BLYMYER
ENGINEERS, INC.

October 10, 2005
BEI Job No. 203004

Mr. Barney Chan
Alameda County Environmental Health
Environmental Protection Division
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Subject: **Workplan for Remedial Investigation / Feasibility Study**
Former Fiesta Beverage Facility
966 89th Avenue
Oakland, California
ACEH Site # RO0000314

Dear Mr. Chan:

On behalf of Fiesta Beverage Company, Blymyer Engineers, Inc. is pleased to forward this workplan to conduct a Remedial Investigation / Feasibility Study (RI / FS) in the vicinity of the subject site (Figures 1 and 2). The work is being conducted in response to the letter from Alameda County Environmental Health (ACEH) dated July 6, 2005.

1.0 Background

In August 1990, one 500-gallon and one 1,000-gallon gasoline underground storage tanks (USTs) were removed from the subject site (Figure 2). Soil and groundwater were reported to be impacted from releases from one or both USTs. Overexcavation of the former UST basins occurred in January 1991. The excavations were reported to have reached approximately 15 feet by 8 feet by 14 feet deep and 12 feet by 7 feet by 14 feet deep, respectively, on January 14, 1991. Beginning in April 1991, aeration of the soil occurred onsite. In April 1993, 74.28 tons of soil were transported to the Remco recycling facility.

In June 1993, groundwater monitoring wells MW-1, MW-2, and MW-3 were installed. In general, the wells encountered black to grey to light brown clay to a depth of approximately 15 below grade surface (bgs). At 15 feet bgs, the three bores encountered a 0.5- to 2.0-foot-thick clayey sand. Below this unit a light brown to grey clay was present to a depth of 18 to 21 feet bgs. Underneath this unit, a 1- to 3-foot-thick sand was encountered in bores MW-1 and MW-2, while a clayey silt was encountered in bore MW-3. Below approximately 21 feet bgs, a green-grey or black clay was encountered to the full explored depth of 26.5 feet bgs in bore MW-1 and to 25 feet bgs in bores MW-2 and MW-3. Saturated soil was encountered below a depth of approximately 13 feet bgs (in clay overlaying the uppermost sand unit). The wells were installed with a screened interval between 10 and 25 feet bgs. Groundwater from the three wells was sampled six times between August 1993 and December 1998.

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In November 1999, after obtaining appropriate permits, AllCal Property Services, Inc. (AllCal) installed four Geoprobe® soil bores downgradient from the former location of the two USTs. The bores were installed in the public right-of-way across 89th Avenue from the subject site, in an unpaved portion of the roadway. Soil bores SB-1 and SB-2 were logged to a depth of 16 feet bgs. Silty clay was encountered to a depth of approximately 13 to 14 feet bgs. Below that depth, soil consisted of clayey silt that alternated between moist and saturated for several vertical feet. Bore SB-1 also encountered a poorly graded sand at 16 feet bgs. Hydrocarbon odors were present in both bores at a depth of approximately 6 feet bgs and green discolored soil was present at 10 feet bgs in bore SB-1. Discolored soil and gasoline odors were noted in both bores throughout the clayey silt, while brownish colored clay was present in both bores just above the silt. The groundwater interface appears to have been encountered at an approximate depth of 16 feet bgs in the sand. Sheen was noted at that depth in SB-1. Groundwater samples were obtained from bores SB-1 and SB-2 after pushing the Geoprobe® system to a total depth of 18 feet bgs. Soil bores SB-3 and SB-4 were directly pushed to a total depth of 18 feet bgs in order to obtain grab groundwater samples. Groundwater samples from bores SB-1 and SB-2 contained elevated concentrations of Total Petroleum Hydrocarbons (TPH) as gasoline, and benzene, toluene, ethylbenzene, and total xylenes (BTEX). Significantly lower concentrations of TPH as gasoline and total xylenes were encountered in the groundwater sample from soil bore SB-3, while all analytes were nondetectable in groundwater collected from soil bore SB-4. No soil samples were submitted for laboratory analysis from the four Geoprobe® bores.

After the review of the January 2001 groundwater monitoring report, the ACEH approved the application of a 7% solution of hydrogen peroxide to the wells in an attempt to remediate dissolved constituents. On March 7, 2001, the solution was applied by AllCal and on April 25, 2001, a groundwater monitoring event was conducted to determine if a reduction in dissolved constituents had occurred. Based on the analytical data, a reduction was seen in wells MW-1 and MW-2, with some reductions also seen in well MW-3. This sampling event and subsequent interpretation was complicated by the presumed mismarking of samples from wells MW-1 and MW-3. No further work at the site is known to have occurred between April 2001 and the March 2003 groundwater monitoring event.

A review of the groundwater analytical data collected prior to and after the application of a 7% solution of hydrogen peroxide (March 2001) suggest that a rebound of contaminant concentrations in groundwater appears to have occurred since that time (see Tables I, II, and III). If this assumption is correct, the data appear to indicate that the peroxide application did suppress groundwater concentrations for awhile; however, it also appears to indicate that the residual contaminant concentrations in soil are an adequate source for the continued degradation of vicinity groundwater. It is likely that the extent of soil removal from the UST basins at the time of the removal of the USTs (August 1990) and at the time of overexcavation (January 1991) was laterally limited due to the immediate proximity of the buildings to the southeast (See Tables IIB and IV).

On January 16, 2003, a new case manager, Mr. Amir Gholami, was assigned by the ACEH. On September 17, 2003, a workplan for a Geoprobe® investigation of the site was submitted to the ACEH. The intent was to attempt to determine the lateral and vertical extent of impacted soil and groundwater in order to better target the residual contamination in future remedial actions to be determined. Due to the lack of a response from the ACEH, on February 17, 2004, Blymyer Engineers issued a *Letter of Intent to Proceed: Geoprobe® Investigation.*

The *Fourth Quarter 2003 Groundwater Monitoring Event* report, dated January 6, 2004, recommended that analysis for fuel oxygenates by EPA Method 8260B be eliminated from the analytical program. It was reasoned that the data generated to date had been very consistent, and further quantification would not significantly add to the level of understanding at the site. Additionally, the concentration of methyl *tert*-butyl ether (MTBE) can be monitored using EPA Method 8021B for no additional cost and the resultant concentration of MTBE can be used as a proxy for the approximate concentration of the remaining fuel oxygenates. Based on the lack of response from the ACEH, it has been presumed that this was found reasonable and acceptable.

On March 15, 2004, Blymyer Engineers issued a letter entitled *Recommendation for Reduction of Groundwater Monitoring* that provided additional rationale for decreasing the groundwater sampling interval from quarterly to semi-annually. It argued that generation of quarterly analytical data would not significantly improve the level of understanding of impacts to the subsurface at the site, and recommended a reduction of the sampling interval to semi-annual. Based on the lack of response from the ACEH, it has been presumed that this was found reasonable and acceptable.

On December 14, 2004, Blymyer Engineers issued to the ACEH the *Report on a Geoprobe® Subsurface Investigation* which documented the installation of nine Geoprobe® soil bores at the site. The work further refined the known lateral and vertical extent of soil impacted by the petroleum release at the site. Grab groundwater samples in the upgradient and the eastern cross-gradient directions defined all petroleum compounds in groundwater to concentrations below the San Francisco Bay Regional Water Quality Control Board (RWQCB) Environmental Screening Levels (ESLs). Grab groundwater samples in the downgradient and western cross-gradient directions were unable to define most petroleum compounds to concentrations below the RWQCB ESLs. The installation of additional permanent groundwater monitoring wells was recommended as appropriate at the site in order to allow for groundwater sampling from a "repeatedly accessed location". It was reasoned that data generated from these locations will assist in determining appropriate remedial actions, and in monitoring remedial progress.

On July 6, 2005, the new case manager for the ACEH, Mr. Barney Chan, issued the letter *Fuel Leak Case RO0000314* commenting on the December 14, 2004 report. The ACEH determined that the collection of additional data is needed to progress the site towards closure. The letter requested a workplan to clear well MW-1 of several feet of sediment due to the potential for groundwater gradient biasing, requested further definition of the groundwater and soil plumes through the installation of additional wells and soil bores, requested a conduit study, and requested a Feasibility Study and Remedial Action Plan. A submittal deadline of August 8, 2005, was placed on the workplan for further plume delineation.

2.0 Scope of Work

The following sections describe the proposed scope of work for the RI / FS.

2.1 Collect additional groundwater analytical parameters from existing wells

Microbial use of petroleum hydrocarbons as a food source is affected by the concentration of a number of chemical compounds dissolved in groundwater at a site. Remediation by Natural Attenuation (RNA) monitoring parameters were established by research conducted by the Air Force Center for Environmental Excellence. The research results were used to develop a technical protocol for documenting RNA in groundwater at petroleum hydrocarbon release sites (Wiedemeier, Wilson, Kampbell, Miller and Hansen, 1995, *Technical Protocol for Implementing the Intrinsic Remediation with Long Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater, Volumes I and II*, U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas). The protocol focuses on documenting both aerobic and anaerobic degradation processes where indigenous subsurface bacteria use various dissolved electron acceptors to degrade dissolved petroleum hydrocarbons.

In order to document that this is the process which appears to have been observed at the site, Blymyer Engineers proposes to monitor groundwater for these parameters for two events. These include the field-monitored parameters dissolved oxygen (DO), Oxidation Reduction Potential (ORP), and ferrous iron. Both DO and ORP will be monitored initially, and then post-purge during each monitoring event, in each well. Purging will be conducted with a flow cell to obtain DO readings, and purging and sampling will be conducted using a low-flow pump to eliminate oxygenation of groundwater during the sampling process.

Laboratory analysis of groundwater samples will additionally be conducted for Carbon Dioxide by Standard Method 5310B; Nitrate and Sulfate by Standard Method E300.1; and Methane by Method RSK 174. The existing suite of contaminant analytes will not be otherwise changed (see Task 2.2).

2.2 Install four groundwater monitoring wells, destroy and reinstall one well

Four wells are proposed at the approximate locations indicated in Figure 2. These locations have been selected in order to help determine the extent of contaminated soil and groundwater that may require remediation. Additionally well MW-1 will be destroyed and reinstalled either in the same borehole, or immediately adjacent due to the non-repairable nature of the casing break.

- **Secure all required permits**

  Upon approval of the workplan, a drilling permit will be obtained from Alameda County Public Works, and an excavation permit will be obtained from the city of Oakland. The locations have been selected under the assumption that a traffic plan will not be required. The locations are either on private property or out of the flow of traffic.

- **Revise the site-specific health and safety plan**

  The health and safety plan will be revised in order to outline potentially hazardous work conditions and contingencies for an emergency.

- **Locate utilities and conduct conduit survey**

  Offsite utilities will be marked for location by Underground Service Alert (USA). Additionally, proposed bore locations will be marked for clearance by a private utility location service. This information will be used in part to conduct the conduit survey, which will include vicinity utilities and known groundwater monitoring wells.

- **Monitoring Well Installation**

  A drill rig will be scheduled to advance hollow-stem augers for the purpose of installing permanent groundwater monitoring wells. The initial bores will be drilled to an assumed depth of approximately 25 feet below grade surface (bgs). Soil samples will be collected at maximum 5-foot intervals using a split-spoon sampler for field screening with a PID and lithological description. The soil sample exhibiting the highest PID reading will be submitted for laboratory analysis. If no elevated PID readings are detected, the soil sample collected from the interval just above the depth that groundwater is first encountered will be submitted for laboratory analysis. All soil samples will be collected in general conformance with Blymyer's *Standard Operating Procedure No. 1, Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig* (Appendix A).

  Well MW-1 will be initially destroyed by overdrilling and the well will be either reinstalled at the same location, or an adjacent location. Should the well not be reinstalled in the same bore hole, the original bore hole will be backfilled with grout, tremied to the bottom of the bore hole.

  The soil bores will be converted to 2-inch-diameter groundwater monitoring wells using Schedule 40 PVC casing, with a 15-foot section of factory-slotted 0.010-inch screen. The screened interval of 10 to 25 feet bgs is based on the assumed confined or semi-confined condition of the shallowest water-bearing zone. The piezometric surface will be above the screened interval.

