

1 probably due to the squeezing of clays from the formation into the open bore. Additionally, some
2 material from the boring wall appeared to slough into the open boring. Circulation was reestablished
3 and well construction continued. However, because of continued tremors, the decision was made to
4 complete well construction instead of removing the well casings and attempting to refurbish the boring,
5 risking loss.

6 1.3.2 Plume Area

7 Several zones within the aquifer with potentially higher yield were identified from the geophysical logs.
8 These zones were selected as intervals to be screened for well completion. A brief description of each
9 screened zone is discussed below. The temperature logs were not used because a characteristic
10 temperature differential between the potential water-bearing zone and boring fluid was present in all
11 zones screened (see Figure 18).

12 Zone A: Screened from 232 feet bgs. Zone A demonstrated an increasing resistivity value, along with
13 a low gamma ray reading, on the Gamma Ray/Guard log. Both of these readings indicated a zone free
14 of large quantities of clay. The Electric Log showed a muted resistivity while the SP log indicated
15 potentially higher porosity than surrounding material. The Lithology Log identified this zone as silty
16 sand.

17 Zone B: Screened from 294 feet bgs. This zone was noted by a resistivity spike and low gamma ray
18 reading on the Gamma Ray/Guard log. The resistivity on the Electric Log was muted but the SP log
19 indicated the possibility of good porosity because of low SP values. The lithology of this zone consists
20 of sand with gravel

21 Zone C: Screen from 380 feet bgs. Zone C displayed a moderate resistivity reading and low gamma
22 ray reading on the Gamma Ray/Guard log. The Electric Log indicated a modest increase in resistivity
23 with possible higher porosity being noted on the SP log. Lithology of this zone was a composite of silty
24 and clayey sand.

1 Zone D: Screened from 486 feet bgs. This zone was at a transition point from lower to higher resistivity
2 on both the Electric Log and the Gamma Ray/Guard log. The Lithologic Log did not correlate with the
3 change noted on the Electric Logs. This was attributed to poor sample collection where finer grain
4 material was lost in the drilling fluid and shale shaker. The potential porosity could not be estimated
5 because of a muted SP signal.

6 Zone E: Screened from 560 feet bgs. This zone was at a transition point from lower to higher resistivity
7 on both the Electric Log and Gamma Ray/Guard log. A definite lithologic change was indicated at this
8 depth and was correlated to the Lithologic Log (silty sand to a clayey sand). The potential porosity
9 could not be estimated because of a muted SP signal.

10 Zone F: Screened from 643 feet bgs. Zone F contained a sand with little fines as indicated by the high
11 resistivity and low gamma ray reading on the Gamma Ray/Guard log. The potential porosity could not
12 be estimated because of a muted SP signal.

13 Zone G: Screened from 704 feet bgs. This zone was identified with a high resistivity and low gamma
14 ray reading on the Gamma Ray/Guard log which was indicative of a sand. The SP log indicated possible
15 increased porosity.

16 Zone H: Screened from 820 feet. A high resistivity spike along with a low gamma ray reading indicated
17 a zone with little fines. The spike was indicative of a lithology change and was confirmed on the
18 Lithology Log as a transition from a silty sand to sand. The potential porosity could not be estimated
19 because of a muted SP signal.

20 Zone I: Screened from 897 bgs. A high resistivity and a low gamma ray reading indicated a clay free
21 zone. The SP log indicated the potential for increased porosity.

22 Zone J: Screened from 950 feet bgs. This zone demonstrated a high resistivity on the Gamma
23 Ray/Guard log with a corresponding low gamma ray reading. These two log characteristics revealed
24 a zone which correlated to the Lithology Log of fine to coarse grained sand. The SP log indicated the
25 potential for increased porosity in this zone.

1 Installation of blank casing and screen commenced after selection of the zones to be screened. A 2-inch
2 threaded tremie pipe was lowered into the boring to total depth. Each 20-foot section of the tremie pipe
3 was measured to the nearest 0.01 foot and recorded for reference with regard to placement of well
4 construction material (sand, benseal, cement, grout). Upon the installation of the tremie pipe, casing
5 and screen sections were lowered into the boring. Each section of casing and screen was measured to
6 the nearest 0.01 foot and recorded by URS personnel for accurate placement of screened intervals
7 opposite the selected zones. All sections were inspected for defects and/or contamination. Screens used
8 in MW01 were 10.5-foot lengths of Schedule 40 pipe based, 0.02-inch continuous wrap stainless steel.
9 The blank casing was constructed of ASTM A53 ERW B NPS milled steel in 21-foot sections.

10 Installation of the well casing began by constructing a sand-cellar (a steel cap welded to the bottom of
11 the first section of blank casing). The blank casing was partially lowered into the well and held in place
12 while a screen was lifted into position. The screen was then lowered and a butt weld was used to join
13 the two sections (casing string). After the weld was inspected for integrity, the casing string was
14 lowered for subsequent additions of screen and blank casing. The casing string was centered within the
15 bore by placing centralizers outside of the blank casing approximately every 60 feet. This operation
16 continued until the casing string reached total depth and extended slightly above ground level.

17 The placement of annular materials followed the installation of the casing string. All monitoring well
18 construction material was dry mixed at the surface and fed through a hopper into a vacuum pump using
19 water from the local municipal water supply. Materials consisted of benseal and #3 silica sand mixture
20 (1:1) for the annular seal and #3 monterey sand (well rounded) for the sand pack portion of the well.

21 The sand pack was placed from the bottom of the well boring to 10 feet above the first screen interval
22 (see Figure 18). A tremie pipe was used to place the material. It was raised as the material was pumped
23 into the annulus. The annular seal was added and brought to a point approximately 10 feet below the
24 next screened interval. Wire line measurements were obtained through the tremie pipe to verify the
25 placement and depth of the annular seals. The placement of the annular seals and sand packs continued
26 until the uppermost screened interval was sand packed and a final 50-foot annular seal was installed (see
27 Table 2).

Appendix A

Table 2

MONITORING WELL MW01
WELL CONSTRUCTION DETAILS

Zone	Top of Zone (ft bgs)	Bottom of Zone (ft bgs)	Elevation Static Water Level (ft msl)	Screened Interval (ft)		Piezometer Elevation (ft)
				To	From	
Grout	3	206				
Benseal	206	226				
A Sand Pack	226	247		232	242	
Benseal	247	288				
B Sand Pack	288	310	963.01	294	304	878.01
Benseal	310	374				
C Sand Pack	374	396		380	390	
Benseal	396	480				
D Sand Pack	480	502	861.28	486	496	687.01
Benseal	502	554				
E Sand Pack	554	576		560	570	
Benseal	576	634				
F Sand Pack	634	660		642	652	
Benseal	660	696				
G Sand Pack	696	719	960.32	704	714	469.51
Benseal	719	810				
H Sand Pack	810	837		820	830	
Benseal	837	885				
I Sand Pack	885	913		897	907	
Benseal	913	941				
J Sand Pack	941	1,000	1057.4	950	960	221.01

1 A 6-sack cement-sand grout mix was pumped into the annulus from the top of the uppermost benseal
2 to within 3 feet of the surface. The casing was cut below grade and a Waterloo® Sampling System (see
3 below) was installed. The wellhead was completed by covering the assembly with a traffic rated street
4 box with access hatch. Detailed construction information was logged in URS field notebooks and on
5 well construction diagrams.

6 **1.3.3 Waterloo® Sampling System Installation**

7 The Waterloo® groundwater sampling system (the system), produced by Solinst, Ltd., was designed to
8 provide multi-port sampling of a monitoring well constructed with a single casing, screened at a number
9 of depth intervals. The system isolated each screened interval using hydratable packers which were
10 installed above and below each screened interval. Water in each interval was pumped up to the ground
11 surface via non-toxic tubing. The system also allowed for the measurement of the piezometric head at
12 selected intervals through the use of dedicated pressure transducers.

13 The Waterloo® groundwater sampling system was designed for and installed within the MW01 well
14 casing using four basic steps:

- 15 ■ Depth Sounding
- 16 ■ System Design
- 17 ■ Component Layout
- 18 ■ Component Construction and Installation

19 The following sections describe the specific design of the system and steps taken to accomplish the
20 installation.

1 **Depth Sounding**

2 The total depth of the 5-inch MW01 casing was measured by the drilling subcontractor prior to system
3 installation. The base of the Waterloo® system was set on the closed bottom of the well casing to support
4 it. To properly position the sampling ports and packers within the well casing, the length of pipe
5 required from the base of the casing to the first packer was assessed by comparing the total depth of the
6 well to the bottom of the deepest well screen section.

