NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TEST PLAN

TITLE:	REVISION: 0
Natural Gradient Cross-Hole Tracer Test at Site 22	DATE: 01-31-06
	PAGE: 1 of 18

TEST PLAN NUMBER:	SUPERSEDES:
TPN-9.5	**Page 8, 9, 10, 11**

CHANGE NOTICE NO. 2

EFFECTIVE DATE: September 5, 2008

PURPOSE: Add additional drop tube sampling to current sampling procedure.

Page 8, Section 5.4: Changed Step 2 to only measure water levels prior to running Bennett pump.

Page 9, Section 5.4: Insert new Step 4 for running drop tube assembly.

Page 9, Section 5.4: Insert new Step 5 for rinsing of drop tube, pump, and lines prior to sampling. Renumber subsequent step.

Page 9, Section 5.4: Update Step 7 to include rinsing of drop tube and availability of rinsate water.

Page 9, Section 5.4: Insert new Step 8 for collecting sample from drop tube.

Page 9, Section 5.4: Insert new Step 9 for reassembly of Bennett pump. Renumber subsequent steps.

CONCURRENCE:

Geoscience Manager — Date: 9/18/08

Principal Investigator — Date: 9/18/08

Quality Assurance Officer — Date: 9/18/08

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TITLE: **Natural Gradient Cross-Hole Tracer Test at Site 22**	REVISION: **0** DATE: **01-31-06** PAGE: **1 of 18**
TEST PLAN NUMBER: **TPN-9.5**	SUPERSEDES: **None**
APPROVAL 2-3-06 Project Manager Date	CONCURRENCE 1/19/06 On-Site Geotechnical Representative Date 1-13-06 Principal Investigator Date 1/23/06 Quality Assurance Officer Date

1.0 INTRODUCTION

This test plan (TPN) provides detailed instructions for a Nye County Nuclear Waste Repository Project Office (NWRPO) natural gradient tracer test, using pentafluorobenzoate (PFBA) and sodium bromide (NaBr) as groundwater tracers, starting in January 2006 at Early Warning Drilling Program (EWDP) Site 22. NWRPO work plan WP-9, *Work Plan for Tracer Testing*, provides the background, purpose, and general objectives of cross-hole tracer testing at Site 22. Detailed plans for initial single- and cross-hole tests at Site 22 are presented in TPN-9.2, *Single-Well Push/Pull Tracer Tests at Well NC-EWDP-22S*, TPN-9.3, *Cross-Hole, Multiple-Well Tracer Test at Site 22*, and TPN-9.4, *Site 22 Cross-Hole Tracer Test Using Perrhenate and Iodide.*

Wells NC-EWDP-22S, -22PA, -22PB and -22PC are referred to herein as 22S, 22PA, 22PB and 22PC, respectively.

Based on preliminary results from the initial tests, which used primarily conservative tracers, the NWRPO determined that it would be beneficial to conduct an additional natural gradient cross-hole test to confirm estimates of the direction and magnitude of the gradient at this site. The test involves the placement of two tracers, PFBA and NaBr, in the lower screen of 22PA (i.e., 22PA Deep). The two tracers shall be allowed to drift downgradient toward 22S. Water from the equivalent open screens in 22S and 22PC shall be sampled monthly for evidence of the tracers with a Bennett sampling pump at low rates (i.e., approximately 0.5 gallon per minute [gpm]), pumping only enough volume to obtain representative samples from the aquifer (i.e., a maximum of approximately 60 gallons). These tracers have differing diffusion coefficients, which provide additional information about direction and rate of natural groundwater flow and allow the investigation of possible diffusion into less mobile water in the system over the extended time frame of the test.

2.0 WELL INFORMATION

Table 1 lists well casing and water level information for 22S.

Table 1
Well Information

Description	Elevation	
	Feet above mean sea level	Feet below ground surface (bgs)
Measuring point	2,851.51	
Static water level in Screen 2 (472.94 feet to fluid)	2,378.57	
6⅝-inch outside diameter (OD) steel casing (6.05-inch inside diameter [ID])		1,190.1
5-inch Schedule 80 PVC pipe (4.768-inch ID)		515
Westbay MP55 casing (2.25-inch ID)		1,185.81
Connection between 5-inch PVC pipe and MP55 casing		515

3.0 COMPLETION INFORMATION

Table 2 summarizes well screen intervals and Westbay port depths for 22S. Completion diagrams for 22S, 22PA, and 22PC are shown on Figures 1 through 3, respectively.

Table 2
Westbay Completion Information

Screen	Screen Interval (feet bgs)	Measurement Port (feet bgs)	Pumping Port (feet bgs)
1	521.5 – 581.3	559.6	569.8
2	661.2 – 760.6	742.6	752.9
3	880.2 – 980.0	960.1	970.4
4	1,140 – 1,180	1,148.0	1,158.3

Source: Westbay completion report.

4.0 EQUIPMENT LIST

Table 3 lists the equipment required for the cross-hole tracer test and the amount specified for each item.

Table 3
Natural Gradient Tracer Test Equipment

Item (In Alphabetical Order)	Amount
Barrel (50-gallon)	1
Carboy (5–gallon, empty)	4
Carboy containing concentrated pentafluorobenzoate (PFBA)	1
Carboy containing concentrated sodium bromide (NaBr)	1
Cone-bottom water tank (1,500-gallon)	2
Datalogger with cable for stand-alone module (SAM) and Westbay MOSDAX® probes	1
Fittings and nipples for surface equipment (2- and 1.25-inch)	Assorted
Gate valve (2-inch, for discharge line)	1
Generator (20 kilowatt (KW), 25 kilovolt-ampere [KVA] minimum)	1
Hand sprayer (1- or 2-gallon)	1
MOSDAX® probe with centralizer	4
Motor for submersible pump (4-inch 10-horsepower [hp] Franklin®, or equivalent alternative)	1
Peristaltic pump	1
Personal protective equipment (PPE)	2 sets
Portable staircase	1
PVC hose (1.25-inch, braided, flexible)	100 feet
PVC pipe (2-inch)	50 feet
Quarter-turn ball valve (2-inch)	4
SAM (250-pounds-per-square-inch-absolute [psia])	1
SAM (30-psia)	1
Sample bottle for monthly samples (250-ml amber glass bottles)	220
Scientific notebook	1
Steel pipe and associated pup joints (2-inch, galvanized)	510 feet
Stopwatch for barrel flow rate test	1
Submersible pump (Myers® S100-40, or equivalent alternative)	1
Variable-speed trash pump	1
Water flow meter (1-inch Vortex with totalizer, on loan from USGS, or NWRPO Multi-Jet)	1
Well sounder (500-foot minimum)	2

5.0 PROCESS

5.1 Borehole Instrument Removal and Preliminary Measurements

Steps in Sections 5.1.1 and 5.1.2 assume that equipment and instruments are already installed in 22S, 22PA, 22PB, and 22PC as described in TPN-9.3.

