August 4, 1994
BEI Job No. 94015

BLYMYER ENGINEERS, INC.

Ms. Juliet Shin
Alameda County Health Care Services Agency
80 Swan Way, Room 200
Oakland, CA 94621

Subject: Revised Subsurface Investigation Letter Workplan
Kawahara Nursery
16550 Ashland Avenue
San Lorenzo, CA

Dear Ms. Shin:

Blymyer Engineers, Inc., on behalf of Kawahara Nursery, is pleased to present this letter workplan to determine the potential source and on-site extent of detected petroleum hydrocarbon contamination in soil and groundwater at the above referenced site. Blymyer Engineers completed a *Preliminary Site Assessment Phase I Subsurface Investigation* report, dated July 28, 1994 and a *Subsurface Investigation Status Report*, dated April 29, 1994. The completed investigations consisted of the installation of groundwater monitoring wells, soil sample collection from the soil bores prior to well installation, collection of groundwater samples from the monitoring wells and the on-site irrigation well, and a thorough research of regulatory files relating to unauthorized releases of petroleum hydrocarbons in the vicinity of the site.

Background

On December 1, 1992, one steel 5,000-gallon diesel underground storage tank (UST) was removed from the property owned by Kawahara Nursery, located at 16550 Ashland Avenue, San Lorenzo, California, by Tank Protect Engineering of Northern California. The UST was reported to be in good condition with no visible evidence of holes at the time of removal. The excavated soil was stockpiled at the site in two distinct piles and a composite soil sample was collected from each pile. Verification soil samples were collected and analyzed for Total Petroleum Hydrocarbons (TPH) as diesel. The soil sample collected from the southeastern wall of the excavation, contained 5,000 milligrams per kilogram (mg/kg) TPH as diesel. The composite soil sample collected from the soil excavated from the southeastern portion of the excavation contained 210 mg/kg TPH as diesel.

The results of the UST closure were described in the *Underground Storage Tank Closure Report*, completed by Tank Protect Engineering and forwarded to the Alameda County Health Care Services Agency (ACHCSA) by Mr. Tom Kawahara. In a letter dated January 27, 1993, the ACHCSA requested that a Preliminary Subsurface Investigation be completed at the site to ascertain the extent of soil and groundwater petroleum hydrocarbon contamination.

On June 10, 1993, Blymyer Engineers supervised the installation of three groundwater monitoring wells (MW-1, MW-2, and MW-3) at the site in the locations depicted on the enclosed Site Plan. Minor concentrations of petroleum hydrocarbons were detected in the soil samples collected during the installation of soil bores. The groundwater sample collected from monitoring well MW-3, installed adjacent to an on-site groundwater well contained 120,000 micrograms per liter (µg/L) of TPH as gasoline, 170,000 µg/L of ethylbenzene, and 27,000 µg/L of total xylenes.

Blymyer Engineers also collected four discrete soil samples from the stockpiled soil removed from the southeastern portion of the excavation and composited them into one sample. The results of the analysis of the composite soil sample did not indicate detectable concentrations of TPH as diesel.

In March 1994, Blymyer Engineers conducted a phased groundwater investigation at the site. The initial phases of the investigation included the review of records at the ACHCSA and the Regional Water Quality Control Board to determine if any toxic chemical or fuel leaks reported within ¼-mile radius may have impacted the site; the review of historical aerial photographs; and the review of all available information regarding the construction and pumping rates of the on-site irrigation well to determine the radius of influence of the well on the local groundwater flow.

Depth to groundwater measurements were collected from each of the monitoring wells prior to the disengagement of the irrigation well pump. After the pump had been disengaged for approximately 48 hours, depth to groundwater measurements were again collected from the wells to determine the influence of the pumping system on the shallow water bearing zone. Following the disengagement of the irrigation well pump, the groundwater elevation decreased less than 0.2 inch in each of the monitoring wells. Blymyer Engineers reactivated the well and collected groundwater samples from each of the three monitoring wells and the irrigation well on March 28, 1994. No detectable concentrations of petroleum hydrocarbons were detected in the groundwater samples collected from the irrigation well or monitoring wells M-1 and MW-2. The analytical results of the groundwater sample collected from monitoring well MW-3 indicated 23,000 µg/L of TPH as diesel, 94,000 µg/L of TPH as gasoline, 4,800 µg/L of benzene, 6,500 µg/L of toluene, 3,000 µg/L of ethylbenzene, and 15,000 µg/L of total xylenes.