7 **System Design**

8 The Waterloo® system was designed to provide a self-contained multi-depth, multi-port sampling of a
9 single monitoring well. MW01 was constructed within a 12-inch-diameter boring and consisted of a 5-
10 inch ID milled steel casing and ten 10-foot screen intervals of pipe-based 0.02-inch slot wire wrapped
11 stainless steel screen set at areas of highest groundwater permeability. The Waterloo® system was
12 comprised of the following components:

- 13 ▪ PVC end cap with an eyehook for steel wire attachment;
- 14 ▪ 10, 5, 2, and 1-foot sections of schedule 80, 3.5 inch OD PVC pipe;
- 15 ▪ 3 foot long hydratable packers (water activated expansion sleeves fitted over a length of well
16 screen);
- 17 ▪ 0.5 foot stainless steel screened sample ports and stainless steel pressure transducer connectors;
- 18 ▪ Dedicated stainless steel double valve nitrogen driven air lift pumps;
- 19 ▪ Stainless steel vibrating wire pressure transducers;
- 20 ▪ 3/8-inch O.D. polyethylene tubing - nitrogen gas lines;

- 1 ▪ 1/4-inch O.D. polyethylene tubing - groundwater sample lines;
- 2 ▪ 10-port sampling manifold and locking manifold cap.

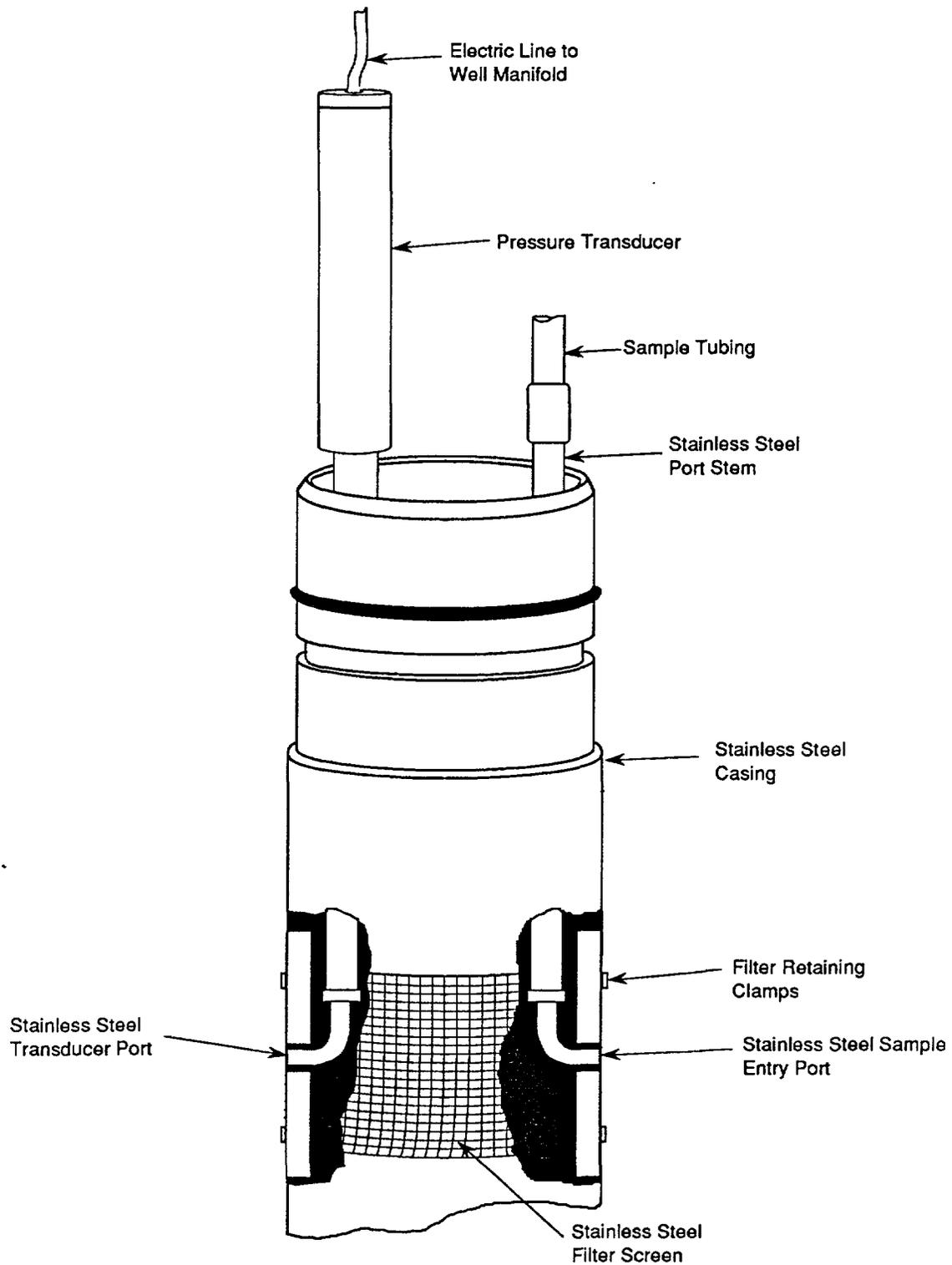
3 The system casing string was comprised of packers, ports, various casing lengths, a base plug, and
4 surface manifold. This allowed for the accurate placement of groundwater entry ports (both sample
5 ports and sample/transducer ports) at the 10-foot screened intervals. The system used modular flush-fitted
6 components to form a sealed casing string.

7 A sampling tube was attached to the stem of each sampling port. It connected the zone, isolated by an
8 upper and lower packer to the ground surface. The four ports selected for transducer installation had
9 a collocated sample port tube connection and a transducer unit connection as shown in Figure 20. The
10 piezometer was connected to the ground surface via a continuous 4-conductor wire. The monitoring
11 tubes, dedicated stainless steel double valve pumps, transducers, and transducer lines were all contained
12 and protected within the sealed casing string.

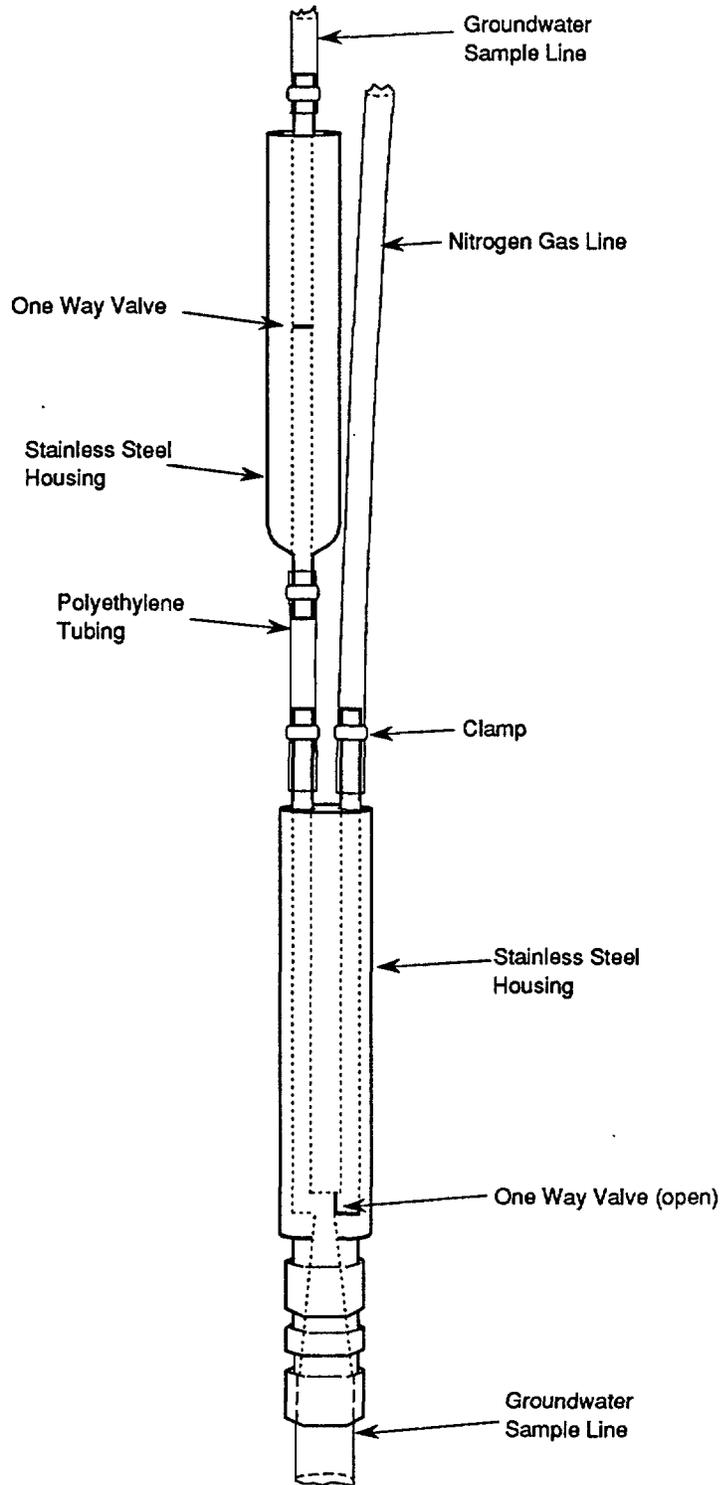
13 Each of the ten-pumps contained within the system utilized two stainless steel, one-way check-valves and
14 a porous polypropylene filter (20 microns in size) in a compact stainless steel housing. These pumps
15 were located at a depth which minimized the distance the pump discharge line had to travel to the surface
16 while still positioning the pump below the hydrostatic water level.

