18500147.07050

Prepared for:

U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street (SFD-7-3)
San Francisco, CA 94105

FIELD PILOT STUDY OF IN SITU CHEMICAL OXIDATION USING OZONE AND HYDROGEN PEROXIDE TO TREAT CONTAMINATED GROUNDWATER AT THE COOPER DRUM COMPANY SUPERFUND SITE

Prepared by:

URS Group, Inc.
2870 Gateway Oaks Drive, Suite 150
Sacramento, CA 95833

December 2006

URS

February 13, 2007

Mr. Eric Yunker
Superfund Project Manager
U.S. Environmental Protection Agency (SFD-7-3)
75 Hawthorne Street
San Francisco, CA 94105

SUBJECT: RAC IX Contract No. W-98-225
Cooper Drum Company WA No. 247-RDRD-091N
Transmittal of Final Field Pilot Study of ISCO Using Ozone
And Hydrogen Peroxide To Treat Contaminated Groundwater

Dear Mr. Yunker:

This letter transmits three copies and four electronic copies of the above referenced field pilot study at the Cooper Drum Company Superfund Site in South Gate, California. EPA Region 9 and DTSC comments have been incorporated in the final report.

If you have any questions or require further information, please contact me at (916) 679-2049.

Sincerely,

URS Group, Inc.

Don Gruber
Task Manager

Attachment

cc: Ms. Michelle Simon, U.S. EPA (1 copy w/attachment)
Ms. Lori Parnass, DTSC (1 copy w/attachment
Site Repository, South Gate, CA (1 copy w/attachment)
Project File (w/attachment)
Chron File (w/o attachment)

URS Corporation
Crown Corporate Center
2870 Gateway Oaks Drive, Suite 150
Sacramento, CA 95833
Tel: 916.679.2000
Fax: 916.679.2900

K:\Wprocess\00147\Cooper Drum\Perozone Pilot Test\DRAFT\cvr ltr Yunker.doc

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AOP	advanced oxidation process
APT	Applied Process Technology, Inc.
bgs	below ground surface
cfm	cubic feet per minute
COC	contaminant of concern
Cr(VI)	hexavalent chromium
DCA	dichloroethane
DCE	dichloroethene
DHS	Department of Health Services
DO	dissolved oxygen
DPA	drum-processing area
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
EPA	United States Environmental Protection Agency
EW	extraction well
FS	feasibility study
ft	feet
g/hr	grams per hour
g/kg	grams per kilogram
gpd	gallons per day
H_2O_2	hydrogen peroxide
HRC®	hydrogen release compound
HSA	hollow-stem auger
HWA	Hard Wash Area
ID	inner diameter
ISCO	in situ chemical oxidation
lb	pound
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mV	millivolt
MW	monitoring well
O_3	ozone
OD	outside diameter
ORP	oxidation reduction potential

ACRONYMS (Continued)

PLC	programmable logic controller
PRG	preliminary remediation goal
psi	pounds per square inch
PVC	polyvinyl chloride
RD	remedial design
RI	remedial investigation
ROD	record of decision
ROI	radius of influence
RWQCB	Regional Water Quality Control Board
SAP	sampling and analysis plan
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SOD	soil oxidant demand
SVOC	semivolatile organic compound
TCE	trichloroethene
TOC	total organic content
URS	URS Group, Inc.
USCS	Unified Soil Classification System
UV	ultraviolet
VOC	volatile organic compound
WDR	Waste Discharge Requirement
µg/L	micrograms per liter

EXECUTIVE SUMMARY

This report presents the results of a field pilot study using an in situ chemical oxidation (ISCO) technology at the Cooper Drum Company Superfund Site (Site) in South Gate, Los Angeles County, California (see Figure 1). The ISCO technology used in the field pilot study is an advanced oxidation process (AOP) using the application of ozone and ozone with hydrogen peroxide. Given the Site groundwater contaminants (1,4-dioxane and volatile organic compounds [VOCs]), the ISCO process is considered a breakthrough technology. The field pilot study was conducted during the remedial design (RD) phase by the U.S. Environmental Protection Agency (EPA) to determine whether to include ISCO into the groundwater remedy for the Site. Use of an ISCO technology is consistent with the groundwater cleanup strategy contained in the Cooper Drum Record of Decision (ROD). The project team consisted of the EPA Region 9 Superfund Project Manager (Eric Yunker), EPA Office of Research and Development (Michelle Simon), URS Group, Inc., Project Manager (Don Gruber), URS Group, Inc., Senior Engineer (Venus Sadeghi), and Applied Process Technology, Inc. (APT) (Doug Gustafason). The work plan for the pilot study was reviewed and approved by the California Environmental Protection Agency Department of Toxic Substances Control (DTSC). As discussed below, the field pilot study results showed reductions of up to approximately 90% in the site groundwater contaminants of concern (COCs) (see Table 1).

BACKGROUND

The use of ozone/hydrogen peroxide is being evaluated because 1,4-dioxane is purportedly resistant to biodegradation. The use of ozone/hydrogen peroxide for in situ treatment of 1,4-dioxane is innovative and is not known to have been implemented in the past at other sites, in part because 1,4-dioxane is an emergent chemical that has not been monitored routinely in California groundwater. Combined ozone and hydrogen peroxide has been used for ex situ treatment of 1,4-dioxane. Therefore, this field pilot study also served the dual purpose of evaluating the effectiveness of an innovative application of an existing technology at this site and hopefully for use at other federal, state, and private sites.

Before performing the ISCO pilot study, an enhanced reductive dechlorination field pilot study was performed at the site using a hydrogen release compound (HRC®). The HRC® pilot study was conducted to evaluate whether the naturally reductive conditions in the site groundwater could be enhanced to promote complete reductive dechlorination of groundwater COCs. During the HRC® pilot study, groundwater monitoring results for emergent compounds showed the presence of 1,4-dioxane. Because the reductive dechlorination process was not found to be effective on this compound, the HRC® Field Pilot Study was discontinued. Consequently, an ISCO bench-scale test was performed in May 2005 on the Site soil and groundwater to evaluate the effectiveness of using ozone and ozone combined with hydrogen peroxide to remediate site groundwater (see Appendix A). The results indicated that ozone alone, as well as ozone combined with hydrogen peroxide, was equally effective in destroying all detected COCs in groundwater. The removal of 1,4-dioxane was apparently enhanced/facilitated by the presence of natural constituents, such as iron and bicarbonate, in the Site soil and groundwater.

PILOT STUDY DESIGN AND OPERATIONS

Data obtained from the bench-scale test and groundwater monitoring performed through April 2005 were used to design and initiate the ISCO pilot study in July 2005. The location of the pilot study was approximately 140 feet downgradient from the former Hard Wash Area (HWA), the main contaminant source area (see Figures 2 and 3). The installation consisted of a barrier configuration with three ozone/hydrogen peroxide injection wells laterally spaced from 35 and 50 feet apart. Each injection well contained two injection points at approximately 70 and 90 feet below ground surface (bgs). The pilot study monitor wells (extraction well [EW]-1, monitoring well [MW]-33A/33B, and MW-20/20B) were located downgradient and within a maximum of 30 feet of the three injection wells (M_{OX}-1, M_{OX}-2, and M_{OX}-3) (see Figures 4 and 5). Each monitor well location included a shallow (approximately 60 to 63 feet bgs) and deep (85 feet bgs) sampling depth.

The pilot study took place between July 2005 and June 2006 for a period of 321 days (approximately 10.5 months). Oxidant injection during this period generally consisted of the following.

- Ozone only for the first 5 months (148 days) in the 3 injection wells. Ozone was injected at a rate of 0.5 pound per day for 50 days and then increased to 2 pounds per day for the remainder of the 5-month period.
- Ozone and hydrogen peroxide for the remaining 5.5 months;
- Increasing the ozone and hydrogen peroxide injection rates by focusing the injection into only two injection wells after 8 months or 244 days. This phase will be referred to as “focused injection” in the remainder of this report.
- Increasing the ozone injection rate (by adding a second ozone generator) from 2 to 4 pounds per day, and reducing the hydrogen peroxide injection rate to 0.7-to-1 moles peroxide per moles ozone (mole:mole), after just over 9 months (281 days) and for the remaining 40 days of the pilot study.

Optimal system operating parameters were eventually achieved by performing the following:

- Using continuous downhole monitoring of the dissolved oxygen (DO) and oxidation reduction potential (ORP) to evaluate the lateral and vertical effect of varying the operating parameters, such as oxidant injection cycles and injection locations;
- Focusing/increasing oxidant injection into two injection wells (M_{OX}-1 and M_{OX}-2);
- Modifying (reducing) the hydrogen peroxide injection rate; and
- Increasing the ozone injection rate from approximately 2 pounds per day to 4 pounds per day.

Note that air also was injected following each oxidant injection to enhance the distribution of the oxidant. The air volume was increased from 1.1 to 2.2 standard cubic feet per minute (scfm) after 99 days and then decreased back to 1.1 scfm after 244 days, and for the remainder of the pilot study.

MONITORING RESULTS

In situ oxidation of site COCs, including trichloroethene (TCE), cis-1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), and 1,4-dioxane, was observed in all wells, with significant reductions (up to 90%) in concentrations of both TCE and 1,4-dioxane, which are the primary COCs. The largest decreases in concentration were observed from the three shallow monitor wells. Concentration trends were unique for each well during the pilot study and are discussed generally hereafter and shown on Figures 7 through 12.

Over the first 5 months of the pilot study, COC concentrations generally showed an overall decrease in the three shallow monitor wells and one deep well (note that one shallow well, MW-33A, showed an increase in TCE prior to the end of the 5-month period). After the 5-month period, when both ozone and hydrogen peroxide were being injected, COC concentrations increased slightly and/or stabilized in the two shallow monitor wells (EW-1 at 63 feet bgs [EW-1-63'] and MW-20) and one deeper well (EW-1 at 85 feet bgs [EW-1-85']). This stabilized trend persisted in one shallow well (EW-1-63') and continued even after initiation of the focused injection. However, the sampling results at this well 40 days after the ozone injection rate was increased from 2 to 4 pounds showed a decrease of 350 micrograms per liter (μg/L) of 1,4-dioxane and 135 μg/L of TCE. At MW-33A, where TCE concentrations increased prior to the injection of hydrogen peroxide (i.e., toward the end of the first 5-month period), the other COC concentrations continued to show an overall decreasing trend throughout the pilot study. TCE eventually decreased at this well by an additional 490 μg/L. 1,1-DCA concentrations decreased by an average of 73% in the three shallow wells; this is notable, considering the reluctant nature of chlorinated ethanes. Monitoring of the third shallow well (MW-20) was discontinued after injection in the closest injection well (M_{OX}-3) was terminated as part of the focused injection phase.

CONCLUSIONS

Based on the pilot study monitor well results, the following conclusions are made for the Site.

- Ozone injection alone can significantly reduce the concentrations of the site COCs, including TCE, cis-1,2-DCE, 1,1-DCA, and 1,4-dioxane. At the end of the pilot study, concentrations of 7 out of the 12 Site COCs at EW-1-63' were reduced to below MCLs (PCE was below MCLs prior to the test and remained as such.). Those still present at concentrations greater than MCLs at this well included TCE (65 μg/L), cis-DCE (44 μg/L), 1,1-DCA (6.2 μg/L), and 1,4-dioxane (47 μg/L).
- Increased injection of oxidants increases the amount of contaminant (or COC) destruction.
- The effect of hydrogen peroxide on COC destruction is not clear. However, ex situ testing of the site groundwater does indicate that it is likely that the injection of stoichiometric (0.7–to–1 mole:mole) or less of hydrogen peroxide to ozone is required to achieve optimal results and to increase oxidation kinetics. This conclusion is supported by the results of laboratory tests conducted to evaluate the destruction efficiency of 1,4-dioxane; one literature source cites the optimal hydrogen peroxide to ozone mole ratio as being greater than zero but less than 0.4 to 0.45 mole:mole (Suh and Mohseni, 2004).
- As corroborated by the bench-test results, the presence of high levels of secondary constituents in the groundwater (e.g., iron, bicarbonates, organic matter) may have enhanced the effectiveness of oxidation by ozone. The presence of these compounds also can lead to scaling, biofouling, and general plugging of equipment installed below the water table. However, during the pilot study, only one well became plugged, and it was easily rehabilitated with a dilute acid.

- Ozone injection rates were crucial to the success of the pilot study. Whereas the soil oxidant demand estimated in the bench test (3 grams per kilogram [g/kg]) appears to have been too high, the pilot study results indicated that an ozone injection rate of 2 pounds per day (lbs/day) per injection well (or 1 lb/day per injection interval) was required to achieve optimal results.
- Overall, a greater radius of influence (ROI) was achieved in the upper injection interval in the shallow aquifer. The ROI of the injection wells appears to be approximately 30 feet, which is the largest distance between an injection well and a monitor well in the pilot study. Vertical profiling of DO and ORP indicated that, for optimal results, the oxidant injection interval probably should be placed a maximum of 10 feet below the targeted treatment area. In addition, the presence of less permeable aquifer material in the 40- to 50-foot bgs interval probably increased the ROI for the shallow injection wells. Therefore, the larger ROI in the upper portion of the shallow aquifer (approximately 50 to 80 feet bgs) may have been related to the injection screen placement and should be considered in full-scale application of the technology.
- Continued migration of contaminant mass from the site source area and the naturally reducing aquifer conditions probably impacted the outcome of the pilot study. A more aggressive network of injection wells and higher oxidant injection rates associated with a full-scale system would be expected to produce a steady reduction in contaminant mass.
- Data logging and the real-time measurement of field parameters, specifically DO and ORP, was crucial to the optimization of the operating parameters.
- The rate of air injection was found not to be a very important factor, though higher injection rates (>1 cubic foot per minute [cfm]) should be avoided to minimize agitating fine sediments in the aquifer.
- An evaluation of the COC destruction trends in conjunction with ORP data (see Section 3.3) indicates that COC destruction was caused by chemical oxidation and not a physical process, such as air stripping
- The introduction of air and oxidants resulted in highly oxygenated and aerobic conditions, which probably promoted the growth of aerobic bacteria. While these bacteria may contribute to direct and/or cometabolic degradation of some COCs, they may cause some biofouling and possible plugging of submerged equipment.
- There was a zero to modest rebound of COC concentrations in the pilot study monitor wells in August 2006, three months after cessation of the pilot study (see Table 7). Some rebound was expected because contaminated plumes originating 30 feet or farther upgradient were expected to reach the pilot study area during this time. Modest rebound was observed in EW-1-63’, where the largest reductions in concentrations had been obtained during the pilot study. TCE concentrations also rebounded slightly in MW-20. Conversely, TCE concentrations in MW-33A and 1,4-dioxane concentrations in MW-33A and MW-20 continued to decline during the three months.

RECOMMENDATIONS

In summary, once the system operating parameters were optimized, the ozone/peroxide injection system was successful in achieving the test objectives of evaluating system performance and reducing COC concentrations without significant rebound. Based on these observations, the following recommendations are made.

- The use of this technology is recommended for full-scale application. It is recommended that the lessons learned from the field pilot study (i.e., optimal operating parameters and injection well construction/placement) be considered in the full-scale application of this technology.
- The full-scale system design should include both injection of ozone and hydrogen peroxide. However, operation of the full-scale system could begin with injection of ozone only and transition to combined injection of hydrogen peroxide and ozone at less than stoichiometric mole ratios of peroxide to ozone.
- With robust remedial design of a full-scale system, it is possible to attain MCLs for all site COCs. It is noted, however, that as concentrations approach MCLs, the oxidation reaction kinetics are expected to be first order with respect to the oxidant concentrations and slower than those observed in the pilot study. Therefore, the ISCO system should be designed to address COC concentrations greater than 50 µg/L. The portions of the plume less than the design concentration but greater than MCLs will be addressed with a downgradient remedy, likely to include groundwater extraction per the ROD.
- The injection wells should be placed so that their ROIs overlap for adequate coverage; therefore, the recommended spacing between injection wells is 50 feet (corresponding to a minimum ROI of 25 feet). The oxidant injection interval probably should be placed at a maximum of 10 feet below the targeted treatment area. Optimal screen placement also will depend on location-specific lithology.
- The full-scale system should be designed for ozone injection rates of 2 lbs/day per injection well (or 1 lb/day per injection interval).
- It is recommended that remediation of the contaminated vadose zone in the source area occur before or concurrently with the full-scale groundwater remediation to minimize further impacts to groundwater.

This page intentionally left blank

1.0 INTRODUCTION

This report presents the results of the field pilot study conducted to evaluate the use of in situ chemical oxidation (ISCO) technology (using ozone and hydrogen peroxide) to facilitate the remediation of 1,4-dioxane and volatile organic compounds (VOCs) in groundwater at the Cooper Drum Company Superfund Site (Site) at 9316 South Atlantic Avenue in South Gate, Los Angeles County, California (see Figure 1). The pilot study was located approximately 140 feet downgradient from the former Hard Wash Area (HWA), which is believed to be the contaminant source area (see Figures 2 and 3). Use of ISCO to remediate contaminated groundwater is consistent with the cleanup strategy selected for groundwater in the *Cooper Drum Record of Decision* (ROD) (United States Environmental Protection Agency [EPA], 2002).

The remainder of this section provides background information on the previous bench-scale and field pilot tests, on the rationale for the present field pilot-test design, and on site hydrogeology and the contaminant plume. Section 2.0 presents the field pilot-study objectives and system design, installation, operation and monitoring. Section 3.0 presents the results of the field pilot test. Section 4.0 provides the conclusions and recommendations. Section 5.0 lists the references cited in this report.

Appendices A through E provide the following documentation:

- Appendix A: Bench-scale test report;
- Appendix B: Field Pilot Study Photographs;
- Appendix C: Boring logs and well completion details;
- Appendix D: Field data sheets; and
- Appendix E: Downhole dissolved oxygen (DO) and oxidation reduction potential (ORP) data.

All tables and figures are provided at the end of this report.

1.1 BACKGROUND

The field pilot study is the second step in conducting treatability studies to evaluate chemical oxidation and to determine whether it is effective under site conditions. A bench-scale test was performed initially in May 2005. The test evaluated the effectiveness of using ozone (O_3) and ozone combined with hydrogen peroxide (H_2O_2) to remediate site groundwater, which was mixed with saturated soil collected at boring SB-33 (see Figure 4) at a depth of 55 to 80 feet below ground surface (bgs).

The results of the bench test indicated that ozone alone, as well as ozone combined with hydrogen peroxide, was equally effective in destroying all detected contaminants of concern (COCs) (see Table 1) in groundwater, including the following:

- 1,4-Dioxane (a relatively recent COC discovered in groundwater since the publication of the ROD);
- Chlorinated ethenes, such as trichloroethene (TCE), isomers of 1,2-dichloroethene (1,2-DCE), both cis and trans isomers, and 1,1-dichloroethene (1,1-DCE); and
- Chlorinated ethanes, such as 1,1-dichloroethane (1,1-DCA).

The bench test discovery that ozone alone was equally capable of destroying 1,4-dioxane in the groundwater was unexpected because this is not commonly observed in ex situ treatment of water contaminated with 1,4-dioxane. In ex situ treatment, the destruction of 1,4-dioxane is achieved by promoting the formation of the hydroxyl radical, either using a combination of ultraviolet (UV) light and hydrogen peroxide, or using hydrogen peroxide in conjunction with ozone. However, it is known that the hydroxyl radical can be produced (at a fraction of the ozone concentration) with ozone alone; literature sources indicate that hydroxyl radical formation can be affected by the presence of iron, soil organic matter, alkalinity (carbonates and bicarbonates), or even olefins (unsaturated hydrocarbons with the general formula C_nH_{2n}, such as ethene) (Bower and Miller, 2002; Donahue, Anderson, and Demerjian, 1998).

Therefore, it was inferred that such constituents in site soil and groundwater might be promoting hydroxyl radical formation even when ozone is used without hydrogen peroxide. This would be a fortunate outcome because it would make it possible to remediate contaminated site groundwater in situ, with ozone injection alone.

To evaluate whether certain soil or groundwater constituents could affect the hydroxyl radical production and 1,4-dioxane destruction, additional bench tests were performed. The results of these bench tests confirmed the initial bench test results and indicated that other constituents, such as iron and bicarbonate, enhance the degradation of 1,4-dioxane. The bench-scale tests also showed the formation of hexavalent chromium (Cr[VI]) and bromate, especially when ozone alone was used. The use of hydrogen peroxide with ozone was found to suppress both Cr(VI) and bromate formation. The final bench test report is included as Appendix A of this report.

A separate field pilot study to evaluate the effectiveness of enhanced reductive dechlorination using a modified hydrogen release compound (HRC®) was performed in December 2003 (URS, 2003a). The test consisted of injecting approximately 4,500 pounds of HRC® into a 15-foot by 25-foot grid area (see Figure 4, HRC® area) in the site source area. The HRC® area is approximately 100 feet upgradient from the oxidation field pilot-test area; therefore, contamination originating in the HRC area would be expected to impact the oxidation pilot study area after approximately 10 months. The results of groundwater sampling after the start of the HRC® pilot study indicated that injection of HRC® promoted and enhanced anaerobic bacterial activity and reductive dechlorination within distances of 50 feet or more directly downgradient from the test area. In fact, full-scale application of HRC® may have been feasible to treat VOCs in groundwater had it not been for the discovery of 1,4-dioxane in groundwater. This semivolatile organic compound (SVOC), routinely used as a solvent stabilizer in the past, has been detected in the monitoring wells in the VOC plume footprint at concentrations ranging from below detection limits to a maximum concentration of approximately 700 micrograms per liter (μg/L). For comparison, the drinking water preliminary remediation goal (PRG) for 1,4-dioxane is 6.1 μg/L, and the Department of Health Services (DHS) action level for this compound is 3 μg/L.

As a result of the HRC field pilot study, reduced/anaerobic aquifer conditions persisted in the vicinity and downgradient from the HRC injection area. (Accordingly, groundwater originating from this area was expected to present a higher oxidant demand as it passed through the oxidation barrier.)

The use of ozone/hydrogen peroxide is being evaluated because 1,4-dioxane is purportedly resistant to biodegradation. (However, aerobic biodegradation of 1,4-dioxane has been observed in a laboratory setting. See, for example, the paper by Mahendra and Alvarez-Cohen [2006] in which the authors discuss the discovery of no less than 13 bacterial isolates capable of transforming 1,4-dioxane.) The use of ozone/hydrogen peroxide for in situ treatment of 1,4-dioxane is innovative and is not known to have been implemented in the past at other sites, in part because 1,4-dioxane is an emergent chemical that has not been monitored routinely in California groundwater. As mentioned earlier, combined ozone and hydrogen peroxide has been used for ex situ treatment of 1,4-dioxane. Therefore, this field pilot study also served the dual purpose of evaluating the effectiveness of an innovative application of an existing technology at this site and hopefully for use at other federal, state, and private sites. In addition, the bench test observation that ozone alone, for the specific conditions at the Site, may be capable of producing enough hydroxyl radicals to destroy 1,4-dioxane in the site soil and groundwater was a promising, and potentially cost saving, possibility that was worth pursuing. The same effect can be obtained using a liquid oxidant, such as Fenton's reagent, which also generates hydroxyl radicals. However, liquid oxidants are commonly applied in temporary injection points during injection events and, because of the relatively high costs, are usually more applicable for source area treatment and for COC concentrations greater than 1,000 µg/L. In addition, there are health and safety concerns with the use of a strong liquid oxidant, such as Fenton's reagent, which can lead to increased subsurface temperatures and off-gassing. In comparison, ozone injection, with or without hydrogen peroxide injection, is an equally aggressive but less costly oxidation process that can be performed cost-effectively in permanent injection wells.

Data obtained from the bench-scale tests, the 2002 Cooper Drum Superfund Site remedial investigation/ feasibility study (RI/FS), and groundwater monitoring performed through April 2005 were used to design this field pilot study. The design involved the injection of ozone, with and without hydrogen peroxide, into the shallow aquifer and monitoring the contaminated groundwater for COC concentrations and other relevant parameters.

Regulatory requirements associated with the field pilot-study design included fulfilling the substantive components (i.e., groundwater monitoring) of the existing General Waste Discharge Requirement (WDR), Order No. R4-2005-0030, for the field test in the Los Angeles Basin, as specified by the California Regional Water Quality Control Board (RWQCB), Los Angeles Region, which were satisfied by the *Cooper Drum Pilot-Scale Field Test Treatability Study Work Plan* (Work Plan) (URS, 2005).

1.2 SITE HYDROGEOLOGY AND CONTAMINANT PLUME

This section provides an overview of the site hydrogeology and the contaminant plume. A detailed description of the site hydrogeology can be found in the 2002 RI/FS report (URS, 2002). The estimated lateral and vertical extent of VOCs (based on TCE concentrations) in the shallow aquifer at the Site is presented on Figure 3. Figure 4 presents a close up of the contaminant plume in the area of the field pilot study. The pilot test was located approximately 120 to 140 feet south-southeast of the HWA, as shown on Figure 4. That figure also includes TCE baseline concentrations for the six monitor wells used during the pilot study. Further discussion of these data is provided in the following sections. A generalized geologic cross section showing the relative locations of the pilot study injection wells and the associated monitor wells is shown on Figure 5.

1.2.1 Site Hydrogeology

As shown on the cross section in Figure 5, the lithology in the pilot study area consists of interbedded deposits of sand and silt with lenses of clay. Shallow groundwater occurs at a depth of approximately 45 to 50 feet bgs. Sandy units varying from very fine to medium and coarse are generally present from approximately 55 to 95 feet bgs, with an underlying finer-grained material. Based on pump test results from EW-1 and EW-2, the average groundwater velocity in this area is estimated at 0.30 foot per day (ft/day). The groundwater flow direction beneath the former HWA in the northeastern portion of the Site is south to southeast, as indicated on Figure 6. On the eastern side of the Site, along Rayo Avenue, the groundwater flow direction is southerly.

Shallow groundwater beneath the Site occurs within or is controlled by an area of lower permeability, the near-surface Bellflower Aquiclude, which incorporates a perched aquifer. The perched aquifer is present in the HWA at approximately 35 feet bgs and is at least 5 feet thick. The perched aquifer has been observed to be intermittent (for example, from 1991 to 1996 the perched zone was dry), and the lateral extent has not been confirmed. The Bellflower Aquiclude extends to a depth of approximately 70 feet bgs, where it overlies the Gaspur Aquifer (also referred to as the shallow aquifer). This aquifer extends to a depth of approximately 110 feet bgs, the maximum depth of the site lithology presented on Figure 5. Groundwater contamination at concentrations exceeding drinking water standards has been found only down to the shallow Gaspur Aquifer. Finer-grained material (clays and silts) are present within the upper portion of the Bellflower Aquiclude and the lower portion of the Gaspur Aquifer, and they have minimized the vertical migration of COCs (including 1,4-dioxane) down into the Exposition Aquifer and deeper aquifers, which are used for drinking water. Municipal groundwater production wells in the vicinity of the Site draw water from the Gage Aquifer, the deepest of the Lakewood Formation aquifers, at approximately 300 feet bgs, as well as from deeper aquifers within the San Pedro Formation. The Exposition Aquifer is the uppermost unit of the deeper aquifer system, and it underlies the Gaspur Aquifer. The Exposition Aquifer is one of four water-bearing units within the Upper Pleistocene Lakewood Formation.

1.2.2 Contaminant Plume in the Source Area

There is evidence that the contaminant plume in the source area has been affected by natural attenuation and the two pilot tests carried out in the vicinity and downgradient of the HWA.

VOC and 1,4-dioxane concentrations in the site groundwater have been significantly (2 to 3 orders of magnitude) higher beneath the HWA as compared to the DPA. This is consistent with the data plotted on Figure 3, which indicate the TCE plume is originating from the HWA. In the HWA, observed concentrations have been historically up to 800 µg/l of TCE, 1200 µg/L of cis-1,2-DCE , and 710 µg/L of 1,4-dioxane. As shown in the table below, evidence of biodegradation from naturally reductive conditions has been observed at the onsite wells in the HWA (see MW-2). Enhancement of the reductive conditions in late 2003 and early 2004 with the HRC pilot test stimulated significant decreases in VOC concentrations in the HWA that appears to be continuing to the present (see EW-2). For example, overall TCE and cis-1,2-DCE concentrations have decreased in EW-2 (located in HWA just downgradient of the HRC test location but upgradient of the ISCO pilot test location). In addition, ethene concentrations have also increased at this well, indicating the presence of a complete reductive dechlorination sequence. (1,4-dioxane concentrations in EW-2 also decreased by approximately 30% during this period, from approximately 700 to 500 µg/L, but this reduction cannot be attributed to reductive biodegradation).

As will be explained in detail in subsequent sections of this report, results from the August 2006 sampling event (approximately three months after completion of the herein ISCO field pilot study) indicate that COC concentrations have significantly decreased in wells monitored in the location of the ISCO pilot test (located approximately 140 feet downgradient of the HRC test).

In conclusion, reductions in VOC concentrations are evident in the plume source area as a result of the two pilot studies that were carried out in the vicinity. In general, the 100 µg/L TCE contour shown in

Figure 3 has significantly contracted in both the upgradient and downgradient areas. (A similar reduction has also been observed in cis-1,2-DCE concentrations.) By contrast, significant 1,4-dioxane reductions have mainly occurred in the area of the ISCO pilot study.

HRC$^{®}$ Pilot Study Monitor Well Results

Location	Date	PCE	TCE	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	VC	1,1-DCA	1,2-DCA	Ethene	1,4-Dioxane
MW-2	Oct-98	<10	640	1,100	46	46	14	220	97	—	—
	Nov-98	<1.0	780	1,200	32	34	12	190	82	—	—
	Mar-99	<1.0	800	800	10	19	5	52	20	—	—
	Oct-00	0.5	290	730	15	47	9	72	30	—	—
	May-03	<25	230	790	29	46	<25	65	<25	<0.67	—
	Dec-03	<1.0	240	810	13	52	17	75	14	0.064	—
	Feb-04	<0.5	220	770	12	48	15	73	19	1.4	—
	Apr-04	<0.5	290	990	10	50	10	86	19	<10.0	69
	Jul-04	<2.5	220	730	15	46	11	64	<2.5	0.88	—
	Nov-04	<0.5	270	790	19	46	23	75	23	0.68	—
	Apr-05	<0.5	220	840	11	38E	5.8	61	16	0.6	67
	Nov-05	<0.5	370	900	23	46	21	130	32	<1.0	100
	Mar-06	<0.5	250	640	14	31	15	85	20	1.1	75
	Aug-06	<0.5	69	510	7.9	26	30	64D	22	3.4	79
EW-2	May-03	<50	86	1,300	46	39	12	260	46	<0.67	—
	Dec-03	<1.0	16	1,200	72	55	13	320	36	0.56	—
	Feb-04	<5.0	140	1,000	56	44	12	230	39	0.84	—
	Apr-04	<0.5	270	1,200	54	63	84	280	48	<8.0	710
	Jul-04	<2.0	130	390	27	51	460	250	39	10	—
	Nov-04	<0.5	130	210	34	72	1,100	240	41	7.8	700
	Apr-05	<0.5	81	140	12	66	360	260	24	20	560
	Nov-05	<0.5	190	120	25	59	430	250	22	21	510
	Mar-06	<0.5	42	20	4.1	42	190	200	16	88	550
	Aug-06	<0.5	30	46	5.4	40	110	200	21	34	430
MW-21	Dec-03	2.3	870	370	25	14	5.2	61	17	0.36	—
	Feb-04	2.2	680	330	27	16	4.9	51	17	0.49	—
	Apr-04	3	980	490	50	20	5	80	20	<8.0	280
	Jul-04	2.8	640	340	29	15	5.8	69	17	<0.6	—
	Nov-04	2.1	720	430	24	11	64	59	21	0.89	—
	Apr-05	0.43	450	300	13	11	20	32	10	1.2	170
	Nov-05	<0.5	220	120	28	12	18	35	6	0.5	240
	Mar-06	<0.5	390	280	19	17	23	50	12	6.1	360
	Aug-06	<0.5	260	260	20	19	30	55	16	12	280

DCA = dichloroethane
DCE = dichloroethene
PCE = tetrachloroethene
TCE = trichloroethene
VC = vinyl chloride
— = not analyzed
µg/L = micrograms per liter

All results in µg/L
HRC$^{®}$ Pilot Study began in December 2003 with the injection of 4,500 pounds of HRC$^{®}$.

This page intentionally left blank

2.0 PILOT STUDY DESCRIPTION

This section describes the field pilot study, including its objectives and components. The section describes the ozone and hydrogen peroxide delivery system and the contaminant destruction process, pilot study layout, system installation, monitor well installation, system operation, and groundwater monitoring program.

2.1 PILOT STUDY OBJECTIVES

The primary objectives of the pilot-scale field test were generally the same as those for the bench-scale test:

- To determine whether ozone, with or without hydrogen peroxide, is capable of destroying 1,4-dioxane and the other COCs; and
- To further assess the soil oxidant demand.

The overall goal was to determine whether ozone/hydrogen peroxide injection is a viable full-scale cleanup strategy for the site groundwater. Unlike the bench-scale test, the field pilot study was performed in situ, under actual site conditions, and was evaluated using data collected from the site monitor wells.

The pilot-scale field test would be deemed successful if the following were observed:

- Concentrations of target COCs were significantly reduced;
- Field monitoring indicated no permanent increase in unwanted products, such as hexavalent chromium and bromate; and
- There was no significant rebound in COC concentrations within a reasonable timeframe, after allowing for the influx of upgradient COCs.

2.2 PILOT STUDY COMPONENTS

2.2.1 Specifications of Ozone and Hydrogen Peroxide Delivery System

The pilot-scale field test consisted of a barrier configuration with three ozone/hydrogen peroxide injection wells and an ozone and hydrogen peroxide delivery system. Applied Process Technologies (APT) provided the ozone/hydrogen peroxide delivery equipment, consisting of a trailer unit chemical oxidation system, the Pulse-Ox 100T, which can direct moderate flow rates of ozone and hydrogen peroxide into injection wells fitted with proprietary MaxOx injection points. The system is designed to remediate both adsorbed and dissolved-phase organic compounds. APT, in Pleasant Hill, California, is a vendor/operator of the remediation equipment and provides a wide range of delivery systems that can supply up to 15 pounds per day (lbs/day) of ozone. Photographs of the Pulse-Ox 100T system and the pilot study injection wells are provided in Appendix B of this report (to be provided in the final report).

The trailer system can be operated to inject individual or variable combinations of air, oxygen, ozone, and hydrogen peroxide into the saturated zone. It uses a pressure-swing adsorption oxygen-generating system for the production and delivery of up to 23 standard cubic feet per hour (scfh) of 90% to 95% oxygen, and it provides sufficient oxygen for the ozone generator to produce up to 36 grams per hour (g/hr) (approximately 2 lbs/day) of ozone. A standard chemical feed pump delivers the hydrogen peroxide from a tank storing 35 gallons of 7% to 35% strength hydrogen peroxide. An air compressor with an 8-port gas delivery manifold provides up to 3.9 standard cubic feet per minute (scfm) of compressed air at 60 pounds per square inch (psi). The Pulse-Ox 100T also contains a 24-port gas/chemical delivery manifold with 0.25-inch stainless steel solenoid valves for pulsing oxygen, air, ozone, and/or hydrogen peroxide into a maximum of eight wells; it is controlled through an integrated programmable logic controller (PLC) system that controls valve sequencing and activates all audio/visual alarms. A call-out modem is included for reporting the system operational status.

2.2.2 Pilot Study Layout

The pilot-scale field test implemented an injection barrier comprising three proprietary MaxOx® ozone/hydrogen peroxide injection wells completed in the vicinity of EW-1 and MW-20. The pilot study layout is presented on Figures 4 and 5. Naturally occurring reductive conditions are observed in this area but not to the extent observed in upgradient monitoring wells closer to the HRC® injection area, such as EW-2 and MW-21. The concentration of COCs in this area has remained high, with initial TCE and 1,4-dioxane concentrations greater than 750 μg/L (Figure 5).

The injection wells contained injection points at depths of 70 and 90 feet bgs and were laterally spaced from 35 to 50 feet apart. The radius of influence (ROI) of each injection well was conservatively assumed to be 15 to 20 feet; therefore, to maximize the use of existing monitoring wells, an injection well was installed 15 feet upgradient from EW-1, and another injection well was installed 10 feet upgradient from MW-20. The third injection well was placed between MW-20 and EW-1 (Figure 4). Subgrade piping was installed to connect the individual wells to the Pulse-Ox 100T reagent delivery system, as shown on Figure 4.

2.2.3 System Installation

During the week of July 5, 2005, the three dual-completion MaxOx wells and three additional monitor wells were installed by Gregg Drilling and Testing of Signal Hill, California. Hollow-stem auger (HSA) drilling methods were used to install the wells inside a 10-inch diameter soil boring. Drilling and well installation were directed by a URS geologist using the methods specified in the *Cooper Drum Company Remedial Design Sampling and Analysis Plan* ([RD SAP]; URS, 2003b).

The injection wells were proprietary MaxOx® wells with the following components: two hydrogen peroxide and two ozone injection screens, each completed with 1-inch outer diameter (OD) stainless steel, 0.02-inch, V-slotted screens, 0.5-inch OD stainless steel tubing, and check valves to prevent backpressure into the injection lines. The ozone and hydrogen peroxide screens for each depth range were provided in a pre-fabricated assembly. The MaxOx® injection assembly was installed with the ozone screen at 90 feet bgs, the bottom of the injection well boring. A Monterey No. 3 sand filter pack was placed surrounding the screens to a depth of 1.5 feet above the top of the screen. A 1.5-foot bentonite seal was then placed above the sand pack surrounding the 1-foot-long ozone screen to prevent short-circuiting. The 3-foot-long hydrogen peroxide screen was positioned above the bentonite seal. Sand pack was then placed surrounding the screen and to a depth of 2 feet above the top of the screen. The borehole was then sealed with bentonite to a depth of 72 feet bgs, where the upper MaxOx® unit was placed in the borehole and installed as described for the deeper unit. Following the installation of the prefabricated assembly and tubing, each borehole was filled with bentonite and then completed with a protective, lockable access vault. Construction diagrams and boring logs for the MaxOx® injection wells are included in Appendix C.

Following the injection well installations, trenching was performed, and the conveyance piping/tubing was installed from the well vaults to the PulseOx trailer. Teflon tubing (3/8-inch inner diameter [ID]) was used for the ozone, and polypropylene (1/4-inch ID) was used for the hydrogen peroxide. All tubing was contained in 1.5-inch diameter Schedule 40 polyvinyl chloride (PVC) pipe.

2.2.4 Monitor Well Installation

Three new monitor wells (MW-20B, MW-33A, and MW-33B) were installed downgradient from the MaxOx® wells at the locations/depths where previously installed monitor wells were not present. The monitor well spacing from the injection locations was varied (10, 15, 20, and 30 feet) (Figure 4) to evaluate the ROI of the injection wells. During drilling of the monitor wells, soil samples were collected for lithologic logging purposes and logged according to the Unified Soil Classification System (USCS). Soil boring logs are presented in Appendix C. Groundwater monitor wells were constructed in boreholes using 2-inch ID, Schedule 40, flush-threaded PVC well casing. Ten feet of 0.020-inch machine-slotted well screen was set at the bottom of each boring. A Monterey No. 3 sand filter pack was installed from the bottom of the boring to 4 feet above the well screen. A 3-foot bentonite seal was placed above the sand pack, and bentonite-cement grout was used to seal the remaining annular space to the surface. The surface completions are traffic-rated, flush-mounted well boxes. Locking well caps were placed on the top of the casings. Well completion details are presented on the boring logs (Appendix C).

2.2.5 System Operation

The oxidation system was brought on line on July 19, 2005. System operation was conducted under the following conditions.

- For the first 148 days (5 months) of operation, ozone and air alone were injected sequentially in the 6 injection points during an hour-long cycle. Ozone was injected at a rate of 0.55 lbs/day for the first 45 days, at which time the ozone injection rate was increased to approximately 1.9 lbs/day over the next 3 weeks. The injection sequence consisted of 10 minutes of ozone/air followed by 5 minutes of air alone into each injection point. The initial volumetric flow rate of pulsed air was 1.1 scfm, which was increased to 2.2 scfm after approximately 100 days of operation.
- Hydrogen peroxide injection was initiated after 148 days (5 months), at a two-to-one mole ratio of peroxide to ozone (2.5 gallons per day [gpd] of 16% hydrogen peroxide solution). Hydrogen peroxide was injected for an hour, followed by 5 hours of lag time. After 195 days of operation, the lag time was reduced to 2 hours, in effect doubling the hydrogen peroxide injection rate (i.e., 5 gpd of 16% hydrogen peroxide solution). Also at this time, two of the deeper injection points (the deeper injection screens of M_{OX}-1, M_{OX}-2), which were found to be plugged, were cleared up. (Note that plugging of M_{OX}-2 occurred as a result of infiltration of fines during installation and was cleared with high pressure water jetting. M_{OX}-1 became plugged after being temporarily shut down. There appeared to be a greenish bio-film on the tubing lowered into the well during an acid treatment; however, acid treatment rehabilitated the well screen, suggesting the screen may have been calcified.)

- After 244 days (8 months), the injection of ozone and hydrogen peroxide was limited to wells M_{OX}-1 and M_{OX}-2 (at shallow and deep intervals) to evaluate the effect of focused ozone/peroxide injection on COC concentrations in monitor wells EW-1 and MW-33. At this time, the ozone injection sequence consisted of a 30-minute cycle, with 5 minutes of ozone in the shallow injection screens and 10 minutes in the deeper injection screens. The hydrogen peroxide injection remained at one hour on, followed with 2 hours of lag time. The focused injection was initiated because continuous data logging with a downhole ORP/DO probe indicated that elevated ORP levels could be sustained over longer time periods when oxidant injection was restricted to a smaller volume, thus increasing the oxidant concentrations. (Downhole data logging was initiated when negative ORP values were observed in the shallow monitor wells [EW-1 and MW-33A] during the November 2005 and January 2006 groundwater sampling events. See Section 3.3 for additional detail.)
- After 281 days (approximately 9 months), an additional ozone generator was installed, and the rate of ozone injection into M_{OX}-1 and M_{OX}-2 was doubled to approximately 4 lbs/day. At this time, the hydrogen peroxide injection rate was reduced (1 hour on, followed by 4 hours of lag time) to obtain a stoichiometric (0.7-to-1 mole:mole) ratio of peroxide to ozone.
- After 292 days (approximately 10 months), ozone injection was increased from 5 minutes to 10 minutes in M_{OX}-1A (shallow interval), thus extending the ozone injection cycle from 30 to 35 minutes.

From system startup on July 19, 2005, until termination of the pilot study on June 5, 2006, the PulseOx-100T operated over a period of 321 days, for a total of 7,182 hours, which equates to an uptime of 93 percent. A detailed summary of all system operational events that occurred during the pilot study is presented as Table 2. A summary of pilot study costs are presented in Table 3.

2.2.6 Groundwater Monitoring Program

Performance of the pilot-scale field test was evaluated using groundwater monitoring that was conducted at 3- to 6-week intervals. Five wells (MW-20 and EW-1 and new wells MW-20B, MW-33A, MW-33B) were monitored to validate the ozone/hydrogen peroxide advanced oxidation process. Well MW-20 is screened from 55 to 70 feet bgs, and the EW-1 screen interval is 48.5 to 88.5 feet bgs. Because of the long screen interval in EW-1 (40 feet), groundwater samples were collected at two depths in this well (63 and 85 feet, as shown on Figure 3). New well MW-20B is screened from 80 to 90 feet bgs; wells MW-33A and MW-33B are screened from 55 to 65 feet bgs and 80 to 90 feet bgs, respectively. Well MW-20, MW-33A, and EW-1 were consistently sampled at depths of 63, 60, and 63 feet bgs, respectively. Wells MW-20B, MW-33B, and EW-1 were consistently sampled at 85 feet bgs. For the purpose of evaluation, MW-20, MW-33A, and EW-1-63' are referred to as shallow wells and MW-20B, MW-33B and EW-1-85' are referred to as deep wells.

On July 12, 2005, an initial or "baseline" round of sampling was performed to identify groundwater conditions before the startup of the ozone/hydrogen peroxide injection system. After system startup, groundwater samples were collected every 3 weeks for 9 weeks, followed by every 4 to 6 weeks for 36 weeks based on evaluation of the concentration trends. A total of 13 groundwater sampling events were performed.

The monitoring protocol employed standard low-flow groundwater sampling techniques with a flow through cell (as specified in the RD SAP) (URS, 2003b). The RD SAP has been updated with an addendum to include the treatability testing, the ongoing monitoring for natural attenuation parameters, and the ongoing sampling of new wells. The addendum is included in the *Cooper Drum Pilot-Scale Field Test Treatability Study Work Plan* (URS, 2005).

The monitor wells were sampled by URS scientists, with the assistance of a field technician from Blaine Tech Services. Field parameters measured during well purging and sampling were recorded on the field data sheets presented in Appendix C. Groundwater samples were shipped by Federal Express to the EPA Region 9 Laboratory in Richmond, California, within 24 hours of collection. Samples analyzed for metals were sent by Federal Express to independent laboratories. On three occasions (July 12 and 28, 2005, and March 1, 2006), the VOC samples also were shipped to an independent laboratory. Given the 24-hour hold time requirements, samples analyzed for Cr(VI) were delivered by courier to EMAX laboratory on the day they were collected. All samples were transported in a cooler with ice under chain-of-custody protocol. The electronic data tables provided by the laboratory and the data validation reports are available at the Records Center at EPA Region 9 in San Francisco.

Beginning on February 21, 2006, URS installed data loggers with downhole probes (YSI 600 XLM system) in wells EW-1, MW-20, and MW-33A to measure the real-time response of DO and ORP to adjustments made in the timing of system operation cycles. Downhole data logging was initiated as a result of negative ORP readings during the November 2005 and January 2006 sampling events, which happened to coincide with the leveling off of COC concentrations. Earlier, DO and ORP were routinely monitored in the flow-through cells during the sampling events. On two occasions (August 5 and December 14, 2005), the DO and ORP readings were verified with a downhole probe in response to low ORP readings. The data logging data, which were downloaded from the downhole probes, are presented in Appendix E. In addition, vertical profiling at 5-foot intervals in the monitor wells was performed; these results also are included in Appendix E. The roster of measured field parameters was modified to include the occasional use of field test kits for hydrogen peroxide and ozone testing.

Water-level measurements were collected during each sampling event from the five monitor wells and selected wells in the area. The water-level data sheets are included in Appendix E.

This page intentionally left blank

3.0 RESULTS

An interpretation of groundwater elevations and analytical data from the 13 monitoring events is provided in the following sections.

3.1 GROUNDWATER FLOW DIRECTIONS AND GRADIENTS

A recent groundwater elevation contour map of the site, based on depth-to-water measurements made on June 6, 2006, is presented as Figure 6. The data indicate that the groundwater gradient in the area of the pilot study was to the south at 0.0017 feet per foot. This is consistent with previous flow directions inferred for this portion of the site and confirms that the monitor wells sampled during the pilot study are generally downgradient from the nearest injection point.

The water levels measured from the shallow wells MW-20 and MW-33A increased up to approximately one foot when compared to the deeper well pair (MW-20B and MW-33B) and more distant wells in the vicinity of the test. This response probably was related to the injection cycle. Considerable air pressure was evident in these wells (and in EW-1) when the well caps were removed for sampling. However, water levels in EW-1 did not appear to be elevated from the injection. The deeper monitor wells and those more distant from the injection wells did not appear to be influenced by the injection.

The pressure buildup observed in the shallow monitor wells is directly related to the finer material (clays and silts) that have been identified as beneath the site from approximately 40 to 50 feet bgs (Figure 5). This material also supports the perched aquifer zone previously identified. The injected air and ozone does not readily flow up through this material, therefore, a temporary pressure buildup is created when the system operates. Consequently, the migration of ozone through the vadose zone and to the surface is very unlikely, and larger injection ROIs would be expected in the shallow injection interval.

3.2 TREND ANALYSIS OF COC CONCENTRATIONS

3.2.1 Shallow Monitor Wells

The concentrations over time of select COCs reported in groundwater samples from shallow monitor wells EW-1 (at 63 feet bgs), MW-33A, and MW-20 are depicted in Figures 7, 8, and 9, respectively. These figures also indicate changes made to the system operating parameters described in Section 2.6. COC concentration data are presented in Table 4. Other general groundwater chemistry data and metal results are presented in Table 5. The following observations are made.

- The COC concentrations display unique trends in each of the monitoring wells.
- Figure 7, EW-1 (at 63 feet bgs): Decreasing COC concentration trends were observed almost immediately after the start of system operation. Maximizing the ozone injection rate had a relatively small effect on these trends. Doubling the air flow rate followed by the start of hydrogen peroxide injection did not improve concentration trends; rather, the start of hydrogen peroxide injection appeared to coincide with a period of increasing COC concentrations. However, the start of focused injection into M_{OX}-1 and M_{OX}-2 and doubling of the

ozone injection rate resulted in significant reduction (>75%) in TCE and 1,4-dioxane concentrations.

- Figure 8, MW-33A: With the exception of 1,4-dioxane, COC concentrations first increased and then leveled off and decreased, once the ozone injection rate was increased. Increasing the volumetric air flow rate appeared to coincide with a period of increasing trends in COC concentrations. Injection of hydrogen peroxide did not significantly affect these trends; however, there was a decrease in COC concentrations once the peroxide injection rate was doubled. There was an additional decrease in concentrations following focused injection into M_{OX}-1 and M_{OX}-2 and after the ozone injection rate was doubled, but the decrease was moderate (<30%). Aside from the moderate increase of TCE midway through the test, COC concentrations steadily decreased throughout the test.
- Figure 9, MW-20: Decreasing COC concentration trends were observed immediately after the start of system operation, but they seemed to level off shortly thereafter. Maximizing the ozone injection rate and increasing the air flow rate had a relatively small decreasing effect on the concentration trends. Injection of hydrogen peroxide did not improve concentration trends; rather, the start of hydrogen peroxide injection coincided with a period of increasing COC concentrations. COC concentrations decreased when hydrogen peroxide was doubled but rebounded after ozone and hydrogen peroxide injections ceased in M_{OX}-3, which is the closest injection well to MW-20.

3.2.2 Deep Monitoring Wells

The COC concentration trends in wells EW-1 (85 feet), MW-33B, and MW-20B are depicted in Figures 10 through 12, respectively.

The data plotted in Figures 10 through 12 show that, in all wells, the initial increase in the ozone injection rate resulted in decreasing concentration trends while doubling the air flow rate and start of hydrogen peroxide injection generally did not (there is an exception in the case of EW-1, where concentrations appeared to decrease following the increase in air flow rates). However, doubling the hydrogen peroxide injection rate coincided with additional reductions in concentrations, especially in MW-33B and MW-20B. The start of focused injection into M_{OX}-1 and M_{OX}-2, followed by doubling of the ozone injection rate, resulted in significant concentration reductions in EW-1 and, to a lesser degree, in MW-33B. As with MW-20, concentrations rebounded in MW-20B after oxidant injection into M_{OX}-3 ceased.

3.2.3 TCE and 1,4-Dioxane Concentrations

For a better perspective, the reported concentrations of TCE and 1,4-dioxane for the six monitoring locations at the beginning and end of the pilot-scale test are listed in Table 6 and shown on the geologic cross section of the sparge barrier on Figure 5.

On average, TCE concentrations decreased by 83%, and 1,4-dioxane concentrations decreased by 74% in the shallow monitor wells. The largest reductions were observed in EW-1 (63 feet), where COC reductions exceeding 90% were obtained. Note that the data provided in Table 6 for MW-20 and MW-20B are from April 2006 when oxidant injection ceased in the vicinity of this well.

Although not included in Table 6, the 1,1-DCA concentrations decreased by an average of 73% in the three shallow wells. This is very notable, considering the reluctant (ITRC, 2005) nature of chlorinated ethanes.

There were overall decreasing concentration trends in the deeper wells as well, with TCE concentrations decreasing an average of 48% in all of the wells. The largest decrease in TCE concentrations was observed in MW-20B, which is unexpected because injection into the nearest injection well ceased after approximately 260 days and this well did not benefit from the increase in ozone injection that occurred after this period. The 1,4-dioxane concentration reduction in EW-1 at 85 feet bgs, since the start of the pilot test, was 82 percent. However, initial 1,4-dioxane concentrations in MW-33B and MW-20B were too low to allow for any meaningful interpretation of concentration trends.

The concentration reductions in the deeper monitor wells, overall, were less than in the shallow monitor wells. The reason may be related to the cone-like diffusion pattern of injected ozone and air from the injection well screens, which results in an increasing ROI with vertical distance above the injection point. In addition, the presence of less permeable aquifer material in the 40- to 50-foot bgs interval probably increased the ROI for the shallow injection wells.

The reported reductions in TCE and 1,4-dioxane concentrations indicate that the application of ozone and hydrogen peroxide was effective at oxidizing the site COCs. Because of the complexity of the groundwater chemistry and the possible contribution from the upgradient source area, it was necessary to use an experimental approach to determine the optimal injection rates for ozone and hydrogen peroxide. It appears that the ozone injection rate is the critical factor in achieving maximum concentration reductions. However, it also is likely that the addition of hydrogen peroxide at stoichiometric ratios to ozone is an important factor. This presumption is corroborated by ex situ testing of water from MW-33A, which indicated that the oxidation reaction kinetics were enhanced by the addition of hydrogen peroxide. Figure 13 is a plot of the test results and shows the correlation between 1,4-dioxane concentrations and ozone. These results indicated that the 1,4-dioxane destruction rate (represented by the slope of the curve when 1,4-dioxane was plotted versus ozone) increased three-fold when hydrogen peroxide was used in addition to ozone. However, the results also showed that better destruction rates were obtained when water from another site was used, indicating that the Site groundwater probably had a larger soil oxidant demand (SOD). In addition, bench testing results previously indicated that addition of hydrogen peroxide suppressed both hexavalent chromium and bromate formation. At least one literature source (Suh and Mohseni, 2004) cites the optimal hydrogen peroxide to ozone mole ratio as being greater than zero but less than 0.40 to 0.45 mole:mole. Therefore, hydrogen peroxide and ozone should be injected at less than stoichiometric mole ratios, when used in a full-scale application.

No harmful by-products were created as a result of the pilot study. As indicated on Table 5, hexavalent chromium was not reported in any of the samples. Although not shown in Table 5, groundwater samples collected on June 5, 2006, also were analyzed for bromate. Bromate was not detected in these samples at levels exceeding the detection limit of 250 μg/L.

3.3 DO AND ORP MEASUREMENTS

DO and ORP measurements are routinely considered the most important field parameters with respect to gauging the effectiveness and the ROI of the oxidant injection process. If oxidant injection is performed successfully, DO and ORP levels are expected to rise. However, it should be noted that the range of these measurements may be undermined by ongoing chemical reactions in the surroundings, and by device selection and device calibration. For example, DO and ORP measurements using downhole and flow-through cell devices often differ significantly, probably because one is measured in situ and the other ex situ. Therefore, whereas the DO and ORP trends can be very helpful, individual readings may be less reliable or even contradictory.

3.3.1 Flow-Through Cell Measurements

The DO trends since the start of oxidation in the shallow and deep wells are shown on Figures 14 and 15, respectively. These data were collected during the groundwater sampling events using the flow-through cell. DO levels responded well to increases in oxidant amounts, as is evident from the positive slopes in the DO curves following increases in ozone and hydrogen peroxide injection rates. Surprisingly, DO levels did not respond positively to the doubling of the air injection rate. This may have been caused by the perturbation of fine sediments following the increase in injected air flow rates.

ORP trends in shallow and deep wells are depicted on Figures 16 and 17, respectively. These data also were collected using the flow-through cell. Similarly to DO trends, the ORP trends responded positively to increases in oxidant injection rates but negatively to increased air flow rate.

DO and ORP measurements (used to construct Figures 14 to 17), as well as other field parameter readings, are listed in Table 3. Note that the DO and ORP values shown on these figures represent a single measurement taken over an extended (4 to 6 week) period. However, these data are useful because they show a general trend with the COC destruction in the shallow monitor wells. For example, during the first three months of the pilot study, COC concentrations were decreasing and ORP values were also positive (see Figure 16). After this time, negative ORP values were observed during the sampling events and COC concentrations also leveled off. In late February 2006, a downhole probe was used to allow for continuous data logging of ORP (discussed in following section). The information obtained during this period led to the decision to focus the injection and ultimately to increase the ozone injection rate at individual injection wells.

