Grab
Ethylbenzene	Weekly, when discharging	Monthly, when discharging	Grab
Tetrachloroethene	Weekly, when discharging	Monthly, when discharging	Grab
Toluene	Weekly, when discharging	Monthly, when discharging	Grab
Trans-1,2-dichloroethene	Weekly, when discharging	Monthly, when discharging	Grab
Trichloroethene	Weekly, when discharging	Monthly, when discharging	Grab
1,2,4 trimethylbenzene	Weekly, when discharging	Monthly, when discharging	Grab
1,3,5 trimethylbenzene	Weekly, when discharging	Monthly, when discharging	Grab
Vinyl chloride	Weekly, when discharging	Monthly, when discharging	Grab
Xylene	Weekly, when discharging	Monthly, when discharging	Grab
Phenols			
2-Chlorophenol	Weekly, when discharging	Monthly, when discharging	Grab
2,4-Dichlorophenol	Weekly, when discharging	Monthly, when discharging	Grab
2,4-Dimethylphenol	Weekly, when discharging	Monthly, when discharging	Grab
2-methyl-4,6-Dinitrophenol	Weekly, when discharging	Monthly, when discharging	Grab
2-methylphenol	Weekly, when discharging	Monthly, when discharging	Grab
2-nitrophenol	Weekly, when discharging	Monthly, when discharging	Grab
4-nitrophenol	Weekly, when discharging	Monthly, when discharging	Grab
2,4,5-Trichlorophenol	Weekly, when discharging	Monthly, when discharging	Grab
2,4,6-Trichlorophenol	Weekly, when discharging	Monthly, when discharging	Grab
Pentachlorophenol	Weekly, when discharging	Monthly, when discharging	Grab
Phenol	Weekly, when discharging	Monthly, when discharging	Grab

Notes

1. After receiving and reviewing the discharge data from several months of monitoring, the Department may make the determination that the monitoring of certain parameters will no longer be necessary, should continue, or assigning discharge limitations is warranted.
2. The quantitation limits specified in the November 2007 DEQ memorandum pertaining to water quality quantitation limits must be addressed for each applicable parameter.

Table 3: Process Monitoring Sampling Schedule—NW Natural[4]

Parameter	Influent Wells	Influent Equalization Tank	Clarifier Influent	Clarifier Effluent	Cyanide Destruct Tank Effluent	Bag Filter Effluent	Carbon Midpoint	Carbon Effluent	Final Effluent
Flow	W	D							D
pH	W	D	D	D	D	D			D
Oxidation-reduction potential (ORP)			D	D	D				D
Temperature[5]	W	D			D				D
Oil & Grease	W	W							W
Total suspended solids		D				D			D
Total & dissolved iron	W	D	D	D		D			D
Total & dissolved manganese	W	D	D	D		D			D
Total, amenable, WAD, available & free cyanide		D			D	D			D
Heavy metals	W	D				D			D
Total hardness		W				W			W
Total organic carbon	W	D			D	D	D	D	D
Volatile organic compounds	W	D			D		D	D	D
Semi-volatile compounds	W	D			D		D	D	D

[4] All samples grab samples, except pH, ORP, & temperature
[5] Temperature continuously recorded

Table 4: Process Monitoring Sampling Schedule—Siltronic[6]

Parameter	Influent	Equalization Tank	Clarifier Effluent	Advanced Oxidation Process Effluent to NW Natural Plant	Clarifier Sludge Solids
Flow	D	W		D	
pH	D	W	D	D	
Oxidation-reduction potential (ORP)			D	D	
Temperature[7]	D	W	D	D	
Oil & Grease	W	W		W	
Total suspended solids	D			D	D
Total dissolved solids	D		D		
Total & dissolved iron	D	W		D	
Total & dissolved manganese	D	W		D	
Total, amenable, WAD, available & free cyanide	D			D	
Heavy metals	D	W		D	
Total hardness	W			W	
Total calcium, as CaCO3	D		D		
Total alkalinity, as CaCO3	D		D		
Total organic carbon	D	W		D	
Volatile organic compounds	D	W		D	D
Semi-volatile compounds	D	W		D	D

SAMPLING LEGEND
D—Daily
W--Weekly

[6] All samples grab samples, except pH, ORP & temperature
[7] Temperature continuously recorded

Sample Collection and Handling

All samples collected for off-site laboratory analysis will be stored in ice and preserved in accordance with the requirements of the particular analytical method. All samples will be transported by courier on the day they are collected for analysis at a local analytical laboratory. One exception may be the analysis for free cyanide using ASTM Method 4282-95 which is performed in a limited number of laboratories and may need to be sent away for special testing.