17 A nitrogen drive system conducted the water to the surface via polyethylene pump
18 discharge/groundwater sample line tubing by applying nitrogen gas to the gas drive line (see Figure 21).
19 The water contained within the pump discharge line, via the hydrostatic head, arrived at the surface in
20 a continuous undisturbed slug through driving and venting nitrogen gas.

21 Using a total casing depth of 981.5 feet, and data on the depths of the screened casing section, various
22 lengths of PVC casing pipe were utilized for the system design, subsequent positioning of the packers,
23 and sampling ports. The design proceeded from the well bottom to the top, positioning the ports 1 foot



Appendix A Figure 20
Waterloo Sampling Port with Pressure Transducer
Newmark Operable Unit RI/FS Report



Appendix A Figure 21
Waterloo Stainless Steel Double Valve
Nitrogen Driven Air Lift Pumps
Newmark Operable Unit RI/FS Report

Not to Scale

1 above the lower packer for the lowest two ports and 2 feet above the packer for the upper eight ports.
2 All calculations involved in the tally of casing sections were double-checked by an independent reviewer
3 for accuracy. A design diagram was employed to visualize the positioning of isolated sampling intervals
4 relative to the screened casing sections.

5 **Component Layout**

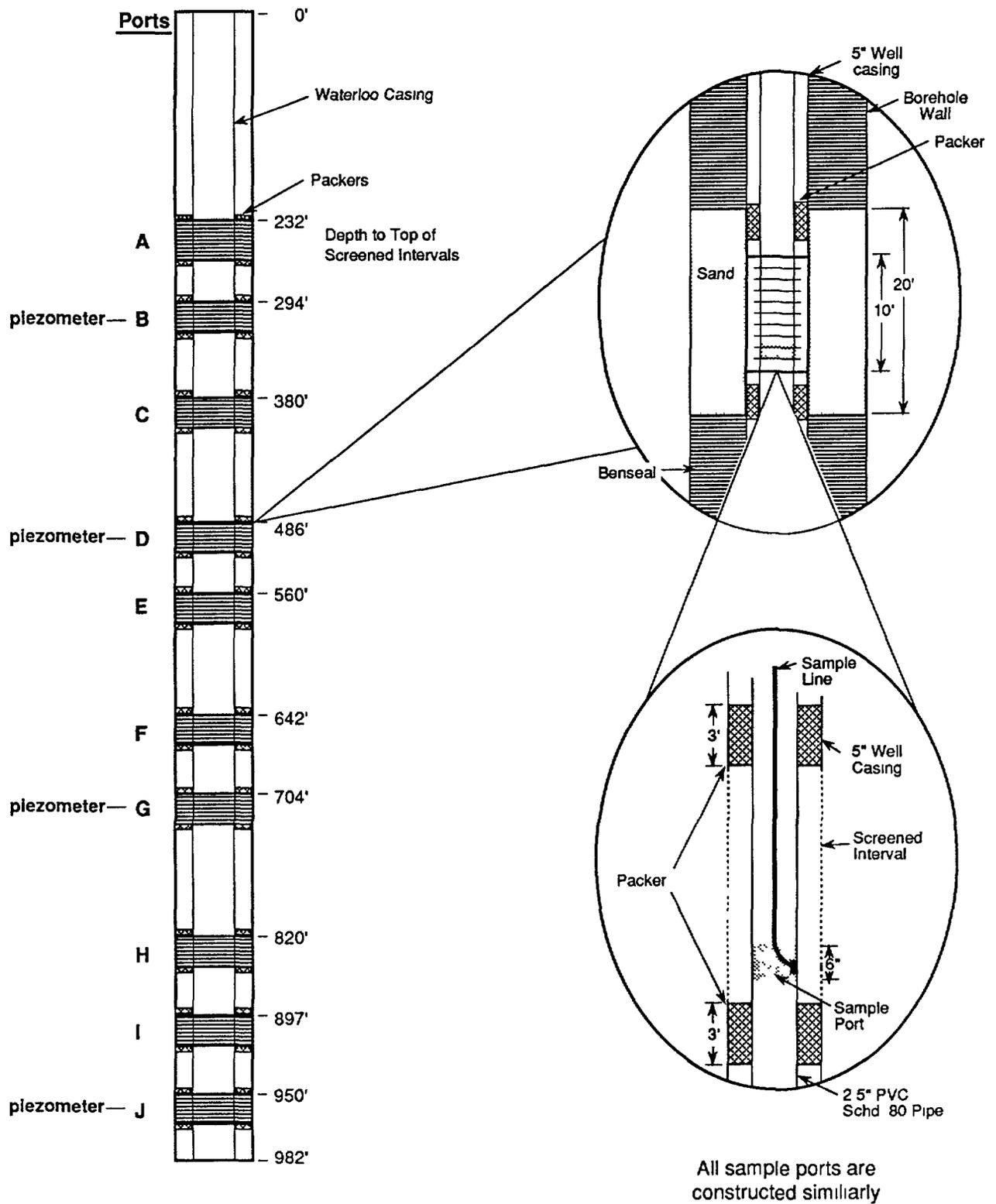
6 A PVC casing and packer tally was conducted first to ensure the total number of individual lengths and
7 components necessary were available. A steel cable was attached to the bottom end cap and laid out
8 along the extent of the work area. This cable also served to remove the system, if necessary. All pipe
9 section packers and ports were checked off the design list; the wires and sampling lines were fed inside
10 the casing sections; and the casing sections were carried towards the well head. As the system
11 components were lowered and ports were installed, additional sampling and piezometer lines were
12 attached. Installation continued as more casing sections were laid out, and the lines were threaded inside
13 as they were brought to the well head to be connected to the previously installed section.

14 **Component Construction and Installation**

15 All casing connections utilized a flush-mounted coupling system. Within the connection, an O-ring was
16 used to prevent transfer of water between the inside and outside of the casing during installation. This
17 transfer could prematurely begin the packer expansion process before the system could be set in place.

18 A forklift was used to lower sections of pipe. Landing clamps were used to hold the casing string during
19 the system installation. A casing section was suspended over the well boring with one clamp while
20 another section was positioned, set on the previous section, and secured with a wire tie. A clamp was
21 then attached to the top of the new section, the lower clamp loosened, and the new section was lowered
22 into the well. This process was continued until all components were assembled (see Figure 22).

23 During the installation, all transducers were tested to ensure that the transducer wires were undamaged.
24 The sample lines and wires were tied together with plastic wire ties to prevent shifting or kinking during
25 installation.



Appendix A Figure 22
MW01 Waterloo® System Installation Within The Well Casing
Newmark Operable Unit RI/FS Report
 Not to Scale

1 Eight double valve pumps were installed at approximately 330 feet bgs. These pumps corresponded to
2 the lowest eight sampling ports. As previously mentioned, the hydrostatic pressure was great enough
3 to draw the water up the sample lines through the pump to the groundwater sample line beyond the level
4 of the pumps (see Figure 21). This allowed the water to surpass the pump body to a depth
5 corresponding to the static water level (approximately 217 feet bgs at the MW01 site). A nitrogen
6 pressure line and groundwater sample line connected the pump to the surface. Pumps corresponding
7 to the parts closest to the ground surface were installed immediately above their respective ports to
8 maximize the height of the water slug and, therefore, maximize the amount of groundwater sample
9 brought to the surface during a nitrogen drive cycle.

10 After all casing pieces were assembled and the bottom was reached, an examination of the boring's true
11 depth was conducted. This examination showed that the system design was within the acceptable total
12 system length/total casing depth variability of 10 feet. The actual difference was only 10 inches. The
13 final steps necessary to complete the system were as follows:

- 14 ▪ Trim all transducer wires, sample lines, and nitrogen lines;
- 15 ▪ Cut a piece of casing to sit flush with the well head;
- 16 ▪ Fit a flush manifold cover for easy identification of sample and nitrogen lines; and
- 17 ▪ Cement a locking manifold well cover in place.

18 **1.4 MONITORING WELL DEVELOPMENT**

19 **1.4.1 Source Area Well Development**

20 All source area wells were allowed to stabilize for a minimum of 24 hours before development. Upon
21 arrival at each well location, static water levels were recorded for the shallow (A) well and the deep (B)
22 well. Both wells were then sealed with a water tight locking cap to prevent cross contamination during

1 development. The well to be developed was then reopened and a development rig was moved over the
2 well. A 2½-inch stainless steel bailer was lowered into the well on a wire line until it touched the
3 bottom of the well. The wire was then marked to prevent dropping the bailer through the bottom of the
4 well. The well was bailed until the purge water was clear of silt and fine sands. The well was then
5 swabbed using a triple sequence of rubber gaskets interconnected with 4½-inch lengths of steel pipe.
6 The swab was lowered to the bottom of the well and then rapidly raised to the top of the screened
7 interval. This process was repeated for approximately 10 to 15 minutes. The well was then bailed again
8 until clear of silt and fines.