5.1.1 Removal of Stand-Alone Modules and Probes

1. Download all probe data stored in the dataloggers.

2. Remove existing 30-psia SAMs and MOSDAX® probes from 22PA, 22PB, and 22PC.

5.1.2 Manual Water Level Measurements

Measure water levels with a 500-foot or greater sounder in all piezometer screens of 22PA, 22PB, and 22PC, referring to technical procedure TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders*. Record the measurements in the scientific notebook.

5.2 Site, Plumbing, Chase-Water, and Tracer Preparation

5.2.1 Carboys

Obtain two 50-liter carboys filled with the tracers listed in Table 4 and their Material Safety Data Sheets (MSDSs) from the University of Nevada, Las Vegas, Harry Reid Center (UNLV/HRC).

Table 4
Tracer Names and Types

Tracer Name	Abbreviation	Tracer Mass (kilograms)	Tracer Injection Target Concentration (Active Tracer) (milligrams per liter [mg/l])
Pentafluorobenzoate	PFBA	10	10,000 (10,000)
Sodium bromide	NaBr	10	10,000 (7,700)

5.2.2 Cone-Bottom Tanks and Discharge Lines

1. The locations of the 1,500-gallon cone-bottom tanks (i.e., Tanks 1 and 2) are shown on Figure 4.

2. On the day before tracer injection, ensure that the main and branch discharge line components shown on Figure 4 are in place. Attach the union end of the 1.25-inch braided PVC hose to the union end of the discharge branch line and place the open end of the hose into the open manway of Tank 1. Tape the hose to the portable staircase for support, if required.

3. Place a 1-inch flow meter in the water discharge line, preferably a USGS meter. Ensure that the water meter is in a straight run of pipe at least 3 feet from any upstream or downstream flow disturbance, such as bends or valves.

5.2.3 Pump Startup and Tank 1 Rinsing and Filling

1. Open the 2-inch gate valve on the main discharge line and close the 2-inch ball valve on the branch discharge line.

2. Record the water meter total in the scientific notebook. Fully open the control gate valve on the discharge line and start the submersible pump in 22S. The pump rate should be approximately 47 gpm.

3. Pump the well for 15 minutes to purge the aquifer near 22S of stagnant water.

4. Slowly open the 2-inch ball valve on the discharge branch line and begin filling Tank 1 with water from 22S by slowly closing the 2-inch gate valve on the main discharge line.

5. Fill the tank with approximately 100 gallons of produced water. While filling, direct the outflow from the 1.25-inch PVC braided hose to the inside walls of the tank to rinse them.

6. After rinsing the tank walls, redirect water through the main discharge line by fully opening the 2-inch gate valve on the main discharge line and slowly closing the 2-inch ball valve on the branch discharge line. Fully drain the water from the tank by opening the ball valve on the outlet at the bottom of the tank.

7. Repeat Steps 4, 5, and 6 twice to complete the rinsing of the tank.

8. Record the initial flow meter totalizer reading in the scientific notebook. Redirect water through the branch discharge line as in Step 4 and fill Tank 1 with 1,000 gallons of produced water.

9. When the flow meter totalizer reading equals the volume recorded in Step 8 plus 1,000 gallons, stop pumping the well and record the final reading in the scientific notebook.

5.2.4 Tank 2 Rinsing and Transfer of Tracer Dilution Water

1. Connect the outlets of Tanks 1 and 2 to the variable-speed pump inlet (Figure 5). Place a 1-inch water meter, preferably a USGS meter, between the tank outlets and the inlet of the variable-speed pump. Ensure that the water meter is in a straight run of pipe at least 3 feet from any upstream or downstream flow disturbance, such as bends or valves.

2. Remove the union end of the braided PVC hose from the branch discharge line and attach it to the discharge union on the variable-speed pump. Place the discharge end of the braided PVC hose into the open manway of Tank 2. Tape the hose to the portable staircase for support, if required. Ensure that the ball valve on Tank 2 is closed.

3. Open the ball valve on Tank 1 and allow the piping to charge with water. Start the variable-speed pump and rinse Tank 2 as described in Steps 5, 6, and 7 of Section 5.2.3.

4. When Tank 2 is rinsed completely, close the valves on Tanks 1 and 2 and shut off the pump.

5. Open the outlet valve on Tank 1 and allow the piping to charge with water. Record the flow meter totalizer reading in the scientific notebook, then start the variable-speed pump to begin transferring tracer dilution water to Tank 2.

6. When the totalizer reading equals the reading in Step 5 plus 248 gallons, simultaneously close the valve on Tank 1 and shut off the pump. Record the totalizer reading in the scientific notebook.

5.2.5 Probe and Stand-Alone Module Removal from 22S

1. On the day before tracer injection, download all 22S probe data stored in the dataloggers.

2. Direct the pumping contractor to remove the submersible pump and motor from the well, being careful not to damage any of the data cables.

3. Set the galvanized steel tubing, submersible pump, motor, pump cable, armored SAM cable, and 250-psia SAM on the ground.

4. Remove the MOSDAX® probes from all zones in 22S, referring to TP-9.2, *Procedures for Operating Westbay MOSDAX® Groundwater Monitoring Equipment in Nye County Wells*.

5. Close the Screen 2 pumping port and open the Screen 1 pumping port, referring to TP-9.2.

6. Obtain water samples from Screen 1, using the Bennett pump set at approximately 40 feet, or as far as possible, below the water level in Screen 1 of 22S.

7. Collect water samples after pumping 10, 20, and 30 gallons in pre-labeled 250-ml amber glass bottles. Cap the bottles and place samples in a cooler with blue ice. Store all samples on ice until they are delivered to UNLV/HRC for analysis.

8. Remove the Bennett pump, close the pumping port for Screen 1, and open the Screen 2 port, referring to TP-9.2.

5.2.6 Tracer Dilution

1. Contact UNLV/HRC at (702) 895-4450 before diluting the tracers so that an analyst can be onsite to collect tracer samples before and several hours after dilution.