Sample Analytical Methods and Mean Reporting Limits

While the analytical laboratory has not been finally selected, a major consideration in the selection will be the ability of the laboratory to analyze for the required parameters down to the Method Reporting Limit (MRL) as specified by Oregon DEQ in Table 1.
Sevenson will also provide split samples to Agency representatives, should it be required.

Pilot Plant Schedule

It is anticipated that the pilot plant would be started up in late May 2009 and continue approximately 4-6 weeks, depending upon the results of the pilot work and the effectiveness of the selected processes in meeting DEQ's discharge limitations. The projected schedule is shown in Appendix C.

Appendix A: Pilot Plant Design and Materials Balance

NW Natural

NW NATURAL GROUNDWATER PILOT PLANT PROCESS DESIGN		
PRELIMINARY DESIGN DATA --50 GPM		**COMMENTS/ASSUMPTIONS**
INFLUENT CHARACTERISTICS--WASTEWATER		
DESIGN AVERAGE FLOW, GPD	18,000	6-Hour Days
, GPM	50	
AVERAGE TOTAL ORGANIC CARBON, LBS/DAY	6.0	@ 40 mg/L
TOTAL SUSPENDED SOLIDS, LBS/DAY	3.0	@ 20 mg/L
TOTAL CYANIDE, LBS/DAY	0.2	@ 1.5 mg/L
TOTAL IRON, LBS/DAY	12	@ 80 mg/L
TOTAL MANGANESE, LBS/DAY	0.2	@ 1 mg/L
REQUIRED EFFLUENT CHARACTERISTICS		
TOC, MG/L	0.05	Assumed
, LBS/DAY	0.01	
, % REMOVAL	99.9%	
VOCs, MG/L	0.02	Approximate (individual values checked)
, LBS/DAY	0.003	
SVOCs, MG/L	0.03	
, LBS/DAY	0.005	Approximate (individual values checked)
TSS, MG/L	0.04	Assumed
, LBS/DAY	0.01	
, % REMOVAL	99.8%	
FREE CYANIDE, MG/L	0.01	DEQ
, LBS/DAY	0.0180	
, % REMOVAL	92.0%	
DISSOLVED IRON, MG/L	0.3	DEQ
, LBS/DAY	0.0	
, % REMOVAL	99.6%	
DISSOLVED MANGANESE, MG/L	0.05	DEQ
, LBS/DAY	0.01	
, % REMOVAL	95.0%	
INFLUENT EQUALIZATION TANKS		Closed tanks with level control
TYPE	FRAC	
NO OF UNITS INSTALLED	2	
UNIT VOLUME, GALS	21,000	
VOLUME, GALS	42,000	
DETENTION TIME, DAYS	4.7	

REACTOR FEED PUMPS		Controlled off reactor level
TYPE	CENTRIFUGAL	
NO OF UNITS	2	
UNIT CAPACITY, GPM	100	
TDH, FT	20	
UNIT HP	3	with VFD
MAZZEI EDUCTORS--FE AERATION IN RECIRC		
STOICHIOMETRIC FACTOR IRON	0.1432	
STOICHIOMETRIC FACTOR MANGANESE	0.2912	
ASSUMED INFLUENT OXYGEN, mg/L	0	
DESIRED RESIDUAL OXYGEN, mg/L	5	
OXYGEN REQUIRED, mg/l	17	
INFLUENT FLOW METERS		
TYPE	MAGNETIC	Tied to VFDs
NUMBER	2	
SIZE, INCHES	2	
CAUSTIC FEED PUMPS		pH Adjustment as required
TYPE	Diaphragm	
CONTROL	pH	
NUMBER OF UNITS	1	
PROJECTED USAGE, GALS/DAY	18	Treatability using 25%
PROJECTED USAGE, LBS/DAY	234	
, GALS/HOUR	2.3	8 hr days
UNIT CAPACITY, GALS/HR	0-4	
STORAGE PROVIDED, GALS	260	Totes
STORAGE PROVIDED, DAYS	14.4	
HYDROGEN PEROXIDE FEED PUMPS		CYANIDE OXIDATION
TYPE	Diaphragm	pH = 10.2
CONTROL	Paced off ORP	ORP = 650 mv
NUMBER OF UNITS	1	
PROJECTED USAGE, GALS/DAY	7	Treatability & Estimate
PROJECTED USAGE, LBS/DAY	72	Estimate
, GALS/HOUR	0.9	
UNIT CAPACITY, GALS/HOUR	0-8	
STORAGE PROVIDED, GALS	260	Totes
STORAGE PROVIDED, DAYS	36.1	
CYANIDE REACTOR		
DESIRED DETENTION TIME, MINS	120	Oxidation to Cyanate
NUMBER OF UNITS	1	
LENGTH, FT	20	
WIDTH, FT	6	
DEPTH	6	
VOLUME, CU FT	720	
VOLUME, GALS	5,386	
DETENTION TIME, MINS	108	