3.3.2 Downhole Probe Measurements

Following these negative ORP readings, 24-hour downhole data logging was performed at MW-20 on February 21, 2006, with only M_{OX}-3 operating. These results indicated elevated ORP and DO levels could be sustained when the injection was focused at a single location. Additional data logging performed from March 20 through March 30, 2006, with only M_{OX}-1 and M_{OX}-2 operating, further supported the presence of sustained elevated levels of ORP and DO. Therefore, a decision was made to focus oxidant injection into M_{OX}-1 and M_{OX}-2 only and to continue to assess the real-time effect of varying operating parameters on DO and ORP levels with the data logging.

Results from data loggers installed and operated in EW-1 (63 feet) and MW-33A from April 17 through June 1, 2006 (272 to 317 days after the start of operations) are presented on Figures 18 and 19; these plots show the continuous ORP readings in EW-1 and MW-33A during this time.

In EW-1 (Figure 18), ORP levels remained negative during the first few days of data logging. On April 25, the system was temporarily shut down, and a second ozone generator was installed and operated, providing an ozone injection rate of approximately 4 lbs/day. Also at this time, the hydrogen peroxide-to-ozone mole ratio was reduced to stoichiometric levels (0.7 to 1), and the air flow rate was reduced back to 1.1 scfm. Following these operational changes, there was a gradual build up in ORP levels to a sustainable ORP level greater than 300 millivolts (mV). These elevated ORP levels were regained shortly after the restart of system operations, following a temporary system shutdown on May 15.

The ORP readings in MW-33A (Figure 19) reflect a steadier elevated profile, but with similar end results. The surrounding lithology in MW-33A is more permeable, resulting in a more immediate response to oxidant injection, compared to EW-1.

The continuous data logging in EW-1 and MW-33A and the achievement of the sustainable and elevated ORP levels in these wells implied that the system operating parameters were at an optimal setting. Therefore, no further changes to the system operations were applied after this time.

These resulting conditions were a clear indication that oxidation was effective in the vicinity of the monitor wells. As noted in Section 3.2, COC concentrations in EW-1 were significantly reduced during this period (see Figure 7), indicating COC destruction was related to chemical oxidation and not a physical process such as air stripping. At 20°C, the dimensionless Henry's constants for TCE, 1,1-DCA, 1,2-DCA and 1,4-Dioxane are: 0.42, 0.23, 0.04, and 0.0002, respectively. TCE is the most volatile and has the highest Henry's constant and 1,4-dioxane (at 2,100 times lower than TCE) has the lowest Henry's constant and is only semi-volatile. The larger the Henry's constant, the more effectively the material is removed using air stripping. The results from EW-1 at 63 feet bgs over the length of the test indicate the TCE, 1,1-DCA, 1,2-DCA, and 1,4-dioxane destruction percentages are very similar (at 90%, 92%, 89%, and 94%, respectively). Considering the differences in volatility, these destruction percentages do not support an air stripping model.

Furthermore, guidelines on effective air sparging for in situ air stripping recommend air volumetric flow rates in the range 3 to 25 cfm (preferably in the higher range of 20 to 25 cfm). By contrast, the injection air flow rate maintained during the most effective portions of the pilot test was approximately 1 cfm. These low air flow rates would have had little or no effect on the less volatile constituents, such as 1,4-dioxane and 1,2-DCA. Additionally, the Site lithology is such that, in the absence of soil vapor extraction (SVE), a good fraction of hypothetical stripped gases would be expected to re-enter the dissolved phase, resulting in higher rebound in COC concentrations than what was observed three months after the pilot test was stopped.

The above is also supported by the bench-scale test (See appendix A), which indicated that the specific site soil and groundwater geochemistry likely led to effective chemical oxidation of all site COCs, even with ozone alone. The bench test indicated that none of the COC destruction occurred as a result of air stripping, as evidenced by the absence of COCs in the headspace of the test bottles. It is likely that the particular conditions of the site subsurface geochemistry may have led to formation of high concentrations of the hydroxyl radical, a non-selective oxidant capable of destroying "reluctant" contaminants, such as isomers of DCA. The characterization of DCA as "reluctant" (as opposed to "recalcitrant") comes from the 2005 ITRC guidance document "*Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater*". This characterization implies that oxidation of DCA is to be expected when ozone and hydrogen peroxide are used as oxidants, although typically not as effectively as more readily oxidized contaminants, such as TCE and DCE. As discussed above, the results of the pilot test indicated that TCE, DCA, and 1,4-dioxane had similar destruction levels, even though the Henry's constant of TCE at 20°C is approximately 2 times greater than that of 1,1-DCA, 11 times greater than that for 1,2-DCA, and 2,000 times greater than that for 1,4-dioxane.

The DO levels also were monitored continuously with the downhole probes. During the later stages of the extended data logging initiated on April 17, 2006, the DO probes were found to have been compromised by a marginal (low) voltage supply and by fine sediment buildup on the probe membrane. Therefore, the later DO readings are not considered accurate, and DO readings are not shown on the figures.

3.3.3 Vertical Profiling

DO and ORP measurements versus depth also were performed in the monitor wells using the downhole probe. These results are included in Appendix D. Measurements were collected at 5-foot intervals in the wells. Given the short screen intervals in MW-20B (10 feet) and MW-33B (10 feet), the measurements did not reflect a significant change in DO or ORP as a function of depth in these monitor wells. However, the shallow wells (MW-20 and MW-33A) did show increased levels of ORP and DO in the 50- to 55-foot depth interval versus the 60- to 65-foot depth interval. This was expected based on the pressure buildup in MW-20 and MW-33A, which was caused by the presence of the semi-confining layer just above 50 feet bgs.

The most remarkable information was from EW-1, which has a 40-foot screen interval. On three out of the five profiling events during the focused injection, there was a significant change (increase) in ORP (up to 230 mV) and DO (up to 5.2 milligrams per liter [mg/L]) at the 80-foot depth interval (as compared to the deeper interval), suggesting the vertical offset of the influence of the injection system was 10 feet or less at this location.

The results of vertical profiling indicated that, for optimal results, the injection interval should be a maximum of 10 feet below the remediation target area. This is likely because of the cone-like diffusion pattern of the injected ozone and air.

3.4 OTHER FIELD MEASUREMENTS

As noted, groundwater samples also were measured occasionally for hydrogen peroxide and ozone using HACH field test kits during the later stages of the pilot study. Ozone was measured at 0.3 mg/L in MW-20 on February 22, 2006. Hydrogen peroxide was detected at wells MW-33A and EW-1 (63 feet) in samples collected between April 17 and April 30, 2006. The hydrogen peroxide reading in MW-33A started out at 20 mg/L but decreased over time to low single digits as a result of system shutdowns and a reduction in the peroxide injection rates. As mentioned, the response to oxidant injection at MW-33A was more pronounced and immediate, probably because this well is screened in a fairly permeable soil interval. Conversely, the peroxide measurements in EW-1 (63 feet) were consistently in the low single digits. Ozone testing results at both of these locations were always negative. The reason may be related to the short half-life of ozone and the relatively larger separation distance between these monitor wells and the injection wells, compared to the distance between MW-20 and M_{OX}-3.

Measured temperature and pH did not vary significantly during the pilot-scale system operations. However, these parameters should be monitored because the injection of hydrogen peroxide at higher rates may lead to increases in temperature, followed by off-gassing (this is not likely if hydrogen peroxide to ozone mole ratios are maintained at less-than-stoichiometric levels). Hydrogen peroxide injection also may result in the formation of metal hydroxides, which could increase pH; conversely, the oxidation process, in general, can produce some acid that can temporarily decrease the pH.

The electrical conductivity measurements, the value of which depends on the amount of total dissolved salts (or ions), indicated an overall decreasing trend since the start of system operations. It should be noted that the amount of oxygen that can be dissolved in water increases with decreasing salt concentration. Total organic content (TOC) also had an overall decreasing trend.

Ferrous iron concentrations decreased to zero in the shallow monitor wells almost immediately after the start of system operations, indicating a rapid oxidation process. However, the decrease in ferrous iron concentrations in the deeper wells was more gradual and incremental.

The reader is referred to Table 5 for the complete listing of general water chemistry parameters and metals results since the start of system operation.

3.5 ANALYTICAL DATA QUALITY ASSESSMENT

The data validation of the groundwater analytical data collected during the 13 groundwater sampling events between July 12, 2005, and June 5, 2006, has been approximately 30% completed. The completed data validation reports (and subsequent reports) can be found in the Records Center at EPA Region 9 in San Francisco, California. The data from the completed reports were determined to be acceptable for decision-making purposes with some estimated data due to sampling and/or laboratory data quality issues.

The overall field sampling procedures and analytical laboratory performance met the acceptable data quality guidelines, with the data completeness result exceeding 99 percent.

This page intentionally left blank

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Based on pilot study monitor well results, the following conclusions are made for the Site.

- Ozone injection alone can reduce significantly the concentrations of the site COCs, including TCE, cis-1,2-DCE, 1,1-DCA, and 1,4-dioxane. At the end of the pilot study, concentrations of seven out of the twelve Site COCs at EW-1-63' were reduced to below MCLs (PCE was below MCLs prior to the test and remained as such.). Those still present at concentrations greater than MCLs at this well included TCE (65 µg/L), cis-DCE (44 µg/L), 1,1-DCA (6.2 µg/L), and 1,4-dioxane (47 µg/L).
- Increased injection of oxidants increases the amount of contaminant (or COC) destruction.
- The effect of hydrogen peroxide on COC destruction is not clear. However, ex situ testing of the site groundwater does indicate that the injection of stoichiometric mole ratios (0.7 to 1 mole:mole) or less of hydrogen peroxide to ozone probably is required to achieve optimal results and to increase oxidation kinetics. This conclusion is supported by the results of laboratory tests conducted to evaluate the destruction efficiency of 1,4-dioxane; one literature source cites the optimal hydrogen peroxide to ozone mole ratio as being greater than zero but less than 0.4 to 0.45 mole:mole (Suh and Mohseni, 2004).
- As corroborated by the bench-test results, the presence of high levels of secondary constituents in the groundwater (e.g., iron, bicarbonates, organic matter) may have enhanced the effectiveness of oxidation by ozone. The presence of these compounds also can lead to scaling, biofouling, and general plugging of equipment installed below the water table. However, during the pilot study, only one well became plugged, and it was easily rehabilitated with a dilute acid.
- Ozone injection rates were crucial to the success of the pilot study. While the soil oxidant demand estimated in the bench test (3,000 milligrams per kilogram [mg/kg]) appears to have been too high, the pilot study results indicated that ozone injection rates of 2 lbs/day per injection well (or 1 lb/day per injection interval) were required to achieve optimal results.
- Overall, a greater ROI was achieved in the upper injection interval in the shallow aquifer. The ROI of the injection wells appears to be approximately 30 feet, the largest distance between an injection well and a monitor well in the pilot study. Vertical profiling of DO and ORP indicated that, for optimal results, the oxidant injection interval probably should be placed a maximum of 10 feet below the targeted treatment area. In addition, the presence of less permeable aquifer material in the 40- to 50-foot bgs interval probably increased the ROI for the shallow injection wells. Therefore, the larger ROI in the upper portion of the shallow aquifer (approximately 50 to 80 feet bgs) may have been related to the injection screen placement and should be considered in a full-scale application of the technology.
- Continued migration of contaminant mass from the Site source area and the naturally reducing aquifer conditions probably impacted the outcome of the pilot study. A more

aggressive network of injection wells and higher oxidant injection rates associated with a full-scale system would be expected to produce a steady reduction in contaminant mass.

- Data logging and real time measurement of field parameters, specifically DO and ORP, was crucial to the optimization of the operating parameters.
- The rate of air injection was found not to be a very important factor, though higher injection rates (>1 cfm) should be avoided to minimize agitating fine sediments in the aquifer.
- An evaluation of the COC destruction trends in conjunction with ORP data (see Section 3.3) indicates that COC destruction was caused by chemical oxidation and not a physical process, such as air stripping
- The introduction of air and oxidants resulted in highly oxygenated and aerobic conditions that probably promoted the growth of aerobic bacteria. While these bacteria may contribute to the direct and/or cometabolic degradation of some COCs, they may cause some biofouling and possible plugging of submerged equipment.
- There was zero to modest rebound of COC concentrations in the pilot study monitor wells in August 2006, three months after cessation of the pilot study (see Table 7). Some rebound was expected because contaminated plumes originating 30 feet or farther upgradient were expected to reach the pilot study area during this time. Modest rebound was observed in EW-1-63’, where the largest reductions in concentrations had been obtained during the pilot study. TCE concentrations also rebounded slightly in MW-20. Conversely, TCE concentrations in MW-33A and 1,4-dioxane concentrations in MW-33A and MW-20 continued to decline during the three months.

4.2 RECOMMENDATIONS

In summary, once the system operating parameters were optimized, the ozone/peroxide injection pilot-scale system was successful in achieving the test objectives of evaluating system performance and reducing COC concentrations. Based on these observations the following recommendation are made.

- The use of this technology is recommended for full-scale application. It is recommended that the lessons learned from the pilot study (i.e., optimal operating parameters and injection well construction/placement) be considered in the full-scale application of this technology.
- The full-scale system design should include the injection of ozone and hydrogen peroxide. However, operation of the full-scale system could begin with the injection of ozone only and transition to the combined injection of hydrogen peroxide and ozone at less than stoichiometric mole ratios of peroxide to ozone.
- With robust remedial design of a full-scale system, it is possible to attain MCLs for all site COCs. It is noted, however, that as concentrations approach MCLs, the oxidation reaction kinetics are expected to be first order with respect to the oxidant concentrations and slower than those observed in the pilot study. Therefore, the ISCO system should be designed to address COC concentrations greater than 50 μg/L. The portions of the plume less than the design concentration but greater than MCLs will be addressed with a downgradient remedy, likely to include groundwater extraction per the ROD.

- The injection wells should be placed so that their ROIs overlap for adequate coverage; therefore, the recommended spacing between injection wells is 50 feet (corresponding to a minimum ROI of 25 feet). The oxidant injection interval probably should be placed a maximum of 10 feet below the targeted treatment area. Optimal screen placement also will depend on location-specific lithology.
- The full-scale system should be designed for ozone injection rates of 2 lbs/day per injection well (or 1 lb/day per injection interval).
- It is recommended that remediation of the contaminated vadose zone in the source area occur prior to or concurrently with the full-scale groundwater remediation to minimize further impact to groundwater.

This page intentionally left blank

5.0 REFERENCES

Bower, F., and C. Miller, 2002. Filter Sand-Phosphate Buffer Effect on 2,4-Dinitrotoluene Ozonation. *J. of Environmental Engineer*, 131-136. February.

Donahue, N., J. Anderson, and K. Demerjian, 1998. *J. Phys. Chem. A*, 102, 3121.

EPA, 2002. *Cooper Drum Record of Decision*. September.

ITRC, 2005. *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater*. January.

Suh, J., and M. Mohseni, 2004. *Water Research*, 38, 2596–2604.

URS, 2002. *Cooper Drum Company Remedial Investigation/Feasibility Study Report.* May.

URS, 2003a. *Cooper Drum Company RD Pilot-Scale Field Test Treatability Work Plan.* October.

URS, 2003b. *Cooper Drum Company Remedial Design Sampling and Analysis Plan.* April.

URS, 2003c. *Cooper Drum Company Superfund Site Remedial Design Field Sampling and Treatability Bench-Scale Test Results Technical Memorandum.* July.

URS, 2005. *Cooper Drum Pilot-Scale Field Test Treatability Study Work Plan.* July.

URS, 2006. *Remedial Design Technical Memorandum for Field Sampling Results, Cooper Drum Company Superfund Site.* July.

Mahendra, S., and L. Alverez-Cohen, 2006. *Environ. Sci. Technol.*, 40, 5435–5442.

This page intentionally left blank

TABLES

TABLE 1

Groundwater Contaminants of Concern and Cleanup Levels
Cooper Drum Company Superfund Site, South Gate, CA

Medium	Contaminant of Concern	Cleanup Level (µg/L)	Basis for Cleanup Level
Groundwater (VOCs)	1,1-Dichloroethane (1,1-DCA)	5	MCL[a]
	1,1-Dichloroethene (1,1-DCE)	6	MCL
	1,2-Dichloroethane (1,2-DCA)	0.5	MCL
	1,2-Dichloropropane (1,2-DCP)	5	MCL
	1,2,3-Trichloropropane (1,2,3-TCP)	1	PQL[b]
	Benzene	1.0	MCL
	cis-1,2-Dichloroethene (cis-1,2-DCE)	6	MCL
	trans-1,2-Dichloroethene (trans-1,2-DCE)	10	MCL
	Tetrachloroethene (PCE)	5	MCL
	Trichloroethene (TCE)	5	MCL
	Vinyl chloride	0.5	MCL
Groundwater (non VOCs)	1,4-Dioxane	6.1	PRG[c]

[a] MCLs from Title 22 California Code of Regulation Section 64431 and 64444, unless otherwise specified.

[b] No MCL established for 1,2,3-trichloropropane. The PQL was identified as a remedial goal.

[c] No MCL established for 1,4-dioxane. The concentration is for the ingestion of drinking water only and does not account for potential dermal and inhalation exposure. EPA has established a screening criteria for PRGs.

EPA = United States Environmental Protection Agency
MCL = California primary maximum contaminant level
PQL = practical quantification limit
PRG = EPA preliminary remediation goal for drinking water
VOC = volatile organic compound
µg/L = micrograms per liter

TABLE 2

System Operation Events for Ozone/Hydrogen Peroxide Pilot Study
Cooper Drum Company Superfund Site, South Gate, CA

Date	Event
19-Jul-05	ISCO pilot study began. Based on bench-scale test, only ozone was injected. Injection rate was 0.5 pound per day. Ozone screen at 2B was plugged; therefore, ozone was injected into H_2O_2 screen. Ozone injection cycle was hourly (10 minutes at each well).
7-Sep-05	Ozone injection concentration increased from 0.5 to 1.5 pounds per day (50 days after startup).
29-Sep-05	Ozone injection concentration increased from 1.5 to 1.85 pounds per day (77 days after startup).
26-Oct-05	Air injection volume increased from 1.1 to 2.2 cfm (99 days after startup).
28-Nov-05	System went down on November 28 at 1730. Sampled on November 29. System restarted on November 30 (134 days); however, well 1B (ozone) was plugged. Switched ozone injection to H_2O_2 screen at 1B.
14-Dec-05	Attempted to unplug ozone screens at 1B and 2B using air compressor and airlifting, was unsuccessful. Began injecting H_2O_2 on December 14 (148 days after startup). H_2O_2 injection cycle was one hour of pumping and 5 hours off. The hourly H_2O_2 cycle was 20 minutes at 1A and 2A and 10 minutes at 3A and 3B. Total daily H_2O_2 pumping was 4 hours per day. Ozone cycle remained hourly (10 minutes each well). H_2O_2 injection pump set at 0.5 gallon per hour for a daily use rate of 2 gallons. The H_2O_2 blend in injection tank was 20 gallons DI water and 15 gallons of 35% H_2O_2 (49 pounds), which calculated to 16% by weight of H_2O_2. Also took round of field measurements with downhole probe on December 14 and 15 to confirm noticeably negative ORP values from the November 29 sampling event.
19-Jan-06	Cleared plugged ozone wells 1B (acidified with HCl) and 2B (jetted with water) 184 days after startup. Began injecting H_2O_2 at 1B and 2B at these two locations and switched ozone to the designed screen at these wells. Revised H_2O_2 hourly injection cycle from 20 minutes at 1A and 2A to 10 minutes at each well. Ozone cycle unchanged.
2-Feb-06	Took round of field measurements using downhole probe. Increased H_2O_2 injection cycle to one hour on and 2 hours off for a total run time of 8 hours per day.
14-Feb-06	Took round of downhole field measurements. Note system up and down appeared to be loose fitting and backpressure from H_2O_2 injection.
21-Feb-06	Performed 24-hour data logging of field measurements February 21 through 23. Performed vertical profiling at all wells; data logged overnight at EW-1 with normal cycle. Next morning, operated system with only MaxOx3A and 3B and data logged at MW-20. Switched back to normal cycle at approximately 8:30 pm and data logged overnight. Installed larger compressor on February 23. The larger compressor allowed the system to inject H_2O_2 at up to 50 psi. Previous shutdowns were related to low shutdown pressure for H_2O_2 injection. Treated 3A (H_2O_2) and 1B (ozone) with acid, based on increased pressure.
20-Mar-06	Performed 24-hour data logging from March 20 (244 days) through March 31. During data logging, system generally operated with only MaxOx1A&B, 2A&B operating on a 30-minute cycle (5 minutes shallow, 10 minutes deep); H_2O_2 remained on 3-hour cycle (1 hour on, 2 hours off); air volume decreased to 1.1 cfm). Minor variations performed to system operation during data logging.
17-Apr-06	Initiated 24-hour data logging at MW-33A and EW-1 on April 17. Shut system down on April 17 at 1600. Restarted at 0813 on April 18 with MaxOx1A&B, 2A&B injecting only oxygen on 30-minute cycle. Added air injection (1.1 scfm) at 0757 on April 19. Added H_2O_2 injection (3-hour cycle) at 1513 on April 19. Added ozone at 0745 on April 21. Sampled both wells for peroxide, ozone, VOCs, and dioxane. Sampled for H_2O_2 on April 17 at EW-1 (positive not quantified) and MW-33A (20+ mg/L). Ozone negative at both wells. Also sampled for H_2O_2 on April 19 (3 mg/L in MW-33A, 1 mg/L in EW-1), on April 21 (1 mg/L both wells), and on April 24 (1mg/L in both wells, ozone negative).

TABLE 2

(Continued)

Date	Event
25-Apr-06	Installed additional ozone generator on April 25. System off and on. Put into steady operation at 1800 on April 26 (281 days). Total ozone output 4 pounds, H_2O_2 cycle switched to 5-hour cycle (60 minutes on, 240 minutes off) at 1mole ratio (approximately 10% solution), air valves 1.1 scfm. No change in injection well cycle (i.e., 1A&B and 2A&B operating at 30-minute cycle). 24-hour data logging continued at EW-1 and MW-33A.
5-May-06	Increased cycle to 35 minutes by increasing O_3 injection from 5 to 10 minutes at 1A. This was done as a result of the drop in ORP at EW-1, which appeared to happen approximately every 3 days. Continued data logging at MW-33A and EW-1.
8-May-06	Sampled wells. H_2O_2 4.0 mg/L at MW-33a and <1.0 mg/L at EW-1 (55' and 63') and MW-33B. Ozone not detected at any location. No change to system operation. Data logging continued.
1-Jun-06	Changed DO membranes on data logging probes as a result of extremely low levels at MW-33A (0.2 mg/L) and somewhat low readings at EW-1. After resetting probes, batteries were determined to be low when data was retrieved from probes. Therefore, data from June 1 to June 7 were lost. Downhole probe measurements did show high levels of DO (up to 13 mg/L); therefore, it appears DO data were invalid from approximately May 21 to June 1.
5-Jun-06	Sampled wells. After arrival to sample, it was determined that system shutdown occurred on June 3, 2006, at 14:49. Total run time hours were 7,182 for O_3 and 961.51 for H_2O_2. Run time hours for second O_3 generator was 4,205 hours. System restarted at 1513 on June 5. Note second ozone generator would not restart. System shutdown on June 7 due to faulty timer on PSA. New PSA ordered; however, based on sampling results, pilot study was terminated.

cfm = cubic feet per minute
DI = deionized water
DO = dissolved oxygen
H_2O_2 = hydrogen peroxide
HCl = hydrochloric acid
ISCO = in situ chemical oxidation
mg/L = milligrams per liter
ORP = oxidation reduction potential
O_3 = ozone
PSA = pressure swing adsorption system
psi = pounds per square inch
scfm = standard cubic feet per minute
VOC = volatile organic compound

TABLE 3

Ozone/Hydrogen Peroxide Pilot Study Costs
Cooper Drum Company Superfund Site, South Gate, CA

Cost Category[a]	Cost
SITE PREPARATION	
Well Drilling – 3 Monitor Wells	$14,250
6 MaxOx Injection wells	$25,300
Electrical Connection	$ 1,500
Trenching and piping	$10,570
Permitting & Regulatory Requirements[b]	N/A
EQUIPMENT RENTAL[c]	
Chemical Oxidation System	$18,750
Air compressor	$ 1,250
Hydrogen Peroxide Skid	$ 2,100
Mobilization	$ 1,800
SYSTEM STARTUP	$ 5,450
CONSUMABLES	
Health and Safety Gear	$ 1,500
Hydrogen Peroxide	$ 2,850
LABOR	
Monitor well and Injection Well Installation	$17,000
Monitor Well Sampling (13 events)	$44,000
UTILITIES	
Electricity (2 lbs/day Ozone generator)	$ 1,800
Electricity (Air compressor)	$ 300
RESIDUALS AND WASTE SHIPPING AND DISPOSAL	
Contaminated Drill Cuttings	$ 4,170
Monitor Well Development and Purge water	$ 2,500
GROUNDWATER MONITORING	
Equipment Rental, 13 Sampling events (Downhole ORP/DO probe, Field test kits, etc.)	$21,200
ANALYTICAL SERVICES[d]	
VOCs, 1,4-dioxane, metals, cations, etc.	$57,200
OPERATION AND MAINTENANCE	$14,720
DEMOBILIZATION	$ 1,400
TOTAL PILOT STUDY COSTS	$249,610

[a] Costs do not include EPA personnel, ongoing project management, data evaluation and final report preparation.

[b] Federal Superfund Sites exempt from permit fees. Costs for Work Plan and Waste Discharge Requirement Permit not included.

[c] Rental Rate discounted approximately 50% of full-scale rate.

[d] Actual analytical costs budgeted from separate program. Analytical fees estimated at $650/sample with 88 total samples. Analyses include VOCs, PP Metals, cations, 1,4-dioxane, hexavalent chromium, bromate, chloride, nitrate, sulfate, bromide, O-phosphate, alkalinity, TSS, TDD, TOC, and sulfide.

lbs/day = pounds per day
ORP = oxidation reduction potential
DO = dissolved oxygen
EPA = United States Environmental Protection Agency
VOC = volatile organic compound
TSS = total suspended solids
TOC = total organic carbon

TABLE 4

Ozone/Hydrogen Peroxide Pilot Study Results for VOCs and 1,4-Dioxane (µg/L)
Cooper Drum Company Superfund Site, South Gate, CA

Date	PCE	TCE	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	VC	1,1-DCA	1,2-DCA	Benzene	1,2-DCPA	1,4-Dioxane	Other VOCs Detected
MW-20												
12-Jul-05	3.2	520D	200D	18	8.2	4.7	54D	10	0.85	4.4	140	
28-Jul-05	1.2	210D	98D	3.8	3.5	0.69	22	8.4	0.45J	3.00	150	
16-Aug-05	2.7	230	81	11	5.5	2.3	30	11	0.5	4.30	160	1,1,2-Trichloroethane (0.40), chlorobenzene (2.3), 1,2,3-trichloropropane (4.4)
07-Sep-05	2	160	60	6.3	2.6	1.1	24	6.8	0.3	2.6	140	Dibromomethane (1.7), 1,1,2-trichloroethane (0.3), chlorobenzene (1.4), 1,2,3-trichloropropane (3.5), bromoform (19)
29-Sep-05	1.7	150	50	5.5	2.7	0.8	21	6.3	0.3	2.6	120	Dibromomethane (2.4), 1,1,2-trichloroethane (0.2J), chlorobenzene (1.5), 1,2,3-trichloropropane (3.4), bromoform (20)
26-Oct-05	2.4	220	71	6.5	3	1	34	6.5	0.4	3.6	120	Dibromomethane (2.9), 1,1,2-trichloroethane (0.4J), chlorobenzene (1.8), 1,2,3-trichloropropane (3.9), bromoform (18J), isobutane (1.8)
29-Nov-05	1.1	130	39	5.4	1.8	0.7	22	3.7	0.3	1.8	98	Dibromomethane (2.0), chlorobenzene (0.9), 1,2,3-trichloropropane (1.8), bromoform (23)
18-Jan-06	2.8	240	64	10	4.2	1	34	6.7	0.5	3.5	110	Dibromomethane (2.8), chlorobenzene (1.7), 1,2,3-trichloropropane (1.1), bromoform (27), chlorodibromomethane (0.3)
1-Mar-06	0.75	110D	31D	2	1	0.62	16	2.7	<0.5	<0.5	79	Chlorobenzene (0.59), bromoform (46D)
5-Jun-06	1.8	340	77	15	6	3.1	34	6.3	0.6	3.6	160	1,1,2-Trichloroethane (0.3J), chlorobenzene (1.7), bromoform (0.9), 1,2,3-trichloropropane (2.8)
55-Foot Sample												
1-Mar-06 @55 feet	<0.5	45D	14	0.74	<0.5	<0.5	8	1.6	<0.5	<0.5	36	Bromoform (55D), dibromochloromethane (0.56), acetone (6.2)
MW-20B												
12-Jul-05	<0.5	0.3J	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	
28-Jul-05	<0.5	16	13	<0.5	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	
16-Aug-05	<0.5	19	17	0.2J	1.4	<0.5	0.3J	<0.5	<0.5	<0.5	0.6	1,2,4-Trichlorobenzene (0.2J), naphthalene(0.5J),1,2,3-trichlorobenzene (0.5J)
07-Sep-05	<0.5	18	13	0.2J	1	<0.5	0.4J	<0.5	<0.5	<0.5	0.5	
29-Sep-05	<0.5	6.2	8.4	<0.5	0.6	<0.5	0.2J	<0.5	<0.5	<0.5	<1.0	
26-Oct-05	<0.5	6	6.9	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0	
29-Nov-05	<0.5	6.1	14	0.2J	1	0.2J	0.4J	<0.5	<0.5	<0.5	0.8J	
18-Jan-06	<0.5	10	17	0.4	1.2	0.3	0.7	0.2	<0.5	<0.5	1.8	Dibromomethane (0.2)
1-Mar-06	<0.5	6.3	16	<0.5	0.87	<0.5	0.8	<0.5	<0.5	<0.5	2.2	Chloromethane (0.73)
5-Jun-06		11	19	0.4J	1.4	0.4J	0.6	<0.5	<0.5	<0.5	1.9	Carbon disulfide (0.3J)
MW-33A												
12-Jul-05	<0.5	2.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	540	Chloromethane (1.1)
28-Jul-05	5.6	940D	190D	29E	12	4.6	50D	8.1	2.5	4.9	630	
16-Aug-05	4.6	1200	190	27	15	7.2	49	7.3	2.2	3.9	470	Chlorobenzene (5.1), 1,2,3-trichloropropane (2.4)
07-Sep-05	4.9	1200	210	33	11	5.5	52	6.1	2	3.3	500	Toluene (0.2), 1,1,2-trichloroethane (0.30), chlorobenzene (5.0), 1,2,3-trichloropropane (2.1)
29-Sep-05	1.6	990	100	9.9	4.3	1.6	19	4.2	0.9	1.9	350	Bromoform (0.30J), chlorobenzene (2.3), 1,2,3-trichloropropane (1.4)
26-Oct-05	2.9	450	100	16	6	2.4	26	4.4	1.2	2.7	440	Bromoform (5.4J), chlorobenzene (3.5), 1,2,3-trichloropropane (1.9), dibromomethane (0.6), 1,1,2-trichloroethane (0.2), 3 TICs
29-Nov-05	4.4	680	140	20	7.8	3.2	42	5	1	3.4	300	Bromoform (9.8), chlorobenzene (3.3), 1,2,3-trichloropropane (2.5), dibromomethane (1.7), 1,1,2-trichloroethane (0.3)
18-Jan-06	1.6	670	74	10	3.7	0.9	18	3.2	0.7	1.4	270	Bromoform (27), chlorobenzene (1.7), 1,2,3-trichloropropane (1.1), dibromomethane (2.8)
1-Mar-06	<2.5	280D	33	4.2	<2.5	<2.5	10	<2.5	<2.5	<2.5	170	Bromoform (19)

TABLE 4

(Continued)

Date	PCE	TCE	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	VC	1,1-DCA	1,2-DCA	Benzene	1,2-DCPA	1,4-Dioxane	Other VOCs Detected
MW-33A (cont'd)												
5-Apr-06	0.60	160	25	2.3	1.1	0.3	9.4	1.7	0.3	0.9	140	Bromoform (26), chlorobenzene (0.9), 1,2,3-trichloropropane (0.8), dibromomethane (2.3)
17-Apr-06	1.1	260	29	5.0	1.9	0.7	12	1.9	0.3	1.0	120	Bromoform (29), chlorobenzene (1.3), 1,2,3-trichloropropane (0.8), dibromomethane (2.6)
8-May-06	0.4	120	14	1.7	0.7	0.2	5.3	0.8	<0.5	0.4	220	Bromoform (24), chlorobenzene (0.5), 1,2,3-trichloropropane (0.4), dibromomethane (1.6)
5-Jun-06	1.6	180	62	3.5	2.1	0.6	22.0	2.3	0.3	2.4	99	Bromoform (3.3), chlorobenzene (1.2), 1,2,3-trichloropropane (2.1), dibromomethane (0.7)
MW-33B												
12-Jul-05	<0.5	39D	41D	1.1	0.5JB	1.9B	1.3	<0.5	<0.5	<0.5	1.4	
28-Jul-05	<0.5	26D	30D	<0.5	2.5	<0.5	1.9	<0.5	0.15J	<0.5	2.1	
16-Aug-05	<0.5	30	36	2.3	3.8	0.6	2.9	0.5	<0.5	<0.5	2.5	
07-Sep-05	<0.5	38	42	2.4	3.3	0.6	2.40	<0.5	<0.5	<0.5	2.0	
29-Sep-05	<0.5	34	32	1.5	2.7	<0.5	1.7	<0.5	<0.5	<0.5	<1.0	Pentene (1.1J)
26-Oct-05	<0.5	35	28	1	2.1	0.2J	1.2	0.3	<0.5	<0.5	0.6	1,2,3-Trichloropropane (0.2J), 2 TICs
29-Nov-05	<0.5	34	28	1.3	2.9	0.3	1.3	0.3	<0.5	<0.5	0.6J	
18-Jan-06	<0.5	41	28	1.5	3.1	0.3	1.4	0.4	<0.5	<0.5	0.7	
01-Mar-06	<0.5	26D	25D	0.97	1.9	<0.5	1.2	<0.5	<0.5	<0.5	0.8	
05-Apr-06	<0.5	30.0	26.0	0.9	1.9	0.3	1.2	<0.5	0.3J	<0.5	0.8	
08-May-06	<0.5	24.0	24.0	1.0	1.9	0.2J	1.1	<0.5	<0.5	<0.5	0.8	
05-Jun-06	<0.5	25.0	28.0	0.9	2.1	0.2	1.0	0.2J	<0.5	<0.5	1.0	
EW-1-63 Feet												
12-Jul-05	0.62	660D	310D	40D	13JD	4.3J	74D	5.6	1.5	2.8	750	
28-Jul-05	0.82	530D	190D	43E	11	3.8	35D	4.4	1.3	2.6	860	
16-Aug-05	2.3	560	150	27	11	5.1	38	5	1.2	2.9	590	Chlorobenzene (4.4), 1,2,3-trichloropropane (1.2)
07-Sep-05	3.0	470	140	30	8.6	4.0	53	4.9	1.1	3.0	530	Chlorobenzene (3.9), 1,2,3-trichloropropane (1.4)
29-Sep-05	1.1	200	55	8.2	3.0	1.1	22	3.1	0.5	1.8	340	Chlorobenzene (1.9), 1,2,3-trichloropropane (1.0)
26-Oct-05	0.6	190	45	6.1	2	0.6	25	2.5	0.3	1.6	450	Chlorobenzene (1.1), 1,2,3-trichloropropane (1.1)
29-Nov-05	0.5	140	38	5.7	3.2	0.7	21	1.6	0.2	1.1	250	Chlorobenzene (0.6), 1,2,3-trichloropropane (0.4J)
18-Jan-06	1.9	250	59	12	4.1	1.1	30	3.9	0.7	2.5	420	Chlorobenzene (2.5), 1,2,3-trichloropropane (1.2)
1-Mar-2006	1.3	210D	53D	6.6	2.6	0.72	27D	3.1	0.52	1.9	420	Chlorobenzene (2.1)
05-Apr-06	1.3 (1.3)	210 (220)	40 (41)	5.8 (5.8)	2.1 (2.0)	0.8 (0.7)	23 (23)	3.1 (3.0)	0.4 (0.4)	1.9 (1.9)	420 (370)	Chlorobenzene (1.8, [1.8]), 1,2,3-trichloropropane (1.4, [1.4]), bromoform (0.2J, [0.2J])
17-Apr-06	1.2	170.0	41.0	5.9	2.2	0.7	25.0	2.7	0.4	1.8	390.0	Chlorobenzene (1.6), 1,2,3-trichloropropane (1.4), bromoform (0.2J)
08-May-06	1.3	200.0	48.0	7.6	2.5	1.0	23.0	3.0	0.5	1.9	410.0	Chlorobenzene (1.8), 1,2,3-trichloropropane (1.5), bromoform (0.7)
05-Jun-06	<0.5	65	44	3.7	5.5	0.5	6.2	0.6	0.2	0.5	47	1,2,3-Trichloropropane (0.6)
55-Foot Sample												
05-Apr-06 @ 53'	0.2J	80	31	2.4	1.2	0.2	17	2.3	0.2	1.2	230	Chlorobenzene (0.4), 1,2,3-trichloropropane (1.3)
08-May-06 @ 55'	0.7	110	32	4.8	1.9	0.6	22	2.3	0.3	1.4	340	Chlorobenzene (1.0), 1,2,3-trichloropropane (1.3)
EW-1-85 Feet												
12-Jul-05	<0.5(<0.5)	44D(40D)	35D(35D)	3(2.9)	2.5(2.3)	0.16J(0.31J)	3.2(3.2)	0.61(0.58)	<0.5(0.15J)	0.22J(<0.5)	29 (29)	

TABLE 4

(Continued)

Date	PCE	TCE	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	VC	1,1-DCA	1,2-DCA	Benzene	1,2-DCPA	1,4-Dioxane	Other VOCs Detected
EW-1-85 Feet (cont'd)												
28-Jul-05	0.19J(0.21J)	55D (89D)	30D (46D)	3.9 (2.9)	3.3 (2.3)	<0.5 (<0.5)	6.3 (4.7)	1.1 (0.69)	0.27J(<0.5)	<0.5(<0.5)	51 (48)	
16-Aug-05	<0.5 (<0.5)	44 (45)	30 (31)	3.8 (3.8)	3.4 (3.5)	<0.5 (<0.5)	4.4 (4.6)	0.6 (0.6)	<0.5 (<0.5)	0.2J (0.2J)	48 (47)	Chlorobenzene (0.2, [0.2J])
07-Sep-05	<0.5 (<0.5)	32 (32)	26 (26)	2.0 (2.1)	2.2 (2.3)	0.3 (0.3)	1.9 (2.0)	<0.5 (<0.5)	<0.5 (<0.5)	<0.5 (<0.5)	22 (20)	
29-Sep-05	<0.5 (<0.5)	40 (41)	27 (26)	1.8 (1.9)	2.3 (2.3)	0.3 (0.3)	2.9 (3.3)	0.5 (0.5)	<0.5 (<0.5)	<0.5 (<0.5)	18 (20)	Chlorobenzene (<0.5, [0.2J])
26-Oct-05	<0.5 (<0.5)	18 (18)	14 (14)	0.8 (0.8)	1.2 (1.2)	<0.5 (<0.5)	2.0 (1.8)	0.4J(0.4J)	<0.5 (<0.5)	<0.5 (<0.5)	52 (46)	Isobutane (1.2)
29-Nov-05	<0.5 (<0.5)	15 (15)	9.0 (9.0)	0.4 (0.4)	0.7 (0.6)	<0.5 (<0.5)	0.7 (0.7)	0.3 (0.4)	<0.5 (<0.5)	<0.5 (<0.5)	8.2 (7.9)	
18-Jan-06	<0.5 (<0.5)	36 (41)	33 (37)	2.2 (2.6)	3.1 (3.4)	0.3 (0.3)	3.4 (3.8)	0.5 (0.6)	<0.5 (0.2)	0.2 (0.3)	24	
1-Mar-06	<0.5 (<0.5)	36D (39D)	36D (38D)	1.8 (1.6)	2.6 (2.4)	<0.5 (<0.5)	3.7 (3.1)	0.58 (<0.5)	<0.5 (<0.5)	<0.5 (<0.5)	35 (40)	
05-Apr-06	<0.5	58.0	46.0	2.1	3.0	0.3J	5.3	0.9	0.2J	0.5	48.0	Chlorobenzene (0.2J), 1,2,3-trichloropropane (0.5)
08-May-06	<0.5	58.0	56.0	3.7	4.5	0.7	5.5	0.7	0.2J	0.5	27.0	Chlorobenzene (0.2J), 1,2,3-trichloropropane (0.4)
05-Jun-06	<0.5	29 (30)	25 (24)	1.1	2.0	0.2	1.4	0.4	<0.5	<0.5	9.4 (5.6)	

B = analyte found in associated method blank and in sample
D = detection associated with sample dilution
DCA = dichloroethane
DCE = dichloroethene
DCPA = dichloropropane
E = concentration exceeds upper level of instrument calibration range
J = estimated value
NA = compound not analyzed
PCE = tetrachloroethene
TCE = trichloroethene
TIC = tentatively identified compound
VC = vinyl chloride
VOC = volatile organic compound
µg/L = micrograms per liter

Duplicate value for VOCs and 1,4-dioxane from EW-1-85 feet shown in parenthesis.
Estimated and dilution values shown for April 2005 sampling round.
All results reported in µg/L.

TABLE 5

Ozone/Hydrogen Peroxide Pilot study Results for General Groundwater Chemistry Parameters
Cooper Drum Company Superfund Site, South Gate, CA

Date	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Jun-06
MW-20										
D.O. (mg/L)	0.12	0.54	7.59 (13)	11.11	7.24	10.2	1.6	1.99	3.66	1.52
ORP (mV)	38.6	-32.4	34 (203)	81.8	170	41.4	18.8	36.8	167	62.1
Temp. (C)	24.17	23.44	22.96	22.96	22.73	22.2	22.48	22.11	22.03	22.45
pH	7.15	7.3	7.93	7.15	7.4	7.5	7.43	7.3	7.44	7.23
Cond. (μmhos)	10,425	5,867	5,269	5,190	4,920	5,206	5,500	5,205	4,803	4,646
Ferrous Iron (mg/L)	1.0	0.0	0.0	0.0	0	0	0	0	0	0
TOC (mg/L)	18.0	25.0	14.0	13.0	11	11	7.1	12		9.8
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (mg/L)	8,70.0	850.0	780.0	690.0	670	640	770	700	600	930
Chloride (mg/L)	390	390	440	430	420	340	310	320	310	250
Bromide (mg/L)	3	2.6	3.3	3.9	3.5	3.4	1.5	2.5	1.9	1.9
Nitrate (mg/L)	<0.10	<0.10	0.33	3.5	4.1	6.8	3.5A3	5.6	12	0.14
o-Phosphate (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulfate (mg/L)	2,500	2,400	2,100	2,200	2,200	1,900	1,900	1,900	1,900	1,800
Aluminum (mg/L)	0.0819	0.06	0.0587J	0.0345J	0.0254J	0.424	0.0336J	<0.200	<0.200	0.119J
Antimony (mg/L)	0.0005	0.00095	<0.001J	0.00099J	0.0012J	<0.01	0.0023J	0.00074J	0.00006J	0.0016J
Arsenic (mg/L)	0.0794	0.0694	0.0596	0.0481	0.0354	0.0279	0.0221	0.016	0.0357	0.0113
Barium (mg/L)	0.251	0.22	0.105	0.0713	0.214	0.133	0.147	0.0705	0.0189	0.146J
Beryllium (mg/L)	<0.002	<.001	<.001	<.001	<.001	<0.005	<0.005	<0.001	<0.001	<0.004
Cadmium (mg/L)	<0.001	<.001	<.001	<.001	0.00036J	<0.005	<0.005	0.00043J	<0.001	0.0015J
Calcium (mg/L)	457	446	449	496	446	382	327	345	342	293
Chromium (mg/)	0.0021	<0.002	0.0015J	<0.002	0.00074J	0.0037	0.0005J	0.0013J	0.0018J	0.0013J
Hex. Chrom. (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	0.00081	0.00094	0.00098J	0.00077J	0.00081J	<0.005	0.00039J	0.00054J	<0.00033J	0.0013J
Copper (mg/L)	0.0067	0.0109	0.0108	0.0157	0.0134	0.0109	0.0133	0.0122	0.0126	0.0306
Iron (mg/L)	0.589	0.092	0.0731J	<0.1	<0.1	0.408	<0.1	<0.1	<0.1	<0.1
Lead (mg/L)	0.00013	0.00018	0.00014J	<0.001	<0.001	<0.005	<0.005	0.00029J	<0.001	0.0051
Magnesium (mg/L)	180	183	192	208	193	159	152	143	148	144
Manganese (mg/L)	3.12	2.31	1.05	4.27	0.958	0.838	0.307	0.669	4.57	1.36

TABLE 5

(Continued)

Date	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Jun-06
MW-20 (cont'd)										
Mercury (mg/L)	0.00011	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0225	0.0246	0.0327	0.0137	0.0251	0.0243	0.0172	0.015	0.0031	0.0268
Potassium (mg/L)	17	16	14.1	17.1	14.7	15.1	17	16.8	16.9	16.9
Selenium (mg/L)	0.012	0.0114	0.0206	0.0234	0.0356	0.0512	0.0194	0.0288	0.0027J	0.007J
Silver (mg/L)	<0.01	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.004
Sodium (mg/L)	978	971	771	659	652	570	790	645	631	745
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.004
Vanadium (mg/L)	<0.01	0.0121	0.0071	0.0037	0.0095	0.008	0.0127	0.0125	0.00051J	0.0153
Zinc (mg/L)	0.0955	0.0104	0.0133	0.0565	0.0705	0.294	0.156	0.009	0.0043	0.0337
MW-20B										
D.O. (mg/L)	0.11	0.32	0.08 (2.36)	0.25	0.37	0.19	0.25	0.14	0.3	0.16
ORP (mV)	-77.7	-117.3	-89.3 (-29.1)	-62.4	-1.1	-3.1	-187.1	-164.8	-110.3	-136.3
Temp. (C)	23.12	22.67	22.97 (20.24)	22.62	23.37	21.9	22.1	21.98	22.72	22.57
pH	7.13	7.16	7.7	7.29	7.1	7.3	7.38	7.1	7.26	7.15
Cond. (μmhos)	16,112	8,912	8,801	8,586	8,146	9,495	9,244	10,080	8,493	8,160
Ferrous Iron (mg/L)	3.1	3.6	3.4	3.6	4.0	3.4	2.8	2.4	3	NM
TOC (mg/L)	12	26	7.9	7.0	6.8	6.7	5.2	6.3		6.4
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (mg/L)	780	750	750.0	720.0	690.0	680.0	690	710	740	770
Chloride (mg/L)	190	170	160	150	140	130	130	130	120	110
Bromide (mg/L)	1.5	1.3	1.3	1.3	1.2	1.2	1.3	1.1	1.2	1.2
Nitrate (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
o-Phosphate (mg/L)	<1.0	<5.0	<5.0	<5.0	<5.0	<10.0	<1.0	<5.0	<1.0	<5.0
Sulfate (mg/L)	5,400	5,400	5,500	4,900	5,000	5,100	4,700	5,400	4,900	5,000
Aluminum (mg/L)	0.0532	<0.2	0.0949J	0.0386J	0.0396J	0.0511J	0.0381	<0.200	<0.200	<0.200
Antimony (mg/L)	0.0005	0.0008	0.00047J	0.00023J	0.0012J	<0.020	0.00027J	0.00012J	0.00059J	<0.020
Arsenic (mg/L)	0.0444	0.0491	0.0481	0.0492	0.0384	0.0397	0.0372	0.0285	0.0114	0.0274

TABLE 5

(Continued)

Date	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Jun-06
MW-20B (cont'd)										
Barium (mg/L)	0.138	0.179	0.201	0.0658	0.174	0.151	0.134	0.0163	0.07	0.0189J
Beryllium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.005	<0.001	<0.001	<0.010
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.005	<0.001	<0.00017J	<0.010
Calcium (mg/L)	400	405	391	433	427	390	390	382	367	347
Chromium (mg/L)	0.0011	0.00098	0.0016J	<0.002	0.0063J	<0.020	<0.010	0.00079J	0.0045	<0.020
Hex. Chrom. (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	0.00099	<0.001	0.00089J	0.00072J	0.00054J	<0.01	0.00026J	0.00025J	0.00048J	<0.010
Copper (mg/L)	0.0158	0.014	0.0152	0.016	0.0171	0.0048J	0.0054J	0.0042	0.0144	0.0102J
Iron (mg/L)	4.34	4.75	4.53	4.52	4.37	3.89	3.63	3.39	3.16	2.91
Lead (mg/L)	0.00004	0.00004	0.00003J	<0.001	<0.001	<0.010	<0.005	<0.001	0.00014J	<0.010
Magnesium (mg/L)	367	370	353	381	388	356	361	355	342	323
Manganese (mg/L)	6.07	6.51	6.12	7.03	7.09	6.07	2.54	4.26	0.0427	3.69
Mercury (mg/L)	0.00021	0.000022	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0079	0.0079	0.0083	0.0021	0.0019	<0.010	0.0018J	0.0014	0.0103	0.0061J
Potassium (mg/L)	21.5	19.7	17.4	21.6	20	21.60	23	20.3	22	26.1
Selenium (mg/L)	0.0154	0.0117	0.0105	0.0032J	0.0038J	<0.050	0.0047J	0.0011J	0.033	0.0051J
Silver (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.005	<0.001	<0.001	<0.01
Sodium (mg/L)	700	1,850	1,700	1,530	1,530	1,470	1,610	1,530	1,550	1,590
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.005	<0.001	<0.001	<0.010
Vanadium (mg/L)	<0.001	0.00063	0.00049J	<0.001	0.00056J	<0.010	0.00045J	0.00037J	0.0119	0.00048J
Zinc (mg/L)	0.0343	0.146	0.108	0.0138	0.144	0.0178J	0.0178	0.0021	0.0058	<0.020

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
MW-33A											
D.O. (mg/L)	0.16	0.88	2.59 (15.34)	1.23	1.2	1.02	0.62	1.18	7.47	11.1	1.96
ORP (mV)	-30.8	-86.9	16.9 (84.9)	4.7	130.7	32.2	-241.4	-107.6	37.2	179.1	36.6
Temp. (C)	24.15	22.99	22.7 (21.04)	23.09	22.18	22.3	22.22	22.12	23.11	21.18	21.09
pH	7.14	7.16	7.58	7.92	6.9	7.2	7.38	7.1	7.23	5.7	7.4
Cond. (µmhos)	7,102	3,955	3,971	3,863	3,488	4,195	4,071	4,877	4,398	4,516	4,142
Ferrous Iron (mg/L)	0.6	0.8	0.4	0.0	0.0	0.3	0	0	0	NM	0

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
MW-33A (cont'd)											
TOC (mg/L)	35.0	41.0	12.0	11	10.0	9.3	9	12		5	8.6
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Alkalinity (mg/L)	900.0	870.0	860.0	850	800.0	750.0	790	620	560	530	770
Chloride (mg/L)	120	110	110	120	100	98	96	100	96	94	92
Bromide (mg/L)	2.7	2.5	2.5	2.7	2.4	2.5	2.3	2.2	2	1.9	2
Nitrate (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.6	0.62	1.9	1.3
o-Phosphate (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulfate (mg/L)	1,700	1,600	1,700	1,800	1,600	1,500	1,500	2,100	2,400	2,500	2,000
Aluminum (mg/L)	0.058	<0.2	<0.2	0.364	0.0161J	0.0325J	0.382J	<0.200	<0.200		0.0276J
Antimony (mg/L)	0.00058	<0.002	0.0005J	0.0019J	0.00026J	0.00087J	0.0017J	0.0006J	0.00031J	0.00037J	0.00057J
Arsenic (mg/L)	0.0515	0.0757	0.0676	0.0488	0.0911	0.105	0.062	0.0628	0.0273	0.0355	0.0296
Barium (mg/L)	0.193	0.121	0.118	0.0779	0.129	0.155	0.229	0.0425	0.0386J	0.0624	0.0265J
Beryllium (mg/L)	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005	<0.003	<0.001	<0.001	<0.001	<0.004
Cadmium (mg/L)	<0.001	<0.001	<0.001	0.00021J	<0.001	<0.005	0.0002J	0.000090J	0.00009J	0.0001J	0.00044J
Calcium (mg/L)	317	417	438	462	448	413	388	508	474		319
Chromium (mg/L)	0.00033	0.00098	0.0013J	<0.002	0.00062J	<0.010	0.00056J	0.00041J	0.00025J	0.0021	<0.008
Hex. Chrom. (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	0.0022	0.0022	0.0024	0.00086J	0.0022	0.002J	0.0014J	0.0012	0.00075J	0.0012	0.0008J
Copper (mg/L)	<0.001	0.003	0.0036J	0.0155	0.0047	0.0031J	0.0094	0.0025	0.0083	0.0114	0.0206
Iron (mg/L)	0.25	0.399	0.204	0.396	0.0932J	0.0676J	<0.10	<0.10	<0.100		<0.10
Lead (mg/L)	0.0007	0.00035J	0.00053J	<0.001	0.00047J	0.001J	<0.003	0.00027J	0.00017J	0.00084J	<0.004
Magnesium (mg/L)	114	139	148	153	151	140	132	161	162		133
Manganese (mg/L)	1.95	2.51	2.57	1.07	2.96	2.58	1.4	2.47	1.84	1.57	0.0549
Mercury (mg/L)	0.0001	<0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0645	0.0696	0.0739	0.0277	0.0633	0.05	0.0412	0.0284	0.0147	0.0111	0.0187
Potassium (mg/L)	12.6	9.87	9.5	10.6	9.41	10.5	12.2	10.1	11.5J		16.2

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
MW-33A (cont'd)											
Selenium (mg/L)	0.0094	0.0083	0.0078J	0.0391	0.0033J	0.0046J	0.0053J	0.0057	0.0065	0.0078	0.0244
Silver (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.003	<0.001	<0.001	<0.001	<0.004
Sodium (mg/L)	630	496	460	406	395	382	460	415	448		608
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.003	<0.001	<0.001	<0.001	<0.004
Vanadium (mg/L)	0.00045	<00034	0.0035	0.0083	0.0022	<0.005	0.0247	0.0031	0.0057	0.0191	0.0285
Zinc (mg/L)	0.038	0.0104	0.0186	0.108	0.0134	0.021	0.183	0.0015J	0.0024	0.0081	0.0058J
MW-33B											
D.O. (mg/L)	0.45	0.33	0.10 (1.80)	0.4	6.6	0.14	0.45	0.12	0.24	0.32	0.11
ORP (mV)	-71.4	-121.4	-58.4 (5.0)	-78.1	87.2	-0.4	-323.1	-169.7	-110.3	-98.8	-147.4
Temp. (C)	24.29	22.64	22.63 (20.32)	22.6	21.5	21.6	22.23	21.56	22.35	21.4	22.03
pH	7.1	7.15	7.75	8.32	7	7.2	7.39	7	7.13	6.5	7.11
Cond. (μmhos)	16,005	8,829	8,667	8,577	7,930	9,622	9,459	10,088	8,526	8,350	8,144
Ferrous Iron (mg/L)	2.8	2.5	4.0	4.0	2.7	4	4.3	4.4	4	2.5	3.2
TOC (mg/L)	13.0	29.0	7.8	7.7	8	7.4	7.1	8.2		8	7.3
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (mg/L)	800.0	800.0	840	810	800	800	790	760	770	740	750
Chloride (mg/L)	210	190	180	190	190	200	200	200	150	170	170
Bromide (mg/L)	1.7	1.5	1.5	1.6	1.4	1.5	1.4	1.4	1.3	1.4	1.3
Nitrate (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.1	<0.10	<0.10
o-Phosphate (mg/L)	<1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<1.0	<0.50	<1.0	<1.0	<5.0
Sulfate (mg/L)	5300	5100	4800	4800	4900	4900	4800	5300	4500	4700	4900
Aluminum (mg/L)	0.0723	0.0486	0.217	0.0522	0.0422J	0.055J	0.0461J	<0.200	<0.200		<0.200
Antimony (mg/L)	0.00046	<0.0004	<0.002	0.00075J	0.00094J	<0.020	0.00076J	0.00007J	<0.002	0.00016J	<0.020
Arsenic (mg/L)	0.0443	0.0574	0.0304	0.0569	0.059	0.0596	0.0574	0.0567	0.0601	0.0658	0.0519
Barium (mg/L)	0.145	0.111	0.112	0.135	0.144	0.145	0.0198	0.0239	0.0239	0.033	0.021J
Beryllium (mg/L)	<0.001	<0.001	<0.002	<0.002	<0.002	<0.01	<0.005	<0.001	<0.001	<0.001	<0.010
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.002	<0.002	<0.010	<0.005	<0.001	<0.001	<0.001	<0.010
Calcium (mg/L)	381	393	350	422	405	371	356	390	370		354