On March 28, 1994, Blymyer Engineers collected one discrete soil sample from the stockpiled soil on the site. The soil sample contained 51 mg/kg of TPH as diesel.

A review of the local regulatory agency records indicated that a Army National Guard facility located approximately 300 feet downgradient of the site has reported an unauthorized release of gasoline into the groundwater. However, the lateral extent of the reported release has not yet been determined. The construction log of the on site irrigation well indicated that the well is screened from approximately 45 to 60 feet below grade surface. Based on the depth of the irrigation well screened interval and the unmeasurable change in depth to groundwater during pump operation and after pump disengagement, it was determined that the irrigation well pump does not influence the shallow, impacted water bearing zone.

Scope of Work

During the second phase of the proposed investigation at the site Blymyer Engineers will complete the following scope of work:

- **Prepare a site-specific health and safety plan**

  A health and safety plan outlining the potentially hazardous work conditions and contingencies for an emergency will be prepared for the site.

- **Conduct a soil gas survey**

  A soil gas survey will be conducted at the site, using up to 10 sampling points, to determine the extent of soil and groundwater petroleum hydrocarbon contamination. The proposed soil gas sampling points are depicted on the enclosed Soil Gas Sample Location Map. Soil gas samples will be collected from each sampling point at a depth of approximately 12 feet below grade surface (bgs). The collected soil gas samples will be analyzed by an on-site California-certified mobile laboratory for concentrations of Total Volatile Hydrocarbons and benzene, toluene, ethylbenzene, and total xylenes (BTEX). Each of the sample points will be backfilled with grout slurry and the surface concrete or asphalt will be replaced following sample collection.

- **Obtain permits**

  Permits will be obtained to install groundwater monitoring wells.

- **Drill three soil bores to a depth of approximately 18 feet**

  Three soil bores will be drilled using a hollow-stem auger drill rig at locations determined following the evaluation of the soil gas survey results. The soil bores will be drilled to approximately 18 feet bgs. Two of soil bores will be drilled downgradient and one soil bore will be drilled up gradient of the defined zone of petroleum hydrocarbon contamination.

- **Drill one soil bore to a depth of approximately 13 feet bgs**

  One soil bore will be drilled within 10 feet to the east of the underground storage tank (UST) excavation to delineate the extent of petroleum hydrocarbons detected in a soil sample collected from the east wall of the excavation.

- **Field screen soil samples**

  Soil samples will be collected from each soil bore, at encountered changes in soil lithology or at a minimum of 5-foot intervals, for field screening using a photoionization detector (PID) and lithologic description.

- **Collect soil samples from the soil bores for laboratory analysis**

  Two soil samples will be collected from each soil bore for laboratory analysis. Samples will be analyzed from the zone directly above the soil/groundwater interface and from the interval displaying the highest field PID reading. The soil samples will be submitted to a California-certified laboratory for analysis of Total Petroleum Hydrocarbons (TPH) as gasoline and TPH as diesel by modified EPA Method 8015, and BTEX by EPA Method 8020.

- **Install groundwater monitoring wells**

  The three 18-foot soil bores will be converted to 2-inch diameter groundwater monitoring wells and the completed wells will be properly developed.

- **Collect groundwater samples for laboratory analysis**

  Following development, the wells will be purged of approximately three well volumes of water and the temperature, conductivity, and pH of the purged groundwater will be monitored to insure that these parameters are within 15 percent of the previous measurement prior to sampling. One groundwater sample will be collected from each well using a clean Teflon® bailer. The groundwater samples will be submitted to a California-certified laboratory for analysis of TPH as diesel and TPH as gasoline by modified EPA Method 8015, and BTEX by EPA Method 8020.

- **Dispose of stockpile soil**

  Approximately 20 cubic yards of soil presently stockpiled on the site and the soil cuttings generated during this investigation, will be transported and disposed of at the Vasco Road, Browning Ferris Landfill, a Class III landfill. Prior to transportation and disposal, one profile soil sample will be collected from the soil and analyzed for Toxicity Characteristic Leaching Procedures (TCLP) BTEX, Soluble Threshold Limit Concentrations (STLC) lead, and reactivity, ignitability, and corrosivity.