SULFURIC ACID FEED PUMPS		pH Adjustment 8-8.5
TYPE	Diaphragm	
CONTROL	Paced off pH	
NUMBER OF UNITS	1	
PROJECTED USAGE @ 28 mg/L, LBS/DAY	6	Estimate
, GALS/HOUR	0.02	
, GALS/DAY	0.2	
UNIT CAPACITY, GALS/HOUR	0-2	
STORAGE PROVIDED, GALS	20	Drum
STORAGE PROVIDED, DAYS	127.5	
IN-LINE MIXER		
NUMBER	1	
TYPE	IN LINE STATIC	
SIZE, INCHES	2	
INCLINED-PLATE CLARIFIER		
TYPE	INCLINED PLATE	
NUMBER	1	
DIMENSIONS, FT		
LENGTH	8	
WIDTH	4	
HEIGHT	8	
PROJECTED SETTLING AREA, SQ FT	250	
LOADING RATE, GPM/SQ FT	0.20	
SOLIDS PRODUCTION		
INFLUENT SOILIDS	2	@ 75% Removal of Influent
CHEMICAL SOLIDS	36	@ 3 X Influent Iron
TOTAL SOLIDS, LBS/DAY	38	
, CONCENTRATION @	3%	
, LBS/DAY	1,276	
, GALS/DAY	150	
, GALS/MIN @ 10 MINS/HR	0.6	
IPC EFFLUENT TANK		
TYPE	Polypropylene	
NO OF UNITS INSTALLED	1	
VOLUME, GALS	2,500	
DETENTION TIME, MINS	50.0	
SLUDGE PUMP		
TYPE	DIAPHRAGM	
NUMBER	1	
CAPACITY, GPM	15	Sandpiper S05 Al
REQUIRED AIR, CFM	14	
AIR COMPRESSOR		
TYPE		
CAPACITY, CFM	25	
PRESSURE, PSI	125	
SLUDGE THICKENER/STORAGE		
NO OF UNITS	1	
UNIT VOLUME, GALS	2,500	
TOTAL VOLUME, GALS	2,500	
SLUDGE FEED, GALS/DAY	150	
STORAGE CAPACITY, DAYS	16.7	
THICKENED SLUDGE, LBS/DAY	34	@ 90% Solids capture
THICKENED SLUDGE, 2 x INFLUENT	6%	
THICKENED SLUDGE, GALS	67	
RECIRCULATED OVERFLOW, GALS/DAY	83	

ANIONIC POLYMER FEED PUMP		Settling Aid
TYPE	Diaphragm	
CONTROL	Manual Stroke	
NUMBER OF UNITS	1	
PROJECTED USAGE @ 8.6 LBS/GAL, LBS/DAY	0.8	@ 5 mg/L
PROJECTED USAGE @ 8.6 LBS/GAL, GALS/DAY	0.1	20-Gallon Carboy
, GALS/HOUR	0.01	
UNIT CAPACITY, GALS/HR	0-1	
DILUTION WATER @ 0.25%, GALS/DAY	36	
, GALS/HOUR	3	
FILTER/GAC FEED PUMPS		
TYPE	CENTRIFUGAL	
NO OF UNITS	1	
UNIT CAPACITY, GPM	75	
TDH, FT	100	
UNIT HP	25.0	
BAG FILTERS		Metals/solids removal
NO OF UNITS	2	In series
BAG MEDIA, MICRONS	10-->5	
GRANULAR ACTIVATED CARBON VESSELS		Organics Removal
DESIGN PARAMETERS		
CONTACT TIME, MINS	15	
LOADING RATE, GPM/SQ FT	4	
NO OF UNITS	2	In Parallel
UNIT DIAMETER, FT	6	
UNIT HEIGHT, FT	10	
CARBON DEPTH, FT	2	
UNIT AREA, SQ FT	28	
TOTAL AREA, SQ FT	57	
EFFECTIVE UNIT VOLUME, CU FT	57	
TOTAL EFFECTIVE VOLUME, CU FT	113	
HYDRAULIC LOADING, GPM/SQ FT	1.8	
LBS CARBON/UNIT @ 30 LBS/CU FT	1,696	
TOTAL AVAILABLE CARBON, LBS	3,391	
EMPTY BED CONTACT TIME , MINS	16.9	
TOTAL ORGANICS TO CARBON UNITS, LBS/DAY	4.5	25% Removal across oxidation/sedimentation
% TOTAL ORGANICS REMOVAL	99%	
EFFLUENT ORGANICS, LBS/DAY	0.05	
, mg/L	0.30	
UTILIZATION RATE, LBS TOCr/LB CARBON	0.10	
UTILIZATION RATE, LBS/CARBON/DAY	45	
, LBS/YEAR	16,274	
ESTIMATED BREAKTHROUGH LEAD COLUMN, DAYS	38	
TOTAL BED LIFE, DAYS	76	