2. Ensure the piping system for mixing tracers is connected to Tank 2, as shown on Figure 5.

3. Open the valve on Tank 2 and start the variable-speed pump. Circulate the tank with the pump.

4. Fill four empty 5-gallon carboys with dilution water from Tank 2, using the PVC hose. Record the volume of each carboy in the scientific notebook and set the carboys aside. The water in these reserved carboys will be used for rinsing.

5. Put on personal protective equipment (PPE), as specified in the MSDSs, and collect a sample of tracer directly from the carboys containing PFBA and NaBr, using a peristaltic pump. Use a pre-labeled 250-ml amber glass bottle. Seal the bottle, pack it in ice, and ship it with the samples described in Step 8.

6. Using the peristaltic pump, empty the carboys containing the tracers into Tank 2 while continuing to circulate the tank.

7. When empty, rinse the tracer carboys and peristaltic pump tubing, using two of the carboys set aside in Step 4. Rinse the peristaltic pump tubing by placing it in one of the rinse carboys and pumping approximately half of the rinse volume through the tubing. Add the rinsate to Tank 2 and continue to circulate the tank. Continue to circulate and mix the tracer throughout the day.

8. Using the braided PVC hose, fill appropriately labeled 250-ml amber glass sample bottles with diluted tracer water from the tank several hours after the start of mixing and again at the end of mixing. Prior to filling bottles, reduce flow out of the braided PVC hose to a rate suitable for filling sample bottles. Seal the bottles, pack them in ice, and ship these samples plus the sample described in Step 5 to UNLV/HRC for immediate analysis. UNLV/HRC will contact NWRPO personnel immediately after completion of the analysis to report tracer concentrations. Target tracer concentrations are listed in Table 4 and found in Attachment F-1 of Nevada Underground Injection Control (UIC) Permit UNEV2003210.

5.2.7 Injection Line

1. Remove the braided PVC hose from Tank 2 and place it approximately 10 feet into the existing 2-inch PVC casing of the lower piezometer in 22PA to inject the tracers (Figure 6).

2. Connect the outlets of Tanks 1 and 2 together as shown on Figure 6. The quarter-turn valves adjacent to Tanks 1 and 2 will be used to control flow from the tanks during injection.

5.3 Tracer Injection

1. Record the time and flow meter totalizer reading in the scientific notebook. Check that the 1.25-inch braided PVC hose is inserted approximately 10 feet into the lower piezometer in 22PA, as shown on Figure 6.

2. If a Los Alamos National Laboratory (LANL) YSI multiprobe has been installed as described in TPN-9.4, note the time on the multiprobe datalogger and start the gravity feed of PFBA and NaBr from Tank 2 by opening the quarter-turn ball valve. If necessary, the variable speed pump may be used to start the flow of injected tracer into the well.

3. After approximately 50 gallons of tracer have been injected into the lower piezometer in 22PA, or after an increase in multiprobe electrical conductivity (EC) values have been observed, LANL personnel will do the following:

a. Pull the multiprobe uphole 5 to 10 feet.

b. Stop and record EC for approximately 1 minute or until the reading has stabilized.

c. Continue moving up at 10-foot intervals, stopping for approximately 1 minute to collect multiprobe readings.

d. After reaching the top of the screen (i.e., at approximately 660 feet bgs), reverse direction and start lowering the multiprobe, again stopping at 10-foot intervals and collecting readings to a depth of 770 feet bgs.

e. Set the multiprobe mid-screen at approximately 710 feet bgs, or at a depth determined by the PI after consultation with LANL personnel onsite. Continue monitoring with the multiprobe.

4. Stop the tracer injection before emptying the tank by closing the quarter turn ball valve on the Tank 2 outlet. A possible stop point is when the tracer level in the tank reaches the bottom of the cone. Record the tank fluid level, water meter reading, and time in the scientific notebook.

5. Rinse the tank with the water from one of the two remaining reserved carboys. Use the hand sprayer filled with the reserved rinse water to rinse the tank walls.

6. Open the outlet ball valve and drain the added rinse water to the level of the bottom of the cone.

7. Turn off the quarter-turn ball valve to isolate Tank 2, repeat Step 4 with the last of the reserved carboys, and then completely drain Tank 2 into the injection line. Close the quarter-turn ball valve on Tank 2.

8. Record the time and flow meter totalizer reading in the scientific notebook. Open the valve on Tank 1 and gravity feed 95 gallons of chase water (i.e., twice the displacement volume of the piezometer plus 9 gallons for surface lines) into the lower screen interval of 22PA.

9. Immediately after closing the valve and stopping the water displacement, record the time and flow meter totalizer reading in the scientific notebook again.

10. At the discretion of the PI, continue to monitor the tracer decay in 22PA Deep. The monitoring frequency and duration will be determined by the PI after consultation with LANL personnel but may last several weeks.

5.4 Sample Collection

1. Initially, water samples will be collected every two weeks for 2 months, starting the day of tracer injection. Subsequent water samples will be collected on a monthly basis. Samples should be obtained by using the Bennett pump.

2. Measure water levels manually in the piezometer screens in 22PA, 22PB, and 22PC and Screen 2 in 22S before running the Bennett pump. Record these manual water levels in the scientific notebook.

3. Before running the Bennett pump into 22S, attach a 30-psia SAM pressure transducer to the pump tubing bundle 3 feet above the top of the pump. Strap the SAM cable to the tubing bundle at regular depth intervals (e.g., every 20 feet) while running them into 22S. This pressure logging may be discontinued at the discretion of the PI or if field conditions do not permit logging.

4. After attaching SAM cable to Bennett pump tubing bundle, remove the inlet screen from bottom of Bennett pump, attach 200 ft of ½ in. PVC drop tubing to the bottom of the pump, and reattach the inlet screen to the bottom of the tubing. Position the Bennett pump, with the drop tube assembly attached, to 493 ft in 22S. (The emplacement depth can be determined from the mechanical counter, which is attached to the roller head). This procedure will set the intake depth to 691 ft which is within the interval for screen 2 (661.2 to 760.6 ft).

5. Sample Collection Procedure 5.4.4 may also be used be used for wells 22PA and 22PC at the discretion of the PI. After sampling with the Bennett pump using the drop tube assembly, implement a three line volume purge (24 gallons) on the tubing bundle/drop tube assembly using a potable water source. Also rinse the outside of the pump and tubing bundle with 5 gallons of water. This will ensure that no cross contamination occurs between sampling events.

6. Record SAM water level data with a MOSDAX® datalogger starting 5 minutes before pumping starts and ending 5 minutes after pumping is stopped. Download the MOSDAX® datalogger at the end of each monthly sampling session.