- **Prepare a final report**

  A final letter report will be prepared which will document all work performed, including summaries of the data, with conclusions and recommendations.

- **Drum decontamination, well development, and purge water**

  All decontamination water, and monitoring well development and purge water will be stored on-site in Department of Transportation-approved, 55-gallon drums for later disposal by the owner. Blymyer Engineers estimates that approximately three 55-gallon drums of water will be generated during this phase of the investigation.

All work will be completed in accordance with the enclosed Blymyer Engineers, Inc.'s *Standard Operating Procedures*.

Proposed Work Schedule

The proposed soil gas survey will be completed within 30 days of the ACHCSA's approval of this letter workplan. The proposed monitoring wells will be installed within 45 days of workplan approval and a final report detailing both phases of the investigation will be submitted to the ACHCSA within 90 days following workplan approval.

Please call Laurie Buckman at (510) 521-3773 with any questions or comments regarding this project.

Sincerely,

Blymyer Engineers, Inc.

By:
Laurie A. Buckman
Project Geologist

REGISTERED GEOLOGIST
JOHN C. MORRISON
No. 5773
Exp. 2/20/95
STATE OF CALIFORNIA

And:
John Morrison, RG 5773
Registered Geologist

Enclosures: Soil Gas Sample Location Map
Blymyer Engineers, Inc.'s, Standard Operating Procedure

No. 1, Soil and Grab Groundwater Sampling Using a Hollow Stem Auger Drill Rig

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

No. 2B, Groundwater Monitoring Well Development

cc: Mr. Sam Kawahara, Kawahara Nursery

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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.

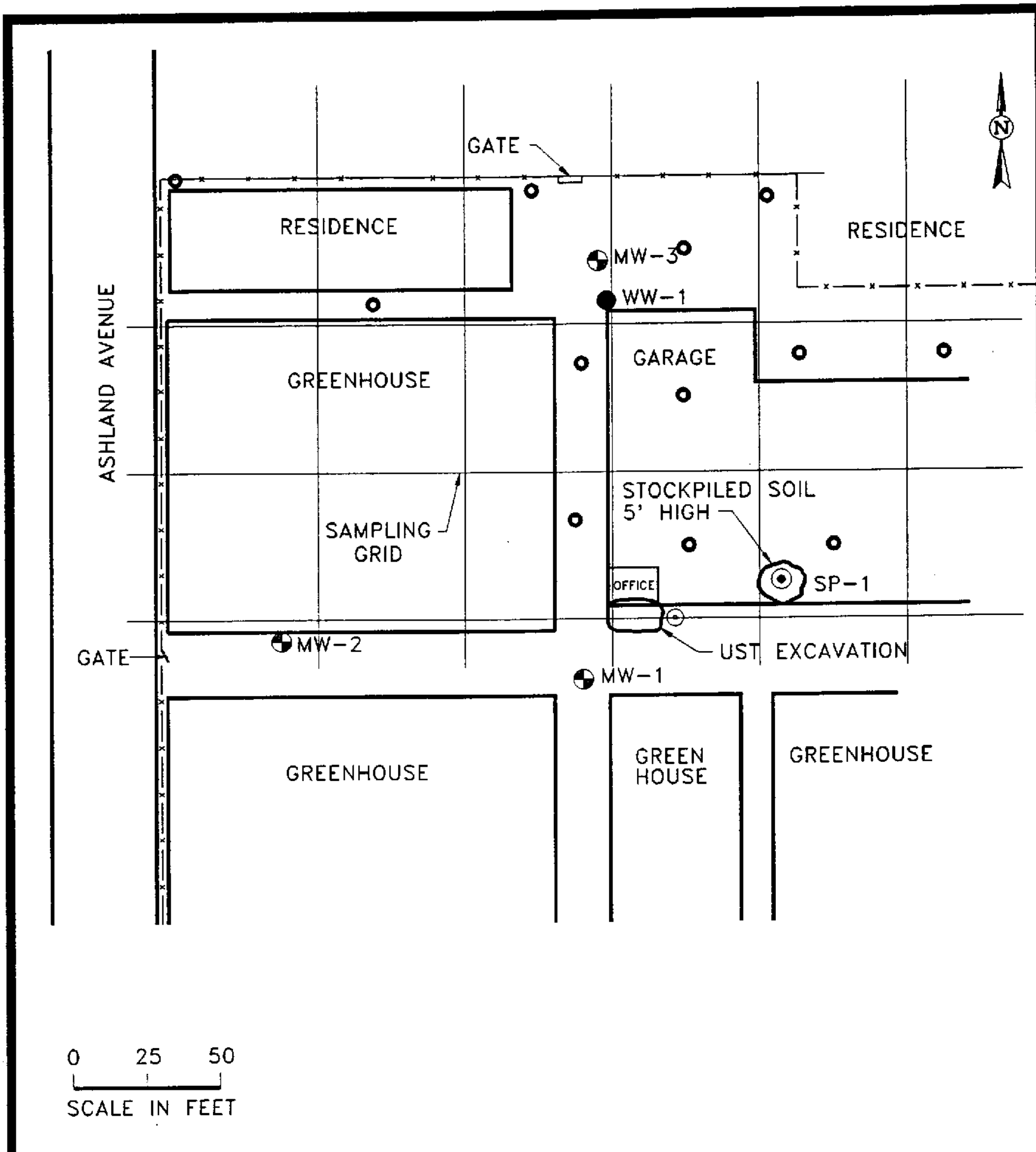
Neilson, D.M., 1991. Practical Handbook of Ground-Water Monitoring. Lewis Publishers, Chelsea, MI, 1991.