EFFLUENT HOLDING TANK		
TYPE	FRAC TANK	
NO OF UNITS INSTALLED	2	
VOLUME, GALS	20,000	
DETENTION TIME, HRS	17.8	
EFFLUENT/GAC BACKWASH PUMPS		
TYPE	CENTRIFUGAL	
NO OF UNITS INSTALLED	2	
UNIT CAPACITY, GPM	339	Backwash Rate = 12 gpm/sq ft
TDH, FT	60	
UNIT BHP	10	
BAG FILTERS		Carbon fines removal removal
NO OF UNITS	1	
BAG MEDIA, MICRONS	0.5	
EFFLUENT FLOW METER		
TYPE	MAGNETIC	
SIZE, INCHES	2	

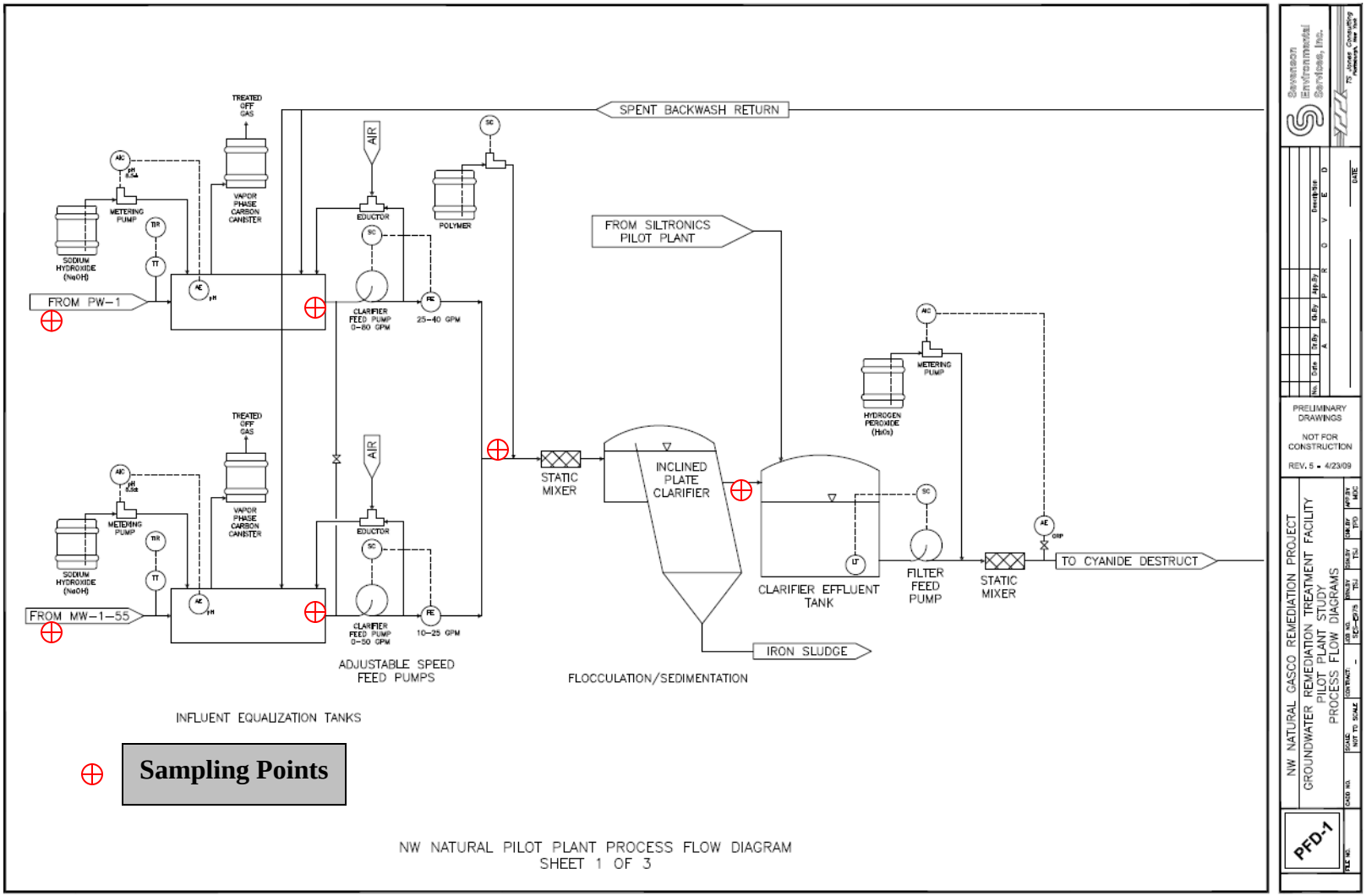
Siltronic

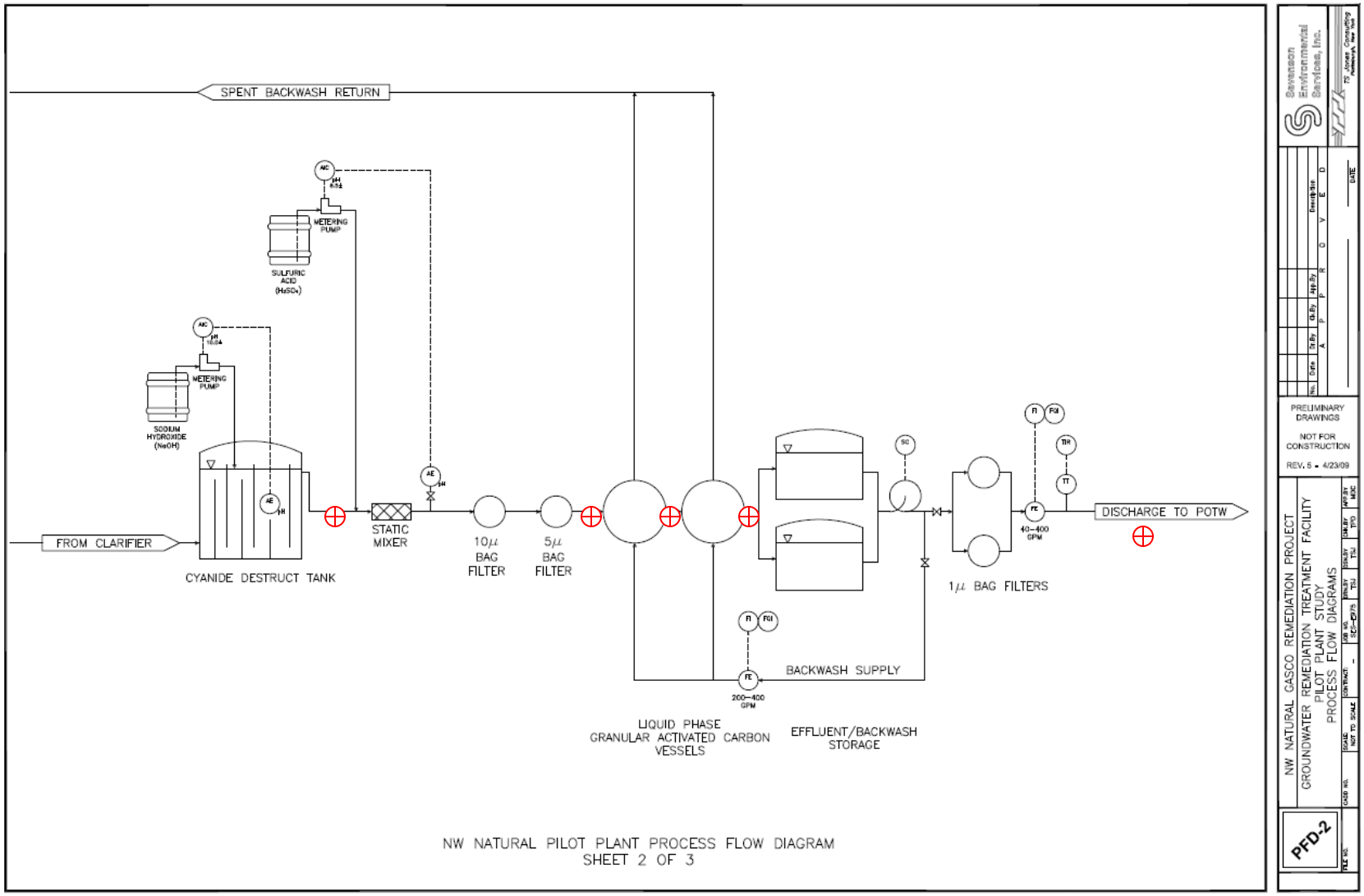
SILTRONICS GROUNDWATER PILOT PLANT PROCESS DESIGN		
PRELIMINARY DESIGN DATA --15 GPM		**COMMENTS/ASSUMPTIONS**
INFLUENT CHARACTERISTICS--WASTEWATER		
DESIGN AVERAGE FLOW, GPD	5,400	6-Hour Days
, GPM	15	
AVERAGE TOTAL ORGANIC CARBON, LBS/DAY	1.1	@ 25 mg/L
TOTAL SUSPENDED SOLIDS, LBS/DAY	0.9	@ 20 mg/L