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
MW-33B (cont'd)											
Chromium (mg/L)	0.00038	<0.0015	0.00072J	<0.004	<0.004	<0.020	0.00037J	0.0026	0.00062J	0.00035J	<0.020
Hex. Chrom. (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	<0.001	<0.00091	0.00046J	0.00052J	0.00046J	<0.010	0.00027J	0.00030J	0.0003J	0.0003J	<0.010
Copper (mg/L)	0.0153	0.0138	0.0061	0.0156	0.0139	0.0088J	0.0058J	0.0047	0.0199	0.002J	0.0093J
Iron (mg/L)	3.78	4.86	4.97	5.46	5.42	5.06	4.98	5.42	5.22		4.69
Lead (mg/L)	<0.001	<0.00004	0.00023J	<0.002	<0.002	<0.010	<0.005	<0.001	0.00009J	0.00023J	<0.010
Magnesium (mg/L)	362	377	331	392	393	367	355	376	355		338
Manganese (mg/L)	5.72	6.17	3.11	6.37	7.34	6.34	2.86	7.45	6.37	6.8	5.5
Mercury (mg/L)	0.00012	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0076	0.008	0.0042	0.0027	0.0019J	<0.010	0.0024J	0.0021	0.0018	0.0014	0.0052J
Potassium (mg/L)	21	19.2	16.6	21.2	18.8	20.7	21.6	19.2	20.4		24.2
Selenium (mg/L)	0.0156	0.0117	0.0044J	0.0024	0.0042J	<0.050	0.0038J	0.0014J	0.0026J	0.0025J	0.0042J
Silver (mg/L)	<0.001	<0.001	<0.001	<0.002	<0.002	<0.010	<0.005	<0.001	<0.001	<0.001	<0.010
Sodium (mg/L)	1,800	1,860	1,670	1,610	1,550	1,530	1,600	1,540	1,510		1,550
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.002	<0.002	<0.010	<0.005	<0.001	<0.001	<0.001	<0.010
Vanadium (mg/L)	<0.001	<0.00048	0.00055J	<0.002	<0.002	<0.010	0.00053J	0.00044J	0.00053J	0.00057J	0.00054J
Zinc (mg/L)	0.029	0.0183	0.0105	0.0268	0.0949	0.0521	0.132	0.0021	0.0035	0.0052	0.0053J
EW-1 (63 feet)											
D.O. (mg/L)	0.14	0.25	1.69 (4.03)	5.46	8.8	10.86	0.57	5.22	5.21	7.06	13.64 (DHP)
ORP (mV)	-86.8	-122.7	15.6 (26.1)	17.2	78.5	32.7	-277.8	-71.9	20.7	59.9	253 (DHP)
Temp. (C)	24.82	24.76	24.04 (20.79)	24.53	25.49	22.4	22.77	22.49	22.41	22.09	21.06 (DHP)
pH	7.34	7.28	7.7	8.06	7.4	7.5	7.46	7.2	7.29	6.7	7.56 (DHP)
Cond. (µmhos)	8,197	4,661	4,832	4,572	4,472	5,140	6,696	5,411	4,514	4,430	4,269 (DHP)
Ferrous Iron (mg/L)	0.6	2.1	0.0	0.0	0	0	0	0	0	0	0
TOC (mg/L)	24	40	16	13	13	12	8.1	14		9.9	6.9
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
EW-1 (63 feet) (cont'd)											
Alkalinity (mg/L)	1,000	950	900	910	820	800	790	780	760	730	820
Chloride (mg/L)	81	72	78	85	80	77	100	87	87	83	99
Bromide (mg/L)	2.6	2.4	2.5	3.0	2.4	2.5	1.9	2.6	2.5	2.5	1.3
Nitrate (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	0.07J	0.89A3	2.3	2.5	3.2	0.41
o-Phosphate (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulfate (mg/L)	1,900	1,900	1,900	1,800	1,900	2,000	3,200	2,200	1,900	2,000	4,100
Aluminum (mg/L)	0.056	<0.2	<0.20	0.0262J	0.0351J	0.0434J	0.031J	<0.200	<0.200		<0.200
Antimony (mg/L)	0.00038	0.00046	<0.001	0.0015J	0.0007J	0.0018J	0.00062J	0.00049J	0.00047J	0.00097J	<0.020
Arsenic (mg/L)	0.0642	0.0713	0.0219	0.0452	0.0241	0.0181	0.0216	0.0146	0.014	0.0171	0.0157
Barium (mg/L)	0.0963	0.131	0.0901	0.28	0.16	0.168	0.14	0.0263	0.0264	0.0342	0.0343J
Beryllium (mg/L)	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.001	<0.010
Cadmium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	0.00015J	0.00018J	0.00006J	<0.010
Calcium (mg/L)	331	317	288	343	319	297	364	321	299		376
Chromium (mg/L)	0.00034	0.00079	0.00038J	<0.002	0.0005J	<0.010	<0.010	0.0017J	0.00090J	0.00023J	<0.020
Hex. Chrom. (mg/L)	<0.01	<.0002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	0.0011	0.0014	0.00091J	0.0018	0.0014	<0.005	0.00087J	0.0012	0.0012	<0.001	<0.010
Copper (mg/L)	0.004	0.0063	0.0035	0.0167	0.0228	0.0238	0.0168	0.0213	0.0244	0.0205	0.0153J
Iron (mg/L)	2.52	1.71	0.136	<0.1	<0.1	<0.1	0.133	<0.10	<0.1		0.067J
Lead (mg/L)	0.00017	0.00022	0.00062J	0.00071J	0.00053J	<0.005	<0.005	0.00065J	0.00055J	0.00066J	<0.010
Magnesium (mg/L)	137	136	127	154	155	155	255	158	151		290
Manganese (mg/L)	2.41	2	0.623	1.31	0.777	0.362J	1.94	0.428	0.361	0.293	2.05
Mercury (mg/L)	0.000044	<0.0002	<0.00020	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0473	0.0578	0.0322	0.0622	0.0569	<0.0461	0.0284	0.0484	0.0463	0.0476	0.0121
Potassium (mg/L)	12.60	12.4	13.5	15.2	13.7	16.7	21.3	14.9	15.8		26.9
Selenium (mg/L)	0.0105	0.0088	0.006	0.0238J	0.032	0.0459	0.0307	0.0558	0.0406	0.0548	0.0129J
Silver (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.001	<0.010

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
EW-1 (63 feet) (cont'd)											
Sodium (mg/L)	801	768	671	637	665	679	1100	683	599		1290
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.001	<0.001	<0.010
Vanadium (mg/L)	<0.001	0.00034	0.0037	0.0091	0.0138	0.0148	0.0148	0.0167	0.0141	0.0168	0.0122
Zinc (mg/L)	0.0082	0.0127	0.0126	0.13	0.0173	0.0915	0.032	0.0025	0.0028	0.0049	0.0112J
EW-1 (85 feet)											
D.O. (mg/L)	0.31	0.33	0.16 (0.82)	0.58	0.4	0.23	0.45	0.48	0.22	0.48	0.16
ORP (mV)	-79.5	-127	-55.4 (-13.0)	-85.5	21.2	6.1	-310.6	-125.7	-79.6	12.8	-72.4
Temp. (C)	22.93	22.5	22.0 (20.15)	22.62	23.1	21.7	21.91	21.75	21.59	21.41	21.86
pH	7.23	7.19	7.83	8.16	7	7.2	7.37	7	7.11	6.6	7.08
Cond. (μmhos)	15,430	8,380	8,490	8,823	8,448	9,564	10,382	10,110	8,728	8,200	8,900
Ferrous Iron (mg/L)	4.2	4.0	NR	4.8	5.5	4.0	3.4	2.6	2.2	0.0	1.8
TOC (mg/L)	15	27	8	7.9	8.8	7.6	8.5	11		7.8	8.3
Sulfide (mg/L)	<1.0	<1.0	<1.0	<1.0	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (mg/L)	810	800	840	810	780	800.0	780	790	790	810.0	750.0
Chloride (mg/L)	180	160	160	180	180	170	230	160	160	130	210
Bromide (mg/L)	1.6	1.4	1.5	1.5	1.5	1.6	1.7	1.5	1.6	1.5	1.6
Nitrate (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.71	<0.1
o-Phosphate (mg/L)	<1.0	<5.0	<5.0	<5.0	<5.0	<10.0	<1.0	<1.0	<1.0	<1.0	<5.0
Sulfate (mg/L)	4,800	4,700	4,800	4,800	5,400	4,400	5,400	5,000	4,700	4,600	5,500
Aluminum (mg/L)	0.075	<0.2	<0.020	0.0366J	0.0454J	0.0509J	0.0445J	<0.200	<0.200		<0.200
Antimony (mg/L)	0.00042	0.00044	<0.001	0.00046J	0.00033J	<0.020	<0.010	0.0004J	0.00018J	0.0052	<0.020
Arsenic (mg/L)	0.0723	0.072	0.065	0.0609	0.0513	0.0415	0.0542	0.0232	0.0197	0.018	0.0223
Barium (mg/L)	0.128	0.08	0.062	0.09	0.0851	0.0938J	0.0822	0.0407	0.0306	0.0368	0.0267J
Beryllium (mg/L)	<001	<0.001	<0.002	<0.002	<0.001	<0.010	<0.005	<0.001	<0.001	<0.001	<0.010
Cadmium (mg/L)	<001	<0.001	<0.001	<0.002	<0.001	<0.010	<0.005	0.00009J	<0.001	<0.001	<0.010
Calcium (mg/L)	367	354	315	386	386	354	394	391	369		380
Chromium (mg/L)	0.00039	0.00077	0.0005J	<0.004	0.00044J	<0.020	<0.010	0.0015J	0.00035J	0.00022J	<0.020

TABLE 5

(Continued)

	12-Jul-05	28-Jul-05	16-Aug-05	7-Sep-05	29-Sep-05	26-Oct-05	29-Nov-05	18-Jan-06	1-Mar-06	5-Apr-06	5-Jun-06
EW-1 (85 feet) (cont'd)											
Hex. Chrom. (mg/L)	<0.01	<0.01	<0.0002	<0.01	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (mg/L)	0.00043	0.00069	0.00034J	0.00058J	0.00081J	<0.010	<0.005	0.0011	0.00082J	0.0033	0.0014J
Copper (mg/L)	0.0195	0.0165	0.0057	0.0158	0.0159	0.0062J	0.0049J	0.0065	0.016	0.0062	0.0108J
Iron (mg/L)	5.41	4.7	4.64	5.08	4.48	3.2	6.27	1.17	0.796		1.36
Lead (mg/L)	0.00004	0.00003	0.00007J	<0.002	<0.001	<0.010	<0.005	<0.001	<0.001	0.00012J	<0.10
Magnesium (mg/L)	360	314	298	385	380	347	448	352	333		399
Manganese (mg/L)	5.79	5.18	2.77	6.25	6.73	5.42	3.41	4.74	4.93	4.8	5.05
Mercury (mg/L)	0.00023	<0.0002	<0.00020	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	0.0078	0.0122	0.006	0.0038	0.0074	0.0076J	0.0025J	0.0068	0.0071	0.0116	).0078J
Potassium (mg/L)	16.2	17.2	15.2	20.3	18.1	19.9	23.6	20.1	20.2		28.9
Selenium (mg/L)	0.0151	0.0109	0.004	0.0031J	0.0076	0.0074J	0.0057J	0.0066	0.0072	0.0138	0.0066J
Silver (mg/L)	<0.001	<0.001	<0.001	<0.002	<0.001	<0.010	<0.005	<0.001	<0.001	<0.001	<0.010
Sodium (mg/L)	1,710	1,630	1,410	1,530	1,460	1,350	1,740	1,360	1,370		15,550
Thallium (mg/L)	<0.001	<0.001	<0.001	<0.002	<0.001	<0.010	<0.005	<0.001	<0.001	0.00008J	<0.010
Vanadium (mg/L)	0.00039	0.00063	0.00051J	<0.002	0.0044	<0.010	0.0014J	0.0112	0.007	0.0171	0.0059J
Zinc (mg/L)	0.0396	0.0123	0.0079	0.0063	0.0086	<0.020	0.0657	0.0023	0.0033	0.0076	0.0083J

°C = degrees Celsius
DHP = downhole probe
DO = dissolved oxygen
J = estimated value
mg/L = milligrams per liter
mV = millivolt
NM = not measured
ORP = oxidation reduction potential
TOC = total organic carbon
μmhos/cm = micromhos per centimeter

Note: DO, ORP, and temperature values shown in parenthesis measured with downhole probe.

TABLE 6

TCE and 1,4-Dioxane Concentrations in Shallow and Deep Monitoring Wells
Cooper Drum Company Superfund Site, South Gate, CA

Well ID	Initial TCE (July 2005) (mg/L)	Final TCE (June 2006) (mg/L)	Percentage Change	Initial 1,4-Dioxane (July 2005) (mg/L)	Final 1,4-Dioxane (June 2006) (mg/L)	Percentage Change
Shallow Wells						
EW-1 (63 ft bgs)	660	65	-90%	750	47	-94%
MW-33A	940	180	-81%	630	99	-84%
MW-20	520	110*	-79%	140	79*	-44%
Shallow Well Average			**-83%**			**-74%**
Deep Wells						
EW-1 (85 ft bgs)	55	29	-47%	51	9.4	-82%
MW-33B	39	25	-36%	1.4	1.0	NA
MW-20B	16	6.3*	-61%	0.5	2.2*	NA
Deep Well Average			**-48%**			**NA**

* Final data for MW-20 and MW-20B are from March 2006 when oxidant injection into the nearest injection well was ceased.

ft bgs = feet below ground surface
mg/L = micrograms per liter
NA = Not applicable; initial concentrations were too low to allow a meaningful evaluation of changes
TCE = trichloroethene

TABLE 7

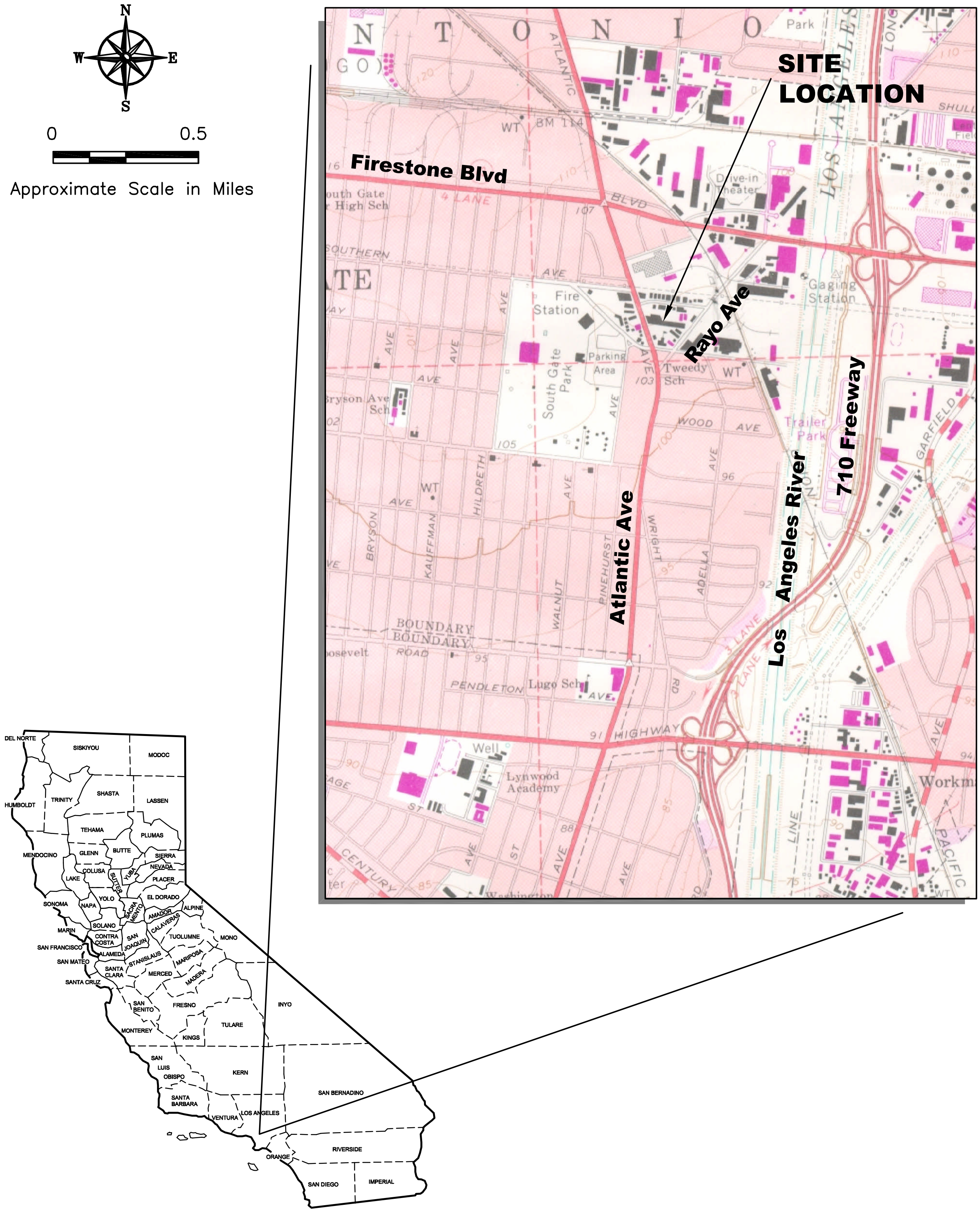
Evaluation of Rebound in Shallow Monitor Wells Three Months After End of Pilot Study
Cooper Drum Company Superfund Site, South Gate, CA

Well	COC	Initial Concentration July 2005 (µg/L)	Concentration in June 2006 (µg/L)	Percentage Change Since Start of Pilot study	Concentration in August 2006 (µg/L)	Percentage Change Since Start of Pilot study
EW-1 (63 ft)	TCE	660	65	-90%	120	-82%
EW-1 (63 ft)	1,4-Dioxane	750	47	-94%	250	-67%
MW-33A	TCE	940	180	-81%	130	-86%
MW-33A	1,4-Dioxane	630	99	-84%	74	-88%
MW-20	TCE	520	110*	-79%	140	-73%
MW-20	1,4-Dioxane	140	79*	-44%	71	-49%

* Final data for MW-20 and MW-20B are from March 2006 when oxidant injection into the nearest injection well was ceased.

COC = contaminant of concern
TCE = trichloroethene
µg/L = micrograms per liter

FIGURES

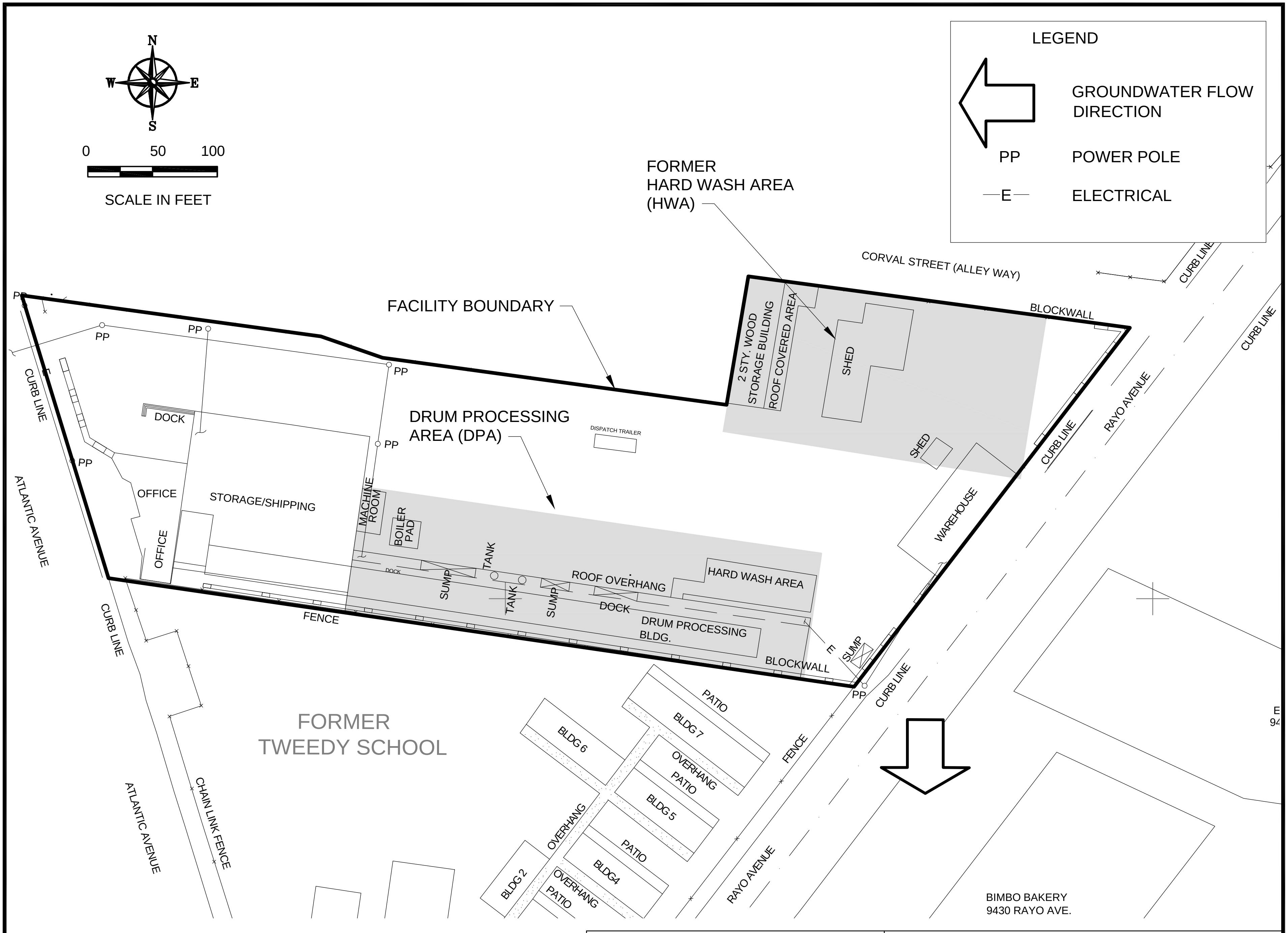


H:\CADD\Current\ENV-INFRA\Cooper Drum\20061103\FIG_1_SLM.dwg Plotted: Dec 05, 2006 – 3:30pm Last Save: Dec 05, 2006 – 2:17pm

URS
2870 GATEWAY OAKS DRIVE, SUITE 300
SACRAMENTO, CA 95833

Cooper Drum Superfund Site South Gate, CA	Figure 1 Site Location Map

H: \CADD\Current\ENV-INFRA\Cooper Drum\20061103\061103_FIG_2_SL.dwg Plotted: Dec 05, 2006 - 3:31pm Last Save: Dec 05, 2006 - 3:29pm

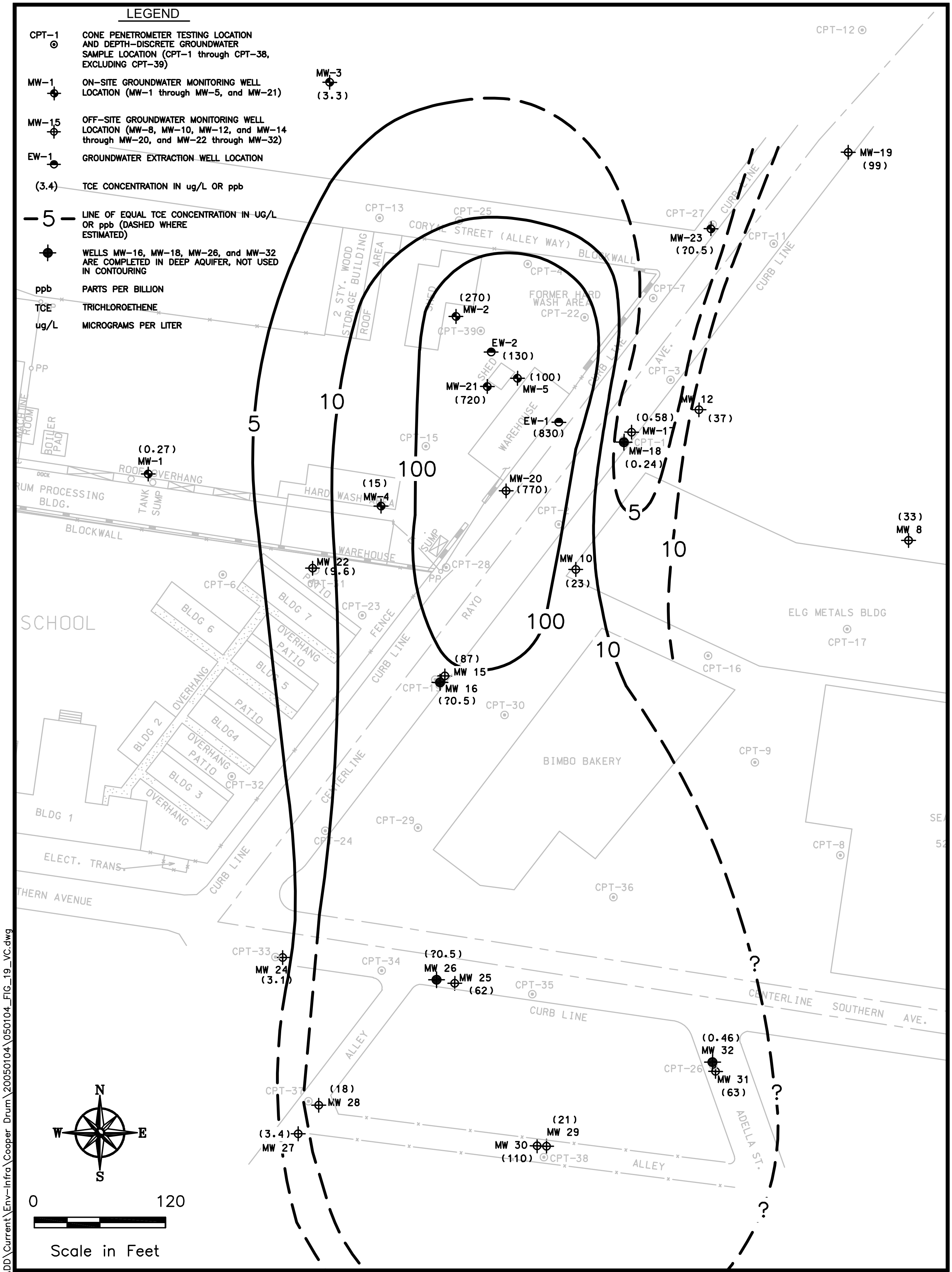


URS

2870 GATEWAY OAKS DRIVE, SUITE 300
SACRAMENTO, CA 95833

Cooper Drum Superfund Site
South Gate, CA

Figure 2
Site Layout and Source Areas

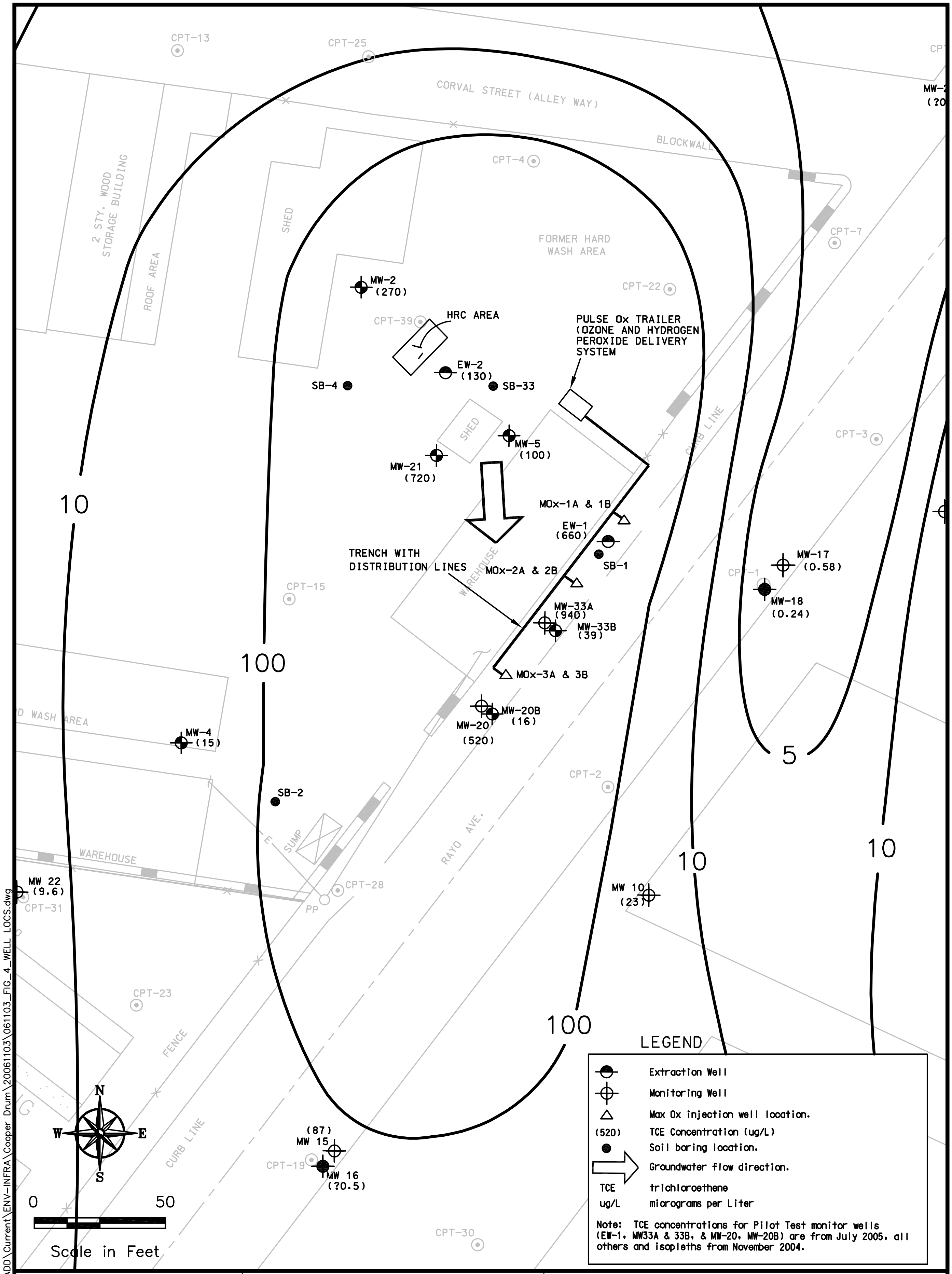


DRAWING: H:\CADD\Current\Env-Infra\Cooper Drum\20050104\050104_FIG_19_VC.dwg

URS
2870 GATEWAY OAKS DRIVE, SUITE 300
SACRAMENTO, CA 95833

Cooper Drum Superfund Site
South Gate, CA

Figure 3
Site Contaminant Plume and TCE Concentrations, July/November 2004



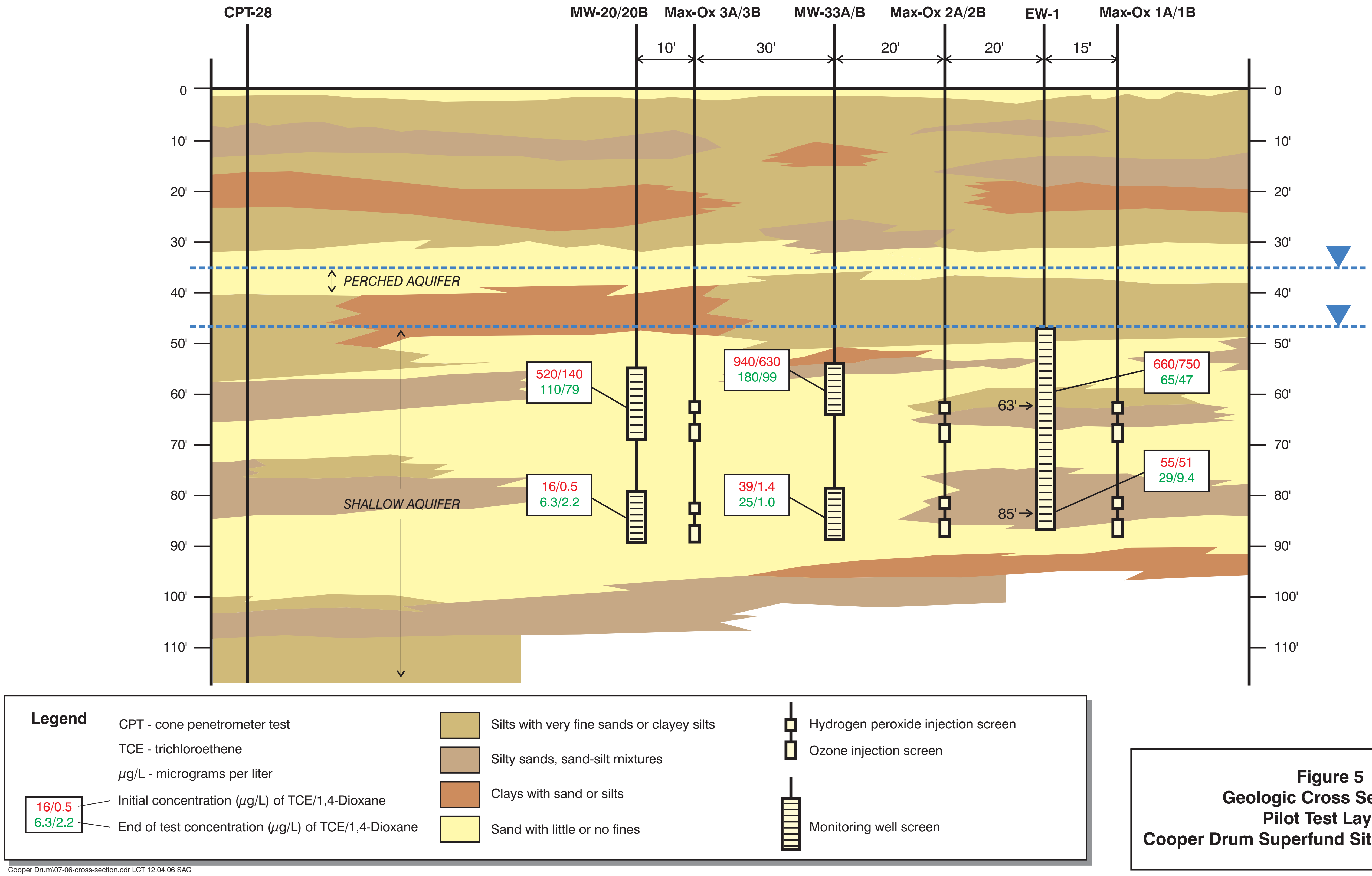
Note: TCE concentrations for Pilot Test monitor wells (EW-1, MW33A & 33B, & MW-20, MW-20B) are from July 2005, all others and isopleths from November 2004.

DRAWING: H:\CADD\Current\ENV-INFRA\Cooper Drum\20061103\061103_FIG_4_WELL LOCS.dwg

URS
2870 GATEWAY OAKS DRIVE, SUITE 300
SACRAMENTO, CA 95833

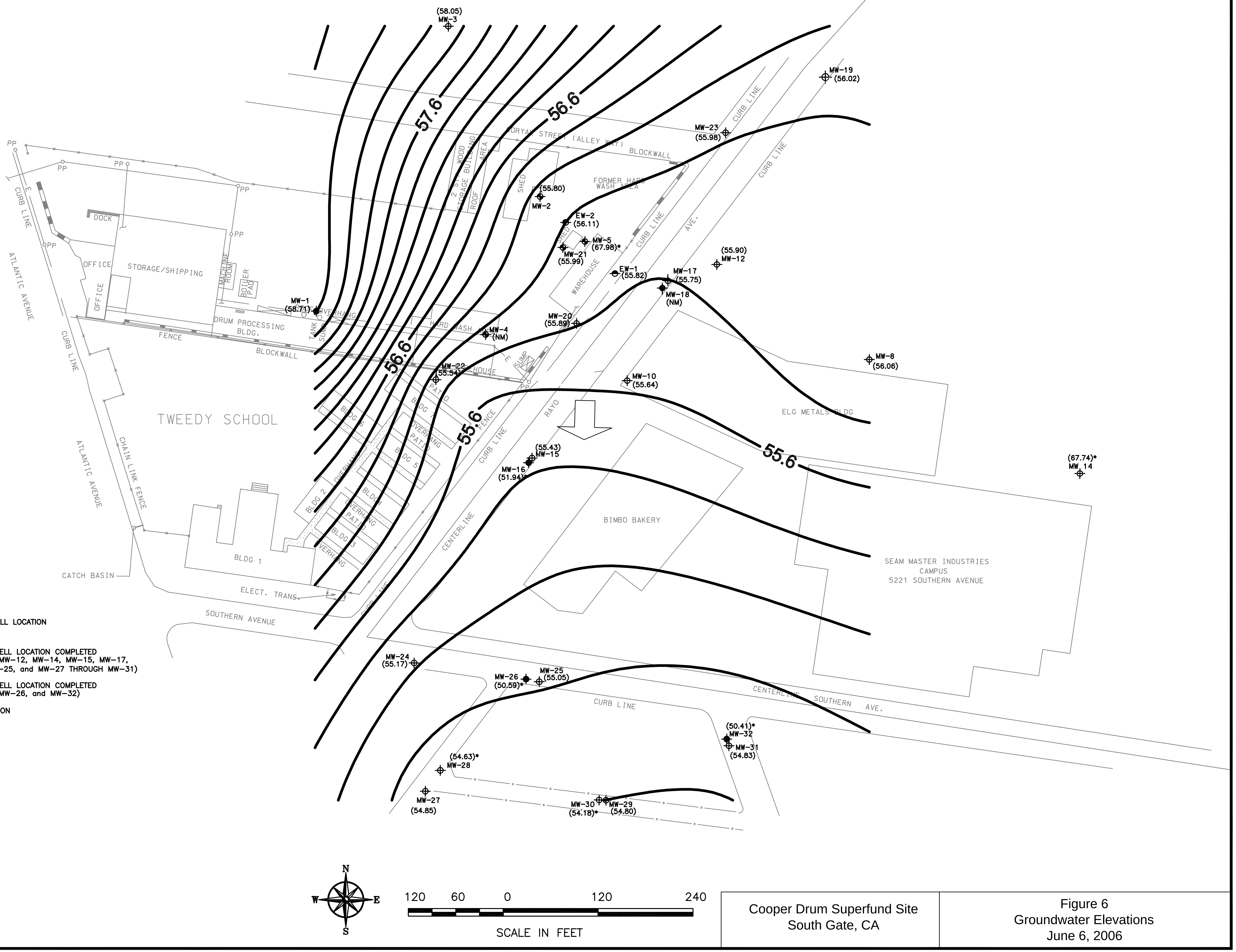
Cooper Drum Superfund Site
South Gate, CA

Figure 4
Field Pilot Test Layout
w/ Baseline TCE Concentrations



Cooper Drum\07-06-cross-section.cdr LCT 12.04.06 SAC

Figure 5
Geologic Cross Section of
Pilot Test Layout
Cooper Drum Superfund Site, South Gate, CA



LEGEND

⌖	ON-SITE GROUNDWATER MONITORING WELL LOCATION (MW-1 through MW-5, and MW-21)
⌖	OFF-SITE GROUNDWATER MONITORING WELL LOCATION COMPLETED IN SHALLOW AQUIFER (MW-8, MW-10, MW-12, MW-14, MW-15, MW-17, MW-19, MW-20, MW-22 THROUGH MW-25, and MW-27 THROUGH MW-31)
●	OFF-SITE GROUNDWATER MONITORING WELL LOCATION COMPLETED IN DEEPER AQUIFER (MW-16, MW-18, MW-26, and MW-32)
⊖	GROUNDWATER EXTRACTION WELL LOCATION
(54.29)	GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
—54.6—	GROUNDWATER ELEVATION CONTOUR
NM	NOT MEASURED
*	NOT USED IN CONTOURING
⇨	GROUNDWATER FLOW DIRECTION

061103_FIG_6_GWGRAD_JUN06_RBF.dwg

MRA Dec 07, 2006

COOPER

URS
2870 GATEWAY OAKS DRIVE, SUITE 300
SACRAMENTO, CA 95833

Cooper Drum Superfund Site
South Gate, CA

Figure 6
Groundwater Elevations
June 6, 2006

Figure 7. COC Concentrations at EW-1 (63 feet)

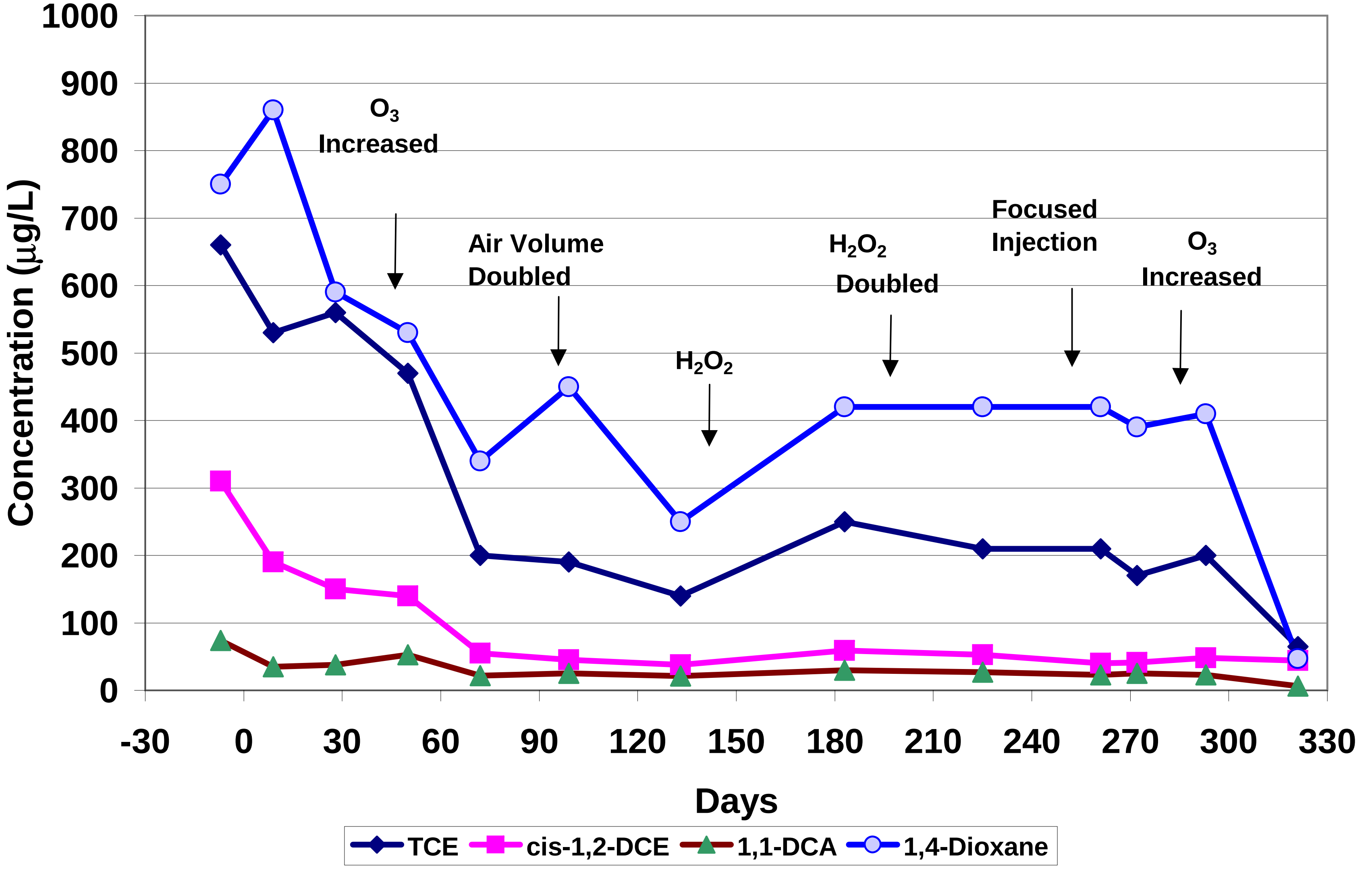


Figure 8. COC Concentrations at MW-33A

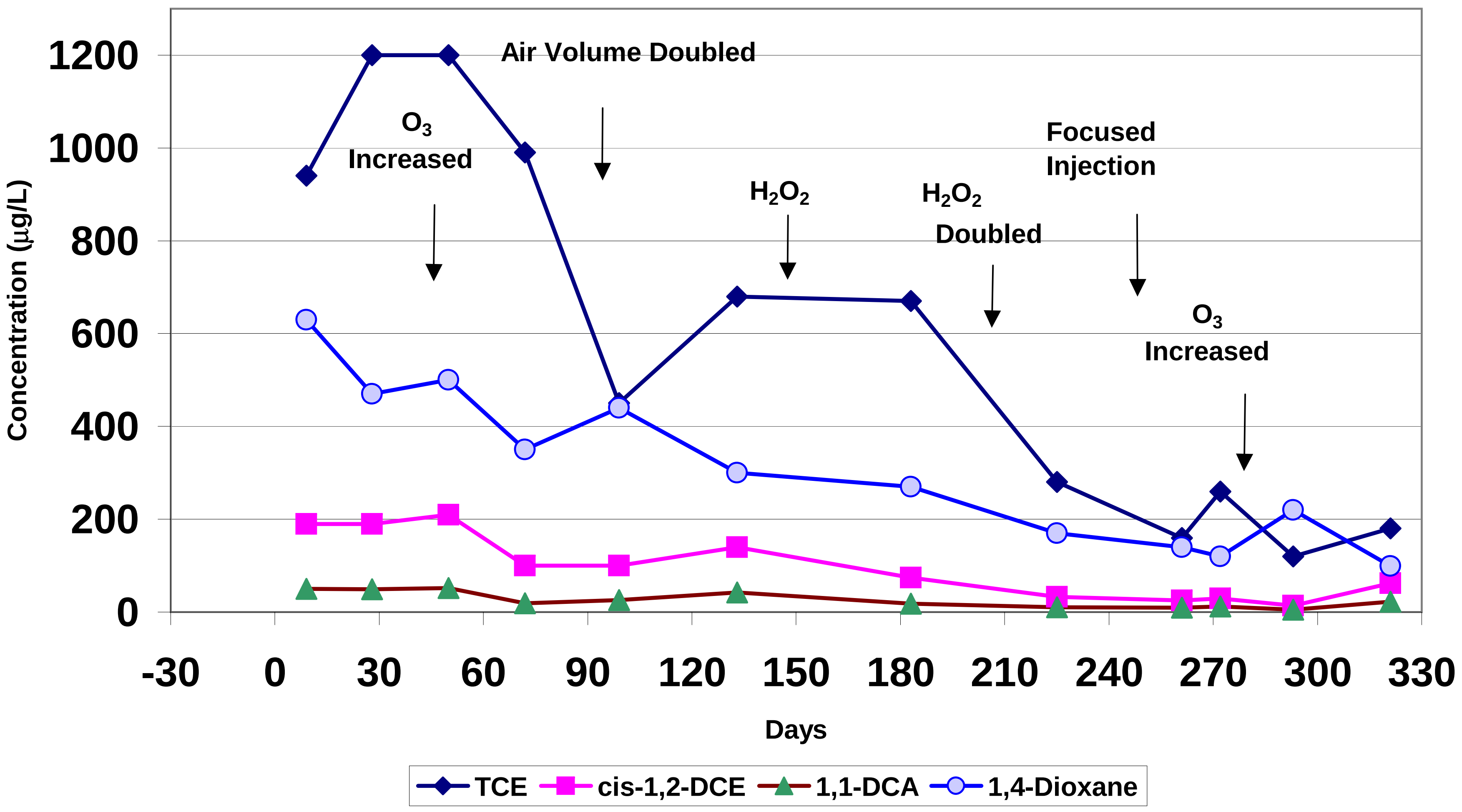


Figure 9. COC Concentrations at MW-20

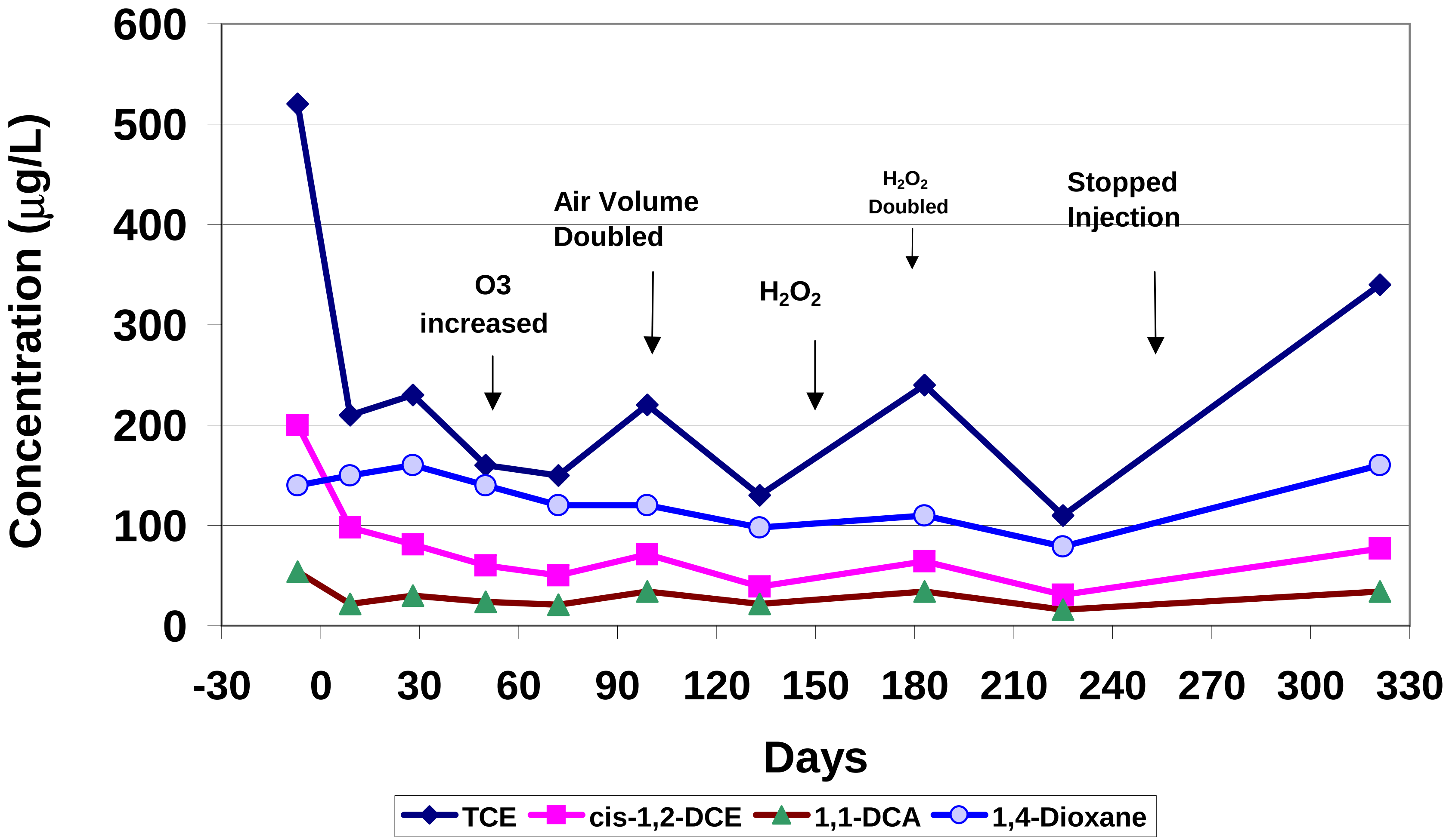


Figure 10. COC Concentrations at EW-1 (85 feet)