The annulus between the borehole wall and the PVC casing will be filled with filter sand from the bottom of the borehole to 1 foot above the screened interval. Two feet of bentonite pellets will then be placed in the annulus and hydrated to form a surface seal. The remaining annular space will be filled with cement grout, and a lockable expansion plug will be set in the casing, and sealed inside a lockable flush-mount well vault set in concrete over the top of the monitoring well.

The monitoring well installation will be performed in general conformance with Blymyer's *Standard Operating Procedure No. 2A, Completion of Borings as Groundwater Monitoring Wells* (Appendix A).

All soil cuttings generated during monitoring well installation will be placed in DOT-approved, 55-gallon, open-top drums, which will be labeled and left on-site for future off-site disposal.

- **Monitoring Well Development and Sampling**

The monitoring wells will be developed by removal of a minimum of six well volumes of groundwater a minimum of 72 hours after installation to allow the grout and concrete to properly set. Each well will be developed until the groundwater appears to be clear of sediment, or until a maximum of 10 well volumes of groundwater have been removed. The monitoring wells will be developed in general conformance with Blaine Tech Services' Standard Operating Procedure (Appendix A).

A groundwater sample will be obtained from each monitoring well a minimum of 72 hours after well development to allow the aquifer to recover from development. The monitoring wells will be purged until field parameters stabilize prior to sampling. Groundwater sample collection procedures will be performed in general conformance with Blaine Tech Services' *Standard Operating Procedure* (Appendix A).

All development and purge water will be placed in DOT-approved, 55-gallon, closed-top drums, which will be labeled and left on-site for future off-site disposal.

- **Soil Sample Selection**

The soil sample displaying the highest PID reading or the soil sample from the groundwater interface will be collected for laboratory analysis. One additional soil sample may be collected from selected bores (a maximum of 8 soil samples may be submitted in total).

- **Soil and Groundwater Sample Analytical Methods**

  Soil samples and groundwater samples will be submitted to a California-certified analytical laboratory for analysis of Total Petroleum Hydrocarbons as Gasoline (TPH-G) using modified EPA Method 8015; and for benzene, toluene, ethylbenzene, total xylenes (BTEX), and methyl tert-butyl ether (MTBE) by EPA Method 8021B. The analytical results will also be provided in EDF format for uploading to the state's GeoTracker database.

- **Well Surveying**

  The vertical elevation of the top-of-casing of all permanent wells will be surveyed relative to mean sea level. The horizontal position of all permanent wells will also be surveyed to conform to GeoTracker requirements. Depth to groundwater will be measured in each well using an oil-water interface probe and will be used to calculate the groundwater flow direction and gradient.

2.3 Reporting

An RI/FS report will be prepared documenting the results of the remedial investigation. The report will include a description of all field activities, including a summary of the soil and groundwater analytical results, a scaled site plan showing the monitoring well locations, groundwater gradient, selected contaminant isoconcentration maps for soil and groundwater, soil bore logs and monitoring well construction diagrams, a copy of the laboratory analytical reports, and conclusions and recommendations for additional investigatory work, if appropriate, based on the findings of the investigation. Assuming that no additional investigatory work is recommended, the report will also include a feasibility study evaluating at least three remedial alternatives for soil and groundwater based on technical and economic feasibility to achieve Tier 1 ESLs. One remedial alternative will be recommended in the feasibility study. The final RI/FS report will be submitted to the ACEH. Upon approval of the recommended remedial alternative, a Corrective Action Plan will be prepared for submittal to the ACEH.

Should you have any questions about this workplan, please call Mark Detterman at (510) 521-3773.

Sincerely,

Blymyer Engineers, Inc.

PROFESSIONAL GEOLOGIST
MARK E. DETTERMAN
No. 1788
CERTIFIED
ENGINEERING
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Ex 9/07
STATE OF CALIFORNIA

By: ______________________
Mark E. Detterman, C.E.G.
Senior Geologist

By: ______________________
Michael S. Lewis
Vice President, Technical Services

Attachments:

Table I:	Summary of Groundwater Elevation Measurements
Table II:	Summary of Groundwater Sample Hydrocarbon Analytical Results
Table IIB:	Summary of Grab Groundwater Sample Hydrocarbon Analytical Results
Table III:	Summary of Groundwater Sample Fuel Oxygenate Analytical Results
Table IV:	Summary of Soil Sample Hydrocarbon Analytical Results

Figure 1: Site Location Map
Figure 2: Site Plan

Appendix A: Blymyer Engineers' *Standard Operating Procedure No. 1, Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig*

Standard Operating Procedure No. 2A, Completion of Borings as Groundwater Monitoring Wells

Blaine Tech Services' *Standard Operating Procedures*

Table 1: Summary of Groundwater Elevation Measurements
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Well Identification	Sampling Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-1	8/6/93	18.72	8.96	9.76
	1/12/96		8.55	10.17
	4/16/96		7.65	11.07
	7/15/96		8.76	9.96
	10/16/96		9.04	9.68
	12/15/98		8.38	10.34
	1/18/01		8.49	10.23
	4/25/01		8.24	10.48
	3/17/03*		8.08	10.64
	6/23/03		8.63	10.09
	9/18/03		8.90	9.82
	12/15/03		8.15	10.57
	6/15/04		8.67	10.05
	12/15/04		7.99	10.73
	6/29/05		7.88	10.84

Table I. Summary of Groundwater Elevation Measurements
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Well Identification	Sampling Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-2	8/6/93	18.44	8.68	9.76
	1/12/96		8.24	10.2
	4/16/96		7.41	11.03
	7/15/96		8.45	9.99
	10/16/96		8.73	9.71
	12/15/98		8.05	10.39
	1/18/01		8.24	10.20
	4/25/01		7.88	10.56
	3/17/03*		7.08	11.36
	6/23/03		8.90	9.54
	9/18/03		8.61	9.83
	12/15/03		7.97	10.47
	6/15/04		8.42	10.02
	12/15/04		8.00	10.44
	6/29/05		9.51	8.93

Table II: Summary of Groundwater Elevation Measurements BEI Job No. 203004, Fiesta Beverage 966 89th Avenue, Oakland, California				
Well Identification	Sampling Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-3	8/6/93	19.01	9.07	9.94
	1/12/96		8.65	10.36
	4/16/96		7.82	11.19
	7/15/96		8.88	10.13
	10/16/96		9.16	9.85
	12/15/98		8.45	10.56
	1/18/01		8.57	10.44
	4/25/01		8.29	10.72
	3/17/03*		8.50	10.51
	6/23/03		9.05	9.96
	9/18/03		9.11	9.90
	12/15/03		8.03	10.98
	6/15/04		8.85	10.16
	12/15/04		8.84	10.17
	6/29/05		9.00	10.01

Notes: TOC = Top of casing
* = Initial data set collected under direction of Blymyer Engineers, Inc.
NM = Not measured

Elevations in feet above mean sea level

Table II: Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Date	Modified EPA Method 8015 (µg/L)	EPA Method 8020 or 8021B (µg/L)				
		TPH as Gasoline	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-1	8/6/93	**17,000**	**7.1**	**8.4**	**9.2**	**53**	NA
	1/12/96	**12,000**	**1,900**	**840**	**370**	**1,100**	NA
	4/16/96	**3,500**	**700**	**55**	**100**	**180**	NA
	7/15/96	**11,000**	**2,300**	**450**	**350**	**910**	NA
	10/16/96	**21,000**	**4,200**	**2,200**	**650**	**2,600**	NA
	12/15/98	**10,000**	**1,800**	**520**	**270**	**1,100**	<350
	1/18/01	**11,000** [a]	**2,000**	**320**	**320**	**1,100**	<120
	4/25/01	**2,100** [a, c]	**270**	**46**	**59**	**130**	<5.0
	3/17/03*	**2,200** [a]	**260**	**19**	**36**	**54**	NA [d]
	6/23/03	**6,100** [a]	**930**	**53**	**99**	**200**	NA
	9/18/03	**3,800** [a]	**660**	**13**	**24**	**34**	NA
	12/15/03	**260** [a]	**19**	**1.1**	<0.5	**1.5**	NA
	6/15/04	**5,200** [a]	**520**	**13**	**38**	**39**	<50
	12/15/04	**2,400** [a]	**370**	**8.2**	**13**	**14**	<15
	6/29/05	**5,500** [a]	**750**	**27**	**94**	**140**	<100

Table II: Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Date	Modified EPA Method 8015 (µg/L)	EPA Method 8020 or 8021B (µg/L)				
		TPH as Gasoline	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-2	8/6/93	**2,700**	**1.3**	**1.7**	**2.0**	**8.1**	NA
	1/12/96	**2,700**	**600**	**310**	**94**	**220**	NA
	4/16/96	**190**	**39**	**11**	**10**	**14**	NA
	7/15/96	**700**	**160**	**33**	**34**	**48**	NA
	10/16/96	**190**	**48**	**8.2**	**10**	**13**	NA
	12/15/98	**200**	**62**	**17**	**4.9**	**14**	**4.4** [b]
	1/18/01	**300** [a]	**74**	**26**	**7.3**	**21**	**7.3**
	4/25/01	<50 [c]	**4.5**	**2.2**	**0.57**	**1.9**	<5.0
	3/17/03*	**78** [a]	**26**	**3.3**	**1.5**	**3.5**	NA [d]
	6/23/03	**160** [a]	**51**	**1.6**	**1.2**	**1.8**	NA
	9/18/03	<50	**2.1**	<0.5	<0.5	<0.5	NA
	12/15/03	<50	**12**	<0.5	<0.5	<0.5	NA
	6/15/04	**95** [a]	**15**	**1.3**	**1.8**	**1.2**	<30
	12/15/04	<50	**11**	**0.97**	**0.57**	**0.91**	**7.8**
	6/29/05	**130**	**29**	**2.0**	**3.3**	**3.4**	**6.7**

Table II. Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Date	Modified EPA Method 8015 (μg/L)	EPA Method 8020 or 8021B (μg/L)				
		TPH as Gasoline	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-3	8/6/93	5,200	2.1	2.9	3.6	17	NA
	1/12/96	4,500	280	180	120	470	NA
	4/16/96	5,400	370	340	160	580	NA
	7/15/96	1,800	200	220	66	250	NA
	10/16/96	2,000	340	140	100	300	NA
	12/15/98	1,400	200	39	72	150	<22
	1/18/01	1,800 [a]	240	41	86	120	<10
	4/25/01	8,300 [a, c]	300	330	200	1,100	<20
	3/17/03*	2,100 [a]	240	78	10	280	NA [d]
	6/23/03	<50	2.5	0.60	0.69	1.4	NA
	9/18/03	<50	<0.5	<0.5	<0.5	<0.5	NA
	12/15/03	2,400	300	120	140	260	NA
	6/15/04	<50	1.1	<0.5	<0.5	<0.5	6.2
	12/15/04	1,600 [a]	140	83	83	230	<15
	6/29/05	230 [a]	27	6.1	7.2	15	<15
MCL		N/A	1.0	150	700	1,750	13
RWQCB RBSL Commercial / Industrial Land Use; Groundwater Not a Potential Source of Drinking Water		500	46	130	290	13	1,800

Table II, Summary of Groundwater Sample Hydrocarbon Analytical Results; continued

Notes: μg/L	=	Micrograms per liter
mg/L	=	Milligrams per liter
TPH	=	Total Petroleum Hydrocarbons
MTBE	=	Methyl *tert*-butyl ether
DO	=	Dissolved oxygen
<x	=	Less than the analytical detection limit (x)
EPA	=	Environmental Protection Agency
N/A	=	Not applicable
NA	=	Not analyzed
MCL	=	Maximum Contaminant Level
>Sol.	=	Greater than the solubility of pure product in water
RWQCB	=	Regional Water Quality Control Board
RBSL	=	Risk Based Screening Level
[a]	=	Laboratory note indicates the unmodified or weakly modified gasoline is significant.
[b]	=	Confirmed with EPA Method 8260.
[c]	=	Groundwater samples for MW-1 and MW-3 suspected to have been switched (mismarked) in field. First collection of groundwater samples after application of Hydrogen Peroxide on March 7, 2001.
[d]	=	Analysis conducted by EPA Method 8260. See Table III.
*	=	Initial data set collected under direction of Blymyer Engineers, Inc.