9 When bailing was complete, the well was developed using air lifting techniques. A 1-inch ID discharge
10 pipe was lowered into the well to approximately 10 feet above the screened interval being developed.
11 An air line was then inserted inside the discharge pipe to a depth about 40 feet below static water level
12 in all A wells and approximately 100 feet above the end of the discharge pipe in all B wells. These
13 depths were chosen to allow the pressure head of water sufficient hydrostatic force to assist the air
14 pressure in initiating the lifting of water out of the well. The air line was connected to an air compressor
15 capable of delivering 100 cubic feet per minute of air at 125 pounds per square inch. Typically, the
16 shallow wells (A wells) were capable of producing 5 to 7 gallons per minute (gpm) and the deeper (B
17 wells) were capable of producing up to 10 gpm during the latter stages of development.

18 Field parameters of temperature, conductivity, pH, and turbidity were measured during development.
19 All development data were recorded on a monitoring well development sheet. Measurements were taken
20 every one-half hour. When the turbidity readings approached 25 nephelometric turbidity units (NTUs),
21 the air valve was turned off for 30 seconds and then reopened. This created a surging effect of the
22 groundwater across the screened interval loosening any remaining drilling mud or obstruction present
23 in the sand pack or the well screen. This surging was repeated two to three times prior to continuing
24 the air lifting process. When the turbidity reading dropped below 25 NTUs, and all development criteria
25 were satisfied, well development was considered complete for that individual well. Table 3 presents the
26 development data for each well.

Appendix A

Table 3

MONITORING WELL DEVELOPMENT DATA

Well	H ₂ O Volume Removed (Gallons)	Dates	Total Time	Final Parameters			
				Temp °C	Conductivity μ mohs ⁽¹⁾	pH	Turbidity NTUs ⁽²⁾
MW01	25,000	3/30/92-4/13/92	59:20	20.4	540	7.8	24.8
MW02A	500	4/2/92	7:30	21.8	410	8.1	20.2
MW02B	2500	4/2/92-4/3/92	15:30	19.6	580	8.2	18.9
MW03A	700	3/19/92-3/26/92	20:00	17.8	620	8.6	24.6
MW03B	1300	3/19/92-3/23/92	18:00	17.7	600	8.2	23.8
MW04A	300	3/7/92-3/8/92	6:30	20.6	500	7.6	20.3
MW04B	2100	3/8/92-3/10/92	17:30	18.7	310	7.3	20.5
MW05A	1800	3/13/92-3/14/92	14:20	19.4	510	7.8	24.4
MW05B	750	3/15/92	7:30	18.6	620	8.1	6.25
MW06A	2000	4/10/92-4/17/92	32:00	21.8	490	7.9	24.8
MW06B	1300	4/13/92-4/14/92	18:00	18.4	590	8.0	33.2
MW07A	3700	6/25/92	9:00	22.0	550	7.3	2.58
MW07B	3100	6/24/92	10:20	23.0	530	7.3	9.81
MW08A	2700	7/3/92-7/6/92	22:15	23.0	480	8.1	82.8
MW08B	7200	7/3/92-7/6/92	29:50	19.5	600	8.0	98.2

⁽¹⁾ micromohs

⁽²⁾ Nephelometric Turbidity Units

1 Development of monitoring wells MW08A and B was completed using the above described methods.
2 However, because of the seismic activity of June 28, 1992, the expected flow rates for MW08A and B
3 were not observed during the development process. MW08B produced an actual flow rate of
4 approximately 4 gallons per minute (gpm) versus an expected flow rate of around 10 gpm. MW08A
5 had an actual flow rate of 1 to 2 gpm versus an expected rate of 5 to 7 gpm with turbidity measurements
6 not falling below 80 NTUs. The probable cause of high turbidity was wall materials sloughed into the
7 well bore and the mixing of sand pack materials and annular seal material by seismic activity.

8 **1.4.2 Plume Well Development**

9 MW01 was developed prior to the installation of the Waterloo® system. After completing MW01
10 installation, the well was allowed to stabilize for 72 hours. Prior to beginning development, a wire line
11 sounder was lowered to the bottom of the well to measure the depth. This depth was compared to the
12 constructed well depth to calculate the amount of sediment in the bottom of the well. Development
13 began by repeatedly lowering a 4-inch outside diameter (OD) by 8-foot long stainless steel bailer to the
14 bottom of the well to remove the accumulated sediments.

15 After the initial bailing was completed, a surge block was lowered to the bottom screened interval and
16 was surged for approximately 15 minutes. This was necessary to loosen any fines or drilling fluid
17 remnants trapped in the filter pack, well bore wall or screen. The surge block was then raised to the
18 next higher screened interval and it was surged. This process was repeated until all ten screened
19 intervals had been surged, then all accumulated sediments were bailed out.

20 A straddle packer and pump assembly consisting of two air inflatable packers separately by
21 approximately 15 feet of pipe and a 1-hp submersible electrical pump was then lowered to each screened
22 interval and the packers inflated, thus isolating the interval. The straddle packer and pump assembly
23 was used to develop each screened interval by alternately over-pumping and surging. The screened
24 interval was pumped at a rate of approximately 10 gallons per minute (gpm) until the turbidity dropped
25 below approximately 50 NTUs. Then the pump was shut off and the column of water in the pump
26 discharge line was allowed to flow back down the line and out the pump, thereby surging the screened
27 interval and loosening any trapped material. The interval was subsequently pumped and surged until

1 minimal increase in turbidity (less than approximately 50 NTUs) was noted after surging. The screened
2 interval was then pumped until the turbidity was below 25 NTUs, at which point the interval was
3 considered to be sufficiently developed. This procedure was completed at each of the ten screened
4 intervals. Field parameters of temperature, conductivity, pH and turbidity were measured approximately
5 every one-half hour. All development data were recorded on a monitoring well development sheet.

6 The development water was pumped into two 22,000-gallon temporary storage tanks. Approximately
7 35,000 gallons of water was pumped during the development of MW01. Prior to Waterloo® sampling
8 system installation, MW01 was re-developed to ensure complete removal of groundwater that might have
9 mixed between screened intervals. The final groundwater development parameters are presented in
10 Table 3.

11 1.5 GROUNDWATER SAMPLING

12 1.5.1 Source Area

13 Following well completion and development, the source area wells were allowed to recharge, or reach
14 equilibrium for a minimum of 24 hours.

15 Prior to purge and sampling operations, all groundwater sampling equipment was decontaminated.
16 Decontamination consisted of the following procedures:

- 17. ■ 5-minute wash (pumping) cycle using tap water and a commercial non-phosphate detergent (e.g.,
18 Alconox);
- 19 ■ Two rinse cycles in separate containers using commercial deionized (DI) water;
- 20 ■ The DI water rinse was followed with a methanol rinse and an HPLC water rinse;

1 ▪ Equipment rinsate blanks were taken to verify the effectiveness of the decontamination process.
2 Blanks were collected by pouring laboratory purged HPLC water through the sampling tube and
3 into sample bottles. The bottles were labeled, secured in an ice chest cooled with blue ice, and
4 submitted for laboratory analysis; and

5 ▪ All decontamination fluids were stored on site in DOT-approved, 55-gallon drums for subsequent
6 disposal.

7 Before purging, static water level was measured with a battery-operated water level indicator and the
8 data were recorded on a URS Monitor Well Sampling Data sheet.

9 During the purging of the well, physical field parameters (temperature, electric conductivity, pH, and
10 turbidity) were measured and recorded a minimum of two times per casing volume. Purging continued
11 until the parameters stabilized to within 10% for three successive measurements and a minimum of three
12 casing volumes of water was removed. This was necessary to ensure the water in the well boring was
13 representative of the groundwater in the surrounding aquifer. The purging and sampling was done using
14 a 2-inch, variable speed, submersible pump lowered to a depth of 250 feet bgs. At the completion of
15 purging, the discharge line was replaced with a clear poly hose through which the environmental samples
16 were collected.

17 For sampling, the flow rate was reduced to approximately 100 to 200 milliliters (ml) per minute. The
18 samples were collected by allowing the water from the clear poly hose to flow down the inside of the
19 bottles which were held at an angle to minimize aeration. Samples were collected in the following order:

- 20 ▪ Total Metals
- 21 ▪ Pesticides/PCBs
- 22 ▪ Total Petroleum Hydrocarbons - Gas and Diesel
- 23 ▪ Volatile Organics (VOAs)

24 While sampling the wells, a 250-ml beaker was filled and the physical parameters of the water sample
25 were measured. After completion of sampling, the groundwater samples were labelled and placed in

1 an ice chest cooled with blue ice, transported to the field office under proper chain-of-custody protocol,
2 and submitted to the mobile laboratory or prepared for shipment to the EPA Region IX laboratory for
3 analysis (Newmark Sample Plan; URS 1992).

4 The mobile laboratory data from the source area groundwater sampling were used for initial screening
5 purposes. The position detection of volatiles in MW03B groundwater sample submitted to the mobile
6 laboratory was utilized in the decision to install monitor wells MW06A/B, MW07A/B, and MW08A/B.
7 All mobile laboratory source area groundwater data results are included in Appendix G. Only validated
8 Region IX laboratory data was used in the evaluation of treatment technologies and contaminant
9 characterization. Therefore, only Region IX laboratory data are included within this report.