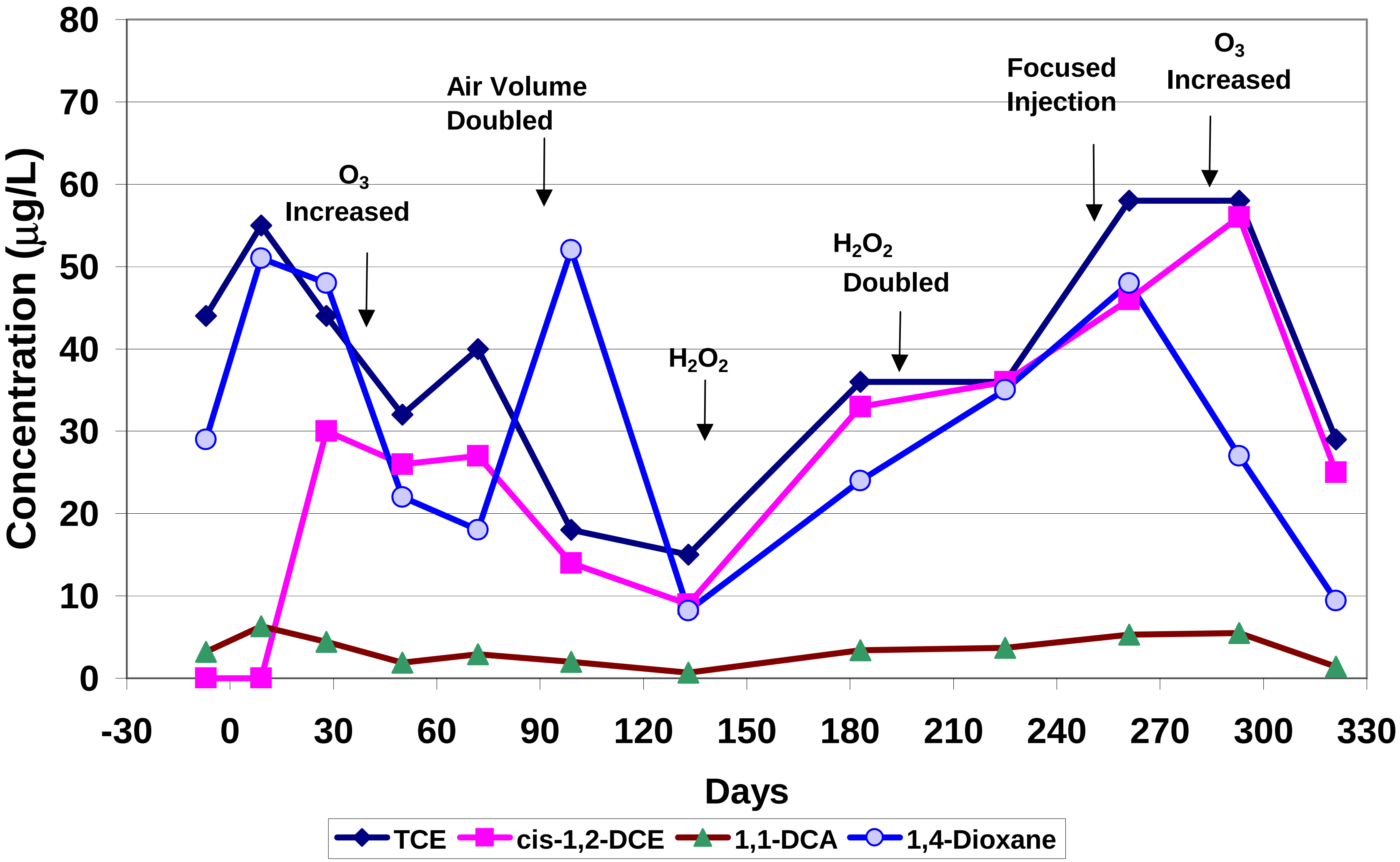


Figure 11. COC Concentrations at MW-33B

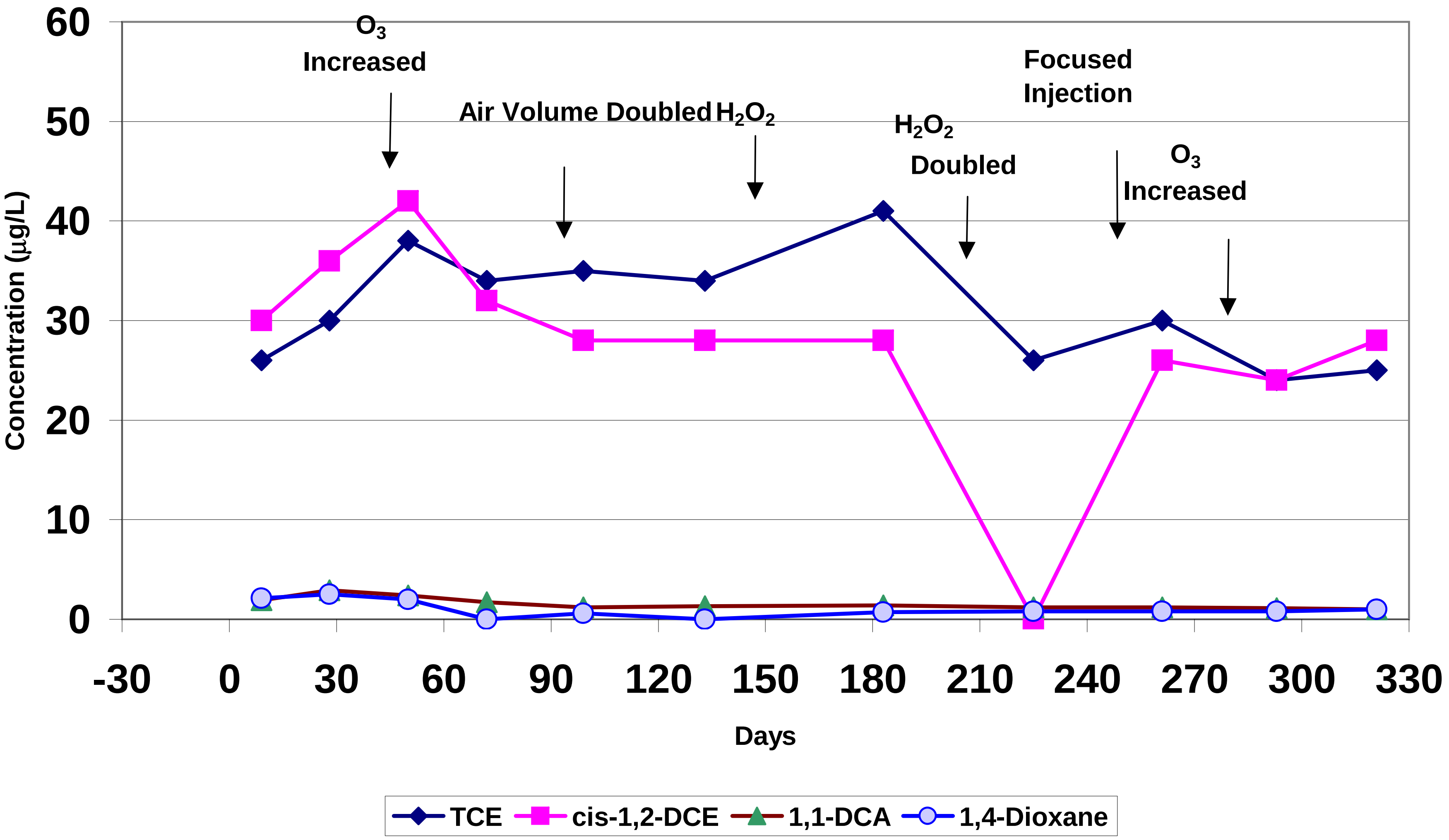


Figure 12. COC Concentrations at MW-20B

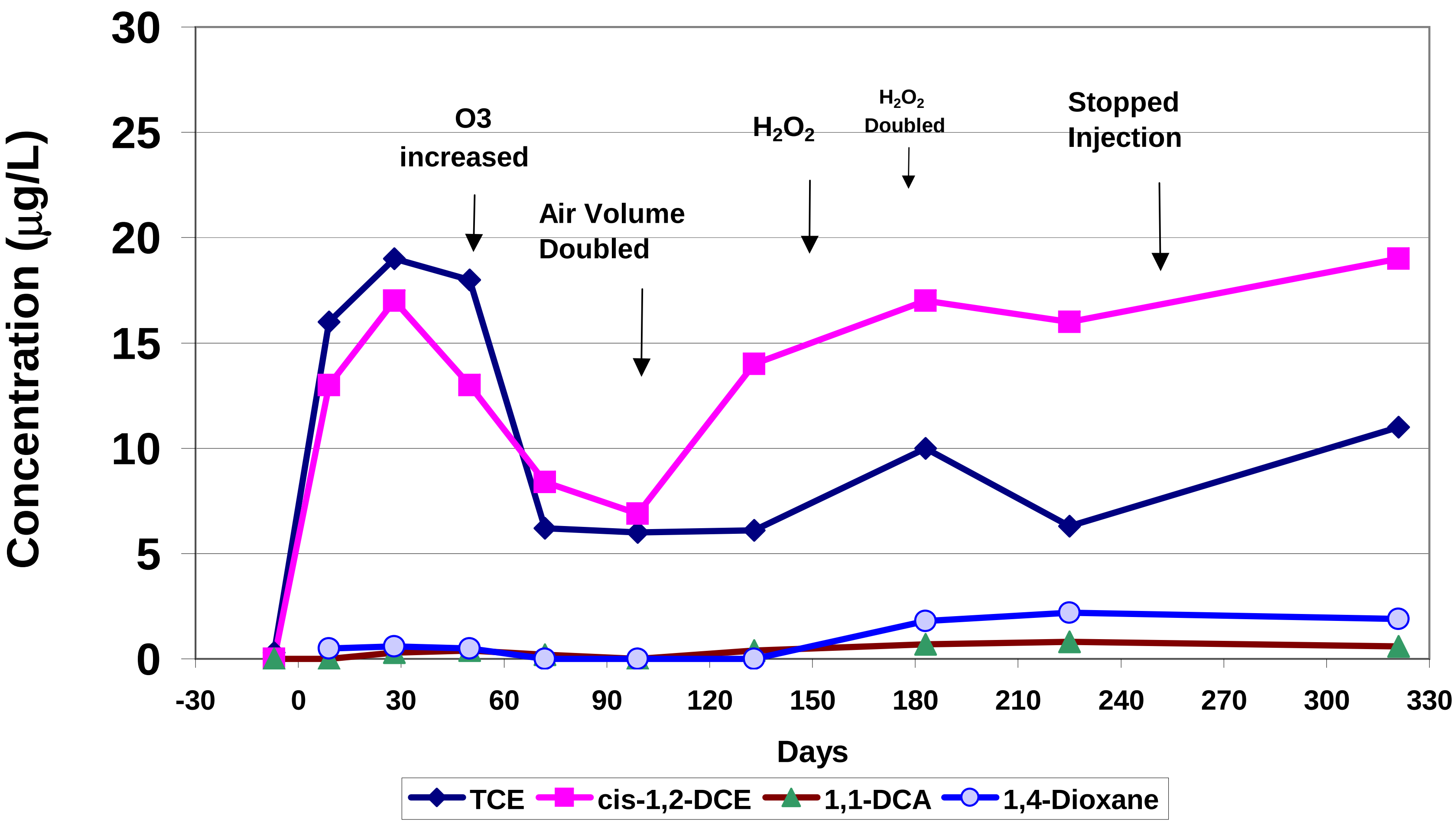


Figure 13 - Ex Situ Test of MW-33 Water Sample

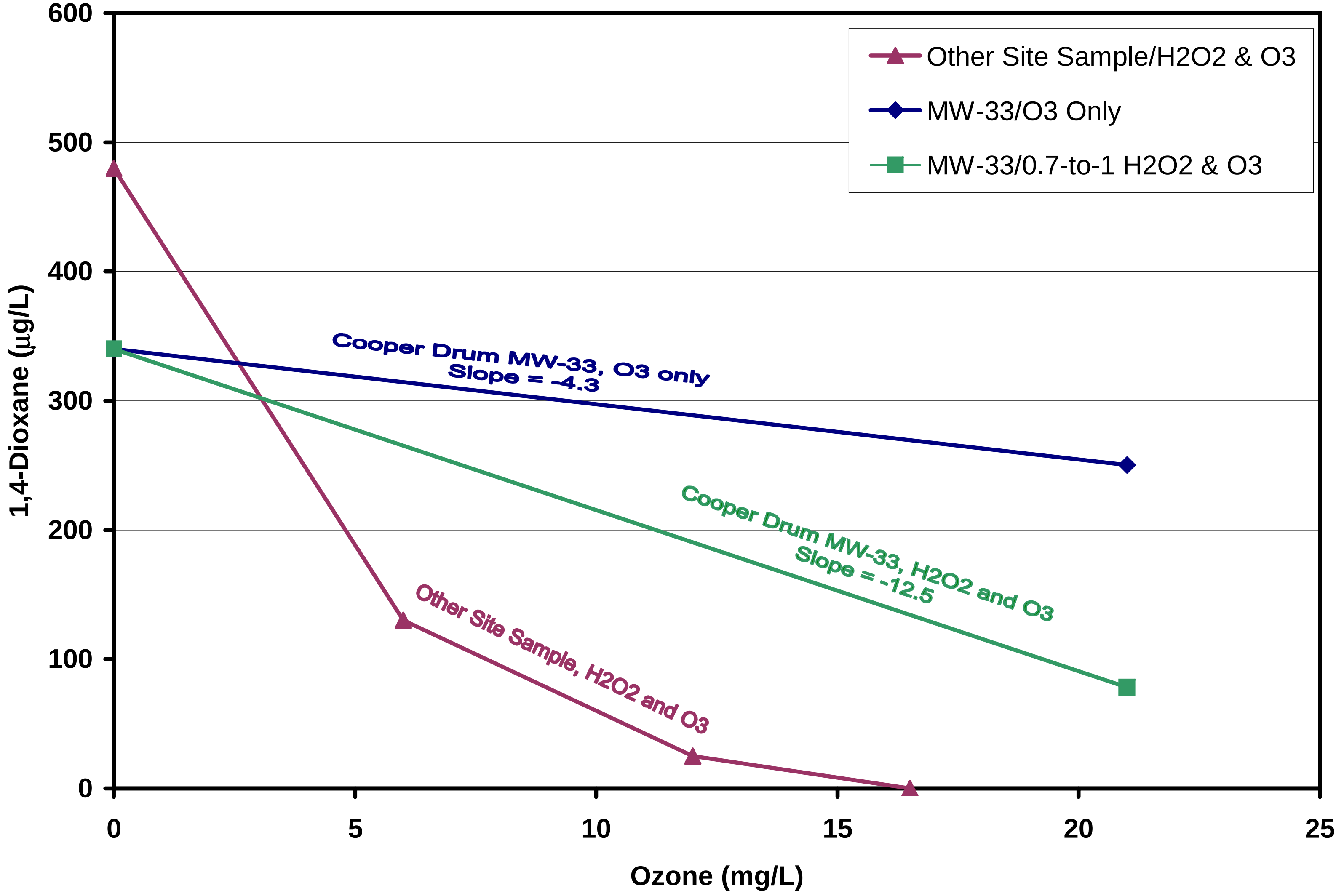


Figure 14: Flow-Through Cell DO Trends in Shallow Wells

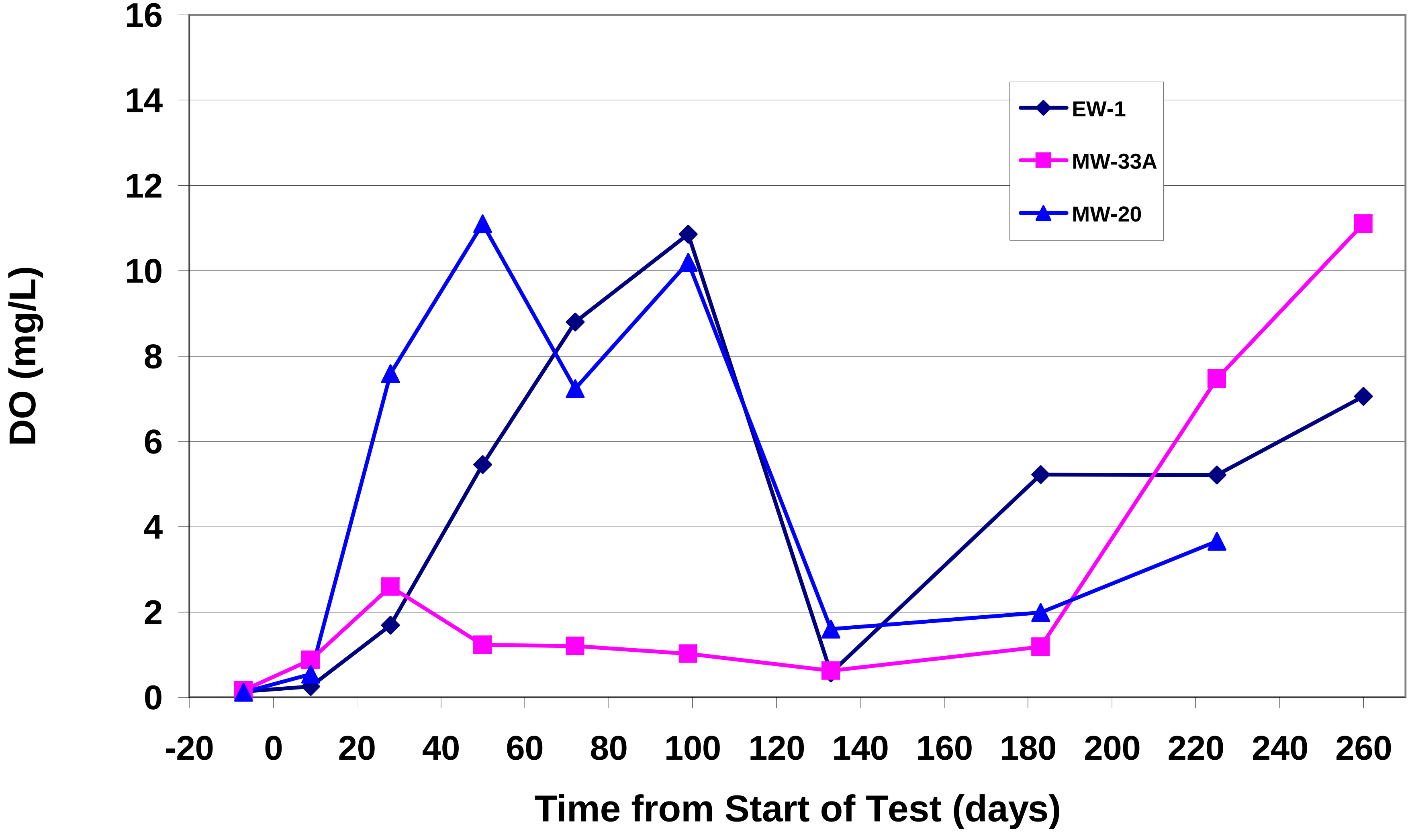


Figure 15: Flow-Through Cell DO Trends in Deep Wells

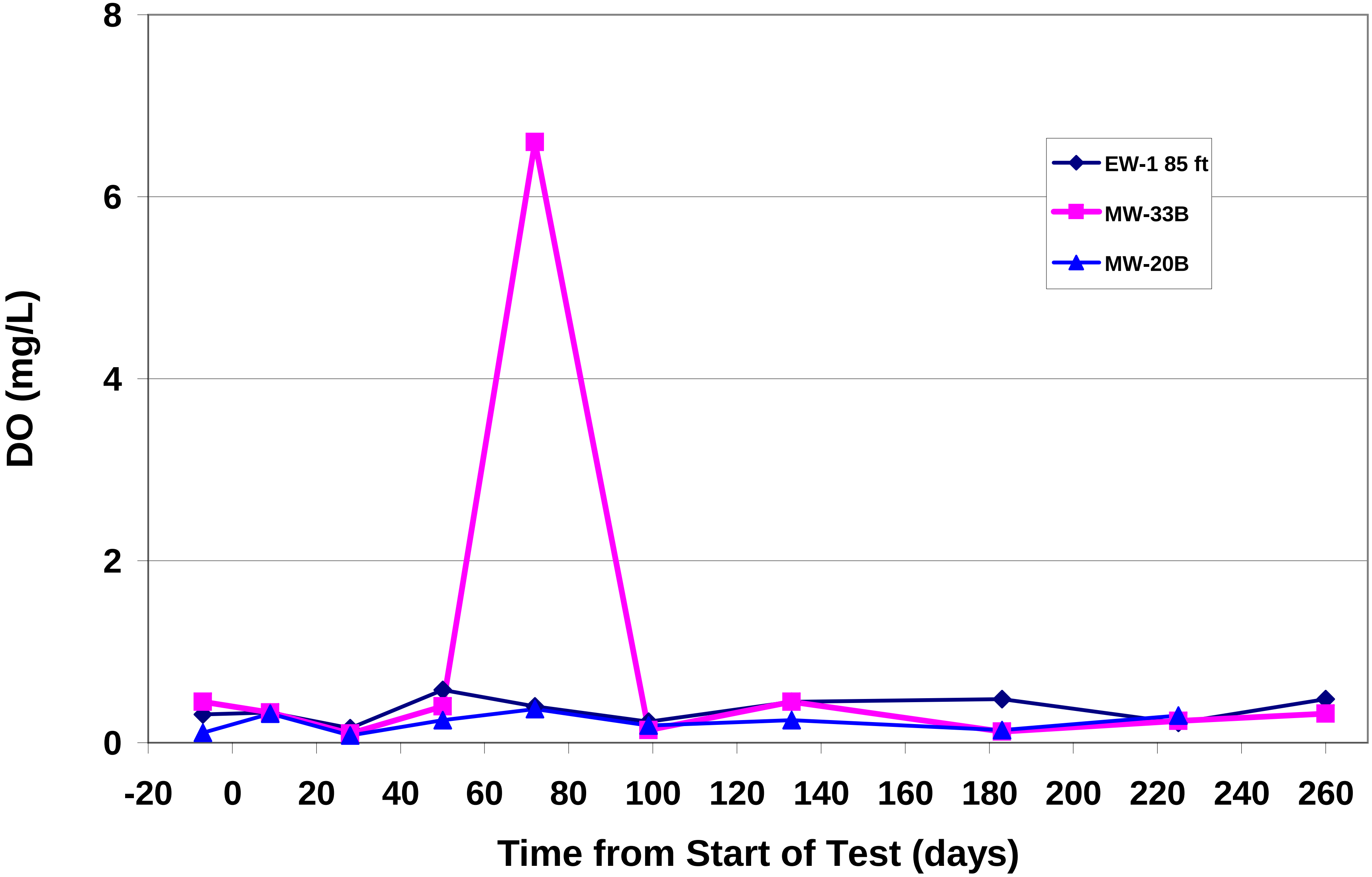
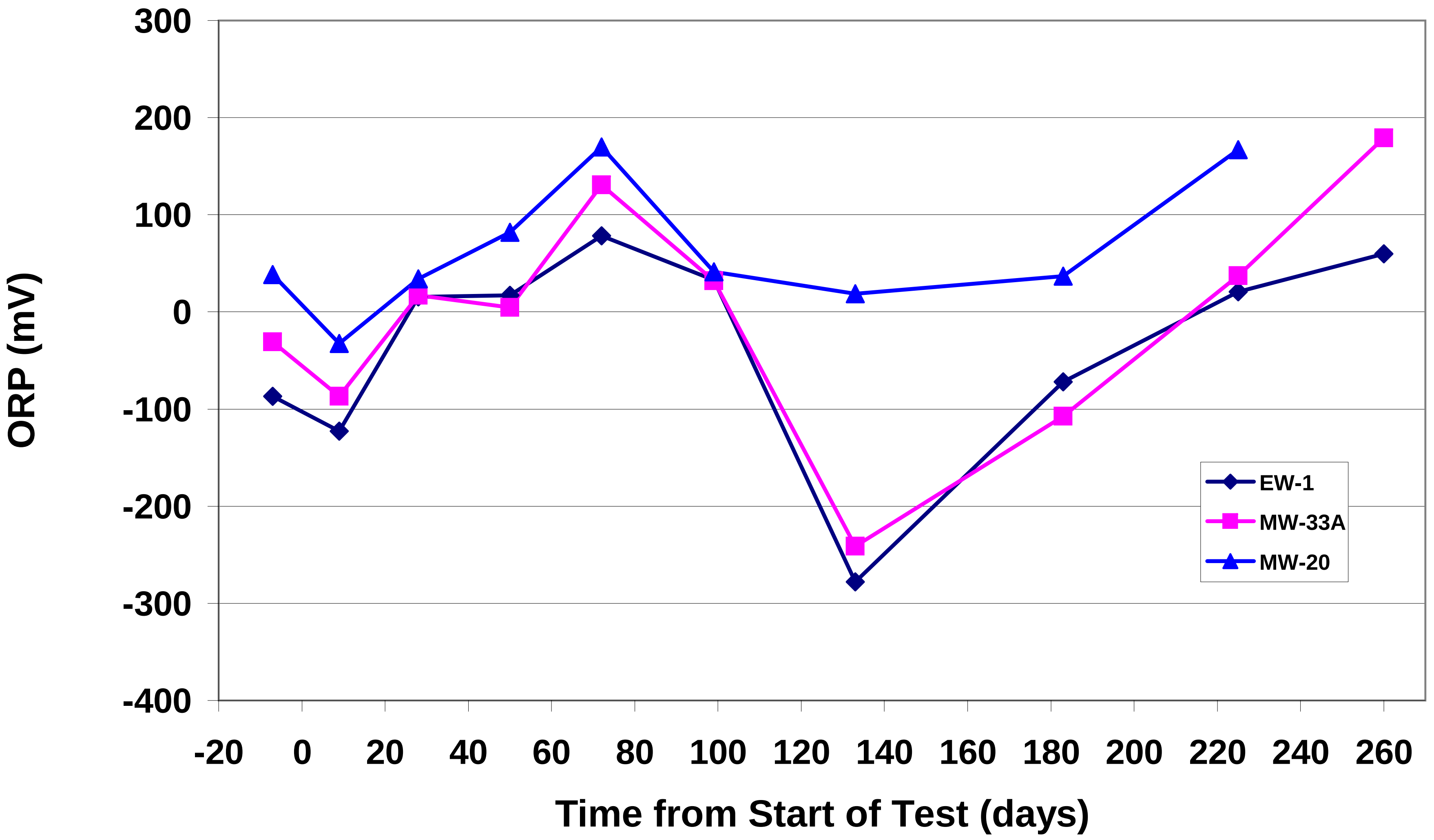


Figure 16: Flow-Through Cell ORP Trends in Shallow Wells



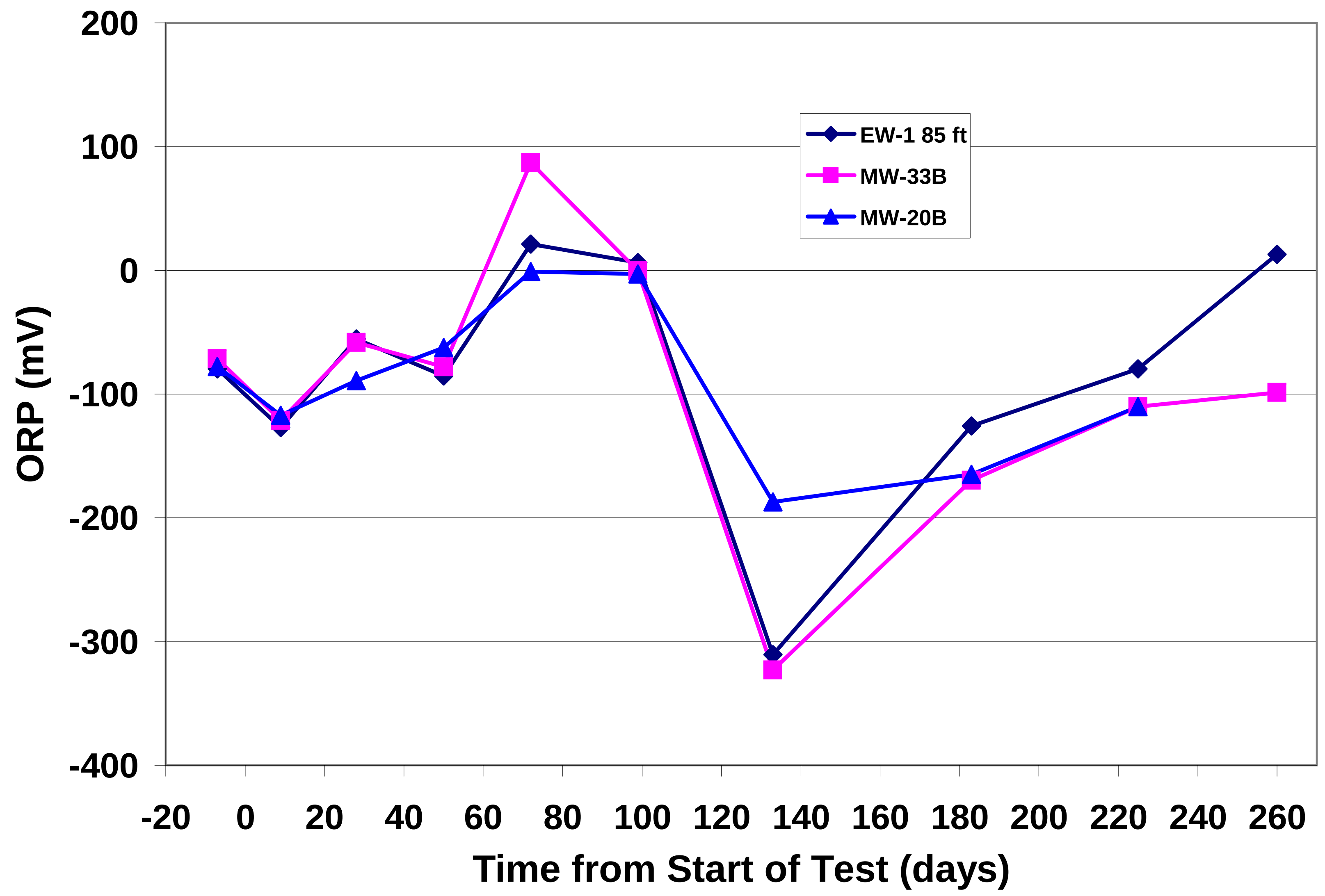


Figure 17: Flow-Through Cell ORP Trends in Deep Wells

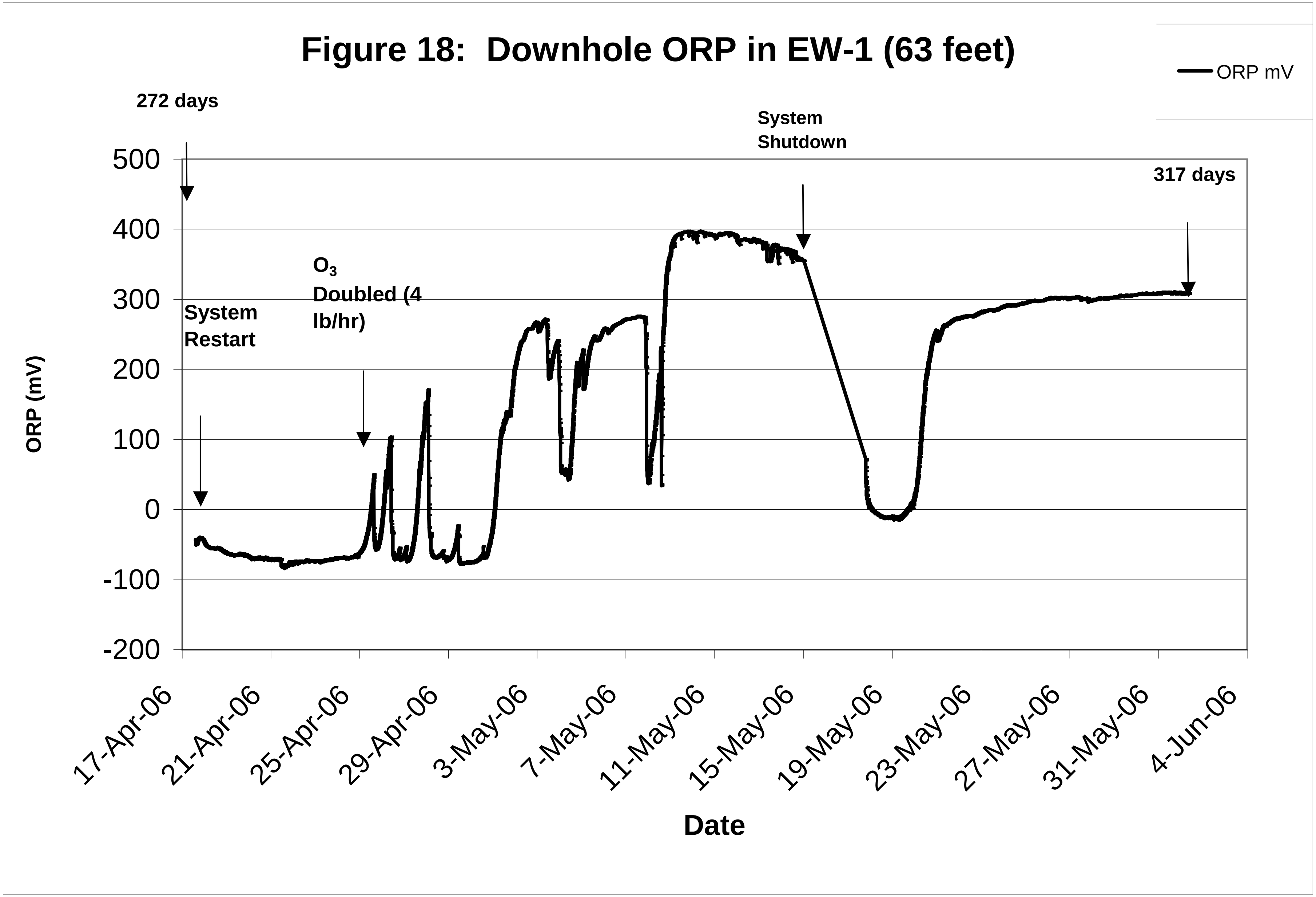


Figure 18: Downhole ORP in EW-1 (63 feet)
ORP mV
272 days
System Restart
O_3 Doubled (4 lb/hr)
System Shutdown
317 days
500
400
300
200
100
0
-100
-200
ORP (mV)
17-Apr-06
21-Apr-06
25-Apr-06
29-Apr-06
3-May-06
7-May-06
11-May-06
15-May-06
19-May-06
23-May-06
27-May-06
31-May-06
4-Jun-06
Date

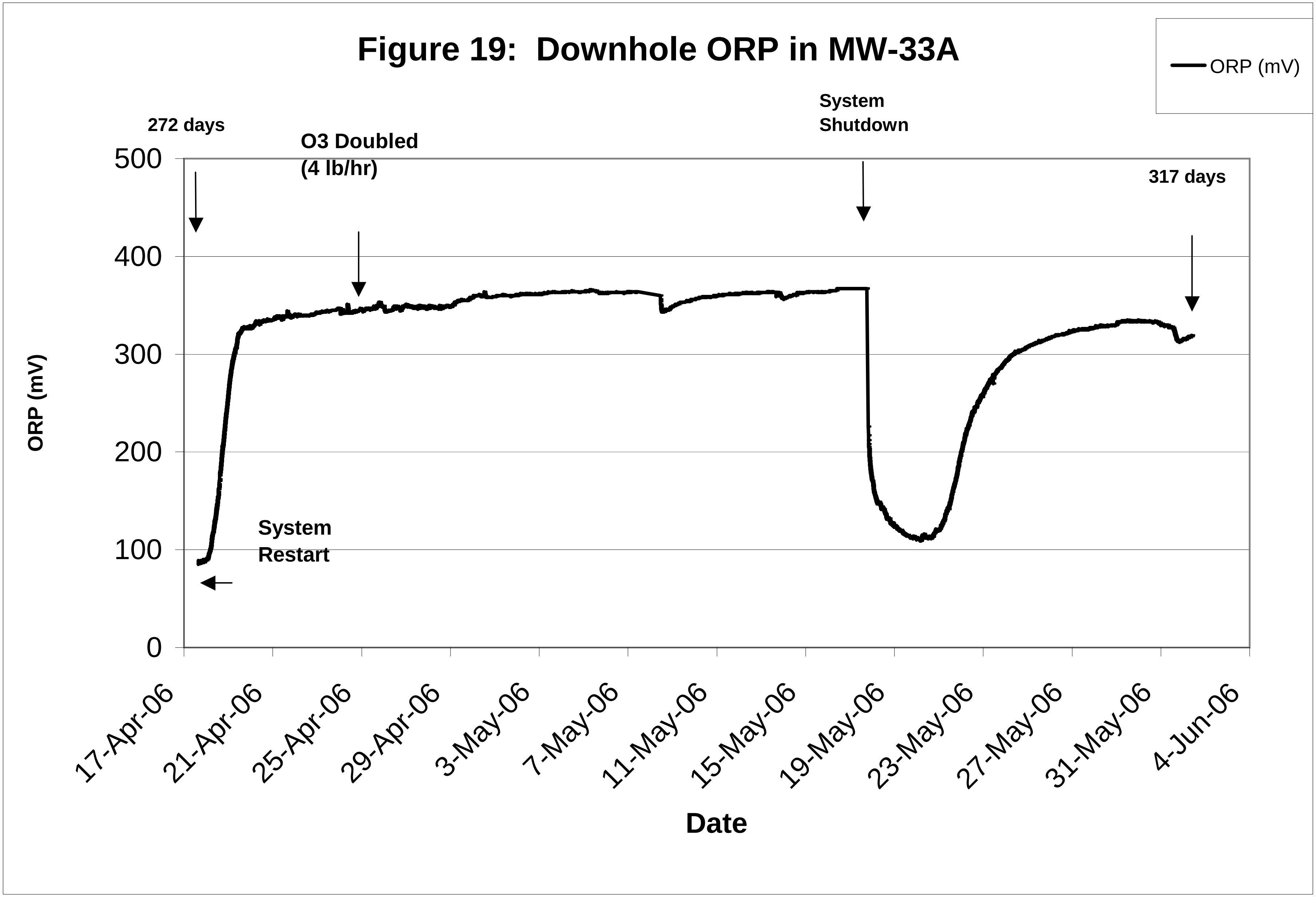


Figure 19: Downhole ORP in MW-33A

APPENDIX A

Bench-Scale Test Report

DRAFT

Report of Findings

Evaluation of Ozone and Peroxone for the Destruction of Dioxane

Cooper Drum

June 30, 2005

Submitted to

Don Gruber
URS Corporation
2870 Gateway Oaks Drive, Suite 300
Sacramento, CA 95833

Submitted by
Cindy G. Schreier, Ph.D.
PRIMA Environmental
10265 Old Placerville Road, Suite 15
Sacramento, CA 95827

Cindy G. Schreier, Ph.D., Principal

Date

EXECUTIVE SUMMARY

Bench-scale treatability testing was conducted on soil SB-33 (collected from 55-77 feet) and groundwater EW-1 from the Cooper Drum site in Southgate, California to evaluate the ability of ozone and Peroxone (a mixture of ozone and hydrogen peroxide) to destroy dioxane. Site groundwater also contained trichloroethene (TCE) and other volatile organic compounds (VOCs), but these were of lesser concern because most are known to be degraded by Peroxone and or ozone. Tests were also conducted to evaluate the potential for ferrous iron, chelated iron, and olefins to enhance the effectiveness of ozone toward dioxane removal.

Bench-scale laboratory testing clearly demonstrated that treatment of soil and groundwater with ozone alone or with Peroxone (a mixture of ozone and H_2O_2) could destroy 1,4-dioxane as well as other VOCs. Complete removal of all COCs from the aqueous phase was achieved with all treatments. Additional tests confirmed that dioxane was also removed from the soil phase. No VOCs were detected in off-gases.

COC removal was due to destruction not volatilization. NO VOCs were detected in off-gases from the ozone and Peroxone tests and dioxane was not removed from the aqueous phase by sparging with nitrogen, an inert gas.

Removal of dioxane by ozone alone was probably due to ‘enhancement” of the ozone by iron, bicarbonate or other compounds naturally present in soil and groundwater. In tests conducted on DI water spiked with dioxane and various potential enhancers, dioxane was completely removed in all cases except when olefins were added. Thus, the addition of H_2O_2 as an enhancer may not be required during in situ applications.

Ozone and Peroxone affected several secondary water quality parameters including bromate, bromide, Cr(VI), vanadium, chromium (total), manganese, iron, nickel, selenium, barium, tungsten and nitrate. The direction of the change (an increase or decrease) was the same in most cases, but the magnitude often varied among the tests. Parameters affected by both ozone and Peroxone were bromate, chromium (total), manganese, iron, nickel, copper, barium, tungsten and nitrate. Parameters affected by either ozone or Peroxone were vanadium and selenium. Copper and chromium (total and Cr(VI)), were effect by ozone and one of the Peroxone tests.

The ozone demand of soil was approximately 3,000 mg O_3/kg soil.

Table of Contents

List of Figures

List of Tables

1.0 INTRODUCTION

Bench-scale treatability testing was conducted on soil SB-33 (collected from 55-77 feet) and groundwater EW-1 from the Cooper Drum site in Southgate, California to evaluate the ability of ozone and Peroxone (a mixture of ozone and hydrogen peroxide) to destroy dioxane. Site groundwater also contained trichloroethene (TCE) and other volatile organic compounds (VOCs), but these were of lesser concern because most are known to be degraded by Peroxone and or ozone. Tests were also conducted to evaluate the potential for ferrous iron, chelated iron, and olefins to enhance the effectiveness of ozone toward dioxane removal.

Peroxone, a mixture of ozone and hydrogen peroxide (H_2O_2), is a strong oxidant that can destroy a wide range of organic compounds, including chlorinated solvents and dioxane. In principal, compounds may be completely mineralized to carbon dioxide (CO_2) and water (H_2O). Oxidation is believed to occur via the formation of hydroxyl and other radicals, which are even stronger oxidants than either ozone or H_2O_2 alone. Other compounds naturally present in water could also potentially react with ozone to generate hydroxyl radicals. These include iron (Bower, K. C. and C. M. Miller. "Filter Sand-Phosphate Buffer Effect on 2,4-Dinitrotoluene Ozonation," *J. Environ. Eng.* February **2002**, 131-136, and references therein), bicarbonate, and olefins (e.g. TCE).

Because ozone is a gas and H_2O_2 decomposes to form oxygen gas, *in situ* treatment via injection of Peroxone into the sub-surface could result in removal of volatile compounds by sparging rather than oxidation. Lab testing therefore addressed whether contaminant removal was due to destruction or volatilization.

Finally, Peroxone is a non-selective oxidizing agent that may react with soil and groundwater components in addition to target compounds. The most likely effects are oxidation of soil chromium to form Cr(VI), mobilization of metals (particularly manganese and arsenic), formation of nitrate (from reduced nitrogen species), formation of bromate (from bromide) and precipitation of dissolved iron.

The specific goals of this proposed bench-scale testing are

- estimate the ozone demand of soil;
- estimate the longevity of H_2O_2 in the presence of ozone,
- confirm removal of COCs and determine whether removal is due to volatilization or destruction,
- measure the effect of Peroxone on secondary water quality parameters including metals, Cr(VI), bromate and nitrate, and
- assess the potential of other naturally occurring compounds to enhance dioxane destruction by ozone.

2.0 EXPERIMENTAL PROCEDURES

Batch tests were conducted to meet the goals in Section 1. A column test was also considered to assess whether Peroxone could be effectively applied in the field, but preliminary tests indicated that such a test would not yield the desired information.

2.1 Soil and Groundwater Preparation

Thirteen (13) sleeves of soil SB-33 (depths ranging from 55 to 77) were received for testing on April 20, 2005. The soil was composited then analyzed for

- Volatile organic compounds (VOCs)
- Low-level dioxane
- Cr(VI)
- Metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tungsten, vanadium, and zinc)

Site groundwater (EW-1) was received for testing in two batches: 8 x 1L on April 21, 2005 and 8 x 1L on April 22, 2005. The water was used as received. Untreated water was analyzed for

- VOCs
- Low-level dioxane
- Bromide and bromate
- Cr(VI)
- Metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tungsten, vanadium, and zinc)
- nitrate

2.2 Ozone Demand

The ozone demand of soil was estimated using a method based on the "Ozone Demand" test described in *Standard Methods for the Examination of Water and Wastewater, 19th Ed.*

A small amount of soil (2 g) was added to 1L of ozone-saturated water, then the concentration of ozone will be measured over time using the indigo method. A control in which no soil was added was also performed. The soil ozone demand (SOD_{oz}) is taken to be the difference in ozone consumption in the presence and absence of site material. It was calculated according to the equation

$$SOD_{oz} = \{[O_3 \text{ Consumed}]_{soil} - [O_3 \text{ Consumed}]_{control}\} \text{ x } V/M \qquad \text{Eqn. 1}$$

where

SOD = soil oxidant demand in mg O_3 consumed/g soil
[O_3 Consumed]$_{control}$ = change in O_3 concentration in the absence of soil in mg/L
[O_3 Consumed]$_{soil}$ = change in O_3 concentration in the presence of soil in mg/L
V = volume of ozonated water in L
M = mass of soil in g

2.3 Confirmation of COC Removal

To confirm that COCs are removed and estimate the amount of removal due to destruction versus volatilization, two sets of tests were conducted as shown in Table 1. The second set of tests was conducted to confirm the results of the first ozone test and to better assess possible loss of dioxane due to sparging. (Dioxane is highly soluble in water and does not easily volatilize upon sparging with a gas. However, to confirm that losses of dioxane in the original tests were due to destruction not volatilization, three additional tests, including one using inert nitrogen gas, were performed).

For each set of tests, soil, groundwater, and if appropriate 30%H_2O_2, were placed in a glass reactor. The reactors to be sparged were each fitted with a gas dispersion tube and vent for off-gases. The control reactors were sealed. All reactors were stirred with a magnetic stirrer. The reactors were sparged with nitrogen or ozone (26 mg/L in air for Set A tests, 31 mg/L in air for Set B tests) at a flowrate of 200 mL/minute for 3 hours. For Set A tests, off-gases were collected in 100-L Tedlar bags. The off-gases were analyzed for VOCs (except dioxane). The aqueous phase of Set A tests was analyzed for VOC and low-level dioxane; soil was not analyzed. For Set B tests, both soil and water were analyzed for low-level dioxane (but not VOCs).

Table 1. Initial Conditions for COC Removal Tests

Test	Soil, g	Groundwater, mL	Initial H_2O_2*, %	Sparge Gas
Set A Tests				
Control-A	100	1,000	0	None
Ozone-A	100	1,000	0	Ozone
Peroxone-Low	100	1,000	0.07	Ozone
Peroxone-High	100	1,000	0.35	Ozone
Set B Tests				
Control-B	100	1,000	0	None
Nitrogen-B	100	1,000	0	Nitrogen
Ozone-A	100	1,000	0	Ozone

* obtained by adding 2.4-12 mL 30% H_2O_2

2.4 Evaluation of Other Potential Ozone "Enhancers"

Because dioxane was destroyed by ozone (as well as Peroxone) in Section 2.3 tests, additional tests were conducted to evaluate compounds naturally present in soil or groundwater that could potentially enhance the effectiveness of dioxane oxidation by ozone. These potential enhancers were ferrous iron, chelated iron, TCE (an olefin), bicarbonate. Most tests were conducted using 1L deionized water spiked with approximately 400 µg/L 1,4-dioxane, since this enabled one compound at a time to be evaluated. Other tests used 1L site groundwater or 100 g site soil, since there may be some unidentified compound in either matrix that may enhance ozone's effectiveness. The tests are summarized in Table 2. The test procedures were similar to those for Section 2.3—that is, the water or soil was sparged with ozone (25 mg/L in air at 250 mL/min for about 3 hours), after which the aqueous was analyzed for low-level dioxane. When applicable, the soil was also analyzed.

Table 2. Summary of Tests evaluating Ozone Enhancers.

Test	Soil, g	Water, mL	Enhancer	Sparge Gas
Control-C	None	1,000 mL Spiked DI[a]	None	Ozone
Ferrous Iron	None	1,000 mL Spiked DI	2 mg/L Iron[b]	Ozone
Chelated Iron	None	1,000 mL Spiked DI	2 mg/L Iron[c]	Ozone
Bicarbonate	None	1,000 mL Spiked DI	1000 mg/L as $CaCO_3$	Ozone
Olefins	None	1,000 mL Spiked DI	500 ppb TCE[d]	Ozone
GW Only	None	1,000 mL site GW[e]	None	Ozone
Soil	Site Soil	1,000 mL Spiked DI	None	Ozone

[a] DI water spiked with about 400 ppb 1,4-dioxane

[b] Added as ferrous sulfate heptahydrate

[c] Added as Grow-More™ agricultural iron (iron EDTA), 13% iron by weight

[d] Water also spiked with ~ 100 µg/LTCE (an olefin)

[e] Site groundwater less settable solids.

2.5 Effect of Treatment on Secondary Water Quality

The effect of ozonation on secondary water quality parameters was determined by analyzing the aqueous phases from the Set A tests in Section 2.3 for bromide, bromate, Cr(VI), dissolved metals (Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, W, V, and Zn), nitrate, and pH.

2.6 Simulation of Peroxone Injection

A column test was to be conducted on site soil and groundwater to simulate the anticipated Peroxone injection procedure that will be used in the field and determine whether this procedure is effective using an apparatus similar to that in Figure 1. Because of the difficulty in designing such a test, a preliminary test using clean sand, DI water and indigo (a blue solution that is rapidly decolorized by ozone) in place of H2O2 was conducted. A two-inch diameter column made of clear PVC was filled with clean silica sand soil and DI water. Ozone was injected toward the bottom of the column, while indigo was added above the ozone injection point.

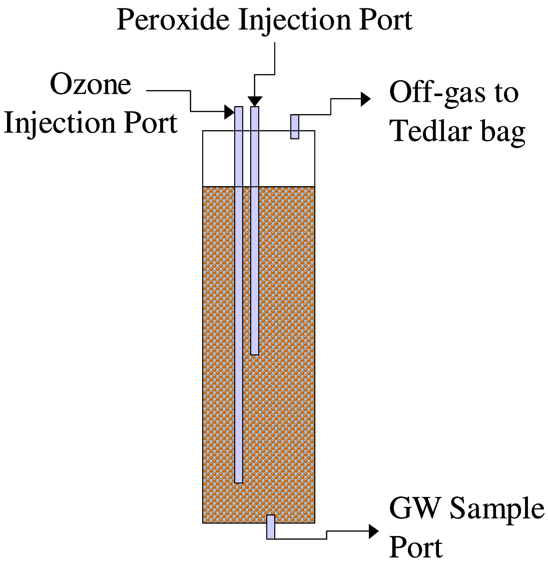


Figure 1. Schematic of Peroxone Column Test Apparatus

Despite extensive effort, it was difficult to disperse evenly the indigo or the ozone the sand column, though when the two reagents did mix, indigo was decolorized. Since it was unknown whether this difficulty would be an issue in the field, it was concluded by PRIMA, URS and EPA personnel that a laboratory column test could not accurately demonstrate the field applicability of Peroxone injection. A column test using site soil and groundwater was therefore not performed. This simulation is discussed further in Section 3.

2.7 Analytical Procedures

The method for each analysis and the laboratory that performed the analysis are given in Table 3.

Table 3. Analytical Methods.

Analyte	**Method**	**Lab performing test***
COCs: VOCs Low-level dioxane	 8260B 8260B direct inject	 Alpha Analytical Alpha Analytical
Metals (Be, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Ag, Cd, Sb, Ba, W, Hg, Tl, Pb)	ICP/MS	Alpha Analytical
Cr(VI)	EPA 7199/Hach**	Excelchem/PRIMA
Nitrate	EPA 300	Excelchem
Bromate and bromide	EPA 300	Columbia Analytical
pH	Probe	PRIMA

* Alpha Analytical (Sparks, NV), PRIMA Environmental, or Excelchem (Roseville, CA), Columbia Analytical Services (Kelso, WA)

** Hach DR 2010 Spectrophotometer and appropriate Hach kit reagents

3.0 RESULTS AND DISCUSSION

Bench-scale laboratory testing demonstrated that treatment of soil and groundwater with ozone alone or with Peroxone (a mixture of ozone and H_2O_2) could destroy 1,4-dioxane as well as other VOCs. Removal was due to destruction, not volatilization. Both Peroxone and ozone affected several secondary water quality parameters. In most cases, the direction of the change was the same, but the magnitude often differed. Treatment of soil and groundwater with ozone was as effective as treatment with Peroxone probably due to iron, bicarbonate and other compounds naturally present in soil and water , which acted as ozone “enhancers” in the same manner as did H_2O_2.

3.1 Characterization of Untreated Soil and Groundwater

The concentrations of COCs and other parameters in untreated soil and groundwater are shown in Table 4. For clarity, only detected compounds are listed. Complete analytical reports are provided in the Appendix. Site soil contained 55 μg/kg dioxane, while groundwater contained 720 μg/L dioxane. No other VOCs were detected in soil. Some chlorinated ethenes and ethane were detected in groundwater—the most prominent were TCE (520 μg/L) and cis-DCE (200 μg/L).

Of the 21 metals tested, untreated groundwater contained detectable quantities of seven: manganese (2,700 μg/L), iron (2,400 μg/L), nickel (72 μg/L), arsenic (45 μg/L), molybdenum (130 μg/L), barium (39 μg/L), and tungsten (9.4 μg/L). All of these metals, as well as several others, were detected in soil. Groundwater contained 2,480 μg/L bromide and < 1.00 μg/L Cr(VI).

3.2 COC Removal / Mechanism of Removal

The results of the Set A tests are shown in Table 5, respectively. Complete analytical reports are provided in the Appendix. No VOCs were detected in the off-gases above the detection limit of 0.4 μg/L.

The ozone and Peroxone tests were nearly identical. In the Set A tests, dioxane and all VOCs detected in untreated groundwater and in the control were removed to below their respective detection limits and no VOCs were detected in the off-gases. The only difference between the tests was the formation of a small amount of bromoform (1.4 μg/L) in the ozone test. Because no VOCs were detected in the off-gases, VOC losses from the aqueous phase must be due to destruction, not volatilization.

Because dioxane is not easily removed from water by sparging, the loss of dioxane from the aqueous phase was assumed to be due to destruction. To test this hypothesis, a second set of tests (Set B tests) was conducted. This set of tests compared dioxane removal by ozone to dioxane removal by nitrogen, an inert gas. The results are shown in Table 6. Dioxane was completely removed from the ozone-sparged test, but was unaffected by sparging with nitrogen. Furthermore, dioxane was not detected in soil from the ozone-sparged test, confirming that removal of dioxane by ozone was due to destruction.

Table 4. Concentrations of COCs and Other Parameters in Untreated Materials.

Analyte	Units	Untreated Soil	Untreated Groundwater
1,4-dioxane	ppb	55	720
1,1,-DCE	ppb	< 20	32
trans 1,2-DCE	ppb	< 20	7.6
1,1-DCA	ppb	< 20	48
cis-DCE	ppb	< 20	200
1.2-DCA	ppb	< 20	5.1
TCE	ppb	< 20	520
Bromate	μg/L	n.m.	< 25
Bromide	μg/L	n.m.	2,480
Cr(VI)	ppb	1.04	< 1.0
Metals			
beryllium	ppb	< 1,000	< 4
aluminum	ppb	19,000,000	< 200
vanadium	ppb	50,000	< 5
chromium (total)	ppb	120,000	< 5
manganese	ppb	540,000	2,700
iron	ppb	29,000,000	2,400
cobalt	ppb	17,000	< 5
nickel	ppb	190,000	72
copper	ppb	36,000	< 10
zinc	ppb	58,000	< 100
arsenic	ppb	4,000	45
selenium	ppb	< 1,000	< 5
molybdenum	ppb	< 1,000	130
silver	ppb	< 1,000	< 5
cadmium	ppb	< 1,000	< 5
antimony	ppb	3,400	< 5
barium	ppb	290,000	39
tungsten	ppb	< 1,000	9.4
mercury	ppb	< 200	< 1
thallium	ppb	< 1,000	< 5
lead	ppb	7,000	< 5
Nitrate	mg/L	n.m.	0.902
pH	--	n.m.	7.43

Table 5. Concentration of COCs in Set A Tests.

Analyte	Units	Control-A	Ozone-A	Peroxone-Low-A	Peroxone-High-A
1,4-dioxane	µg/L	680	< 3	< 3	< 3
1,1,-DCE	µg/L	23	< 1	< 1	< 1
trans 1,2-DCE	µg/L	6	< 1	< 1	< 1
1,1-DCA	µg/L	39	< 1	< 1	< 1
cis-DCE	µg/L	160	< 1	< 1	< 1
1.2-DCA	µg/L	< 5	< 1	< 1	< 1
TCE	µg/L	420	< 1	< 1	< 1
Bromoform	µg/L	< 5	1.4	< 1	< 1

Table 6. Concentration of Dioxane in Set B Tests.

Test	1,4 Dioxane, ppb	
	Soil	Groundwater
Untreated	< 50	690
Control-B	110	600
Nitrogen-B	110	600
Ozone-B	< 50	< 3

3.3 Evaluation of Ozone Enhancers

Conventional wisdom states that ozone alone cannot destroy dioxane— H_2O_2 is required in order to generate hydroxyl radicals. However, the results presented in Tables 4 and 5 clearly demonstrate that sparging site soil and groundwater with ozone alone can destroy dioxane and reduce aqueous concentrations from about 690 µg/L to < 3 µg/L. This implies that other compounds naturally present in soil or groundwater can "enhance" the effectiveness of ozone in the same manner as H_2O_2. To test this hypothesis, additional tests were performed. The results are shown in Table 7.

Table 7. Concentration of Dioxane in Ozone "Enhancer" Tests

Test #	Test ID	1,4 Dioxane, ppb	
		Soil	Groundwater
n.a.	Untreated Spiked DI	n.a.	400
1	Control (no enhancer)	n.m.	98
3	Ferrous Iron	n.m.	< 3
7	Chelated Iron	n.m.	< 3
4	Bicarbonate	n.m.	< 3
5	TCE (Olefins)*	n.m.	69
6	GW Only	n.m.	< 3
8	Soil Only	< 50	< 3

Notes:

- n.a. = not applicable
- n.m. = not measured
- Initial TCE concentration in Test 5 = 69 µg/L
- Test # provided to correlate Table 6 results with analytical reports provided in Appendix

Complete removal of dioxane was obtained in all of the tests except the test in which an olefin (TCE) was the “enhancer”. Dioxane concentration was reduced in (but not completely removed from) the control, which was sparged with ozone but contained no enhancer. This confirms that iron (ferrous or chelated iron), bicarbonate (alkalinity) and possibly other, unidentified compounds can enhance the ability of ozone to destroy dioxane.

3.4 Effect of Peroxone and Ozone on Secondary Water Quality

The effect of ozone and Peroxone treatment on secondary water quality parameters is shown in Table 8. Treatment with ozone or Peroxone affected several parameters, including bromate, bromide, Cr(VI), vanadium, chromium (total), manganese, iron, nickel, copper, selenium, barium, tungsten and nitrate. The direction of the change (an increase or decrease) was the same in most cases, but the magnitude often varied among the tests.