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

BLYMYER ENGINEERS 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.

BEI JOB NO. 94015

DATE 4/29/94

LEGEND
- = MONITORING WELL
- = SOIL SAMPLE LOCATION
- = WATER WELL
- = PROPOSED SOIL GAS SAMPLE LOCATION
- = SOIL BORE

SOIL GAS SAMPLE LOCATION MAP
KAWAHARA NURSERY
16550 ASHLAND AVE.
SAN LORENZO, CA

FIGURE

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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,

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.

Date 6/22/94

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.

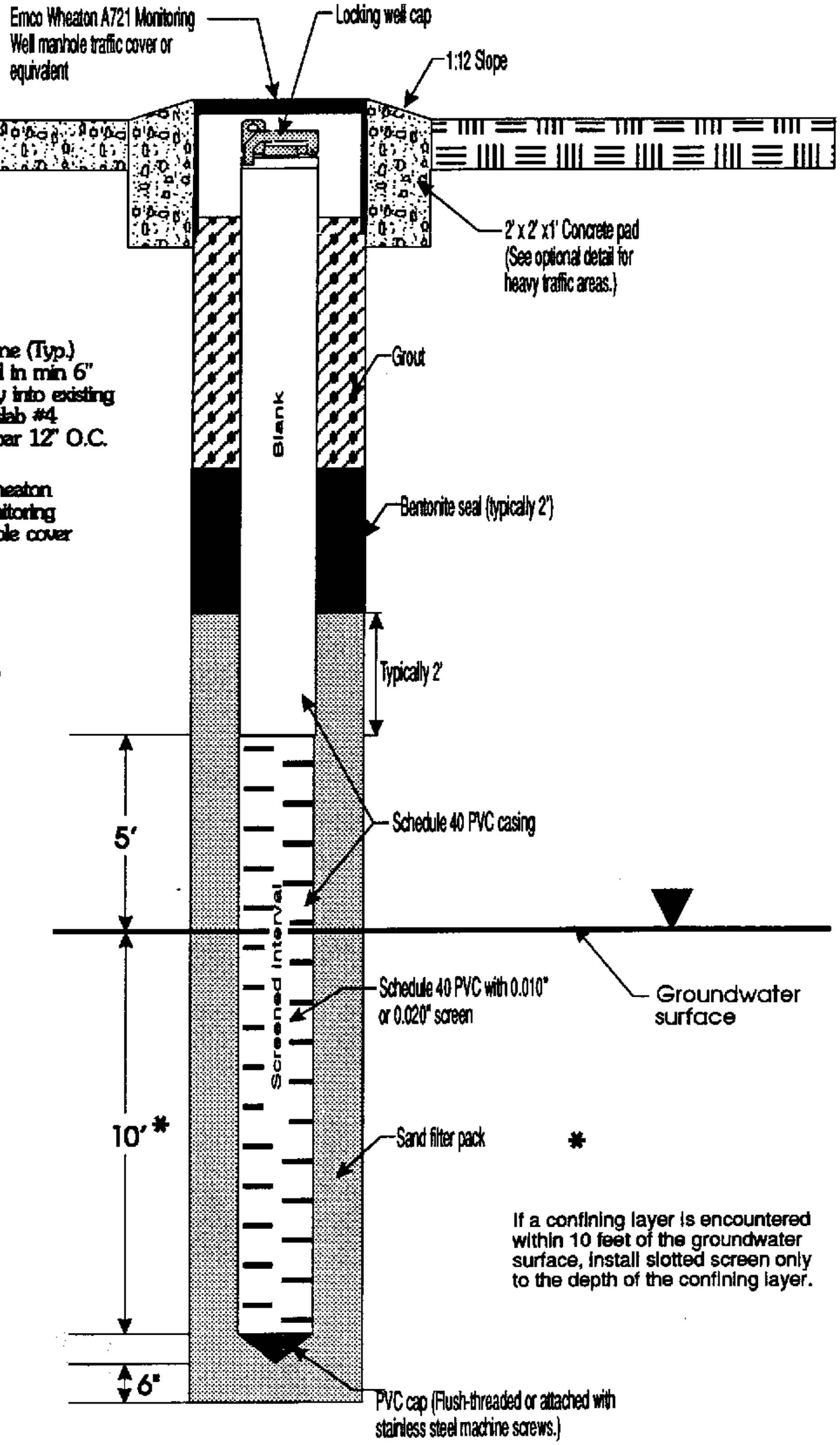
American Society for Testing and Materials, 1992. ASTM Standards On Ground Water and Vadose Zone Investigations. ASTM, Philadelphia, PA, 1992.

