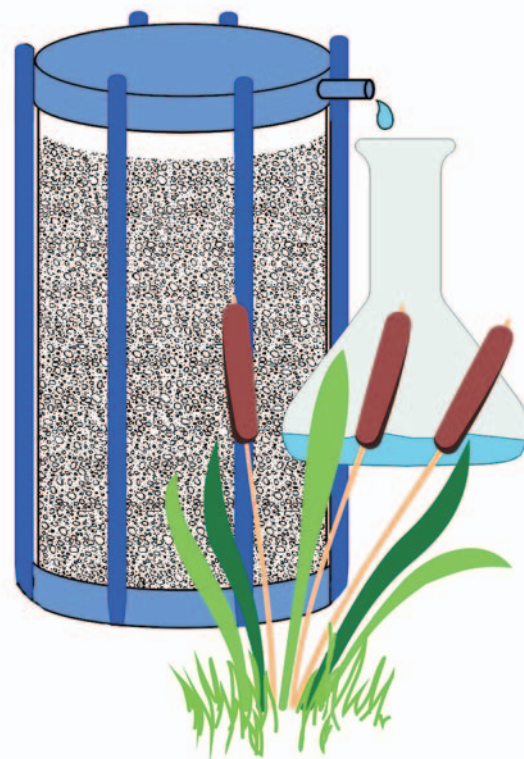


Environmental Sciences Laboratory

Construction Summary and As-Built Report for Ground Water Treatment System Monticello, Utah, Permeable Reactive Barrier Site

August 2005



Prepared for
U.S. Department of Energy
Grand Junction, Colorado



Work Performed Under DOE Contract No. DE-AC01-02GJ79491 for the U.S. Department of Energy
Approved for public release; distribution is unlimited.

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Work Performed by S.M. Stoller Corporation under DOE Contract No. DE-AC01-02GJ79491
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Appendix A—Completion Diagrams for Extraction Well (EW-1) and Infiltration Well (IW-1)

**Plates are not available in electronic format. Please contact
lm.records@gjo.doe.gov to request**

Plate 1—As-Built Site Layout for Treatment Cell, Monticello, Utah

Plate 2—As-Built Engineering Drawings of Treatment Cell, Monticello, Utah

1.0 Introduction

1.1 Purpose and Scope

This report details the construction of a semi-passive ground water treatment system installed at the Monticello, Utah, permeable reactive barrier (PRB) site in June 2005. As-built drawings (Plates 1 and 2), specifications of components, and descriptions of monitoring systems are included.

1.2 Background

A PRB containing 300 tons of zero-valent iron (ZVI) filings was installed in June 1999 at a former uranium-ore milling site near Monticello, Utah (Morrison et al. 2002). Satisfactory performance of the PRB requires that contaminant concentrations are lowered to regulated levels, a high proportion of the ambient ground water flow is treated, and there are no adverse effects to land use. Contaminant concentrations remain low in samples from most wells in the ZVI zone, which satisfies the first criterion. Attainment of the second and third criteria is less certain however, considering a continuously rising ground water mound upgradient of the PRB. This occurrence is likely coupled to an order of magnitude loss of permeability as determined by serial gas-injection slug tests (DOE 2005), presumably because of observed mineral precipitation in the ZVI zone. As a result, a very shallow water table now threatens crop production, and the proportion of treated ground water may have decreased significantly from an initial mass-balance estimate of 4 gallons per minute (gal/min).

To alleviate the ground water mounding and provide additional treatment capacity, a supplemental treatment cell was installed in June 2005. The cell is currently (July 2005) treating about 2 gal/min. Performance data (flow, pressure, and pH value) collected and transmitted daily to operations personnel indicate that the cell is operating normally. Effluent concentrations of uranium remain less than the ground water standard. While there are some operational and maintenance costs for the treatment cell, the costs are relatively minor. The amount of data required to confirm the performance of the treatment cell is much less than the amount required to confirm the performance of the PRB at a similar level of confidence.

2.0 Construction Methods

[Table 1](#) contains a chronological list of events that occurred during the project. [Table 2](#) provides specifications and costs of materials, and [Table 3](#) lists the subcontractors used. Costs for subcontracts and materials were \$10,875 and \$20,603, respectively. Total construction cost, not including labor and travel for project personnel, is \$31,478.

A 6-foot (ft)-diameter by 5-ft-deep vertical concrete culvert was used for the treatment cell ([Figure 1](#)). The culvert weighs 16,000 pounds and has an 8-inch-thick concrete base. The culvert and valve box were unloaded at a staging area on Clay Hill Drive (about 1 mile from the site) and moved to the site with a front-end loader ([Figures 2 and 3](#)). The valve box weighs about 12,000 pounds and has inside dimensions of 6-ft long, 4-ft wide, and 3.6 ft deep. A small excavator was used to dig a cavity for the treatment cell and valve box ([Figure 4](#)). The treatment

cell and valve box were placed on a 4-inch bed of pea gravel and leveled (Figure 5). Figure 6 shows the treatment cell and valve box in place.

Two-inch diameter holes were “clean” cut into the treatment cell to accommodate piping. The holes were placed 3 ft above the floor of the treatment cell. One-inch-diameter galvanized nipples were grouted into the holes for fluid to enter and leave the cell (Figures 7 and 8). A well was installed by attaching a 2-inch section of poly vinyl chloride (PVC) pipe to the metal stair rungs inside the treatment cell (Figure 9 and 10). The bottom of the well rests on about 2-inches of pea gravel and the well is screened from the bottom to a height of about 4.5 ft. The well can be used for a transducer, sampling, or other measurement tools.