Table 8. Effect of Ozone and Peroxone on Secondary Water Quality

Analyte	Units	Control-A	Ozone-A	Peroxone-Low-A	Peroxone-High-A
Bromate	µg/L	< 25	232	46	78
Bromide	µg/L	2,310	1,910	2,260	4,170
Cr(VI)	ppb	< 1.00	9.98	< 10	< 10
H2O2, residual	ppm	0	0.00	~ 400	~ 2,000
Metals					
beryllium	ppb	< 4	< 4	< 4	< 4
aluminum	ppb	< 200	< 200	< 200	< 200
vanadium	ppb	27	30	130	160
chromium (total)	ppb	< 5	12	< 5	6.6
manganese	ppb	2,400	< 10	180	190
iron	ppb	2,400	1,900	1,200	1,200
cobalt	ppb	< 5	< 5	< 5	5.5
nickel	ppb	66	29	18	26
copper	ppb	30	40	26	79
zinc	ppb	< 100	< 100	< 100	< 100
arsenic	ppb	25	29	25	26
selenium	ppb	7.0	18	7.4	9.6
molybdenum	ppb	150	160	150	140
silver	ppb	< 5	< 5	< 5	< 5
cadmium	ppb	< 5	< 5	< 5	< 5
antimony	ppb	< 5	< 5	< 5	< 5
barium	ppb	31	19	18	16
tungsten	ppb	10	< 5	< 5	< 5
mercury	ppb	< 1	< 1	< 1	< 1
thallium	ppb	< 5	< 5	< 5	< 5
lead	ppb	< 5	< 5	< 5	< 5
Nitrate	mg/L	< 0.5	29.2	38.7	15.6
pH	--	7.37	8.15	8.16	8.20

“ppb” = µg/L; “ppm” = mg/L

Parameters affected by both ozone and Peroxone were bromate, chromium (total), manganese, iron, nickel, copper, barium, tungsten and nitrate. Bromate increased from < 25 µg/L in the control to 232 µg/L in the ozone test and 46 to 78 µg/L in the Peroxone tests. Nitrate increased from < 0.5 mg/L in the control to 15 to 39 mg/L in the ozone and Peroxone tests. Manganese decreased from 2,400 µg/L in the control to < 10 µg/L in the ozone test, but to only 180 to 190 µg/L in the Peroxone tests. In contrast, the reduction in iron was more significant in the Peroxone tests than in the ozone test. Nickel concentrations decreased from 66 µg/L to 18-29 µg/L, barium decreased from 31 µg/L to 16-19 µg/L, and tungsten decreased from 10 µg/L to < 5 µg/L.

Parameters affected by either ozone or Peroxone were vanadium and selenium. Vanadium increased from 27 µg/L in the control to 130-10 µg/L in Peroxone tests, but was not affected by ozone alone. In contrast, selenium increased from 7.0 µg/L in the control to 18 µg/L in the ozone test, but was not affected by Peroxone.

Copper and chromium (total and Cr(VI)), were effect by ozone and one of the Peroxone tests. Specifically, ozone and Peroxone-High increased the concentration of copper from 30 µg/L to 40-79 µg/L, but the Peroxone-Low test had no effect. Similarly, Total Cr increased in the ozone and Peroxone-High tests, but not in the Peroxone-Low test. Cr(VI) was detected in the ozone test at 9.98 µg/L. Cr(VI) was not detected above the detection limit of 10 µg/L in the Peroxone-High test. (Note: the Cr(VI) results reported in Table 7 were measured using a Hach test kit. Analyses were also performed using EPA Method 7199, but the value for the Peroxone tests was much higher than total Cr values and Cr(VI) measurements made with the Hach kit and are therefore not reported. PRIMA Environmental has encountered this problem in the past when using EPA Method 7199 to analyze low pH samples containing residual peroxide.)

3.5 Soil Oxidant Demand (Ozone)

The concentration of ozone over time is shown in Figure 2 for the soil ozone demand test. The measured soil ozone demand, calculated from Eqn. 1, was approximately 3,000 mg O_3/kg soil. The ozone applied in the Ozone-A test in Section 3.2 was 940 mg, which is about 3 times greater than the mass of ozone needed based on the measured SOD. This was sufficient to destroy all of the COCs, implying that a large excess of ozone is not required.

3.6 Simulation of Peroxone Injection

A column test was conducted in an attempt to determine whether ozone and H2O2 (the components of Peroxone) injected one above the other in the same well would mix in the subsurface and destroy dioxane. To observe the potential for mixing directly, a column test using clean white sand, DI water, ozone and indigo was performed. Indigo was used in place of H2O2 because indigo is a blue liquid that decolorizes quickly upon contact with ozone. White sand was used so the indigo could be easily observed.

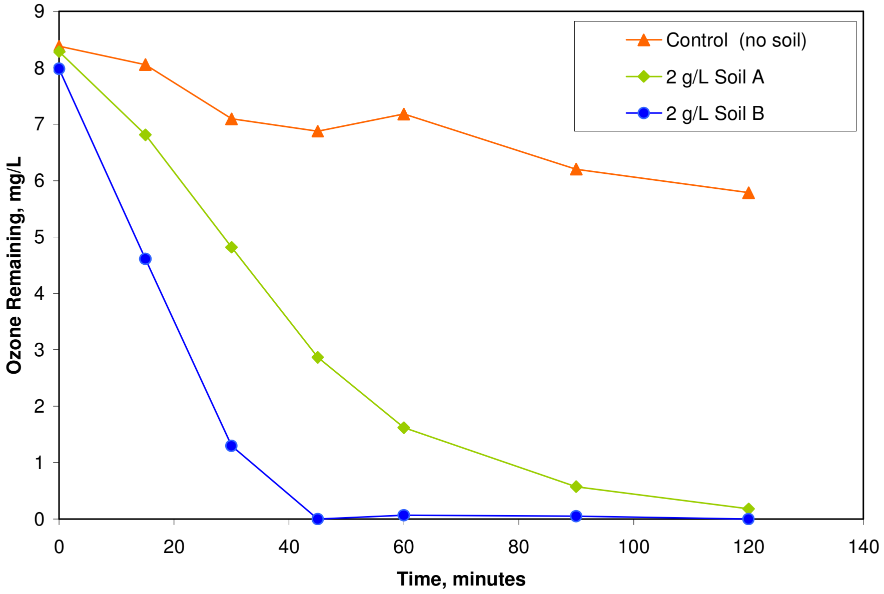


Figure 2. Soil Oxidant Demand (Ozone). Ozone Remaining.

The indigo was added to a ¼-inch injection “well” about three inches above the ozone injection well. When air-pressure was applied to the indigo well, the indigo moved out into the sand column. However, once air-pressure was removed, the indigo was mostly sucked back into the well. Repeated applications of pressure resulted in only a little mixing between the indigo and the DI water within column.

Mixing between ozone and indigo was erratic. Application of ozone often resulted in channeling. If the channels were in the area of the indigo, then the indigo quickly decolorized. However, if the channels were away from the indigo, then the indigo persisted, suggesting that dissolution of ozone into the water and diffusion of ozone to the indigo was relatively slow. Varying the ozone flowrate and pressure caused the channels to shift, eventually enabling decolorization of indigo.

Because of the difficulties distributing ozone and indigo in this column test and because of the uncertainty about whether these problems would occur in the field, personnel from PRIMA Environment (Cindy G. Schreier), URS (Don Gruber and Venus Sadeghi), and USEPA (Michelle Simon), who were present when this column test was conducted, concluded that a column test could not accurately predict the effectiveness of the proposed field delivery system of Peroxone. Consequently, no column test was conducted using site soil, site groundwater and Peroxone.

4.0 ENGINEERING CONSIDERATIONS

Both ozone and Peroxone effectively destroyed 1,4-dioxane and other VOCs in site soil and groundwater. Some observations that should be taken into consideration when evaluating these technologies for full-scale application are provided.

Peroxone vs. Ozone. Although conventional wisdom indicates that ozone alone cannot destroy low-levels of dioxane, complete removal of dioxane to < 3 µg/L was observed in when soil and groundwater were treated with ozone alone, as well as with Peroxone (ozone + H_2O_2). Additional tests indicate that iron, alkalinity (bicarbonate) and possibly other compounds naturally present in site soil and groundwater can enhance the effectiveness of ozone in a similar manner as H_2O_2. Therefore, at this site, ozone may be as effective at destroying COCs as Peroxone.

Ozone Demand. The results of the laboratory study can be used to estimate the size of the ozone generator needed for full-scale application. In this study, approximately 940 mg O_3 was applied to the soil-groundwater mixture, which was about 3 times the dose (300 mg O_3) required to meet the measured soil ozone demand. This dose resulted in complete removal of dioxane and all VOCs, but also resulted in the formation of 232 µg/L bromate. A lower ozone dose may be able to achieve the same degree of COC removal without generating as much bromate.

Destruction vs. Volatilization. No VOCs were observed in off-gases from the ozone or Peroxone tests, implying that the VOCs were destroyed, not volatilized. Dioxane was not removed from water that was sparged with inert nitrogen gas, implying that dioxane was also destroyed by ozone and Peroxone.

Field vs. Laboratory Conditions. The concentrations and magnitude of changes in secondary water quality parameters may differ between the field and the laboratory due to differences in the reaction conditions. However, the laboratory data are useful as guides as to which parameters, if any, may be of concern in the field.

5.0 CONCLUSIONS

Bench-scale laboratory testing clearly demonstrated that treatment of soil and groundwater with ozone alone or with Peroxone (a mixture of ozone and H_2O_2) could destroy 1,4-dioxane as well as other VOCs. Complete removal of all COCs from the aqueous phase was achieved with all treatments. Additional tests confirmed that dioxane was also removed from the soil phase. No VOCs were detected in off-gases.

COC removal was due to destruction not volatilization. NO VOCs were detected in off-gases from the ozone and Peroxone tests and dioxane was not removed from the aqueous phase by sparging with nitrogen, an inert gas.

Removal of dioxane by ozone alone was probably due to ‘enhancement” of the ozone by iron, bicarbonate or other compounds naturally present in soil and groundwater. In tests conducted on DI water spiked with dioxane and various potential enhancers, dioxane was completely removed in all cases except when olefins were added. Thus, the addition of H_2O_2 as an enhancer may not be required during in situ applications.

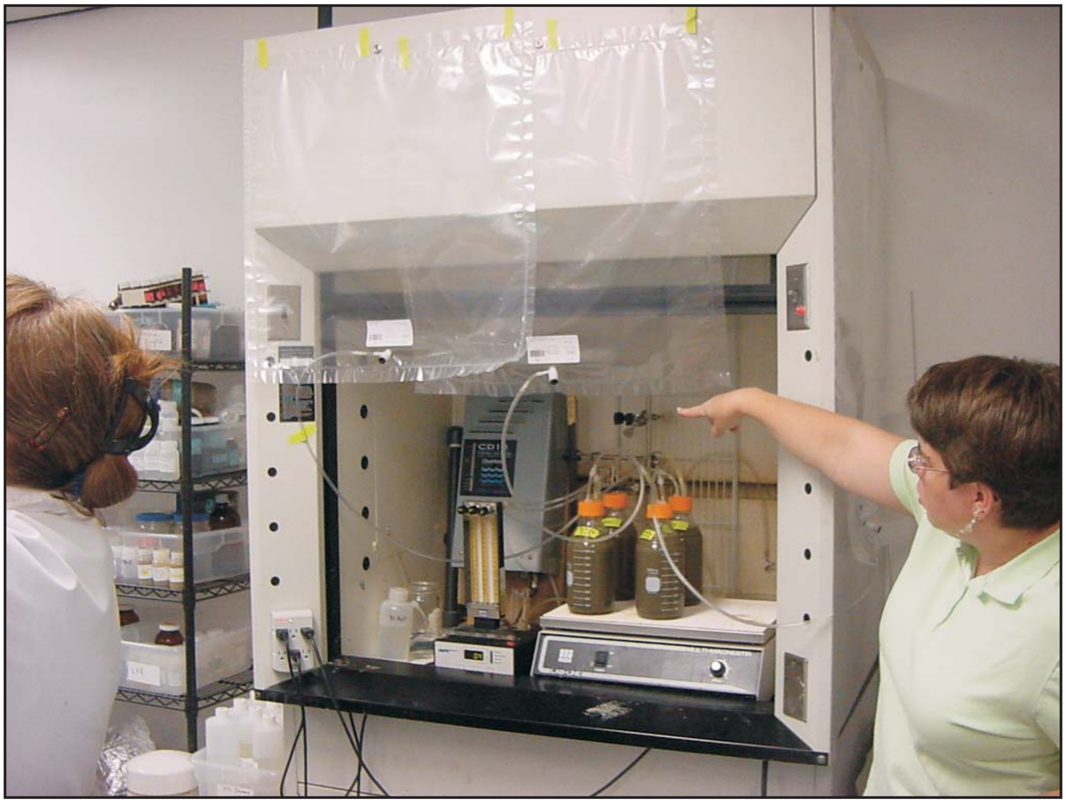
Ozone and Peroxone affected several secondary water quality parameters including bromate, bromide, Cr(VI), vanadium, chromium (total), manganese, iron, nickel, selenium, barium, tungsten and nitrate. The direction of the change (an increase or decrease) was the same in most cases, but the magnitude often varied among the tests. Parameters affected by both ozone and Peroxone were bromate, chromium (total), manganese, iron, nickel, copper, barium, tungsten and nitrate. Parameters affected by either ozone or Peroxone were vanadium and selenium. Copper and chromium (total and Cr(VI)), were effect by ozone and one of the Peroxone tests.

The ozone demand of soil was approximately 3,000 mg O_3/kg soil.

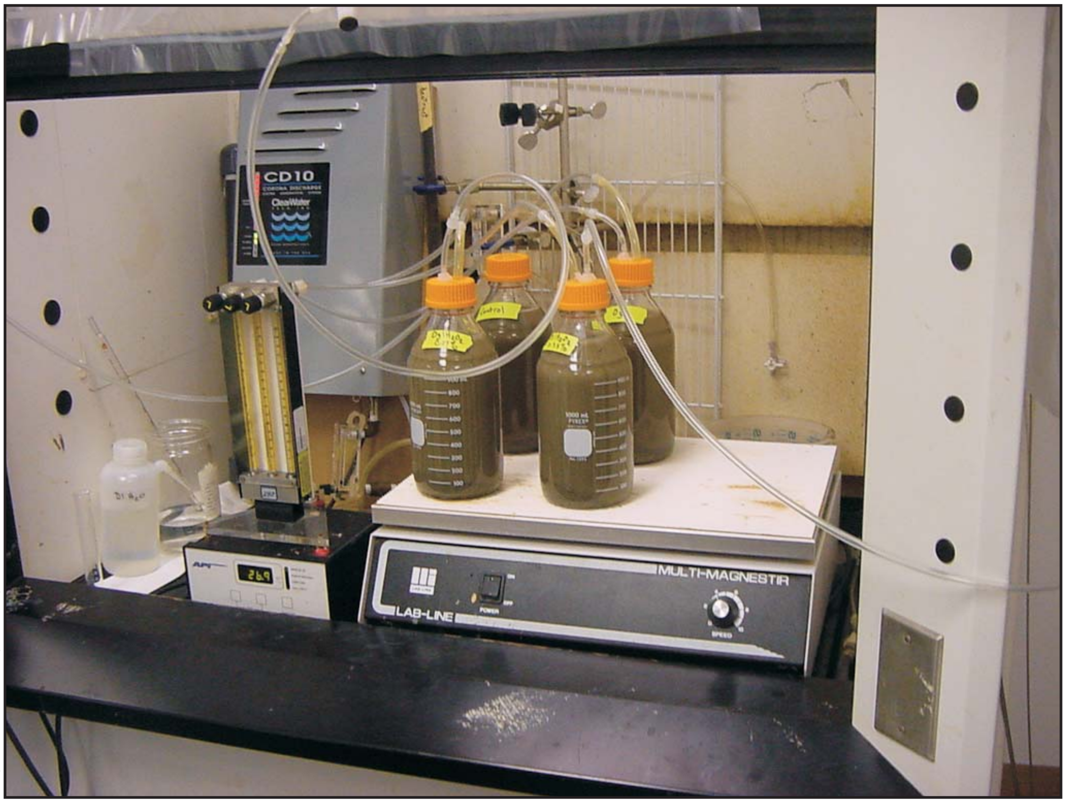
Column tests (as described in this study) cannot accurately predict the effectiveness of proposed field application methods Peroxone injection.

APPENDIX B

Field Pilot Study Photographs



B-1. Bench Scale Test Setup

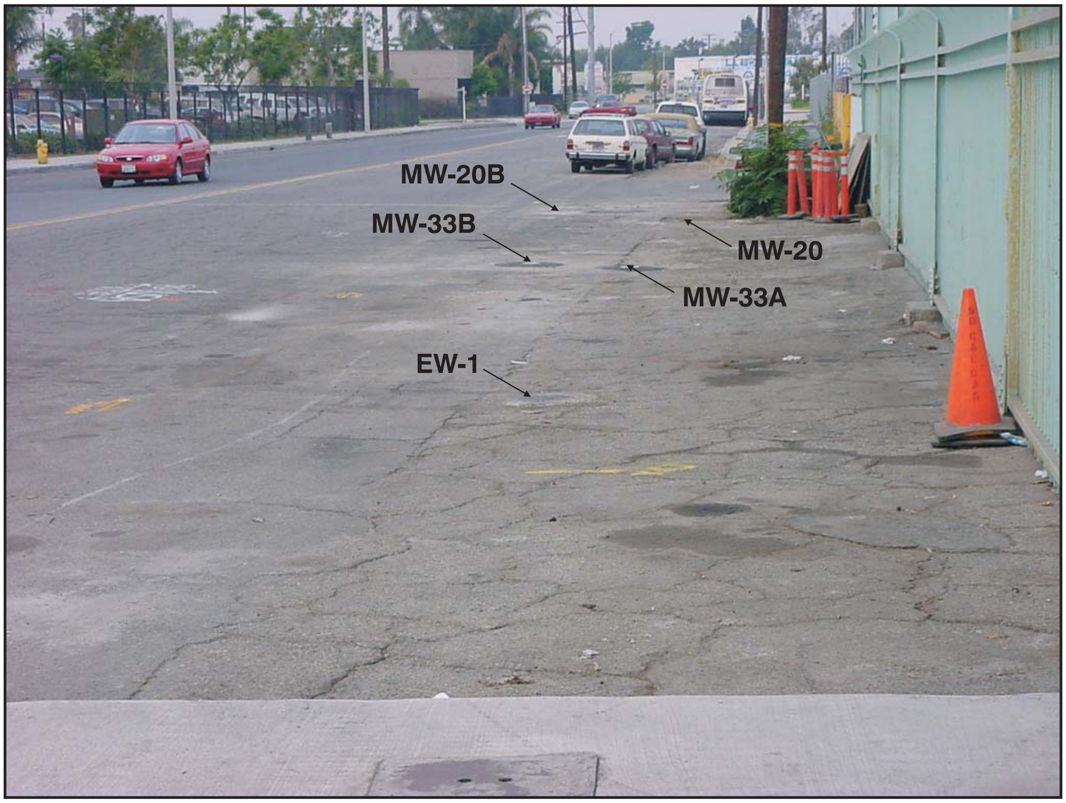


B-2. Bench Scale Test

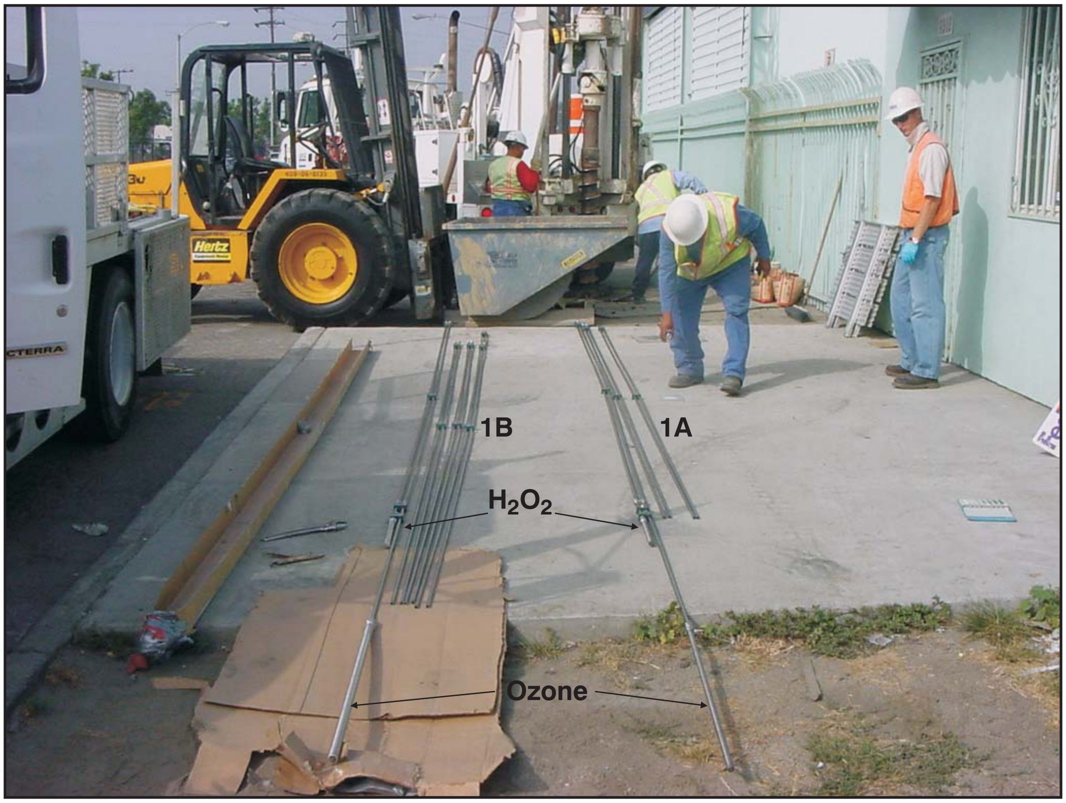
Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 1

B-3. Bench Scale Test Setup

B-4. Bench Scale Test (Attempted Column Test)



B-5. Pilot Test Monitor Wells



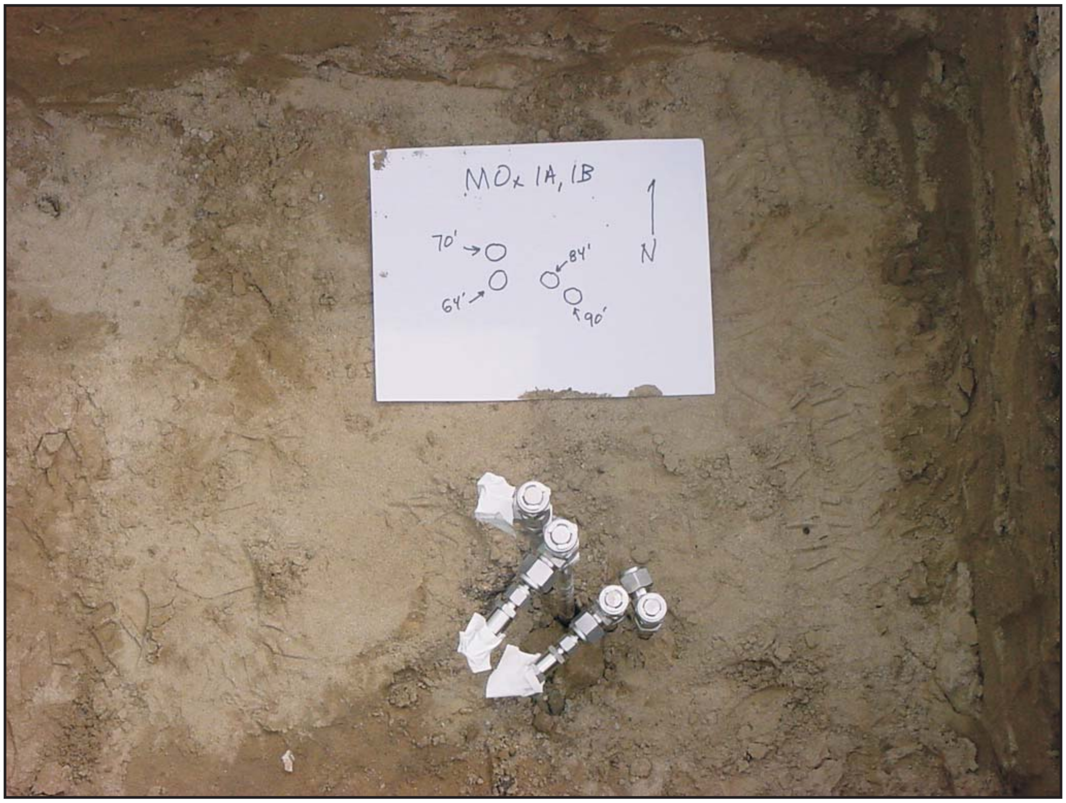
B-6. Pilot Test Max Ox Injection Well Installation (MOx-1A and -1B)

B-7. 3-Foot Ozone Injection Screen

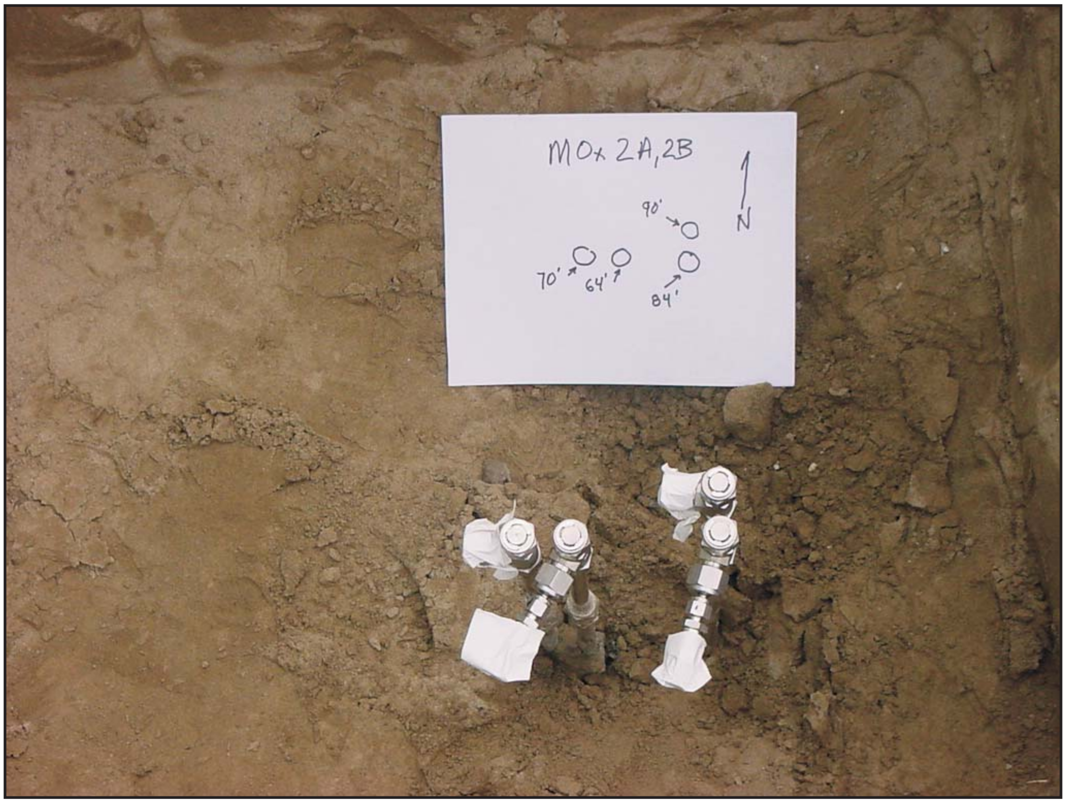
B-8. 1-Foot Hydrogen Peroxide Injection Screen

Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 4

B-9. Injection Well Installation



B-10. Injection Well Above-Ground Valving (MOx-1A and -1B)



B-11. MOx-2A and -2B)

B-12. MOx-3A and -3B)

B-13. Injection Well Vault Box

B-14. Pilot Test Trenching

B-15. Pilot Test Piping Connection to Pulse Ox Trailer

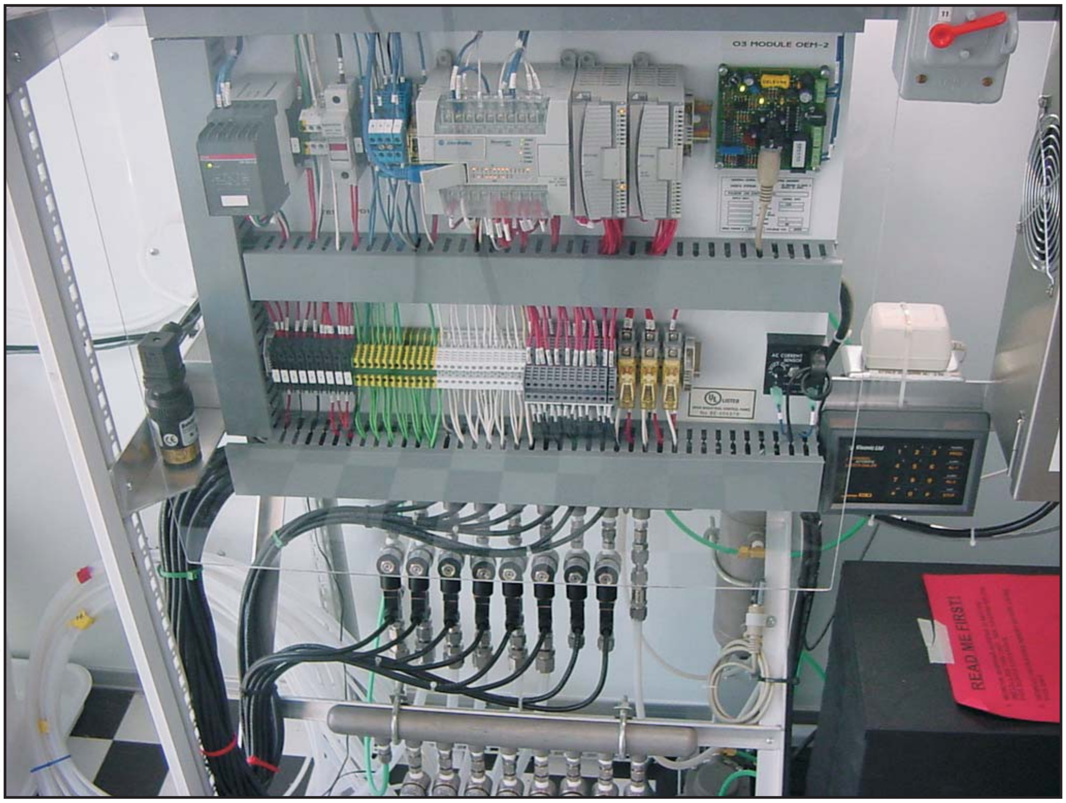
B-16. Applied Process Technologies (APT) Pulse Ox 100T Trailer

B-17. Pulse Ox 100 Chemical Oxidation System

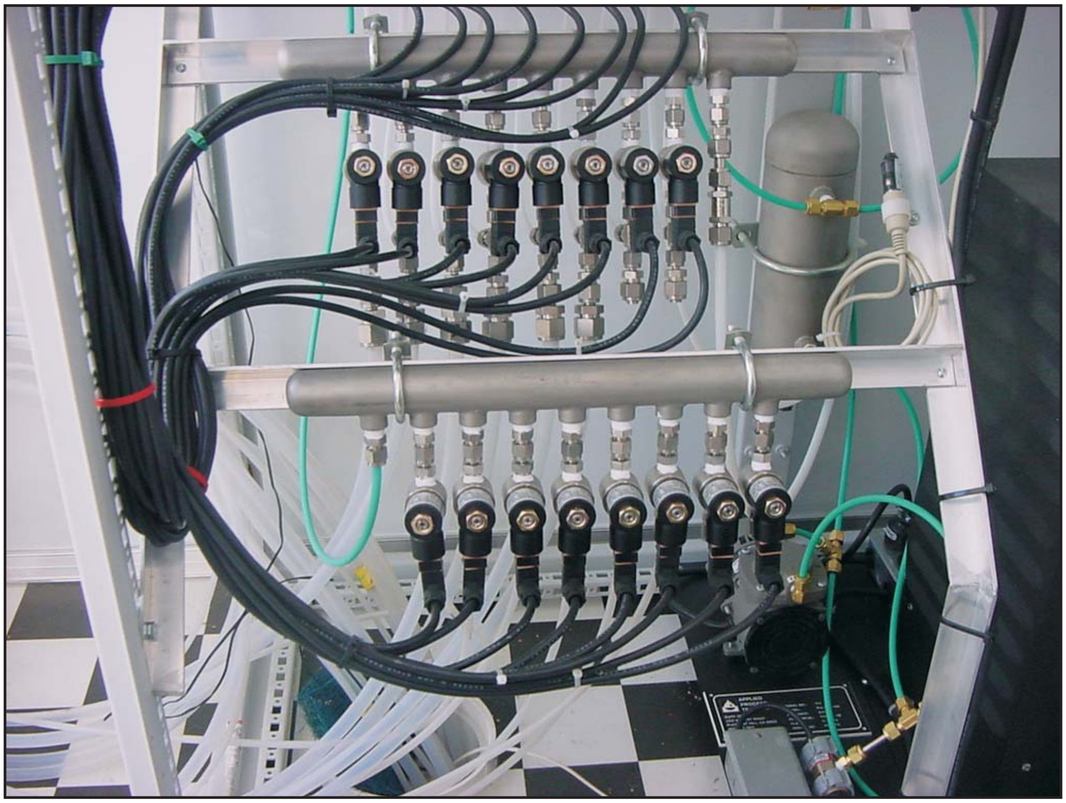
B-18. Pulse Ox 100 Chemical Oxidation System

Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 9

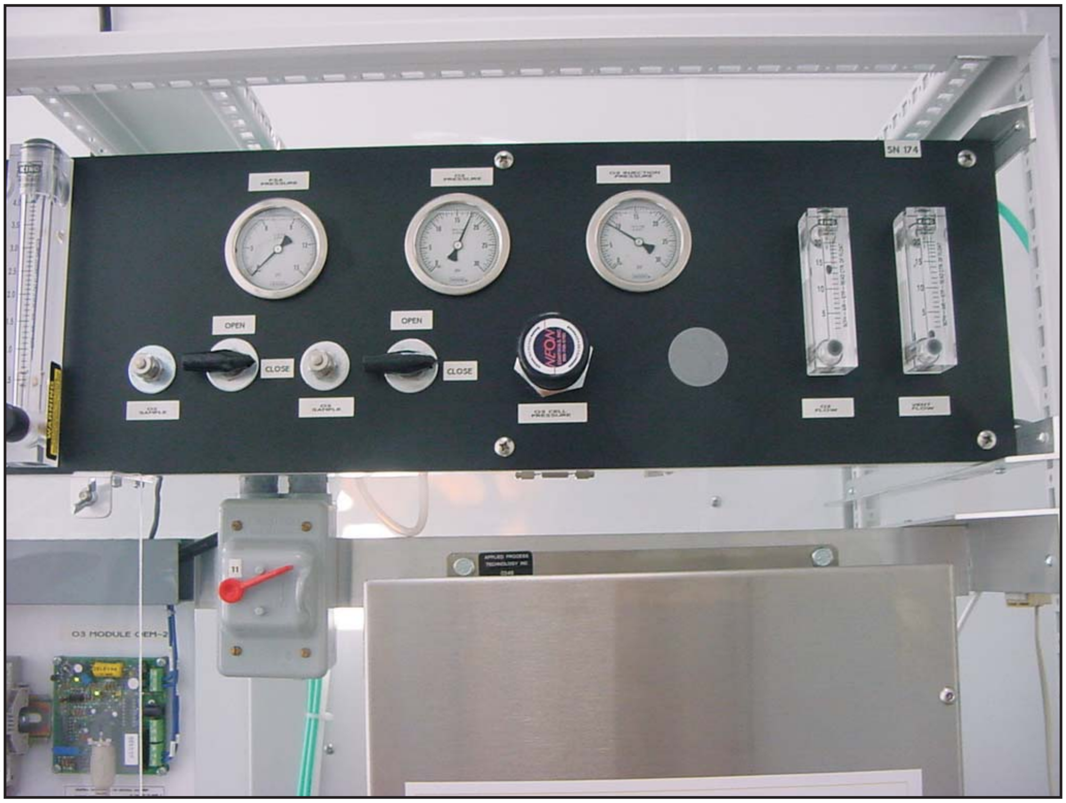
B-19. Operator Interface Terminal



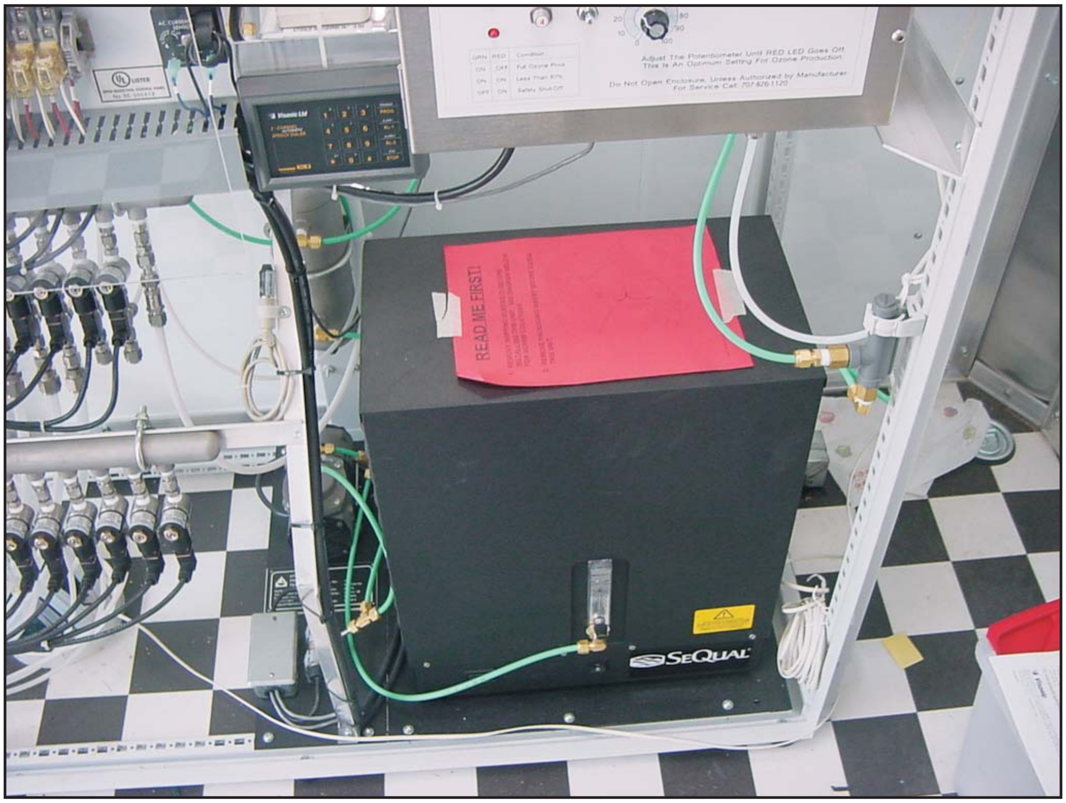
B-20. Process Logic Controller (PLC) *(Top of Photo)*



B-21. Distribution Manifolds (8-Solenoid)



B-22. System Pressure and Air Flow Gauges

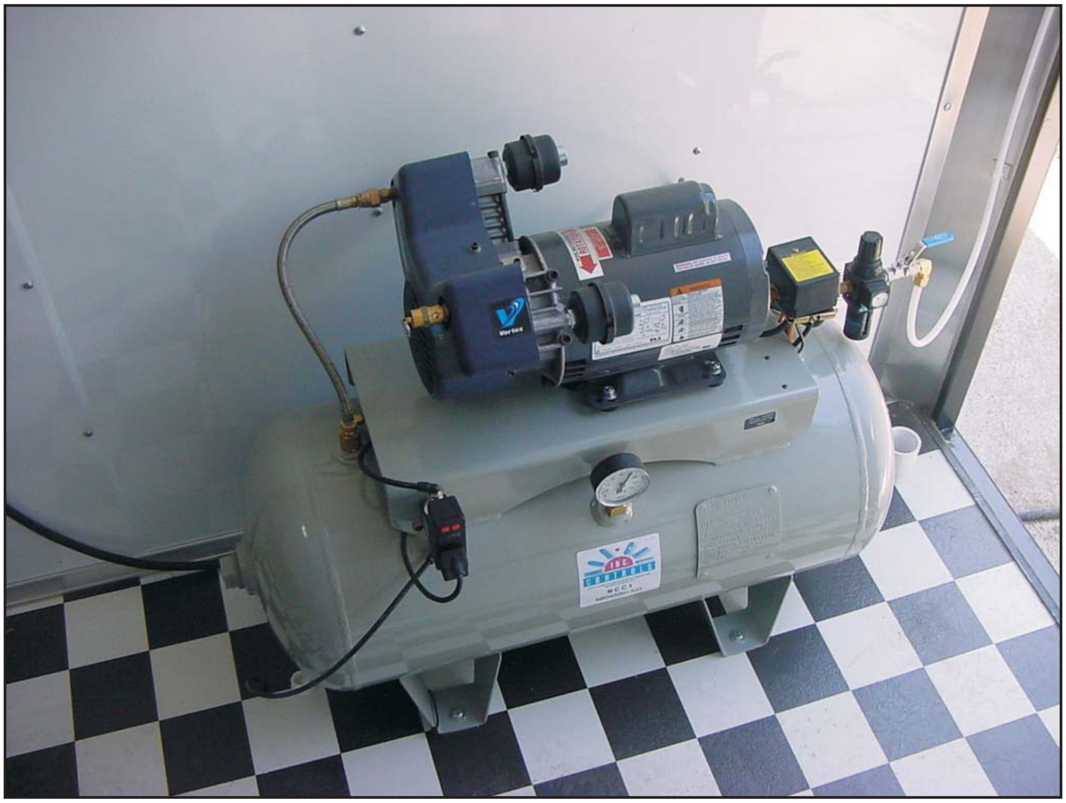


B-23. Oxygen Generator Pressure Swing Adsorption System

B-24. Ozone Generator

Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 12

B-25. Hydrogen Peroxide Injection Skid



B-26. Air Injection Skid

Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 13

Cooper Drum\12-06-cooper-drum-photos.cdr LCT 12.21.06 SAC 14

B-27. Groundwater Sampling at Monitoring Well MW-20

APPENDIX C

Boring Logs and Well Completion Details

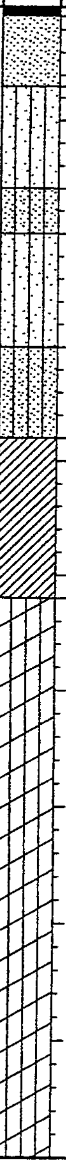
Project: Cooper Drum
Project Location: 9316 S. Atlantic Ave., South Gate, California
Project Number: 53F4005900.02

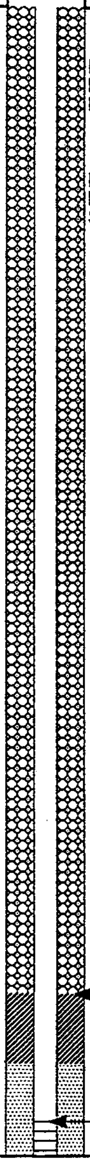
Log of Boring EW-1

Sheet 1 of 2

Date(s) Drilled	3/29/99 - 3/29/99	Logged By	JD Gonsalves	Checked By	
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	13.5-inch	Total Depth Drilled (feet)	92.0
Drill Rig Type	CME-95	Drilling Contractor	Gregg Drilling & Testing	Hammer Weight/ Drop (lbs/in.)	
Groundwater Level (feet)	56	Date Measured	3/29/99	Approx. Surface Elevation (feet)	103.6 MSL
Diameter of Hole (inches)	14-inch Diameter of Well (inches) 6-inch	Type of Well Casing	Schedule 40 PVC	Screen Perforation	0.020-inch
Type of Sand Pack	Monterey #1C sand	Type/Thickness of Seal(s)	Neat cement grout mixture with 5% bentonite		
Comments	Upon reaching total depth, boring converted to 6" diameter extraction well, nested with 1" diameter piezometer.				

Elevation feet	Depth, feet	SAMPLES Type	Number	Blows/foot	Headspace (ppm)	Graphic Log	MATERIAL DESCRIPTION	Drilling Progress (24-hour clock)	Well Completion Log	REMARKS AND WELL DETAIL
	0						ASPHALT			
							SAND (SP) Poorly graded, fill, gray, dry, medium dense medium grained			
100										Begin advancing EW-1 boring @0900 adjacent to boring SB-1 on 3/29/99.
	5						SANDY SILT (ML), dark brown, moist, non plastic, firm, very fine grained			
95							SILTY SAND (SM), brown, moist, medium dense, very fine grained			No samples collected, lithology based on boring SB-1
	10						SANDY SILT (ML), gray brown, moist, firm, low plasticity			
90										
	15						SILTY SAND (SM), dark brown, moist, very fine to fine grained,			
85										
	20						SILTY CLAY (CL), grayish brown, moist, firm, low to moderate plasticity, minor very fine grained sand			
80										
	25									
							CLAYEY SILT (ML), brown, moist, firm, low plasticity, minor very fine grained sand			
75										
	30									
70										
	35									
65										
	40									
60										Bentonite pellet seal 43 to 46' bgs
	45									
55										0.020" slotted screen
	50									





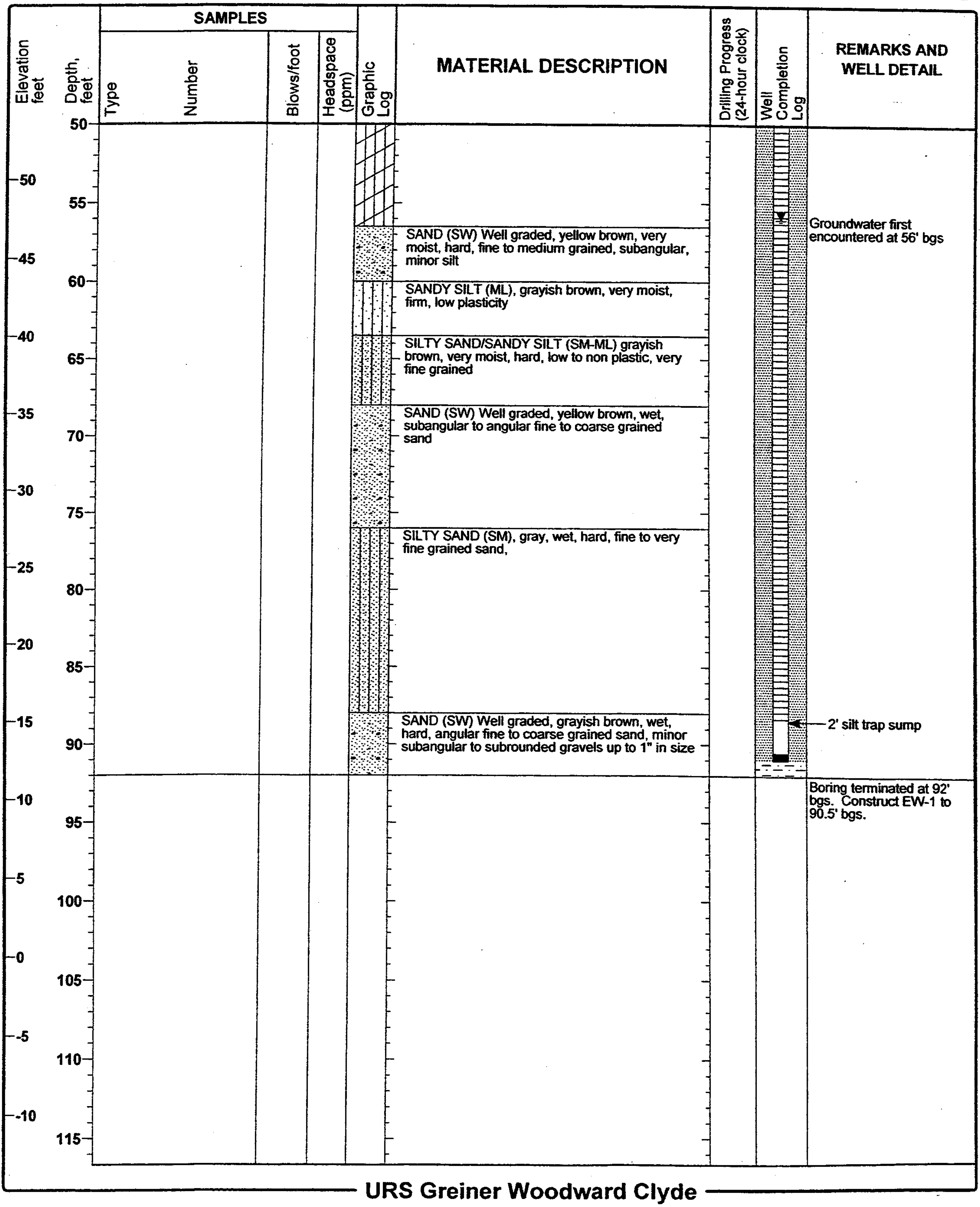
Report: ENV_1A; Project File: D:\GINTW\PROJECTS\COOPDW.GPJ; Data Template:WC_CORP1.GDT Printed: 7/13/99

URS Greiner Woodward Clyde

Project: Cooper Drum
Project Location: 9316 S. Atlantic Ave., South Gate, California
Project Number: 53F4005900.02

Log of Boring EW-1

Sheet 2 of 2



SAND (SW) Well graded, yellow brown, very moist, hard, fine to medium grained, subangular, minor silt

SANDY SILT (ML), grayish brown, very moist, firm, low plasticity

SILTY SAND/SANDY SILT (SM-ML) grayish brown, very moist, hard, low to non plastic, very fine grained

SAND (SW) Well graded, yellow brown, wet, subangular to angular fine to coarse grained sand

SILTY SAND (SM), gray, wet, hard, fine to very fine grained sand,

SAND (SW) Well graded, grayish brown, wet, hard, angular fine to coarse grained sand, minor subangular to subrounded gravels up to 1" in size

Groundwater first encountered at 56' bgs

2' silt trap sump

Boring terminated at 92' bgs. Construct EW-1 to 90.5' bgs.

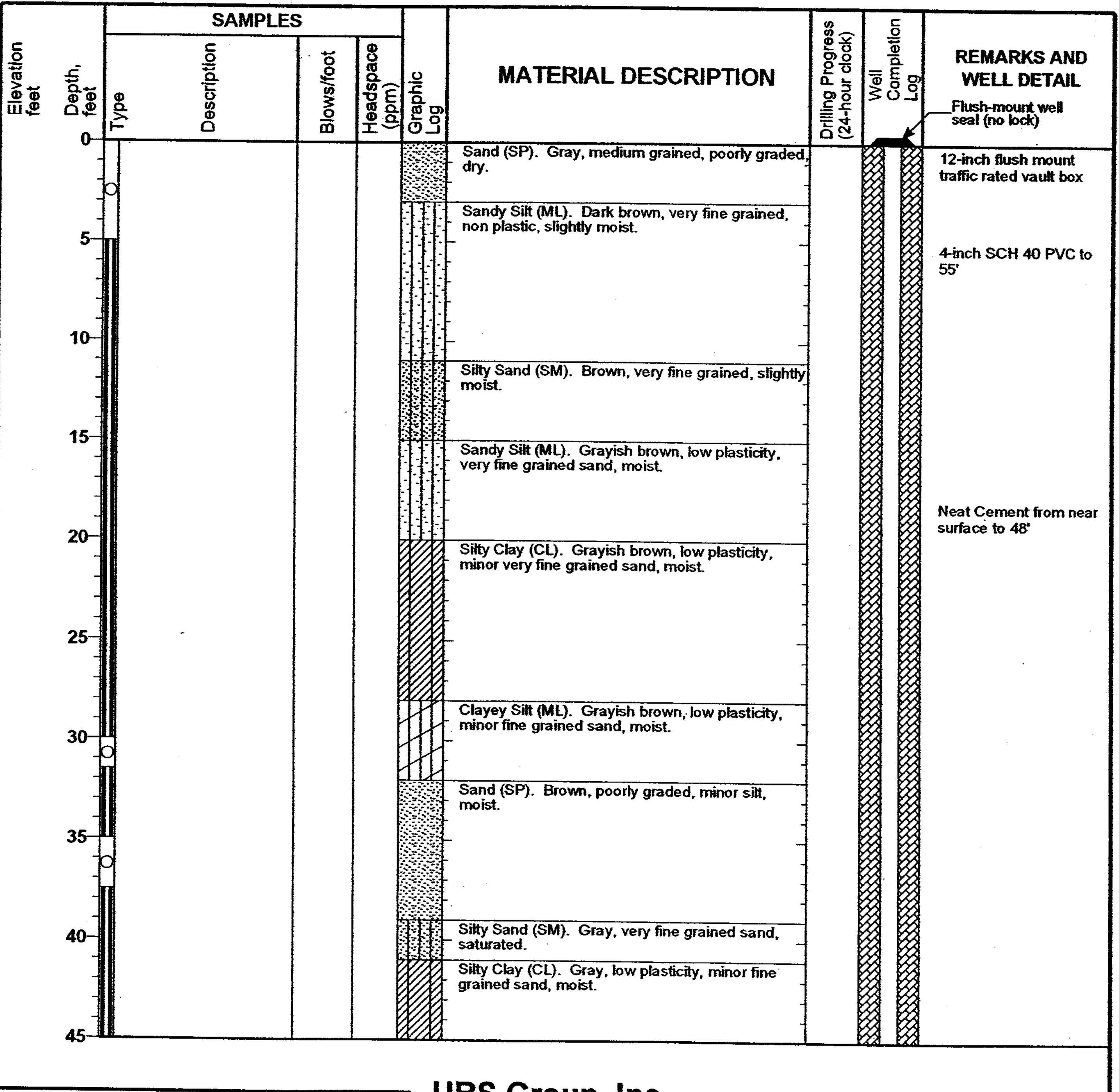
Report: ENV_1A; Project File: D:\GINTW\PROJECTS\COOPDW.GPJ; Data Template:WC_CORP1.GDT Printed: 7/13/99

Project: Cooper Drum
Project Location: 9316 S. Atlantic Ave., South Gate, CA
Project Number: 18600047.03020

Log of Boring MW-20

Sheet 1 of 2

Date(s) Drilled	2/26/03 - 2/27/03	Logged By	D. Gruber	Checked By	Don Gruber
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	10-inch	Total Depth Drilled (feet)	75.0
Drill Rig Type	CME-95	Drilling Contractor	Water Development Corp.	Hammer Weight/ Drop (lbs/in.)	
Groundwater Level (feet)		Date Measured		Approx. Surface Elevation (feet)	
Diameter of Hole (inches)	10-inch Diameter of Well (inches) 4-inch	Type of Well Casing	SCH 40 PVC	Screen Perforation	0.020-inch
Type of Sand Pack	#3 Sand	Type/Thickness of Seal(s)	Neat Cement Grout with 5% Bentonite		
Comments	CME Continuous Core - 5' barrel				



MATERIAL DESCRIPTION

Sand (SP). Gray, medium grained, poorly graded, dry.

Sandy Silt (ML). Dark brown, very fine grained, non plastic, slightly moist.

Silty Sand (SM). Brown, very fine grained, slightly moist.

Sandy Silt (ML). Grayish brown, low plasticity, very fine grained sand, moist.

Silty Clay (CL). Grayish brown, low plasticity, minor very fine grained sand, moist.

Clayey Silt (ML). Grayish brown, low plasticity, minor fine grained sand, moist.

Sand (SP). Brown, poorly graded, minor silt, moist.

Silty Sand (SM). Gray, very fine grained sand, saturated.

Silty Clay (CL). Gray, low plasticity, minor fine grained sand, moist.