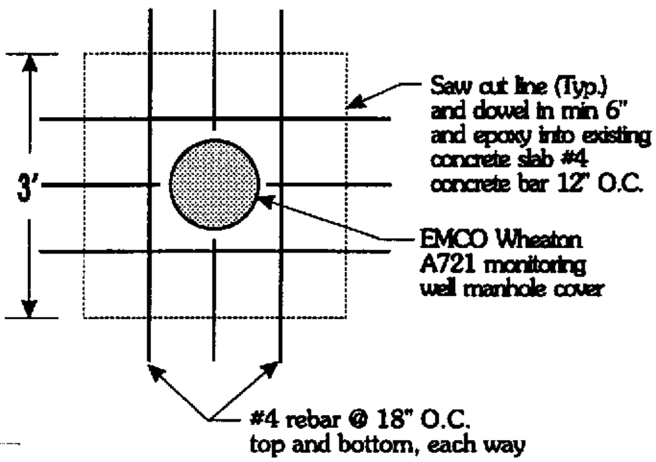
Driscoll, F.G., 1986. Groundwater and Wells. Johnson Filtration Systems Inc., St. Paul, MN, 1986.

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.

MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR UNCONFINED WATER-BEARING ZONE





OPTIONAL MONITORING WELL MANHOLE COVER DETAIL

NOT TO SCALE

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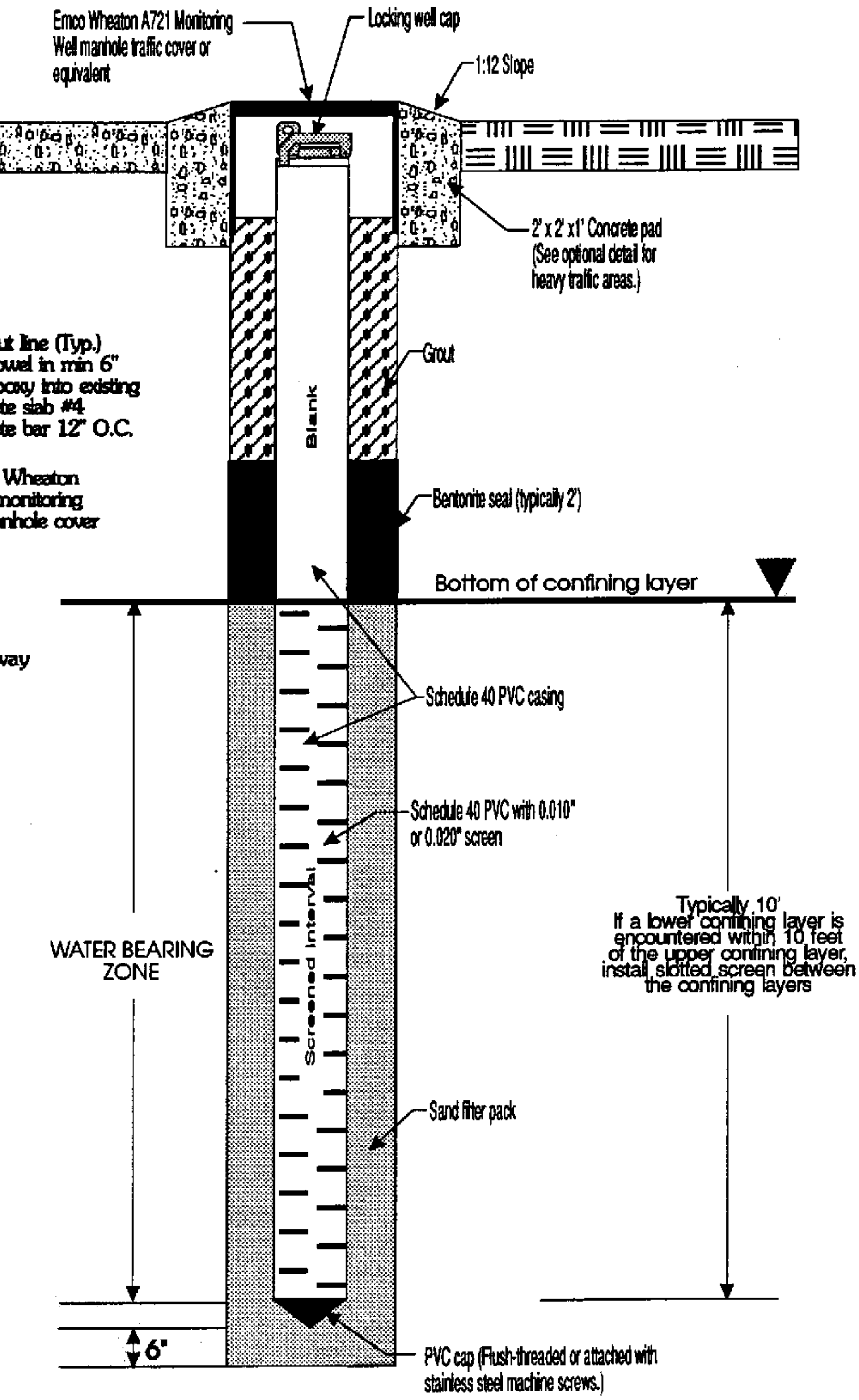
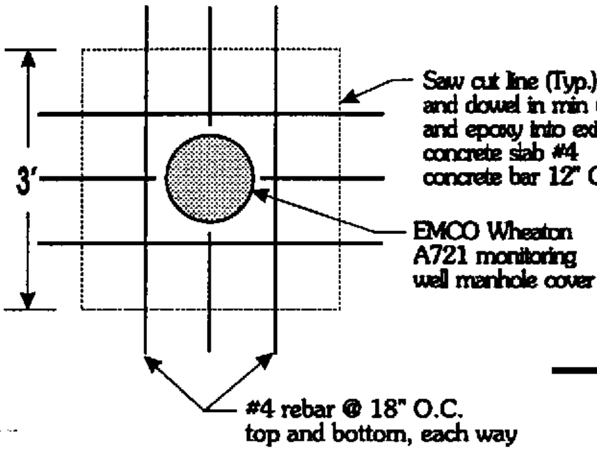
MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR CONFINED WATER-BEARING ZONE





OPTIONAL MONITORING WELL MANHOLE COVER DETAIL

NOT TO SCALE

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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?

mo\forms\drum.inv

Date Client Informed? ______________________ All drums labeled? ______________________

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 2B

Groundwater Monitoring Well Development

Revision No. 1

Approved By:

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

Date 6/24/94

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes procedures to develop wells that have been properly installed. Typically, fine soil particles are entrained within the filter pack and adjacent formation during well installation. The well development procedures described herein are intended to help remove the fine soil particles, resulting in enhanced hydraulic response of the well and increased representativeness of groundwater samples collected from the well for chemical analysis.