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the MCL.

Table IIB. Summary of Grab Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Date	Modified EPA Method 8015 (μg/L)	EPA Method 8020 (μg/L)				
		TPH as Gasoline	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
W1*	1/15/91	**25,000**	**3,100**	**2,900**	**380**	**2,800**	NA
W2*	1/15/91	**36,000**	**3,700**	**4,300**	**840**	**4,900**	NA
B-1	11/30/99	**850** [a,b]	**0.94**	**3.0**	**0.70**	**5.7**	<5.0
B-2	11/30/99	**3,200** [a,c]	**94**	**210**	**79**	**370**	<10
B-3	11/30/99	**90** [b]	<0.5	<0.5	<0.5	**0.52**	<5.0
B-4	11/30/99	<50	<0.5	<0.5	<0.5	<0.5	<5.0
GP1-W	9/27/04	**14,000** [c]	**210**	**190**	**84**	**420**	<50
GP2-W	9/27/04	**790** [c]	**28**	**59**	**25**	**110**	<10
GP3-W	9/27/04	<50	<0.5	**1.3**	<0.5	**0.53**	**8.7**
GP4-W	9/27/04	**7,200** [c]	5.0	<5	**46**	**110**	<50
GP5-W	9/27/04	**14,000** [c]	**94**	**25**	**380**	**1,300**	<50
GP6-W	9/27/04	**12,000** [c]	**99**	**60**	**320**	**1,200**	<50
GP7-W	9/27/04	<50	**1.4**	<0.5	<0.5	**0.88**	**12**
GP8-W	9/27/04	**1,300** [c]	**73**	**180**	**37**	**150**	<15
RWQCB RBSL Commercial / Industrial Land Use; Groundwater Not a Potential Source of Drinking Water		500	46	290	130	13	1,800

Table IIB, Summary of Grab Groundwater Sample Hydrocarbon Analytical Results, cont.

Notes: $\mu g/L$	=	Micrograms per liter
TPH	=	Total Petroleum Hydrocarbons
MTBE	=	Methyl *tert*-butyl ether
NA	=	Not analyzed
<x	=	Less than the analytical detection limit (x)
EPA	=	Environmental Protection Agency
*	=	Pit water collected at a depth of 14 feet below grade surface.
[a]	=	Laboratory note indicates that heavier gasoline range compounds are significant (aged gasoline?).
[b]	=	Laboratory note indicates no recognizable pattern.
[c]	=	Laboratory note indicates unmodified or weakly modified gasoline is significant.

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the RWQCB RBSL value.

Table III: Summary of Groundwater Sample Fuel Oxygenate Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Date	EPA Method 8260B				
		DIPE (μg/L)	ETBE (μg/L)	MTBE (μg/L)	TAME (μg/L)	TBA (μg/L)
MW-1	3/17/03	<0.50	<0.50	**10**	**8.3**	<5.0
	6/23/03	<2.5	<2.5	**8.0**	**6.4**	<25
	9/18/03	<2.5	<2.5	**8.5**	**5.3**	<25
	12/15/03[1]	<0.5	<0.5	**12**	**9.0**	<5.0
MW-2	3/17/03	<0.50	<0.50	**13**	**2.1**	**6.0**
	6/23/03	<0.50	<0.50	**11**	**4.5**	<5.0
	9/18/03	<2.5	<2.5	**5.0**	**0.74**	<25
	12/15/03[1]	<0.5	<0.5	**13**	**3.2**	**5.2**
MW-3	3/17/03	<0.50	<0.50	**10**	**4.3**	**8.6**
	6/23/03	<0.50	<0.50	**5.6**	**2.6**	<5.0
	9/18/03	<2.5	<2.5	**10**	**3.6**	<25
	12/15/03[1]	<0.5	<0.5	**13**	**2.7**	<5.0

Notes:
DIPE = Di-isopropyl ether
ETBE = Ethyl *tert*-Butyl ether
MTBE = Methyl *tert*-butyl ether
TAME = *tert*-Amyl methyl ether
TBA = *tert*-Butyl alcohol
μg/L = Micrograms per liter
[1] = After this date, fuel oxygenates were monitored using MTBE detected by EPA Method 8020B, as a proxy for the approximate concentration of the remaining fuel oxygenates.

Table IV. Summary of Soil Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Depth (ft)	Date	Modified EPA Method 8015 (mg/Kg)	EPA Method 8020 (mg/Kg)				
			TPH as Gas	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
1	9*	8/24/90	**350**	**3.5**	**15**	**4.5**	**28**	NA
2	9*	8/24/90	**4,900**	**59**	**260**	**100**	**500**	NA
3	9*	8/24/90	**780**	**13**	**41**	**13**	**67**	NA
4	9*	8/24/90	**810**	**16**	**52**	**17**	**87**	NA
Composite 1 5A - 5D	N/A	8/24/90	**1,000**	**0.16**	**1.8**	**0.57**	**22**	NA
Composite 2 6A - 6D	N/A	8/24/90	**10**	**0.0071**	**0.032**	**0.037**	**1.1**	NA
Composite 3 7A - 7D	N/A	8/24/90	**440**	**0.10**	**0.59**	**1.7**	**13**	NA
S1	14**	1/15/91	<0.5	<0.005	**0.0068**	<0.005	**0.0077**	NA
S2	14**	1/15/91	**2.2**	**0.081**	**0.013**	<0.005	**0.0092**	NA
MW-1	6.0	6/24/93	**43**	**0.900**	**0.710**	**0.700**	**3.80**	NA
MW-1	11.0	6/24/93	**60**	**2.80**	**2.30**	**3.50**	**10**	NA
MW-2	6.0	6/24/93	**260**	**7.9**	**30**	**6.30**	**49**	NA
MW-2	11.0	6/24/93	**11**	**0.097**	**0.340**	**0.440**	**1.60**	NA
MW-3	6.0	6/24/93	**5.0**	**0.150**	**0.160**	**0.180**	**0.480**	NA
MW-3	11.0	6/24/93	**22**	**0.290**	**2.20**	**0.290**	**5.60**	NA
GP1-6	6.0	9/27/04	**2.1** [c]	**0.027**	**0.0090**	<0.005	<0.005	<5.0
GP1-15.5	15.5	9/27/04	**23** [d]	**0.0056**	<0.005	<0.005	**0.070**	<5.0
GP2-11.5	11.5	9/27/04	**140** [c]	**1.4**	**2.0**	**2.3**	**6.4**	<0.50

Table IV: Summary of Soil Sample Hydrocarbon Analytical Results
BEI Job No. 203004, Fiesta Beverage
966 89th Avenue, Oakland, California

Sample ID	Depth (ft)	Date	Modified EPA Method 8015 (mg/Kg)	EPA Method 8020 (mg/Kg)				
			TPH as Gas	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
GP3-14.5	14.5	9/27/04	<1.0	<0.005	<0.005	<0.005	<0.005	<5.0
GP4-11.5	11.5	9/27/04	**310** [c]	**0.28**	**0.40**	**1.4**	**2.1**	<1.0
GP5-11	11.0	9/27/04	**540** [c]	**1.1**	**0.22**	**8.3**	**12**	<0.50
GP5-12.5	12.5	9/27/04	**23** [c]	**0.13**	**0.030**	**0.24**	**0.62**	<5.0
GP6-6	6.0	9/27/04	**200** [c]	**0.63**	**0.83**	**3.3**	**12**	<1.0
GP6-11.5	11.5	9/27/04	**390** [c]	**0.63**	**0.56**	**4.5**	**18**	<1.0
GP7-2.5	2.5	9/27/04	**2.7** [c]	**0.028**	<0.005	<0.005	**0.018**	<5.0
GP7-11.5	11.5	9/27/04	<1.0	<0.005	<0.005	<0.005	<0.005	<5.0
GP8-6.5	6.5	9/27/04	**170** [c]	**1.8**	**2.5**	**3.2**	**10**	<0.50
GP8-11.5	11.5	9/27/04	**32** [c]	**0.27**	**1.1**	**0.44**	**2.2**	<0.50
GP9-11.5	11.5	9/27/04	**120** [c]	**0.2**	**0.32**	**1.3**	**5.3**	<0.50
GP9-15.5	15.5	9/27/04	**40** [d]	**0.011**	**0.037**	**0.066**	**0.30**	<5.0
RWQCB RBSL Commercial / Industrial Land Use; **Surface Soil**; Groundwater Not a Potential Source of Drinking Water			400	0.39	8.4	24	1.0	1.0

Table IV, Summary of Soil Sample Hydrocarbon Analytical Results (cont.)

Notes:

ft	=	feet
mg/Kg	=	Milligrams per kilogram
TPH	=	Total Petroleum Hydrocarbons
MTBE	=	Methyl *tert*-butyl ether
NA	=	Not analyzed
<x	=	Less than the analytical detection limit (x)
EPA	=	Environmental Protection Agency
*	=	Assumed to be bottom samples.
**	=	Bottom samples (per Tank Protect Engineering *Preliminary Site Assessment Report*, dated December 15, 1993).
[a]	=	Laboratory note indicates the result is a hydrocarbon within the diesel range but that it appears to be the less volatile constituents of gasoline.
[b]	=	Also detected "High Point Hydrocarbons" calculated as oil at 300 mg/kg, and Oil and Grease at 80 mg/kg.
[c]	=	Laboratory note indicates unmodified or weakly modified gasoline is significant.
[d]	=	Laboratory note indicates no recognizable pattern.

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the RWQCB RBSL value.

UNITED STATES GEOLOGICAL SURVEY 7.5' QUADS. "OAKLAND EAST, CA & SAN LEANDRO, CA", BOTH PHOTOREVISED 1981.

QUADRANGLE LOCATION

BLYMYER ENGINEERS, INC.

BEI JOB NO. 203004 | DATE 3-19-03

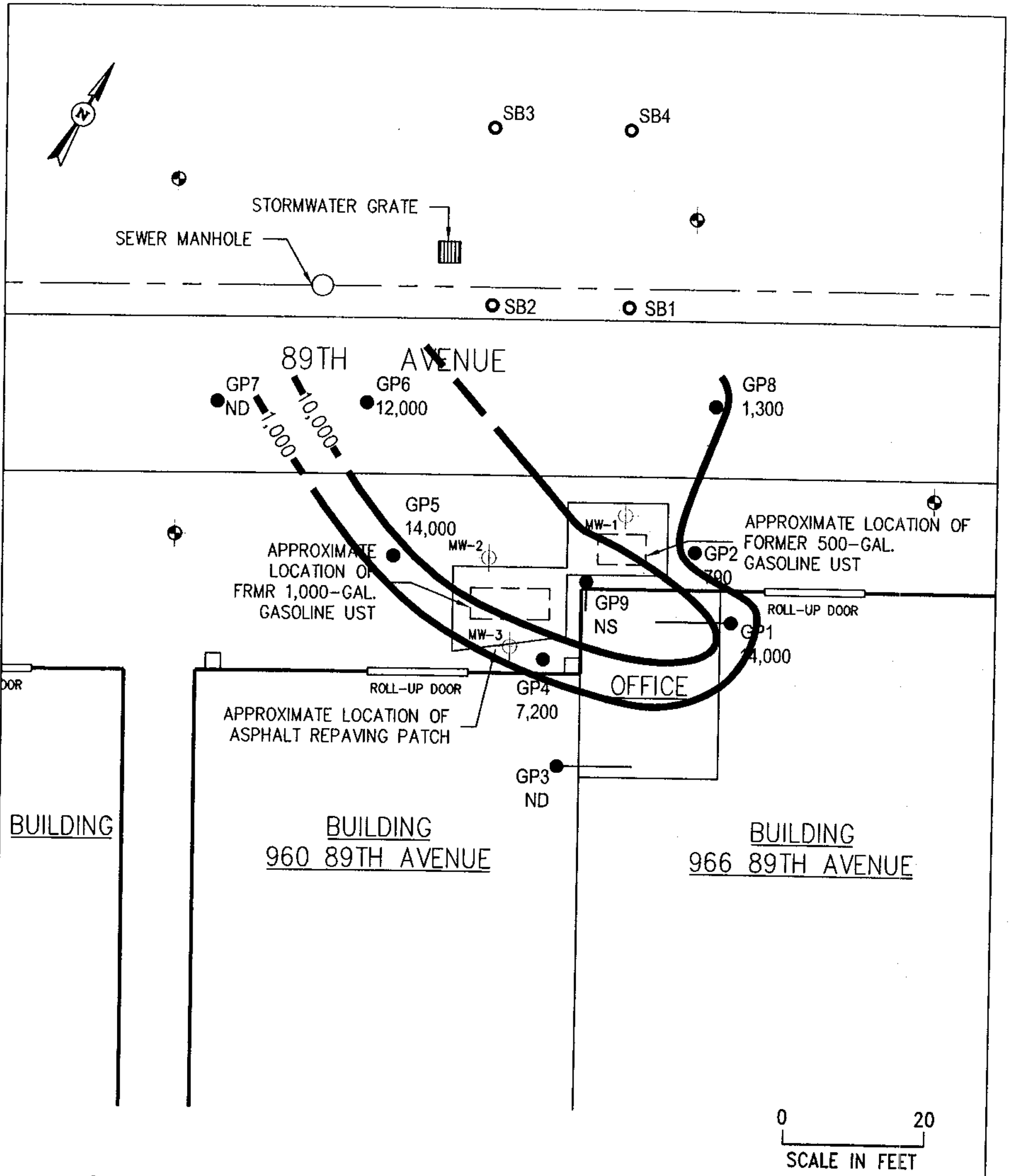
0 1000 2000
SCALE IN FEET

N

SITE LOCATION MAP

FORMER FIESTA BEVERAGE
966 89TH AVE.
OAKLAND, CA

FIGURE 1



REFERENCE: "ALLCAL ENVIRONMENTAL GROUNDWATER GRADIENT MAP 08-23-01"

BLYMYER ENGINEERS, INC.