10 **1.5.2 Waterloo® Sampling Procedures**

11 The sampling of the Waterloo® system was conducted in the following steps:

- 12 ▪ Water level recording
- 13 ▪ Sample system equipment setup
- 14 ▪ Interval sampling

15 **Waterloo® Level Recording**

16 Four vibrating wire-line pressure transducers were installed within the Waterloo® system. These were
17 set at 960, 711.5, 494, and 303 bgs, corresponding to sampling ports J, G, D, and B, respectively (see
18 Table 2). The manifold cover was unlocked and color-coded alligator clips from the transducer reader
19 are attached to corresponding leads associated with each transducer. The transducer output displayed
20 on the LED readout was recorded from the transducer reader. This process was repeated until all
21 transducer readings were recorded. The transducer readings were then converted to depth-to-water
22 measurements.

1 The calculations involved in converting these readings to depth-to-water figures for each interval with
2 a transducer is described below.

3 All four transducers were read prior to installation. Initial transducer values were recorded and
4 considered to be the Zero Readings. The temperature was also recorded. To be strictly correct, one
5 should also consider the barometric pressure at the time of reading but as these transducers were
6 relatively high pressure (100, 250 and 500 psi), the correction for barometric pressure was negligible.

7 Prior to sampling, transducer and temperature readings were taken and recorded as discussed above.
8 These were the Subsequent Readings. With the two sets of readings, the pressure, corrected for
9 temperature, was determined by the following equation:

10
$$P = (R_0 - R_1) C + K(T_1 - T_0) \text{ where}$$

11 R_0 = Zero reading

12 R_1 - Subsequent reading

13 C = Calibration factor in psi/digit as found on the individual transducer calibration sheet

14 T_1 = Subsequent temperature

15 T_0 = Zero temperature reading

16 K = Thermal factor in psi/degree C rise found on the individual transducer calibration sheet

17 The water column height (in feet) was calculated by the following equation:

18
$$W = F \times P, \text{ where}$$

19 W = Water column height

20 F = Conversion factor, pressure gradient of fresh water in ft/psi (equal to 2.309 ft/psi)

21 P = Water pressure corrected for temperature

1 The depth to water from the top of casing was calculated by subtracting the piezometric head produced
2 by the sampling interval from the height of the casing elevation above sea level using the following
3 equation:

4 $D_w = E - (W + (E - D_p))$, where

5 D_w = Depth to water from the top of casing

6 E = Elevation of the top of casing

7 W = Height of the water column

8 D_p = Depth of port below top of casing

9 These specific depths to water were used to assess whether these intervals represented unconfined or
10 confined aquifers.

11 **Sample System Equipment Setup**

12 All equipment needed for purging and sampling was assembled to begin purging water into the plastic
13 water cooler bottles via the sample line extension hoses. The equipment included:

- 14 ▪ Solinst nitrogen vent/drive timer control box
- 15 ▪ Solinst pressure drive slave unit box
- 16 ▪ Solinst 10 gauge drive manifold
- 17 ▪ Various pressure hoses for connection to tank and boxes
- 18 ▪ Four 253 cubic foot nitrogen bottles
- 19 ▪ One 400 psi (maximum) regulator
- 20 ▪ One 200 psi (maximum) regulator
- 21 ▪ Ten 3/8" 10-foot sample line extension hoses
- 22 ▪ Five 5-gallon plastic water cooler bottles

1 Sample Interval Purging

2 When possible, multiple ports were purged at the same time. Since eight of the pumps (ports C through
3 J) were set at approximately the same depth, the optimal drive and vent time for one of the ports was
4 applied to the others. For ports A and B, the nitrogen drive line was connected directly to the nitrogen
5 gas inlet on the manifold.

6 The purge volume was calculated by subtracting the volume of a 12.5-foot x 3.5-inch OD cylinder from
7 the volume of a 12.5-foot x 5-inch ID cylinder. The average purge volume of an interval was found
8 to be approximately 7 gallons. Because the Waterloo® system packers prevented the groundwater from
9 being exposed to air, only one casing volume was purged prior to sampling. One well casing volume
10 for a port would be:

11
$$V = [\pi r_1^2 h - \pi r_2^2 h_2] (7.48 \text{ gal/ft}^3), \text{ where}$$

12 r_1 = radius of the well casing pipe (in feet)

13 h_1 = height of the port interval

14 r_2 = radius of the Waterloo® casing (in feet)

15 h_2 = height of the Waterloo® casing within the port interval

16 Prior to sampling, a volume ≥ 7 gallons was removed from each interval, except interval A. Only 5.5
17 gallons were removed from interval A because of low purge volumes obtained during the drive cycle.
18 In order to ensure that the groundwater samples taken represented formation water, three temperature,
19 conductivity, pH, and turbidity readings were collected during the purging of each interval. The sample
20 was collected after these readings stabilized to within $\pm 10\%$ of the previous reading.

21 Interval Sampling

22 Groundwater samples were collected in the following order:

- 23
 - Total Metals

- 1 ▪ Pesticides/PCBs
- 2 ▪ Base Neutral Acids (BNAs)
- 3 ▪ Total Petroleum Hydrocarbons - Gas and Diesel
- 4 ▪ Volatile Organics (VOAs)

5 These samples were submitted to the EPA Region IX laboratory. Halogenated and aromatic volatile
6 organics and TPH-gas samples were also collected at the same time as the EPA Region IX laboratory
7 samples and were submitted to the FASP mobile laboratory for analysis. Samples were taken from the
8 middle of a slug of water delivered during the nitrogen drive cycle in order to avoid the gas-water
9 interface.

10 The equipment needed for purging and sampling is as follows:

- 11 ▪ Solinst nitrogen vent/drive timer control box
- 12 ▪ Solinst pressure drive slave unit box
- 13 ▪ Solinst 10 gauge drive manifold
- 14 ▪ Various pressure hoses for connection to tank and boxes
- 15 ▪ Four 253 cubic foot nitrogen bottles
- 16 ▪ One 400 psi (maximum) regulator
- 17 ▪ One 200 psi (maximum) regulator
- 18 ▪ Ten 3/8" 10-foot sample line extension hoses
- 19 ▪ Five 5-gallon plastic water cooler bottles

20 The following sets were conducted for installation of sampling equipment:

- 21 1. Installation of the 200 and 400 psi regulators to a nitrogen tank;
- 22 2. Connection of a 300 psi (maximum) nylon hose from the 200 psi regulator to the nitrogen air
23 pressure inlet on the control box;

- 1 3. Attachment of a line from the pump line outlet on the control box to the drive in on the slave
2 box;

- 3 4. Connection of a 500 psi (maximum) nylon hose from the 400 psi regulator to the nitrogen
4 pressure in on the slave box;

- 5 5. Connection of a nylon line from the pump drive to the 10 gauge drive manifold;

- 6 6. Attachment of one nitrogen pressure quick connect line to each of the bottom 5-port nitrogen
7 pressure in lines.

- 8 7. Connection of one end of the pre-marked 10-foot extension line to the appropriate sample tube
9 and placement of the other end in a 5-gallon plastic water cooler bottle;

- 10 8. Slow increase in pressure at the tank regulators until inflow control box pressure of 60 psi and
11 an inflow slave box pressure of 150 psi was set;

- 12 9. During the drive cycle, pressure regulator on the control box was set to 50 psi;

- 13 10. Individual pump pressures for each of the five ports connected, using the corresponding
14 regulators on the manifold was set.

- 15 11. With a watch, the drive cycle time was set to 35 seconds and vented to 60 seconds.

- 16 12. Adjustment of vent and drive times and individual port pressure regulators until optimal
17 performance was achieved. The ideal operating conditions existed when the drive cycle
18 provided a steady flow of water without any flow acceleration or nitrogen gas burst. This
19 was achieved by setting the vent cycle to a period long enough for the hydrostatic pressure
20 present in the sample port interval to push water into the sample tube above the pump. For

1 example, if the hydrostatic pressure forces water into 50 feet of sample tubing above the
2 pump one way valve, the drive time should be set so that a volume of water just less than that
3 which would be contained in 50 feet of hose is brought to the surface.

4 Sample Interval Purging

5 When possible, multiple ports were purged at the same time. Since eight of the pumps (ports C through
6 J) were set at approximately the same height, the optimal drive and vent time for one of the ports was
7 applied to the others. For ports A and B, the nitrogen drive line was connected directly to the nitrogen
8 gas inlet on the manifold.

9 The purge volume was calculated by subtracting the volume of a 12.5-foot x 3.5-inch OD cylinder from
10 the volume of a 12.5-foot 5-inch ID cylinder. One well casing volume for a port would be:

$$11 \quad V_{wc} = [\pi r_1^2 h_1 - \pi r_2^2 h_2] (7.48 \text{ gal/ft}^3) \text{ where}$$

12 r_1 = radius of the well casing pipe (in feet)

13 h_1 = height of the port interval

14 r_2 = radius of the Waterloo® casing (in feet)

15 h_2 = height of the Waterloo® casing within the port interval

16 V_{wc} = Volume of well casing

$$17 \quad (3.142 \times (\frac{2.5}{12})^2 \times 12.5) - (3.142 \times (\frac{1.75}{12})^2 \times 12.5) (7.48)$$

$$18 \quad (3.142 \times 0.0424 \times 12.5) - (3.142 \times 0.02127 \times 12.5) (7.48)$$

$$19 \quad (1.7045 - 0.8354) (7.48)$$

$$20 \quad (0.8691) (7.48)$$

$$21 \quad V_{wc} = 6.5 \text{ gallons}$$

1 This figure was rounded up to 7.0 gallons in order to provide a conservative figure. Because the
2 packers isolated each individual sampling interval, preventing the groundwater from being exposed to
3 air, only one casing volume was purged prior to sampling.