TOTAL CYANIDE, LBS/DAY	0.02	@ 0.5 mg/L
TOTAL IRON, LBS/DAY	2.25	@ 50 mg/L
TOTAL MANGANESE, LBS/DAY	0.05	@ 1 mg/L
REQUIRED EFFLUENT CHARACTERISTICS		
TOC, MG/L	0.05	Assumed
, LBS/DAY	0.00	
, % REMOVAL	99.8%	
TSS, MG/L	0.04	Assumed
, LBS/DAY	0.00	
, % REMOVAL	99.8%	
TOTAL CYANIDE, MG/L	0.0014	DEQ
, LBS/DAY	0.0025	
, % REMOVAL	88.8%	
TOTAL IRON, MG/L	0.3	DEQ
, LBS/DAY	0.01	
, % REMOVAL	99.4%	
TOTAL MANGANESE, MG/L	0.05	DEQ
, LBS/DAY	0.002	
, % REMOVAL	95.0%	
INFLUENT EQUALIZATION TANK		Closed tanks with level control
TYPE	FRAC	
NO OF UNITS INSTALLED	1	
UNIT VOLUME, GALS	21,000	
VOLUME, GALS	21,000	
DETENTION TIME, DAYS	3.9	
REACTOR FEED PUMP		Controlled off reactor level
TYPE	CENTRIFUGAL	
NO OF UNITS	1	
UNIT CAPACITY, GPM	30	with 100% recycle
TDH, FT	20	
UNIT HP	0.5	with VFD

