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Alameda County
Environmental Health

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Nov 29, 2007

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

Re: Perjury Statement
Former J & R Automobile Dismantlers
819 – 823 East 12th Street
Oakland, California
SLIC Case # RO00002475

Dear Mr Wickham,

"I declare under penalty of perjury, that the information and / or recommendations contained in the attached proposal or report is true and correct to the best of my knowledge."

Tuong Tran, Owner

cc. Mr. Mark Detterman, Blymyer Engineers, Inc.

Revised Remedial Action Plan

Former J & R Automobile Dismantlers
819-823 East 12th Street
Oakland, California
SLIC Case # RO0002475

11/16/2007
BEI Job No. 207068

Prepared for:

Mr. Tuong Tran
Tranvu, LLC
526 Calero Avenue
San Jose, CA 95123

Prepared by:

Blymyer Engineers, Inc.
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Limitations

Services performed by Blymyer Engineers, Inc. have been provided in accordance with generally accepted professional practices for the nature and conditions of similar work completed in the same or similar localities, at the time the work was performed. The scope of work for the project was conducted within the limitations prescribed by the client. This report is not meant to represent a legal opinion. No other warranty, expressed or implied, is made. This report was prepared for the sole use of the client, Tranvu, LLC.

Blymyer Engineers, Inc.

By:____________________________

Mark E. Detterman, CEG
Senior Geologist

PROFESSIONAL GEOLOGIST
MARK E. DETTERMAN
No. 1788
CERTIFIED ENGINEERING GEOLOGIST
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STATE OF CALIFORNIA

And:____________________________

Michael S. Lewis, REA
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1.0 Introduction

1.1 Background

On May 20, 1996, Basics Environmental (Basics) visited the subject site (Figures 1 and 2) for the purposes of conducting a *Phase I Environmental Site Assessment* (ESA). The Phase I ESA report was issued by Basics on May 22, 1996. In the Phase I ESA, Basics documented the presence of heavy oil and grease staining on the floor inside the then existing building at the front of the property, and on the unpaved soil surface to the rear of the building where vehicles had formerly been stored for their parts. Distressed vegetation was noted in the central region of the rear unpaved yard behind the existing building. Three unlabeled 55-gallon drums were present in the rear yard; one in the corner formed by the former building and the building on the adjacent property, and two towards the rear of the property along the southeastern property line. Basics determined that a cleanup order had been issued for this contamination by the Alameda County Environmental Health Services (ACEHS) in 1991, and that the subject site was shown as an active site on the Regional Water Quality Control Board's Fuel Leak List.

In the Phase I ESA, Basics also noted that the adjacent building on the northeast was at that time a "Body and Fender Shop" and had formerly been a "Truck Body Assembly" shop. The adjacent building on the southeast was a "Sewing / Garment Factory" in 1996; however, Basics found that it had formerly been used for "Paint Shop and Storage". To the south and southwest (behind the subject property) was also a "Sewing / Garment Factory" in 1996; however, Basics found that it had formerly been used as a "Truck Body Works".

In the Phase I ESA, Basics recommended compliance with the ACEHS cleanup order, the development of a workplan to assess the condition of soil and groundwater beneath the subject site, and also recommended that the contents of the 55-gallon drums be determined and then properly disposed of. Towards that end, Basics developed a workplan under the guidance of ACEHS personnel for subsurface investigation at the site. In the *Phase II Environmental Site Investigation* report dated September 25, 1996, Basics reported on a subsurface investigation in the unpaved area. The work consisted of the installation of four soil bores (B1 through B4, Figure 2) to a depth of 16 to 19 feet below ground surface (bgs). Soil samples were collected at 0.5 feet, 5 feet, 10 feet and 15 feet bgs in each soil bore. Grab groundwater samples were collected from three of the soil bores. All samples were analyzed for Total Recoverable Petroleum Hydrocarbons (TRPH; EPA Method 418.1) and the five metals associated with leaking underground fuel tanks (LUFT; cadmium, chromium, lead, nickel and zinc). Concentrations of TRPH up to 19,000 milligrams per kilogram (mg/kg) and lead up to 870 mg/kg were detected in the soil samples collected at 0.5 feet bgs. TRPH concentrations were non-detectable in the soil samples at 5 feet bgs, indicating that the heavy oil contamination observed during the Phase I ESA was limited to near-surface soil. TRPH was found in two of the soil bores at a depth of 10 feet bgs and in one of the grab groundwater samples. Basics attributed the deeper soil and groundwater contamination to another source, possibly a former sump located in the unpaved area. The ACEHS issued a ASecond Notice of Violation,@ dated March 21, 2001, requesting a technical workplan to delineate soil and groundwater contamination at the site. The letter requested submittal of a workplan by April 23, 2001.

On June 27, 2001, Blymyer Engineers issued a workplan entitled *Phase II Subsurface Investigation Workplan* to the ACEHS. The ACEHS approved the workplan, with modifications, in a letter entitled *Work Plan Approval*, dated July 2, 2001. The ACEHS requested an additional soil bore be advanced in, or near, the former sump and that the grab groundwater samples be collected in non-preserved bottles. Blymyer Engineers responded in a letter to the ACEHS entitled *Modified Bore Locations for Phase II Subsurface Investigation Workplan*, dated July 11, 2001. In the referenced Blymyer Engineers letter, bore B8 was relocated to the depression identified as the former sump, in that it would be reasonably considered a worst-cast location. The referenced letter also included a fifth bore (B9) at the former location of B8, and the collection of two soil samples at a depth of 2 feet bgs in bore B9 and B7, in an attempt to limit the vertical depth of elevated metal concentrations. These modifications were verbally accepted by the ACEHS in a telephone conversation on July 24, 2001.

On August 7, 2001, Blymyer Engineers installed four soil bores to depths ranging between 20 to 24 feet bgs at the site (Figure 2), and a fifth bore to a depth of 2.5 feet bgs. The soil bores were installed using a Geoprobe hydraulic push system. Soil was collected continuously in isobutylene sleeves and soil samples were collected for lithologic description and organic vapor field-screening with a Photoionization Detector (PID). Groundwater was encountered in each bore at between approximately 14 to 18.5 feet bgs, but field stabilized at higher elevations depending on the length of time the bore was allowed to remain open. Soil samples were selected for laboratory analysis based upon depth and elevated PID readings.

Temporary PVC well screen was placed in each deeper soil bore in order to collect grab groundwater samples for laboratory analysis. When obtained, the grab groundwater sample from each bore was noted as turbid. After collection of the groundwater samples, all soil bores were backfilled with bentonite grout. The soil cuttings from the advancement of the soil bores were contained in labeled, DOT-approved, 5-gallon pails, pending proper disposal by the owner.

The soil and groundwater samples were sent to a California-certified laboratory. The soil and groundwater samples were analyzed for TRPH using EPA Method 418.1 and the five LUFT metals using EPA Method 6010. The grab groundwater samples were filtered by the laboratory prior to analysis. The three soil samples and two grab groundwater samples with the highest TRPH concentrations were additionally analyzed for Volatile Organic Compounds (VOCs) using EPA Method 8240 and Semi-VOCs (SVOCs) using EPA Method 8270. Soil sample B9-2, collected for metals analysis, was additionally analyzed for TRPH. Analytical results for the soil samples are summarized in Tables I and II, while analytical results for groundwater samples are summarized in Table III. Table IV contains the results of the geotechnical soil sample analysis.

In general, the site is underlain by a minimum of 6 feet of silty clay; however, the silty clay or clayey silt did extend to a depth of 15.5 feet bgs in B6. Beneath the silty clay in most other soil bores, clayey gravel was encountered. The bottom of the clayey gravel was encountered at depths ranging from 10.5 to 15 feet bgs. A second silty clay was encountered beneath the clayey gravel and extended to depths ranging from 12 to 18 feet bgs. Beneath this silty clay an intermix of more granular bedding units was encountered. Groundwater was generally associated with these more granular units. It is suspected, but not confirmed, that groundwater is confined.

The following conclusions were made from the data generated during the subsurface investigation at the site (*Subsurface Investigation and ASTM RBCA Health Risk Assessment*, dated January 11, 2002):

- $ Detectable concentrations of TRPH are present in all near surface soil at the site, and appear to extend to an approximate depth of up to 3.5 feet bgs. Elevated concentrations of TRPH are present within the stained area of distressed vegetation, and additionally at bore B2.

- $ Discolored soil is present to a depth of approximately 3.5 feet bgs and again from 10.5 feet bgs to 16.5 feet bgs in bore B7. A zone of relatively non-discolored soil appears to separate the two zones. A similar separation of discolored soil has previously been observed in bores B2, B3, and B4.

- $ A very soft, potential void was encountered at a shallow depth during the installation of bore B7. A bit of metal and dark oily blobs were also noted at depth in this bore and may also suggest additional fill (or sumps) may have previously been present at the site.

- $ Except for minor layers, discolored soil is present from the surface to total depth in bore B8b.

- $ Bore B8a appeared to encounter fill and highly impacted soil to the total explored depth of 12 feet bgs.

- $ Except for the surface detection of TRPH in bores B5 and B6, and a thin, potentially discolored, water-bearing zone in bore B6, soil from bores B5 and B6 appeared to be largely non-impacted.

- $ Elevated concentrations of each of the five LUFT metals are present in the vicinity of the depression identified as a sump (B8). These concentrations are above 10 times the Soluble Threshold Limit Concentration (STLC) value or above the Total Threshold Limit Concentration (TTLC) for some of the metals.

- $ Near surface stained soil (bores B1, B2, B3, B4, B5, B7, and B8) consistently contained lead concentrations over one or more regulatory value (STLC or TTLC).

- $ Toluene, ethylbenzene, and total xylenes were the only detectable VOCs present in heavily impacted soil samples. This suggests that gasoline or diesel may have been used and disposed of at the site.

$ The significant increase in toluene, ethylbenzene, and total xylenes at a depth of 15 feet in bore B8b may suggest a second, petroleum-fuel-related source is impacting the site.

$ The only SVOCs detected at the site were 2-methylnaphthalene and naphthalene.

$ TRPH was present in all grab groundwater samples submitted for analysis. Elevated concentrations were present in bore B8b. Elevated concentrations of benzene, toluene, ethylbenzene, and total xylenes (BTEX) were present only in the grab groundwater sample collected from bore B8b. These compounds were present above their respective Maximum Contaminant Levels (MCLs); however the laboratory noted that the groundwater sample contained over 5% suspended sediment. This may indicate that the higher result is representative of the suspended sediment rather than dissolved concentrations in groundwater.

$ Only cadmium was present in one filtered, non-preserved grab groundwater sample, at a concentration slightly above the MCL. No other metals were detected in the groundwater samples.

$ Use of the Oakland Risk-Based Corrective Action (ORBCA) or San Francisco - Regional Water Quality Control Board (SF-RWQCB) risk assessment programs is inappropriate at this site due to the presence of more than five contaminants of concern (a prerequisite for use).

The following conclusions were made from the data generated during the health risk evaluation of the contaminants at the site in the cited report:

$ Two principal assumptions were employed to generate the risk evaluation:

  $ Preclusion of residential soil exposure by remedial actions and/or capping

  $ On- or off-site groundwater ingestion is not a complete pathway, except at a relatively unlikely exposure at a hypothetical old hand dug well

$ For all modeled contaminants, health-based risks including carcinogenic target risks and toxic hazard quotient and hazard indexes were not exceeded onsite, and are significantly below the appropriate risk goal.

$ With first-order biodegradation allowed, only the groundwater source (sump) concentration of benzene exceeded offsite Point of Exposure (POE) limits at the property line (MCL limit) and at the unlikely, but potential, residential hand dug well POE.

$ In order to eliminate offsite degradation of groundwater over MCL concentrations, a reduction in groundwater benzene source concentrations from 1.7 mg/L to 3.9 Fg/L would be required. This also eliminates the residential occupant exposure to groundwater via a hand dug well.

$ Lead was excluded from the analysis due to the lack of a published Reference Dose (RfD) for lead by the EPA. The SF - RWQCB promulgated remedial goals were relied on as an alternative method to define a SSTL for lead. To meet these concentration limits, a reduction in the concentration of lead to 255 mg/Kg at the site would be required, unless otherwise negotiated with the SF-RWQCB.

1.2 Further Regulatory Discussions

In further discussing the project with Mr. Roger Brewer of the SF-RWQCB, a known association between older auto dismantler facilities and the scrapping of polychlorinated biphenyl (PCB)-oil containing transformers has been documented in the Bay Area. Mr. Brewer recommended that possible PCB impacts be investigated.

1.3 Geophysical Survey

An additional geophysical investigation was conducted under the direction of Blymyer Engineers. The results are contained herein.

1.3.1 Purpose

On July 11, 2002, Norcal Geophysical Consultants (Norcal), under the direction of Blymyer Engineers, conducted a geophysical survey at the site. The survey was conducted to address the following issues:

$ A significant jump in VOC concentrations was noted at groundwater in soil bore SB8-B. This suggested that an underground storage tank (UST) might be a source of these contaminants and it was recommended that an onsite investigation be conducted due to this potential.

$ One known sump was located at the site and it was judged possible that additional unknown sumps might exist, particularly in light of the discovery of elevated concentrations of TRPH and metals at depth in bore B7, and other current surface depressions in the vicinity of bore B7, at some distance to the known sump.

1.3.2 Results

Norcal conducted geophysical investigations at the site using vertical magnetic gradient (VMG), terrain conductivity (TC), hand-held metal detector (MD), and ground penetrating radar (GPR) techniques. Contour maps were generated for the VMG and TC data sets. A report of the results and associated contour maps is included as Appendix A to this RAP.