Fluid enters the treatment cell via the galvanized nipple that is attached to a galvanized union and then to a 1-inch, reinforced, nylon flexible hose (Figure 11). The flexible hose connects to the distribution piping at the bottom of the treatment cell (Figures 12 and 13). The distribution system consists of a series of six slotted (0.08-inch), schedule 80, 2-inch PVC pipes (Figure 14) connected by 2-inch PVC connections (Figure 15). The entire system sits on a 2-inch bed of pea gravel and is attached to the flexible hose (Figure 13).

The treatment cell was filled with treatment media in approximately 0.5- to 1-ft lifts. Pea gravel (3/8-inch chips of dioritic composition) was obtained from a local quarry. ZVI (2 tons of - 4 +10 mesh; Peerless brand) was delivered to the site in 1-ton super sacks (Figure 16). Material was poured in the cell and then raked with a garden rake to homogenize and level. At the base was Unit 1 (Table 4) consisting of about 0.5 ft of pea gravel enclosing the distribution pipes (Figures 13 and 17). The gravel/ZVI mixtures were agitated in a concrete mixer and poured into the treatment cell (Figures 18 and 19). Unit 2 consists of 1 ft of gravel mixed with 10% (by volume) ZVI (Table 4). Unit 3 consists of 1 ft of gravel mixed with 20% ZVI (by volume). Figure 20 shows the fill material after raking the top of Unit 3. Unit 4 consists of 1.5 ft of gravel mixed with 30% ZVI.

Unit 5 contains the collection piping system enclosed by 0.5 ft of pea gravel (Figure 21). A flexible hose connects to the collection piping with a camlock fitting so that it can be easily removed if the reactive media need to be serviced (Figure 22). The other end of the flexible tubing is connected through a galvanized union to the galvanized nipple on the side of the treatment cell (Figure 23). Figure 24 shows the top of Unit 5, the gravel layer covering the collection piping. Figure 25 shows the top of Unit 6 consisting of 2 inches of ZVI. About 0.5 ft of void space remains below the rim of the concrete treatment cell. The lid to the treatment cell is made of aluminum and fits tightly into the concrete opening (Figure 26). Although the fit is tight, no seals were used and some gas exchange will likely occur. The door is locked in an upright position until a mechanical release lever is activated for closing. A float switch is used to control the water level in the treatment cell and to prevent overflow (Figure 27). The switch is connected to the “smart box” in the electrical panel; Figure 28 shows the electrical connection to the treatment cell.

Reinforced flexible 1-inch hose was used to connect the two galvanized nipples of the treatment cell to 1-inch PVC pipes that pass through holes drilled in the valve box (Figure 29). The outflow line transmits water from the collection piping to the infiltration well (IW-1) or to the infiltration galley. The inflow line transmits water from the extraction well (EW-1) to the distribution piping. Figure 30 shows a portion of the outflow line in the east end of the valve box. The pipe is

1-inch in diameter except for a short stretch of 0.5 inch gray pipe in front of the flow meter. The sequence of equipment encountered after the pipe enters through the east wall of the valve box is right angle, PVC ball valve, filter housing (without filter), in-line pressure sensor with 4- to 20-milliamper (mA) output, right angle, dial pressure gauge, union, pH probe, filter (20 mesh), flow meter with digital readout and 4- to 20-mA signal output, and sampling port (Figure 30). Data are collected by a Campbell Scientific datalogger and transmitted daily to the Grand Junction office (Figure 31). The transmission antenna is shown in Figure 32. Figure 33 shows the electrical controls for the treatment cell float switch (blue “Smart” box) and the extraction well level sensors (black relay).

Piping and electrical cables were placed in trenches and buried about 3 to 4 ft deep. Electricity was supplied from a pole to a 440-volt breaker box connected to a panel at the landowner’s well house (Figure 34). The electrical line to the treatment cell was run from the landowner’s pump house (see Plate 1 for locations). Figure 35 shows the trench with piping and electrical lines going to well EW-1. A pitless adapter is used to connect the pipe to the extraction well (Figure 36). Figure 37 shows pipe and transducer cable in trench going to the infiltration well IW-1. All pipes are 2-inch schedule 40 PVC except for about 1 ft that connects a gate valve (Figure 38). The gate valve is used to control flow to the infiltration well. A pitless adapter is used to connect the pipe to well IW-1 (Figure 38).

An infiltration gallery was installed to augment infiltration capacity. The infiltration gallery is about 3-ft long and was constructed from 2-inch schedule 40 PVC pipe (Figure 39). Holes (about 0.25 inch) were drilled into the pipe. The pipe is enclosed by 3/8-inch pea gravel and is located along the bed of Montezuma Creek just north of the treatment cell (see Plates 1 and 2). Figure 40 shows the piping (2-inch schedule 40 PVC) going to the infiltration gallery and a gate valve used to control flow to the infiltration gallery.

The extraction and infiltration wells (EW-1 and IW-1, respectively) were drilled with a cable tool drilling rig (Figure 41). Wells were completed with 30-inch steel manholes and concrete pads (Figures 42 and 43). The pump intake in EW-1 is positioned 9.34 ft below top of casing. Level sensors were placed at 8.0 and 10.8 ft below top of casing.

As-built engineering drawings are included as Plates 1 and 2.