Typically, this SOP will be used to develop 2- or 4-inch-diameter groundwater monitoring wells and occasionally larger diameter monitoring or pumping wells, all screened within a single groundwater zone. The procedures described herein may also need modification if floating product or an immiscible dense layer (sinker) is observed in the well.

Well development activities generally include decontaminating the downhole equipment, repetitive combinations of surging/swabing and overpumping/bailing, measurement and observation of well yield, turbidity, and field parameters, and containerizing the development wastewater. Development is typically conducted until no further improvement in well response and turbidity is observed or a reasonable time has been devoted to development.

2.0 Equipment and Materials

- Pressure washer or steam cleaner.
- Buckets and bristle brushes for decontamination.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- Clean water.
- Steel, 55-gallon, open-top drums that meet the specification of DOT 17H.
- Field organic vapor monitor.
- Glass beaker, ±250 milliliter for measurement of field parameters. A similar flow-through cell may also be used.
- Water level meter.

- Drum labels, Well Development Log, Drum Inventory Sheet, and field notebook.

- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters.

- Vented surge block or swab of appropriate diameter for the screened interval of the well casing. (Do not use a swab on PVC well casing).

- Bailing and/or overpumping equipment consisting of one or a combination of the following:

  Bailer: Stainless steel or PVC. Dedicated or new bailer rope. Generally as large a diameter as will fit down well.

  Surface Centrifugal Pump: Limited to water lift of approximately 20 feet. Dedicated or new flexible plastic suction hose. Foot valve and flow control valve optional.

  Air-Lift Pump: Dual-casing assembly with eductor casing (outer casing) to extend at least 2 feet beyond inner casing. Foot valve should be provided at the bottom of the eductor casing to prevent release of aerated water into the well when the air lift pump is turned off. Air from compressor should be dual-filtered to remove oil. Clean section of flexible polyethylene pipe and associated connectors to replace existing air compressor hose. (Do not use the air compressor hose.)

  Submersible Pump: Two-inch Grundfos electric submersible pump or equivalent.

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

3.0 Typical Procedures

The following procedures are intended to cover the majority of well development conditions. However, normal field practice requires re-evaluation of these procedures upon encountering unusual or unexpected conditions such as observation of floating product or an immiscible dense layer, measuring elevated pH in the development water, or observation of dramatic increases in turbidity as development progresses. Deviations from the following procedures may be expected and should be documented.

1. Development should generally be initiated after the well sealing materials (grout) have obtained an initial cure. Typically, development may begin 3 to 7 days after well completion.

2. Remove top cap and perform field organic vapor monitoring of well casing.

3. Measure static water level and total depth of well. Compare total depth to well completion diagram. Calculate volume of standing water in casing.

4. Decontaminate downhole equipment in accordance with section 6.0. Verify effectiveness of oil-air separator on air-lift pump prior to use and record in field notebook. Place a clean white cloth over the air discharge, opening the discharge valve fully, and then check the cloth for oil staining.

5. Complete calibration of field equipment and record in field notebook.

6. Begin bailing or overpumping using as high an evacuation rate as possible. Record the following on the Well Development Log (copy attached) at the beginning of development and during each bail/overpump cycle:

   - Volume removed and time
   - pH, temperature, and specific conductance
   - Turbidity (clarity and color)
   - Approximate drawdown and well yield
   - Whether well was bailed/pumped dry
   - Other observations (such as presence of product) as appropriate

   Bail/overpump until at least one casing volume of standing water has been removed. Continue bailing/overpumping if the removed water remains very turbid, indicating removal of fines from the screened interval. Terminate bailing/overpumping upon improvement of clarity.

7. Surge/swab the well to loosen fines from the screened interval. Position vented surge block several feet above the screened interval and surge/swab with upward motion. The

initial surging motion should be relatively gentle. As the surge block is lowered, the force of the surging should be increased. Lower the surge/swab several feet and repeat, keep surging/swabbing progressively lower intervals until the bottom of the screened interval is reached. For each interval, surge/swab for several minutes or as indicated by field experimentation.