REMARKS AND WELL DETAIL

Flush-mount well seal (no lock)

12-inch flush mount traffic rated vault box

4-inch SCH 40 PVC to 55'

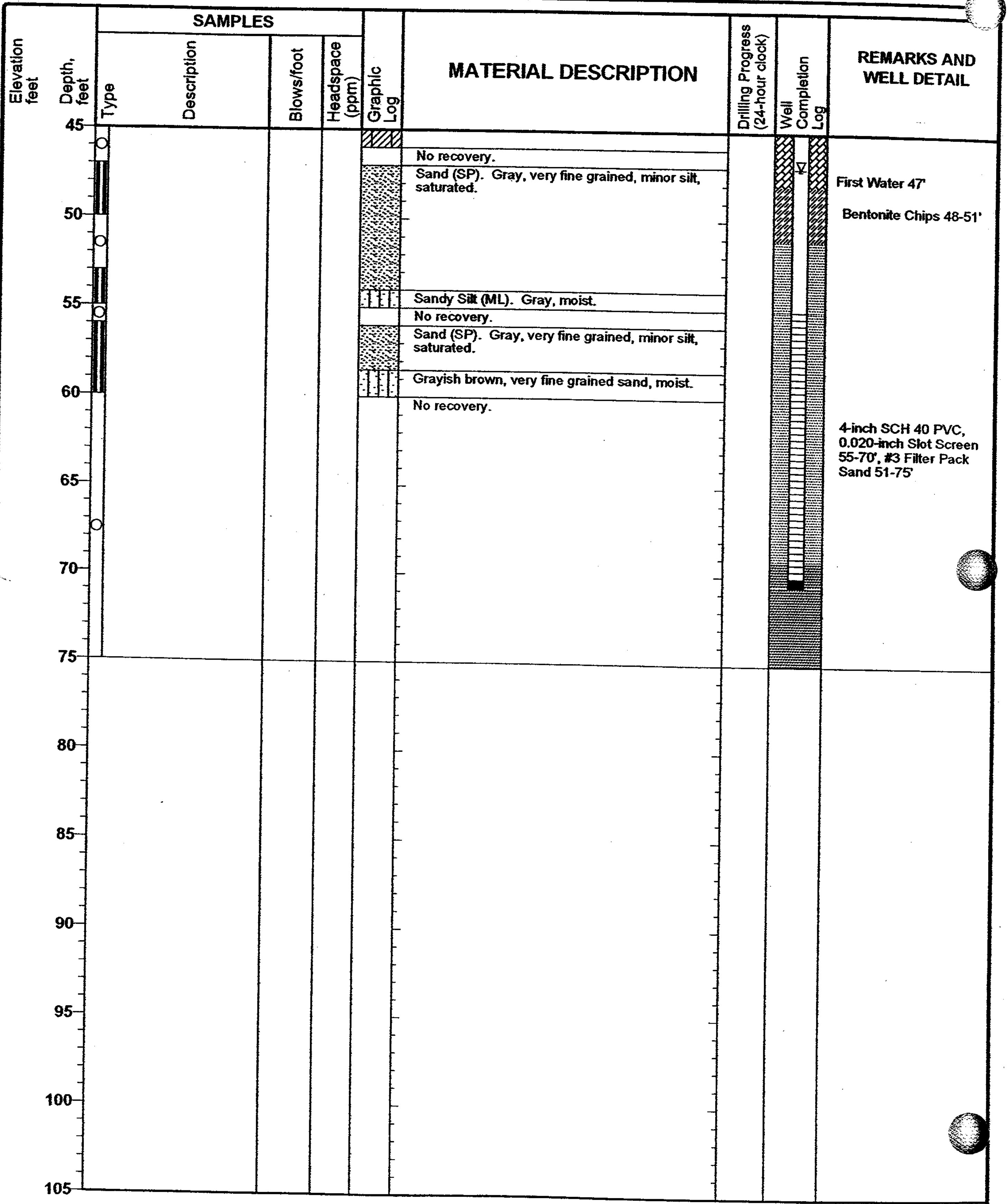
Neat Cement from near surface to 48'

URS Group, Inc.

Project: Cooper Drum
Project Location: 9316 S. Atlantic Ave., South Gate, CA
Project Number: 18600047.03020

Log of Boring MW-20

Sheet 2 of 2



MATERIAL DESCRIPTION

No recovery.

Sand (SP). Gray, very fine grained, minor silt, saturated.

Sandy Silt (ML). Gray, moist.

No recovery.

Sand (SP). Gray, very fine grained, minor silt, saturated.

Grayish brown, very fine grained sand, moist.

No recovery.

REMARKS AND WELL DETAIL

First Water 47'

Bentonite Chips 48-51'

4-inch SCH 40 PVC, 0.020-inch Slot Screen 55-70', #3 Filter Pack Sand 51-75'

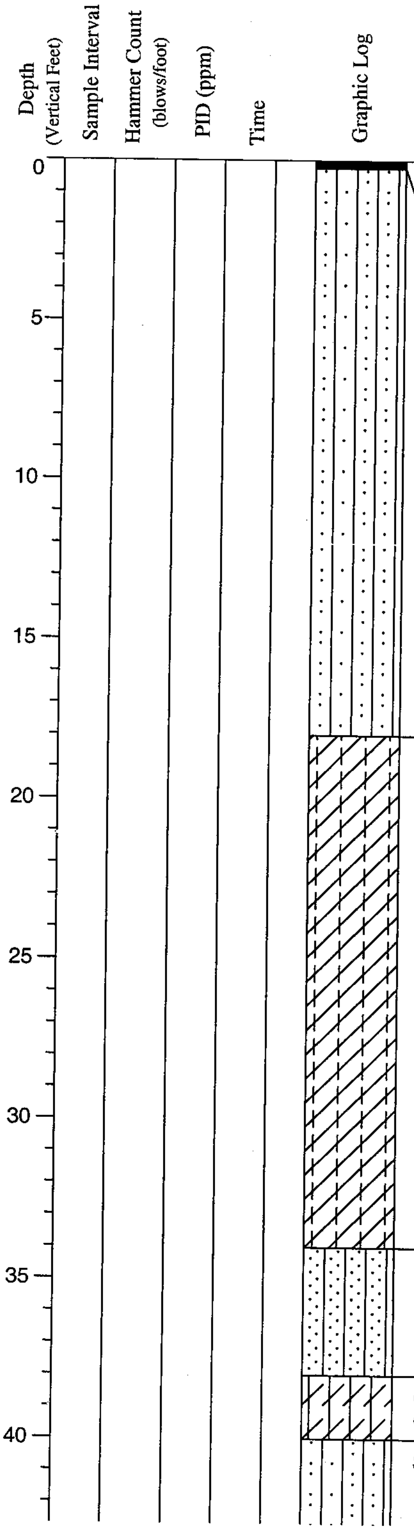
Project: Cooper Drum

Location: 9316 S. Atlantic Ave., South Gate, CA **Project Number: 18600047**

Log of Montoring Well: MW-20B

Dates Drilled: 7/5/2005	Total Depth: 90 feet		Borehole Name:
Drilling Contractor: Gregg Drilling and Testing	Well Construction Date:		Logged By: R. Morley
Borehole Diameter: 8-inch	Casing Diameter: 2-inch	Casing Type: SCH 40 PVC	Checked By: Don Gruber
Drilling Method: Hollow Stem Auger	Screen Interval: 80-90 feet	Slot Size: 0.020-inch	Sampling Method: CA Modified Split Spoon

Comments: Logged cuttings 0 - 70', sampled every 5' from 70' - 90'



LITHOLOGY DESCRIPTION

Asphalt.

Sandy Silt (ML). Dark grayish brown (10YR 4/2), very fine grained sand, soft, moist.

Sandy Silt (ML). Very dark grayish brown (10YR 3/2), decreasing sand content, very moist.

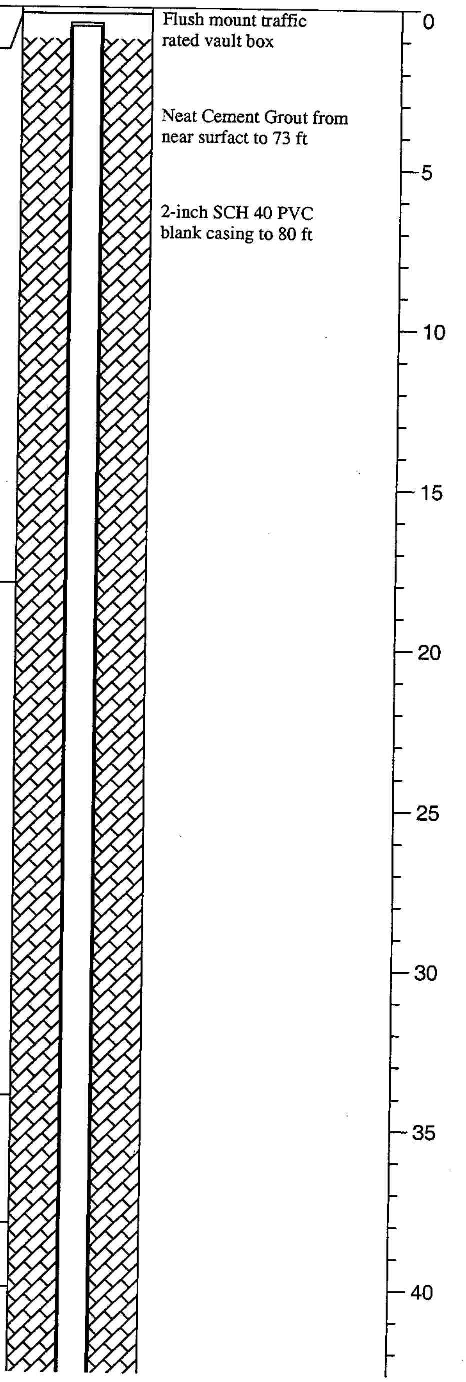
Silty Clay with Sand (CL). Dark grayish brown (2.5Y 4/2), soft, plastic, very wet.

Silty Sand (SM). Dark gray (2.5Y 4/1), fine grained sand, saturated.

Clayey Silt (ML). Very dark gray (5Y 3/1), stiff, very low plasticity, damp.

Sandy Silt (ML). Very dark gray (5Y 3/1), very fine grained sand.

WELL CONSTRUCTION



Flush mount traffic rated vault box

Neat Cement Grout from near surface to 73 ft

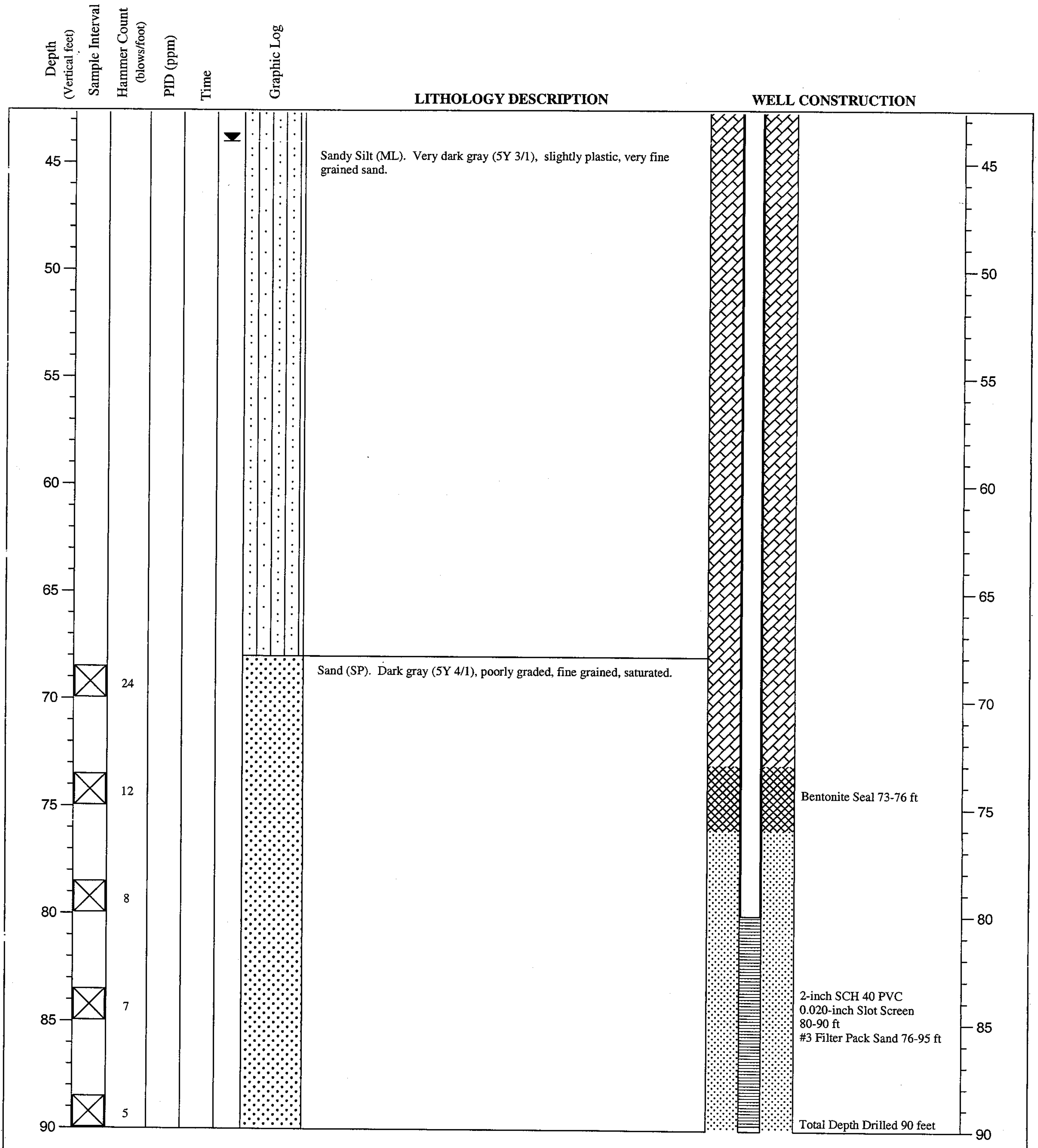
2-inch SCH 40 PVC blank casing to 80 ft

URS
2870 Gateway Oaks Dr., Ste 300
Sacramento, CA 95833
916-679-2000

Project: Cooper Drum

Location: 9316 S. Atlantic Ave., South Gate, CA **Project Number: 18600047**

Log of Monitoring Well: MW-20B



Sandy Silt (ML). Very dark gray (5Y 3/1), slightly plastic, very fine grained sand.

Sand (SP). Dark gray (5Y 4/1), poorly graded, fine grained, saturated.

Bentonite Seal 73-76 ft

2-inch SCH 40 PVC
0.020-inch Slot Screen
80-90 ft
#3 Filter Pack Sand 76-95 ft

Total Depth Drilled 90 feet

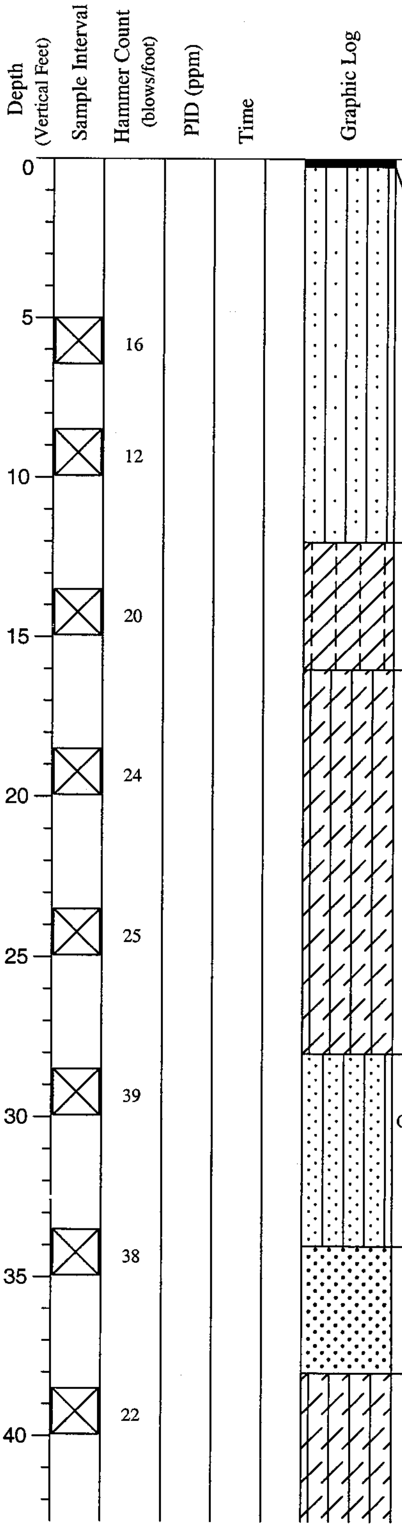
Project: Cooper Drum

Location: 9316 S. Atlantic Ave., South Gate, CA **Project Number: 18600047**

Log of Montoring Well: MW-33A/MW-33B

Dates Drilled: 7/6/2005	Total Depth: 90 feet		Borehole Name:
Drilling Contractor: Gregg Drilling and Testing	Well Construction Date:		Logged By: R. Morley
Borehole Diameter: 8-inch	Casing Diameter: 2-inch	Casing Type: SCH 40 PVC	Checked By: Don Gruber
Drilling Method: Hollow Stem Auger	Screen Interval: A - 55-65'; B - 80-90'	Slot Size: 0.020-inch	Sampling Method: CA Modified Split Spoon

Comments: Wells were installed as single completion wells in two adjacent 8-inch diameter borings. Lithology from MW-33B.



LITHOLOGY DESCRIPTION

Asphalt.

Sandy Silt (ML). Dark grayish brown (10YR 4/2), very fine grained sand, moist.

Silty Clay (CL). Dark grayish brown (10YR 4/2), low plasticity, very damp.

Clayey Silt (ML). Dark grayish brown (2.5Y4/2), very low plasticity, trace very fine grained sand, moist.

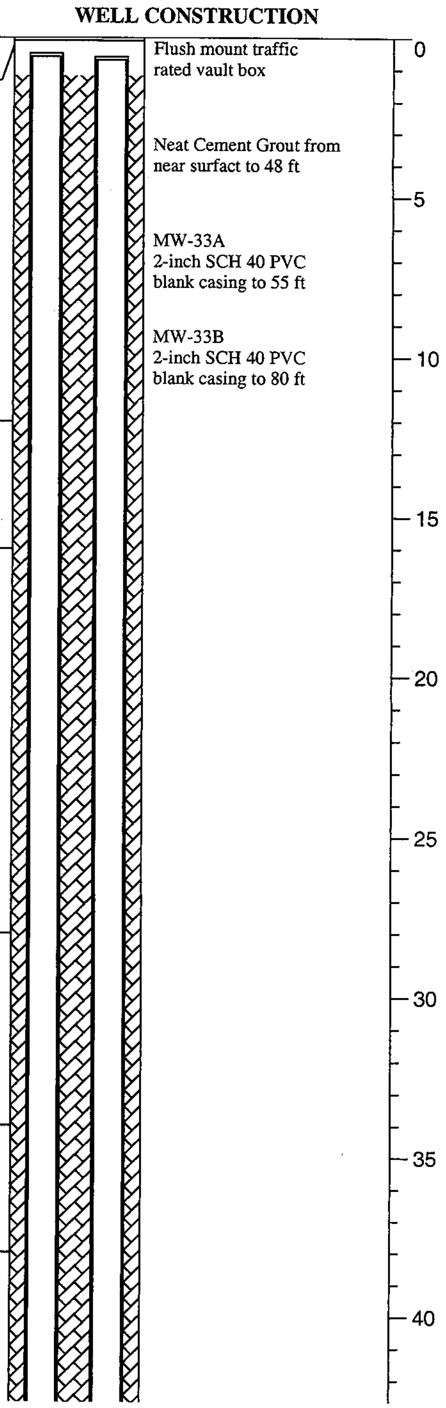
Silty Sand (SM). Olive gray (5Y 5/2), very fine grained, moist.

Clayey silt interbed at 30'.

Sand (SP), Olive gray (5Y 5/2), poorly graded, fine grained, damp.

Clayey Silt (ML). Very dark gray (5Y 3/1), stiff, very low plasticity, damp.

WELL CONSTRUCTION



Flush mount traffic rated vault box

Neat Cement Grout from near surface to 48 ft

MW-33A
2-inch SCH 40 PVC
blank casing to 55 ft

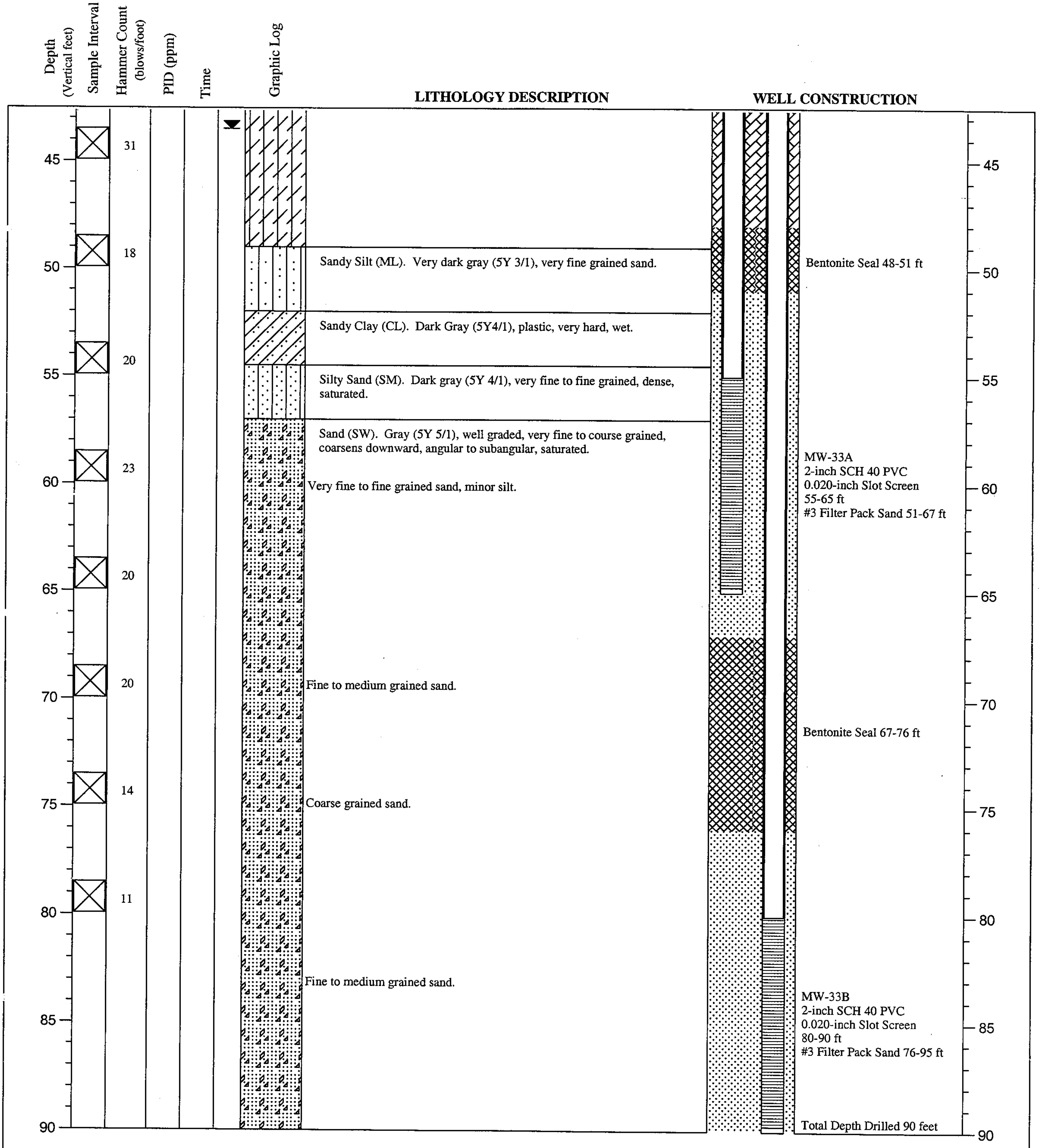
MW-33B
2-inch SCH 40 PVC
blank casing to 80 ft

URS 2870 Gateway Oaks Dr., Ste 300
Sacramento, CA 95833
916-679-2000

Project: Cooper Drum

Location: 9316 S. Atlantic Ave., South Gate, CA **Project Number: 18600047**

Log of Monitoring Well: MW-33A/MW-33B



Sandy Silt (ML). Very dark gray (5Y 3/1), very fine grained sand.

Sandy Clay (CL). Dark Gray (5Y4/1), plastic, very hard, wet.

Silty Sand (SM). Dark gray (5Y 4/1), very fine to fine grained, dense, saturated.

Sand (SW). Gray (5Y 5/1), well graded, very fine to course grained, coarsens downward, angular to subangular, saturated.

Very fine to fine grained sand, minor silt.

Fine to medium grained sand.

Coarse grained sand.

Fine to medium grained sand.

Bentonite Seal 48-51 ft

MW-33A
2-inch SCH 40 PVC
0.020-inch Slot Screen
55-65 ft
#3 Filter Pack Sand 51-67 ft

Bentonite Seal 67-76 ft

MW-33B
2-inch SCH 40 PVC
0.020-inch Slot Screen
80-90 ft
#3 Filter Pack Sand 76-95 ft

Total Depth Drilled 90 feet

GREGG

MONITORING WELL DEVELOPMENT LOG

Page ______ of ______

All measurements taken from: ☒ Top of Casing ☐ Protective Casing ☐ Ground Level

Sample ID ____________

Qty. of Drilling Fluid Lost ____________

Well Number MW-33A

Borehole Diameter ____________

Minimum Gal. to be Purged 27.13

Date 7/8/05

Screen Length ____________

Development Method ____________

Time Start: ________ End: ________

Measured Depth (pre-development) 64.75

Client URS

Measured Depth (post-development) 65.21

Purging Equipment Grounfos 2"

Project ____________

Static Water Level (ft.) 48.79

Water Level Equipment ____________

Job Number ____________

Standing Water Column (ft.) 1596

pH/EC Meter Horiba - U-10

Installation Date ____________

One Well Volume (gal.) 2.71

Turbidity Meter "

Well Diameter 2"

One Annulus Vol. (gal.) ____________

Other ____________

Time	Amount Purged (gal)	Field Parameters Measured							Comments	Field Tech.
		EC MS/CM	pH	Temp.	Turbidity	D.O.	SAL.	GPM / W.L.	9.34 Started	
9:36.	6.0	3.23	7.24.	21.8	999	2.01	0.16	200/54.57	Pumping 2GPM	
9:42	18	3.47	7.21	21.4	999	1.89	0.17	"/54.90	Bailed 15 Gls	
9:48	27.	3.49	7.22	21.3	927	1.59	0.17	"/54.92		
9:55	40	3.54	7.21	21.2.	103	1.53	0.17.	"/55.34		
10:05	60	3.58	7.21	21.2	59	1.62	0.17	"/55.37		
10:15	80	3.59	7.21	21.2	48	1.71	0.17	"/ "		
10:25	100	3.61	7.21	21.2.	41	1.82	0.17	" "		

FINAL FIELD PARAMETER MEASUREMENTS

GREGG

MONITORING WELL DEVELOPMENT LOG

Page ______ of ______

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

Sample ID ____________

Qty. of Drilling Fluid Lost ____________

Minimum Gal. to be Purged 67.67

Development Method ____________

Purging Equipment ____________

Water Level Equipment ____________

pH/EC Meter Horiba U-10.

Turbidity Meter 〃

Other ____________

Well Number MW-33B

Date 7/8/05

Time Start: ________ End: ________

Client UNS

Project ____________

Job Number ____________

Installation Date ____________

Well Diameter 2"

Borehole Diameter ____________

Screen Length ____________

Measured Depth (pre-development) 88.32

Measured Depth (post-development) 90.41

Static Water Level (ft.) 48.51

Standing Water Column (ft.) 39.81

One Well Volume (gal.) 6.76

One Annulus Vol. (gal.) ____________

Time	Amount Purged (gal)	Field Parameters Measured							Comments	Field Tech.
		EC	pH	Temp.	Turbidity	D.O.	SAL.	GPM / W.L.		
1147	10	8.25	7.24	22.1	999	1.46	0.43	2/49.32	Started pumping	
1152	20	8.32	7.20	21.6	372	1.53	0.45	〃/〃	11.44 Flow	
1157	30	8.32	7.20	21.6	113	1.47	0.45	〃/〃	2GPM	
1203	40	8.39	7.18	21.3	26	1.57	0.46	〃/〃		
1212	60	8.39	7.17	21.2	12	1.73	0.46	〃/〃		
1232	100	8.39	7.17	21.2	3	1.58	0.46	〃/〃		

FINAL FIELD PARAMETER MEASUREMENTS

GREGG

MONITORING WELL DEVELOPMENT LOG

Page ______ of ______

All measurements taken from: ☒ Top of Casing ☐ Protective Casing ☐ Ground Level

Sample ID ____________

Well Number MW-20B

Date ____________

Time Start: ________ End: ________

Client URS

Project ____________

Job Number ____________

Installation Date ____________

Well Diameter 2"

Borehole Diameter ____________

Screen Length ____________

Measured Depth (pre-development) 88.20

Measured Depth (post-development) 90.23

Static Water Level (ft.) 48.32

Standing Water Column (ft.) 39.88

One Well Volume (gal.) 6.77

One Annulus Vol. (gal.) ____________

Qty. of Drilling Fluid Lost ____________

Minimum Gal. to be Purged 67

Development Method ____________

Purging Equipment ____________

Water Level Equipment ____________

pH/EC Meter ____________

Turbidity Meter ____________

Other ____________

Time	Amount Purged (gal)	Field Parameters Measured							Comments	Field Tech.
		EC	pH	Temp.	Turbidity	D.O.	SAL.	GPM / W.L.		
0250	15	11.4	7.17	22.3	999	1.73	0.64		Started pumping 244	
0257	30.	11.5	7.17	21.9	999	1.61	0.65			
0304	45	11.5	7.17	21.8	743	1.60	0.65			
0312	70.	8.51	7.17	21.7	614	1.52	0.46			
0323	90	8.45	7.16	21.7	999	1.72	0.46			
0329	102.	8.48	7.17	21.7	180	1.51	0.46			
0342	130.	8.49	7.17	21.7	12	1.54	0.46			

FINAL FIELD PARAMETER MEASUREMENTS

PROJECT NAME Cooper Drum
SITE LOCATION Rayo Ave
DRILLING COMPANY Gregg
DRILL RIG M12
DRILL CREW Juan, Tim, Luis
DATE DRILLED 07/11/05
DRILLING METHOD H-S-A
BORING DIAMETER (IN) 10"
TOTAL DEPTH OF BORING (FT) 90
LOGGED BY R.M
SAMPLING METHOD Cuttings
HAMMER WEIGHT (LBS)
HAMMER DROP (IN)
START TIME
STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS
								SURFACE CONDITIONS: 3" Asphalt
5								SAND; ~~loose~~; dry; fine grain; uniform
10								Silty SAND Dark Brown; V. fine grain; moist; uniform; no odor or staining
15								Sandy Silt; Dark brown; soft; v. fine sand
20								Silty CLAY with sand; soft; very wet; plastic; v. fine sands; olive brown
25								CLAY - dark gray; wet; soft; very plastic
30								Same as above

SKETCH OF BORING LOCATION

MOv 2A, 2B BORING NUMBER

Page 1 of 3

URS

PROJECT NAME Cooper Drum

SITE LOCATION Rayo Ave

DRILLING COMPANY Gregg Drilling + Testing

DRILL RIG

DRILL CREW

DATE DRILLED 07/11/05

DRILLING METHOD H-S-A

BORING DIAMETER (IN) 10

TOTAL DEPTH OF BORING (FT) 90

LOGGED BY RM

SAMPLING METHOD Cuttings

HAMMER WEIGHT (LBS)

HAMMER DROP (IN)

START TIME

STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS:
35								Same as above; wet; med stiff;
40								Silty clay; Gray; slightly plastic; Crumbly; damp; med stiff;
45								Sandy SILT; saturated; soft mushy; v. fine sands:
50								Silty clay; soft; plastic; very damp; some v. fine sand
55								Clayey silt; saturated; – thick slurry like; gray
60								Same as above

SKETCH OF BORING LOCATION

MO_x 2A, 2B **BORING NUMBER**

Page 2 of 3

URS

PROJECT NAME Cooper Dram

SITE LOCATION

DRILLING COMPANY Gregg

DRILL RIG M-12

DRILL CREW Juan, Luis Tim

DATE DRILLED 07/11/05

DRILLING METHOD H-S-A

BORING DIAMETER (IN)

TOTAL DEPTH OF BORING (FT)

LOGGED BY R.M

SAMPLING METHOD Cuttings

HAMMER WEIGHT (LBS)

HAMMER DROP (IN)

START TIME

STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS:
65								SAME AS ABOVE
70								Sandy silt; saturated; fine grain; uniform
75								Same as above.
80								silty sand; very saturated; ~~very~~ fine grain with med grains;
85								Sand with silt; very saturated (soupy) fine grain;
90								

SKETCH OF BORING LOCATION

35 bags Bentonite used
4 bags of #3 Sand

BORING NUMBER MO, 2A, 2B

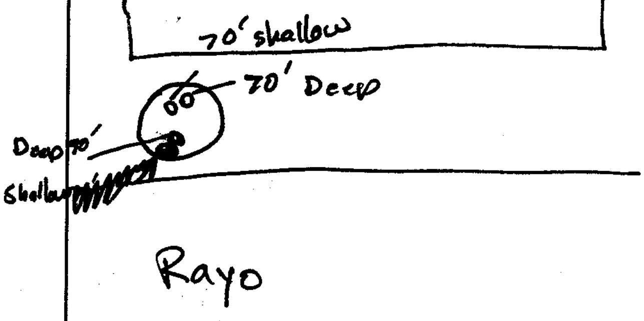
Page 3 of 3

URS

PROJECT NAME Cooper Drum
SITE LOCATION
DRILLING COMPANY Gregg Drilling + Testing
DRILL RIG M-12
DRILL CREW Juan, Tim, Luis
DATE DRILLED 07/11/05
DRILLING METHOD H-S-A
BORING DIAMETER (IN) 10
TOTAL DEPTH OF BORING (FT)
LOGGED BY R. Morley
SAMPLING METHOD cuttings
HAMMER WEIGHT (LBS)
HAMMER DROP (IN)
START TIME
STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS: 3" Asphalt
5							2.5Y 6/3	Silty SAND; fine grain; slightly moist, light yellowish brown
10							2.5Y 3/2	very dark grayish brown Silty SAND increase in silt content; v. fine grain; uniform; damp.
15							"	Clayey Silt; soft; crumbly; v. slightly plastic; moist;
20							"	Same as above; increas in Clay content
25							"	Sandy SILT; v. fine sands; damp; uniform; soft.
30							2.5Y 4/1	Dark gray silty clay; soft; plastic; damp;

SKETCH OF BORING LOCATION



MOx 3A, 3B
BORING NUMBER

Page 1 of 3

URS

from HSA cuttings

PROJECT NAME Cooper Drum
SITE LOCATION Rayo Ave
DRILLING COMPANY Gregg Drilling + Testing
DRILL RIG M-12
DRILL CREW
DATE DRILLED 07/11/05
DRILLING METHOD H-S-A
BORING DIAMETER (IN)
TOTAL DEPTH OF BORING (FT)
LOGGED BY RM
SAMPLING METHOD cuttings
HAMMER WEIGHT (LBS)
HAMMER DROP (IN)
START TIME
STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS:
65								Same as above
70								
75								SAND with silt; saturated; fine grain loose; uniform
80								SAND with silt; saturated: fine to med grain; loose; uniform grain
85								Sand: fine to med grain; saturated; loose
90								Sand: same as above

SKETCH OF BORING LOCATION

Sand 90 - 85'
Bentonite 85 → 84.5
Sand 84.5 - 81
Bentonite 81 - 71.80
#3SAND 71.80 → 66.5'

MOx 3A 3B BORING NUMBER

Page 3 of 3

URS

PROJECT NAME Cooper Drum		SITE LOCATION	
DRILLING COMPANY	DRILL RIG	DRILL CREW	DATE DRILLED 07/11/05
DRILLING METHOD H-S-A	BORING DIAMETER (IN) 10	TOTAL DEPTH OF BORING (FT) 90	LOGGED BY R. Morles
SAMPLING METHOD Cuttings	HAMMER WEIGHT (LBS)	HAMMER DROP (IN) START TIME	STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS:
35			1315				2.5Y4/2	Dark grayish brown clay; plastic; med stiff; damp.
40							"	SAND with silt; fine grain; uniform; wet;
45								Sandy silt; saturated; v. fin
50								Same as above; Saturated; increase in silt concentration; slight increase in sand size to fine grain.
55								Same as above
60								Silty clay: saturated; soft; plastic trace sand (fine)

SKETCH OF BORING LOCATION

MOx 3A,3B

BORING NUMBER

Page 2 of 3

URS

PROJECT NAME Cooper Drum
SITE LOCATION 9313 Rayo Ave, SouthGate

DRILLING COMPANY Gregg Drilling + Testing
DRILL RIG M-12
DRILL CREW Juan, Tim, Luis
DATE DRILLED 07/12/05

DRILLING METHOD H-S-A
BORING DIAMETER (IN) 10
TOTAL DEPTH OF BORING (FT) 90
LOGGED BY R. Morley

SAMPLING METHOD cuttings
HAMMER WEIGHT (LBS)
HAMMER DROP (IN)
START TIME
STOP TIME

DESCRIPTION OF SUBSURFACE MATERIALS

SURFACE CONDITIONS: 3" Asphalt

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS
5								SAND: fine grain; moist; uniform.
10			0845				10YR 3/2	very Dark grayish brown Silty SAND; v. fine grain; moist; uniform.
15			0850				2.5Y 5/2	Grayish brown Silty SAND; increase in silt content; v. fine sand; uniform; moist;
20			0853				2.5Y 4/2	Dark grayish brown Sandy SILT; soft; moist; v. fine SAND;
25							2.5Y 3/2	Very Dark grayish brown Clayey SILT; Soft; slightly plastic; damp.
30			0908				2.5Y 4/2	Dark grayish brown Silty ClAY; Soft Damp; very plastic;

SKETCH OF BORING LOCATION

MOx 1A, 1B **BORING NUMBER**

Page 1 of 3

URS

PROJECT NAME Cooper Drum	SITE LOCATION 9313 Rayo Ave		
DRILLING COMPANY Gregg Drilling	DRILL RIG H-12	DRILL CREW Juan	DATE DRILLED 07/12/05
DRILLING METHOD H-S-A	BORING DIAMETER (IN)	TOTAL DEPTH OF BORING (FT)	LOGGED BY R.M
SAMPLING METHOD Cuttings	HAMMER WEIGHT (LBS) -	HAMMER DROP (IN) - START TIME	STOP TIME

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS SURFACE CONDITIONS: 3" Asphalt.
35			0815				2.5Y 4/2	CLAY; med stiff; v. plastic; moist; Dark grayish brown
40			0845				GLEY1 4/10Y	Dark greenish gray ~~Same as above~~: silty SAND; Saturated; fine grain; uniform.
45							"	Sandy silt; fine grain; saturated; uniform grain:
50							Gley1 3/10Y	very dark greenish gray; Sandy Clay; fine grain; Saturated; ~~moist~~; soft; V. plastic
55							"	Same as Above:
60							"	Sandy Clayes Silt; slightly plastic; Saturated; very soft; fine grain sands

SKETCH OF BORING LOCATION

MOx 1A, 1B BORING NUMBER

Page 2 of 3

URS

PROJECT NAME ~~LAUSD~~ Cooper Drum. ~~High School #2~~
SITE LOCATION ~~School #8~~ 9313 Rayo Ave. South Gate

DRILLING COMPANY Gregg Drilling +Testing
DRILL RIG M-12
DRILL CREW Juan, Tim, Luis
DATE DRILLED 07/12/05

DRILLING METHOD H-S-A
BORING DIAMETER (IN) 10
TOTAL DEPTH OF BORING (FT) 90
LOGGED BY R. Horley

SAMPLING METHOD Cuttings
HAMMER WEIGHT (LBS) -
HAMMER DROP (IN) -
START TIME
STOP TIME

SURFACE CONDITIONS: 3" Asphalt

DEPTH (FT)	SAMPLE LOCATION	SAMPLE ID	TIME OF SAMPLE	BLOWS PER 6 IN	PID (PPM)	USCS SOIL GROUP	MUNSELL COLOR	DESCRIPTION OF SUBSURFACE MATERIALS
65							''	SAME AS ABOVE.
70							Gley 1 4/1	Sandy SIILT : Dark greenish gray Sandysilt to Silty Sand; fine grain; uniform Sands
75								Same as above.
80							''	silty SAND; Saturated; (slury-like) loose; fine grain sands with medgrain.
85								Same as aboue
90								Same as above

SKETCH OF BORING LOCATION

90'

90' 86.5 - Sand #3
86.6 - 85 - Bentonite Pellets
85 - 80.5 - SAND #3
80.5 - 72 - Bentonite Pellets
72 - 66.5 - #3 Sand
66.5 - 65 - Bentonite Pellets
65 - 60.5 - SAND
60.5 - 58.5 Bentonite Pellets
58.5 - ~~Surface~~ 2' Bentonite Chips

BORING NUMBER MO, 1A, 1B

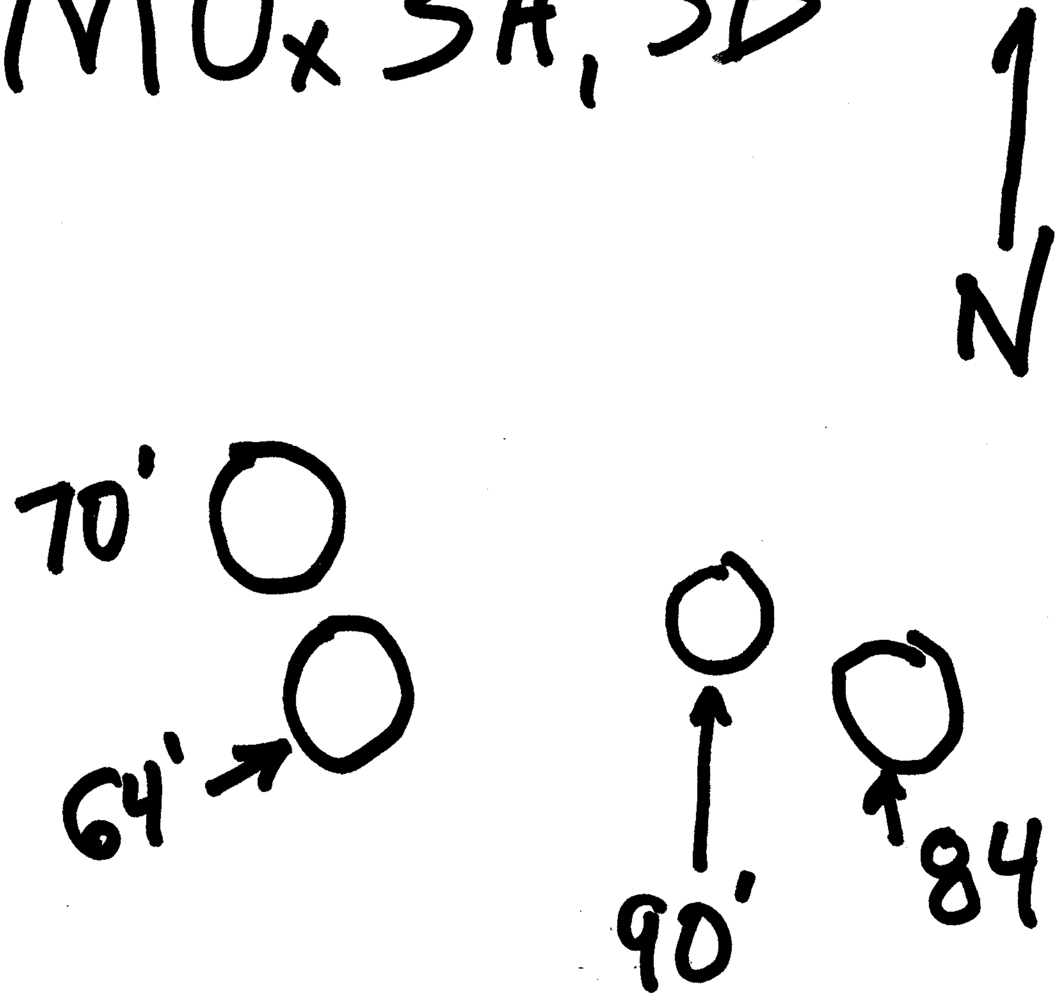
Page 3 of 3

URS

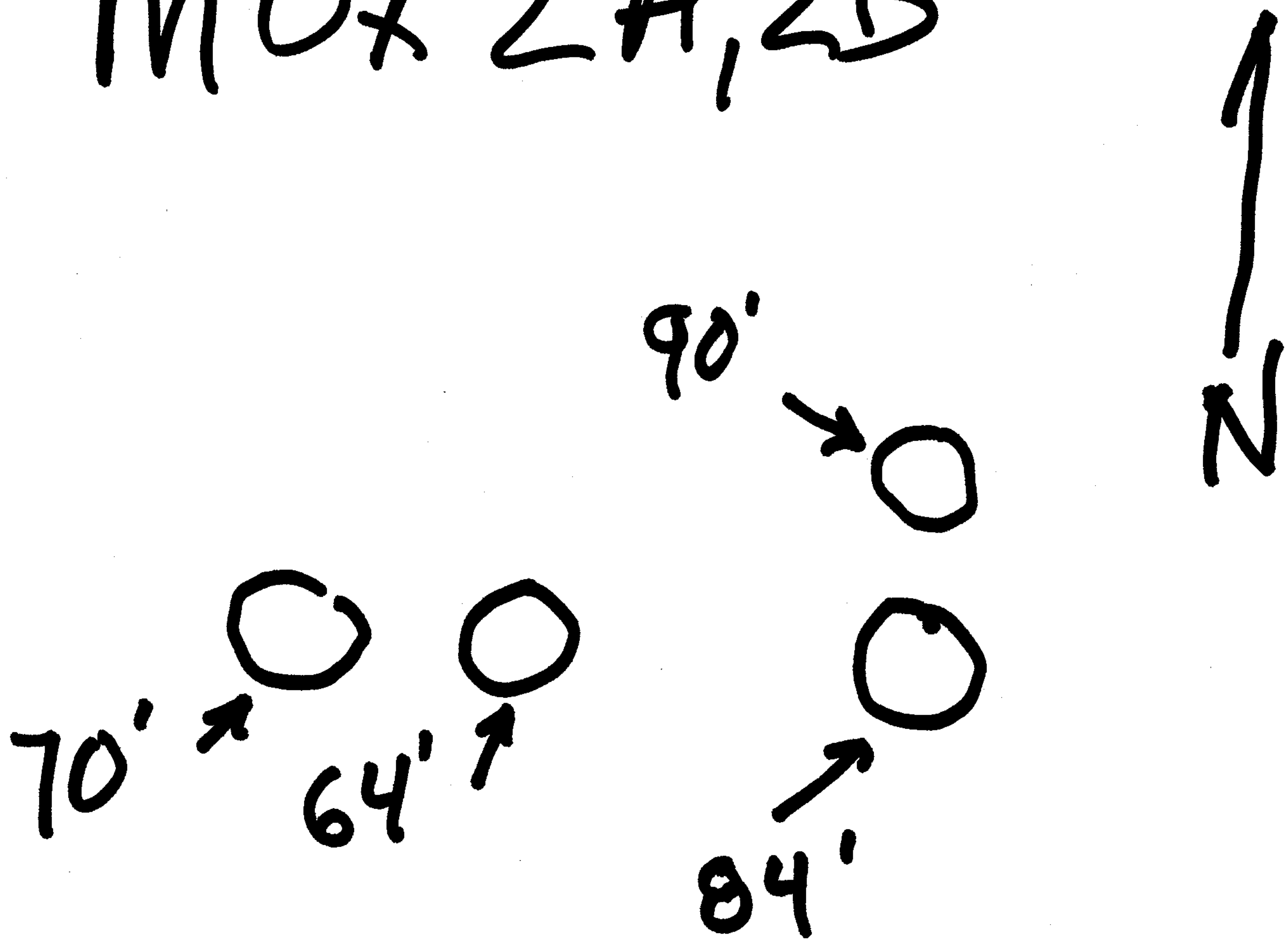
Cooper Drum MaxOx well as built description

1-inch stainless steel, 0.020-inch V-slot screen 87 ft. to 90 ft , ½-inch O.D. stainless steel tubing 0 to 87 ft.
#3 filter sand 86.5 ft to 90 ft
bentonite pellets 85 ft to 86.5 ft
1-inch stainless steel, 0.020-inch V-slot screen 83 to 84 ft., ½-inch O.D. stainless steel tubing 0 to 83 ft. with metal brackets every 10 feet to surface
#3 filter sand 81 ft to 85 ft.
bentonite pellets 72 ft to 81 ft
1-inch stainless steel, 0.020-inch V-slot screen 67 ft. to 70 ft , ½-inch O.D. stainless steel tubing 0 to 67 ft.
#3 filter sand 66.5 ft to 72 ft
bentonite pellets 65 ft to 66.5 ft
1-inch stainless steel, 0.020-inch V-slot screen 63 to 64 ft., ½-inch O.D. stainless steel tubing 0 to 63 ft. with metal brackets every 10 feet to surface
#3 filter sand 61 ft to 65 ft.
bentonite pellets 58 ft to 61 ft.
bentonite seal 2 ft to 58 ft.

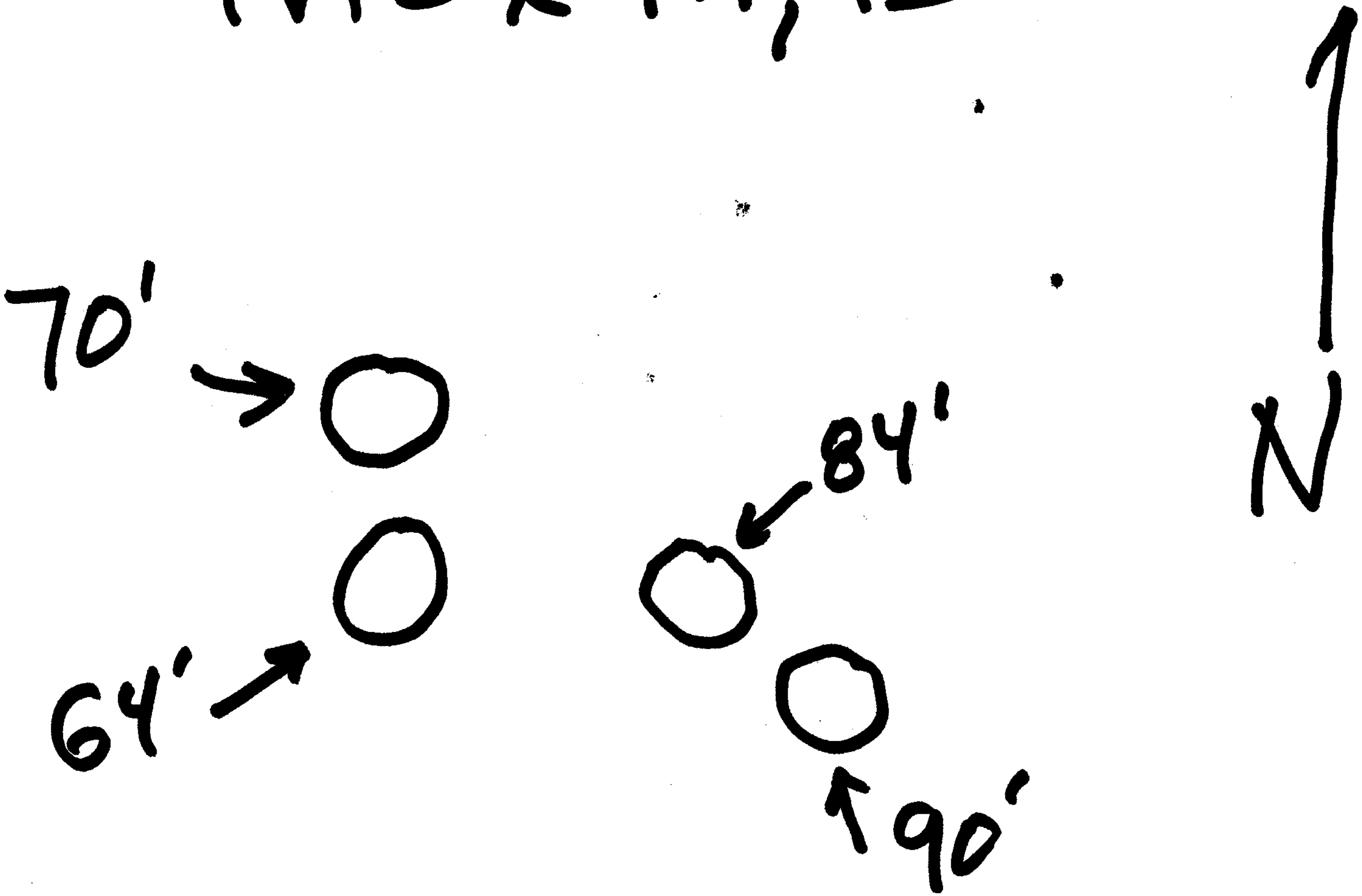
MOx 3A, 3B



MOx 2A,2B



MOx 1A, 1B



APPENDIX D

Field Data Sheets

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18600047.07030**

Sample No(s): **37500**

Sampler(s): **SL/DG**

Sampling Date: 07/12/05

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.60 ft
(from casing top as marked)

3) Well Depth (WD): 75
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14\ [(D/2)/12\ \text{in.ft}]^2 h\ (7.48\ \text{gal/cu. Ft.})$

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: 07/12/05

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 1.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0848	23.13	9781	7.16	25	117.6	0.47	48.81	.02400	.800	
0851	24.12	9871	7.16	45	104.8	0.47	48.74	.048	.800	
0854	24.05	9922	7.15	62	102.0	0.46	48.76	.066	.600	
0857	24.10	9970	7.14	67	97.1	0.36	48.78	.084	.600	
0900	24.96	10018	7.14	70	88.1	0.27	48.78	.102	.600	
0903	24.67	10155	7.14	84	80.6	0.22	48.78	.120	.600	
0906	24.44	10255	7.14	105	68.0	0.17	48.77	.138	.600	
0909	24.41	10306	7.14	124	61.9	0.16	48.77	.156	.600	
0912	24.33	10368	7.15	127	48.1	0.15	48.77	.174	.600	
0915	24.17	10425	7.15	138	38.6	0.12	48.77	.192	.600	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Set pump @ 63 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Sample No(s): **37501**

Sampling Date: 07/12/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ______

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s): ______ Date: ______

Weather: ______

Ambient Temp. (F): ______

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 80-90 ~~55-70~~

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.44 f
(from casing top as marked)

3) Well Depth (WD): ~~75~~ 98ft
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Date: 07/12/05

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 3.1

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1003	22.57	15937	7.18	>1000	-14.8	0.22	48.66	.0150	0.400	
1006	22.25	15948	7.18	>1000	-27.7	0.25	48.63	.042	0.400	
1009	22.95	16008	7.17	>1000	-39.2	0.28	48.64	.069	0.400	
1012	23.00	16053	7.17	>1000	-48.2	0.24	48.60	.096	0.400	
1015	23.03	16091	7.17	>1000	-53.3	0.18	48.58	.123	0.400	
1018	23.05	16107	7.16	954	-59.5	0.14	48.57	.150	0.400	
1021	23.10	16107	7.16	721	-62.0	0.12	48.57	.177	0.400	
1024	23.05	16110	7.12	357	-69.1	0.12	48.57	.204	0.400	
1027	23.07	16112	7.12	310	-74.1	0.11	48.57	.231	0.400	
1030	23.09	16104	7.14	214	-72.1	0.11	48.57	.258	0.400	
1033	23.12	16112	7.13	176	-77.7	0.11	48.57	.275	0.400	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Set pump @ 85 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37502**

Sampler(s): **SL/DG**

Sampling Date: 07/12/05

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval:

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.84 ft
(from casing top as marked)

3) Well Depth (WD): 65 ft.
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: 07/12/05

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.6

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1112	22.90	7476	7.21	>1000	0.1	0.32	49.37	.024	.808	
1115	23.54	7353	7.18	>1000	-17.2	0.40	49.40	.048	.808	
1118	23.98	7317	7.17	815	-28.0	0.35	49.40	.072	.800	
1121	24.09	7280	7.17	581	-31.7	0.29	49.43	.096	.800	
1124	24.09	7240	7.16	428	-34.0	0.25	49.40	.120	.800	
1127	24.06	7203	7.16	357	-33.4	0.22	49.48	.144	.800	
1130	24.16	7172	7.15	166	-32.9	0.19	49.48	.168	.800	
1133	24.19	7153	7.15	163	-31.7	0.17	49.41	.192	.800	
1136	24.15	7102	7.14	150	-30.8	0.16	49.40	.216	.800	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Set pump @ 63 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18600047.07030**

Sample No(s): **37503**

Sampler(s): **SL/DG**

Sampling Date: 07/12/05

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval:

1) Well Casing Elevation (WCE) 80-90 ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.65 ft
(from casing top as marked)

3) Well Depth (WD): ______
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: 07/12/05

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 2.8

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1213	24.43	15857	7.26	980	-47.9	2.31	48.70	.024	0.808	
1216	23.81	15656	7.19	759	-58.0	1.80	48.71	.048	0.808	
1219	24.07	15697	7.15	505	-63.2	1.60	48.70	.072	0.808	
1222	24.32	15807	7.13	400	-66.4	1.51	48.70	.096	0.808	
1225	24.30	15878	7.12	312	-66.4	1.32	48.70	.120	0.808	
1228	24.29	15919	7.11	272	-658	1.12	48.70	.144	0.808	
1231	24.20	15930	7.10	238	-65.9	0.98	48.70	.168	0.8	
1234	24.31	15944	7.10	199	-65.9	0.87	48.70	.192	0.8	
1237	24.35	16008	7.10	156	-67.7	0.71	48.70	.216	0.8	
1240	24.16	16015	7.10	134	-68.1	0.63	48.70	.240	0.8	
1243	24.25	16020	7.10	95	-69.0	0.55	48.70	264	0.8	
1246	24.22	16008	7.10	84	-70.4	0.47	48.70	.288	0.8	
1249	24.29	16005	7.10	78	-71.4	0.45	48.70	.312	0.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-63

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s):

Sampling Date: 07/12/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No:

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder **Y** N

Other:

Screened interval:

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 49.00 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 07/12/05

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.6

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1426	25.75	14988	7.26	28	-61.5	0.29	49.11	0.024	0.8	
1429	23.98	11952	7.33	19	-68.3	0.27	49.11	0.048	0.8	
1432	24.65	8228	7.57	16	-79.5	0.25	49.11	0.072	0.8	
1435	24.62	8188	7.37	6	-81.8	0.23	49.11	0.096	0.8	
1438	24.65	8182	7.35	5	-84.5	0.20	49.11	0.120	0.8	
1441	24.82	8197	7.34	5	-86.0	0.14	49.11	0.144	0.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 60 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page 1 of 1

MONITOR WELL NO: **EW-1**-90

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **37503/37504**

Sampling Date: 07/12/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 49.10 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [$(D/24)^2$]

CV = 3.14 [$((D/2)/12 \text{ in.ft})^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____ gals

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Purge Date: 07/12/05

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 4.2

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1331	22.56	16239	7.18	523	-74.8	0.61	49.10	0.024	0.8	
1334	22.19	16265	7.15	256	-79.9	0.58	49.10	0.048	0.8	
1337	22.40	16162	7.13	136	-83.8	0.59	49.10	0.072	0.8	
1340	22.66	16085	7.12	80	-86.8	0.58	49.10	0.096	0.8	
1243	22.89	15923	7.23	60	-74.2	0.49	49.10	0.120	0.8	
1246	22.91	15777	7.24	47	-75.6	0.35	49.10	0.144	0.8	
1249	22.91	15599	7.23	43	-78.4	0.33	49.10	0.168	0.8	
1252	22.93	15430	7.23	39	-79.5	0.31	49.10	0.192	0.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 85 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **37508**

Sampling Date: 7/28/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date: 7/28/05

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **55 - 70**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.62 ft
(from casing top as marked)

3) Well Depth (WD): ~~[illegible]~~ 70
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
[✓ 4]	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Date:

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0732	22.46	5798	7.30	>1000	153.0	2.38	48.57	2400	.800	
0735	22.61	5809	7.26	>1000	134.3	0.95	48.65	4.8		
0738	22.65	5821	7.23	>1000	118.2	0.98	48.73	7.2		
0741	22.69	5820	7.23	>1000	94.9	1.19	48.70	9.6		
0744	22.79	5820	7.24	716	74.8	1.09	48.71	12.0		
0747	23.11	5865	7.24	680	52.9	1.01	48.72	14.4		
0750	23.19	5871	7.25	550	39.3	0.91	48.73	16.8		
0753	23.24	5873	7.26	443	25.3	0.89	48.75	19.2		
0756	23.24	5872	7.27	404	16.1	0.82	48.72	21.6		
0759	23.34	5871	7.28	332	4.6	0.75	48.73	24.0		
0802	23.31	5869	7.28	319	-0.3	0.71	48.74	26.4		
0805	23.33	5867	7.28	290	-7.2	0.67	48.75	28.8		
0808	23.38	5868	7.29	281	-13.5	0.64	48.74	31.2		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 63'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data (cont.)