BEI JOB NO.	DATE
203004	10-10-05

LEGEND

- UST — UNDERGROUND STORAGE TANK
- NS — NOT SAMPLED
- ND — NOT DETECTED
- GROUNDWATER MONITORING WELL
- SB4 — SOIL BORE (INSTALLED BY ALLCAL)
- GP1 — SOIL BORE
- SOIL BORE-ANGLED
- TPH GROUNDWATER ISO CONTOUR (μG/L)
- PROPOSED GROUNDWATER MONITORING WELL

GRAB GROUNDWATER TPH ISOCONCENTRATION MAP

FORMER FIESTA BEVERAGE
966 89TH AVE.
OAKLAND, CA

FIGURE
2

L:\Acad\2003dwg\203004\203004fig2h.dwg October 11, 2005 - 9:44AM lwittstock

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 1

Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig

Revision No. 1

Approved By:

Michael Lewis
Quality Assurance/Quality Control Officer
Blymyer Engineers, Inc.

5/31/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for drilling with the use of hollow-stem augers, soil sampling with the use of split-spoon samplers, and grab groundwater sampling through an open borehole. Drilling activities covered by this SOP may be conducted to obtain soil and grab groundwater samples or to create a borehole within which a well may be constructed. Soil samples may be obtained to log subsurface materials, to collect samples for chemical characterization, or to collect samples for physical parameter characterization.

The soil sampling techniques described in this SOP are generally suitable for chemical characterization and physical classification tests; because a driven split-spoon sampler is employed, the resulting soil samples should generally be considered "disturbed" with respect to physical structure and may not be suitable for measuring sensitive physical parameters, such as strength and compressibility. The augering techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the auger flights, a relatively small annulus of remolded soil surrounding the outside diameter of the auger flights, and limited capability for cross-contamination between subsurface strata as the leading flights of the augers pass from contaminated strata to uncontaminated underlying strata. However, should conditions require strict measures to help prevent cross-contamination or maintain the integrity of an aquitard, consideration should be given to augmenting the procedures of this SOP, for example, by using pre-drilled and grouted isolation casing.

The procedures for hollow-stem auger drilling and split-spoon soil sampling generally consist of initial decontamination, advancement of the augers, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon and continued augering and sampling until the total depth of the borehole is reached. Withdrawal of the augers upon reaching the total depth requires completion of the borehole by grouting, by constructing a well, or other measures; well construction is not covered in this SOP.

2.0 Equipment and Materials

- Drill rig, drill rods, hollow-stem augers, and drive-weight assembly (for driving the split-spoon sampler) should conform to ASTM D 1586-Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) hollow-stem augers may exceed 6.5 inches inside diameter as may be necessary for installing 4-inch diameter well casing, (2) hollow-stem augers should have a center bit assembly (end plug), (3) alternative drive-weight assemblies or downhole hammers are acceptable as long as the type, weight, and equivalent free fall are noted on the boring log.

- Split-spoon sampler should conform to ASTM D 1586-Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) split-spoon should be fitted with liners for collection of chemical characterization samples, and (2) allowable split-spoon diameters include nominal 1.5-inch inside diameter by nominal 2-inch outside diameter (Standard Penetration Test split-spoon), nominal 2-inch inside diameter by nominal 2.5-inch outside diameter (California Modified split-spoon), or nominal 2-1/2-inch inside diameter by nominal 3-inch outside diameter (Dames & Moore split-spoon). The split-spoon type and length of the split barrel portion of the sampler should be noted on the boring log, as should the use of a sample catcher if employed.

- Liners should be 3- to 6-inch length, fitted with plastic end caps, brass or stainless steel, with a nominal diameter corresponding to that of the inside diameter of the split-spoon sampler. The boring log should note whether brass or stainless steel liners were used.

- Teflon® sheets, approximate 6-mil thickness, precut to a diameter or width of the liner diameter plus approximately 1 inch.

- Plastic end caps.

- Adhesiveless silicone tape.

- Disposable polyethylene bailer.

- Type I/Type II Portland cement.

- Groundwater sample containers (laboratory provided only).

- Kimwipes®, certified clean silica sand, or deionized water (for blank sample preparation).

- Sample labels, boring log forms, chain-of-custody forms, drum labels, Drum Inventory Sheet, and field notebook.

- Ziploc® plastic bags of size to accommodate a liner.

- Stainless steel spatula and knife.

- Cooler with ice or dry ice (do not use blue ice) and packing material.

- Field organic vapor monitor. The make, model, and calibration information for the field organic vapor monitor (including compound and concentration of calibration gas) should be noted on the boring log.

- Pressure washer or steam cleaner.
- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of hollow-stem augers, drill rod, and end plug.
- Buckets and bristle brushes for decontamination of liners, split-spoon sampler, and other small gear.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- Distilled water.
- Heavy plastic sheeting such as Visqueen.
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H, if required.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 Typical Procedures

The following typical procedures are intended to cover the majority of drilling and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected subsurface conditions. Deviations from the following typical procedures may be expected and should be noted on the boring log.

1. Investigate location of the proposed boreholes for buried utilities and obstructions. At least 48 hours before drilling, contact known or suspected utility services individually or through collective services such as "Underground Service Alert."

2. Decontaminate drill rig, drill rods, hollow-stem augers, split-spoon sampler and other drilling equipment immediately prior to mobilization to the site.

3. Calibrate field organic vapor monitor equipment in accordance with the manufacturer's specifications. Note performance of the calibration in the geologist's field notebook.

4. Conduct "tail-gate" meeting and secure the work area in accordance with the Site Safety Plan.

5. Core concrete, if required.

6. Using hand-augering device, hand auger to a depth of 5 feet, if feasible, to clear underground utilities and structures not located by a utility service or on drawings. As appropriate, retain private buried utility location services or geophysical investigation services to search for buried utilities and obstructions. During initial advancement of each borehole, drill cautiously and have the driller pay particular attention to the "feel" of drilling conditions. The suspected presence of an obstruction, buried pipeline or cable, utility trench backfill, or similar may be cause for suspension of drilling, subject to further investigation.

7. Advance hollow-stem auger, fitted with end plug, to the desired sampling depth. Note depth interval, augering conditions, and driller's comments on boring log. Samples should be taken at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.

8. Remove drill rod and the end plug from the hollow-stem auger and note presence of water mark on drill rod, if any. If below the groundwater table in clean sand, allow water level in hollow-stem auger to equilibrate prior to removing end plug and remove plug slowly so as to minimize suction at the base of the plug. Also, monitor the top of the hollow-stem auger using field organic vapor monitor, as appropriate. In situations where heaving sand occurs, the use of a clean, inert knock-out plate may be employed, if necessary, to set wells. Also, clean water may be introduced into the hollow-stem auger to create a positive head pressure to exceed the hydrostatic pressure of the heaving sand formation.

9. Decontaminate split-spoon sampler, liners, spatulas and knives, and other equipment that may directly contact the chemical characterization sample. Fit the split-spoon sampler with liners and attach to drill rod.

10. Lower split-spoon sampler through hollow-stem of auger until sampler is resting on soil. Note in field notebook discrepancy between elevation of tip of sampler and leading edge of augers, if any. If more than 6 inches of slough exists inside the hollow-stem augers,

consider the conditions unsuitable and re-advance the hollow-stem augers and end plug to a new sampling depth.

11. Drive and recover split-spoon sampler according to the requirements of ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Record depth interval, hammer blows for each 6 inches, and sample recovery on boring log (copy attached). Monitor the recovered split-spoon sampler with the field organic vapor monitor, as appropriate.

12. Remove either bottom-most or second-from-bottom liner (or both) from split-spoon sampler for purposes of chemical characterization and physical parameter testing. Observe soil at each end of liner(s) for purposes of completing sample description. Place Teflon® sheet at each end of liner, cover with plastic caps, and tape plastic caps with adhesiveless silicone tape (do not use electrical or duct tape) to further minimize potential loss of moisture or volatile compounds. Label liner(s) and place in Ziploc® bag on ice or dry ice inside cooler.

13. Extrude soil from remaining liner(s) and subsample representative 1-inch cube (approximate dimensions). Place subsample in Ziploc® bag and seal. Allow bag to equilibrate at ambient conditions for approximately 5 minutes and screen for organic vapors by inserting the probe of the field organic vapor monitor into the bag. Record depth interval, observed sample reading, and ambient (background) reading on the boring log. Discard bag and sample after use in the solid waste stockpile.

14. Classify soil sample in approximate accordance with ASTM D 2488-Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) and in accordance with the Unified Soil Classification System (USCS). Description should include moisture content, color, textural information, group symbol, group name, and odor. Optional descriptions, especially if classification is performed with protective gloves, include particle angularity and shape, clast composition, plasticity, dilatancy, dry strength, toughness, and reaction with HC1. Add notes on geologic structure of sample, as appropriate. Record depth interval, field organic vapor monitor reading, USCS classification, and other notes on the boring log.

15. Repeat steps 7 through 14 until total depth of borehole is reached.

16. If grab groundwater sample is to be collected, slowly lower bailer through the open borehole or partially retracted hollow-stem augers to minimize agitation and aeration of the sampled water. Transfer the grab groundwater sample into sample container(s).

Label sample container(s), place packing materials around containers, and place on ice or dry ice inside cooler.

17. After augers are removed, complete borehole according to the requirements specified elsewhere or by abandonment in accordance with section 8.0.

18. Decontaminate hollow-stem augers, drill rod, and end plug between boreholes and after finishing last borehole prior to drill rig leaving site.

19. Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.

20. Containerize decontamination liquids in 17H steel drums. Affix completed "Caution - Pending Analysis" labels to the drums.

21. Store bore cuttings on and cover with heavy plastic sheeting. If required by local regulations or due to site constraints, store bore cuttings in 17H steel drums. Affix completed "Caution - Analysis Pending" labels to drums.

22. Complete Drum Inventory Sheet (copy attached).

23. Complete pertinent portion of the chain-of-custody form and enter descriptions of field work performed in the field notebook.

4.0 Quality Assurance and Quality Control (QA/QC)

Optional quality control sampling consists of sequential replicates, collected at an approximate frequency of one sequential replicate for every 10 collected soil samples. Sequential replicates are collected by packaging two adjacent liners of soil from a selected split-spoon drive. Each sample is labeled according to normal requirements. The replicate samples obtained in such a manner are suitable for assessing the reproducibility of both chemical and physical parameters. Interpretations of data reproducibility should recognize the potential for significant changes in soil type, even over 6-inch intervals. Accordingly, sequential replicates do not supply the same information as normally encountered in duplicate or split samples. Duplicate or split samples are better represented by the laboratory performing replicate analyses on adjacent subsamples of soil from the same liner.