3.0 Data Collection and Transmission System

The goal of the data collection system is to obtain data that can be used to continually evaluate the performance of the system and streamline troubleshooting. Minerals precipitate within the ZVI treatment system as a natural consequence of the corrosion process (Morrison et. al. 2001). Mineral precipitation leads to clogging of the media and a decrease in hydraulic conductivity. Thus, one focus of our monitoring program is to collect data that can be used to assess changes in hydraulic conductivity. The corrosion process causes an increase in pH; therefore, pH values are being measured to provide information about the extent of reaction occurring in the treatment media. Water levels in the extraction well are being measured to help assess the performance of the pumping system and to determine changes in ground water mounding hydraulically upgradient of the PRB. Water level in the infiltration well is measured to prevent overflow and to determine if well efficiency is decreasing.

The following data are being recorded:

- Rates of water flow into and out of the treatment cell
- Total amount of water treated
- Pressures at inlet and outlet of treatment cell
- pH values of outflow from treatment cell
- Water levels in the extraction and infiltration wells
- Battery voltage
- Hydraulic conductivity (calculated using Darcy's Law)

These data are recorded every 5 minutes and automatically transmitted daily to Grand Junction. The data are read into a software package (Vista Data Vision) that automatically produces user-friendly graphs. The data are viewed daily to ensure that the system is operating normally.

4.0 References

DOE 2005. *Variation in Hydraulic Conductivity Over Time at the Monticello Permeable Reactive Barriers*, U.S. Department of Energy Environmental Science Laboratory, ESL-RPT-2005-01, Grand Junction, Colorado.

Morrison, S.J., Carpenter, C.C., Metzler, D.R., Bartlett, T.R., Morris, S.A., 2002. "Design and Performance of a Permeable Reactive Barrier for Containment of Uranium, Arsenic, Selenium, Vanadium, Molybdenum, and Nitrate, at Monticello, Utah", *in* Naftz, D.L., Morrison, S.J., Davis, J.A., Fuller, C.C. (eds), *Handbook of Groundwater Remediation Using Permeable Reactive Barriers, Applications to Radionuclides, Trace Metals, and Nutrients*, Academic Press, Amsterdam, pp. 371–399.

Morrison, S.J., Metzler, D.R., Carpenter, C.E., 2001. "Uranium Precipitation in a Permeable Reactive Barrier by Progressive Irreversible Dissolution of Zero-Valent Iron," *Environ. Sci. Technol.*, v. 35, pp. 385–390.

Table 1. Chronology of Events

Activity	Date (2005)
Installed piezometers near Montezuma Creek. Indicated contaminated flow to creek	March 14
Measured water levels. Sampled creek.	March 14
Complete draft design drawings	March 18
Design/construction meeting	March 30
Permitting for discharge initiated with State of Utah (C. Cady, M. Gardner)	April 29
Kick off meeting	May 9
Readiness review	May 20
Concrete cell complete; "clean cut" holes and grouted galvanized nipples	May 23
ZVI delivered from Peerless	May 23
Line locates (Trevino)	May 23
Measured water levels in all PRB wells. Water level in air-sparge system high – cannot be used for discharge. New options sought	May 23
Excavated for treatment cell and valve box (Reams)	May 23
Sampled air sparge pipe (ASP) and risers (B1, B2, B3) Uranium results (µg/L): 140.2, 180.5, 155.9, 273.3, respectively	May 24
Treatment cell and valve box installed and leveled (Reams)	May 24
Laid 1-inch of gravel in treatment cell (bedding for distribution piping)	May 24
Installed distribution piping. Started filling treatment cell with media.	May 25
Completed filling cell. Installed collection piping. Drilling delayed.	May 26
Electrical contractor working on line from pole to landowner's electrical box	June 2
Installed and developed wells EW-1 and IW-1	June 6-9
Tests conducted on infiltration well. (max uptake about 1.5 gal/min)	June 13
Electrical connections made to vault and cell	June 13
Excavated trenches for piping and cables (J. Slade)	June 14
Measured baseline depth to water in wells upgradient of PRB	June 14
Installed pipes and cabling to wells and infiltration gallery	June 14
Placed wire in trenches to aid in locating piping. Backfilled trenches.	June 15
Started flow to system. Porosity calculated at 47%. Total volume of fluid = 497 gal.	June 15'
Installed data collection system.	June 21
Located lines for surveying	June 23
Surveyed system	June 28-29

Table 2. Specifications of Components

Component	Cost	Vendor ¹	Specifications
Concrete treatment cell	\$1,915	GJ Pipe	Inside dimensions: 5 ft deep, 6 ft diameter. Base: 98 inches diameter, 8 inches thick. Delivered to Monticello.
Valve box	\$1,900	GJ Pipe	7 ft long, 5 ft wide, 3.67 ft deep. Delivered to Monticello.
Lid for valve box	\$1,304	Halliday	Valve box molded to fit lid. Delivered to Grand Junction (GJ Pipe).
Lid for treatment cell	\$840	Halliday	Treatment cell molded to fit lid. Delivered to Grand Junction (GJ Pipe).
Zero-valent iron (ZVI)	\$2,400	Peerless	2 tons, -4 + 10 mesh ZVI, packaged and delivered to Monticello, Utah
Gravel	\$242	Sonderegger	10 yd 3/8-inch pea gravel (chip). Delivered.
Slotted 2-inch pipe	\$171	Kelly Pipe	For collection and distribution piping in cell. 0.08-inch slots
Plumbing/electrical	\$1,500	na	Piping, connections, wiring, etc., other than subcontractor costs
Data logger, power supply, enclosure	\$1,875	Campbell Sci	Model CR 1000-4M (logger); PS100 (battery); ENC-12/14 (enclosure)
Cell modem	\$540	Campbell Sci	Redwing 100 Airlink Digital Modem (for Verizon network)
Antenna	\$205	Campbell Sci	8dBd Yogi /10 ft cable
2 Pressure transducers	\$2,179	In Situ	PXD-261 + 100 ft cable
2 In-line pressure sensors	\$540	Omega	PX605-100GI
2 In-line flow meters with data transmission	\$1,670	GPM	GPI GP-G2S05N09GM (meter); GPI GP-125100-1 (4 to 20 mA signal)
Phone charges	\$300	Verizon	First month. Future charges ~\$80 per month
Pump for EW-1	\$501	Campbell Mono	Grunfos, 5SQE03A-90NE 1/3HP 1PH 230 volt
Level sensors	\$270	Munro	Ametek BW1500GL2S700X
Float control switch	\$35	Munro	Snap action pilot duty float switch
Smart box controls for float switch	\$400	Munro	
Controller for EW-1 pump	\$385	Campbell Mono	Grunfos CU300 + potentiometer
Manholes	\$338	American	2 18-inch round by 12 inch iron manholes with shipping
Construction rentals	\$400	Sonderegger	Skid loader, etc.
SUBTOTAL	\$20,603		