7. Before each use of the Bennett pump, rinse the outside of the pump and tubing bundle with 5 gallons of water obtained from potable water sources. Note that the potable water source in Lathrop Wells may not be used due to gate 510 closure. Also rinse the outside of the first 150 feet of tubing bundle/SAM cable with the hand sprayer to prevent cross-contamination. Also rinse the inside and outside of drop tube pipe.

8. After lowering the pump and drop tube assembly to the depth indicated in Step 4, begin pumping water and recording field parameters (pH, EC, Temp). After field parameters stabilize collect one 250 ml sample.

9. Remove Bennett pump and drop tube assembly, remove inlet screen from bottom of drop tubing, reattach to bottom of Bennett, and collect and sample for each of the cumulative gallon amounts listed in Table 5.

10. After lowering the Bennett pump to the depth indicated in Step 4, collect a sample for each of the cumulative gallon amounts listed in Table 5. Also, obtain cumulative water samples from screen 2 of 22S and 22PC deep as follows: After the first 10 gallons of produced water is obtained from the Bennett pump, collect in a tank all remaining produced water with the exception of the previously described samples in Table 5. After collecting cumulative water production from the pump, mix the tank thoroughly and take one 250 ml sample. Collect a cumulative sample at both 22PC and 22S. At the discretion of the PI, the water sample volumes may be modified depending upon field results. Collect all water samples in pre-labeled 250-ml amber

glass bottles. Cap the bottle and place the sample in a cooler with blue ice. Store all samples on ice until they are delivered to UNLV/HRC for analysis.

11. Continue to sample monthly until the PI gives approval to stop. Sampling is anticipated to continue for 15 to 30 months.

Table 5
Bennett Pump Sampling Schedule

Well	Frequency	Number of Samples	Cumulative Gallons
22S	Once every 2 weeks for two months, then monthly	1	10
		1	35
		1	60
22PC	Once every 2 weeks for two months, then monthly	1	10
		1	28
		1	46

5.5 Preparation for Pumpback of Tracers

Tracers shall be pumped back from 22S only at the direction of either the PI or state of Nevada Division of Environmental Protection, preferably after tracer breakthrough and adequate definition of the tracer recovery curves of concentration versus time. Preparation for possible pumpback shall include the following steps.

1. Place the generator specified in Table 3 onsite at 22S. Hang a suitable pump control panel on the generator.
2. At the direction of the PI, direct the pumping contractor to lift the submersible pump and motor, with the pumping rig, slightly off the ground so that the pump is in a vertical position.
3. Tape a 250-psia SAM as close as possible to the top of the 5-foot-long pump. The SAM must be less than 7 feet above the pump intake. Protect the SAM with the spider centralizer.
4. Record the distance between the midpoints of the pump intake and the SAM in the scientific notebook.
5. Run the submersible pump into 22S on the 2-inch galvanized steel pipe, being careful to avoid damaging the SAM cable. Tape the SAM cable to the pipe above and below each collar as it is being fed into the hole.
6. Set the bottom of the pump 3 feet above the top of the existing PVC pipe/MP55 casing connection to maximize available drawdown for the pump.

7. Record all depth control information on a Tubing and Casing Record, found in TP-7.0, *Drill Site Management.*

8. Ensure that the pumping contractor remains onsite until the submersible pump has been restarted in 22S.

9. Connect a 2-inch galvanized steel pipe and PVC discharge line to the submersible pump at the wellhead as shown on Figure 7. Ensure that a 1-inch water meter is in a straight run of pipe at least 3 feet from any upstream or downstream flow disturbance, such as bends or valves, and upstream from the control gate valve.

10. Photograph the discharge line to comply with permit regulations.

11. Attach the 250-psia SAM to the datalogger and begin recording readings. Continue logging until the pumping described in Section 5.6 is stopped and the PI directs logging to stop.

5.6 Pumping and Sampling

1. Record the water meter volume in the scientific notebook.
2. Start the pump. After the pump has run for more than 15 minutes, obtain a grab sample. Collect all water samples in pre-labeled 250-ml amber glass bottles. Cap the bottle and place the sample in a cooler with blue ice. Store all samples on ice until delivered to UNLV/HRC for analysis.
3. Obtain grab samples from the discharge line attached to 22S according to the schedule in Table 6. The first 6 samples will be analyzed as soon as possible by UNLV/HRC. Tracer concentrations will be reported to NWRPO personnel immediately after completion of the analysis for reporting requirements of UIC Permit UNEV2003210. These data will also be used to determine pumpback termination.
4. During pumpback, collect manual water level measurements in all piezometer screens in 22PA, 22PB, and 22PC at the frequency listed in Table 6. Record water level measurements in the scientific notebook.

Table 6
Pumpback Grab Sampling Schedule From 22S

Elapsed Time	Frequency	Total Number of Samples	Minimum Number of Analyses
Days 0 – 5	Once per day	6	6
Days 6 – 30	Every time the generator is re-fueled (approximately every 3 days)	Approximately 9	5