The VMG data contour map indicates numerous boundary magnetic effects, likely the result of the perimeter sheet metal and chain-link fences. Additionally, two areas were detected and mapped with closed contours (Abull=s eyes@). The areas are small in size and are closely associated with two MD anomalies. It was suggested that the anomalies could be produced by relatively minor metal debris such as A...balls of wire, paint can lids, short sections of metal pipes, etc.@

The TC data contour map also indicates boundary magnetic effects, again likely the result of the sheet metal and chain-link fences, or large aboveground structures outside of the investigation area. Additionally, one large closed contour anomaly area was mapped. The area is located beneath and southwest of the surficial physical expression of the sump. Because the anomaly is not associated with VMG or MD anomalies, it indicates, at a minimum, a disturbance of soil. Additional causes for the TC anomaly provided by the report are burial of non-ferrous materials such as wood or concrete.

The results of the GPR survey were inconclusive. Additional unknown sumps, or an onsite UST, were apparently not located by the survey. It should be noted that an area 5 feet in width around the perimeter property boundary of the site could not be surveyed due to the sheet metal and chain-link fence lines. The perimeter fence additionally did not allow the geophysical survey to extend into the public sidewalk, used at numerous sites for UST burial. For further details, please consult the geophysical report attached as Appendix A.

1.4 Recent Events

On June 28, 2007, Mr. Jerry Wickham of the ACEHS issued a letter responding to June 15, 2007, letter from Tranvu, LLC (Tranvu) which requested approval for capping the site with concrete slab floor and foundation for a new building. The ACEHS did not find the proposal suitable for the subject site, and requested a revised RAP that included collection of the following additional subsurface information:

- In addition to the collection of two additional soil samples proposed in the RAP for PCBs, additional pre-excavation sampling was requested using the *Recommended Minimum Verification Analyses* for waste, used, or unknown oils, and
- Collection of soil vapor and groundwater samples following the proposed soil excavations in order to confirm the proposed excavations were effective in removing sources of soil vapor and groundwater contamination. The ACEHS allowed that these tasks could be proposed in the Revised RAP or a separate Work Plan following the excavations.

1.5 Site Conditions

The property is located in the city of Oakland, Alameda County, California (Figure 1). It is bounded on the northeast by 12th Street and on the southeast, southwest, and northwest by commercial buildings. Across 12th Street are located additional commercial buildings. The property is located approximately 1,650 feet north of the Brooklyn Basin of the Alameda - Oakland Estuary. The site is predominately unpaved, with a relatively small concrete slab located in the northeastern portion of the site, immediately adjacent to the 12th Street sidewalk. The building reported in the Phase I ESA was no longer present.

2.0 Remedial Action Goals

Site-Specific Target Levels (SSTLs; remedial action goals) for soil and groundwater were established for all contaminants of concern (COCs) at the site (Table V); however, only the following COCs require remedial actions:

- TRPH (soil):

  Risk analysis indicates that existing contaminant concentrations are not a residential health-risk for future site occupants. The identified residential health-risk was defined to be above the highest concentration present at the site. However, because long term site-specific groundwater monitoring data is not available for the site, and secondary nuisance-based goals may be triggered due to the leaching of heavy hydrocarbons from soil, a secondary nuisance-based screening level remedial action goal will be utilized. For residential facilities, this remedial goal was defined to be 500 milligrams per kilogram (mg/Kg) for motor oil (residual fuels) in surface soil up to approximately 10 feet bgs and 1,000 mg/Kg for soil deeper than 10 feet bgs (*December 2001 Update to Risk-Based Screening Levels for Impacted Soil and Groundwater*, SF-RWQCB, dated December 26, 2001). These remedial goals have not been modified by subsequent revisions to the ESL document (*Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, February 2005*, SF-RWQCB, dated February 2005, with selected revisions dated March 2005).

- Lead (soil):

  At the time the risk analysis was conducted, lead was excluded from the risk analysis due to the lack of a published Reference Dose (RfD) for lead by the EPA. However since that time, the SF-RWQCB included in the February 2005 ESL revision a generic ESL of 150 mg/Kg for lead in residential situations for surface soils to an approximate depth of 10 feet bgs and an ESL of 750 mg/Kg for soil deeper than 10 feet bgs.

- Benzene (groundwater):

Risk analysis indicated that in order to eliminate offsite degradation of groundwater over MCL concentrations, a reduction in benzene source concentrations from 1.7 mg/L to the SSTL of 3.9 Fg/L would be required.

3.0 Additional Remedial Investigation

3.1 Generate a Remedial Investigation Workplan

Blymyer Engineers has generated this Remedial Investigation (RI) Workplan for submittal to the ACEHS. The RI Workplan details the installation of 10 onsite Geoprobe[7] soil bores to address the request for additional pre-excavation soil sampling, and the future installation of up to three groundwater monitoring wells, in order to address the request for groundwater sampling. The wells will not be installed until after the remedial excavations have occurred and will utilize the additional analytical data collected during the Geoprobe[7] investigation and the remedial excavation to assist in the placement of the wells. ACEHS additionally requested the collection of vapor samples in the June 28, 2007 letter. While likely appropriate, Blymyer Engineers has not included the collection of these samples in this workplan in order to judge the appropriateness after reviewing the analytical data to be generated during the Geoprobe[7] investigation, and during the remedial excavation. Upon approval of the RI Workplan, Blymyer Engineers will proceed with installation of the Geoprobe[7] bores.

3.2 Install 10 Geoprobe[7] Soil Bores

Geoprobe[7] soil bores are proposed for the approximate locations indicated in Figure 2. These locations have been selected in order to help determine the extent of contaminated soil that may require remediation.

3.2.1 Secure all Required Permits

Upon acceptance of the workplan completed under Task 1 by the ACEHS, a drilling permit will be obtained from Alameda County Public Works Agency (ACPWA).

3.2.2 Generate Site-Specific Health and Safety Plan

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

3.2.3 Locate Utilities

Offsite utilities will be marked for location by Underground Service Alert (USA). Onsite utilities are not anticipated, thus a private utility locating service will not be employed; however, the bores will be hand cleared to a depth of 4 feet bgs.

3.2.4 Drill Geoprobe[7] Soil Bores

A Geoprobe[7] rig will be scheduled to drill for up to two days in order to install the proposed bores. Generally eight to nine bores can be installed in one day. The Geoprobe[7] bores will be installed as generally depicted in Figure 2, or otherwise modified. The Geoprobe[7] soil bores will be hydraulically pushed to a depth of approximately 20 feet bgs. A continuous soil core will be collected from each bore. All soil samples will be collected in accordance Standard Operating Procedure No. 4 *Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment*.

3.2.5 Field Screen and Collect Soil Samples for Laboratory Analysis

At a minimum of 5-foot intervals, selected soil samples will be collected from the soil cores for field screening using a photoionization detector (PID) and for lithologic description. Sampling intervals will be staggered in order to investigate more depth intervals across the site. On average, three soil samples per soil bore will be submitted for analysis. The soil sample displaying the highest PID reading and the soil sample from the groundwater interface will be collected from each bore for laboratory analysis. Additional samples will be collected in selected Geoprobe[7] bores to investigate the depth of the oil-impacted surface layer, the depth of contamination regardless of the depth to groundwater, or at other depths based on bore-specific discoveries. An estimated 35 samples will be submitted in total. The soil samples will be analyzed for Fuel Fingerprint / Multi-Range Hydrocarbons (specifically including Total Petroleum Hydrocarbons [TPH] as gasoline, TPH as diesel, and TPH as motor oil) by modified EPA Method 8015C; and for benzene, toluene, ethylbenzene, total xylenes, (BTEX) and methyl tert-butyl ether (MTBE) by EPA Method 8021B. The change in analysis specification from Total Recoverable Petroleum Hydrocarbons (TRPH) to TPH will allow a better understanding of contaminants at the site, and a better targeting of future laboratory testing. The soil sample in each bore with the highest PID reading will be reviewed and up to seven of these soil samples will be analyzed for a full volatile organic compound (VOCs) scan by EPA Method 8260B, including all fuel oxygenates (MTBE, di-isopropyl ether (DIPE), ethyl *tert*-butyl ether (ETBE), *tert*-amyl methyl ether (TAME), and *tert*-butyl alcohol (TBA)); lead scavengers (1,2-Dibromoethane (EDB) and 1,2-Dichloroethane (1,2-DCA)), and ethanol and methanol; and Semi-Volatile Organic Compounds (SVOCs) including Poly-Chlorinated Biphenyls (PCB), Polynuclear Aromatic Hydrocarbons (PNAs), and Creosote by EPA Method 8270. If PCBs are detected, additional analysis for dibenzofurans (PCBs) and phencyclidine (PCP) will be required. To help delineate the extent of soil impacted by lead, at an approximate depth of 2 feet bgs, up to eight of the 35 soil samples will be submitted for analysis of total lead by EPA Method 6010. Existing metals analysis indicates that lead is the only metal of concern at the site.

Four grab groundwater samples will be collected from selected Geoprobe[7] bores yielding groundwater. The groundwater samples will be used in order to help determine appropriate disposal methods should groundwater control be required during the remedial excavation. The grab groundwater samples will be submitted for Multi-Range TPH by Modified EPA Method 8015C; a full VOC scan including BTEX, all fuel oxygenates and lead scavengers; for PCBs, PNAs, Creosote by EPA Method 8270.

All samples will be submitted to a California-certified laboratory on a standard 5-day turnaround. The data will be requested to be formatted by the laboratory for uploading and inclusion of site data in the GeoTracker database maintained by the State. Due to the recent inclusion (mid 2005) of SLIC (Spills, Leaks, Investigations, and Cleanups) sites into the State GeoTracker database, this is now required.

3.2.6 Soil Handling

Due to the volume of soil that is anticipated to be generated, all soil cuttings will be stored in a Department of Transportation (DOT)-approved 55-gallon drum for later disposal by the owner. All purge and decontamination water will also be stored on-site in a DOT-approved 55-gallon drum for later disposal by the owner.

3.2.7 Generate Geoprobe[7] Investigation Report

A report on the Geoprobe[7] investigation will be generated for submittal to ACEHS, and will document the work performed and will include summaries of data, tables, figures, and conclusions and recommendations for further work, if warranted.

3.3 Install Three Groundwater Monitoring Wells

Up to three groundwater monitoring wells will be installed post-remedial excavation at locations to be determined in the future, in conjunction with ACEHS. These locations will depend on existing analytical data, analytical data proposed in this workplan, and knowledge of any existing vicinity wells that may be useful for the subject investigation, and will incorporate site development plans. It is currently anticipated that a minimum of two wells will be installed onsite.

3.3.1 Conduct a Regulatory Case File Review

In order to gain a better understanding of local vicinity geology and hydrogeology, and to use all previously generated data, Blymyer Engineers will review the ACEHS regulatory file for the Cakebread=s Garage UST site located at 802 East 12th Street. This file contained no information when last reviewed by Basics Environmental in May 1996. Some work may have been completed in the intervening period of time. Groundwater contamination may emanate from the site, and may in part be responsible for the elevated concentration of gasoline-related fuel hydrocarbons in groundwater at the subject site. This review will also assist in determining alternative placement of the proposed groundwater monitoring wells, and may minimize the need for additional wells in the future.

3.3.2 Secure all Required Permits

Upon concurrence by the ACEHS of the number and position of the proposed groundwater monitoring wells, well permits will be obtained from the Alameda County Public Works Agency and the City of Oakland, should offsite work be agreed upon.

3.3.3 Install and Develop up to Three Groundwater Monitoring Wells

Using a hollow-stem auger drill rig, the well soil bores will be drilled to a depth of approximately 25 feet bgs for later conversion to monitoring wells. All soil samples will be collected in accordance with the Blymyer

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

The soil bores will be converted to 2-inch-diameter, PVC-cased, groundwater monitoring wells, which will be properly developed. A minimum of six well volumes of groundwater will be removed from the wells a minimum of 72 hours after installation to allow the grout and concrete to properly set. The wells 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 wells will be installed in accordance with the Blymyer Engineers' *Standard Operating Procedure No. 2A, Completion of Borings as Groundwater Monitoring Wells* and the Blaine Tech Services, Inc. (Blaine) *Standard Operating Procedures* for groundwater well development (Appendix C).

3.3.4 Field screen and collect soil samples for laboratory analysis

Soil samples will be collected from the soil bores at a minimum of 5-foot intervals for field screening using a PID and for lithologic description. The two soil samples displaying the highest PID readings or the soil sample from the groundwater interface will be collected for laboratory analysis. The soil samples will be analyzed at a minimum for the appropriate TPH range (as gasoline, as diesel, or as motor oil, depending on the results of the Geoprobe[7] investigation and the remedial excavation) by modified EPA Method 8015C; for BTEX and MTBE by EPA Method 8021B; and for all fuel oxygenates, lead scavengers, and ethanol and methanol by EPA Method 8260B. Additional analysis for lead by EPA Method 6010, VOCs by EPA Method 8260B; PCBs, PNA, or Creosote by EPA Method 8270 may also be performed depending on the results of the Geoprobe[7] soil bores investigation. The soil samples will be submitted to a California-certified laboratory on a standard 5-day turnaround.