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0811	23.40	5868	7.29	280	-18.9	0.59	48.72	33.6	.8	
0814	23.43	5870	7.30	242	-24.4	0.58	48.73	36.0		
0817	23.42	5863	7.30	178	-28.7	0.56	48.72	38.4		
0820	23.44	5867	7.30	192	-32.4	0.54	48.73	40.8		

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum
Location No:
Sample No(s): 37509
Sampling Date: 7/28/05
Sampling Method: Direct from dedicated tubing
Sampling Time: ~~7/28/05~~ 0950

Job No: 18600047.07030
Sampler(s): SL/DG
Reviewer(s):
Date: 7/28/05
Weather:
Ambient Temp. (F):

WATER ELEVATION DATA
Method of Measurement: Depth Sounder Y N
Other:
Screened interval: ~~55-70~~ 80-90
1) Well Casing Elevation (WCE) ft
(from casing top as marked)
2) Depth to Water Surface (DTW 48.31 f
(from casing top as marked)
3) Well Depth (WD): ~~75~~ 90
(from casing top as marked)
4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N
Depth to Product:
Method of Measurement: Interface Probe Y N
Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
[✓ 2]	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)
Number of Casing Volumes to Purge (NC) gals
Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump
Purge Date: 7/28/05
Was Well Pumped Dry? Y [✓ N]
Fe^2 (mg/L): 3.6

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0917	22.06	8719	7.16	>1000	-68.4	0.40	48.40	1	1.0	
0920	22.38	8797	7.12	>1000	-85.3	0.55	48.41	2		
0923	22.46	8821	7.12	>1000	-93.0	0.63	48.42	3		
0926	2253	8851	7.13	>1000	-100.7	0.46	48.43	4		
0929	2258	8859	7.14	>1000	-104.7	0.42	48.44	5		
0932	22.64	8884	7.15	>1000	-107.2	0.39	48.45	6		
0935	22.73	8915	7.15	537	-110.5	0.38	48.46	7		
0938	22.66	8908	7.16	149	-113.7	0.34	48.45	8		
0941	22.64	8904	7.16	124	-115.3	0.36	48.46	9		
0944	22.67	8914	7.16	104	-117.3	0.32	48.45	10		

INSTRUCTIONS AND COMMENTS
Purging/Sampling Remarks Pump set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **37510**

Sampling Date: 7/28/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time: 1100

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date: 7/28/05

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval:

1) Well Casing Elevation (WCE) 55-65 ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.70 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
[✓ 2]	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 7/28/05

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.8

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1832	22.70	4088	7.21	>1000	-61.5	1.30	49.08	1	1.0	
1035	22.77	39.43	7.19	293	-75.6	0.58	48.95	2		
1038	22.96	3953	7.19	324	-82.5	0.89	48.99	3		
1041	22.94	3950	7.19	201	-87.1	0.73	49.04	4		
1044	22.99	3956	7.18	398	-88.5	0.69	49.02	5		
1047	22.97	3954	7.16	142	-87.4	0.66	49.00	6		
1050	22.96	3953	7.16	94	-87.0	0.70	49.02	7		
1053	22.99	3955	7.16	141	-86.9	0.88	49.05	8		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks PUMP set @ 60'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **37511**

Sampling Date: 7/28/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time: 1155

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date: 7/28/05

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 80-90

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.45 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
[✓ 2]	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12 \text{ in.ft}]^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 7/28/05

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 2.5

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1137	22.01	8534	7.23	362	-96.0	0.42	48.55	1	1.0	
1140	22.36	8711	7.20	283	-107.1	0.46	48.56	2		
1143	22.49	8764	7.16	210	-111.7	0.48	48.56	3		
1146	22.49	8775	7.16	213	-116.4	0.41	48.58	4		
1149	22.61	8813	7.15	206	-119.0	0.36	48.59	5		
1152	22.64	8829	7.15	365	-121.4	0.33	48.58	6		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1[redacted]

Monitor Well Sampling Data

Project: Cooper Drum

Location No:

Sample No(s): 37513

Sampling Date: 7/28/05

Sampling Method: Direct from dedicated tubing

Sampling Time: 1400

Job No: 18600047.07030

Sampler(s): SL/DG

Reviewer(s):

Date: 7/28/05

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 48.5 - 88.5

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.89 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
[✓ 6]	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date: 7/28/05

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 2.1

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1319	23.39	4573	7.30	8	-103.8	0.40	48.94	1	1.0	
1322	23.98	4605	7.29	7	-111.6	0.37	48.95	2		
1325	24.36	4637	7.28	7	-115.5	0.34	48.94	3		
1328	24.44	4639	7.28	7	-118.0	0.32	48.95	4		
1331	24.55	4645	7.28	6	-120.0	0.27	48.96	5		
1334	24.62	4649	7.28	6	-121.6	0.25	48.95	6		
1337	24.76	4661	7.28	6	-122.7	0.25	48.96	7		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks PUMP set @ 63'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90

Monitor Well Sampling Data

Project: Cooper Drum

Location No:

Job No: 18600047.07030

Sample No(s): 37512

Sampler(s): SL/DG

Sampling Date: 7/28/05

Reviewer(s):

Date: 7/28/05

Sampling Method: Direct from dedicated tubing

Weather:

Sampling Time: 1320

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 48.5 - 88.5

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.89 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
[✓ 6]	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date: 7/28/05

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y [✓ N]

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1239	22.25	8821	7.21	40	-101.0	0.75	48.85	1	1.0	
1242	22.14	8627	7.20	14	-112.8	0.39	48.90	2		
1245	22.40	8592	7.19	23	-117.5	0.46	48.89	3		
1248	22.55	8561	7.19	35	-121.0	0.45	48.90	4		
1251	22.50	8456	7.19	15	-124.6	0.39	48.91	5		
1254	22.55	8380	7.19	14	-127.0	0.33	48.91	6		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________

Job No: **18600047.07030**

Sample No(s): **37516**

Sampler(s): **SL/DG**

Sampling Date: 8/16/05

Reviewer(s): ____________ Date: ____________

Sampling Method: **Direct from dedicated tubing**

Weather: ____________

Sampling Time: 0815

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____________

Screened interval: **55 - 70**

1) Well Casing Elevation (WCE) ____________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.10 ft
(from casing top as marked)

3) Well Depth (WD): 70
(from casing top as marked)

4) Height of Water Column (H) ____________ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____________ gals

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: ____________

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

ORP	Depth	Downhole DO
213.7	50	19.75
207.5	55	21.44
203.5	63	13.00

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed m(L)	Flow Rate (L/min)	Observations Phys. App.
0743	Start	Pump		@	63'		48.10	—	.8	
0746	21.76	5053	8.18	427	46.9	10.89	48.08	2400		
0749	22.51	5145	8.15	330	40.7	9.72	48.09	4800		
0752	22.91	5212	8.12	296	36.4	9.14	48.09	7200		
0755	22.99	5230	8.09	277	35.6	8.84	48.07	9600		
0758	23.02	5295	8.03	194	35.0	7.99	48.00	12,000		
0801	22.99	5296	8.01	170	34.5	8.08	47.95	14,400		
0804	22.95	5260	8.02	94	34.5	8.19	47.94	16,800		
0807	23.00	5148	8.13	39	35.8	8.13	48.00	19,200		
0810	23.05	5176	8.02	20	35.1	8.90	47.99	21,600		
0813	22.94	5211	7.95	25	33.9	8.15	47.92	24,000		oz 1 Valve on
0816	22.96	5269	7.93	43	34.0	7.59	47.93	26,400		

O_3 = 0.0 mg/L

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump set @ 63'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20B**

Monitor Well Sampling Data

Project: **Cooper Drum**
Location No:
Sample No(s): **37517**
Sampling Date: 8/16/05
Sampling Method: **Direct from dedicated tubing**
Sampling Time: 0940

Job No: **18600047.07030**
Sampler(s): **SL/DG**
Reviewer(s): Date:
Weather:
Ambient Temp. (F):

WATER ELEVATION DATA
Method of Measurement: Depth Sounder Y N
Other:
Screened interval: 80- 90
1) Well Casing Elevation (WCE) ft
(from casing top as marked)
2) Depth to Water Surface (DTW 48.15 f
(from casing top as marked)
3) Well Depth (WD): 90
(from casing top as marked)
4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N
Depth to Product:
Method of Measurement: Interface Probe Y N
Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)
Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 3.4

Downhole:

Depth	T °c
85	20.24

D.O.	ORP
2.36	-29.1 mV

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed m(L)	Flow Rate (L/min)	Observations Phys. App.
0858	PUMP Started								.8	
0901	21.32	8414	8.19	>1000	-90.1	0.25	48.15	2400		
0904	21.69	8480	8.05	>1000	-93.5	0.20	48.15	4800		
0907	22.15	8596	7.95	>1000	-93.0	0.17	48.16	7200		
0910	22.54	8666	7.89	870	-95.4	0.13	48.29	9600		
0913	23.01	8769	7.82	427	-95.5	0.10	48.27	12,000		
0916	22.92	8769	7.79	460	-92.9	0.10	48.25	14,400		
0919	22.82	8768	7.77	426	-91.8	0.10	48.30	16,800		
0922	22.90	8771	7.75	198	-91.0	0.09	48.32	19,200		
0925	22.92	8793	7.72	239	-88.8	0.09	48.35	21,600		
0928	22.97	8801	7.70	208	-89.3	0.08	48.34	24,000		

INSTRUCTIONS AND COMMENTS
Purging/Sampling Remarks PUMP Set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37518**

Sampler(s): **SL/DG**

Sampling Date: 8/16/05

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time: 1050

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.38 ft
(from casing top as marked)

3) Well Depth (WD): 65
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 0.4

Pre-purge
Downhole:
DTW: 60.00
D.O.: 15.34
ORP: 84.9
T(°C): 21.04

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed mL(L)	Flow Rate (L/min)	Observations Phys. App.
1017	Start Pump								.8	
1020	22.73	3894	7.83	>1000	10.7	5.17	48.15	2400		
1023	23.89	3992	7.68	>1000	14.2	4.28	48.50	4800		
1026	22.82	3910	7.62	>1000	16.4	3.56	48.33	7200		
1029	23.08	3938	7.56	702	18.7	1.79	48.25	9600		
1032	23.10	3949	7.55	914	19.0	1.45	48.20	12.000		
1035	26.14	4193	7.56	>1000	16.5	2.18	48.20	14,400		
1038	25.35	4126	7.58	>1000	16.1	2.12	48.22	16,800		
1041	22.57	3926	7.60	>1000	154	3.20	48.40	19,200		
1044	22.54	3912	7.58	916	17.4	2.87	48.42	21,600		
1047	22.70	3922	7.52	756	17.9	2.42	48.39	24,000		
1050	22.70	3971	7.58	750	16.9	2.59	48.38	26,400		

O_3 = 0.0 mg/L

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks PUMP set @ 60'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

~~POST PURGE~~
~~T(C) = 20.32~~
~~ORP = 30.0~~
~~D.O. = [illegible]~~

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: Cooper Drum
Location No:
Sample No(s): 37519
Sampling Date: 8/16/05
Sampling Method: Direct from dedicated tubing
Sampling Time: 1145

Job No: 18600047.07030
Sampler(s): SL/DG
Reviewer(s): Date:
Weather:
Ambient Temp. (F):

WATER ELEVATION DATA
Method of Measurement: Depth Sounder Y N
Other:
Screened interval: 80 - 90
1) Well Casing Elevation (WCE) ft
(from casing top as marked)
2) Depth to Water Surface (DTW ft
(from casing top as marked)
3) Well Depth (WD): 90
(from casing top as marked)
4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N
Depth to Product:
Method of Measurement: Interface Probe Y N
Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)
Number of Casing Volumes to Purge (NC) gals
Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump
Purge Date:
Was Well Pumped Dry? Y N
Fe^2 (mg/L): 4.0

Downhole:
Depth: 85.00
T(°C): 20.32
ORP: 5.0 mV
D.O.: 1.80 mg/L

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed m(L)	Flow Rate (L/min)	Observations Phys. App.
1128	Start PUMP								.8	
1131	21.56	8281	8.08	442	-38.8	0.22	48.50	2400		
1134	21.74	8387	7.95	384	-40.4	0.17	48.51	4800		
1137	22.23	8505	7.87	248	-46.5	0.20	48.50	7200		
1140	22.46	8601	7.85	226	-51.5	0.16	48.51	9600		
1143	22.56	8646	7.81	194	-54.7	0.12	48.49	12,000		
1146	22.62	8663	7.78	197	-58.6	0.11	48.47	14,400		
1149	22.63	8667	7.75	188	-58.4	0.10	48.48	16,800		

INSTRUCTIONS AND COMMENTS
Purging/Sampling Remarks PUMP set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

POST-PURGE
T (°C): 20.32
ORP: -30.1 mV
D.O.: 1.01 mg/L
Depth: 85'

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37520**

Sampler(s): **SL/DG**

Sampling Date: 8/16/05

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time: 1350

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.83 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Pre-purge
Downhole:
T(°c) : 20.79
ORP: 26.1 mV
D.O.: 4.03 mg/L
Depth: 63'

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed m(L)	Flow Rate (L/min)	Observations Phys. App.
1314	Start Pump								.8	
1317	22.80	4275	7.96	20	8.9	1.87	48.83	2400		
1320	23.71	4342	7.81	12	13.2	1.79	48.83	4800		
1323	23.95	4371	7.79	10	12.6	1.92	48.82	7200		
1326	23.99	4380	774	11	14.8	1.77	48.83	9600		
1329	24.17	4391	7.72	10	14.9	1.76	48.83	12,000		
1332	24.04	4832	7.70	10	15.6	1.69	48.83	14,400		

O_3 = 0.0 mg/L

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks PUMP set @ 63'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

POST-PURGE
T(°c) : 21.15
ORP : 78.5 mV
D.O. : 4.40
Depth : 63'

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **37521**

Sampling Date: 8/16/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time: 1240

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.81 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14 [(D/2)/12 \text{ in.ft}]^2 h$ (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L):

Pre-purge
Downhole:
T(C): 20.15
ORP: -13.0 mV
D.O.: 0.82 mg/L
Depth: 85'

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed m(L)	Flow Rate (L/min)	Observations Phys. App.
1234	Start Pump								.8	
1237	21.93	8423	8.11	23	-40.4	0.31	48.80	2400		
1240	22.44	8490	7.87	13	-42.8	0.28	48.80	4800		
1243	22.69	8567	7.85	15	-47.9	0.24	48.79	7200		
1246	22.63	8608	7.85	14	-51.5	0.25	48.80	9600		
1249	22.72	8562	7.84	11	-53.2	0.22	48.80	12,000		
1252	22.90	8490	7.83	9	-55.4	0.16	48.81	14,400		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump Set @ 85'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18600047.07030**

Sample No(s): **37526**

Sampler(s): **SL/DG**

Sampling Date: **9/7/05**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.03 ft
(from casing top as marked)

3) Well Depth (WD): 70
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0710	21.86	5000	7.14	275	128.1	14.81	47.88	2.4	.8	47.78
0713	22.54	5074	7.19	181	115.8	14.52	47.68	4.8	.8	
0716	22.74	5086	7.35	92	104.8	15.18	47.75	7.2	.8	
0719	22.81	5084	7.35	80	98.8	12.40	47.87	9.6	.8	
0722	22.88	5096	7.32	64	93.3	10.97	47.90	12.0	.8	
0725	22.86	5167	7.31	53	89.4	11.89	47.85	14.4	.8	
0728	22.84	5126	7.12	74	87.1	11.78	47.83	16.8	.8	
0731	22.88	5167	7.27	123	84.1	11.37	47.85	19.2	.8	
0734	22.86	5790	7.15	111	81.8	11.11	47.85	21.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______ Job No: **18600047.07030**

Sample No(s): **37527** Sampler(s): **SL/DG**

Sampling Date: **9/7/05** Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing** Weather: ______

Sampling Time: ______ Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.09 f
(from casing top as marked)

3) Well Depth (WD): 90
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 3.6

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0808	21.77	8260	6.66	>1000	-47.7	0.77	48.40	2.4	.8	
0811	21.99	8421	6.84	>1000	-50.1	0.65	48.38	4.8	.8	
0814	22.21	8472	6.94	>1000	-52.6	0.75	48.38	7.2	.8	
0817	22.25	8493	7.05	784	-55.4	0.43	48.38	9.6	.8	
0820	22.57	8554	7.15	539	-57.8	0.33	48.39	12.0	.8	
0823	22.61	8564	6.95	399	-58.4	0.31	48.39	14.4	.8	
0826	22.61	8576	7.15	340	-60.1	0.29	48.39	16.8	.8	
0829	22.71	8591	7.18	255	-61.7	0.28	48.37	19.2	.8	
0832	22.62	8586	7.29	174	-62.4	0.25	48.37	21.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18600047.07030**

Sample No(s): **37528**

Sampler(s): **SL/DG**

Sampling Date: **9/7/05**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.55 ft
(from casing top as marked)

3) Well Depth (WD): ______
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0918	24.30	3957	7.75	>1000	19.2	3.25	48.00	2.4	0.8	
0921	24.58	3984	7.70	>1000	19.0	3.08	48.02	4.8	0.8	
0924	24.69	4004	7.70	741	17.8	2.90	48.18	7.8	1.0	
0927	24.52	3979	7.70	506	16.4	2.21	48.22	10.8	1.0	
0930	24.17	3951	7.74	572	13.2	2.29	48.24	13.8	1.0	
0933	22.58	3786	7.91	192	11.3	0.74	48.24	16.8	1.0	
0936	22.77	3824	7.92	152	7.1	0.85	48.25	19.8	1.0	
0939	22.96	3851	7.92	220	6.0	1.41	48.25	22.8	1.0	
0942	23.03	3862	7.92	164	5.5	1.53	48.26	25.8	1.0	
0945	23.01	3863	7.92	112	4.7	1.23	48.26	28.	1.0	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ___ of ___

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________

Job No: **18600047.07030**

Sample No(s): **37529**

Sampler(s): **SL/DG**

Sampling Date: **9/7/05**

Reviewer(s): ____________ Date: ____________

Sampling Method: **Direct from dedicated tubing**

Weather: ____________

Sampling Time: ____________

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder **Y** N

Other: ____________

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ____________ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.62 ft
(from casing top as marked)

3) Well Depth (WD): ____________
(from casing top as marked)

4) Height of Water Column (H) ____________ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Purge Date: ____________

Number of Casing Volumes to Purge (NC) ____________ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1019	21.92	8271	8.36	191	-79.4	1.30	48.52	3	1.0	
1022	22.24	8405	8.32	166	-78.0	0.86	48.54	6	1.0	
1025	22.51	8512	8.30	158	-77.1	0.48	48.54	9	1.0	
1028	22.63	8557	8.31	165	-77.5	0.44	48.54	12	1.0	
1031	22.63	8577	8.32	160	-78.1	0.40	48.54	15	1.0	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________________

Job No: **18600047.07030**

Sample No(s): **37530**

Sampler(s): **SL/DG**

Sampling Date: **9/7/05**

Reviewer(s): ____________________ Date: ____________________

Sampling Method: **Direct from dedicated tubing**

Weather: ____________________

Sampling Time: ____________________

Ambient Temp. (F): ____________________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____________________

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____________________ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.72 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ____________________ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________________

Method of Measurement: Interface Probe Y N

Other: ____________________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Purge Date: ____________________

Number of Casing Volumes to Purge (NC) ____________ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1152	23.15	6706	8.08	12	-69.3	3.45	48.73	3	1.0	
1155	24.00	4596	8.04	7	-25.9	5.36	48.73	6	1.0	
1158	24.32	4562	7.97	6	-0.3	5.54	48.80	9	1.0	
1201	24.65	4582	7.95	7	9.9	5.52	48.82	12	1.0	
1204	24.72	4587	7.96	7	13.6	5.57	48.82	15	1.0	
1207	24.61	4575	8.06	7	16.0	5.55	48.82	18	1.0	
1210	24.53	4572	8.06	7	17.2	5.48	48.82	21	1.0	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________ Job No: **18600047.07030**

Sample No(s): **37531** Sampler(s): **SL/DG**

Sampling Date: **9/7/05** Reviewer(s): ____________ Date: ____________

Sampling Method: **Direct from dedicated tubing** Weather: ____________

Sampling Time: ____________ Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____________

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.72 ft
(from casing top as marked)

3) Well Depth (WD): ____________
(from casing top as marked)

4) Height of Water Column (H) ____________ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [$(D/24)^2$]

CV = 3.14 [$((D/2)/12 \text{ in.ft})^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Purge Date: ____________

Number of Casing Volumes to Purge (NC) ____________ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Fe^2 (mg/L): 4.8

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1113	22.46	8781	8.07	217	-67.2	0.84	48.89	3	1.0	
1116	22.06	8814	8.15	179	-79.2	0.60	48.92	6	1.0	
1119	22.44	8865	7.98	189	-81.2	0.60	48.92	9	1.0	
1122	22.58	8877	8.07	193	-84.1	0.68	48.92	12	1.0	
1125	22.58	8867	8.06	190	-84.5	0.60	48.90	15	1.0	
1128	22.62	8823	8.16	162	-85.5	0.58	48.90	18	1.0	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37536**

Sampler(s): **SL/DG**

Sampling Date: **9/29/05**

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.76 ft
(from casing top as marked)

3) Well Depth (WD): 70
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14\ [(D/2)/12\ \text{in.ft}]^2 h\ (7.48\ \text{gal/cu. Ft.})$

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) ____ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0918	22.22	4675	7.5	248	180.6	18.25	47.82	1	0.8	
0921	22.54	4717	7.5	191	182.6	17.59	47.85	~~1.8~~ 3.4	0.8	
0924	22.77	4748	7.5	130	184.1	16.45	47.93	~~3.6~~ 8.6	0.8	
0927	22.77	4764	7.4	98	184.3	15.19	47.96	~~4.4~~ 10.56	0.8	
0930	22.76	4789	7.4	68	183.5	13.57	47.96	~~5.2~~ 12.96	0.8	
0933	22.80	4828	7.3	54	181.3	11.41	47.97	~~6.0~~ 15.36	0.8	
0936	22.77	4868	7.3	43	178.5	9.38	48.00	~~6.8~~ 17.76	0.8	
0939	22.76	4891	7.3	36	176.3	9.36	48.00	~~7.6~~ 20.16	0.8	
0942	22.73	4920	7.4	32	170.0	7.24	48.00	~~8.4~~ 22.56	0.6	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18600047.07030**

Sample No(s): **37537**

Sampler(s): **SL/DG**

Sampling Date: **9/29/05**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ______ ft (from casing top as marked)

2) Depth to Water Surface (DTW) 47.92 ft (from casing top as marked)

3) Well Depth (WD): 90 (from casing top as marked)

4) Height of Water Column (H) ______ ft (from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14\ [(D/2)/12\ in.ft]^2 h\ (7.48\ gal/cu.\ Ft.)$

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals (CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals (VW x NC = TC)

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1020	2255	7989	7.1	338	35.5	~~1.45~~	48.08	5	1	
1025	22.91	8051	7.1	228	27.0	~~10.9~~	48.06	7 8	1	
1029	23.08	8086	7.1	122	19.8	0.72	48.04	11	1	
1031	23.20	8109	7.1	84	15	0.60	48.03	14	1	
1034	23.24	8114	7.1	60	9.9	0.46	48.03	17	1	
1037	23.26	8129	7.1	53	6.8	0.46	48.03	20	1	
1040	23.29	8133	7.1	45	2.5	0.42	48.03	23	1	
1043	23.32	8146	7.1	33	-1.1	0.37	48.03	26	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**
Location No: ____
Sample No(s): **37538**
Sampling Date: **9/29/05**
Sampling Method: **Direct from dedicated tubing**
Sampling Time: ____

Job No: **18600047.07030**
Sampler(s): **SL/DG**
Reviewer(s): ____ Date: ____
Weather: Clear
Ambient Temp. (F): 65°F

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N
Other: ____
Screened interval: **55 - 65**
1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)
2) Depth to Water Surface (DTW 47.18 ft
(from casing top as marked)
3) Well Depth (WD): ____
(from casing top as marked)
4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N
Depth to Product: ____
Method of Measurement: Interface Probe Y N
Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)
Number of Casing Volumes to Purge (NC) ____ gals
Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**
Purge Date: ____
Was Well Pumped Dry? Y N
Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0823	2248	3462	7.0	450	146.0	2.4	48.55	6	1.5/1	High silt load
0828	22.06	3458	7.0	197	134.4	1.6	48.45	6.5	1.5	clearing
0831	22.13	3472	7.0	91	135.2	1.3	48.57	8.0	1.5	clear
0834	22.12	3476	6.9	82	133.7	1.4	48.50	9.5	1.5	
0837	22.15	3482	6.9	92	132.4	1.3	48.49	11.0	1.5	
0840	22.18	3488	6.9	67	130.7	1.2	48.50	12.5	1.5	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________

Job No: **18600047.07030**

Sample No(s): **37539**

Sampler(s): **SL/DG**

Sampling Date: **9/29/05**

Reviewer(s): ____________ Date: ____________

Sampling Method: **Direct from dedicated tubing**

Weather: ____________

Sampling Time: ____________

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: 48.21

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ____________ft
(from casing top as marked)

2) Depth to Water Surface (DTW____________ft
(from casing top as marked)

3) Well Depth (WD): ____________
(from casing top as marked)

4) Height of Water Column (H) ____________ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________gals
(CV x H = VW)

Purge Date: ____________

Number of Casing Volumes to Purge (NC) ____________gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____________gals
(VW x NC = TC)

Fe^2 (mg/L): 2.7

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0730	20.98	7720	6.9	140	135.9	7.8	48.37	3 ~~500~~ 1	1 l/min	
0733	21.36	7880	7.0	119	107.2	9.0	48.36	6 2		
0706	21.47	7905	7.0	54	101.1	7.2	48.30	9 3		
0709	21.52	7919	7.0	30	94.9	7.6	48.28	12 4		
0742	21.45	7917	7.0	30	90.6	7.5	48.32	15 5		
0745	21.52	7930	7.0	11	87.2	6.6	48.32	18 6		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____________

Sample No(s): **37540**

Sampling Date: **9/29/05**

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ____________

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s): ____________ Date: ____________

Weather: ____________

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____________

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW ____________ ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ____________ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____________ gals

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: ____________

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1210	24.84	4465	7.4	4	77.5	9.25	48.60	2	0.8	
1213	25.51	4481	7.4	4	79.5	9.4	48.61	4.8	0.8	
1216	25.71	4443	7.4	4	79.1	9.0	48.60	6.8	0.8	
1219	25.46	4469	7.4	4	78.9	9.0	48.56	9.2	0.8	
1222	25.49	4472	7.4	4	78.5	8.8	48.60	11.6	0.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37541**

Sampler(s): **SL/DG**

Sampling Date: **9/29/05**

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.63 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14\ [(D/2)/12\ \text{in.ft}]^2 h\ (7.48\ \text{gal/cu. Ft.})$

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 5.5

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1126	22.92	8591	7.0	11	60.7	7.3	48.57	4	1	
1129	22.91	8580	7.3	7	54.9	0.6	48.59	7	1	
1132	23.06	8554	7.0	6	42.9	0.5	48.51	10	1	
1135	23.17	8531	7.0	5	32.1	0.4	48.56	13	1	
1138	23.12	8496	7.0	4	26.8	0.4	48.56	16	1	
1141	23.10	8448	7.0	4	21.2	0.4	48.56	19	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37546**

Sampler(s): **SL/DG**

Sampling Date: **10/26/05**

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.07 ft
(from casing top as marked)

3) Well Depth (WD): ~~70~~ 68.82
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0733	20.6	4970	7.5	~~37.9~~ 184	37.9	~~14.0~~ 14.8	47.95	—	1	
0736	21.6	5043	7.5	140	38.8	~~14.6~~ 13.0	47.85	3	↓	
0739	22.0	5165	7.5	107	40.0	12.45	47.75	6		
0742	22.1	5175	7.5	63	40.8	12.40	47.75	9		
0745	22.3	5170	7.5	43	41.0	12.19	47.85	12		
0748	22.2	5206	7.5	36	41.4	10.20	49.90	15		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum

Location No: ______

Job No: 18600047.07030

Sample No(s): 37547

Sampler(s): SL/DG

Sampling Date: 10/26/05

Reviewer(s): ______ Date: ______

Sampling Method: Direct from dedicated tubing

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other: ______

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.15 ft
(from casing top as marked)

3) Well Depth (WD): ~~90~~ 90.30
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 3.4

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0827	21.0	9264	7.3	>1000	8.2	0.34	48.15	3	1	
0830	21.0	9272	7.3	971	6.7	0.24	48.09	6	↓	
0833	21.7	9417	7.3	543	2.8	0.16	48.09	9		
0836	21.8	9441	7.3	382	1.7	0.25	48.05	12		
0839	21.9	9466	7.3	263	0.7	0.23	48.04	15		
0842	21.9	9468	7.3	176	-1.1	0.22	48.04	18		
0845	21.9	9495	7.3	113	-2.2	0.21	48.04	21		
0848	21.9	9495	7.3	77	-3.1	0.19	48.04	24		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____

Job No: **18600047.07030**

Sample No(s): **37548**

Sampler(s): **SL/DG**

Sampling Date: **10/26/05**

Reviewer(s): ____ Date: ____

Sampling Method: **Direct from dedicated tubing**

Weather: ____

Sampling Time: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other: ____

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ____ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.60 ft
(from casing top as marked)

3) Well Depth (WD): 63.80
(from casing top as marked)

4) Height of Water Column (H) ____ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____gals
(CV x H = VW)

Purge Date: ____

Number of Casing Volumes to Purge (NC) ____gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____gals
(VW x NC = TC)

Fe^2 (mg/L): 0.3

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0924	20.9	4075	7.3	703	29.9	1.88	48.26	—	1	
0927	21.5	4106	7.2	193	31.5	1.02	48.38	3	↓	
0930	22.0	4147	7.2	152	31.9	1.19	48.25	6		
0933	22.1	4163	7.2	136	32.2	1.18	48.25	9		
0936	22.2	4174	7.2	80	31.9	0.94	48.25	12		
0939	22.2	4185	7.2	81	32.2	1.04	48.25	15		
0942	22.3	4195	7.2	80	32.2	1.02	48.25	18		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Job No: **18600047.07030**

Sample No(s): **37549**

Sampler(s): **SL/DG**

Sampling Date: **10/26/05**

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.35 ft
(from casing top as marked)

3) Well Depth (WD): 90.30
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1020	20.3	9196	7.2	153	31.9	1.26	48.29	–	1	
1023	20.9	9396	7.3	122	16.2	0.24	48.35	3		
1026	21.4	9518	7.3	146	8.6	0.22	48.33	6		
1029	21.5	9570	7.3	158	5.7	0.20	48.31	9		
1032	21.5	9589	7.3	99	3.1	0.17	48.26	12		
1035	21.6	9610	7.3	68	1.4	0.16	48.33	15		
1038	21.6	9584	7.2	42	0.3	0.13	48.33	18		
1041	21.6	9622	7.2	34	-0.4	0.14	48.33	21	↓	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1[illegible]

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: A

Sample No(s): **3755**~~1~~0

Sampling Date: **10/26/05**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.70 ft
(from casing top as marked)

3) Well Depth (WD): 90.50
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1227	20.7	4964	7.8	11	25.9	12.14	48.77	–	1	
1230	21.1	4997	7.6	16	28.9	11.12	48.72	3		
1233	21.9	5086	7.6	15	30.2	10.83	48.68	6		
1236	22.3	5132	7.6	15	31.5	10.73	48.70	9		
1239	22.4	5143	7.5	15	32.4	10.86	48.70	12		
1242	22.4	5140	7.5	15	32.7	10.86	48.70	15		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @** ~~85~~ 63 TN **ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: **EW-1** -90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No:

Sample No(s): **3755~~0~~** 1

Sampling Date: **10/26/05**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18600047.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.70 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1118	20.3	9041	7.2	15	30.4	2.62	48.72	—	1	
1121	20.6	9525	7.2	14	18.3	0.38	48.84	3	~~3~~ 1	
1124	21.2	9583	7.2	14	12.4	0.31	48.79	6	↓	
1127	21.5	9581	7.2	14	8.6	0.27	48.77	9		
1130	21.5	9574	7.2	13	7.1	0.24	48.78	12		
1133	21.7	9564	7.2	15	6.1	0.23	48.75	15		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ ~~68~~ ft** 85 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____

Sample No(s): **37556**

Sampling Date: **11/29/05**

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ____

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): ____ Date: ____

Weather: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.02 ft
(from casing top as marked)

3) Well Depth (WD): 70
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____ gals

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Purge Date: ____

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0724	Start purge								.8	
0727	20.52	5245	7.37	240	175.9	2.03	48.05	2.4	.8	
0730	21.19	5313	7.38	210	158.7	1.88	48.05	4.8	.8	
0733	21.84	5400	7.39	177	130.2	1.82	48.06	7.2	.8	
0736	22.19	5452	7.40	163	100.1	1.78	48.06	9.6	.8	
0739	22.32	5490	7.41	165	68.2	1.72	48.06	12.0	.8	
0742	22.35	5495	7.42	144	48.7	1.70	48.06	14.4	.8	
0745	22.39	5498	7.42	116	32.2	1.68	48.01	16.8	.8	
0748	22.41	5496	7.42	117	18.4	1.62	48.01	19.2	.8	
0751	22.48	5500	7.43	87	18.8	1.60	48.01	21.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum

Location No:

Job No: 18500147.07030

Sample No(s): 37557

Sampler(s): SL/DG

Sampling Date: 11/29/05

Reviewer(s):

Date:

Sampling Method: Direct from dedicated tubing

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.90 f
(from casing top as marked)

3) Well Depth (WD): 90
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 2.8

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0820	Start purge								.8	
0923	20.96	8844	7.29	71000	-62.4	0.31	47.90	2.4	.8	Odor
0826	20.61	8924	7.32	742	-92.6	0.38	47.90	4.8	.8	
0829	21.54	9087	7.34	394	-121.1	0.36	47.90	7.2	.8	
0832	21.89	9167	7.35	291	-140.1	0.30	47.89	9.6	.8	
0835	21.96	9202	7.35	196	-151.3	0.28	47.89	12.0	.8	
0838	21.95	9215	7.36	142	-161.8	0.27	47.89	14.4	.8	
0841	22.07	9244	7.36	94	-173.9	0.27	47.89	16.8	.8	
0844	22.11	9248	7.37	68	-187.1	0.25	47.89	19.2	.8	
0847	22.16	9244	7.38	60	-[illegible]	0.25	47.92	21.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____

Job No: **18500147.07030**

Sample No(s): **37558**

Sampler(s): **SL/DG**

Sampling Date: **11/29/05**

Reviewer(s): ____ Date: ____

Sampling Method: **Direct from dedicated tubing**

Weather: ____

Sampling Time: ____

Ambient Temp. (F): ____

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) 8 ft
(from casing top as marked)

2) Depth to Water Surface (DTW 49.62 ft
(from casing top as marked)

3) Well Depth (WD): ____
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Purge Date: ____

Number of Casing Volumes to Purge (NC) ____ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond µS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1019	Start Purge						8		.8	
1022	21.35	4020	7.43	361	-118.4	2.32	49.65	2.4	.8	
1025	21.48	4023	7.40	406	-160.5	0.79	48.65	4.8	.8	
1028	22.85	4129	7.41	344	-184.0	1.26	48.05	7.2	.8	
1031	23.24	4162	7.42	248	-182.8	1.48	48.35	9.6	.8	
1034	23.90	4231	7.41	108	-181.9	1.80	48.57	12.0	.8	
1037	24.09	4228	7.45	45	-165.8	1.50	48.43	14.4	.8	
1040	22.56	4098	7.37	44	-205.0	0.64	48.71	16.8	.8	
1043	22.27	4076	7.37	31	-232.9	0.51	48.72	19.2	.8	
1046	22.22	4071	7.38	33	-241.4	0.62	48.72	21.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18500147.07030**

Sample No(s): **37559**

Sampler(s): **SL/DG**

Sampling Date: **11/29/05**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.15 ft
(from casing top as marked)

3) Well Depth (WD): ______
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 4.3

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1016	Start	purge							.8	
1019	21.01	9032	7.38	113	-227.9	0.62	48.12	2.4	.8	
1022	21.56	9162	7.38	96	-264.8	0.82	48.12	4.8	.8	
1025	22.03	9305	7.38	84	-282.8	0.62	48.12	7.2	.8	
1028	22.27	9405	7.40	94	-305.1	0.48	48.12	9.6	.8	
1031	22.30	9432	7.40	100	-328.9	0.47	48.12	12.0	.8	
1034	22.23	9459	7.39	103	-323.1	0.45	48.12	14.4	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ______

Job No: **18500147.07030**

Sample No(s): **37560**

Sampler(s): **SL/DG**

Sampling Date: **11/29/05**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.65 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 6.0

Time	Temp (C)	Cond µS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1155	Start	Purge							.8	
1158	21.26	6490	7.48	15	-2[illegible].9	0.76	48.57	2.4	.8	
1201	21.81	6540	7.48	14	-247.1	0.62	48.58	4.8	.8	
1204	22.50	6641	7.46	13	-269.1	0.61	48.58	7.2	.8	
1207	22.77	6696	7.46	13	-277.8	0.57	48.58	9.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ______ of ______

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ____

Sample No(s): **37561/37562 (dup)**

Sampling Date: **11/29/05**

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ____

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): ____ Date: ____

Weather: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.65 ft
(from casing top as marked)

3) Well Depth (WD): ____
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____ gals

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: ____

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 3.4

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1110	Start Purge								.8	
1113	21.25	100165	7.40	>1000	-219.4	0.51	48.68	2.4	.8	
1116	21.28	100208	7.41	160	-266.4	0.67	48.68	4.8	.8	
1119	21.69	100301	7.39	52	-293.5	0.64	48.68	7.2	.8	
1122	21.85	100368	7.38	19	-309.5	0.49	48.68	9.6	.8	
1125	21.91	100382	7.37	14	-310.6	0.45	48.67	12.0	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-2

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-2

Sample No(s): 37566

Sampling Date: 11/29/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: 18500147.07030

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 50-82 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 49.67 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 2.4

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1240	Start Purge								.8	
1243	20.52	10843	7.32	8	-278.2	0.58	50.07	24	.8	
1246	21.10	10927	7.31	5	-300.6	0.58	49.94	4.8	.8	
1249	21.63	11080	7.30	5	-325.4	0.36	49.95	7.2	.8	
1252	21.78	11129	7.30	5	-348.9	0.31	49.95	9.6	.8	
1255	21.90	11149	7.30	5	-357.2	0.31	49.95	12.0	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-2

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: EW-2

Sample No(s): 37569

Sampling Date: 11/29/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: 18500147.07030

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 38.5-78.5 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.55 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14\ [(D/2)/12\ \text{in.ft}]^2 h\ (7.48\ \text{gal/cu. Ft.})$

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond uS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1324	Start Purge								.8	
1327	20.42	6286	7.47	5	-341.1	0.49	48.94	2.4	.8	Odor
1330	20.69	6290	747	5	-369.1	0.29	48.96	4.8	.8	
1333	21.32	6372	7.47	4	-394.3	0.27	48.96	7.2	.8	
1336	21.60	6411	747	4	-404.1	0.25	48.96	9.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: MW-21

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-21

Job No: 18500147.07030

Sample No(s): 37568

Sampler(s): **SL/DG**

Sampling Date: 11/29/05

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 55-75 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.79 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [$(D/24)^2$]

CV = 3.14 [$((D/2)/12 \text{ in.ft})^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Fe^2 (mg/L): 2.0

Time	Temp (C)	Cond µS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1417	Start purge								.8	
1420	20.57	5731	7.45	39	-311.2	0.94	48.80	2.4	.8	
1423	20.98	5517	7.44	30	-336.1	0.80	48.80	4.8	.8	
1426	21.75	5545	7.44	27	-348.1	0.65	48.80	7.2	.8	
1429	21.79	5520	7.44	26	-357.9	0.58	48.80	9.6	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: MW-5

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-5

Sample No(s): 3756~~6~~7

Sampling Date: 11/29/05

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: 18500147.07030

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 30-75 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 35.84 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0.

Time	Temp (C)	Cond µS/cm (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1459	Start Purge								.8	
1507	20.36	3338	7.62	120	-311.1	1.05	36.36	2.4	.8	
1505	20.36	3335	7.62	70	-328.1	1.12	36.35	4.8	.8	
1508	20.79	3368	7.60	29	-336.7	0.98	36.36	7.2	.8	
1511	20.98	3383	7.60	20	-339.0	0.92	36.36	9.6	.8	
1514	21.12	3389	7.60	18	-333.2	1.00	36.35	12.0	.8	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 60 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-20

Monitor Well Sampling Data

Project: Cooper Drum
Location No: MW-20
Job No: 18500147.07030
Sample No(s): 37571
Sampler(s): SL/DG
Sampling Date: 01/18/06
Reviewer(s):
Date:
Sampling Method: Direct from dedicated tubing
Weather:
Sampling Time:
Ambient Temp. (F):

WATER ELEVATION DATA
Method of Measurement: Depth Sounder [✓ Y] N
Other:
Screened interval: 55 - 70
1) Well Casing Elevation (WCE) ft
(from casing top as marked)
2) Depth to Water Surface (DTW 47.15 ft
(from casing top as marked)
3) Well Depth (WD): 70
(from casing top as marked)
4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N
Depth to Product:
Method of Measurement: Interface Probe Y N
Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)
Purge Date: 1/18/06
Number of Casing Volumes to Purge (NC) gals
Was Well Pumped Dry? Y N
Total Volume of Water to Purge (TV) gals
(VW x NC = TC)
Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (~~L~~) mL	Flow Rate (L/min)	Observations Phys. App.
0730	21.26	5259	7.3	245	43.5	1.10	[illegible]	2700	.9mL	
0733	21.83	5374	7.3	151	13.3	0.48	[illegible]	[illegible]	"	
0736	21.93	5419	7.3	—	-5.8	0.36	47.23	[illegible]	"	
0739	21.91	5448	7.3	—	-14.9	0.26	47.19	10800	"	
0742	21.90	5432	7.3	—	-22.0	0.26	46.80	12500	"	
0745	22.02	5370	7.3	—	-33.1	0.23	46.51	15200	"	
0748	22.13	5078	7.3	—	-3.8	1.61	46.65	17900	"	
0751	22.29	4983	7.3	46	18.7	2.44	46.88	20600	"	
0754	22.22	5000	7.3	28	59.3	4.12	46.99	23300	"	
0757	22.11	5205	7.3	16	36.8	1.99	46.97	26000	"	

INSTRUCTIONS AND COMMENTS
Purging/Sampling Remarks Pump @ 63 ft. AV5 & AV6 on during purge

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum

Location No: MW-20B

Job No: 18500147.07030

Sample No(s): 37572

Sampler(s): SL/DG

Sampling Date: 01/18/06

Reviewer(s): ____ Date: ____

Sampling Method: Direct from dedicated tubing

Weather: ____

Sampling Time: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.59 f
(from casing top as marked)

3) Well Depth (WD): 90
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____ gals

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date: 1|18|06

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 2.4

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed ~~L~~ mL	Flow Rate (L/min)	Observations Phys. App.
0836	20.78	9803	7.2	865	-133.2	0.81	47.75	3000	1	
0839	21.51	9972	7.1	599	-145.7	0.35	47.60	6000	1	
0842	21.51	9980	7.1	423	-154.0	0.19	47.62	9000	1	
0845	21.67	10015	7.1	246	-160.6	0.15	47.63	12,000	1	
0848	21.88	10056	7.1	135	-160.5	0.14	47.63	15000	1	
0851	21.82	10054	7.1	105	-163.8	0.15	47.62	18,000	1	
0854	21.98	10080	7.1	72	-164.8	0.14		21,000	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33A**

Job No: **18500147.07030**

Sample No(s): **37573**

Sampler(s): **SL/DG**

Sampling Date: **01/18/06**

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 46.38 ft
(from casing top as marked)

3) Well Depth (WD): ______
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 1/18/06

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed L ~~(L)~~ mL	Flow Rate (L/min)	Observations Phys. App.
0933	21.57	4830	7.1	179	-92.8	1.03	46.95	3~~000~~	1	
0936	21.96	4870	7.1	228	-95.9	1.34	46.98	6	"	
0939	22.15	4888	7.1	190	-98.2	1.21	46.97	9	"	
0942	22.13	4884	7.1	225	-104.5	1.37	46.97	12	"	
0945	22.05	4877	7.1	176	-107.4	1.21	46.98	15	"	
0948	22.14	4884	7.1	167	-106.6	1.21	46.96	18	"	
0951	22.12	4877	7.1	141	-107.6	1.18	46.90	21	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: Cooper Drum

Location No: MW-33B

Job No: 18500147.07030

Sample No(s): 37574

Sampler(s): SL/DG

Sampling Date: 01/18/06

Reviewer(s): ____________ Date: ____________

Sampling Method: Direct from dedicated tubing

Weather: ____________

Sampling Time: ____________

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____________

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ____________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.67 ft
(from casing top as marked)

3) Well Depth (WD): ____________
(from casing top as marked)

4) Height of Water Column (H) ____________ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____________ gals

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date: ____________

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 4.4

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1029	21.18	9841	7.1	100	-147.8	0.23	47.90	3	1	
1032	21.70	10006	7.0	133	-156.4	0.17	4785	6	"	
1035	21.89	10100	7.0	172	-161.7	0.12	47.80	9	"	
1038	21.77	10107	7.0	165	-162.8	0.12	47.85	12	"	
1041	22.04	10176	7.0	104	-168.4	0.11	47.86	15	"	
1044	21.80	10061	7.0	63	-168.7	0.12	47.86	18	"	
1047	21.56	10088	7.0	41	-169.7	0.12	—	21	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

EW-1

Sample No(s): **37575**

Sampling Date: **01/18/06**

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ______

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): ______ Date: ______

Weather: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 48.5 - 88.5

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.23 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14 [(D/2)/12 \text{ in.ft}]^2 h \text{ (7.48 gal/cu. Ft.)}$

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: ______

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 00

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1207	21.28	5259	7.2	7	-69.4	5.93	48.14	3	1	
1210	22.01	5345	7.2	6	-68.9	5.57	48.20	6	"	
1213	22.19	5368	7.2	7	-68.4	5.48	48.21	9	"	
1216	22.36	5392	7.2	7	-69.8	5.37	48.19	12	"	
1219	22.46	5405	7.2	7	-70.8	5.29	—	15	"	
1222	22.49	5411	7.2	6	-71.9	5.22	—	18	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **EW-1-90ft**

Job No: **18500147.07030**

Sample No(s): **37576/37577 (dup,MW-6)**

Sampler(s): **SL/DG**

Sampling Date: **01/18/06**

Reviewer(s): ____ Date: ____

Sampling Method: **Direct from dedicated tubing**

Weather: ____

Sampling Time: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.23 ft
(from casing top as marked)

3) Well Depth (WD): ____
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Purge Date: 1/18/06

Number of Casing Volumes to Purge (NC) ____ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Fe^2 (mg/L): 2.6

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1123	20.55	10027	7.0	3	-96.3	1.95	48.14	3	1	
1126	21.18	10251	7.0	4	-106.1	1.06	48.18	6	1	
1129	21.49	10220	7.0	5	-114.1	0.77	48.27	9	1	
1132	21.56	10153	7.0	5	-120.2	0.52	48.26	12	1	
1135	21.68	10163	7.0	6	-122.0	0.53	48.23	15	1	
1138	21.75	10110	7.0	6	-125.7	0.48	—	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-20**

Job No: **18500147.07030**

Sample No(s): 37581

Sampler(s): **SL/DG**

Sampling Date: 3/1/06

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time: 0750

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: 55 - 70

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 46.83 ft
(from casing top as marked)

3) Well Depth (WD): 70
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: 3-1-06

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0753	20.51	4713	7.48	454	229.2	7.02	47.10	3	1	
0756	21.36	4769	7.49	376	208.5	5.95	47.11	6	1	
0759	21.78	4809	7.47	276	193.1	4.56	47.13	9	1	
0802	21.86	4821	7.46	217	182.5	4.20	47.17	12	1	
0805	21.99	4820	7.45	157	174.6	3.96	47.22	15	1	
0808	22.04	4808	7.45	119	170.8	4.01	47.25	18	1	
0811	22.03	4807	7.45	117	169.4	3.83	47.28	21	1	
0814	22.03	4803	7.44	110	167.0	3.66	47.29	24	1	
@ 55'										
0828	21.83	4712	20.89	238	288.7	21.19				
0832	21.96	4725	21.97		395	19.73				

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

O_3 = 0.0 Collected VOC Sample MW-7C @ 55'

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum

Location No: MW-20B

Sample No(s): 37582

Sampling Date: 3/1/06

Sampling Method: Direct from dedicated tubing

Sampling Time:

Job No: 18500147.07030

Sampler(s): SL/DG

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) fl
(from casing top as marked)

2) Depth to Water Surface (DTW 47.43 f
(from casing top as marked)

3) Well Depth (WD): 90
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 3.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0856	20.34	8490	7.32	>1000	-137.3	0.35	47.63	3	1	
0859	20.64	8486	7.33	>1000	-138.5	0.34	47.53	6	1	
0902	21.31	8491	7.33	436	-143.6	0.39	47.51	9	1	
0905	21.70	8508	7.31	387	-150.1	0.64	47.51	12	1	
0908	22.06	8519	7.29	251	-136.9	0.68	47.52	15	1	
0911	22.30	8516	7.28	146	-133.6	0.46	47.53	18	1	
0914	22.41	8516	7.27	97	-126.2	0.39	47.53	21	1	
0917	22.47	8505	7.27	82	-117.8	0.36	47.52	24	1	
0920	22.44	8510	7.26	63	-111.5	0.32	47.52	27	1	
0923	22.72	8493	7.26	50	-110.3	0.30	47.52	30	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33A**

Sample No(s): **37583**

Sampling Date: 3/1/06

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.91 ft
(from casing top as marked)

3) Well Depth (WD): 64.03
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1008	21.79	4377	7.28	574	19.6	11.55	47.54	5	1	silty
1011	21.82	4380	7.22	484	111.3	9.57	47.54	8	1	silty
1014	21.96	4391	7.20	283	32.3	9.19	47.54	11	1	
1017	22.53	4392	7.21	337	33.4	8.87	47.55	14	1	
~~1024~~		- recali	brate	D.O.	—					
1024	22.89	4376	7.22	365	66.5	7.85	47.55	21	1	
1027	22.97	4389	7.22	393	53.5	7.71	47.55	24	1	
1030	22.99	4392	7.23	706	45.6	7.57	47.55	27	1	
1033	22.93	4404	7.23	534	42.0	7.50	47.55	30	1	
1036	23.11	4398	7.23	504	37.2	7.47		33	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33B**

Sample No(s): 37584

Sampling Date: 3/1/06

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.70 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 4.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1117	20.92	8350	7.14	515	-89.7	0.33	47.69	3	1	
1120	21.38	8370	7.13	341	-104.7	0.23	47.66	6	1	
1123	21.61	8400	7.13	250	-109.7	0.45	47.69	9	1	
1126	21.85	8424	7.13	203	-105.1	0.37	47.70	12	1	
1129	22.04	8454	7.13	160	-105.5	0.32	47.70	15	1	
1132	22.26	8467	7.13	136	-102.8	0.28	47.70	18	1	
1135	22.38	8495	7.13	117	-109.0	0.24	47.70	21	1	
1138	22.35	8526	7.13	129	-110.3	0.24	47.70	24	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

EW-1

Sample No(s): 37585

Sampling Date: **3/1/06**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder **Y** N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.01 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12\ \text{in.ft}]^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1248	21.85	4497	7.33	16	9.8	5.70	48.19	3	1	
1251	21.73	4508	7.30	12	14.1	5.50	48.20	6	1	
1254	22.01	4509	7.29	11	16.6	5.45	4820	9	1	
1257	22.44	4512	7.29	11	19.4	5.38	48.20	12	1	
1300	22.43	4513	7.30	11	18.9	5.29	48.20	15	1	
1303	22.41	4514	7.29	11	20.7	5.21	48.20	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: Cooper Drum

Location No: EW-1-90ft

Job No: 18500147.07030

Sample No(s): 37586

Sampler(s): SL/DG

Sampling Date: 3/1/06

Reviewer(s): ______ Date: ______

Sampling Method: Direct from dedicated tubing

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: 48.5 - 88.5

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.01 ft
(from casing top as marked)

3) Well Depth (WD): ______
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 2.7

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1213	20.95	8720	7.11	129	-58.9	0.36	48.07	3	1	
1216	21.24	8732	7.11	11	-65.6	0.31	48.00	6	1	
1219	21.39	8744	7.11	13	-70.4	0.45	48.00	9	1	
1222	21.57	8780	7.11	10	-75.3	0.30	48.00	12	1	
1225	21.56	8731	7.11	12	-79.3	0.26	48.00	15	1	
1228	21.59	8728	7.11	13	-79.6	0.22	48.00	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 85 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-2

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-2

Sample No(s): 37591

Sampling Date: 3/2/06

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No:

Sampler(s): **SL/DG**

Reviewer(s):

Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 50-82 ft

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 49.25 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12\ \text{in.ft}]^2h$ (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Method: ~~2" Grundfos submersible pump~~
Watera

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 2.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0750	19.56	10323	7.11	30	-104.0	2.67	49.57	3	1	
0753	19.63	10292	7.11	32	-113.1	2.64	49.57	6	1	
0756	19.70	10273	7.10	33	-117.9	2.96	49.57	9	1	
0759	19.76	10091	7.11	39	-116.3	404	49.57	12	1	
0802	19.81	10049	7.11	33	-118.0	4.03	49.57	15	1	
0805	19.80	10006	7.11	32	-120.0	3.94	49.57	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks ______ Pump at 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: MW-3

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-3

Job No:

Sample No(s): 37592

Sampler(s): **SL/DG**

Sampling Date: 3/2/06

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 52-73.5 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 46.36 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: ~~2" Grundfos submersible pump~~ Watera

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.2

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1148	20.37	1389	7.52		-65.2 ~~3.49~~	3.49				
	- stop purge to reposition pump -									
1153	21.25	1373	7.48	26	-54.3	1.94	48.19	0.5L	1.5	
1156	21.22	1370	7.46	11	-52.3	1.74	48.20	0.5	3.0	
1159	21.03	1369	7.52	11	-48.6	1.96	48.20	0.5	4.5	
1202	20.77	1369	7.46	10	-53.2	1.51	48.22	0.5	6.0	
1205	20.72	1369	7.46	11	-55.3	2.30	48.24	0.5	7.5	
1208	21.07	1370	7.45	10	-59.6	1.15	48.24	0.5	9.0	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump at 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-21

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: MW-21

Job No:

Sample No(s): 37593

Sampler(s): **SL/DG**

Sampling Date: 3/2/06

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 55-75 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.42 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: ~~2" Grundfos submersible pump~~ Waterra
1/2 ID tubing

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 1.8

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1040	20.23	8446	7.07	40	-100.8	0.58	48.47	3	1	
1043	20.35	8382	7.05	53	-107.1	0.50	48.46	6	1	
1046	20.36	8332	7.06	40	-116.3	0.51	48.47	9	1	
1049	20.45	8329	7.06	36	-120.3	0.28	48.47	12	1	
1052	20.53	8284	7.05	36	-121.0	0.37	48.47	15	1	
1055	20.48	8279	7.05	40		0.36	48.47	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump at 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-2

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: EW-2

Job No:

Sample No(s): 37594

Sampler(s): **SL/DG**

Sampling Date: 3/2/06

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: 38.5-78.5 ft

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.15 ft
(from casing top as marked)

3) Well Depth (WD):
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: ~~2" Grundfos submersible pump~~ Watera

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0903	20.21	5848	7.24	44	-240.2	0.83	48.69	3	~~3~~ 1	
0906	20.31	5852	7.24	58	-253.2	0.83	48.70	6	~~6~~ 1	
0909	20.26	5842	7.24	53	-262.1	0.55	48.70	9	1	
0912	20.29	5846	7.24	41	-269.9	0.45	48.70	12	1	
0915	20.30	5842	7.24	40	-274.2 ~~-27.6~~	0.45	48.70	15	1	
0918	20.33	5844	7.23	38	-280.3	0.40	48.70	18	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump at 65 ft

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33A**

Sample No(s): 37596

Sampling Date: 4/5/06

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.46 ft
(from casing top as marked)

3) Well Depth (WD): 62.71
(from casing top as marked)

4) Height of Water Column (H) ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**
switched to watera for second purge & sample

Purge Date: 4-5-06

Was Well Pumped Dry? Y N

Fe^2 (mg/L): N/M

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1102	20.89	4495	5.5	255	167.7	10.88	47.49	6	2	
1105	21.44	4505	5.5	439	174.3	11.10	47.49	12		
1108	21.20	4519	5.5	300	178.2	11.24	47.49	18		
1111	21.18	4516	5.7	183	179.1	11.11	47.49	24		
1454	20.85	4489	7.4	>1000	39.5	17.37	47.49	27	1	
1457	21.04	4456	7.2	>1000	51.5	16.69	47.49	30		
1500	21.08	4455	7.0	>1000	60.5	15.38	47.49	33		
1503	20.85	4508	6.9	>1000	67.0	16.25	47.49	36		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33B**

Sample No(s): 37597

Sampling Date: 4/5/06

Sampling Method: **Direct from dedicated tubing**

Sampling Time: ____________

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): ____________ Date: ____________

Weather: ____________

Ambient Temp. (F): ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other: ____________

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ____________ ft

(from casing top as marked)

2) Depth to Water Surface (DTW 47.16 ft

(from casing top as marked)

3) Well Depth (WD): 95.40

(from casing top as marked)

4) Height of Water Column (H) ____________ ft

(from casing top as marked)

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14 [(D/2)/12 \text{ in.ft}]^2 h$ (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________ gals

(CV x H = VW)

Number of Casing Volumes to Purge (NC) ____________ gals

Total Volume of Water to Purge (TV) ____________ gals

(VW x NC = TC)

Purge Date: ____________

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 2.5

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1212	20.30	8086	6.5	87	-46.7	0.25	47.33	3	1	
1215	20.77	8213	6.5	98	-74.2	0.23	47.33	6		
1218	21.01	8273	6.5	109	-87.5	0.55	47.43	9		
1221	21.19	8302	6.5	142	-93.0	0.93	47.43	12		
1224	21.21	8350	6.5	116	-96.5	0.47	47.43	15		
1227	21.40	8350	6.5	91	-98.8	0.32	47.43	18	↓	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page _____ of _____

MONITOR WELL NO: EW-1-53'

Monitor Well Sampling Data

Project: Cooper Drum

Location No: EW-1-53'

Job No: 18500147.07030

Sample No(s): 37601

Sampler(s): SL/DG

Sampling Date: 4/5/06

Reviewer(s):

Date:

Sampling Method: Direct from dedicated tubing

Weather:

Sampling Time:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: 48.5 - 78.5

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW ______ ft
(from casing top as marked)

3) Well Depth (WD): 82
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: 2" Grundfos submersible pump

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date:

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1409	21.26	4349	6.9	11	52.3	11.89	47.97	3	1	
1412	21.60	4330	6.9	10	59.2	12.43	47.97	6		
1415	21.80	4326	6.9	10	64.5	12.51	47.97	9		
1418	21.79	4322	6.9	10	68.6	12.52	47.97	12		
1421	22.02	4321	6.8	9	72.2	12.31	47.97	15		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 53 ft.