¹Vendor List

American: American Eagle Wholesale, Inc., 840 West, 1700 South, Salt Lake City, UT, 84104. (801) 973-2555.

Campbell Mono: Campbell Monoflex, 127 E Spring St., Bechtelsville, PA 19505. (800) 523-0224.

Campbell Sci: Campbell Scientific, 815 W, 1800 N, Logan, UT 84321. (435) 753-2342.

GJ Pipe: Grand Junction Pipe & Supply Co., 2868 I-70 Bus Loop, Grand Junction, CO 81504. (970) 243-4604.

GPM: Great Plains Meter, Inc., 115 South 16th Street, Aurora, NE 68818. (402) 694-4114.

Halliday: Halliday Products, Inc., 6401 Edgewater Dr., Orlando, FL 32810. (407) 298-4470.

In Situ: In Situ Inc., 1150 Escalera, Laramie, WY 82072. (970) 498-1565 (Jim Broderick).

Kelly: Kelly Pipe Co., 3170 W. Directors Rd, Salt Lake City, UT 84104. (801) 973-8200.

Munro: Munro Supply, Inc., 735 S 9th, Grand Junction, CO 81501. (970) 242-6810.

Peerless: Peerless Metal Powders & Abrasives, 124 South Military, Detroit, MI 48209. (313) 841-5400.

Omega: Omega Engineering, Inc., One Omega Dr., Stamford, CT 06907. (203) 359-1660.

Sonderegger, Inc., P.O. Box 713, Monticello, UT, 84535. (435) 587-2035.

Table 3. Construction Subcontracts

Item	Cost	Vendor ¹	Specifications
Electrical contract	\$4,386	Reams	Electrical work
Construction	\$1,013	Reams	Move valve box and vault; excavation
Drilling	\$4,661	Zimmerman	Install wells EW-1 and IW-1. Includes mobilization and supplies.
Cut holes in concrete	\$150		To accommodate 1-inch galvanized pipe
Surveys	\$665	High Desert	Survey locations and elevations
Subtotal	\$10,875		

Reams: Reams Construction Co., P.O. Box 106, Naturita, CO 81422. (970) 865-2886.

Zimmerman: Zimmerman Drilling, P.O. Box 325, Lasal, UT 84530.

High Desert: High Desert Surveying, P.O. Box 40017, Grand Junction, CO 81504-0017. (970) 254-8649.

Table 4. Contents of Treatment Cell (Lift 1 is at bottom of cell). Porosity of media calculated at 47% and liquid occupies 497 gal.

Unit	Start ¹	Thickness (ft)	Weight (lb)	Volume (ft ³)	Material
6	4.5	0.17	1177 (ZVI)	4.8	100% ZVI
5	4.0	0.5	1313 (gravel)	14.1	Gravel + collection pipe
4	2.5	1.5	3948 (gravel) 1415 (ZVI)	42.4	Gravel + ~30% ZVI
3	1.5	1.0	2632 (gravel) 943 (ZVI)	28.3	Gravel + ~20% ZVI
2	0.5	1.0	2632 (gravel) 472 (ZVI)	28.3	Gravel + ~10% ZVI
1	0	0.5	1313 (gravel)	14.1	Gravel + distribution pipe

¹Distance from base (feet) at start of lift.



Figure 1. Delivery of treatment cell and valve box from Grand Junction Pipe and Supply.



Figure 2. Movement of treatment cell to site.



Figure 3. Placement of valve box and treatment cell



Figure 4. Excavation for treatment cell and valve box.



Figure 5. Excavation ready for treatment cell and valve box. Bed of pea gravel for leveling.



Figure 6. Treatment cell and valve box in position. Pea gravel pile in background.



Figure 7. Galvanized pipe (1 inch) grouted in treatment cell for connection to valve box.



Figure 8. Galvanized nipples (1 inch) for connection to valve box from inside treatment cell.



Figure 9. Well in treatment cell. Two-inch-schedule 40 PVC pipe with slotted well screen and end cap. Orange paint marks are at each foot from base of treatment cell.



Figure 10. Bottom of well in treatment cell resting on 2-inches of pea gravel. Distribution pipe in foreground.



Figure 11. Galvanized connection with union from reinforced flexible hose coming from distribution piping to 1-inch-threaded galvanized nipple coming from valve box.



Figure 12. Galvanized connection from distribution piping to reinforced 1-inch flex hose.



Figure 13. Distribution piping in place on 2-inch bed of pea gravel. Orange paint marks at 1-ft intervals from base of concrete treatment cell.



Figure 14. Piping used for distribution (bottom of cell) and collection (top of cell) networks. Two-inch schedule 80 PVC pipe with 0.080-inch-wide slots.