3.3.5 Collect groundwater samples for laboratory analysis

Following development and purging of the monitoring wells, a groundwater sample will be collected from each well and will be submitted to a California-certified laboratory for analysis including the appropriate TPH range by modified EPA Method 8015 and BTEX / MTBE by EPA Method 8021B at a minimum. Additional analysis may also include all fuel oxygenates, lead scavengers, ethanol, and methanol by EPA Method 8260B, or any other detected chemical compound of interest. Groundwater samples will be obtained a minimum of 72 hours after well development to allow the water-bearing zone to recover from development. All groundwater sample collection procedures will be performed in general accordance with the Blaine Tech Services *Standard Operating Procedures* for groundwater gauging and sampling (Appendix C).

3.3.6 Survey wells

In order to determine the groundwater flow direction and groundwater gradient, Blymyer Engineers will coordinate a survey of the top-of-casing elevation and horizontal position of the wells to GeoTracker standards.

3.3.7 Manage soil and groundwater waste

Soil generated during drilling will be placed in DOT-approved 55-gallon open top drums and retained onsite for later disposal by the owner. All decontamination, purge, and development water will be stored on-site in DOT-approved 55-gallon drums for later disposal by the owner.

4.0 Revised Remedial Action Plan Scope of Work

4.1 Prepare a Revised Remedial Action Plan for Submittal to the ACEHS

Blymyer Engineers has prepared this revised Remedial Action Plan (RAP) to describe the proposed work and to document standard operating procedures. Further revision of the RAP may be appropriate after data is obtained from the Geoprobe[7] investigation and prior to implementation of remedial actions.

4.2 Generate an RFP for Remedial Excavation

A Request for Proposal (RFP) will be generated to seek a minimum of three competitive bids from qualified remedial contractors holding appropriate hazardous waste licenses. Blymyer Engineers can assist in pre-selecting qualified contractors and analyzing resulting competitive bids. A pre-bid site walk will be mandatory.

4.3 Generate a Health and Safety Plan for Level C Site Control

A health and safety plan (HASP) will be generated to outline potentially hazardous work conditions and contingencies for an emergency. The HASP will be reviewed and signed by a Certified Industrial Hygienist (CIH) due to Level C site safety control required by the surface lead contamination documented at the site, and will be protective of the general public. Should PCBs or other additional contaminants be detected during the Geoprobe[7] investigation the data will be incorporated into the HASP.

4.4 Remove Upper 1.5 to 2 Feet of Lead- and TRPH / TPH-Impacted Soil

Blymyer Engineers will oversee the remedial contractor excavate and stockpile the upper 1.5 to 2 feet of lead- and TRPH / TPH-impacted soil. Dust emissions will be controlled by the application of water spray, or other dust control measure. The stockpiles will be covered with heavy plastic sheeting (minimum 8 mils) to control fugitive dust emissions after excavation, pending stockpile characterization. Efforts to segregate heavily contaminated material from less contaminated material will be undertaken in order to attempt to minimize disposal cost. An estimated 325 to 575 cubic yards of soil (un-fluffed) will be generated depending on the depth of stripping. Final excavation depth will be determined by laboratory analysis, and any available future data.

4.5 If Required, Explore VMG and TC Anomalies

Further exploration of the two VMG and MD anomalies will be undertaken by pothole excavation if the likely causes of these anomalies are not discovered during the excavation of the upper several feet of soil at the site.

4.6 Collect Near Surface Excavation Confirmation Samples and Submit to Laboratory

Soil samples will be collected from the bottom and sidewalls of the near surface soil excavation (and any VMG or MD anomaly excavation if appropriate) in order to confirm the removal of TRPH / TPH and lead to the appropriate SSTLs. As planned, the excavation will initially be selectively sampled to determine if the assumed initial removal depth will achieve the SSTLs. Final clearance bottom and sidewall samples will be collected according to the following schedule:

- Sidewall samples: One grab soil sample for every 20 feet of linear sidewall. Soil samples will be positively biased towards soil with residual impacts.

- Bottom samples: The excavation bottom will be subdivided into an approximately equal-dimensional grid pattern (approximately fifty - 12 foot by 10 foot grids), each will be numbered, and a random number generator will be used to select 20 grids for final clearance analytical sampling. Soil samples will be positively biased towards soil with residual impacts within each grid.

The soil samples will be submitted to and analyzed by a California-certified laboratory on a standard 1-week turnaround for the appropriate TPH range(s) Modified EPA Method 8015 and total lead using EPA Method 6010. An estimated 20 to 30 soil samples will be submitted for bottom confirmation, and approximately 20 soil samples will be submitted for sidewall confirmation of the lateral excavation limits.

4.7 Characterize Stockpiles for Disposal Purposes

After the results of the final excavation clearance samples are available and it has been determined that the SSTLs have been achieved, the soil excavation stockpiles will be characterized for disposal purposes. A four-point composite will be collected for each 250 yards of stockpile volume, or as otherwise required by the selected disposal facility. Each composite will be submitted to and analyzed by a California-certified laboratory on a standard 1-week turnaround for the appropriate TPH analysis by Modified EPA Method

8015, VOCs using EPA Method 8260B, appropriate SVOCs by EPA Method 8270, and the seventeen California Metals (CAM 17) by various appropriate EPA methodologies. The results will be reviewed to help identify the appropriate disposal location.

Should analyte concentrations indicate that all or portions of the stockpiled soil be potentially hazardous, selective additional analytical testing will be conducted. Additional analysis may include a Reactivity, Corrosivity, and Ignitability (RCI) panel, and the Soluble Threshold Limit Concentration (STLC) Waste Extraction Test (WET) for selected metal contaminants exceeding the applicable Total Threshold Limit Concentrations (TTLC) regulatory levels (California Title 22), or the Toxicity Characteristic Leaching Procedure (TCLP) for selected metals exceeding the TTLC or STLC. All tests will be conducted using appropriate California or Federal EPA methodologies.

4.8 Transport Near Surface Excavated Soil Offsite

The soil stockpile will be managed and transported offsite under manifest to an appropriate designated disposal facility. The facility will be selected in consultation based on the results of the analytical characterization program, and the resulting cost and long-term liability that will be realized by Tranvu. Dust emissions will be controlled by the application of water spray, or an alternative dust palliative. Dust control measures such as trailer tarping will be instituted during transportation to the selected disposal facility.

4.9 Excavate Known Sump and Other Identified Problem Areas

4.9.1 Known Sump

Excavation of the sump will be focused on the visible surface depression located approximately mid-lot at the site. The extent of the excavation is currently unknown; however, the Geoprobe[7] investigation will provide additional resolution of the size and scope of any excavation. The size and depth of the remedial excavation will be determined in conjunction with Tranvu and ACEHS, prior to generation of the RFP. Dust emissions will be controlled by the application of water spray, or another dust palliative. The stockpile generated will be covered with heavy plastic sheeting (minimum 8 mils) to control fugitive dust emissions after excavation. Efforts to segregate heavily contaminated material from less contaminated material will be undertaken in an attempt to minimize disposal cost. At the present time, an estimated minimum of 125 to

275 cubic yards of soil is likely to be generated depending on the size of the final sump excavation. Based on the results of the TC geophysical survey conducted at the site (Appendix A), the sump may extend another approximately 20 to 30 feet to the southwest. Final excavation depth will extend to at least groundwater (encountered at between 14 to 18 feet bgs); however, laboratory analysis will determine the lateral extent of the excavation.

4.9.2 Soil Bore B7

Amorphous blobs of oil were also encountered at a depth of 14.5 feet bgs in soil bore B7. When laboratory analyzed, the soil sample yielded a concentration of 2,400 mg/Kg TRPH. Additionally, a soft zone was identified by the driller and metal bits (the latter potentially dragged down from the surface) were encountered at a depth of 7 to 9 feet bgs in the bore. Further, there are several relatively minor surface depressions in the vicinity of the bore location. Although these depressions do not appear to be the site of unauthorized surface discharges, other previously used and currently unknown sumps may be located in proximity to bore B7. These areas will be explored in the Geoprobe[7] Investigation and may also require excavation. The extent of any excavation in this area will be determined in conjunction with Tranvu and the ACEHS prior to generation of the RFP.

4.10 Collect Excavation Confirmation Soil Samples and Submit to Laboratory

Soil samples will be collected from the sidewalls of required soil excavations in order to confirm the removal of TRPH / TPH, BTEX, lead, or other potential contaminants to the appropriate SSTLs. The sidewall samples will be collected according to the following schedule:

- Sidewall samples: One grab soil sample for every 20 feet of linear sidewall will be collected and will be positively biased towards samples with residual soil impacts.

- Bottom samples: Excavation bottom samples will be collected to document the extent of removal vertically. The bottom will be divided into a minimum of two representative grids and a soil sample will be collected from each gird. Soil samples will be positively biased towards soil with residual impacts within each grid.

The soil samples will be submitted to and analyzed by a California-certified laboratory on a standard 1-week turnaround for TPH for the appropriate range by Modified EPA Method 8015, BTEX by EPA Method 8021B, total lead by EPA Method 6010, and other appropriate analytical methods yet to be determined.

4.11 Potential Application of Remedial Compounds to Deep Remedial Excavation(s)

After determining the lateral and vertical limits for both deep remedial excavation(s), Oxygen Releasing Compound (ORC) or other remedial compounds may be applied, according to the manufacturer's specifications, to the open excavations. This application will assist in achieving degradation of any groundwater contaminant plume. Details of any planned applications will be contained in an amendment to the RAP.

4.12 Characterize Stockpiles for Disposal Purposes

After the results of the final excavation clearance samples are available and it has been determined that the SSTLs have been achieved, the soil excavation stockpiles will be characterized for disposal purposes. A four-point composite will be collected for each 250 cubic yards of stockpile volume, or as otherwise required by the selected disposal facility. Each composite will be submitted to and analyzed by a California-certified laboratory on a standard 1-week turnaround for an appropriate TPH range(s) by Modified EPA Method 8015, VOCs by EPA Method 8260B, SVOCs using EPA Method 8270, CAM 17 metals using various appropriate EPA methodologies, or other appropriate analytical compounds. The results will be reviewed to help identify the appropriate disposal location(s).

Should analyte concentrations indicate that all or portions of the stockpiled soil be potentially hazardous, selective additional analytical testing will be conducted. Additional analysis may include an RCI panel, and the STLC WET for selected metal contaminants exceeding the applicable TTLC regulatory levels, or the TCLP for selected metals exceeding the TTLC or STLC. All tests will be conducted using appropriate California or Federal EPA methodologies.

4.13 Transport Sump and Other Excavation Soil Offsite

Soil stockpiles will be managed and transported offsite under manifest to an appropriate designated disposal facility. The facility will be selected in consultation with Tranvu based on the results of the analytical characterization program, and the resulting cost and long-term liability that will be realized. Dust emissions will be controlled by the application of water spray, or an alternative dust palliative. Dust control measures such as trailer tarping will be instituted during transportation to the selected disposal facility.

4.14 Backfill All Excavations

All resulting excavations will be backfilled to the required construction subgrade with appropriate import fill materials and to an appropriate density for structural support. The determination of construction subgrade will be identified by others. Compaction testing will document the adequacy of the excavation backfill.

4.15 Generate a Corrective Action Summary Report

A Corrective Action Summary Report will be generated at the completion of all phases of corrective action at the site. The report will include summaries of data and conclusions and recommendations for further work, if required. A report on the installation of three groundwater monitoring wells will be submitted under a separate cover. Appropriate methodology for the collection of vapor samples, or other actions, will additionally be identified at that time.

Tables

Table I, Results of Soil Sample Hydrocarbon, VOC, and SVOC Analysis
BEI Job No. 207068, Tranvu, LLC
819-823 East 12th Street, Oakland, California

Sample I.D.	Depth	Sample Date	EPA Method 418.1	VOCs EPA Method 8240[1]				SVOCs EPA Method 8270	TOC EPA Method 9060
	(feet)		TRPH (mg/Kg)	Benzene (Fg/Kg)	Toluene (Fg/Kg)	Ethylbenzene (Fg/Kg)	Total Xylenes (Fg/Kg)	(mg/Kg)	(mg/Kg)
B1-1*	0.5	9/16/96	**600**	NA	NA	NA	NA	NA	NA
B1-2*	5	9/16/96	<10	NA	NA	NA	NA	NA	NA
B1-3*	10	9/16/96	<10	NA	NA	NA	NA	NA	NA
B2-1*	0.5	9/16/96	**4,400**	NA	NA	NA	NA	NA	NA
B2-2*	5	9/16/96	<10	NA	NA	NA	NA	NA	NA
B2-3*	10	9/16/96	**5,300**	NA	NA	NA	NA	NA	NA
B3-1*	0.5	9/16/96	**19,000**	NA	NA	NA	NA	NA	NA
B3-2*	5	9/16/96	<10	NA	NA	NA	NA	NA	NA
B3-3*	10	9/16/96	<10	NA	NA	NA	NA	NA	NA
B4-1*	0.5	9/16/96	**89**	NA	NA	NA	NA	NA	NA
B4-2*	5	9/16/96	<10	NA	NA	NA	NA	NA	NA
B4-3*	10	9/16/96	**340**	NA	NA	NA	NA	NA	NA
B5-0.5	0.5	8/7/01	**32**	NA	NA	NA	NA	NA	NA
B5-5	5	8/7/01	**13**	NA	NA	NA	NA	NA	NA
B5-10	10	8/7/01	<10	NA	NA	NA	NA	NA	NA
B5-15	15	8/7/01	<10	NA	NA	NA	NA	NA	NA