4 **1.6 MUNICIPAL WELL SAMPLING**

5 One Cal EPA well scheduled for sampling could not be sampled because the dedicated pump was
6 broken. Twenty municipal wells and five Cal EPA wells were sampled during the month of April 1992
7 (see Figure 23). Two City of San Bernardino Municipal Water Department employees provided
8 assistance during the sampling effort. The employees either took static water level measurements, or
9 guided URS personnel to well locations, and operated the wells during sampling activities. Water levels
10 were measured and used to estimate well volumes. Before sampling inactive wells, the pumps were
11 turned on and allowed to run for 30 minutes. Given the capacity of the pumps, this was more than
12 sufficient to purge three volumes from each well. The volume purged was calculated from the flow
13 meter for each well. The static water levels and the calculated and actual purged well volumes are
14 presented on Table 4.

15 Prior to sample collection, a minimum of two sets of field parameters (pH, electrical conductivity,
16 temperature, and turbidity) were recorded on the URS Well Sampling Data sheets. The parameters were
17 measured and recorded until results displayed < 10% deviation. Water samples were collected from the
18 existing sampling spigot closest to the pump and upstream of any chemical additions. The spigot was
19 decontaminated in accordance with the Newmark Sample Plan (URS 1992). Three 40-ml glass vials
20 were collected for each sample.

21 The five Cal EPA wells were purged and sampled using dedicated submersible pumps already installed
22 in the wells. The sixth Cal EPA well was not sampled because the pump was inoperative. The wells
23 were purged a minimum of three calculated well volumes and until field parameters displayed < 10%
24 deviation. A minimum of two measurements were taken per well volume.

1 Figure 23 Municipal Well Sample Locations

Appendix A

Table 4

MUNICIPAL WELL INFORMATION SUMMARY

URS Well No.	Well Name	State Well No.	Recordation No.	Well Diameter (in.)	Total Depth (ft.)	Screen Intervals (ft. bgs)	Depth to Water (ft. bgs/date)	Well Elevation (ft. msl)	Calculated (3) Well Volumes (gal.)	Well Volume Pumped (gal.)	New Depth to Water (ft./date)	Pumping Rate (gpm)	Age of Well (yrs)	Sampling Parameters		
														pH	Temp °C	Conductivity
MUNI-01	C.S.B.* - Devil Canyon #1	1N4W08M01	313600712	24	285	186 to 236	178.2 / 3-91	1530.00	6,787	29,850	189.0 / 3-92	995	19	7.28	17.6	380
MUNI-02	C.S.B. - Devil Canyon #2	1N4W07F01	313600711	26	450	177 to 292 306 to 316 356 to 400	162.9 / 3-91	1621.96	23,919	26,400	159.0 / 3-92	880	62	7.30	20.1	220
MUNI-03	C.S.B. - Newmark #4	1N4W16E04	303602399	20	441	300 to 404	208.8 / 3-91	1413.57	11,227	58,080	210.0 / 3-92	1,936	25	6.58	18.2	510
MUNI-04	C.S.B. - Newmark #2	1N4W16E02	313600715	20	359.5	148 to 240 252 to 335	194.5 / 3-91	1405.26	7,119	42,510	213.0 / 3-92	1,417	46	6.63	18.1	610
MUNI-05	C.S.B. - Newmark #1	1N4W16E01	313600714	26 to 233' 12 to 413'	413	--	210.1 / 3-91	1412.99	16,686	28,980	210.0 / 3-92	966	26	6.36	18.4	590
MUNI-06	C.S.B. - Newmark #3	1N4W16E03	313600716	16	495	232 to 270 283 to 305 331 to 462	203.8 / 3-91	1407.92	8,985	45,000	209.7 / 3-92	1,500	38	6.61	18.4	480
MUNI-07	DHS** - Electric Drive #1	W1-2	--	5	255	240 - 250			114	120	215.0 / 3-92	10	--	7.7	19.2	490
MUNI-08	DHS - Electric Drive #1	W1-3	--	5	405	390 - 400	--	--	714	716	171.0 / 3-92	10	--	7.7	19.8	500
MUNI-09	DHS - Electric Drive #2	W2-3	--	5	435	415 - 425	--	--	822	825	166.0 / 3-92	10	--	7.5	20.4	480
MUNI-10	DHS - Electric Drive #2	W2-1 (275')	--	5	275	260 - 270	--	--	--	--	pump broken	--	--	--	--	--
MUNI-11	DHS - Parkdale School	W3-1 (505')	--	5	505	490 - 500	--	--	768	770	254.0 / 3-92	10	--	7.5	19.0	540
MUNI-12	DHS - Parkdale School	W3-3	--	5	365	350 - 360	--	--	537	540	189.0 / 3-92	10	--	7.5	16.5	460
MUNI-13	C.S.B. - Waterman Ave.	1N4W27A01	303600728	20	662	258 to 267 295 to 610	250.3 / 2-91	1244.77	18,954	85,200	272.0 / 3-92	2,840	43	7.0	19.9	510
MUNI-14	C.S.B. - 31st St. & Mt. View	1N4W27B01	303602081	20	577	325 to 553	247.1 / 2-91	1233.01	15,600	50,490	256.0 / 3-92	1,683	30	7.0	19.7	500
MUNI-15	C.S.B. - 30th St. & Mt. View (Marshall)	1N4W27G01	303600719	20	523	373 to 523	234.7 / 2-91	1227.38	13,023	85,530	255.0 / 3-92	2,851	66	7.0	19.2	480
MUNI-16	C.S.B. - Leroy	1N4W27A02	303602401	20	693	450 to 660	243.9 / 2-91	1239.67	20,169	86,850	278.0 / 3-92	2,895	25	7.1	19.6	520

++ DHS = Cal EPA

-- No Data

Appendix A

Table 4 (Cont'd.)

MUNICIPAL WELL INFORMATION SUMMARY

URS Well No.	Well Name	State Well No.	Recordation No.	Well Diameter (in.)	Total Depth (ft.)	Screen Intervals (ft. bgs)	Depth to Water (ft. bgs/date)	Well Elevation (ft. msl)	Calculated (3) Well Volumes (gal.)	Well Volume Pumped (gal.)	New Depth to Water (ft./date)	Pumping Rate (gpm)	Age of Well (yrs)	Sampling Parameters		
														pH	Temp °C	Conductivity
MUNI-17	C.S.B. - Lynwood	1N4W26E02	303600727	20	690	320 to 335 344 to 584 629 to 660	264.0 / 2-91	1236.23	21,333	68,580	251.0 / 3-92	2,286	38	6.9	17.4	450
MUNI-18	C.S.B. - 27th Street	1N4W27M02	303601671	20	749	243 to 259 290 to 410 442 to 456 477 to 717	218.5 / 2-91	1184.07	25,950	45,840	215.0 / 3-92	1,528	36	7.4	20.1	630
MUNI-19	C.S.B. - North "E" Street	1N4W27M01	303600727	20	785	460 to 756	200.1 / 2-91	1192.05	27,312	56,310	223.0 / 3-92	1,877	42	7.3	19.8	380
MUNI-20	C.S.B. - 23rd Street	1N4W27N01	303602264	20	958	354 to 370 428 to 448 494 to 828	171.8 / 2-91	1174.75	36,642	39,690	204.0 / 3-92	1,323	28	7.3	19.3	600
MUNI-21	C.S.B. - Perris Hill #4	1N4W35C03	*	20	314	130 to 215 244 to 291	187.5 / 2-91	1168.25	5,247	27,090	206.0 / 3-92	903	44	6.7	19.5	570
MUNI-22	C.S.B. - 17th Street	1N4W34G01	303600725	20	700	494 to 571.5 576.5 to 670	103.3 / 2-91	1142.01	25,563	52,020	174.0 / 3-92	1,734	44	7.0	19.1	540
MUNI-23	C.S.B. - 16th Street	1N4W34G03	303600726	20	708	490 to 680	185.1 / 2-91	1135.13	26,049	66,870	172.0 / 3-92	2,229	42	7.1	19.9	550
MUNI-24	C.S.B. - Gilbert Street	1N4W35M03	303600729	20	685	480 to 603 625 to 685	145.9 / 2-91	1123.54	25,806	90,000	154.0 / 3-92	3,000	40	7.4	18.6	550
MUNI-25	C.S.B. - 10th & J Street	154W04B04	NEW	20	1215	280 to 1160	145.11 / 2-91	--	50,493	107,400	176.0 / 3-92	3,580	2	7.5	23.7	370
MUNI-26	C.S.B. - 7th Street	154W03J05	303602265	20	962	552 to 830 861 to 938	113.4 / 2-91	1057.39	41,211	88,230	114.0 / 3-92	2,941	27	7.2	18.7	460

++ DHS = Cal EPA

-- No Data

1 The FASP mobile laboratory volatile samples were also collected concurrently with the EPA Region IX
2 laboratory samples at a selected number of well locations. The samples were labeled, placed in an ice
3 chest cooled to 4°C with blue ice, transported to the field office under proper chain-of-custody
4 procedures, and prepared for shipment to the EPA Region IX laboratory for analysis (Newmark Sample
5 Plan, URS 1992). The EPA Region IX laboratory halogenated VOC results for the municipal and Cal
6 EPA wells are presented in Appendix D. The FASP mobile laboratory halogenated results are presented
7 in Appendix G.