Optional quality control samples may be collected to check for cross-contamination using field blanks. Field blanks may be prepared by (1) wipe sampling decontaminated liners and split-spoon with Kimwipes®, (2) pouring clean silica sand into a decontaminated split-spoon sampler that has been fitted with liners, or (3) pouring deionized water over the decontaminated liners and split-spoon sampler and collecting the water that contacts the sampling implements for aqueous analysis. Field blanks may be prepared at the discretion of the field staff given reasonable doubt regarding the efficacy of the decontamination procedures.

The comparability of the field soil classification may be checked by conducting laboratory classification tests. Requests for laboratory testing verification of the field classification should be left to the discretion of the field staff.

Field decisions that may also affect the quality of collected data include the frequency of sampling and the thoroughness of documentation. Subject to reasonable limitations of budget and schedule, the completeness, comparability, and representativeness of data obtained using this SOP will be enhanced by decreasing the sampling interval (including collecting continuous samples with depth) and increasing the level of detail for sample classification and description of drilling conditions. More frequent sampling and more detailed documentation may be appropriate in zones of chemical concentration or in areas of critical geology (for example, zones of changing strata or cross-correlation of confining strata).

As required, rinse or wipe samples may be collected from the sampling equipment before the initial sampling is conducted to establish a baseline level of contamination present on the sampling equipment. Rinse or wipe samples may also be collected at intervals of decontamination wash and rinse events or after the final decontamination wash and rinse event.

5.0 Documentation

Observations, measurements, and other documentation of the drilling and soil sampling effort should be recorded on the following:

- Field notebook
- Boring log
- Sample label
- Chain-of-custody form

Documentation should include any deviations from this SOP, notations of unusual or unexpected conditions, and documentation of the containerization and disposal of investigation-derived waste. Information to be documented on the sample label and boring log is listed below.

5.1 Sample Label

- Project name and project number
- Borehole or well number
- Sample depth interval (feet below ground surface), record the depth interval using notation similar to "19.2-19.7;" generally do not record just one depth "19.2" because of uncertainty regarding the location such depth corresponds to (midpoint, top, etc.)
- Sample date and sample time
- Name of on-site geologist
- Optional designation of orientation of sample within the subsurface, for example, an arrow with "up" or "top" designated

5.2 Boring Log

- Project name, project number, and name of on-site geologist
- Borehole number
- Description of borehole location, including taped or paced measurements to noticeable topographic features (a location sketch should be considered)
- Date and time drilling started and completed
- Name of drilling company and name of drilling supervisor, optional names and responsibilities of driller's helpers
- Name of manufacturer and model number of drill rig

- Inside and outside diameter of the auger flights of the hollow-stem augers, type and size of sampler, optional description of type of bit on end plug and leading edge of auger, optional description of the size of drill rod

- USCS classification

- Number of blow counts, sampling interval, and total depth of borehole.

- Depth at which groundwater was first encountered with the notation "initial" and any other noted changes in groundwater movement or stabilized water level.

- Field organic vapor monitor readings

- Method of boring completion

- Other notations and recordings described previously in section 2.0, Equipment and Materials, and section 3.0, Typical Procedures

6.0 Decontamination

Prior to entering the site, the drill rig and appurtenant items (drill rod, hollow-stem augers, end plug, split-spoon sampler, shovels, troughs and buckets, driller's stand, etc.) should be decontaminated by steam cleaning or pressure washing. Between each borehole, appurtenant items that contacted downhole soil (essentially all appurtenant items including drill rod, hollow-stem augers, end plug, split-spoon sampler, shovels, troughs and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. The drill rig should be steam cleaned or pressured washed as a final decontamination event. On-site decontamination should be conducted within the confines of a trough or lined pit to temporarily contain the wastewater. Between each borehole and prior to demobilization, the trough or lined pit should be decontaminated by steam cleaning or pressure washing. If a rack or other support is used to suspend appurtenant items over the trough or lined pit during decontamination, only the rack or other support needs to be decontaminated between boreholes.

Prior to collection of each sample, the split-spoon sampler, liners, sample catcher, spatulas and knives, and other equipment or materials that may directly contact the sample should be decontaminated. Decontamination for these items should consist of a soap wash (Alconox®, Liquinox®, or other organic-free, low-residue soap), followed by a clean water rinse. If testing for metals, a final rinse of deionized water should be conducted. Wastewater should be temporarily contained.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before installation of each borehole is begun, fresh decontamination solutions should be prepared. Decontaminated equipment should be kept off of the ground surface. Cleaned equipment should be placed on top of plastic sheeting, which is replaced after completion of each borehole or on storage racks.

More rigorous decontamination procedures may be employed if necessary to meet sampling or QA/QC requirements.

7.0 Investigation-Derived Waste

Wastes resulting from the activities of this SOP may include soil cuttings, excess soil samples, decontamination liquids, and miscellaneous waste (paper, plastic, gloves, bags, etc.).

Solid waste from each borehole should be placed on and covered with heavy plastic sheeting unless required to be containerized in 17H steel drums. Solids from multiple boreholes may be combined within a single stockpile if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the solids are similarly uncontaminated or similarly contaminated. Given sufficient space and reasonable doubt, separate stockpiles should be used for solid waste from each borehole.

Decontamination liquids for each borehole should be placed in individual 17H steel drums with completed "Caution - Analysis Pending" labels affixed. Liquids from multiple boreholes may be combined, subject to the same limitations as solids.

8.0 Borehole Abandonment

Each borehole that is not to be completed as a monitoring well should be completely filled with a neat cement (5.5 gallons of water in proportion to one 94-pound bag of Type I/Type II Portland cement, ASTM C-150) from the bottom of the bore to grade surface. Water used to hydrate cement should be free of contaminants and organic material. Bentonite may be added to reduce shrinkage and improve fluidity. Add 3 to 5 pounds of bentonite with 6.5 gallons of water and one 94-pound bag of Type I/Type II Portland cement. The water and bentonite should be mixed first before adding the cement. The borehole should be filled from the bottom first to grade surface. A tremie pipe should be used in small diameter boreholes or in formations prone to bridging or collapse. The tremie pipe should be lifted as the cement grout is poured, but should never be lifted above the surface of the neat cement. In boreholes deeper than 50 feet, the neat cement may need to be applied with pressure.

9.0 References

Aller, L., Bennett T.W., Hackett G., Petty R.J., Lehr J.H., Sedoris H., and Nielson D.M., 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH, 1989.

American Society for Testing and Materials, 1992. ASTM Standards On Ground Water and Vadose Zone Investigations. ASTM, Philadelphia, PA, 1992.

Driscoll, F.G., 1986. Groundwater and Wells. Johnson Filtration Systems Inc., St. Paul, MN, 1986.

Neilson, D.M., 1991. Practical Handbook of Ground-Water Monitoring. Lewis Publishers, Chelsea, MI, 1991.

United States Environmental Protection Agency, 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document. U.S. EPA, 1986.

BLYMYER
ENGINEERS, INC.

BORING & WELL CONSTRUCTION LOG:

Job No.:
Client:
Site:

Date Drilled:
Sample Container:

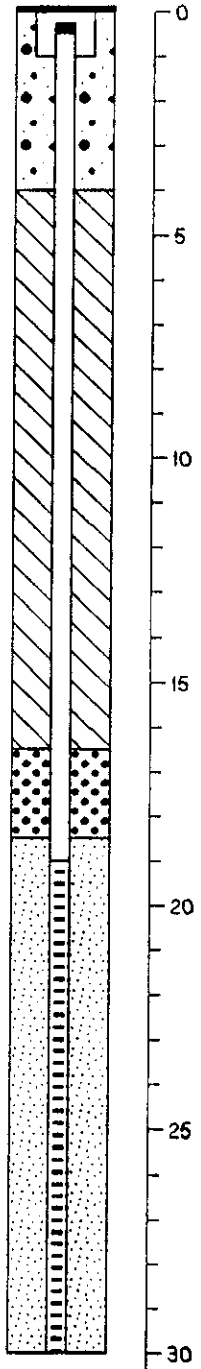
Driller:
Drilling Contractor:
Logged By:
Drilling Equipment:
Bore Diameter:
Total Depth: Ft.

Well Completion Depth: '
Component Size/Type — Depths in Feet From / To

Surface Completion:
Blank Casing:
Slotted Casing:
Filter Pack:
Seal:
Annular Seal:
Surface Seal:
Bottom Seal:

Initial Water Level: ▽
Stabilized water level: ▼

Depth (ft)	Blows/6 In.	P.I.D. (ppm)	Samples	DESCRIPTION	Unified Soil Classification	Graphic Log	Water Depth
0							
5							
10							
15							
20							
25							
30							



(continued on next page)

BLYMYER ENGINEERS DRUM INVENTORY FORM

Number of Drums	Date Generated	Person on-site when generated	Soil or Groundwater	Contents (Cuttings, Purge Water, Development Water, Decon Water, PPE)	% Full	Bore or Monitoring Well ID	Do Lab Results Exist for Contents?

Date Client Informed? ____________________ All drums labeled? ____________________

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 2A

Completion of Borings as Groundwater Monitoring Wells

Revision No. 1

Approved By:

Michael Lewis
Quality Assurance/Quality Control Officer
Blymyer Engineers, Inc.

6/22/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for installation of a groundwater monitoring well within an existing borehole. The well construction techniques discussed in this SOP are generally suitable for construction of wells that are screened in one groundwater zone and that will be used for water quality sampling and/or observations of groundwater elevation (piezometers). Typically, 2- or 4-inch-diameter wells with total depths less than 80 feet will be installed using this SOP. Large-diameter or deeper wells may require modification of the methods described herein. Discussion of specific well casing and screen material is beyond the scope of this SOP, and well casing and screen material should be selected on a site-specific basis. The permitting activities of this SOP apply in California. Different permits are required in other locations.

The procedures for construction of wells generally consist of well permitting, well design, decontamination of well casing and screen, simultaneous assembly and lowering of casing and screen into the borehole, placement of the filter pack around the screen, installation of a bentonite seal above the filter pack, sealing of the remaining annular space with grout, and surface completion.

2.0 Equipment and Materials

- Pressure washer or steam cleaner.
- Equipment for mixing grout.
- Clean water.
- Hand tools (pipe wrenches, chain wrenches, pipe vise, shovels, rubber mallet, etc.).
- Tape measure long enough to reach the bottom of the boring.
- Well casing, screen, bottom plug, and well cap using threaded, flush-joints. Use Schedule 40 PVC unless noted otherwise. Well screen shall be factory slotted.
- Stainless steel machine screws.
- Centralizers (generally not required).

- Buckets and bristle brushes for decontamination.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- Tremie pipe (1.5-inch diameter).
- Filter pack material (typically clean sand of specified gradation).
- Bentonite pellets for seal above filter pack, unaltered sodium bentonite.
- Type I or Type II Portland cement for grout.
- Bentonite powder (for grout only).
- Locking well cap with lock.
- Emco Wheaton A721 Monitoring Well manhole traffic cover (or equivalent).
- Steel, 55-gallon drums that meet the specification of DOT 17H.
- Drum labels, Boring and Well Construction Log, Drum Inventory Sheet, DWR 188 (Water Well Drillers Report), and field notebook.
- Calculator.

Site-specific conditions may require other specialized equipment.

3.0 Typical Procedures

The following procedures apply to most well installations. However, normal field practice requires re-evaluation and modification of these procedures upon encountering unexpected situations during well construction. Deviations from the following procedures may occur and should be documented.

1. Determine local jurisdiction charged with regulation of wells and apply for required local permits or prepare required workplan. Local jurisdictions may include county, water district, or city. Determine special design considerations (such as minimum length of grout seal) and inspection requirements (such as witnessing the placement of the grout

seal).

2. Well design begins with the conception of the purpose for the well, and should include consideration of the analytes of interest, anticipated subsurface conditions at the intended well location, and the actual subsurface soil conditions encountered during drilling and recorded on the Boring and Well Construction Log (copy attached).