Table I, Results of Soil Sample Hydrocarbon, VOC, and SVOC Analysis
BEI Job No. 207068, Tranvu, LLC
819-823 East 12th Street, Oakland, California

Sample I.D.	Depth	Sample Date	EPA Method 418.1	VOCs EPA Method 8240[1]				SVOCs EPA Method 8270	TOC EPA Method 9060
	(feet)		TRPH (mg/Kg)	Benzene (Fg/Kg)	Toluene (Fg/Kg)	Ethylbenzene (Fg/Kg)	Total Xylenes (Fg/Kg)	(mg/Kg)	(mg/Kg)
B6-0.5	0.5	8/7/01	**26**	NA	NA	NA	NA	NA	NA
B6-5	5	8/7/01	<10	NA	NA	NA	NA	NA	715
B6-10	10	8/7/01	<10	NA	NA	NA	NA	NA	NA
B6-15	15	8/7/01	<10	NA	NA	NA	NA	NA	260
B7-0.5	0.5	8/7/01	**330**	NA	NA	NA	NA	NA	NA
B7-2	2	8/7/01	NA	NA	NA	NA	NA	NA	NA
B7-7.5	7.5	8/7/01	<10	NA	NA	NA	NA	NA	NA
B7-10	10	8/7/01	<10	NA	NA	NA	NA	NA	NA
B7-14.5	14.5	8/7/01	**2,400**	NA	NA	NA	NA	NA	NA
B8B-0.5	0.5	8/7/01	**54,000**	<10	**50**	**30**	**240**	<8.0 to 40	NA
B8B-5.5	5.5	8/7/01	**1,100**	NA	NA	NA	NA	NA	NA
B8B-10	10	8/7/01	**600**	<5.0	<5.0	**58**	**110**	<0.33 to 1.6[2]	NA
B8B-15	15	8/7/01	**7,900**	<100	**140**	**1,400**	**11,000**	<1.0 to 5.0[3]	NA
B9-2	2	8/7/01	**54**	NA	NA	NA	NA	NA	NA

Table I, *Results of Soil Sample Hydrocarbon, VOC, and SVOC Analysis*; continued

Notes:	EPA	=	Environmental Protection Agency
	mg/Kg	=	milligrams per kilogram (parts per million)
	Fg/Kg	=	micrograms per kilogram (parts per billion)
	VOC	=	Volatile organic compounds
	SVOC	=	Semi-volatile organic compounds
	TOC	=	Total Organic Carbon
	NA	=	Not analyzed
	N/A	=	Not applicable
	*	=	Collected by Basics Environmental in 1996
	B7-15	=	Sample number: e.g. Bore 7 at a depth of 15 feet below grade surface
	[1]	=	All other VOC analytes were non-detectable at elevated limits of detection. Please see the laboratory report for details.
	[2]	=	2-Methylnaphthalene and Naphthalene detected at **0.36** and **0.38** mg/Kg, respectively. All other SVOC analytes were non-detectable at the indicated elevated limits of detection.
	[3]	=	2-Methylnaphthalene and Naphthalene detected at **6.0** and **7.2** mg/Kg, respectively. All other SVOC analytes were non-detectable at the indicated elevated limits of detection.

Results in **bold** indicate detectable concentrations.

Table II, Results of Soil Sample Metal Analysis BEI Job No. 207068, Tranvu, LLC 819-823 East 12th Street, Oakland, California							
Sample I.D.	Depth (feet)	Sample Date	EPA Method 6010				
			Cd (mg/Kg)	Cr (mg/Kg)	Pb (mg/Kg)	Ni (mg/Kg)	Zn (mg/Kg)
B1-1*	0.5	9/16/96	0.72	34	**270**	26	320
B1-2*	5	9/16/96	<0.5	29	6.0	15	20
B1-3*	10	9/16/96	<0.5	31	4.3	36	36
B2-1*	0.5	9/16/96	7.3	40	**870**	39	1,100
B2-2*	5	9/16/96	<0.5	8.1	<3.0	10	6.3
B2-3*	10	9/16/96	<0.5	37	8.2	34	41
B3-1*	0.5	9/16/96	3.8	40	**750**	43	650
B3-2*	5	9/16/96	<0.5	25	10	40	17
B3-3*	10	9/16/96	<0.5	38	5.4	48	40
B4-1*	0.5	9/16/96	0.6	33	**83**	25	77
B4-2*	5	9/16/96	<0.5	27	5.0	17	20
B4-3*	10	9/16/96	<0.5	40	5.5	43	34
B5-0.5	0.5	8/7/01	<0.5	28	16	19	43
B5-5	5	8/7/01	<0.5	26	6.3	26	22
B5-10	10	8/7/01	<0.5	31	7.6	63	37
B5-15	15	8/7/01	<0.5	20	6.0	32	34
B6-0.5	0.5	8/7/01	<0.5	32	9.8	23	19
B6-5	5	8/7/01	<0.5	29	6.9	36	30
B6-10	10	8/7/01	0.70	37	5.8	58	44
B6-15	15	8/7/01	<0.5	25	5.9	48	49
B7-0.5	0.5	8/7/01	0.95	26	**270**	43	220
B7-2	2	8/7/01	<0.5	33	8.4	24	21
B7-7.5	7.5	8/7/01	<0.5	33	7.0	27	15
B7-10	10	8/7/01	<0.5	24	7.9	24	14
B7-14.5	14.5	8/7/01	<0.5	30	6.6	27	33
B8B-0.5	0.5	8/7/01	**52**	**110**	**3,100**	**240**	2,100

Table II, Results of Soil Sample Metal Analysis
BEI Job No. 207068, Tranvu, LLC
819-823 East 12th Street, Oakland, California

Sample I.D.	Depth (feet)	Sample Date	EPA Method 6010				
			Cd (mg/Kg)	Cr (mg/Kg)	Pb (mg/Kg)	Ni (mg/Kg)	Zn (mg/Kg)
B8B-5.5	5.5	8/7/01	<0.5	41	12	15	23
B8B-10	10	8/7/01	<0.5	33	9.8	64	42
B8B-15	15	8/7/01	0.57	35	**74**	28	43
B9-2	2	8/7/01	<0.5	28	11	30	21
STLC	N/A	N/A	1.0	5	5.0	20	250
TTLC	N/A	N/A	100	2,500	1,000	2,000	5,000

Notes: EPA = Environmental Protection Agency
mg/Kg= milligrams per kilogram (parts per million)
B7-15 = Sample number: e.g. Bore 7 at a depth of 15 feet below grade surface
N/A = Not applicable
STLC = Soluble Threshold Limit Concentration (Title 26, State of California)
TTLC = Total Threshold Limit Concentration (Title 26, State of California)
Cd = Cadmium
Cr = Chromium
Pb = Lead
Ni = Nickel
Zn = Zinc
* = Collected by Basics Environmental in 1996

Results in **bold** indicate concentrations ten times above the respective STLC value.
Shaded results indicate concentrations above the respective TTLC value.

Table III, Results of Grab Groundwater Sample Hydrocarbon, VOC, SVOC and Metals Analysis
BEI Job No. 207068, Tranvu, LLC
819-823 East 12th Street, Oakland, California

Sample I.D.	Sample Date	EPA Method 418.1	VOCs EPA Method 8240[1]				SVOCs EPA Method 8270	EPA Method 6010				
		TRPH (mg/L)	Benzene (Fg/L)	Toluene (Fg/L)	Ethylbenzene (Fg/L)	Total Xylenes (Fg/L)	(Fg/L)	Cd (mg/L)	Cr (mg/L)	Pb (mg/L)	Ni (mg/L)	Zn (mg/L)
B2-W*	9/16/96	**2,000[2, 4]**	NA	NA	NA	NA	NA	<0.005[uf]	<0.005[uf]	0.13[uf]	0.16[uf]	<0.05[uf]
B3-W*	9/16/96	**13[2, 4]**	NA	NA	NA	NA	NA	<0.005[uf]	<0.005[uf]	0.077[uf]	0.060[uf]	0.073[uf]
B4-W*	9/16/96	**<1.0[2]**	NA	NA	NA	NA	NA	0.005[uf]	0.007[uf]	0.082[uf]	0.080[uf]	0.11[uf]
B5W	8/7/01	**41[2]**	NA	NA	NA	NA	NA	<0.005	<0.02	<0.005	<0.05	<0.05
B6W	8/7/01	**1.5**	NA	NA	NA	NA	NA	<0.005	<0.02	<0.005	<0.05	<0.05
B7W	8/7/01	**4.8[2]**	<1.0	<1.0	**7.6**	<1.0	<10 to 50	**0.0061**	<0.02	<0.005	<0.05	<0.05
B8W	8/7/01	**2,000[2]**	**1,700**	**2,500**	**790**	**4,100**	<25 to 125[3]	<0.005	<0.02	<0.005	<0.05	<0.05
MCLs	N/A	N/A	1.0	150	700	1,750	various	0.005	0.05	0.015[5]	0.1	5[6]

Table III Results of Grab Groundwater Sample Hydrocarbon, VOC, SVOC and Metals Analysis; continued

Notes:

EPA	=	Environmental Protection Agency
VOC	=	Volatile organic compounds
SVOC	=	Semi-volatile organic compounds
MCLs	=	Maximum Contaminant Level
*	=	Collected by Basics Environmental in 1996
mg/L	=	milligrams per liter (parts per million)
Fg/L	=	micrograms per liter (parts per billion)
N/A	=	Not applicable
NA	=	Not analyzed
Cd	=	Cadmium
Cr	=	Chromium
Co	=	Cobalt
Pb	=	Lead
Ni	=	Nickel
Zn	=	Zinc
[uf]	=	Unfiltered groundwater sample
[1]	=	All other VOC analytes were non-detectable at elevated limits of detection. Please see the laboratory report for details.
[2]	=	Laboratory notes that the liquid sample contained greater than approximately 5% by volume sediment.
[3]	=	2-Methylnaphthalene and Naphthalene detected at **280** and **430** Fg/L, respectively. All other SVOC analytes were non-detectable at the indicated elevated limits of detection.
[4]	=	Laboratory notes indicate a lighter than water immiscible sheen is present
[5]	=	Federal level
[6]	=	California Secondary MCL

Results in **bold** indicate detectable concentrations.
Shaded results indicate concentrations above the respective MCL value.

Table IV, Results of Geotechnical Soil Sample Analysis
BEI Job No. 207068, Tranvu, LLC
819-823 East 12th Street, Oakland, California

Sample I.D.	Depth (Feet)	Sample Date	Soil Description	Hydraulic Conductivity	Moisture Density	Porosity	Percent moisture
				cm/sec	pounds/ cubic foot	Percent	Percent
B6-17-18	17 to 18	8/7/01	Brown Clayey Sand to Brown Sandy Silt	NA	105.6	36.9	22.1
B7-16.5-17.5	16.5 to17.5	8/7/01	Brown Clay with sand	8×10^{-8}	NA	NA	NA

Notes:

cm/sec = centimeters per second
B6- 17-18 = Bore 6 at a depth of 17 to 18 feet below grade surface
NA = Not analyzed

Table V, Summary of Site Specific Target Levels
BEI Job No. 207068, Tranvu, LLC
Former J & R Automobile Dismantlers, 819-823 East 12th Street, Oakland, California

Media	Benzene	Toluene	Ethylbenzene	Total Xylene	TPH Aliph. (TPH as motor oil)	Cd	Cr	Pb	Ni	Zn
Soil SSTL * (mg/Kg)	0.057	160	180	520	> Saturation	12	>Saturation	150 / 750 **	420	6,000
Calculated Representative Concentration (mg/Kg)	0.0025	0.18	1.8	14	13,000	11	48	**730**	72	580
SF- RWQCB Nuisance Threshold (mg/Kg)	NA	NA	NA	NA	500	NA	NA	NA	NA	NA
Groundwater SSTL * (mg/L)	0.0039	150	19	>200	>Saturation	>0.066	>170,000	NA	2.6	39
Calculated Representative Concentration (mg/L)	**1.7**	2.5	0.79	4.1	2,000	0	0	0	0	0
SF- RWQCB Nuisance Threshold (mg/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

>	=	Indicates Site Specific Target Level (SSTL) is greater than constituent residual saturation value.
SSTL	=	Site Specific Target Level
SF - RWQCB	=	San Francisco Regional Water Quality Control Board
mg/Kg	=	Milligrams per kilogram
mg/L	=	Milligrams per liter
*	=	Primary driver for certain soil and groundwater SSTLs is a relatively unlikely POE at offsite well water ingestion target.
**	=	SF-RWQCB ESL <10 ft. / > 10 ft.

Results in **bold** indicate calculated representative concentration of analyte is over SSTL.

Figures

UNITED STATES GEOLOGICAL SURVEY 7.5' QUADS. "OAKLAND EAST" & "OAKLAND WEST, CA", PHOTOREVISED 1980.

QUADRANGLE LOCATION

BLYMYER ENGINEERS, INC.