8 Purged water from the five Cal EPA wells was collected in a 600-gallon portable tank. When the tank
9 was full, the water was transported to holding tanks located in the Newmark Wellfield. It was stored
10 until results of chemical analyses indicated only nondetectable contaminants. The water was then
11 discharged into the flood control channel west of the wellfield (see Figure 1-3, Section 1.0). Purged
12 water from the municipal wells either entered the water treatment and distribution system. For wells
13 with no previously detected contamination, the purge water was discharged into the storm drain.

14 1.7 ANALYTICAL METHODS AND DATA QUALITY EVALUATION

15 EPA Region IX laboratory and FASP mobile laboratory analytical methods used for this investigation
16 are discussed in this section and are listed in Table 5. The investigation is focused on three specific
17 areas. The areas included the municipal wells, the source area, and the plume area. The analytical
18 methods were selected in order to provide information on what contaminants were present and to provide
19 adequate data to support the preparation of the FS and preliminary remedy selection. A description of
20 each analytical method is included in Sections 1.7.1 and 1.7.2.

21 Analyses were performed in accordance with the EPA guidelines through the EPA Region IX Laboratory
22 by Field Analytical Support Program (FASP) mobile laboratory using standard and modified published
23 methods. To attain the required detection limits, sample preparation procedures and analytical
24 determinations were modified.

Appendix A

Table 5

REGION IX LABORATORY RAS & SAS ANALYSES

Area	Matrix	Analyses
Municipal Wells	Water	SAS VOA 624 Halogenated Volatile Organics
Source	Water	SAS VOA 624 Halogenated Volatile Organics SAS TPH 8015 Gas and Diesel RAS BNA RAS Pesticides/PCBs RAS Total Metals
	Soil	RAS VOA RAS BNA RAS Pesticides/PCBs RAS Total Metals
Plume	Water	SAS VOA 624 Halogenated Volatile Organics SAS TPH 8015 Gas and Diesel RAS BNA RAS Pesticides/PCBs RAS Total Metals

SAS = Special Analytical Services

RAS = Routine Analytical Services

1 **1.7.1 Region IX Laboratory Analyses**

2 The Routine Analytical Services (RAS) and Special Analytical Services (SAS) methods used for analyses
3 of municipal well source, and plume area samples by the EPA Region IX laboratory are shown in Table
4 5.

5 EPA Region IX laboratory analyses were used to confirm the mobile laboratory results and provide a
6 larger number of analysis in order to assess possible contaminants existing from historical operations.

7 RAS and SAS requests were utilized for the samples. A RAS analytical request was submitted for
8 samples that required Contract Laboratory Program (CLP) 3/90 Statement of Work (SOW) analyses for
9 both groundwater and soil samples and a SAS analytical request was performed on specific samples that
10 required low detection limits and other methods not included in the 3/90 SOW.

11 All RAS analytical methods shown were run under the EPA CLP 3/90 SOW. The SAS analytical
12 method requested for EPA Method 624 utilized a 25-ml purge for all waters while Total Petroleum
13 Hydrocarbons (TPH) utilized a modified EPA Method 8015. The analytical result tables presented in
14 Appendices C and D list the constituents reported for each analytical method utilized for the project.

15 **1.7.2 FASP Mobile Laboratory Analyses**

16 The methods used by the FASP laboratory for analyses of municipal well, source, and plume area
17 samples are shown in Table 6. The EPA Region IX Environmental Services Branch (ESB) provided the
18 FASP mobile laboratory for on-site preliminary sample analysis of volatiles concentrations necessary to
19 obtain fast screening data. Data results were utilized for decisions about site safety and to provide
20 analytical results necessary to make a one-time evaluation of potential groundwater contaminants. This
21 laboratory is considered a non-CLP laboratory. The groundwater samples from the municipal wells and
22 the soil and groundwater samples from the source and the plume areas were analyzed for halogenated

Appendix A

Table 6

FASP MOBILE LABORATORY ANALYSES

Area	Matrix	Analyses
Municipal Wells	Water	Halogenated Volatile Organics
Source	Water	EPA 601 Halogenated Volatile Organics EPA 602 Aromatic Volatile Organics EPA 5020 Total Petroleum Hydrocarbons - Gas EPA 8015 Total Petroleum Hydrocarbons - Diesel
	Soil	EPA 8010 Halogenated Volatile Organics EPA 8020 Aromatic Volatile Organics EPA 5020 Total Petroleum Hydrocarbons - Gas EPA 8075 Total Petroleum Hydrocarbons - Diesel
Plume	Water	EPA 601 Halogenated Volatile Organics EPA 602 Aromatic Volatile Organics EPA 5020 Total Petroleum Hydrocarbons - Gas

1 and aromatic volatile organic compounds (VOCs) using EPA Methods 601/8010 and 602/8020, TPH
2 using EPA Method 5020 (headspace for gasoline), and modified EPA Method 8015 (diesel). Selected
3 samples were submitted to EPA Region IX laboratory for confirmation and verification of the
4 preliminary mobile lab analytical results. Data tables in Appendices F and G list the constituents
5 reported for both the volatile and TPH methods utilized for the project.

6 Mobile laboratory analyses were conducted to provide:

- 7 ▪ Immediate results of possible TCE and PCE soil contamination;
- 8 ▪ Better criteria for the selection of samples to go to EPA Region IX laboratories;
- 9 ▪ Field evaluation of depth and extent of soils contamination; and
- 10 ▪ Data for more accurate placement of monitoring well screen intervals, and sampling intervals of
11 subsequent well clusters.

12 **1.7.3 Data Quality Evaluation**

13 During the project planning phase, overall data quality objectives (DQOs) were developed for the
14 project. The extent of the study area, scope of the well installation, use of specific field instruments,
15 and other items related to data collection were considered in terms of the overall project goals. During
16 this process, the required analytical methods and DQOs for these methods were devised. The DQOs for
17 water and soil samples analyzed by the FASP and EPA Region IX laboratories are summarized in Tables
18 7 through 10. The definition of the analytical DQO categories is as follows:

Appendix A

Table 7

DATA QUALITY OBJECTIVES FOR WATER SAMPLES ANALYZED BY THE MOBILE LABORATORY

Analysis	Method ⁽¹⁾	Units ⁽²⁾	Targeted Detection Limit ⁽³⁾	Accuracy ⁽⁴⁾ %	Precision ⁽⁵⁾ %	Completeness %
Halogenated Volatile Organics	EPA 601	µg/L	0.5-1.0	70-125	25	85
Aromatic Volatile Organics	EPA 602	µg/L	0.5-20	70-125	25	85
Total Petroleum Hydrocarbons	EPA 5020 ⁽⁶⁾	µg/L	500	65-125	35	85

(1) Methods for analysis were obtained from EPA 1982 and LUFT 1989.

(2) Units reported in mass/volume.

(3) Derived from FASP mobile laboratory reporting limits.

(4) Derived from FASP mobile laboratory attainable control limits through analytical surrogate recovery and laboratory control samples.

(5) Derived from laboratory relative percent difference between results of field replicate samples.

(6) Headspace method (LUFT 1989). The extracts will be analyzed by GC/FID. This method is equivalent to EPA SW846 Method 3810.

Appendix A

Table 8

DATA QUALITY OBJECTIVES FOR SOIL SAMPLES ANALYZED BY THE MOBILE LABORATORY

Analysis	Method ⁽¹⁾	Units ⁽²⁾	Targeted Detection Limit ⁽³⁾	Accuracy ⁽⁴⁾ %	Precision ⁽⁵⁾ %	Completeness %
Halogenated Volatile Organics	EPA 8010	µg/Kg	20-50	60-125	40	85
Aromatic Volatile Organics	EPA 8020	µg/Kg	50	60-125	40	85
Total Petroleum Hydrocarbons	EPA 5020 ⁽⁶⁾	µg/Kg	10,000	65-125	40	85

(1) Methods for analysis were obtained from EPA 1986, 1989b; LUFT 1989.

(2) Units reported in mass/volume.

(3) Derived from FASP mobile laboratory reporting limits.

(4) Derived from FASP mobile laboratory attainable control limits through analytical surrogate recovery and laboratory QC.

(5) Derived from laboratory relative percent difference between results of field replicate samples.

(6) Headspace Method (LUFT 1989). The extracts will be analyzed by GC/FID. This method is equivalent to EPA SW846 Method 3810.