8. Repeat items 6 and 7 until evacuated water at the end of the bailing/overpumping cycle is low or non-turbid, field parameters are representative of natural groundwater conditions, and well yield has stabilized at a value representative of the intercepted groundwater zone. Terminate development after a reasonable period of time even if these conditions are not observed. Unless otherwise specified in a Workplan, Quality Assurance Project Plan, or Sampling Plan, 4 hours may typically be taken as a reasonable time effort.

9. Terminate development by bailing or overpumping for an extended period of time to remove fines that have been loosened by the last cycle surging/swabing. Record final observations.

10. Containerize development water and decontamination wastewater in steel drum(s). Affix drum(s) with completed "Caution - Analysis Pending" labels.

4.0 Quality Assuarance and Quality Control (QA/QC)

Meters for measurement of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented in the field notebook.

Quantitative turbidity measurements may be taken with a turbidity meter (both field and laboratory versions are available). If qualitative descriptions of turbidity are used, these terms (high-, moderate-, low-turbidity) may be further defined on the well development log. Representative samples may also be collected and returned to the laboratory for measurement with a turbidity meter.

Because well development is typically the first activity of a newly completed well and because the activity is fairly vigorous, the following precautions may be appropriate:

- If product is observed but not anticipated within the groundwater zone intercepted by a well, and the well penetrated a contaminated overlying groundwater zone, well development may be interrupted subject to further consideration or study. Faulty well sealing may result in migration of product from overlying to underlying groundwater zones, which is exacerbated during development.

- If elevated pH is observed but not anticipated, and the well is being developed soon after completion, well development may be interrupted subject to further consideration or study. Elevated pH may originate from grout that has not yet cured, or from grout infiltration into the filter pack.

- If turbidity increases dramatically after surging/swabbing and does not return to previously observed levels, the cause may be a broken well casing, broken screen, or dislodged end cap, which allows soil to enter the casing unretarded by the filter pack. Probing the well may disclose a break or faulty joint. Consider interrupting well development if this condition is suspected.

5.0 Documentation

The well completion schematic should be taken into the field to serve as reference information. Observations, measurements, and other documentation of the development effort should be recorded on the following:

- Field notebook
- Well Development Log
- Drum Inventory Sheet

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

6.0 Decontamination

Prior to entering the site, well development equipment should be decontaminated by steam cleaning, pressure washing, or equivalent.

Prior to development of each well, downhole equipment should be decontaminated by steam cleaning or pressure washing, washing with soap, and rinsing with tap water, or equivalent.

Equipment should be steam cleaned, pressure washed, or equivalent, after well development is complete.

7.0 Investigation-Derived Waste

Development water and decontamination wastewater should be containerized in steel drums. Drums should be labeled with completed "Caution - Analysis Pending" labels, including: generator's name, accumulation date, a description of contents, and well number of waste origination. Waste from different wells may be combined in single drums, but suspected chemically-affected and clean wastes should not be mixed.

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.

Nielson, D.M., 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 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?

[illegible]

Date Client Informed? ____________________ All drums labeled? ____________________

BLYMYER ENGINEERS, INC.

WELL DEVELOPMENT LOG

Page ______ of ______

All measurements taken from: ❐ Top of Casing ❐ Protective Casing ❐ Ground Level

Well Number: ____________
Date: ____________
Time Start: ________ End: ________
Client: ____________
Project: ____________
Job Number: ____________
Installation Date: ____________
Well Diameter: ____________
Condition of Manhole Locking Cap: ____________

Borehole Diameter: ____________
Screen Length: ____________
Measured Depth (pre-development): ____________
Static Water Level (ft.): ____________
Standing Water Column (ft.): ____________
One Well Volume (gal.): ____________
One Annulus Volume (gal.): ____________
Equipment Calibrated: ____________

Qty. of Drilling fluid Lost: ____________
Minimum Gal. to be Purged: ____________
Development Method: ____________
Purging Equipment: ____________
Water Level Equipment: ____________
T/pH/EC Meter: ____________
Turbidity Meter: ____________
Other: ____________

Time	Amount Purged (gal)	Field Parameters Measured						Comments	Field Tech.
		EC	pH	Temperature	Turbidity	PID			

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