BEI JOB NO. 202041

DATE 10-3-02

0 1000 2000

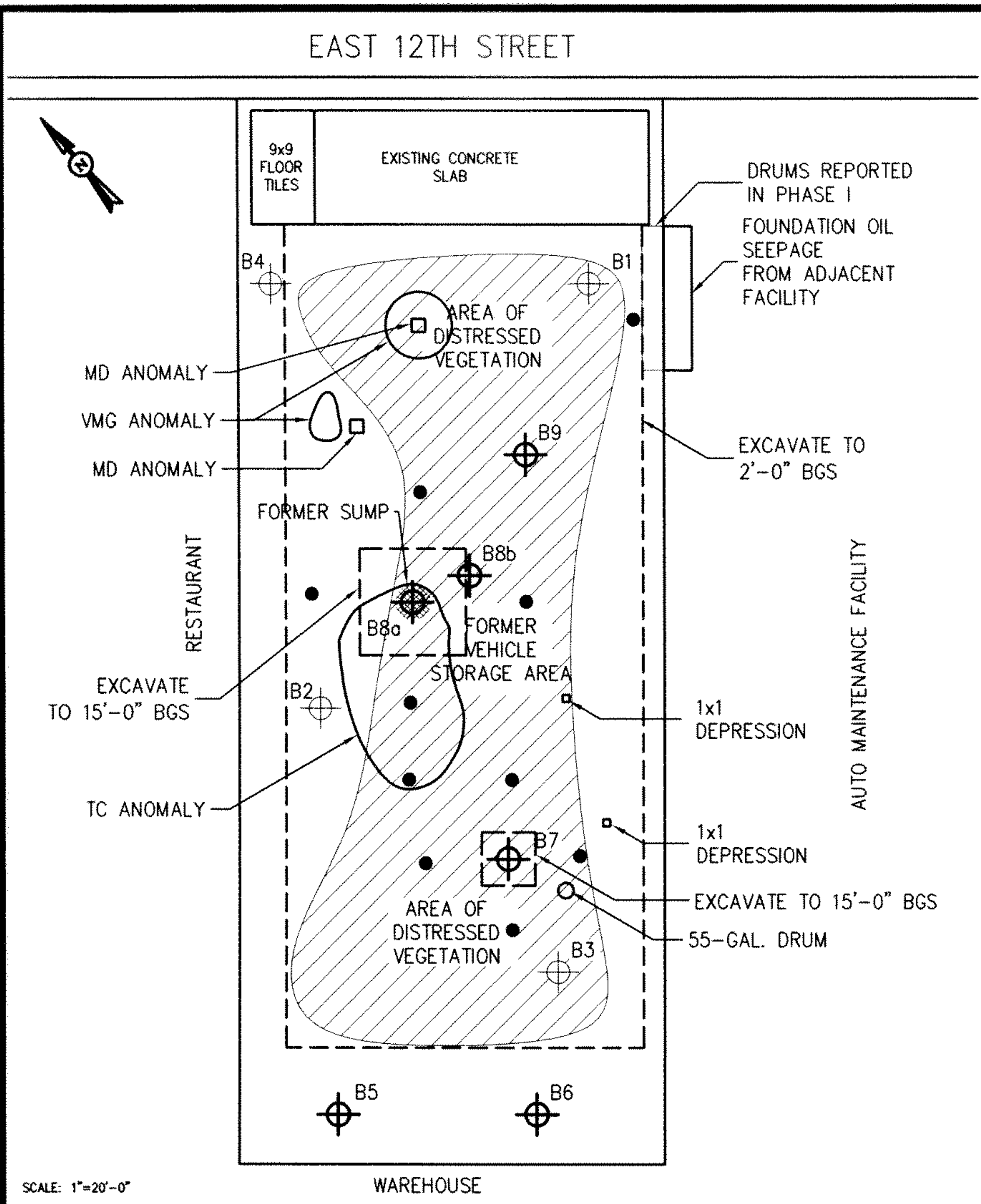
SCALE IN FEET

N

SITE LOCATION MAP

FORMER J & R AUTOMOBILE DISMANTLERS
819-823 EAST 12TH ST.
OAKLAND, CA

FIGURE 1



BLYMYER ENGINEERS, INC.

BEI JOB NO.	DATE
207068	10-26-07

LEGEND
- ⊕ (bold) BLYMYER ENGINEERS BORES
- ⊕ PREVIOUS BASICS ENVIRONMENTAL BORES
- BGS BELOW SURFACE GRADE
- MD METAL DETECTOR
- TC TERRAIN CONDUCTIVITY
- VMG VERTICAL MAGNETIC GRADIENT
- ● PROPOSED BORE LOCATIONS

SITE PLAN
FORMER J & R AUTOMOBILE DISMANTLERS
819-823 12th ST.
OAKLAND, CA

FIGURE 2

L:\Acad\2002dwg\202041\202041FIG2.dwg 10/3/02 12:22 pm

Appendix A

Norcal Geophysical Consultants, Inc,
Geophysical Investigation,
August 13, 2002

August 13, 2002

Mr. Mark Detterman
Blymyer Engineers, Inc.
1829 Clement Avenue
Alameda, CA 94501-1396

Subject: Geophysical Investigation
Vacant Lot
Oakland, California

Dear Mr. Detterman:

This letter presents the findings of a geophysical investigation performed on a portion of a vacant lot in Oakland, California. Geophysicist David Bissiri and Field Technician Jeff Blom conducted the field investigation on July 11, 2002. Site logistics were provided by Mr. Mark Detterman of Blymyer Engineers, Inc.

SITE DESCRIPTION

The site is located at 819-823 East 12th Street. The site is a rectangular open dirt lot bordered by a chain link fence along 12th Street on the east, and other assorted fences and walls of the adjoining buildings on the south, west, and north (see Site Map, Plate 1). The reported previous use of the site was that of an automobile dismantling facility. The proposed investigation area encompass an approximately 140- by 50-foot portion of the lot and is depicted on the site map with the dashed green line. Notable site features within the investigation area include a concrete pad and chain link fence in the eastern portion; a 55-gallon steel drum and two nearby surface depressions along the southern boundary; and a known sump in the central portion. Fences and walls of various adjacent buildings surround the site.

PURPOSE

The purpose of the investigation was to determine if various buried objects that may be associated with the former facility still exist. Possible anticipated buried objects include underground storage tanks (UST's), unknown sumps, and miscellaneous debris.

METHODOLOGY

We performed the geophysical investigation using vertical magnetic gradient (VMG), terrain conductivity (TC), hand-held metal detector (MD), and ground penetrating radar (GPR) techniques. Detailed descriptions of these techniques and the geophysical instrumentation we used are provided in Appendix "A".

DATA ACQUISITION

The first task undertaken at the site was to establish a survey grid to provide horizontal control during the VMG and TC data acquisition. Using a site map supplied by Blymyer Engineers we established a baseline 5 feet west of, and parallel to, the eastern fence. The survey grid consisted of a series of east-west lines spaced 5 feet apart oriented perpendicular to the baseline. Data measurement points were then distributed at 5-foot intervals along each line. Following the grid set-up, we used a proton precession magnetometer to collect VMG data and an electromagnetic terrain conductivity meter to collect TC data. After the VMG and TC data collection, the data sets were up-loaded to a field computer and processed to produce preliminary VMG and TC contour maps. We then analyzed these contour maps to determine the locations of VMG and TC anomalies that might be caused by buried objects or disturbed soil.

Following the VMG and TC surveys, we used the MD method in two ways. The first was to perform site-specific investigations of anomalous areas identified on the VMG and TC contour maps. These site-specific MD investigations involved multi-directional traverses over selected VMG and TC anomalies to determine the general extent and orientation of detected buried object or objects causing such anomalies. The second way we used the MD was to conduct a reconnaissance of the perimeter area outside of the VMG/TC investigation area. This perimeter area was comprised of the site within five feet of the fences and walls. This was done since experience has shown that any VMG and TC data which would have been obtained in this portion of such sites is usually adversely affected by these above ground objects.

The next field procedure was to use the GPR to obtain data from bidirectional traverses at five suspect areas: two areas in the immediate vicinity of buried metal objects delineated by the MD; one area west of the known sump; and two areas located at the two surface depressions along the southern boundary. The locations of the GPR traverses are depicted on Plate 1 as the solid red lines.

The final task undertaken was to map the site and the locations of detected subsurface features.

RESULTS

A site map depicting the locations of the VMG/TC investigation area, pertinent above ground objects, and interpreted subsurface features is presented on Plate 1. The geophysical data is presented in the form of VMG and TC contour maps on Plates 2 and 3, respectively. These contour maps show the data contour lines, the limits of the investigation area, and pertinent site features. Specific results and interpretations for the VMG, TC, MD and GPR methods are discussed below. A general discussion of data analysis, contour map interpretation and limitations is presented in Appendix B.

VMG

The VMG contour map displays numerous closely spaced and convoluted contour lines, primarily along the boundary of the investigated area. Such contours result from the magnetic effects of ferrous objects. While most of the contours can be attributed to the effects of the nearby walls and fences, or the 55-gallon drum, there are two assemblages of contours that could not be attributed to such effects. These anomalous contours appear as two small closures, or "bull's eyes" in the northeast portion of the site and are depicted on Plate 2 as the shaded red circles labeled Roman numerals "I" and "II". The location of these VMG anomalies are coincident or close to the locations of two metal-detector anomalies (see below). The extent and magnitude of these two VMG anomalies are consistent with those produced by minor amounts of metal debris such as of balls of wire, paint can lids, short sections of metal pipe, etc.

TC

The TC data is shown on Plate 3. Similar to the VMG contour map, this TC data also displays numerous closely spaced and convoluted contour closures. These convoluted contours indicate variations in terrain conductivity. Inspection of the data shows that the contours are most closely spaced in two portions of the investigation area. The first area where the TC contours are closely spaced is along the boundary of the investigation area. Here, the contour lines for the most part appear somewhat parallel to the boundary. Such contours are typical of the TC effects of large above ground objects *outside* of the investigation area, in this case the buildings and fences along the boundary.

The second area of closely spaced contours is immediately west of the known sump. Here the contours appear as a monopole or "bull's eye" of localized low TC values. This localized low is interpreted as consisting of contours below 50 milliSiemens/meter and is considered anomalous since there is no nearby above ground object which could be the source. This interpreted zone is depicted on Plate 3 as the shaded light blue oval area. The location of this TC anomaly does not coincide with the location of either a VMG or MD anomaly. This indicates that this TC anomaly is probably caused by non-ferrous materials such as wood, concrete, or perhaps disturbed soils. The proximity of this anomaly to the known sump further suggests that they may be related to each other. One possibility is that perhaps the known sump may have more compartments to the west than what is expressed on the surface.

MD

The site specific investigation of VMG and TC anomalies with the MD resulted in the delineation of two small shallowly buried metallic anomalies. The locations of these two anomalies are in the eastern portion of investigation site and are depicted on Plates 1 and 2 as the shaded dark blue squares labeled "A" and "B". The MD instrument response suggests that the metal objects at these locations are relatively small, perhaps only a foot or two across, and buried within two feet or so of the surface. Such instrument response is typical of that produced by minor amounts of metallic debris. The approximate centers of these two anomalies were marked in the field with plastic "brush flags".

The MD reconnaissance of the perimeter portion of the site did not detect any notable buried metallic objects.

GPR

The GPR results were generally inconclusive. Even though the MD instrument indicated that the suspected metal objects causing the MD anomalies A and B were shallowly buried and within the normal expected range of GPR detection we were unable to image them to any satisfactory degree. Likewise, we were unable to further characterize any buried features west of the known sump or at either surface depression along the southern boundary.

STANDARD CARE AND WARRANTY

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the shallow subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. The services were performed in a manner consistent with the level of skill ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the services or products delivered under this agreement, expressed or implied, is made by NORCAL.

We appreciate having the opportunity to provide you with this information.

Respectfully,

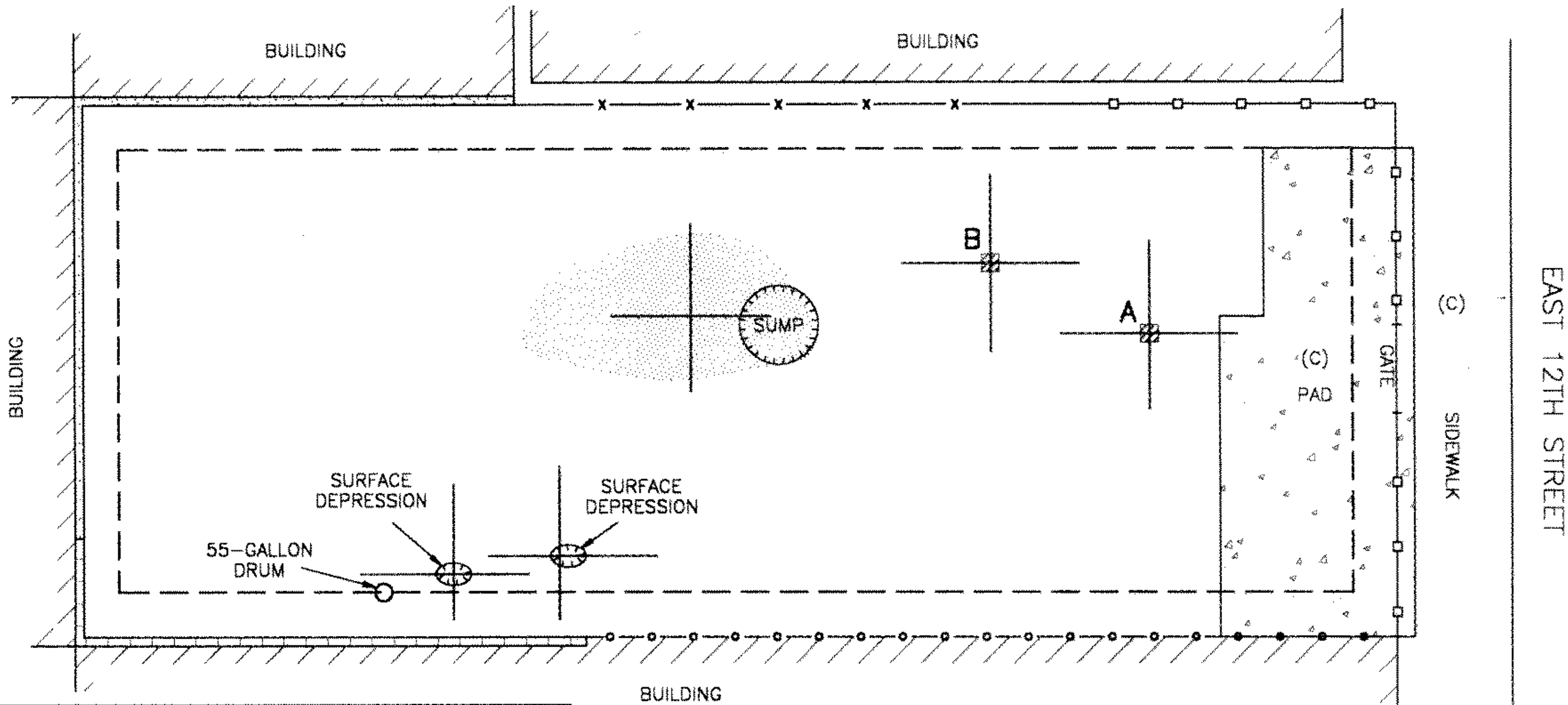
NORCAL Geophysical Consultants, Inc.