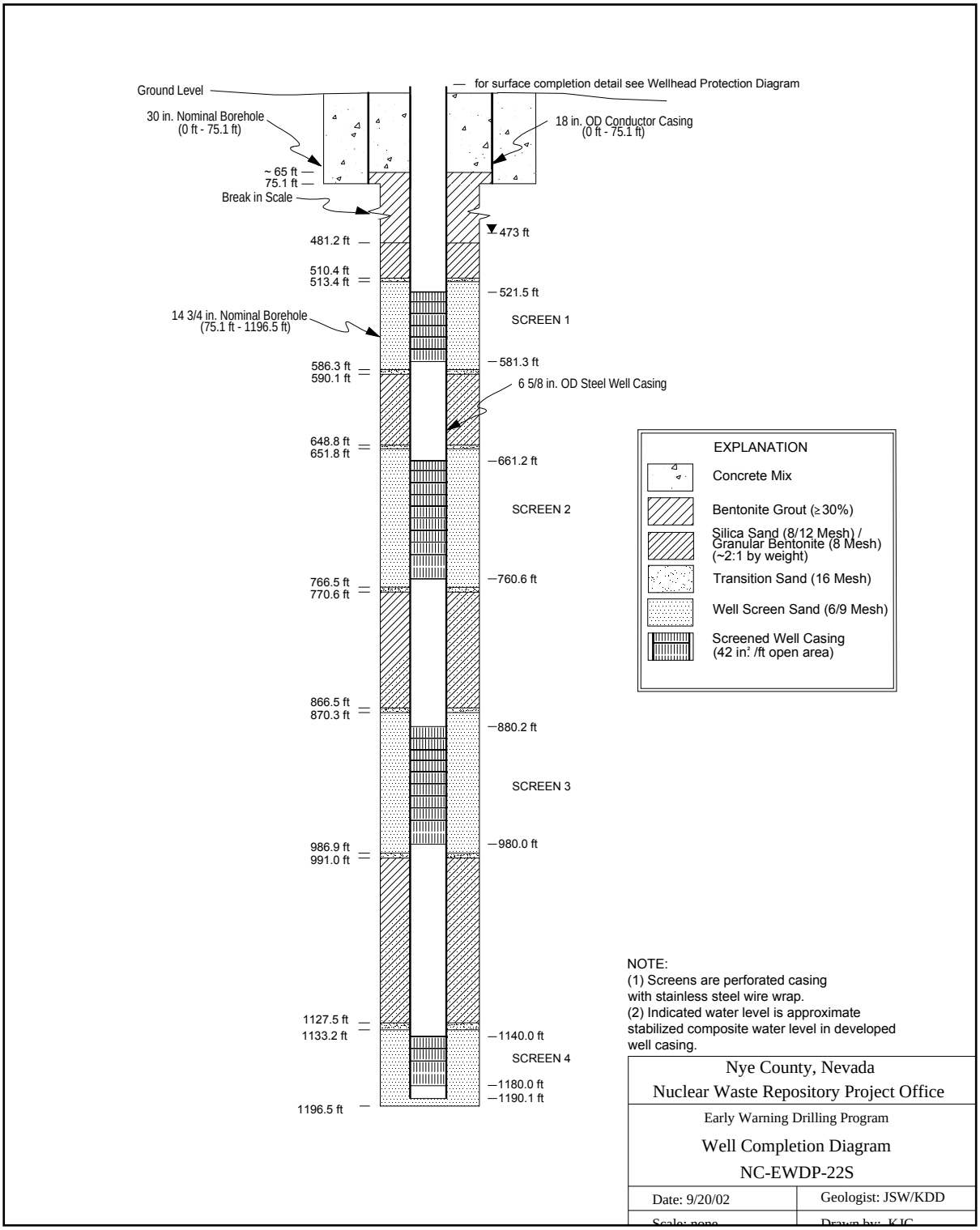

Figure 1
Completion Diagram for 22S

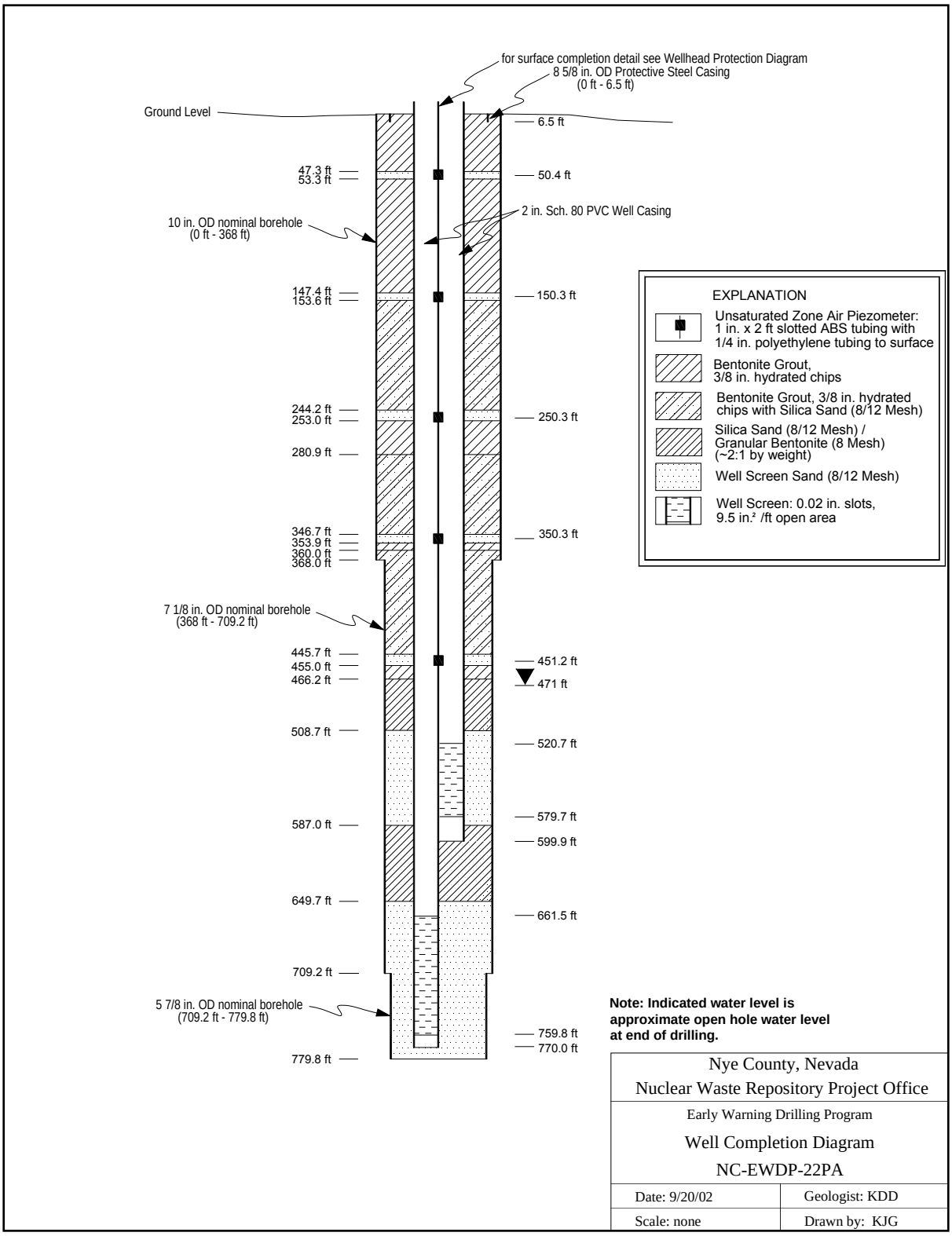

Figure 2
Completion Diagram for 22PA