Figure 15. Close up of PVC connections in distribution system.



Figure 16. Zero-valent iron in super sacks. Each sack contains 1 ton of $-4 +10$ mesh ZVI. Two tons were used in treatment cell (one additional bag of ZVI was ordered and delivered but not used).



Figure 17. Treatment cell after installing Unit 1 (pea gravel and distribution piping).



Figure 18. Mixing pea gravel and ZVI in a concrete mixer.



Figure 19. Gravel/ZVI mixtures were poured directly into the treatment cell, then raked to homogenize.



Figure 20. Top of Unit 3 after raking to homogenize.



Figure 21. Collection piping system (Unit 5) resting on about 2-inch thickness of pea gravel.



Figure 22. Camlock connection of collection piping to flexible hose.

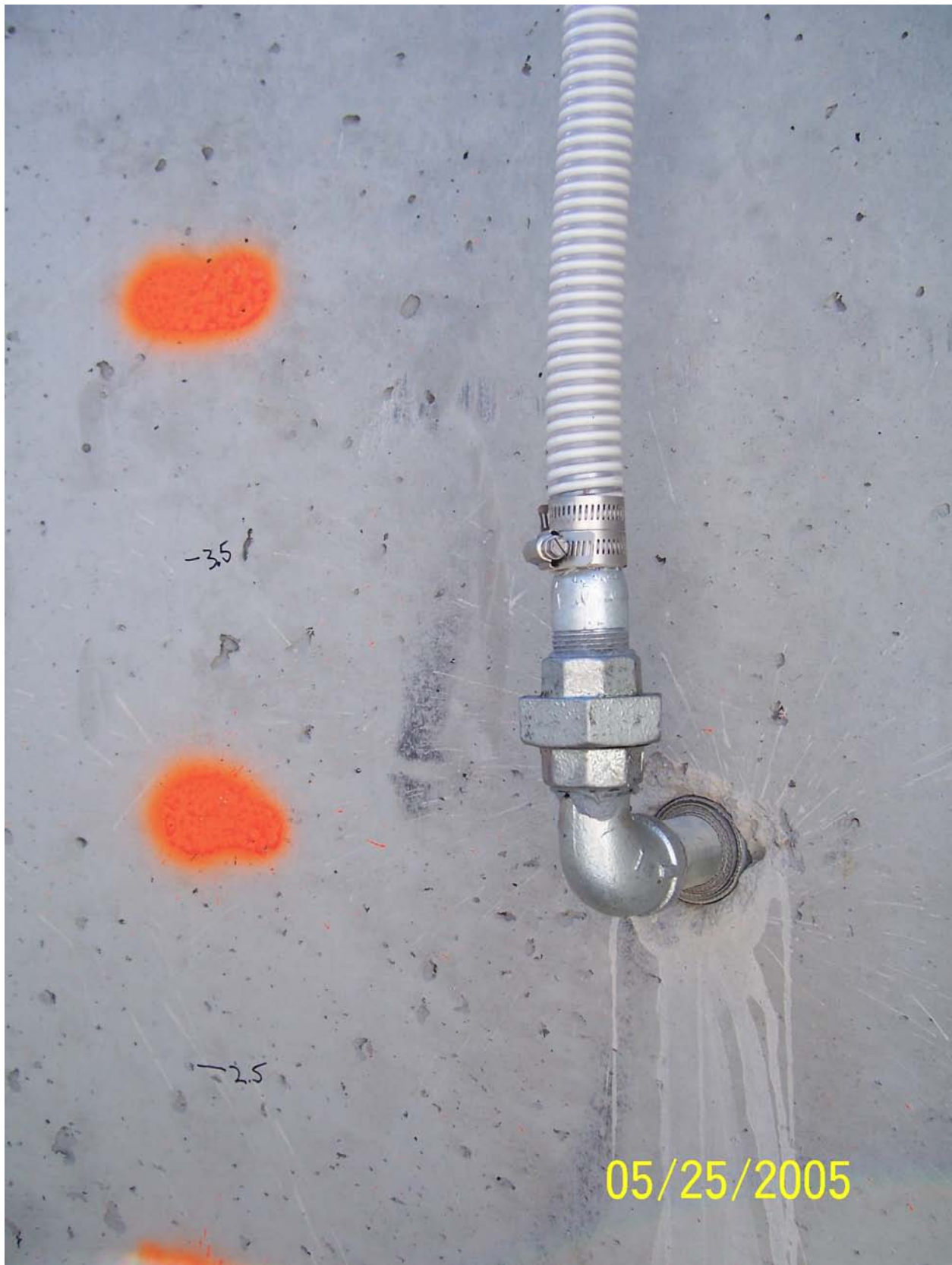


Figure 23. Galvanized connection with union from reinforced flexible tubing from collection piping to galvanized 1-inch nipple going to valve box.



Figure 24. Top of Unit ; gravel covers the collection piping.



Figure 25. Top of Unit 6 (ZVI). Filling of the treatment cell is complete. Orange paint mark is 5 ft from base of the concrete floor.



Figure 26. Treatment cell filled with reactive material with aluminum lid in place. Note bar that keeps door in upright position and top of well.



Figure 27. Float switch temporarily positioned in plastic bucket. The switch was later mounted permanently to the ribbing on the aluminum lid. Note the red rust color of the ZVI layer, this photo was taken about 2 weeks after startup.



Figure 28. Electrical connection for float switch on top of treatment cell lid.



Figure 29. 1-inch PVC pipe outflow line passing through hole cut in east end of valve box.