David Bissiri
Geophysicist GP-1009

DJB/WEB/jm

Enclosures: Plates 1 through 3

Appendix A GEOPHYSICAL METHODOLOGY AND INSTRUMENTATION
Appendix B DATA ANALYSIS, CONTOUR MAP INTERPRETATION AND LIMITATIONS

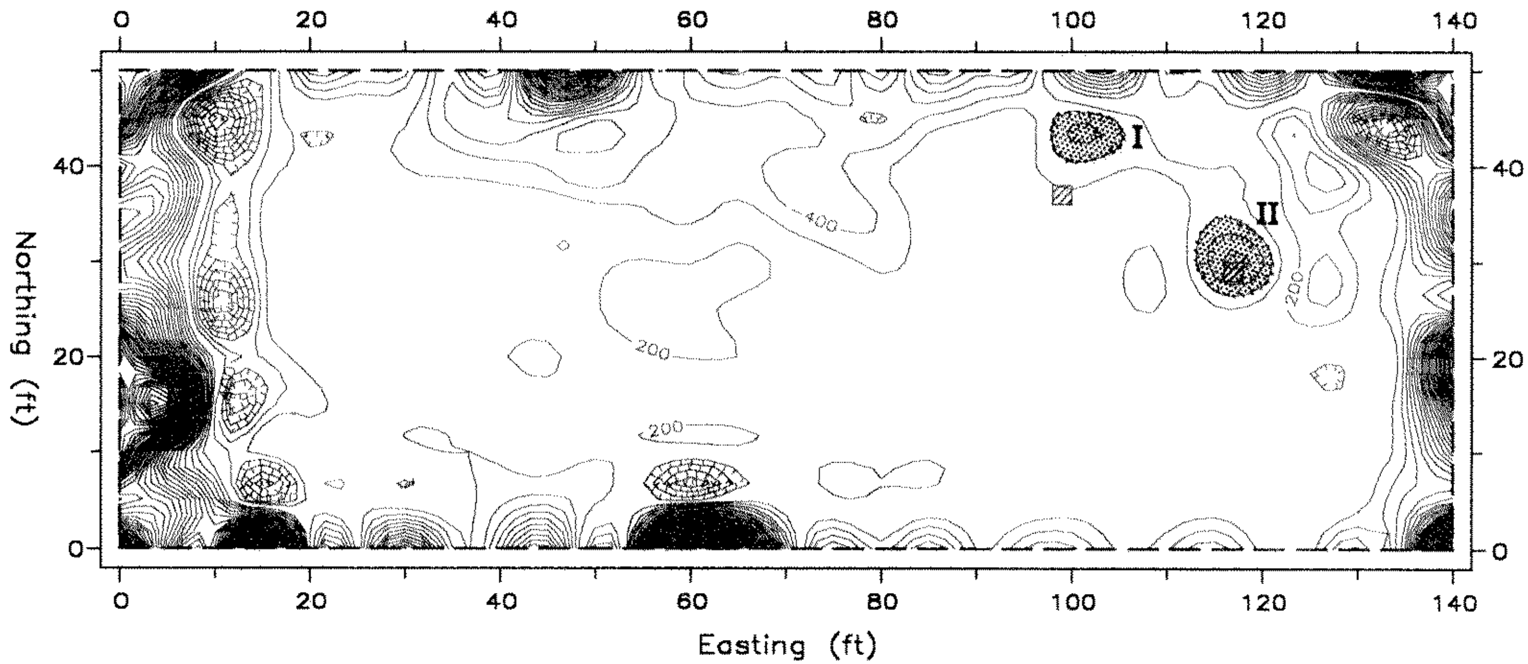


LEGEND

— — —	LIMITS OF GEOPHYSICAL SURVEY
A	METAL DETECTOR ANOMALY
	INTERPRETED LOCALIZED ZONE OF ANOMALOUSLY LOW TERRAIN CONDUCTIVITY VALUES
	GPR TRAVERSE
—x—	CHAIN-LINK FENCE
	SHEET METAL FENCE
	WOODEN WALL
	CONCRETE WALL
	BRICK WALL
(C)	CONCRETE

SCALE
0 10 20 40
(1 inch = 20 feet)

NORCAL	SITE MAP FORMER J&R AUTO DISMANTLERS	
	LOCATION: OAKLAND, CALIFORNIA	
	CLIENT: BLYMYER ENGINEERS, INC.	PLATE
JOB #: 02-531.02	NORCAL GEOPHYSICAL CONSULTANTS INC.	1
DATE: JUL. 2002	DRAWN BY: G.RANDALL / APPROVED BY: DJB	



SCALE

0 10 20 40

(1 inch = 20 feet)

LEGEND

— — —	LIMITS OF GEOPHYSICAL SURVEY
~~0~~	VERTICAL MAGNETIC GRADIENT CONTOUR (CONTOUR INTERVAL = 200 nT/m)
I	INTERPRETED LOCALIZED ZONE OF ANOMALOUSLY LOW VERTICAL MAGNETIC GRADIENT VALUES
▨	METAL DETECTOR ANOMALY

NORCAL

VERTICAL MAGNETIC GRADIENT CONTOUR MAP
FORMER J&R AUTO DISMANTLERS

LOCATION: OAKLAND, CALIFORNIA

CLIENT: BLYMYER ENGINEERS, INC.

JOB #: 02-531.02

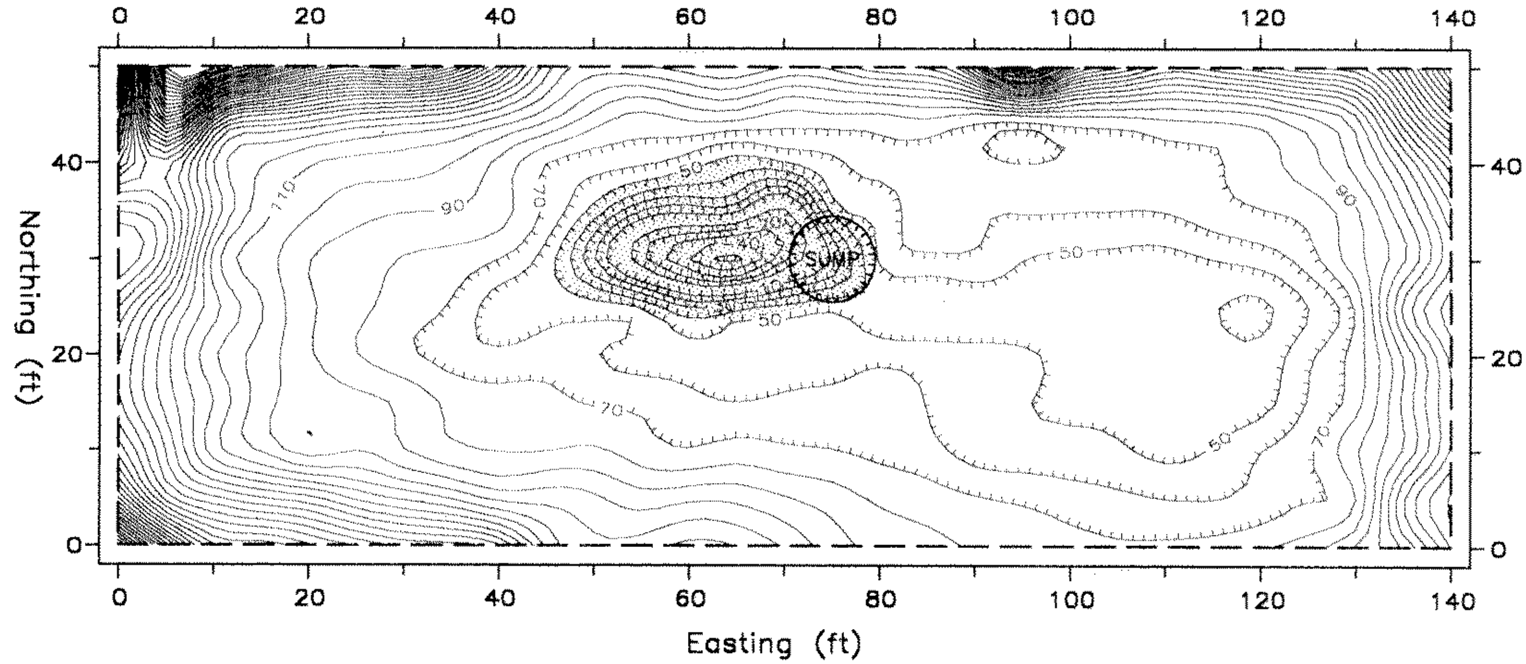
NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: JUL. 2002

DRAWN BY: G.RANDALL

APPROVED BY: DJB

PLATE 2



SCALE

0 10 20 40

(1 inch = 20 feet)

LEGEND

— — —	LIMITS OF GEOPHYSICAL SURVEY
~~0~~	TERRAIN CONDUCTIVITY CONTOUR (CONTOUR INTERVAL = 20 mS/m)
(stippled area)	INTERPRETED LOCALIZED ZONE OF ANOMALOUSLY LOW TERRAIN CONDUCTIVITY VALUES

NORCAL	TERRAIN CONDUCTIVITY CONTOUR MAP FORMER J&R AUTO DISMANTLERS		
	LOCATION: OAKLAND, CALIFORNIA		
	CLIENT: BLYMYER ENGINEERS, INC.		PLATE 3
JOB #: 02-531.02	NORCAL GEOPHYSICAL CONSULTANTS INC.		
DATE: JUL. 2002	DRAWN BY: G.RANDALL	APPROVED BY: DJB	

Appendix A

GEOPHYSICAL METHODOLOGY and INSTRUMENTATION

Appendix A

GEOPHYSICAL METHODOLOGY and INSTRUMENTATION

Vertical Magnetic Gradient (VMG) Magnetics

The magnetic field at any given point on the earth's surface is the vector sum of the earth's field combined with the magnetic fields of nearby magnetic objects. Most magnetometers measure the total intensity of the resulting magnetic field. These are referred to as "Total Field" measurements (TF) and are recorded in units of nanoTesla (nT). In environmental investigations it is often useful to measure the vertical gradient of the magnetic field as well. The vertical magnetic gradient is the vertical rate of change of the total field magnetic intensity. These are referred to as "Vertical Magnetic Gradient" (VMG) measurements, and are recorded in units of nanoTesla/meter (nT/m). While both TF and VMG measurements are related to the same phenomena (i.e. the magnetic field), each has certain advantages over the other. The VMG method is often chosen for environmental investigations because of the following advantages:

1) VMG measurements are generally less affected by nearby *above* ground objects, especially objects to the side of the instrument.

2) VMG measurements are not affected by temporal (diurnal) variations in the earth's magnetic field, unlike TF measurements.

3) VMG effects attenuate more rapidly with increasing distance from magnetic sources, thus allowing more precise determination of a buried object's location.

It should be noted, however, that because the VMG method is very sensitive, small near surface objects can be a source of "noise" in VMG data.

A vertical magnetic gradiometer is the device that is used to obtain the VMG data. This is accomplished by simultaneously measuring the total magnetic field intensity at two sensors which are vertically separated by a fixed distance (in this case, about one meter). The difference in magnetic intensity at each sensor is then divided by their separation distance to yield the vertical magnetic gradient. For this investigation, we used a Scintrex EnviMag magnetometer. This instrument consists of a console and two total field magnetic sensors that are positioned on a vertical staff. The staff is carried by the operator, with the lower sensor at about shoulder-level and the upper sensor at about head-level. The magnetometer features a built-in memory that stores the TF, VMG and survey grid information. The survey information can later be up-loaded to a computer for further processing.