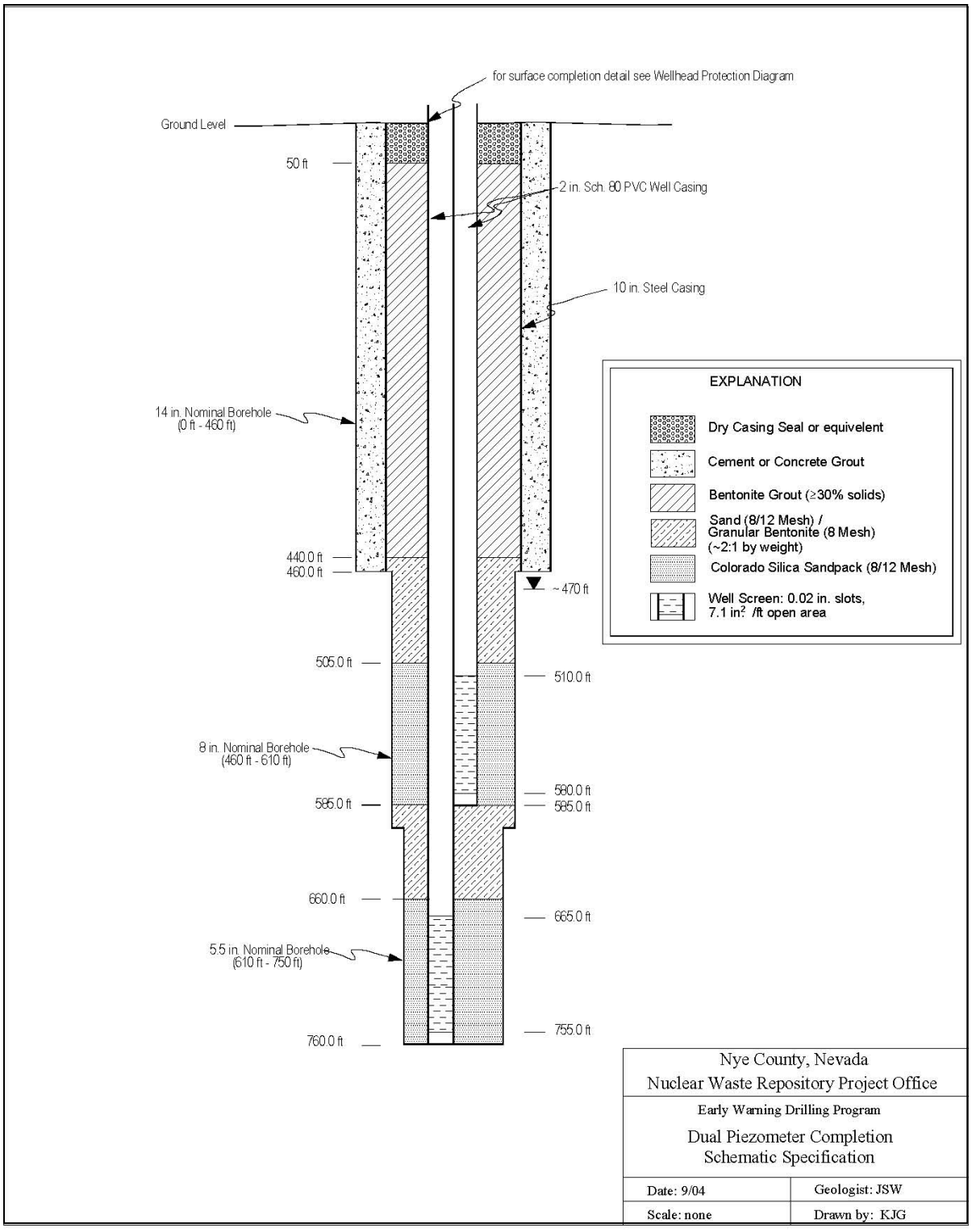

Figure 3
Proposed Completion Diagram for 22PC

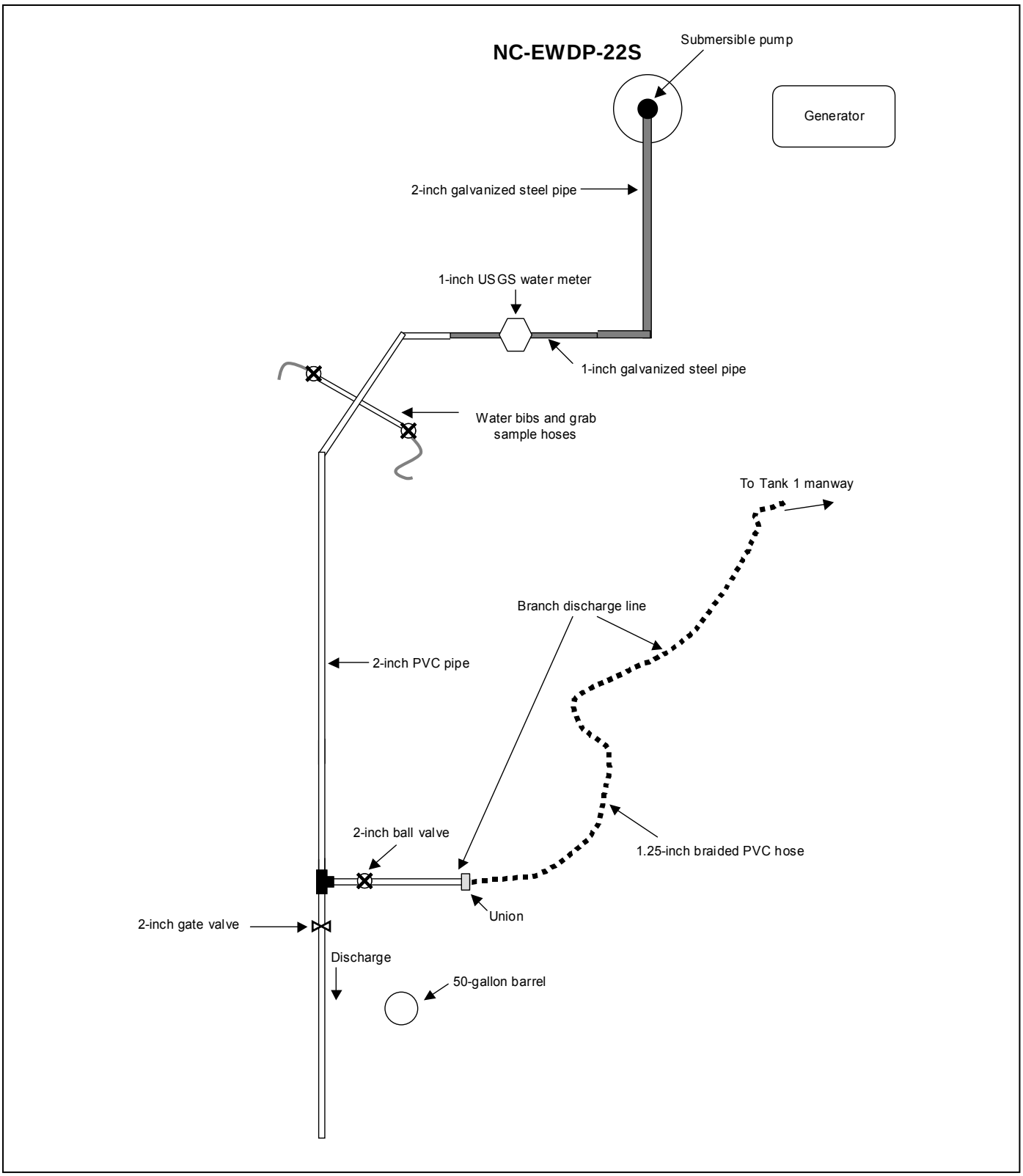

Figure 4
Piping Schematic for Rinsing and Filling of Tank 1 with Water