Figure 30. Portion of outflow line showing valve, filters, pressure transducer, pressure gauge, pH probe, and flow meter.

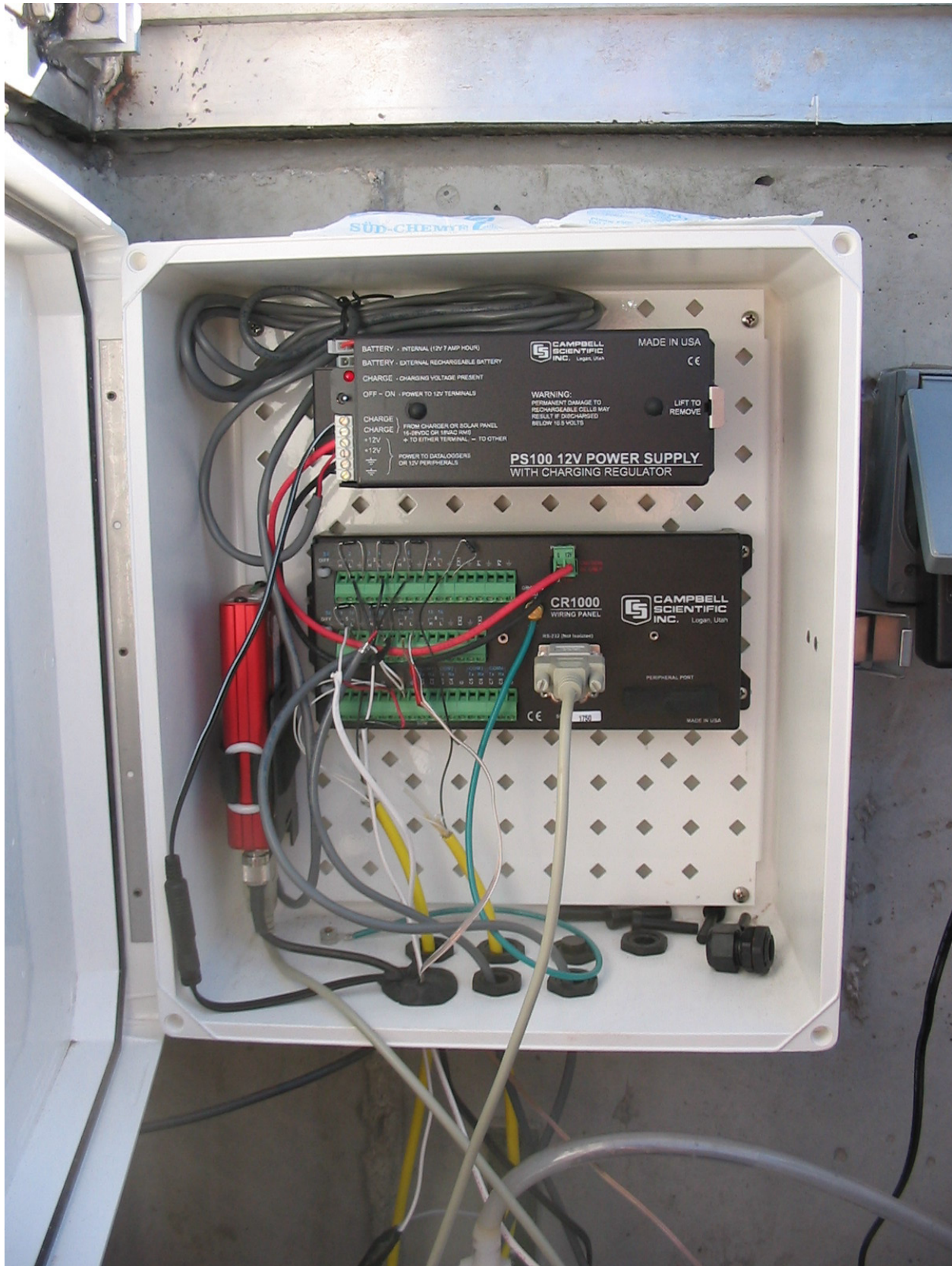


Figure 31. Data logger (bottom), power unit (top), and cell modem (red box to left).



Figure 32. Antenna for data transmission. Attached to electrical panel.