Terrain Conductivity (TC)

The electrical conductivity of the near sub-surface can be measured through electromagnetic induction (EM). This is typically accomplished by some form of high frequency signal (primary field) produced by a transmitter coil inducing a secondary (induced) signal in the earth. A receiver coil located a short distance away from the transmitter reacts to the resulting magnetic field associated with both the primary signal and that of the induced signal. However, by careful design of a TC instrument, only the effects of the secondary induced current flow can be isolated and measured. This secondary signal has both quadrature and in-phase components (as measured in reference to the primary signal). Analysis of these two components can provide useful information about subsurface conditions. For most earth materials, the quadrature component provides the most useful information. This is because the amplitude of the quadrature component is linearly proportional to the electrical conductivity of the resistive material. This allows an absolute measurement of electrical conductivity in units of milliSiemens/meter (mS/m). Since the measured value at any given surface location represents the conductivity of a certain volume of material rather than individual elements within that volume, it is an *apparent* value and is referred to as "terrain conductivity". With conductive materials such as buried metal, the quadrature response is not linearly proportional. This non-linear behavior makes the TC device also useful as a metal detector.

Terrain conductivity values can be processed to form contour maps. These maps can then be interpreted to determine the location of buried metal, some types of contaminant plumes, variations in soil type or moisture content, and large back-filled areas. Interpretation of TC contour maps is similar in may ways to the interpretation of VMG contour maps. Contour map interpretation and is described in more detail in Appendix B - Data Analysis. Generally speaking, areas that are relatively free of sharp conductivity contrasts and/or large amounts of buried metal will result in smooth, evenly spaced contours with positive values. In contrast, areas containing significant amounts buried metal will exhibit closely spaced contours of both positive and negative values that may locally form closures. In some cases negative TC values are measured. Intuitively, negative conductivity is meaningless. However, negative values do occur. They result from measurements taken in the proximity of discrete, highly conductive objects. When such an object is buried somewhere beyond either of the two coils, the receiving coil detects a normal, or "positive image" of the object. However, if the object is buried between the two coils, the receiver coil detects a "mirror image" of the object and this results in a "negative" data value.

We performed the TC survey using a Geonics EM-31 terrain conductivity meter. This instrument consists of two boom-mounted, horizontally wound coils attached to a control console carried by the operator. The coils are at opposite ends of the 3-meter long boom with one of the coils acting as the transmitter coil and the other acting as the receiver coil. The control console is used to regulate the sensitivity of the instrument, the phasing of the primary signal, and the conversion of the secondary signal into quadrature and in-phase components. The instrument is carried across the survey area at hip level (approximately 3-ft above the ground surface), and readings are obtained at fixed intervals. For this investigation, we collected TC data every 10 feet along the survey traverses. The TC values and survey grid information are stored in a digital data logger that is connected to the instrument. The data can be up-loaded to a computer for further processing.

<u>Ground Penetrating Radar (GPR)</u>

Ground penetrating radar is a method that provides a continuous, high resolution graphical cross-section which depicts variations in the electrical properties of the shallow subsurface. The entails repeatedly radiating an electromagnetic pulse into the ground from an antenna as it is moved along a traverse. Reflected signals are received by an antenna (often the same one used to generate the signal) and sent to a control unit for processing. The processed data are then printed in cross-sectional form on a graphical recorder.

GPR is particularly sensitive to variations to the electrical properties of conductivity (the ability of a material to conduct a charge when a field is applied) and permittivity (the ability of a material to hold a charge when a field is applied). Most earthen and earthen-like materials such as concrete are electrically resistive and often have a relatively low permittivity, they are relatively transparent to electromagnetic energy. This means that only a portion of the radar signal incident upon them is reflected back to the surface. On the other hand, when the signal encounters an object composed of a material that has the opposite electrical properties, especially one with a high permittivity (such as metal) much of the incident energy is reflected.

For this investigation, we used a Geophysical Survey Systems, Inc. SIR-2 Subsurface Interface Radar System equipped with a 500 megahertz (MHz) transducer. This unit is comprised of a combined control and data recording unit that is connected by a telemetry cable to the antenna. This system usually provides both the resolution and depth penetration for characterizing the shallow subsurface at a site such as this.

Metal Detection (MD)

This method is used to detect buried near surface metal objects such as UST's, metal conduits, rebar in concrete, manhole covers, and various metallic debris. This is done by carrying a hand-held radio transmitter-receiver unit above the ground and continuously scanning the surface. The unit utilizes two orthogonal coils that are mounted on a common staff. One of the coils transmits an electromagnetic signal (primary magnetic field) which in turn produces a secondary magnetic field about the subsurface metal object. Since the receiver coil is orthogonal to the transmitter coil (that is, in a "null" position), it is unaffected by the primary field. However, a buried metal object is not in a similar "null" position and therefore the secondary magnetic field produced by the buried metal object will generate an audible response from the unit. The peak of this response usually occurs when the unit is directly over the metal object. Our MD instrument for this investigation was a Fisher TW-6 pipe and cable locator. The TW-6 does not provide a recordable data output that can be used for later computer processing. Results are generally limited to marking the interpreted outlines of detected objects in the field and mapping their locations.

Appendix B

DATA ANALYSIS, CONTOUR MAP INTERPRETATION AND LIMITATIONS

Appendix B

DATA ANALYSIS

Computer Processing

We up-loaded the VMG, and TC data we obtained in the survey area to a portable computer at the end of each field day. The data were then converted into a format suitable for contouring. The contouring program SURFER from Golden Software was used to calculate an evenly spaced array of values (data grid) based on the measured field data. The gridded values were then contoured to produce various draft contour maps for preliminary analysis in the field. Final processing of the data was done at NORCAL's Petaluma office.

CONTOUR MAP INTERPRETATION

Generally speaking VMG and TC contour maps share common characteristics and interpretation criteria, even though they represent different physical parameters. In a region with uniform conditions VMG and TC values vary smoothly from one area to another. In contrast, in areas where variations are strong, the contours are moderately to closely spaced. In many cases, the variations are so strong that the contours are highly contorted and convoluted, with differences of several hundred units. These contorted contours may appear as roughly concentric circles forming "bull's eyes", tightly wound loops and whorls, or elongated parallel lines. If the source of a particular anomaly is an isolated object or a group of closely spaced objects, the contours may form isolated, somewhat symmetric closures known as "monopoles" (bull's eyes) or paired positive-negative closures known as "dipoles". If the source of a particular anomaly is a group of several objects not very closely spaced, then the contours will often form highly irregular, non-symmetric closures.

Areas that are typically considered anomalous are those which display large differences in data readings from one locality to the next. This is particularly the case when there are no obvious nearby above ground sources that could cause the variation. Actual anomaly magnitude and shape are dependent on the relative position and size of the buried objects with respect to the location of the measuring instrument. In general, anomaly magnitude decreases and anomaly width increases as distance (depth) to the source increases. Monopoles that are centered on a single data point and limited in extent to roughly the data point spacing of the sampling grid are often caused by small, near surface objects. Such objects may consist of well caps, pull boxes, balls of wire, etc. Larger monopoles that extend across an area equal to several data points are typically associated with larger objects. Isolated dipoles are often, but not always, attributed to a single object such as a UST, vault, buried ordnance, etc. A large accumulation of buried objects may appear as a group of closely spaced, contorted anomalies or a single large, less contorted anomaly. Elongated anomalies with parallel contour lines or a linear alignment of circular or elliptical closures is often indicative of a buried pipeline or other elongate object. Those anomalies that are neither monopoles or dipoles often are associated with multiple objects buried near each other, such as those comprising a debris field.

NORCAL

LIMITATIONS

Magnetic Methods

Buried ferrous metal objects produce localized variations in the earth's magnetic field. The magnetic intensity associated with these objects depends on the mass of the metal and the distance the metal object is from the magnetometer sensor. As the distance between the object and the magnetometer sensor increases, the intensity of the associated field decreases, thereby making detection more difficult.

In addition, the ability to detect a buried metal object is based on the intensity of these variations in contrast to the intensity of background variations. The intensity of background variations is based on the amount of above and below ground metal that is present within the survey area. Cultural features such as chain link fences, buildings, debris, railroad spurs, utilities, above ground electric lines, etc. typically produce magnetic variations with high intensities. These variations may mask effects from buried metal objects, or make it very difficult to determine whether the magnetic variations are associated with below ground metal or above/below ground cultural features.

Terrain Conductivity (TC)

Many of the same general comments made above for magnetics applies to the TC method as well. The primary differences are that variations due to non-metallic material can be detected as well and usually TC variations are not as precisely determined as they are with magnetics.

Ground Penetrating Radar (GPR)

The ability to detect subsurface targets is dependent on site specific conditions. These conditions include depth of burial, the size or diameter of the target, the condition of the specific target in question, the type of backfill material associated with the target, and the surface conditions over the target. Typically, the GPR depth of detection will be reduced as the clay and/or moisture content in the subsurface increases. Therefore, it is possible that targets such as UST's and utilities buried greater than 2 to about 4 feet, may not be detectable by the GPR technique.

Appendix B

Blymyer Engineers Standard Operating Procedures:

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

Standard Operating Procedure No. 4 Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment

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:

[signature] 5/31/94

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

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.

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BORING & WELL CONSTRUCTION LOG:

Job No.:
Client:
Site:

Date Drilled:
Sample Container:

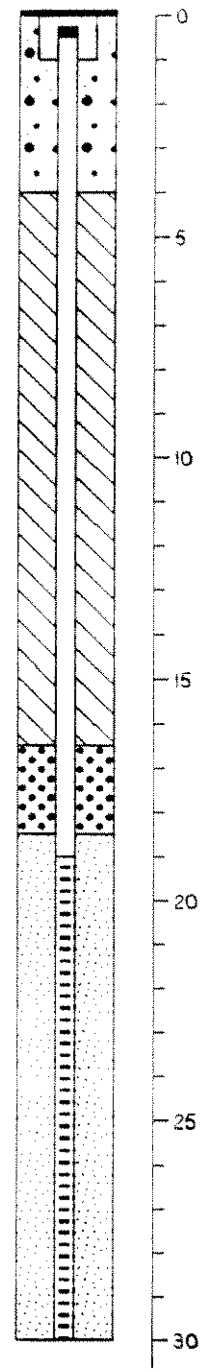
Driller:
Drilling Contractor:
Logged By:
Drilling Equipment:
Bore Diameter:
Total Depth: Ft.

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							



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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?

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:

[signature]
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.:

Location:	Client:	Drilling Company:
	Project Site Address:	
	BEI Job No:	Driller:
	Logged By:	License No.:
	Sampling Method:	Drilling Method:
	Started Time:	Date:
Scale: Elevation (msl):	Completed Time:	Date:

Total Bore Depth/Diameter:	Water Depth:	Initial: (∇):		Stabilized: (▼):
Total Well Depth/Diameter:	Time:			
Surface Seal Type/Completion:	Date:			

Annular Seal Type/Interval:

Seal Type/Interval:

Sand Type/Interval:

Blank Casing Type/Diameter/Interval:

Screened Casing Type/Diameter/Interval:

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	

H:\PUBLIC\USERS\LWITTSTO\DRAWINGS\BLKEY/REVISED 4/18/95

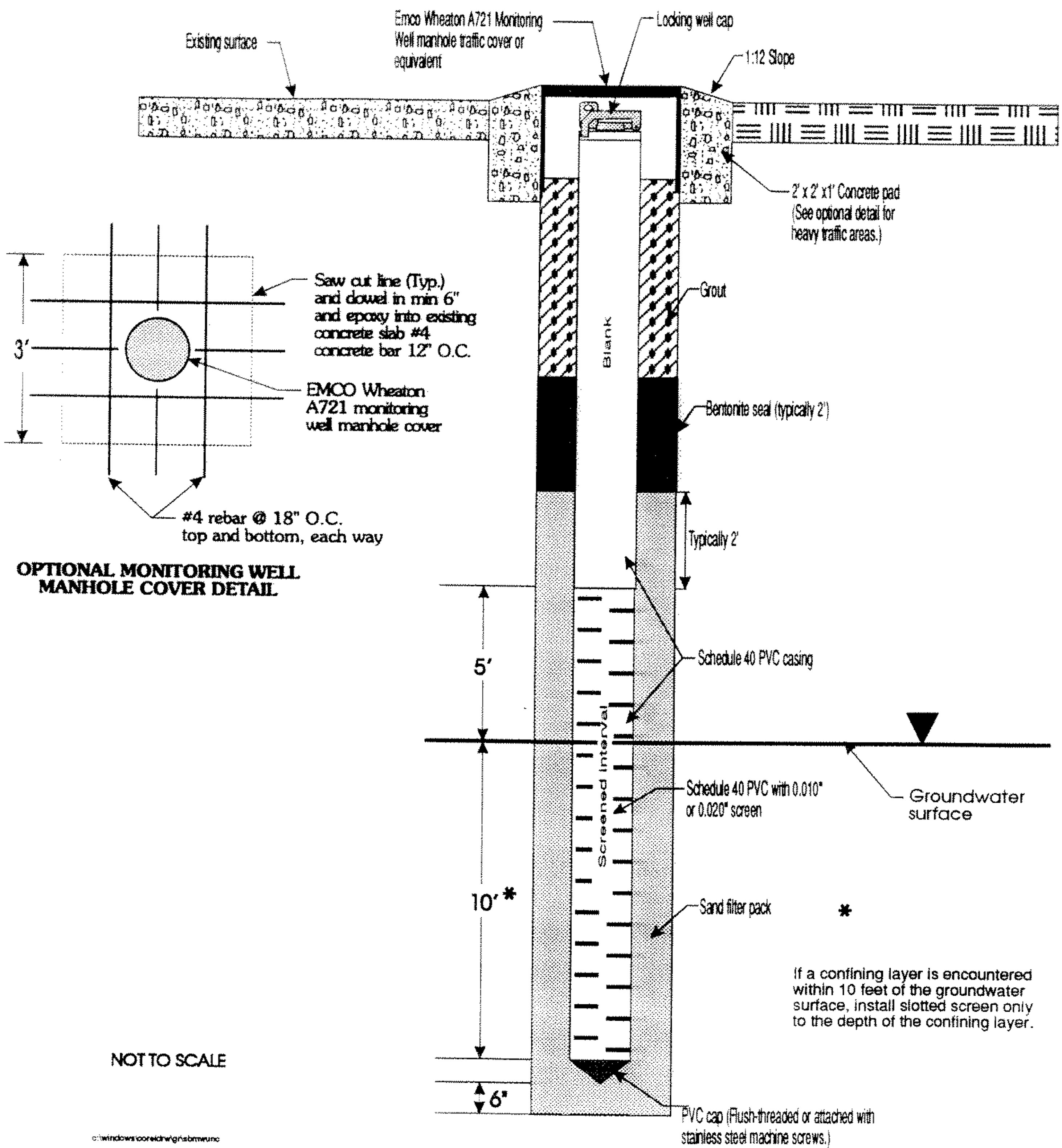
BLYMYER ENGINEERS DRUM INVENTORY FORM

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?**

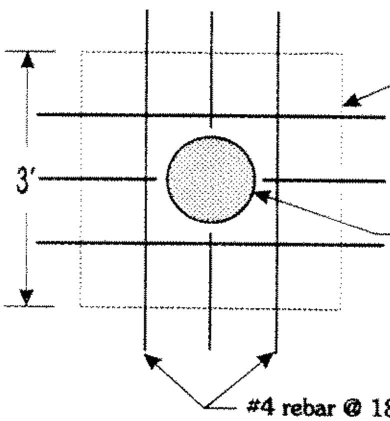
[illegible]