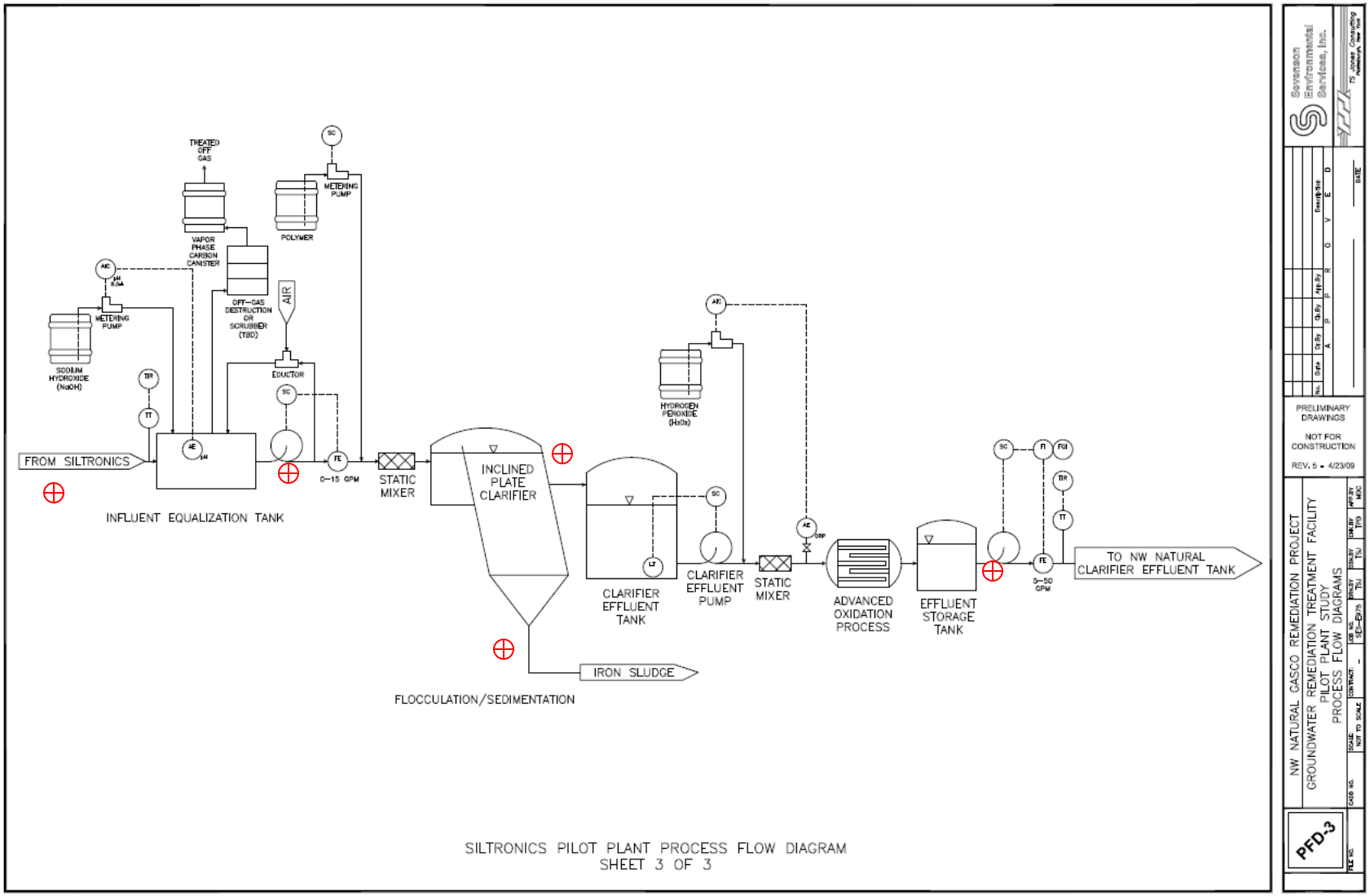
MAZZEI EDUCTORS--FE AERATION IN RECIRC		
STOICHIOMETRIC FACTOR IRON	0.1432	
STOICHIOMETRIC FACTOR MANGANESE	0.2912	
ASSUMED INFLUENT OXYGEN, mg/L	0	
DESIRED RESIDUAL OXYGEN, mg/L	5	
OXYGEN REQUIRED, mg/l	12	
INFLUENT FLOW METER		
TYPE	MAGNETIC	Tied to VFD
NUMBER	1	
SIZE, INCHES	1	
CAUSTIC FEED PUMP		pH Adjustment as required
TYPE	Diaphragm	
CONTROL	pH	
NUMBER OF UNITS	1	
PROJECTED USAGE, GALS/DAY	5	Treatability using 25%
PROJECTED USAGE, LBS/DAY	70	
, GALS/HOUR	0.7	8 hr days
UNIT CAPACITY, GALS/HR	0-2	
STORAGE PROVIDED, GALS	260	Tote
STORAGE PROVIDED, DAYS	48.1	
IN-LINE MIXER		
NUMBER	1	
TYPE	IN LINE STATIC	
SIZE, INCHES	1	
INCLINED-PLATE CLARIFIER		
TYPE	INCLINED PLATE	
NUMBER	1	
DIMENSIONS, FT		
LENGTH	8	
WIDTH	4	
HEIGHT	8	
PROJECTED SETTLING AREA, SQ FT	80	
LOADING RATE, GPM/SQ FT	0.19	
SOLIDS PRODUCTION		
INFLUENT SOILIDS	1	@ 75% Removal of Influent
CHEMICAL SOLIDS	7	@ 3 X Influent Iron
TOTAL SOLIDS, LBS/DAY	8	
, CONCENTRATION @	3%	
, LBS/DAY	255	
, GALS/DAY	30	
, GALS/MIN @ 10 MINS/HR	0.1	
IPC EFFLUENT TANK		
TYPE	Polypropylene	
NO OF UNITS INSTALLED	1	
VOLUME, GALS	2,500	
DETENTION TIME, MINS	0.5	