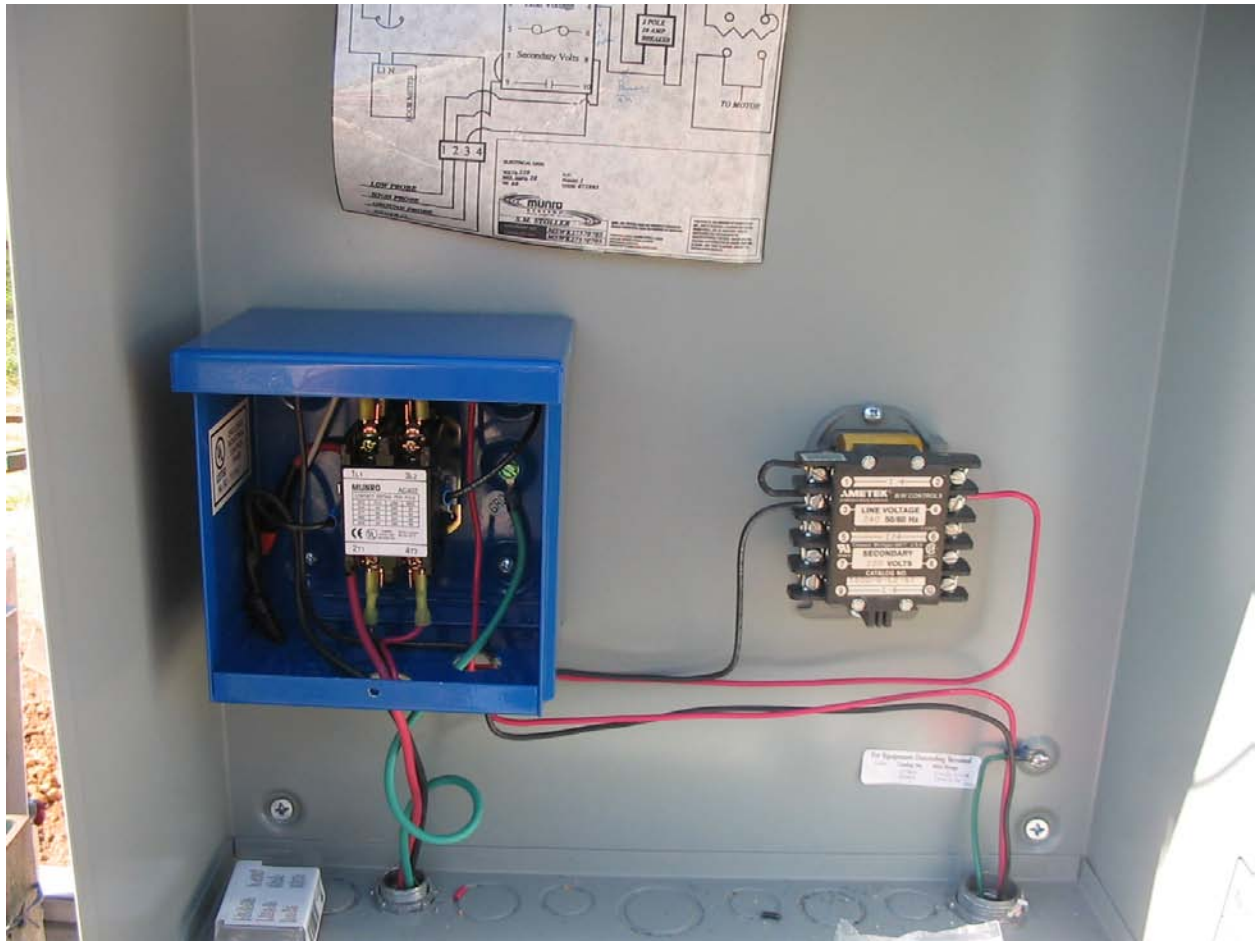


Figure 33. Electrical controls for float switch (blue “Smart” box) and level sensors (black relay).



Figure 34. Trenching for electrical line to landowner's pump house. Electrical supply pole in background.



Figure 35. Piping (1-in schedule 40 PVC) and cables going to extraction well EW-1 prior to burial. Blue cable is 220 volt power for pump. Yellow cables are connections for level sensors and transducer signal.



Figure 36. Closeup of pipe and cables at well EW-1 showing pitless adapter.



Figure 37. Piping (2-inch schedule 40 PVC) and yellow transducer cable going to well IW-1 prior to burial.



Figure 38. Connection to IW-1 showing pitless adapter and gate valve.



Figure 39. Infiltration gallery before burial.



Figure 40. Gate valve and riser to infiltration gallery.



Figure 41. Cable tool drilling rig set up on well EW-1.



Figure 42. Completed well EW-1. Small (0.5-inch) internal PVC pipe houses the water level control sensors. Yellow cable is for transducer. Blue cable is 220-volt power supply for pump.



Figure 43. Completed well IW-1. Small PVC pipe is valve riser. Yellow cable is for transducer.

End of current text

Appendix A

Completion Diagrams for Extraction Well (EW-1) and Infiltration Well (IW-1)

Project PRB Mending Borehole/Well Number EW-1 Date Drilled (start) 6/6/05 (end) 6/7/05
 Location Monticello Hole Depth (ft) 12.5 Ground Surface Elev. (ft) _____
 Site M.M.T.S Well Depth (ft) 11.7 Water (ft, BTOC), date 2.8' bgs 6/7/05
 Drilling Method Cable foot Borehole Diameter (in) 10 Casing Stick-Up Height (ft) ~0.75' bgs
 Drilling Company Zimmerman Sampling Method Cuttings Slot Size (in) #20
 Rig Type Bugrus Erie Date Developed 6/7/05 Locking Cover (Y/N), Padlock No. _____
 Driller C. Zimmerman Logged by T. Bartlett Remarks Extraction Well

Well Materials Type/Size	Interval (ft) bgs
Surface Casing	_____ to _____
Blank Well Casing	_____ to _____
Well Screen	_____ to _____
Sump/End Cap	_____ to _____
Surface Seal	_____ to _____
Grout	_____ to _____
Bentonite Seal	_____ to _____
Upper Sand Pack	_____ to _____
Lower Sand Pack	_____ to _____



Depth (ft)	Blows Per 6"	PID ppm	Sample Type and Depth	Well Construction Diagram	Graphic Log	Description: Required information: Formation name or soil type; Unified Soil Classification; Munsell soil color; rock color chart; percentage sand and gravel; sorting (poor to well); grain angularity; induration or plasticity; moisture content (moist to saturated)
0			Concrete			
2			bentonite chips			0-8' Sandy silt grading to f. - m. sand w/ silt.
4			fine sand			8-12.5' sand + gravel w/ fines.
6						12.5' Bedrock - gray mudstone.
8						
10			10-20 sand			
12			Sump			
14			bedrock			