Date Client Informed? ______________________ All drums labeled? ______________________

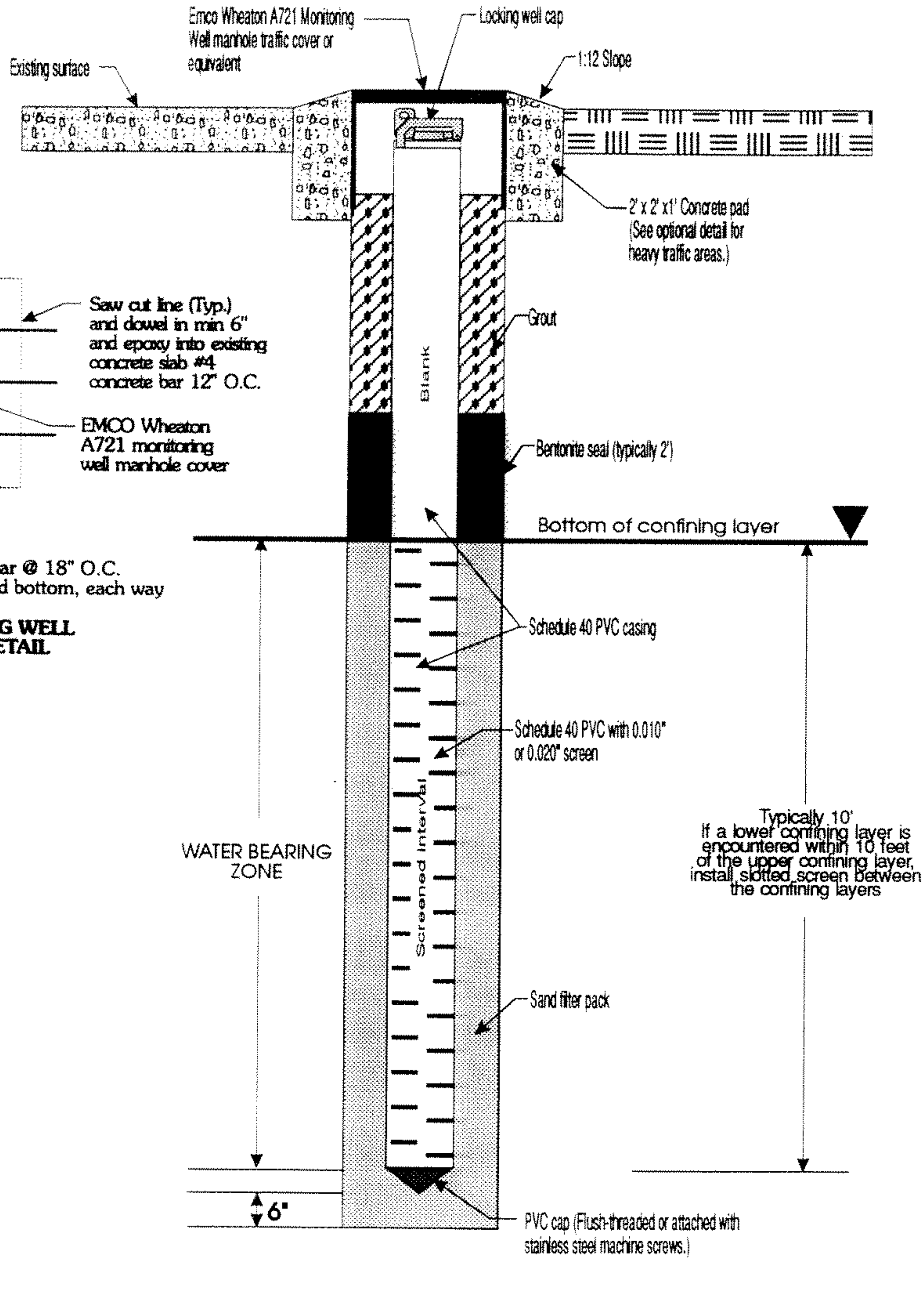
MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR UNCONFINED WATER-BEARING ZONE



MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR CONFINED WATER-BEARING ZONE



OPTIONAL MONITORING WELL MANHOLE COVER DETAIL



NOT TO SCALE

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BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 4

Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment

Revision No. 1

Approved By:

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

Date 9/1/94

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for drilling with the use of hydraulically-driven equipment, soil sampling with the use of split-spoon samplers, and grab groundwater sampling through an open borehole. Drilling activities covered by this SOP are conducted to obtain soil and grab groundwater samples. 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 techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the drill rods, a relatively small annulus of remolded soil surrounding the outside diameter of the drill rods, and limited capability for cross-contamination between subsurface strata as the leading drill rods 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 hydraulically-driven soil sampling generally consist of initial decontamination, advancement of the drill rods, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon and continued driving and sampling until the total depth of the borehole is reached. Withdrawal of the drill rods upon reaching the total depth requires completion of the borehole by grouting or other measures.

2.0 Equipment and Materials

- Drill rods and drive-weight assembly (hydraulic hammer or vibrator) for driving the drill rods and split-spoon sampler.

- 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 and Well Construction Log (copy attached), 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 and Well Construction 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 and Well Construction Logs, chain-of-custody forms, drum labels, Drum Inventory Sheet (copy attached), 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 in the field notebook.

- Pressure washer or steam cleaner.

- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of 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.

- 55-gallon, open-top, DOT-approved, 17H drums

- 5-gallon open-top DOT-approved pails, 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 hydraulic 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 and Well Construction 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 rods, 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 drill rods, or nested drill rods, to the desired sampling depth using hydraulic hammer or vibrator. Note depth interval, augering conditions, and driller's comments on Boring and Well Construction Log. Samples should be collected at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.

The sampling procedure varies depending on whether the drill rods are nesting-type. With nesting-type drill rods, the inner and outer drill rods are driven simultaneously. As they are driven, soil is forced into the lined inner drill rod. The outer drill rod is left in place and the inner drill rod is relined with sample sleeves and replaced for the next sampling segment. Where nesting-type drill rods are not used, a split-spoon sampler is used. The following sampling procedures cover sampling with a split-spoon sampler:

8. Remove drill rod and note presence of water mark on drill rod, if any. Also, monitor the top of hollow drill rods using field organic vapor monitor, as appropriate.

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 until sampler is resting on soil. If more than 6 inches of slough exists inside the borehole, consider the conditions unsuitable and re-advance the drill rods and sampler to a new sampling depth.

11. Drive and recover split-spoon sampler. Record depth interval and sample recovery on Boring and Well Construction Log. 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 and Well Construction 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 and Well Construction Log.

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

16. If a grab groundwater sample is to be collected, slowly lower bailer through the open borehole 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 inside cooler.

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

18. Decontaminate drill rods 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 - Analysis Pending" labels to the drums.

21. Store any excess soil sample on and cover with heavy plastic sheeting. If required by local regulations or due to site constraints, store excess soil sample in 5-gallon pails. Affix completed "Caution - Analysis Pending" labels to drums.

22. Complete Drum Inventory Sheet.

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:

- Sample label
- Boring and Well Construction Log
- Field notebook
- Chain-of-custody form
- Drum Inventory Sheet

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 and Well Construction Log is listed below.

5.1 Sample Label

- Project name and project number
- Borehole 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 sampling rig
- Type and size of sampler, optional description of the size of drill rod
- USCS classification
- 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 sampling rig and appurtenant items (drill rods, 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, split-spoon sampler, shovels, troughs, and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. The sampling 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 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 or containerized in DOT-approved 5-gallon pails. 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 should be completely filled with 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, 1992. RCRA Ground-Water Monitoring: Draft Guidance Document. U.S. EPA, 1992.

BLYMYER
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BORING & WELL CONSTRUCTION LOG:

Job No.:
Client:
Site:
Date Drilled:
Sample Container:

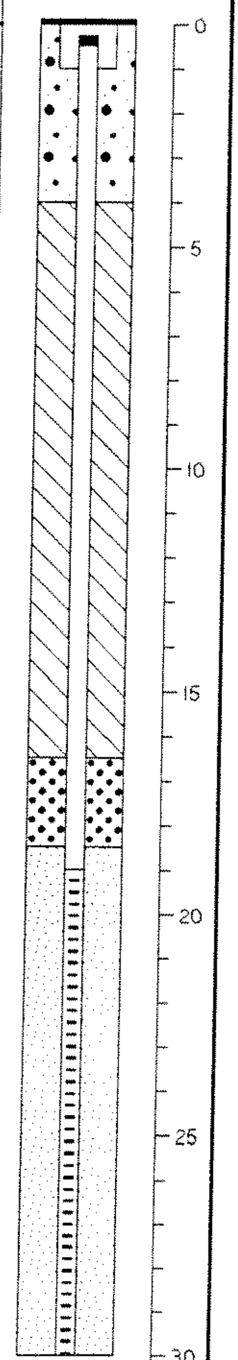
Driller:
Drilling Contractor:
Logged By:
Drilling Equipment:
Bore Diameter:
Total Depth: Ft.

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							



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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?

jmo\form\drum.wv

Date Client Informed? ______________________ All drums labeled? ______________________

Appendix C

Blaine Tech Services, Inc. Standard Operating Procedures:

Well Development

Water Level, Separate Phase Level, and Total Well Depth Measurements (Gauging);

Well Water Evacuation (Purging);

Sample Collection From Groundwater Wells Using Bailers

Blaine Tech Services, Inc.
Standard Operating Procedure

WELL DEVELOPMENT

1. INITIAL MEASUREMENTS. Collect initial DTW and TD measurements.

2. CALCULATE SWAB TIME. The amount of time spent swabbing depends on the length of well screen submerged below the water column. Unless otherwise directed, spend one minute swabbing for each foot of submerged screen. If the dimensions of the screened interval are unknown, swab well for 15 minutes.

3. SWAB WELL. Using an appropriately sized swab, flush out debris from the slots of the screen by raising and lowering the swab quickly through the entire screened interval for the required time.

4. BEGIN PUMPING. Lower a Stainless Steel pneumatic pump into well so that pump intake is close to well bottom. Set purge rate at 0.5 – 1.0 GPM. While purging, raise and lower pump through the screened interval and gently tap against the well bottom to continue agitating well.

5. COLLECT PARAMETER MEASUREMENTS. Collect required water quality parameter readings at each casing volume removed. Unless otherwise directed, collect measurements for pH, Temperature, Electrical Conductivity, and Turbidity. Continue to collect DTW measurements while purging to confirm the height of the water column.

6. FINISH DEVELOPMENT. Well development is considered complete when ALL of the following conditions have been met:

    10 CASE VOLUMES. Well has been purged of 10 case volumes.

    HARD BOTTOM. All sediment that can be removed has been removed. Well bottom is hard, not silty.

    PARAMETERS STABILIZED. Measurements for pH, EC and Temp have stabilized over the last 3 case volumes. If applicable, required Turbidity level has been achieved.

    If these three conditions have been met, collect a final TD measurement and secure well.

    If the parameters remain unstable or the bottom remains soft after the removal of the 10th case volume, collect a TD measurement and contact the BLAINE Project Coordinator for instruction. Further development may be warranted.

DEWATERING WELLS. If the well begins to de-water during the pumping process, adjust the pumping rate. If a well is dewatering, cease pumping activities. Remove pump and calculate and note recharge rate. Call BLAINE Project Coordinator for direction. If well development continues, the well must be allowed sufficient time to recharge and must be re-swabbed prior to restart of pumping efforts.

LARGER DIAMETER WELLS. For 4" or greater diameter wells, pumping activities may be augmented with an Electric Submersible pump once loose sediments have been removed, a "hard bottom" has been obtained and a minimum of one casing volume removed. In these cases, the Three Inch Electric Submersible Pump purging 2 – 5 GPM may be used to complete development activities. However, if DTW measurements show that the water level is dropping and the well is dewatering, the Stainless Steel pneumatic pump must be used for the entire well development.

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.