Appendix A

Table 9

DATA QUALITY OBJECTIVES FOR WATER SAMPLES ANALYZED BY THE EPA REGION IX LABORATORY

Analysis	Method ⁽¹⁾	Units ⁽²⁾	Targeted Detection Limit ⁽³⁾	Accuracy ⁽⁴⁾	Precision ⁽⁵⁾	Completeness %
Volatile Organic Analysis	CLP-SAS EPA 624-M	µg/L	1.0-2.0 ⁽⁶⁾	61-145%	15%	85
Semivolatile	CLP-RAS 3/90 SOW	µg/L	10-25	9-145%	50%	85
Pesticides/PCBs	CLP-RAS 3/90 SOW	µg/L	0.05-1.0	38-127%	30%	85
Total Petroleum Hydrocarbons	CLP-SAS EPA 8015-M	mg/L	0.05-1.0	58-126%	20%	85
Total Metals	CLP-RAS 3/90 SOW	mg/L	0.001-2.5	75-125%	20%	85
Mercury	CLP-RAS 3/90 SOW	mg/L	0.0002	75-125%	20%	85
pH	Field Measurement	pH Units	-	± 0.3 pH units	± 0.2 pH units	80
Conductivity	Field Measurement	µmho at 25°C	-	-	± 5	85
Temperature	Field Measurement	degrees (°C)	-	± 1° C	± 0.5° C	85

(1) Methods for analyses were obtained from EPA 1989b, 1990a, 1990b; LUFT 1989.

(2) Units reported in mass/volume unless otherwise indicated.

(3) Derived from laboratory reporting limits. TPH laboratory attainable limits derived from RWQCB 1990.

(4) Derived from laboratory attainable control limits through analytical surrogate or matrix spike recovery and laboratory QC.

(5) Derived from laboratory relative % difference between results of field replicate samples or through matrix duplicates.

(6) Range met by purging 5x the volume of the sample required for the analysis. Ten (10) µg/L is acceptable for acetone, 2-butanone, 4-methyl-2-pentanone, and 2-hexanone (EPA 1989b).

Appendix A

Table 10

DATA QUALITY OBJECTIVES FOR SOIL SAMPLES ANALYZED BY THE EPA REGION IX LABORATORY

Analysis	Method ⁽¹⁾	Units ⁽²⁾	Targeted Detection Limit ⁽³⁾	Accuracy ⁽⁴⁾ %	Precision ⁽⁵⁾ %	Completeness %
Volatile Organic Analysis	CLP-RAS 3/90 SOW	µg/Kg	10.0	60-172	25	85
Semivolatile Organic Analysis	CLP-RAS 3/90 SOW	µg/Kg	300-800	11-142	50	85
Pesticides/PCBs	CLP-RAS 3/90 SOW	µg/Kg	1.7-170	23-139	50	85
Metals Mercury	CLP-RAS 3/90 SOW	mg/Kg	0.01-2500 0.02	75-125 75-125	20 20	85 85

- (1) Methods for analyses were obtained from EPA 1990a and 1990b.
- (2) Units reported in mass/volume unless otherwise indicated.
- (3) Derived from laboratory reporting limits.
- (4) Derived from laboratory attainable control limits through analytical spike recovery.
- (5) Derived from laboratory relative % difference through analytical spikes.

1 **Precision**

2 Precision examines data deviation from the mean. The spread presents how different the individual
3 reported values are from the average reported values. Precision is a measure of the magnitude of errors
4 and will be expressed as the relative percent difference (RPD) or the relative standard deviation (RSD)
5 in case of two or more replicates. The lower the values, the more precise the data. These quantities
6 are defined as follows (EPA 1987):

7
$$\text{RPD (\%)} = \frac{|D1 - D2|}{(D1 + D2)/2} \times 100$$

9
$$\text{RSD (\%)} = 100(S/\bar{X})$$

10 where: D1 = First sample value
11 D2 = Second sample value (duplicate)
12 S = Standard deviation
13 \bar{X} = Mean

14 **Accuracy**

15 Accuracy measures the average or systematic error of an analytical method. This measure is defined
16 as the difference between the average of reported values and the actual value.

17 Accuracy will be expressed as the percent bias. The closer this value is to zero, the more accurate the
18 data. This quantity is defined as follows:

19
$$\text{Bias (\%)} = \frac{MC - KC}{KC} \times 100$$

21 where: KC = Known concentration of an analyte
22 MC = Measured concentration of an analyte

1 **Completeness**

2 Completeness establishes whether a sufficient amount of valid measurements were obtained. The closer
3 this value is to 100, the more complete the measurement process. This quantity will be calculated as
4 follows:

5 **Completeness (%)** = $\frac{V}{P} \times 100$
6

7 where: V = Number of valid measurements
8 P = Number of planned measurements

9 In addition to the qualitative analytical goals, the following quantitative and qualitative goals were also
10 considered:

11 **Representativeness**

12 Representativeness expresses the degree to which data accurately and precisely represent the
13 environmental condition. Following a determination of precision, a statement of representativeness will
14 be prepared noting the degree to which data represent the environment.

15 **Comparability**

16 Comparability expresses the confidence with which one set of data can be compared to another.
17 Following the determination of both precision and accuracy, a statement on comparability will be
18 prepared citing the acceptance criteria established in Sample Plan Section 3.0, Data Quality Objectives,
19 in relation to using the data sets in assessing the usefulness of the data.

20 In order to attain the DQOs established in Tables 7 through 10, CLP-Routine Analytical Services (CLP-
21 RAS) Statement of Work (SOW), methods with lower-than-standard detection limits and more rigorous
22 QA/QC were used for data generation by laboratory analysis during implementation of the remedial
23 work. The modifications of the 624 method resulted in it being a CLP-SAS analysis. DQOs are
24 developed by the EPA based upon the premise that different end-uses of data necessitate varying levels

1 of analytical data quality. The EPA defines five levels of analytical data quality, which range from field
2 screening protocols (Level I) to method-specific protocols with low detection limits and rigorous QA/QC
3 (Level V). Level II was used for mobile laboratory soil and groundwater analyses. Analytical levels
4 III and IV were used for the EPA Region IX laboratory soil and groundwater samples to confirm that
5 the remedial objectives were achieved. A summary of the analytical levels appropriate to their data uses
6 is presented in Table 11.

7 One hundred percent of all Region IX laboratory data was validated by the EPA Region IX
8 Environmental Services Assistance Team (ESAT). Low level data review was also conducted by ESAT.

9 **Region IX Laboratory Adherence to Analytical DQOs**

10 For all methods, the EPA Region IX laboratory reported data within the quantitation and detection limit
11 ranges stated in Tables 9 and 10.

12 An evaluation of the analytical surrogate or matrix spike recovery and laboratory quality control (QC)
13 matrix by the Region IX laboratory pointed to the following results:

- 14 ▪ All surrogates were within the acceptable control limits;
- 15 ▪ The laboratory QC matrix spikes for all the organic analyses were within the established control
16 limits requirement in the CLP SOW; and
- 17 ▪ All matrix spike and matrix spike duplicate samples for total metals analysis were within the
18 acceptable control limits with the exception of two aluminum, one antimony, three arsenic, three
19 lead, one iron, two selenium and one thallium recoveries. The data results for the environmental
20 samples associated with the matrix spikes are valid and usable for limited purposes only;

Appendix A

Table 11

SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

Data Uses	Data Quality Objective Level	Type of Analysis	Limitations	Data Quality
Site Characterization Evaluation of Alternatives Monitoring During Implementation	Level II	<ul style="list-style-type: none"> - Variety of organics by GC; inorganics by AA; ICP - Tentative ID; Analyte-specific - Detection limits vary from low ppm to low ppb 	<ul style="list-style-type: none"> - Tentative ID - Techniques/instruments limited mostly to volatiles, metals 	<ul style="list-style-type: none"> - Dependent upon QA/QC steps employed - Data typically reported in concentration ranges
Risk Assessment PRP Determination Site Characterization Evaluation of Alternatives Engineering Design Monitoring Design	Level III	<ul style="list-style-type: none"> - Organics/inorganics using EPA procedures 	<ul style="list-style-type: none"> - Tentative ID in some cases 	<ul style="list-style-type: none"> - Low detection limits - Data of same quality as levels IV, V
Risk Assessment PRP Determination Evaluation of Alternatives Engineering Design	Level IV	<ul style="list-style-type: none"> - HSL organics by GC/MS; Inorganics by AA, ICP - Low PPB detection limit 	<ul style="list-style-type: none"> - Tentative identification (ID) of non-HSL parameters - Some time may be required for validation of packages 	<ul style="list-style-type: none"> - Goal is data of known quality - Rigorous QA/QC

1 Field duplicates for each analyses within each matrix were collected at a frequency of one per ten
2 environmental samples collected. For each set of duplicate samples, the precision found among
3 individual constituents within samples run by the FASP mobile laboratory and the EPA Region IX
4 laboratory was calculated. Since the EPA Region IX laboratory and FASP mobile laboratory duplicate
5 data results for TPH gas and diesel and Pesticide/PCBs did not show any detections, precision values
6 for those duplicate sample sets could not be calculated. Duplicate data results for volatile organics
7 indicated that there were three detections. Precision values for these sample sets were equal to zero in
8 each case. Total metals have two sets of duplicate samples. Duplicate data results for total metals
9 showed fourteen detections of which two detections were outside the acceptable criteria of 20 percent.
0 Precision values of the remaining twelve detections range from 0.22 to 6.6 with a mean of 2.16.