3. Prior to installation in the borehole, well casing and screen should be decontaminated and inspected. If not certified clean by the manufacturer and delivered to the site in a protective casing, decontaminate well casing and screen and all fittings prior to insertion into the borehole.

4. Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.

5. Assembly of the well screen and blank casing is accomplished simultaneously with insertion into the borehole. Initially, a bottom plug is screwed onto the bottom of the screen (or, if the bottom of the screen is cut, the plug is attached with stainless steel machine screws) and the screen is lowered into the borehole. The next length of casing (screen or blank depending on the specific well design) is attached and the process is repeated until the well extends from the bottom of the borehole to the ground surface. Various types of mechanical clamps are used to prevent dropping of the well screen into the well during assembly. It is useful to leave surplus blank casing extending above grade at this point to facilitate subsequent construction activities. Attached are Blymyer Engineers, Inc.'s Monitoring Well Construction Specifications for Unconfined Water-Bearing Zone and Monitoring Well Construction Specifications for Confined Water-Bearing Zone to be used as references once the hydraulic characteristics of the aquifer have been determined. The well casing and screen should be installed as straight vertically as possible. Centralizers should be used if necessary to center the casing in the borehole.

   Measure the length of well screen and blank casing inserted into the borehole and record the quantities on the Boring and Well Construction Log, a copy of which is attached. The total length of well screen and casing should be confirmed by taping. Cap the well casing temporarily so that no foreign materials may enter the well during installation.

6. Install the filter pack by pouring filter pack material into the annulus between the casing and borehole. Unless impractical due to site conditions or otherwise delineated in a Workplan, Quality Assurance Project Plan, or Sampling Plan, in an unconfined water-

bearing zone, install filter pack from an elevation approximately 6 inches beneath the elevation of the bottom plug of the well casing to approximately 2 feet above the top of the screened interval. In a confined water-bearing zone, install the filter pack from an elevation approximately 6 inches beneath the elevation of the bottom plug of the well casing to the approximate bottom of the confining layer which should correspond to the top of the screen interval.

If augers or drill casing remain in the ground during well construction, the annulus between the augers and the casing may be used as a tremie pipe. If the well is constructed in an open borehole that exceeds 20 feet of depth or is below the groundwater table, then the filter pack should be placed using a tremie pipe. The filter pack should be poured slowly into the borehole and the depth to the top of the filter pack should be tagged periodically with a tape. Adequate time should be allowed for the filter pack material to settle through standing water prior to tagging or the tape may be lost by burial. Tagging may be time consuming but provides reasonable precaution against filter pack bridging during installation.

If augers are being used as a tremie pipe, they should be withdrawn as the filter pack is placed. During placement, the elevation of the tip of the augers or temporary casing should be kept slightly above the top of the filter pack (but no more than 5 feet above the top of the filter pack). Minimizing the separation between the top of the filter pack and tip of the augers or temporary casing during filter pack placement will help prevent inclusions of formation material or slough into the filter pack. However, if the tip of the augers or temporary casing is not kept above the top of the filter pack and the filter pack is allowed to settle within the augers or temporary casing, a filter pack bridge may occur and the well casing may become "locked" inside the augers/temporary casing. The bridged material should be broken mechanically before installing more filter pack material.

The theoretical quantity of filter pack material required to fill the annulus should be calculated. The quantity of filter pack material actually installed in the well should be measured and compared to the calculated quantity. Both quantities should be recorded on the Boring and Well Construction Log.

7. The bentonite seal is installed by pouring bentonite pellets onto the top of the filter pack. The bentonite seal should be tamped down to ensure that no bridging has occurred. For wells deeper than 20 feet, a tremie pipe should be used to place the bentonite seal. Unless impractical due to site-specific conditions or otherwise delineated in a Workplan, Quality Assurance Project Plan, or Sampling Plan, the bentonite seal should extend

approximately 2 feet above the top of the filter pack. The manufacturer's name, quantity used, and type of bentonite used should be recorded on the Boring and Well Construction Log. The top of the bentonite seal should be measured by taping. A tremie pipe may also be used in small-diameter boreholes or in formations prone to bridging or collapse. The tremie pipe is lifted as the bentonite pellets are poured onto the top of the filter pack. If placed in the unsaturated zone, clean water (approximately 5 gallons) should be poured on top of the pellets after their installation and the pellets should be allowed to hydrate for approximately 10 minutes before proceeding with installation of the overlying grout seal.

8. Where the top of the screened interval is deeper than 5 feet, the grout seal should be tremied into the well to prevent inclusions of formation material or slough into the grout seal. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, the grout seal should consist of neat cement grout (5.5 gallons of water in proportion to one 94-pound bag of Type I or Type II Portland cement (ASTM C-150)). Water used to hydrate the cement is to be free of contaminants and organic material. Bentonite powder may added to reduce shrinkage, retain flexibility to accommodate freeze/thaw conditions, and improve fluidity. If bentonite powder is to be used, add 3 to 5 pounds of bentonite powder with 6.5 gallons of water and one 94-pound bag of Type I or Type II Portland cement. The water and bentonite should be mixed first before adding the cement. Local requirements may require inspection of grout seal placement by the regulating authority.

   If augers or temporary casing remain in the borehole during grouting, the level of the grout should be kept above the tip of the augers or casing to help prevent inclusions of formation material in the grout seal.

   The volume of the grout actually used should be recorded on the Boring and Well Construction Log and compared to the theoretical annular volume of the sealed interval. Any discrepancies should be noted on the Boring and Well Construction Log.

9. Complete the surface of the well by installing an Emco Wheaton A721 Monitoring Well Manhole traffic cover (or equivalent) in accordance with the attached construction specification. Attach the locking cap and lock.

10. The completed well should be protected from disturbance while the bentonite seal hydrates and the grout cures. Further well activities, such as development or sampling, should be withheld for a period of 72 hours to allow these materials to obtain an initial set. Local requirements may require longer than 72 hours.

11. Complete and file form DWR 188 (Water Well Drillers Report) and submit to local agency.

12. Containerize decontamination liquids in 17H steel drums. Affix completed "Caution - Pending Analysis" labels to the drums.

13. Complete the Drum Inventory Sheet (copy attached) and the Boring and Well Construction Log.

14. Enter descriptions of field work performed in the field notebook.

4.0 Quality Assurance and Quality Control (QA/QC)

Quality assurance checks for well completion include comparison of theoretical versus actual volumes of filter pack, bentonite seal, and grout seal. Discrepancies that indicate actual "take" was less than theoretical may indicate inclusions of formation material or slough within the annulus. Specific attention to such discrepancies is necessary if the bentonite seal and grout seal are needed to separate contaminated from uncontaminated zones that may be penetrated by the well.

Other quality assurance checks include accurate measurement and documentation of the lengths and types of materials used to complete the well.

5.0 Documentation

Observations, measurements, and other documentation of the well completion effort should be recorded on the following:

- Field notebook
- Boring and Well Construction Log
- DWR 188 (Water Well Drillers Report)
- Drum Inventory Sheet

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposal of investigation-derived waste.

6.0 Decontamination

Materials used for filter pack, bentonite seal, and grout seal should be new at the beginning of each project. Damaged or partially-used containers of material that are brought on site by drillers or other material suppliers should not be used for well completion. If there is sufficient question regarding contamination of materials, obtain representative samples for later laboratory testing.

If not certified clean by the manufacturer and delivered to the site in a protective casing, decontaminate well casing and screen and all fittings prior to insertion into the borehole.

Between each borehole, appurtenant items that contacted downhole soil and groundwater should be decontaminated. The drill rig should be steam cleaned or pressured washed as a final decontamination event. On-site decontamination should be conducted within the confines of a trough or lined pit to temporarily contain the wastewater. Between each borehole and prior to demobilization, the trough or lined pit should be decontaminated by steam cleaning or pressure washing. If a rack or other support is used to suspend appurtenant items over the trough or lined pit during decontamination, only the rack or other support needs to be decontaminated between boreholes.

Prior to insertion in each borehole, the measuring tape, and other materials and supplies that may directly contact the soil or groundwater, should be decontaminated. Decontamination of these items should consist of a soap wash (Alconox®, Liquinox®, or other low-residue, organic-free soap) followed by a clean water rinse. Decontamination liquids should be stored in labeled 17H drums.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before installation of each well is begun, fresh decontamination solutions should be prepared. Decontaminated equipment should be kept off of the ground surface. Cleaned equipment should be placed on top of plastic sheeting, which is replaced after completion of each borehole, or on storage racks.

More rigorous decontamination procedures may be employed if necessary to meet sampling or QA/QC requirements.

7.0 Investigation-Derived Waste

Wastes resulting from the activities of this SOP may include decontamination liquids and miscellaneous waste (paper, plastic, gloves, bags, etc.). These wastes should be containerized in 17H steel drums for each borehole. Wastes from multiple boreholes may be combined within a single drum if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the boreholes are similarly uncontaminated or similarly contaminated. Given reasonable doubt, separate drums should be used for waste from each borehole.

Completed "Caution - Analysis Pending" labels should be affixed to each drum.

8.0 References

Aller, L., Bennett T.W., Hackett G., Petty R.J., Lehr J.H., Sedoris H., and Nielson D.M., 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH, 1989.

American Society for Testing and Materials, 1992. ASTM Standards On Ground Water and Vadose Zone Investigations. ASTM, Philadelphia, PA, 1992.

Driscoll, F.G., 1986. Groundwater and Wells. Johnson Filtration Systems Inc., St. Paul, MN, 1986.

Neilson, D.B., 1991. Practical Handbook of Ground-Water Monitoring. Lewis Publishers, Chelsea, MI, 1991.

United States Environmental Protection Agency, 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. U.S. EPA, 1992.

BLYMYER ENGINEERS, INC.

BORE/WELL CONSTRUCTION LOG

BORE/WELL NO.:

ocation:

Client:

Project Site Address:

Drilling Company:

BEI Job No:

Driller:

Logged By:

License No.:

Sampling Method:

Drilling Method:

Started Time:

Date:

Completed Time:

Date:

N

Scale:

Elevation (msl):

Total Bore Depth/Diameter:

Total Well Depth/Diameter:

Surface Seal Type/Completion:

Annular Seal Type/Interval:

Seal Type/Interval:

Sand Type/Interval:

Blank Casing Type/Diameter/Interval:

Screened Casing Type/Diameter/Interval:

Water Depth:	Initial: (▽):		Stabilized: (▼):
Time:			
Date:			

LITHOLOGIC DESCRIPTION	U.S. Classification/ Contact Type	Depth (ft.)	Sample Intervals (symbols)	Sample Number	Blows/6 in.	Inches Driven	Inches Recovered	PID Readings (ppm)	Screened/Blank Casing Intervals	Sand/Seal Intervals
		1								
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								
		11								
		12								
		13								
		14								
		15								

BLYMYER ENGINEERS, INC

BORE/WELL CONSTRUCTION LOG (continued)

BORE/WELL NO.:

Notes:

LITHOLOGIC DESCRIPTION	U.S.C. Contact Type	Depth (ft.)	Sample Interval	Sample Number	Blows/6 In.	Inches Driven	Inches Recovered	PID Readings (ppm)	Casing Intervals	Sand/Seal Intervals

KEY TO BORE/WELL CONSTRUCTION LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN NO. 200 SIEVE)	GRAVEL (MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE)	CLEAN GRAVEL WITH LESS THAN 5% FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES
		GRAVEL WITH OVER 12% FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURES
	SAND (MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SAND WITH LESS THAN 5% FINES	SW	WELL GRADED SAND, GRAVELLY SAND
			SP	POORLY GRADED SAND, GRAVELLY SAND
		SAND WITH OVER 12% FINES	SM	SILTY SAND, SAND-SILT MIXTURES
			SC	CLAYEY SAND, SAND-CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE)	SILT AND CLAY (LIQUID LIMIT LESS THAN 50)		ML	INORGANIC SILT, ROCK FLOUR, SANDY OR CLAYEY SILT OF LOW PLASTICITY
			CL	INORGANIC CLAY OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAY (LEAN)
			OL	ORGANIC SILT AND ORGANIC SILTY CLAY OF LOW PLASTICITY
	SILT AND CLAY (LIQUID LIMIT GREATER THAN 50)		MH	INORGANIC SILT, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT
			CH	INORGANIC CLAY OF HIGH PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY (FAT)
			OH	ORGANIC CLAY, ORGANIC SILT OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

FILL MATERIALS

C	CONCRETE
F	FILL
A	ASPHALT

WELL CONSTRUCTION MATERIALS

CEMENT GROUT	
BENTONITE	
FILTER SAND	

SEE ABOVE FOR CONCRETE SYMBOL

SOIL CONSISTENCY FROM DRIVE SAMPLER

NON-COHESIVE SOILS*		COHESIVE SOILS*		UNCONFINED COMPRESSIVE STRENGTH
SANDS & GRAVELS	BLOWS PER FOOT	SILTS AND CLAYS	BLOWS PER FOOT	STRENGTH TONS/SQ. FT.
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 1/4
LOOSE	4 - 10	SOFT	2 - 4	1/4 - 1/2
MED. DENSE	10 - 30	MEDIUM STIFF	4 - 8	1/2 - 1
DENSE	30 - 50	STIFF	8 - 16	1 - 2
VERY DENSE	OVER 50	VERY STIFF	16 - 32	2 - 4
		HARD	OVER 32	OVER 4

* = STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. (1-3/8-INCH I.D.) SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS ARE RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.