HYDROGEN PEROXIDE FEED PUMP		CYANIDE OXIDATION
TYPE	Diaphragm	
CONTROL	Paced off ORP	ORP = 650 mv
NUMBER OF UNITS	1	
PROJECTED USAGE, GALS/DAY	2	Treatability & Estimate
PROJECTED USAGE, LBS/DAY	22	Estimate
, GALS/HOUR	0.3	
UNIT CAPACITY, GALS/HOUR	0-8	
TOTAL CAPACITY, GALS/HOUR	0-16	
STORAGE PROVIDED, GALS	260	Totes
STORAGE PROVIDED, DAYS	120.4	
IN-LINE MIXER		
NUMBER	1	
TYPE	IN LINE STATIC	
SIZE, INCHES	1	
ADVANCED OXIDATION FEED PUMP		Controlled off reactor level
TYPE	CENTRIFUGAL	
NO OF UNITS	1	
UNIT CAPACITY, GPM	15	
TDH, FT	20	
UNIT HP	0.5	with VFD
ADVANCED OXIDATION REACTOR		Ultraviolet Lights
DESIRED DETENTION TIME, MINS	90	Oxidation of halogenated organics
NUMBER OF UNITS	1	
LENGTH, FT	6	
WIDTH, FT	6	
DEPTH	6	
VOLUME, CU FT	216	
VOLUME, GALS	1,616	
DETENTION TIME, MINS	108	
EFFLUENT HOLDING TANK		
TYPE	FRAC TANK	
NO OF UNITS INSTALLED	1	
VOLUME, GALS	18,000	
DETENTION TIME, HRS	26.7	
EFFLUENT PUMP		
TYPE	CENTRIFUGAL	
NO OF UNITS INSTALLED	1	
UNIT CAPACITY, GPM	25	
TDH, FT	50	
UNIT BHP	0.5	
EFFLUENT FLOW METER		
TYPE	MAGNETIC	
SIZE, INCHES	1	