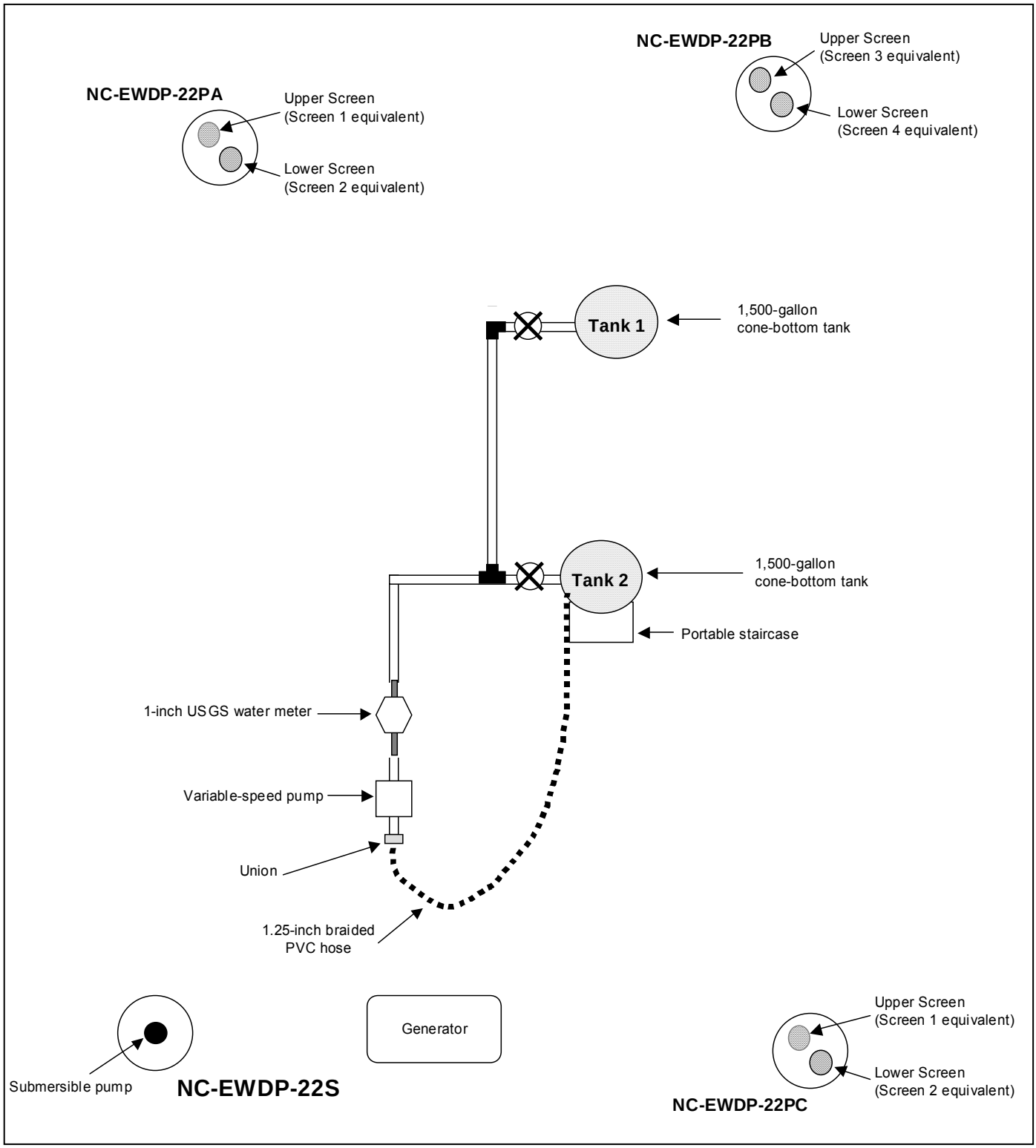

Figure 5
Piping Schematic for Rinsing, Filling, and Diluting Tracers In Tank 2

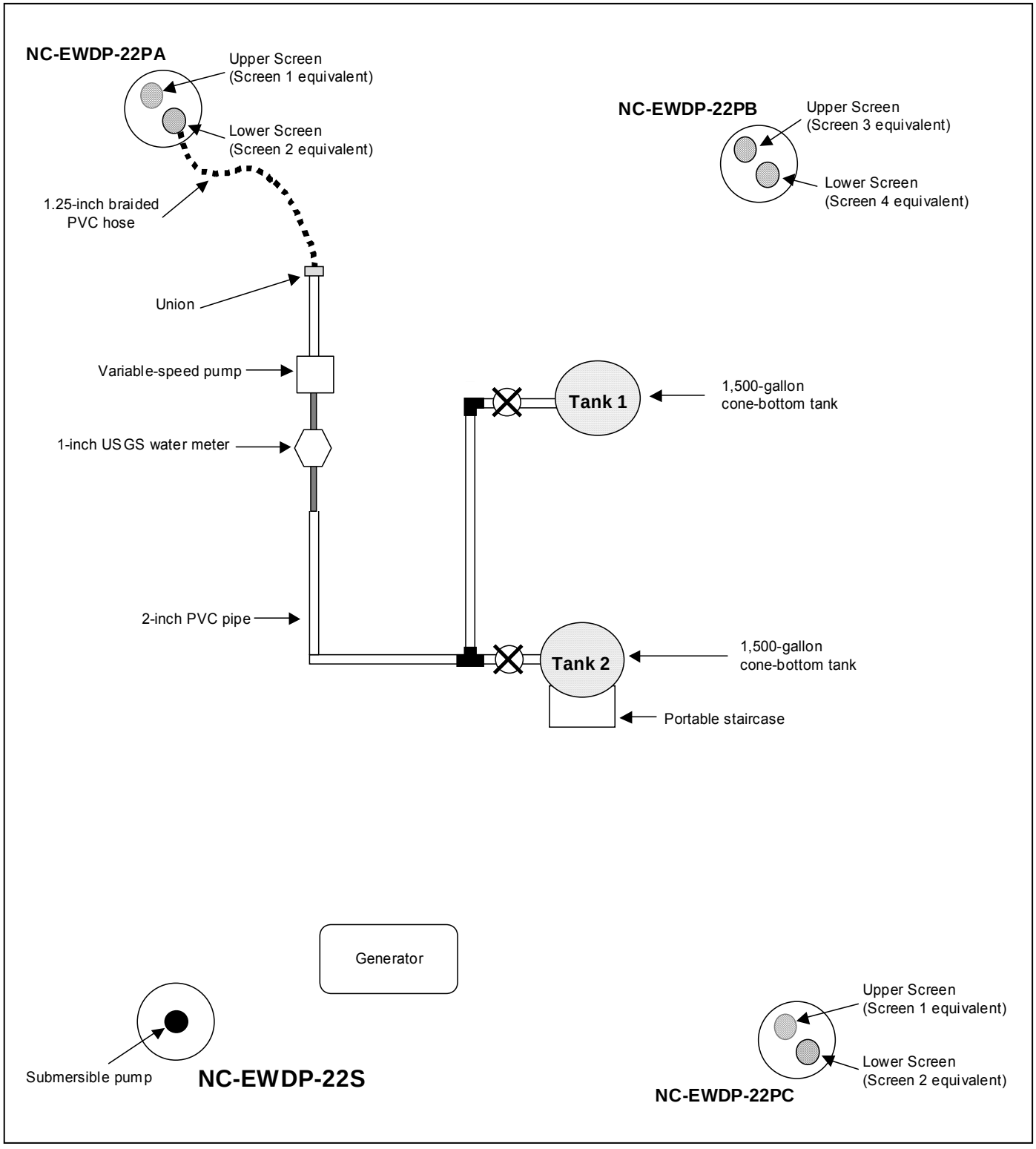