^a all depths measured from ground surface

Completed By Tim Bartlett

Verified By _____

WELL NO. EW-1

DATE 6/6/05 TIME _____

pg 2 of 2

PLANNED INSTALLATION

FINAL INSTALLATION

CASING DIAMETER 6 inch

CASING STICKUP HEIGHT flush

TOP OF GROUT N/A

GROUT TYPE N/A

TOP OF PELLETS ground

SIZE OF PELLETS 3/8" chips

WATER ADDED TO PELLETS yes
(Gallons)

TOP OF FINE SAND 3

SAND SIZE 100 mesh

TOP OF FILTER SAND 4.3

FILTER SAND SIZE 10-20

TOP OF SCREEN 6.3

TOP OF SLOTS 6.3'

TYPE OF SCREEN PVC V-Wrap

SLOT SIZE #20

BOTTOM OF SLOTS 11.0

TOP OF SUMP/END CAP 11.3'

BOTTOM OF SUMP/END CAP 11.7'

CASING STICKUP HEIGHT _____

TOP OF GROUT _____

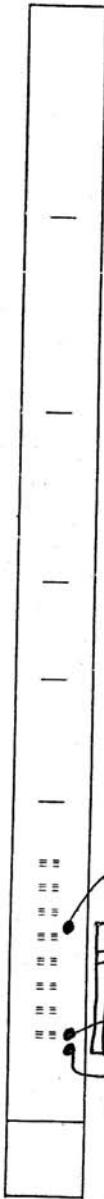
TOP OF PELLETS _____

TOP OF FINE SAND _____

TOP OF FILTER SAND _____

TOP OF SCREEN _____

Pump AND SENSOR PLACEMENTS



Upper Level sensor (8.0')
8.07 ft TOP OF Pump
9.34 ft middle of 2" intake for pump
Lower Level sensor (10.8')
11.09 ft Bottom of pump
11.0 ft Transducer

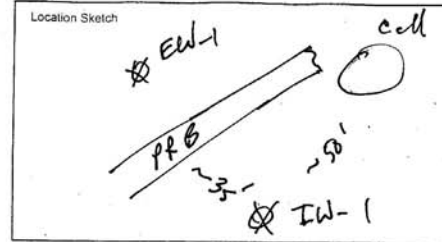
TOP OF SUMP/END CAP _____

BOTTOM OF SUMP/END CAP _____

TOTAL DEPTH 12.5 ft

Project PRB Mending Borehole/Well Number IW-1
 Location Monticello Hole Depth (ft) 14
 Site MMTS Well Depth (ft) 13.6 bgs
 Drilling Method Cable Tool Borehole Diameter (in) 10
 Drilling Company Zimmerman Sampling Method Cuttings
 Rig Type Bucyrus Erie Date Developed 6/13/05
 Driller C. Zimmerman Logged by T. Bartlett
 Date Drilled (start) 6/7/05 (end) 6/7/05
 Ground Surface Elev. (ft) _____
 Water (ft, ~~STOC~~), date 9.9' bgs 6/13/05
 Casing Stick-Up Height (ft) _____
 Slot Size (in) #20
 Locking Cover (Y/N), Padlock No. NA
 Remarks Injection Well

Well Materials Type/Size	Interval (ft) bgs
Surface Casing	_____ to _____
Blank Well Casing	<u>via Sch 40 PVC</u> <u>0.5</u> to <u>3.2</u>
Well Screen	<u>" " V-wrap</u> <u>3.2</u> to <u>13.2</u>
Sump/End Cap	<u>" " "</u> <u>13.2</u> to <u>13.6</u>
Surface Seal	<u>Concrete/18" Flush Vault</u> <u>0</u> to <u>0.5</u>
Grout	_____ to _____
Bentonite Seal	<u>3/8 inch chips</u> <u>0.5</u> to <u>1</u>
Upper Sand Pack	<u>20/40</u> <u>1</u> to <u>3</u>
Lower Sand Pack	<u>gravel</u> <u>3</u> to <u>13.6</u>



Depth ^a (ft)	Blows Per 6"	PID ppm	Sample Type and Depth	Well Construction Diagram	Graphic Log	Description: Required information: Formation name or soil type; Unified Soil Classification; Munsell soil color; rock color chart; percentage sand and gravel; sorting (poor to well); grain angularity; induration or plasticity; moisture content (moist to saturated)
0						
2				Concrete		0-7' sand + silt
4				chips		7-14' sand/gravel/silt/clay
6				fine sand		
8				gravel pack		
10				Screen		
12						
14						

^a all depths measured from ground surface

Completed By T. Bartlett

Verified By _____

18 C O F C

WELL NO. IW-1

DATE 6/7/05

TIME

PLANNED INSTALLATION

FINAL INSTALLATION

CASING DIAMETER 6 inch

CASING STICKUP HEIGHT

CASING STICKUP HEIGHT flush
18" vault in 0.5' thick
concrete pad

TOP OF GROUT N/A

TOP OF GROUT

GROUT TYPE N/A

TOP OF PELLETS ground

TOP OF PELLETS

SIZE OF PELLETS 3/8 inch chips

WATER ADDED TO PELLETS yes
(Gallons) 1

TOP OF FINE SAND

TOP OF FINE SAND

SAND SIZE 20/40

TOP OF FILTER SAND 3

TOP OF FILTER SAND

FILTER SAND SIZE gravel

TOP OF SCREEN 3.2

TOP OF SCREEN

TOP OF SLOTS 3.4

TYPE OF SCREEN V-wrap PVC

SLOT SIZE # 20

BOTTOM OF SLOTS 13

TOP OF SUMP/END CAP

TOP OF SUMP/END CAP 13.2

BOTTOM OF SUMP/END CAP 13.6

BOTTOM OF SUMP/END CAP

TOTAL DEPTH 14