Appendix B: Pilot Plant Process Flow Diagrams


SPENT BACKWASH RETURN
TREATED OFF GAS
VAPOR PHASE CARBON CANISTER
METERING PUMP
SODIUM HYDROXIDE (NaOH)
FROM PW-1
FROM MW-1-55
AIR
EDUCTOR
POLYMER
CLARIFIER FEED PUMP 0-60 GPM
25-40 GPM
CLARIFIER FEED PUMP 0-50 GPM
10-25 GPM
ADJUSTABLE SPEED FEED PUMPS
INFLUENT EQUALIZATION TANKS
FROM SILTRONICS PILOT PLANT
STATIC MIXER
INCLINED PLATE CLARIFIER
IRON SLUDGE
FLOCCULATION/SEDIMENTATION
CLARIFIER EFFLUENT TANK
HYDROGEN PEROXIDE (H2O2)
FILTER FEED PUMP
TO CYANIDE DESTRUCT
Sampling Points
NW NATURAL PILOT PLANT PROCESS FLOW DIAGRAM
SHEET 1 OF 3
PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION
REV. 5 - 4/23/09
NW NATURAL GASCO REMEDIATION PROJECT
GROUNDWATER REMEDIATION TREATMENT FACILITY
PILOT PLANT STUDY
PROCESS FLOW DIAGRAMS
PFD-1


SPENT BACKWASH RETURN
SULFURIC ACID (H_2SO_4)
METERING PUMP
SODIUM HYDROXIDE (NaOH)
METERING PUMP
FROM CLARIFIER
CYANIDE DESTRUCT TANK
STATIC MIXER
10μ BAG FILTER
5μ BAG FILTER
LIQUID PHASE GRANULAR ACTIVATED CARBON VESSELS
EFFLUENT/BACKWASH STORAGE
BACKWASH SUPPLY
200–400 GPM
1μ BAG FILTERS
40–400 GPM
DISCHARGE TO POTW
NW NATURAL PILOT PLANT PROCESS FLOW DIAGRAM
SHEET 2 OF 3
PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION
REV. 5 - 4/23/09
NW NATURAL GASCO REMEDIATION PROJECT
GROUNDWATER REMEDIATION TREATMENT FACILITY
PILOT PLANT STUDY
PROCESS FLOW DIAGRAMS
PFD-2


TREATED OFF GAS
VAPOR PHASE CARBON CANISTER
OFF-GAS DESTRUCTION OR SCRUBBER (TBD)
AIR
EDUCTOR
METERING PUMP
POLYMER
SODIUM HYDROXIDE (NaOH)
FROM SILTRONICS
INFLUENT EQUALIZATION TANK
0-15 GPM
STATIC MIXER
INCLINED PLATE CLARIFIER
FLOCCULATION/SEDIMENTATION
IRON SLUDGE
HYDROGEN PEROXIDE (H2O2)
CLARIFIER EFFLUENT TANK
CLARIFIER EFFLUENT PUMP
STATIC MIXER
ADVANCED OXIDATION PROCESS
EFFLUENT STORAGE TANK
5-50 GPM
TO NW NATURAL CLARIFIER EFFLUENT TANK
SILTRONICS PILOT PLANT PROCESS FLOW DIAGRAM
SHEET 3 OF 3
PRELIMINARY DRAWINGS
NOT FOR CONSTRUCTION
REV. 5 - 4/23/09
NW NATURAL GASCO REMEDIATION PROJECT
GROUNDWATER REMEDIATION TREATMENT FACILITY
PILOT PLANT STUDY
PROCESS FLOW DIAGRAMS
PFD-3

Appendix C: Pilot Plant Schedule