SAMPLE INTERVAL SYMBOLS

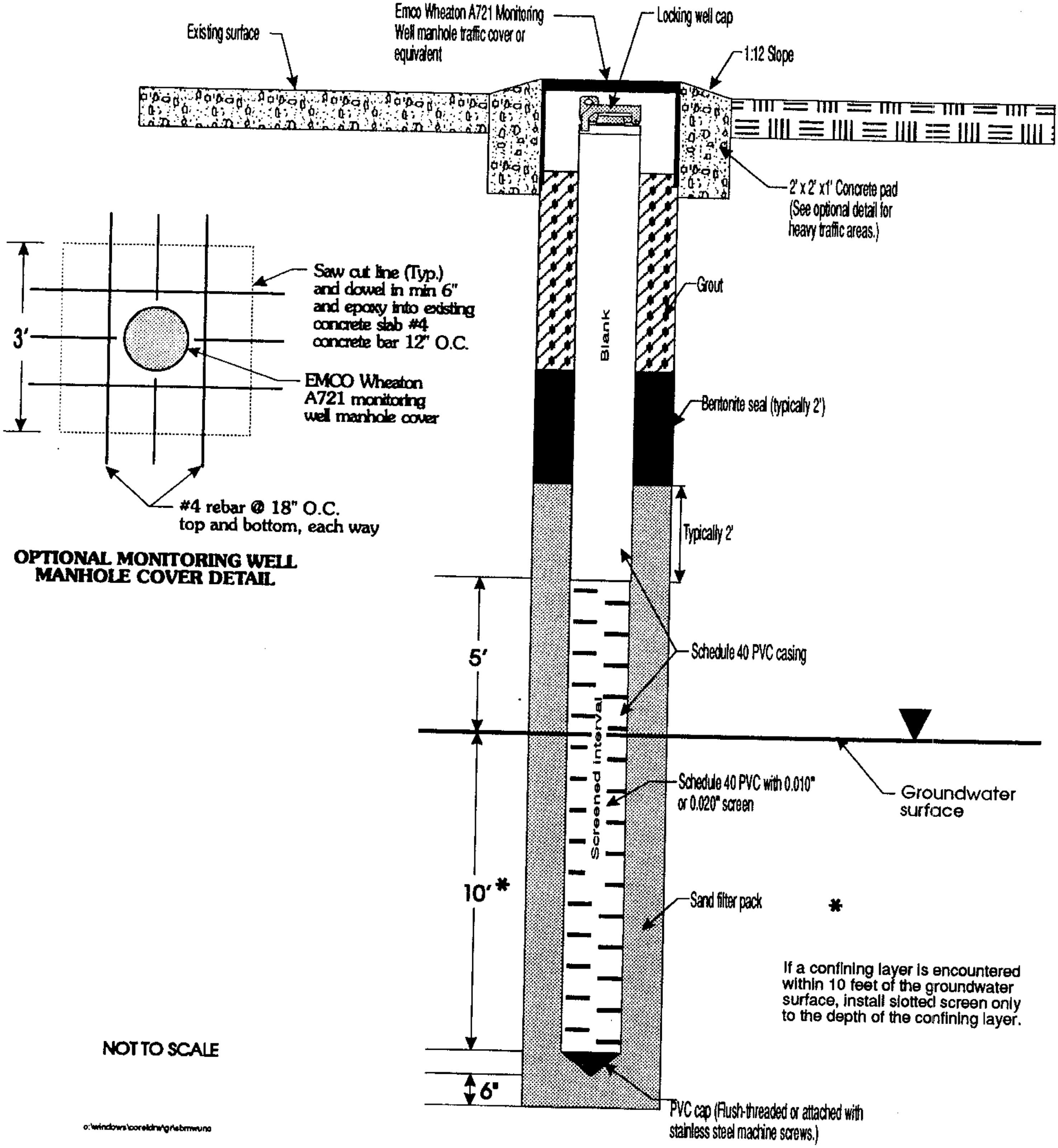
CORED/RECOVERED	CORED/RECOVERED/SAMPLED/ANALYZED
CORED/ NO RECOVERY	N/A NON APPLICABLE/NOT AVAILABLE
CORED/RECOVERED/SAMPLED	

BLYMYER ENGINEERS DRUM INVENTORY FORM

Number of Drums	Date Generated	Person on-site when generated	Soil or Groundwater	Contents (Cuttings, Purge Water, Development Water, Decon Water, PPE)	% Full	Bore or Monitoring Well ID	Do Lab Results Exist for Contents?

Date Client Informed? ______________________ All drums labeled? ______________________

MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR UNCONFINED WATER-BEARING ZONE



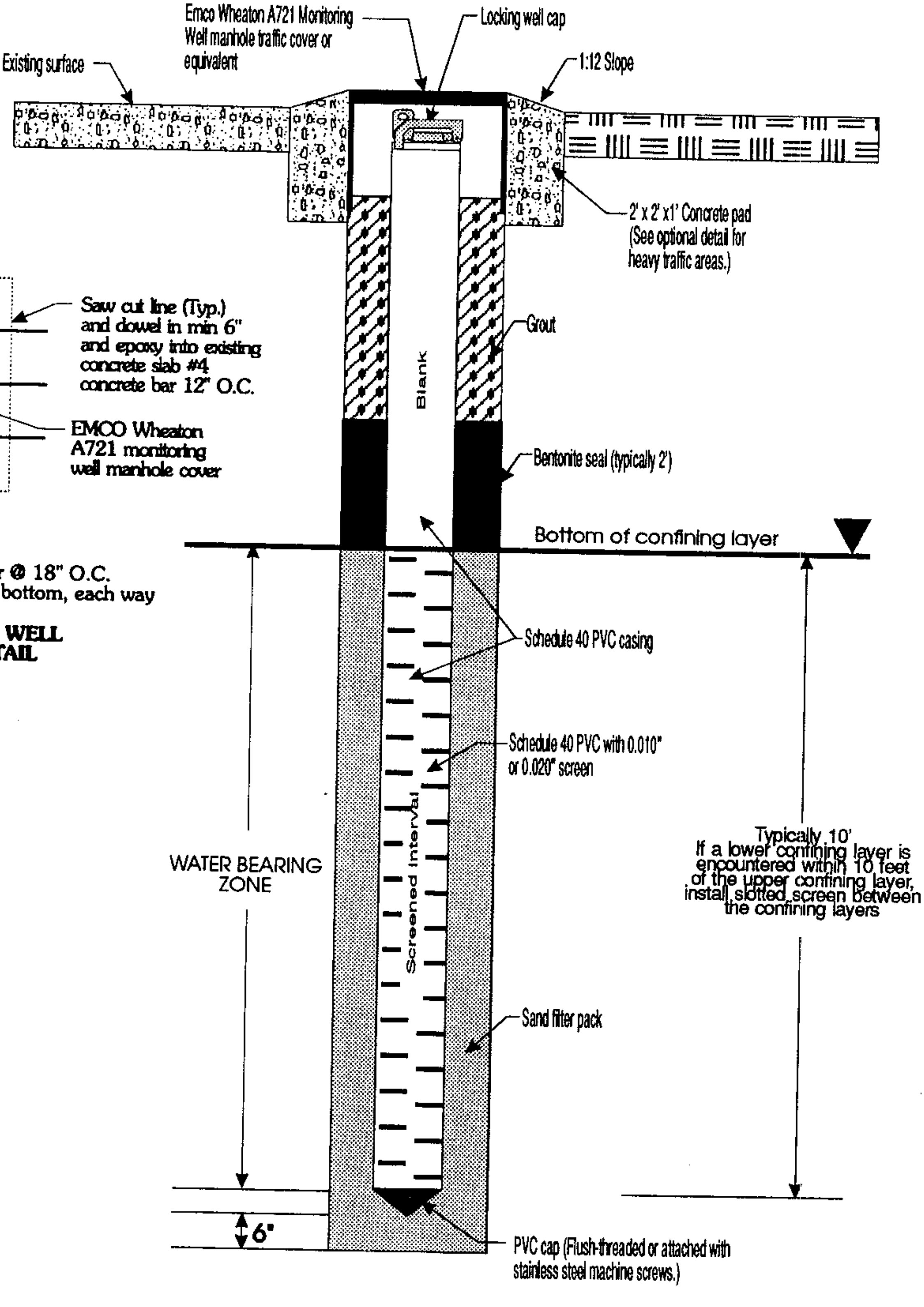
OPTIONAL MONITORING WELL MANHOLE COVER DETAIL

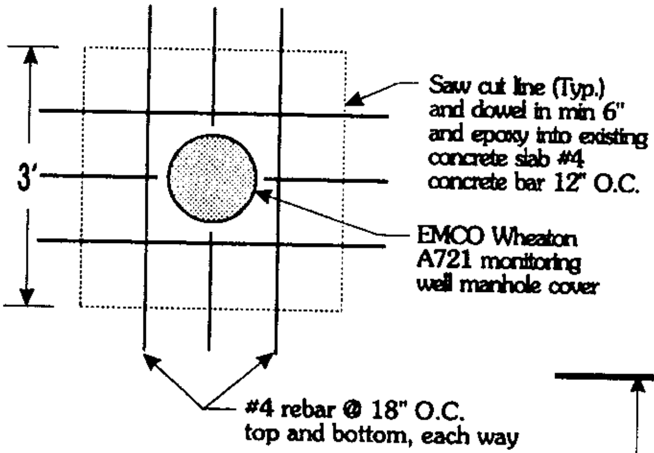
* If a confining layer is encountered within 10 feet of the groundwater surface, install slotted screen only to the depth of the confining layer.

NOT TO SCALE

o:\windows\coreldrw\gr\sbmwuno

MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR CONFINED WATER-BEARING ZONE





OPTIONAL MONITORING WELL MANHOLE COVER DETAIL

NOT TO SCALE

o:\windows\coreldrw\gr\sbmwcon

Blaine Tech Services. Inc.
Standard Operating Procedure

WATER LEVEL, SEPARATE PHASE LEVEL AND TOTAL WELL DEPTH MEASUREMENTS (GAUGING)

Routine Water Level Measurements

1. Establish that water or debris will not enter the well box upon removal of the cover.
2. Remove the cover using the appropriate tools.
3. Inspect the wellhead (see Wellhead Inspections).
4. Establish that water or debris will not enter the well upon removal of the well cap.
5. Unlock and remove the well cap lock (if applicable). If lock is not functional cut it off.
6. Loosen and remove the well cap. CAUTION: DO NOT PLACE YOUR FACE OR HEAD DIRECTLY OVER WELLHEAD WHEN REMOVING THE WELL CAP. WELL CAP MAY BE UNDER PRESSURE AND/OR MAY RELEASE ACCUMULATED AND POTENTIALLY HARMFULL VAPORS.
7. Verify and identify survey point as written on S.O.W.
   TOC: If survey point is listed as Top of Casing (TOC), look for the exact survey point in the form of a notch or mark on the top of the casing. If no mark is present, use the north side of the casing as the measuring point.
   TOB: If survey point is listed as Top of Box (TOB), the measuring point will be established manually. Place the inverted wellbox lid halfway across the wellbox opening and directly over the casing. The lower edge of the inverted cover directly over the casing will be the measuring point.
8. Put new Latex or Nitrile gloves on your hands.
9. Slowly lower the Water Level Meter probe into the well until it signals contact with water with a tone and/or flashing a light.
10. Gently raise the probe tip slightly above the water and hold it there. Wait momentarily to see if the meter emits a tone, signaling rising water in the casing. Gently lower the probe tip slightly below the water. Wait momentarily to see if the meter stops emitting a tone, signaling dropping water in the casing. Continue process until water level stabilizes indicating that the well has equilibrated.
11. While holding the probe at first contact with water and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Water column.
12. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable)

Water Level and Separate Phase Thickness Measurements in Wells Suspected of Containing Separate Phase

1. Establish that water or debris will not enter the well box upon removal of the cover.
2. Remove the cover using the appropriate tools.
3. Inspect the wellhead (see Wellhead Inspections).
4. Establish that water or debris will not enter the well upon removal of the well cap.