Figure 6
Piping Schematic for Injecting Tracers and Chase Water into 22PA Deep

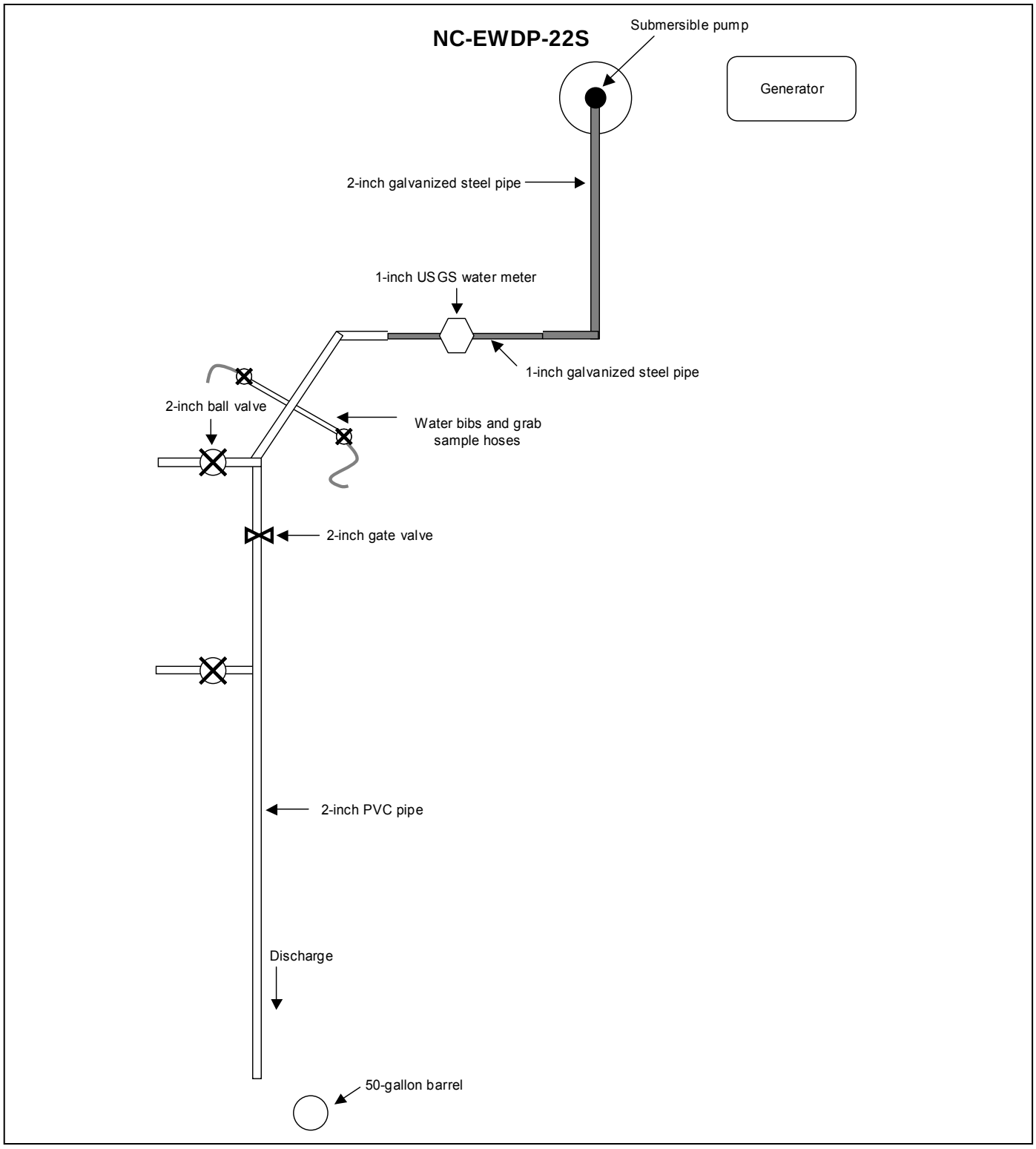

Figure 7
Piping Schematic for Pumpback of Tracers from 22S