5. Unlock and remove the well cap lock (if applicable). If lock is not functional cut it off.
6. Loosen and remove the well cap. CAUTION: DO NOT PLACE YOUR FACE OR HEAD DIRECTLY OVER WELLHEAD WHEN REMOVING THE WELL CAP. WELL CAP MAY BE UNDER PRESSURE AND/OR MAY RELEASE ACCUMULATED AND POTENTIALLY HARMFULL VAPORS.
7. Verify and identify survey point as written on S.O.W.

   TOC: If survey point is listed as Top of Casing (TOC), look for the exact survey point in the form of a notch or mark on the top of the casing. If no mark is present, use the north side of the casing as the measuring point.

   TOB: If survey point is listed as Top of Box (TOB), the measuring point will be established manually. Place the inverted well box lid halfway across the well box opening and directly over the casing. The lower edge of the inverted cover directly over the casing will be the measuring point.
8. Put new Nitrile gloves on your hands.
9. Slowly lower the tip of the Interface Probe into the well until it emits either a solid or broken tone.

   BROKEN TONE: Separate phase layer is not present. Go to Step 8 of Routine Water Level Measurements shown above to complete gauging process using the Interface probe as you would a Water Level Meter.

   SOLID TONE: Separate phase layer is present. Go to the next step.
10. Gently raise the probe tip slightly above the separate phase layer and hold it there. Wait momentarily to see if the meter emits a tone, signaling rising water in the casing. Gently lower the probe tip slightly below the separate phase layer. Wait momentarily to see if the meter stops emitting a tone, signaling dropping water in the casing. Continue process until water level stabilizes indicating that the well has equilibrated.
11. While holding the probe at first contact with the separate phase layer and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Product column.
12. Gently lower the probe tip until it emits a broken tone signifying contact with water. While holding the probe at first contact with water and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Water column.
13. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable).

Routine Total Well Depth Measurements

1. Lower the Water Level Meter probe into the well until it lightens in your hands, indicating that the probe is resting at the bottom of well.
2. Gently raise the tape until the weight of the probe increases, indicating that the probe has lifted off the well bottom.
3. While holding the probe at first contact with the well bottom and the tape against the well measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Total Well Depth column.

4. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable).

Blaine Tech Services, Inc.
Standard Operating Procedure

WELL WATER EVACUATION (PURGING)

Purpose

Evacuation of a predetermined minimum volume of water from a well (purging) while *simultaneously* measuring water quality parameters is typically required prior to sampling. Purging a minimum volume guarantees that actual formation water is drawn into the well. Measuring water quality parameters either verifies that the water is stable and suitable for sampling or shows that the water remains unstable, indicating the need for continued purging. Both the minimum volume and the stable parameter qualifications need to be met prior to sampling. This assures that the subsequent sample will be representative of the formation water surrounding the well screen and not of the water standing in the well.

Defining Casing Volumes

The predetermined minimum quantity of water to be purged is based on the wells' casing volume. A casing volume is the volume of water presently standing within the casing of the well. This is calculated as follows:

Casing Volume = (TD – DTW) VCF

1. Subtract the wells' depth to water (DTW) measurement from its total depth (TD) measurement. This is the height of the water column in feet.
2. Determine the well casings' volume conversion factor (VCF). The VCF is based on the diameter of the well casing and represents the volume, in gallons, that is contained in one (1) foot of a particular diameter of well casing. The common VCF's are listed on our Well Purge Data Sheets.
3. Multiply the VCF by the calculated height of the water column. This is the casing volume, the amount of water in gallons standing in the well.

Remove Three to Five Casing Volumes

Prior to sampling, an attempt will be made to purge all wells of a minimum of three casing volumes and a maximum of five casing volumes except where regulations mandate the minimum removal of four casing volumes.

Choose the Appropriate Evacuation Device Based on Efficiency

In the absence of instructions on the SOW to the contrary, selection of evacuation device will be based on efficiency.

Measure Water Quality Parameters at Each Casing Volume

At a minimum, water quality measurements include pH, temperature and electrical conductivity (EC). Measurements are made and recorded at least once every casing volume. They are considered stable when all parameters are within 10% of their previous measurement.

Note: The following instructions assume that well has already been properly located, accessed, inspected and gauged.

Prior to Purging a Well

1. Confirm that the well is to be purged and sampled per the SOW.
2. Confirm that the well is suitable based on the conditions set by the client relative to separate phase.
3. Calculate the wells' casing volume.
4. Put new Latex or Nitrile gloves on your hands.

Purging With a Bailer (Stainless Steel, Teflon or Disposable)

1. Attach bailer cord or string to bailer. Leave other end attached to spool.
2. Gently lower empty bailer into well until well bottom is reached.
3. Cut cord from spool. Tie end of cord to hand.
4. Gently raise full bailer out of well and clear of well head. Do not let the bailer or cord touch the ground.
5. Pour contents into graduated 5-gallon bucket or other graduated receptacle.
6. Repeat purging process.
7. Upon removal of first casing volume, fill clean parameter cup with purgewater, empty the remainder of the purgewater into the bucket, lower the bailer back into the well and secure the cord on the Sampling Vehicle.
8. Use the water in the cup to collect and record parameter measurements.
9. Continue purging until second casing volume is removed.
10. Collect parameter measurements.
11. Continue purging until third casing volume is removed.
12. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.

Purging With a Pneumatic Pump

1. Position Pneumatic pump hose reel over the top of the well.
2. Gently unreel and lower the pump into the well. Do not contact the well bottom.
3. Secure the hose reel.
4. Begin purging into graduated 5-gallon bucket or other graduated receptacle.
5. Adjust water recharge duration and air pulse duration for maximum efficiency.
6. Upon removal of first casing volume, fill clean parameter cup with water.
7. Use the water in the cup to collect and record parameter measurements.
8. Continue purging until second casing volume is removed.

9. Collect parameter measurements.
10. Continue purging until third casing volume is removed.
11. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.
12. Upon completion of purging, gently recover the pump and secure the reel.

Purging With a Fixed Speed Electric Submersible Pump

1. Position Electric Submersible hose reel over the top of the well.
2. Gently unreel and lower the pump to the well bottom.
3. Raise the pump 5 feet off the bottom.
4. Secure the hose reel.
5. Begin purging.
6. Verify pump rate with flow meter or graduated 5-gallon bucket
7. Upon removal of first casing volume, fill clean parameter cup with water.
8. Use the water in the cup to collect and record parameter measurements.
9. Continue purging until second casing volume is removed.
10. Collect parameter measurements.
11. Continue purging until third casing volume is removed.
12. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.
13. Upon completion of purging, gently recover the pump and secure the reel.

Blaine Tech Services, Inc.
Standard Operating Procedure

SAMPLE COLLECTION FROM GROUNDWATER WELLS USING BAILERS

Sampling with a Bailer (Stainless Steel, Teflon or Disposable)

1. Put new Latex or Nitrile gloves on your hands.
2. Determine required bottle set.
3. Fill out sample labels completely and attach to bottles.
4. Arrange bottles in filling order and loosen caps (see Determine Collection Order below).
5. Attach bailer cord or string to bailer. Leave other end attached to spool.
6. Gently lower empty bailer into well until water is reached.
7. As bailer fills, cut cord from spool and tie end of cord to hand.
8. Gently raise full bailer out of well and clear of well head. Do not let the bailer or cord touch the ground. If a set of parameter measurements is required, go to step 9. If no additional measurements are required, go to step 11.
9. Fill a clean parameter cup, empty the remainder contained in the bailer into the sink, lower the bailer back into the well and secure the cord on the Sampling Vehicle. Use the water in the cup to collect and record parameter measurements.
10. Fill bailer again and carefully remove it from the well.
11. Slowly fill and cap sample bottles. Fill and cap volatile compounds first, then semi-volatile, then inorganic. Return to the well as needed for additional sample material.

    Fill 40-milliliter vials for volatile compounds as follows: Slowly pour water down the inside on the vial. Carefully pour the last drops creating a convex or positive meniscus on the surface. Gently screw the cap on eliminating any air space in the vial. Turn the vial over, tap several times and check for trapped bubbles. If bubbles are present, repeat process.

    Fill 1 liter amber bottles for semi-volatile compounds as follows: Slowly pour water into the bottle. Leave approximately 1 inch of headspace in the bottle. Cap bottle.

    Field filtering of inorganic samples using a stainless steel bailer is performed as follows: Attach filter connector to top of full stainless steel bailer. Attach 0.45 micron filter to connector. Flip bailer over and let water gravity feed through the filter and into the sample bottle. If high turbidity level of water clogs filter, repeat process with new filter until bottle is filled. Leave headspace in the bottle. Cap bottle.

    Field filtering of inorganic samples using a disposable bailer is performed as follows: Attach 0.45 micron filter to connector plug. Attach connector plug to bottom of full disposable bailer. Water will gravity feed through the filter and into the sample bottle. If high turbidity level of water clogs filter, repeat process with new filter until bottle is filled. Leave headspace in the bottle. Cap bottle.

12. Bag samples and place in ice chest.
13. Note sample collection details on well data sheet and Chain of Custody.

Blaine Tech Services, Inc.
Standard Operating Procedure

FLOW CELL PURGING AND SAMPLING

Flow Cell purging provides the user with a constant stream of real time, highly accurate water quality information during the purge process. Typically, this equipment is utilized as part of the Low-Flow sampling process, where parameter stabilization is the most important prerequisite prior to sample collection and/or when very accurate Dissolved Oxygen measurements are required.

The Flow Cell system consists a flow cell, a sonde, a display unit and various hose lines. Flow cell system brands commonly used by BLAINE include YSI, HORIBA and QED. A separate pump must be used to supply the flow of water to the Flow Cell. The pump must be capable of purging water at rates that are variable and low. The most common purge pump used is the Grunfos Redi-Flo II variable speed electric submersible pump. Both peristaltic and pneumatic bladder pumps are common alternatives.

As the Low-Flow methodology stipulates sampling through the purge tube (as opposed to a bailer) to minimize disturbance to the water column, dedicated, small-diameter tubing is typically used.

Flow cell purging and sampling using dedicated, in-place, pump

1. Plug the display unit into the sonde.
2. Calibrate the sonde for all parameters using the supplied calibration fluids, following the manufacturer's instruction manual.
3. Connect the flow cell to the sonde.
4. Without disturbing the water column in the well, connect the water line from the in-place pump to the lower end of the flow cell.
5. Connect a water discharge line to the upper end of the flow cell.
6. Without disturbing the water column, connect the power source (electricity, compressed air, etc.) to the in-place pump.
7. Lower an electronic water level indicator (sounder) slowly into the well until it hits the water surface.
8. While monitoring the sounder, commence pumping at a rate that does not induce draw-down in the well.
9. Collect parameter measurements from the display unit as per job specifications (ie. every 1 minute, every 3 minutes, etc.).
10. Monitor flow cell to make sure it remains free of air bubbles.
11. Once parameters have stabilized, adjust the pump rate to the lowest technically feasible setting.
12. Disconnect the water line from the lower end of the flow cell.
13. Fill the appropriate sample containers.
14. Remove power supply and sounder from well.