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

EW-1

Sample No(s): 37599

Sampling Date: **4/5/06**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW ______ ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12 \text{ in.ft}]^2h$ (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1332	20.79	4525	6.9	9	22.0	7.76	47.97	3	1	
1335	21.27	4441	6.8	7	31.4	7.57	47.97	6	↓	
1338	21.95	4433	6.7	7	42.6	7.39	47.97	9		
1341	22.02	4423	6.7	6	47.5	7.38	47.97	12		
1344	22.16	4429	6.7	6	52.8	7.27	47.97	15		
1347	22.12	4430	6.7	6	56.7	7.28	47.97	18		
1350	22.09	4430	6.7	6	59.9	7.06	47.97	18		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **EW-1-90ft**

Job No: **18500147.07030**

Sample No(s): 37598

Sampler(s): **SL/DG**

Sampling Date: 4/5/06

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: ______

Sampling Time: ______

Ambient Temp. (F): ______

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ______

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.97 ft
(from casing top as marked)

3) Well Depth (WD): 90.26
(from casing top as marked)

4) Height of Water Column (H) ______ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12 \text{ in.ft}]^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: ______

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1302	20.37	8260	6.5	7	23.8	0.34	47.97	3	1	
1305	20.74	8238	6.6	4	19.9	0.29	47.97	6		
1308	21.05	8223	6.6	4	17.7	0.30	47.97	9		
1311	21.35	8216	6.6	4	15.3	0.48	47.97	12		
1314	21.41	8200	6.6	3	12.8	0.48	47.97	15		
~~1453~~	~~20.87~~	~~44~~								

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: **MW-33A**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33A**

Sample No(s): 37609

Sampling Date: May 8, 2006

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 46.83 ft
(from casing top as marked)

3) Well Depth (WD): 61.85
(from casing top as marked)

4) Height of Water Column (H) 15.02 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
[✓ 2]	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0 mg/L

Time	Temp (C)	Cond. (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
~~0952~~									~~0.5~~	
1028	20.91	4980	7.6	>1000	103.1	17.82	—	—	1	
1031	20.89	4992	7.6	>1000	104.3	18.50	—	6	1	
1034	20.94	4998	7.5	>1000	1053	19.26	—	9	1	
1037	20.92	5053	7.5	>1000	105.2	18.31	—	12	1	
1040	20.90	5052	7.5	>1000	105.3	18.28	—	15	1	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.** Ozone = 0 Hydrogen Peroxide 4.0 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33B**

Job No: **18500147.07030**

Sample No(s): 37610

Sampler(s): **SL/DG**

Sampling Date: May 8, 2006

Reviewer(s): ____ Date: ____

Sampling Method: **Direct from dedicated tubing**

Weather: ____

Sampling Time: ____

Ambient Temp. (F): ____

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ____

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ____ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.30 ft
(from casing top as marked)

3) Well Depth (WD): ____
(from casing top as marked)

4) Height of Water Column (H) ____ ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ____

Method of Measurement: Interface Probe Y N

Other: ____

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____ gals
(CV x H = VW)

Purge Date: 5/8/06

Number of Casing Volumes to Purge (NC) ____ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ____ gals
(VW x NC = TC)

Fe^2 (mg/L): 3.8 mg/L

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1110	20.65	8100	7.2	142	-74.4	2.55	—	2.4	0.8	
1113	21.07	8309	7.3	151	-85.7	0.89	—	4.8	"	
1116	21.63	8390	7.3	101	-92.6	0.58	—	7.2	"	
1119	21.87	8467	7.2	93	-97.8	0.47	—	9.6	"	
1122	21.96	8454	7.2	75	-100.6	0.49	—	12.0	"	
1125	22.01	8478	7.2	64	-101.4	0.41	—	14.4	"	
1128	22.09	8541	7.2	63	-100.7	0.38	—	16.8	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.** Hydrogen Peroxide = <1 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **EW-1**

Monitor Well Sampling Data

Project: **Cooper Drum**

Monitor Well **EW-1-53'**

Sample No(s): 37613

Sampling Date: **May 8, 2006**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder **Y** N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.79 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) 42.73 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date:

Was Well Pumped Dry? Y N

Fe^2 (mg/L): 0.0 mg/L

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1349	22.12	4462	7.5	8	55.9	9.76	47.80	2.4	0.8	
1352	22.78	4423	7.5	10	61.0	11.19	47.80	4.8	"	
1355	23.15	4427	7.5	10	64.3	11.16	47.80	7.2	"	
1358	23.27	4437	7.5	8	69.7	10.95	47.80	9.6	"	
1401	23.36	4442	7.5	8	70.9	10.79	47.80	12.0	"	
1404	2343	4442	7.5	7	75.7	10.92	47.80	14.4	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 53 ft** Ozone = 0.0 mg/L Hydrogen Peroxide = <1 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page of

MONITOR WELL NO: EW-1

Monitor Well Sampling Data

Project: Cooper Drum

Monitor Well EW-1

Sample No(s): 37612

Sampling Date: May 8, 2006

Sampling Method: Direct from dedicated tubing

Sampling Time:

Job No: 18500147.07030

Sampler(s): SL/DG

Reviewer(s): Date:

Weather:

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder **Y** N

Other:

Screened interval: 48.5 - 88.5

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.77 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) 42.73 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date: 5/8/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.0 mg/L

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1313	21.00	4479	7.4	6	31.6	9.32	47.80	2.4	0.8	
1316	21.60	4470	7.4	6	37.8	9.09	47.80	4.8	"	
1319	22.11	4472	7.4	4	44.6	8.81	47.80	7.2	"	
1322	22.40	4473	7.4	5	48.7	8.71	47.80	9.6	"	
1325	22.58	4475	7.4	4	55.1	8.62	47.80	12.0	"	
1328	22.69	4475	7.4	4	58.4	8.68	47.80	14.4	"	
1331	22.76	4476	7.4	4	57.9	8.59	47.80	16.8	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Pump @ 63 ft Ozone = 0.0 mg/L Hydrogen Peroxide = <1.0 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **EW-1-90ft**

Job No: **18500147.07030**

Sample No(s): 37611

Sampler(s): **SL/DG**

Sampling Date: May 8, 2006

Reviewer(s):

Date:

Sampling Method: **Direct from dedicated tubing**

Weather:

Sampling Time: 1245

Ambient Temp. (F):

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.77 ft
(from casing top as marked)

3) Well Depth (WD): 90.20
(from casing top as marked)

4) Height of Water Column (H) 42.43 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ________ gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) ________ gals

Total Volume of Water to Purge (TV) ________ gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 5/8/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.6 mg/L

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1235	19.97	8631	7.2	8	-1.3	9.26	—	2.4	0.8	
1238	20.65	8641	7.2	17	-15.5	4.74	—	5.8	"	
1241	21.19	8651	7.2	6	-23.6	1.65	47.83	8.2	"	
1244	21.49	8611	7.2	6	-27.6	0.96	47.82	19.6	"	
1247	21.68	8567	7.2	5	-27.6	0.83	47.82	13.0	"	
1250	21.78	8529	7.2	5	-27.8	0.76	47.82	19.4	"	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft** hydrogen peroxide 0.0 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

TABLE 2
Request for Analysis
Monitor Well Groundwater Samples - ISCO Field Pilot Test
Regional Analytical Program
April 5, 2006 Case# R06S10 and CLP # 35218

MATRIX = WATER																			
					ORGANICS	ISCO GROUNDWATER MONITORING													
PARAMETER - According to the Requirements of the DQIs (if applicable)					VOCs (8260)	Priority Pollutant Metals[a] (E6010)	Hexavalent Chromium[a] (E7196A)	1,4-Dioxane	Chloride (E300.0)	Nitrate (E300.0)	Sulfate (E300.0)	Bromide (E300.0)	O-phosphate (E300.0)	Alkalinity (E310.1)	TSS (160.2)	TDS (E160.1)	TOC (E415.2)	Sulfide (E376.2)	Cations (barium, boron, calcium, iron, magnesium, manganese, potassium, and sodium [200.7])
PRESERVATIVES					HCL to pH <2, Cool to 4°C	HNO_3 to pH <2, Cool to 4°C	Cool to 4°C	Cool to 4°C	Cool to 4°C								HCL to pH <2, Cool to 4°C	NaOH/zinc acetate to pH >9, Cool to 4°C	HNO_3 to pH <2, Cool to 4°C
TECHNICAL HOLDING TIMES					14 days	28 days	24 hours		28 days	48 hours	28 days		48 hours	14 days	7 days	7 days	28 days	28 days	6 months
CONTRACT HOLDING TIMES					7 days	7 days	24 hours	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days	NA
Sample Location	CLP Sample No.	URS Sample No.	QA/QC	Sampling Schedule	No. of 40 mL VOA vials	No. of 500 mL poly bottles	No. of 500 mL poly bottles	No. of 1 L amber bottles	No. of 1-L polyethylene bottles								No. of 40 mL VOA vials	No. of 500 mL poly bottles	No. of 250 mL polyethylene bottles
				17	Seveth Round Groundwater Samples														
MW-33A	MY2FY7	~~37596~~	37606	4/5/06	3	1	1	2	1								2	1	
~~MW-33B~~	~~MY2FY8~~	~~37597~~		4/5/06	3	1	1	2	1								2	1	
~~EW-1-90'~~	~~MY2FY9~~	~~37598~~	Lab QC[b]	4/5/06	3	2	2	2	2								4	2	
EW-1	MY2FZ0	~~37599~~	37605	4/5/06	3	1	1	2	1								2	1	
MW-6	~~MY2FZ1~~	~~37600~~	~~Duplicate~~	4/5/06	3	1	1	2	1								2	1	
~~EW-1-53'~~	~~MY2FZ2~~	~~37601~~		4/5/06	3			2											
MW-7	MY2FZ3	37602	Equipment Blank	4/5/06	3	1	1	2	1								2	1	
MW-7A		3760~~3~~8	Trip Blank	4/5/06	3														
~~MW-7B~~		~~37604~~	~~Field Blank~~	4/5/06	3														
Total # of Samples/Containers					9/27	6/7	6/7	7/14	6/7								6/14	6/7	

Notes:

[a] Priority pollutant metals and hexavalent chromium will be analyzed during the initial sampling round and biannually thereafter. All other analyses will be conducted during each sampling event.

[b] Lab QC = MS/MSD

DQI = data quality indicator
HCl = hydrochloric acid
HNO_3 = nitric acid
ISCO = In Situ Chemical Oxidation
L = liter
mL = milliter
MS/MSD = matrix spike/matrix spike duplicate

NA = not available
NaOH = sodium hydroxide
No. = number
QA/QC = quality assurance/quality control
TDS = total dissolved solids
TOC = total organic carbon
TSS = total suspended solids
VOA = volatile organic analysis
VOC = volatile organic compound

EW-1	37605	4/17/06	1210
MW-33A	37606	4/17/06	1300
Trip Blank	37608		

Sampled only two wells
No monitor well data sheets

MONITOR WELL NO: **MW-20**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-20**

Job No: **18500147.07030**

Sample No(s): 37615

Sampler(s): **SL/DG**

Sampling Date: June 5, 2006

Reviewer(s): ______ Date: ______

Sampling Method: **Direct from dedicated tubing**

Weather: Cloudy

Sampling Time: ______

Ambient Temp. (F): 73°F

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other: ______

Screened interval: **55 - 70**

1) Well Casing Elevation (WCE) ______ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 46.98 ft
(from casing top as marked)

3) Well Depth (WD): **70**
(from casing top as marked)

4) Height of Water Column (H) 23.02 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ______

Method of Measurement: Interface Probe Y N

Other: ______

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	$CV = (23.49) \times [(D/24)^2]$

$CV = 3.14 [(D/2)/12 \text{ in.ft}]^2 h$ (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ______ gals
(CV x H = VW)

Purge Date: 6/5/06

Number of Casing Volumes to Purge (NC) ______ gals

Was Well Pumped Dry? Y [✓ N]

Total Volume of Water to Purge (TV) ______ gals
(VW x NC = TC)

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
0950	21.19	4676	7.25	259	185.6	2.56	47.11	2.4	0.8	
0953	21.64	4687	7.25	232	146.0	2.52	47.11	4.8		
0956	22.06	4690	7.24	279	121.6	2.24	47.11	7.2		
0959	22.20	4670	7.25	488	97.4	2.23	47.12	9.6		
1002	22.55	4661	7.24	389	89.4	2.19	47.12	12.0		
1005	22.61	4651	7.24	245	84.7	2.11	47.13	14.4		
1008	22.46	4645	7.23	205	74.2	1.84	47.13	16.8		
1011	22.46	4646	7.23	195	65.7	1.62	47.13	19.2		
1014	22.45	4646	7.23	175	62.1	1.52	47.13	21.6		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-20B

Monitor Well Sampling Data

Project: Cooper Drum

Location No: MW-20B

Sample No(s): 37616

Sampling Date: June 5, 2006

Sampling Method: Direct from dedicated tubing

Sampling Time:

Job No: 18500147.07030

Sampler(s): SL/DG

Reviewer(s):

Date:

Weather: cloudy

Ambient Temp. (F): 74°F

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: 80 - 90

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.00 ft
(from casing top as marked)

3) Well Depth (WD): 90
(from casing top as marked)

4) Height of Water Column (H) 43.00 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: 2" Grundfos submersible pump

Purge Date: 6/5/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L):

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1048	20.97	8107	7.20	1000	-201.1	0.12	47.03	1.5	0.5	
1051	20.95	8172	7.19	743	-176.6	0.14	47.03	3.0		
1054	21.13	8190	7.18	512	-162.5	0.19	47.03	4.5		
1057	21.53	8199	7.16	358	-149.7	0.18	47.04	6.9	0.8	
1100	22.16	8196	7.16	293	-150.7	0.17	47.04	8.3		
1103	22.53	8182	7.15	266	-143.1	0.16	47.04	10.7		
1106	22.57	8160	7.15	251	-136.3	0.16	47.04	13.1	↓	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.**

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: MW-33A

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33A**

Sample No(s): 37617

Sampling Date: June 5, 2006

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather: Cloudy

Ambient Temp. (F): 74°F

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **55 - 65**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 48.76 ft
(from casing top as marked)

3) Well Depth (WD): 59.13
(from casing top as marked)

4) Height of Water Column (H) 10.37 ft
(from casing top as marked)

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x $[(D/24)^2]$

CV = 3.14 $[(D/2)/12 \text{ in.ft}]^2$h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Watera pump**

Purge Date: 6/5/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1220	Began	purgi	ng	well	w/	Watera	pump	—		
1232	21.09	4142	7.40	>1000	36.6	1.96	–	~25.0		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 60 ft.** 0.0 ozone, Fe^{2+} = 0.0 mg/L
Hydrogen Peroxide = 1-2 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: **MW-33B**

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **MW-33B**

Sample No(s): 37618

Sampling Date: June 5, 2006

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s):

Date: 6/5/06

Weather: Cloudy

Ambient Temp. (F): 75°F

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **80 - 90**

1) Well Casing Elevation (WCE) ______ ft (from casing top as marked)

2) Depth to Water Surface (DTW 47.22 ft (from casing top as marked)

3) Well Depth (WD): 90.15 (from casing top as marked)

4) Height of Water Column (H) 42.93 ft (from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) ______ gals (CV x H = VW)

Number of Casing Volumes to Purge (NC) ______ gals

Total Volume of Water to Purge (TV) ______ gals (VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 6/5/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 3.2

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1312	21.35	7915	7.12	161	-88.3	0.44	47.36	2.4	0.8	
1315	21.49	8040	7.13	78	-118.8	0.22	47.36	4.8	↓	
1318	21.86	8099	7.11	77	-129.1	0.14	47.36	7.2		
1321	21.99	8128	7.11	77	-138.0	0.11	47.36	9.6		
1324	22.03	8144	7.11	50	-147.4	0.11	47.36	12.0		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft.** Hydrogen Peroxide = 0.0 , No ozone reading

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

MONITOR WELL NO: EW-1

Monitor Well Sampling Data

Project: Cooper Drum

EW-1

Sample No(s): 37619

Sampling Date: **June 5, 2006**

Sampling Method: **Direct from dedicated tubing**

Sampling Time:

Job No: **18500147.07030**

Sampler(s): **SL/DG**

Reviewer(s): Date:

Weather: partly cloudy

Ambient Temp. (F): 79°F

Product Obs: Y N

Depth to Product:

Method of Measurement: Interface Probe Y N

Other:

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other:

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.64 ft
(from casing top as marked)

3) Well Depth (WD): **90.5**
(from casing top as marked)

4) Height of Water Column (H) 42.86 ft
(from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Single Casing Volume of Water in Well (VW) gals
(CV x H = VW)

Number of Casing Volumes to Purge (NC) gals

Total Volume of Water to Purge (TV) gals
(VW x NC = TC)

Purge Method: **2" Grundfos submersible pump**

Purge Date: 6/5/06

Was Well Pumped Dry? Y [✓ N]

Fe^2 (mg/L): 0.0

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1359	21.06	4269	7.56	-	253.7	13.64	–	–	–	Downhole probe,
										prior to sampling
1454	22.18	6641	7.15	2	28.4	3.05	47.71	2.4	0.8	
1457	22.14	6959	7.12	2	12.3	1.66	47.71	4.8		
1500	22.49	6967	7.11	2	6.9	1.31	47.71	7.2		
1503	22.44	6979	7.11	2	8.6	0.99	47.71	9.6		
1506	22.41	6995	7.11	2	1.2	0.76	47.71	12.0		
1509	22.39	7022	7.11	2	-5.8	0.68	47.71	14.4	↓	

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 63 ft** H_2O_2 = 0.0 mg/L

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO: EW-1-90'

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: **EW-1-90ft**

Job No: **18500147.07030**

Sample No(s): 37620

Sampler(s): **SL/DG**

Sampling Date: June 5, 2006

Reviewer(s): ____________ Date: ____________

Sampling Method: **Direct from dedicated tubing**

Weather: mostly Sunny

Sampling Time: ____________

Ambient Temp. (F): 79°F

Product Obs: Y N

Depth to Product: ____________

Method of Measurement: Interface Probe Y N

Other: ____________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder [✓ Y] N

Other: ____________

Screened interval: **48.5 - 88.5**

1) Well Casing Elevation (WCE) ____________ ft
(from casing top as marked)

2) Depth to Water Surface (DTW 47.64 ft
(from casing top as marked)

3) Well Depth (WD): 90.5
(from casing top as marked)

4) Height of Water Column (H) 42.86 ft
(from casing top as marked)

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ____________ gals
(CV x H = VW)

Purge Date: 6/5/06

Number of Casing Volumes to Purge (NC) ____________ gals

Was Well Pumped Dry? Y [✓ N]

Total Volume of Water to Purge (TV) ____________ gals
(VW x NC = TC)

Fe^2 (mg/L): 1.8

Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
1411	21.40	8790	7.10	4	-35.5	0.31	47.78	2.4	0.8	
1414	21.68	8899	7.09	2	-62.6	0.20	47.78	4.8	↓	
1417	21.73	8902	7.09	1	-67.5	0.17	47.76	7.2		
1420	21.74	8913	7.09	1	-73.1	0.14	47.76	9.6		
1423	21.74	8912	7.09	1	-78.1	0.14	47.76	12.0		
1426	21.86	8900	7.08	1	-72.4	0.16	47.76	14.4		

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks **Pump @ 85 ft** H_2O_2 = 0.0 mg/L O_3 dNS

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

Page ____ of ____

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum   Event ISCO Water Levels   Sampler

Project No.   Datum TOC   Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-20	7-12-05	0848	48.60		102.84 54.24
MW-20B		1003	48.44		102.45 54.01
MW-33A		1112	48.84		103.06 54.22
MW-33B		1213	48.65		102.79 54.14
EW-1		1331	49.00		103.37 54.37

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum

Event 8/15/05

Sampler SD

Project No. ____________

Datum TOC

Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-17	8/15/05	1236	48.89		
MW-21	"	1242	49.15		
MW-4	"	1252	48.44		
MW-20	"	1256	48.20		
MW-20B	"	1300	48.15		
MW-33B	"	1304	48.37		
EW-1	"	1307	48.87		
MW-33A	"	1308	47.50		
MW-23	"	1314	49.35		
EW-2	"	1320	48.85		
MW-15	"	1635	48.56		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum
Event 8/16/05
Sampler DG/SDL

Project No.
Datum TOC
Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-20	8-16-05	0700	47.85		
MV-33A	"	0702	47.38		
EW-1	"	0703	48.83		
MW-33A	"	0737	47.58		
MV-20	"	0738	48.02		
					ORP 203.5 @ 63' D.O. 13.0 mg/l
MW-20	"	0743	48.10		W.L. came up during sampling
MW-20B	"	0858	48.15		
MW-33A	"	1017	47.38		
MW-33B	"	1128	48.50		
EW-1	"	1314	48.83		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum

Event

Sampler DG

Project No.

Datum TOC

Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-15	9/6/05	1409	48.56		
MW-17	"	1412	48.84		
MW-23	"	1414	49.28		
EW-2	"	1422	48.82		
MW-21	"	1428	49.08		
MW-4	"	1431	48.19		
MW-20	"	1436	47.98		
MW-20B	"	1442	48.10		
MW-33B	"	1444	48.32		
MW-33A	"	1448	47.68		
EW-1	"	1446	48.82		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum

Event O_2 Pilot Test

Sampler S. Lookingbill

Project No. ______________

Datum TOC

Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOC ~~TOTAL~~ DEPTH	COMMENTS
MW-17	9/28/05	1137	48.67	103.36	54.69
MW-15		1142	48.40	102.77	54.37
MW-23		1150	49.14	104.15	55.01
EW-2		1155	48.66	103.65	54.99
MW-21		1215	48.91	103.63	54.72
MW-4		1210	48.11	102.91	54.80
MW-20		1219	47.80	102.84	55.04
MW-20B		1220	47.98	102.45	54.47
MW-33A		1222	47.46	103.06	55.60
MW-33B		1227	48.19	102.79	54.60
EW-1		1235	48.45	103.37	54.92

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum
Event ISCO PT
Sampler D Grube
Project No. ____________
Datum TOC
Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
EW-2	10/25/05	1415	48.76		
MW-23	"	1417	49.28		
MW-17	"	1422	48.75		
MW-15	"	1425	48.50		
MW-4	"	1433	48.25		
MW-20	"	1436	47.94		
MW-20B	"	1440	48.00		
MW-33B	"	1444	48.31		
MW-33A	"	1446	47.75		
MW-21	"	1449	49.13		
EW-1	"	1452	48.80		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum Event ISCO - Sounding Round. Sampler

Project No. 18500147.07030 Datum TOC Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-15	11-29-05	0710	48.34		
MW-17		0714	48.70		
MW-23		0721	49.11		
MW-4		1411	47.92		
MW-20		0724	48.02		
MW-20B		0820	47.90		
MW-33A		0919	48.62		
MW-33B		1016	48.15		
~~MW~~ EW-1		1110	48.65		
MW-2		1240	49.67		
EW-2		1324	48.55		
MW-21		1417	48.79		
MW-5		1459	35.84		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum
Event 1/19/06
Sampler Scott Lookingbill

Project No. ______
Datum TOC
Sheet 1 of 1

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-17	1/19/06	0745	48.19		
MW-15		0748	45.92		
MW-23		0750	48.68		
MW-21			N/M		
EW-2		0752	48.13		
MW-4		0755	47.62		
EW-1		0730	48.13		
MW-33A		0735	46.44		
MW-20		0740	47.08		
MW-20B		0742	47.43		
MW-33B		0737	47.60		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum Event ISCO PT Sampler SL/DG

Project No. ______ Datum TOC Sheet 1 of 2

WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-16	6/6/06	0712	50.81	~~50.81~~	
MW-15	"	0714	47.34		
MW-17	"	0717	47.61		
MW-18	"	0719	—		lid too tight
MW-26	"	0737	51.35		
MW-25	"	0742	46.74		
MW-32	"	0747	50.87		
MW-31	"	0749	46.48		
MW-30	"	0759	46.90		
MW-29	"	0809	46.33		
MW-27	"	0814	46.77		
MW-28	"	0817	46.90		
MW-24	"	0824	46.82		
MW-22	"	0829	47.85		
MW-19	"	0835	48.03		
MW-23	"	0840	48.17		
MW-3	"	0846	45.93		
SVE-1	"	0852	36.01		
MW-2	"	0853	48.79		
EW-2	"	0858	47.54		
EW-1	"	0907	47.42		
MW-33B	"	0909	47.02		
MW-33A	"	0912	46.73		
MW-20	"	0914	46.95		

URS CORPORATION

HYDRODATA SHEET

Project Cooper Drum

Event

Sampler SL/DG

Project No.

Datum TOC

Sheet 2 of 2

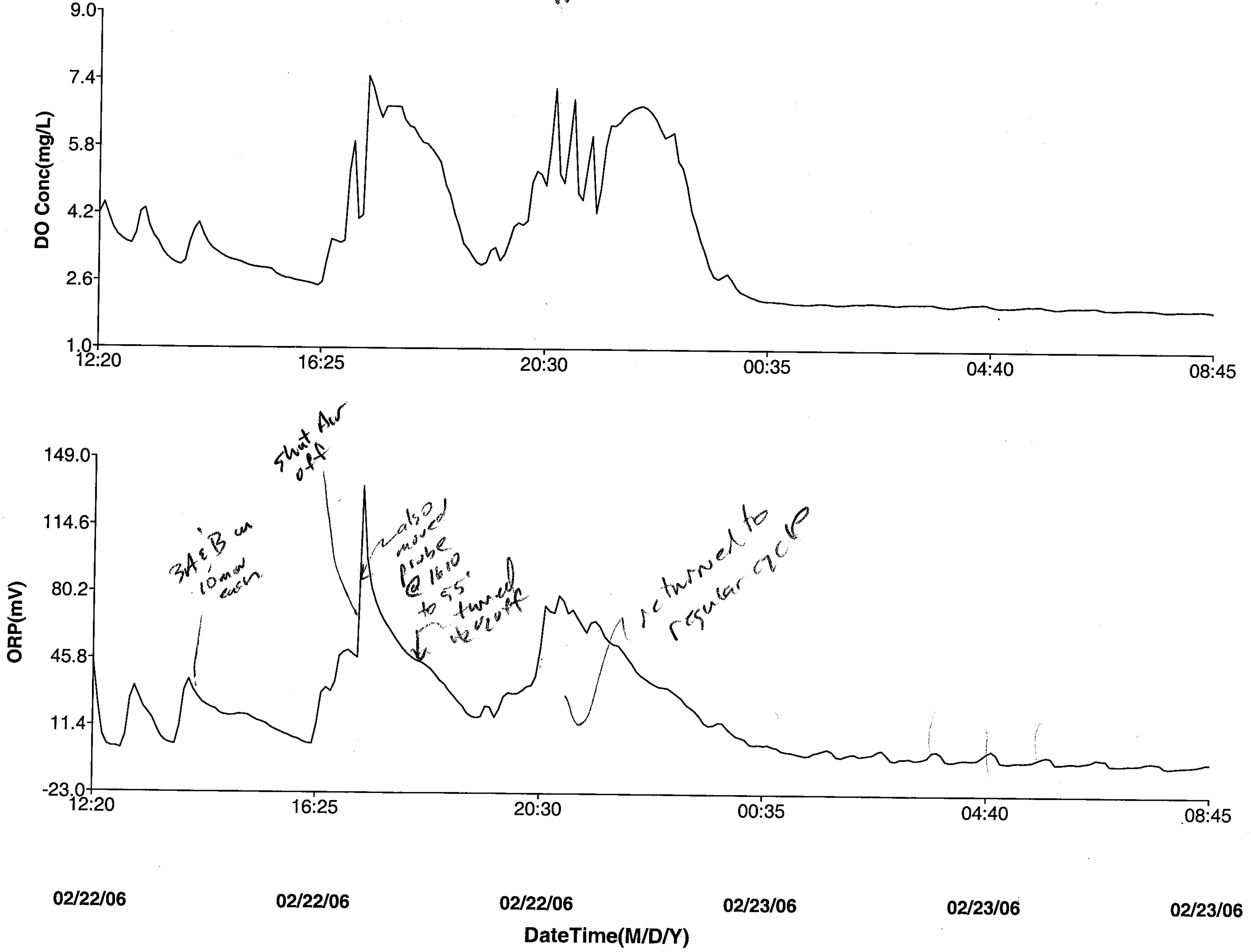
WELL or LOCATION	DATE	TIME	MEASUREMENT	TOTAL DEPTH	COMMENTS
MW-21	6/6/06	0920	47.64		
MW-5	"	0923	35.44		
MW-12	"	1000	48.35		
MW-10	"	1002	48.19		
MW-8	"	1015	47.15		
MW-14	"	1022	34.48		
MW-20B	"	1055	46.82		
MW-1	"	1410	44.12		
MW-4	"				beneath pallets

APPENDIX E

Downhole DO and ORP Data

FEB21T~1.DAT

MW-20



3A & B on 10 min each

Shut Air off

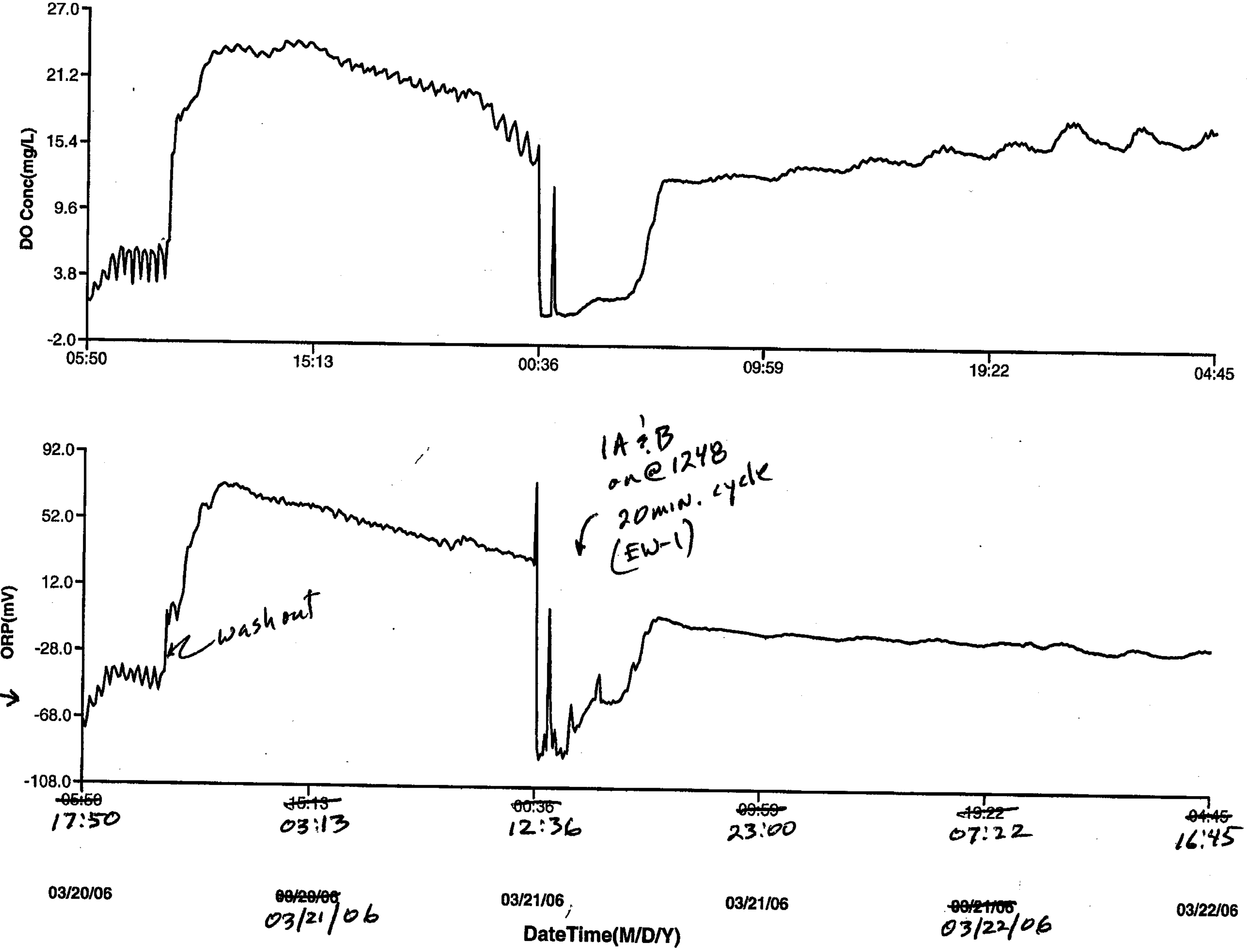
also moved probe @ 1610 to 55'

turned oz off

returned to regular ocp

MW-20 & EW-1 @ 63 ft

(page 1 of 4)



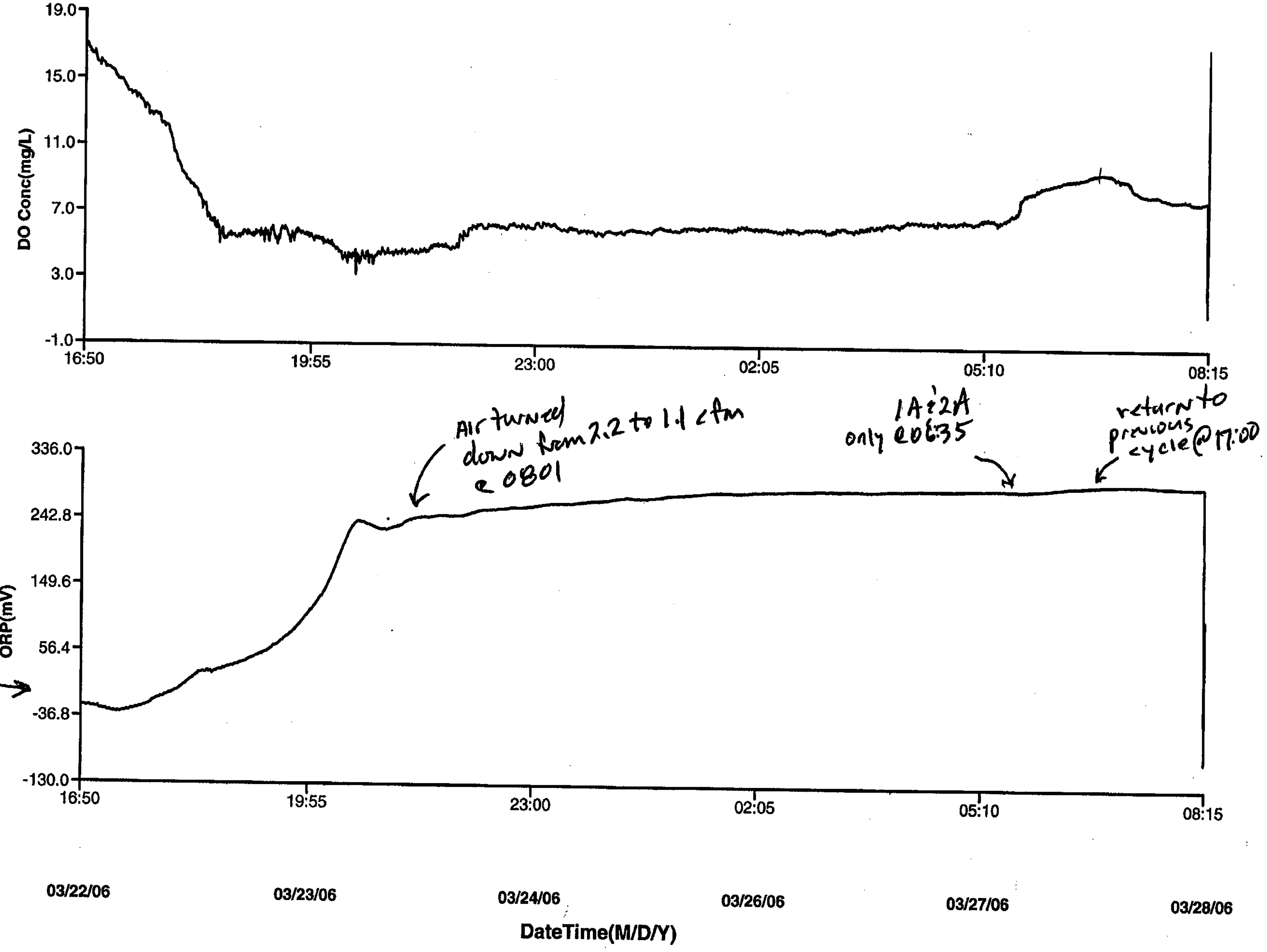
3A & B on @ 1738 20 min. cycle (MW 20)

washout

1A & B on @ 1248 20 min. cycle (EW-1)

EW-1 @ 63 ft (continued)

(page 2 of 4)



1A & B
2A & B
on @ 1655
30 min. cycle

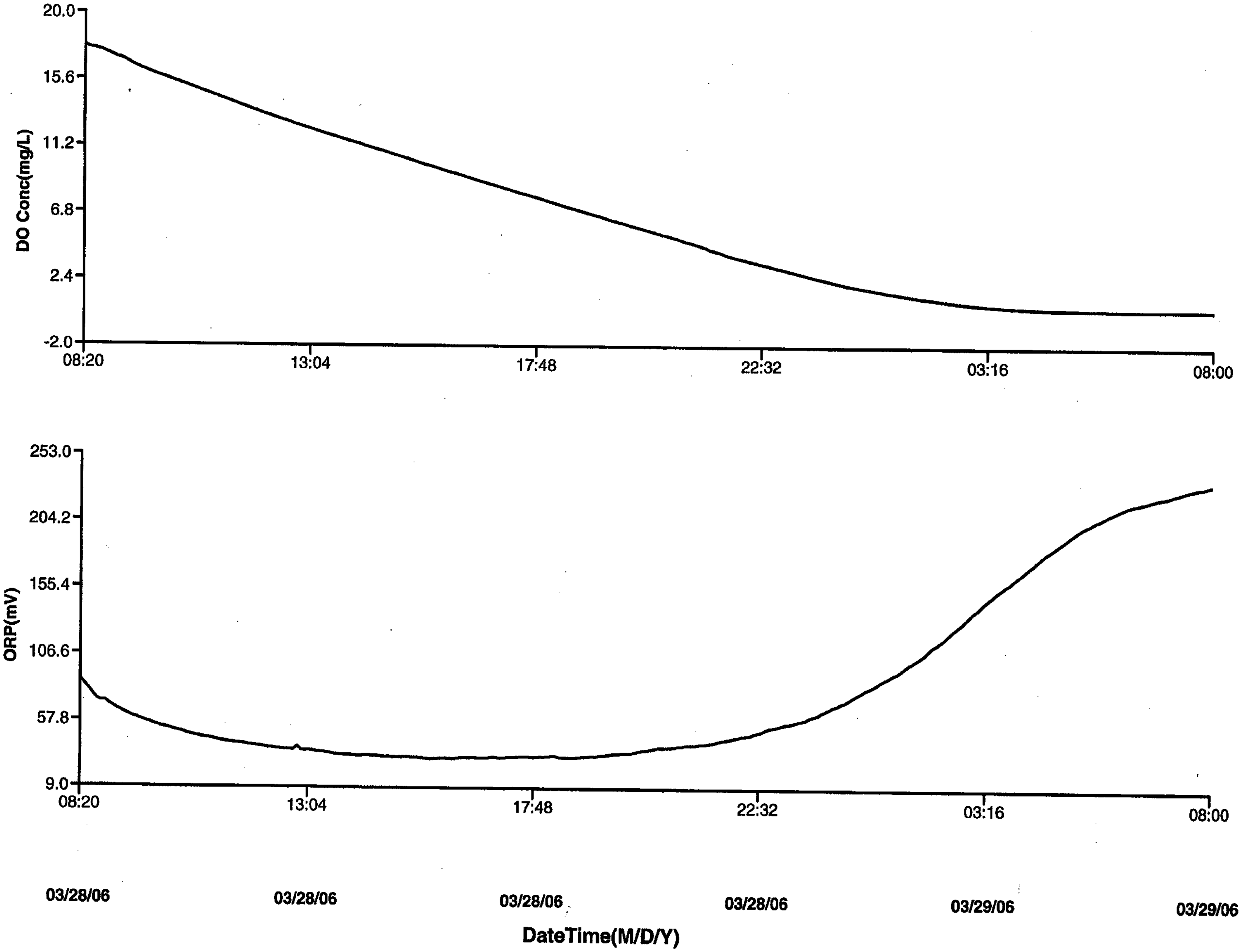
Air turned down from 2.2 to 1.1 cfm @ 0801

1A & 2A only @ 06:35

return to previous cycle @ 17:00

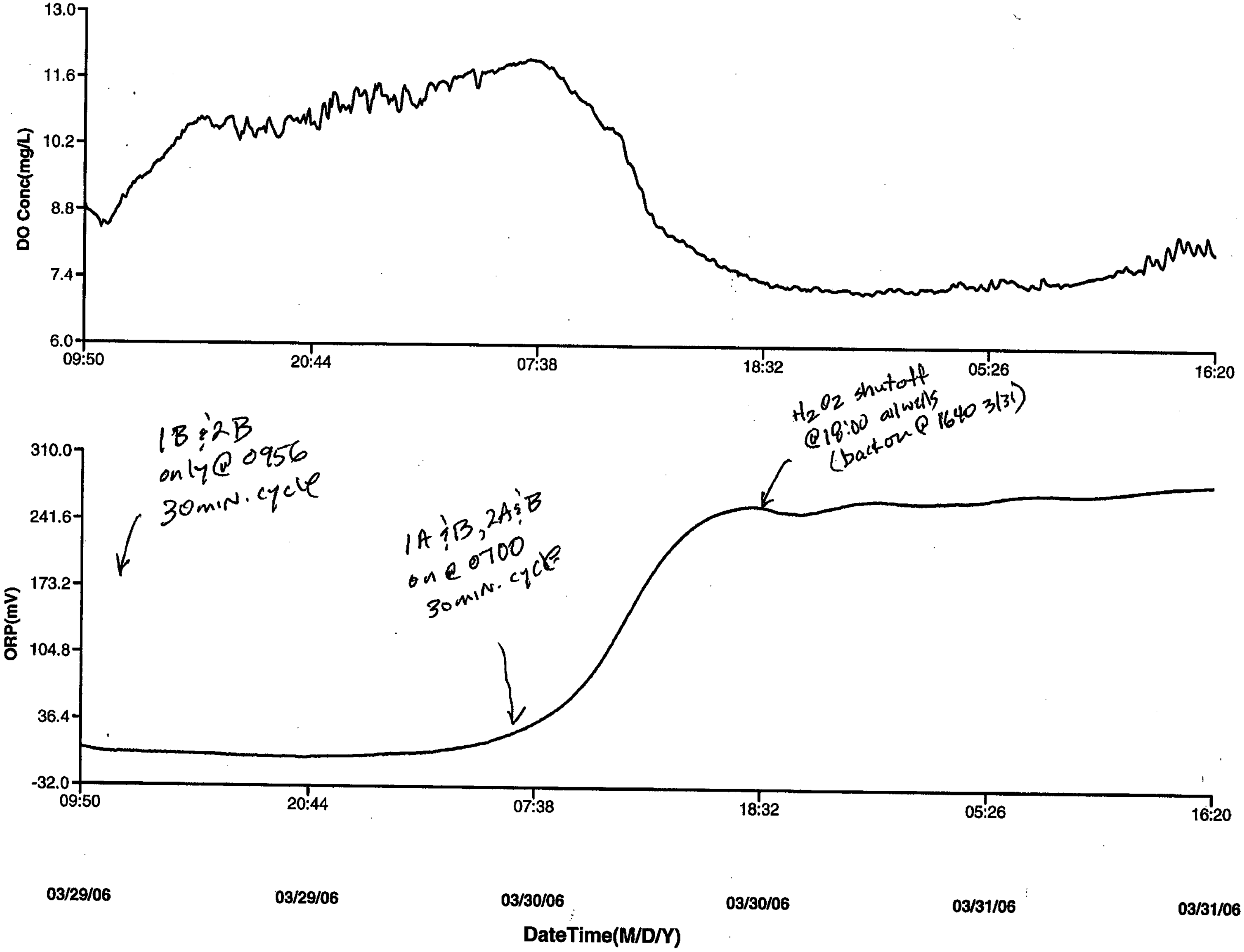
MW-33A

(page 3 of 4)



Back to EW-1 @ 63 ft

(page 4 of 4)

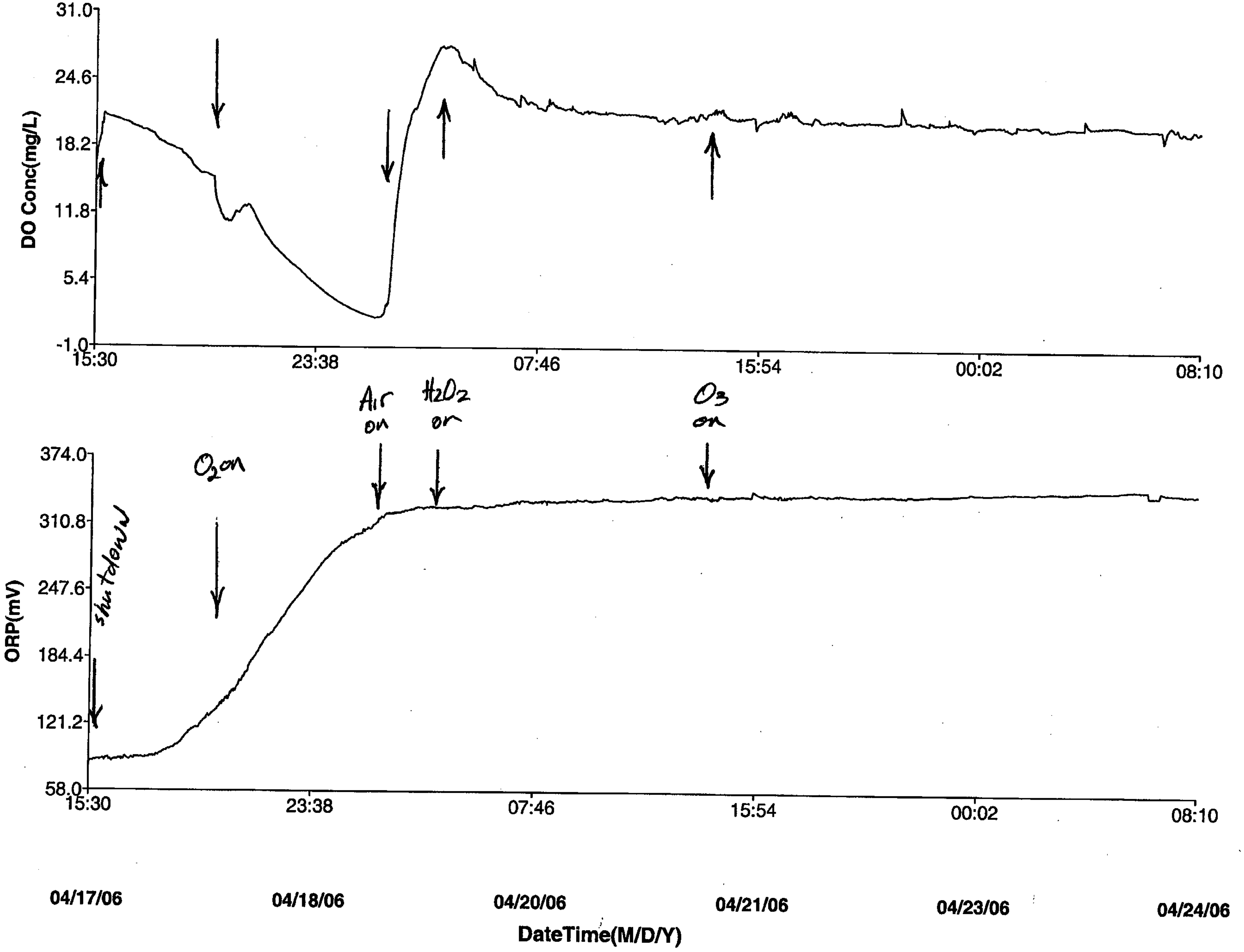


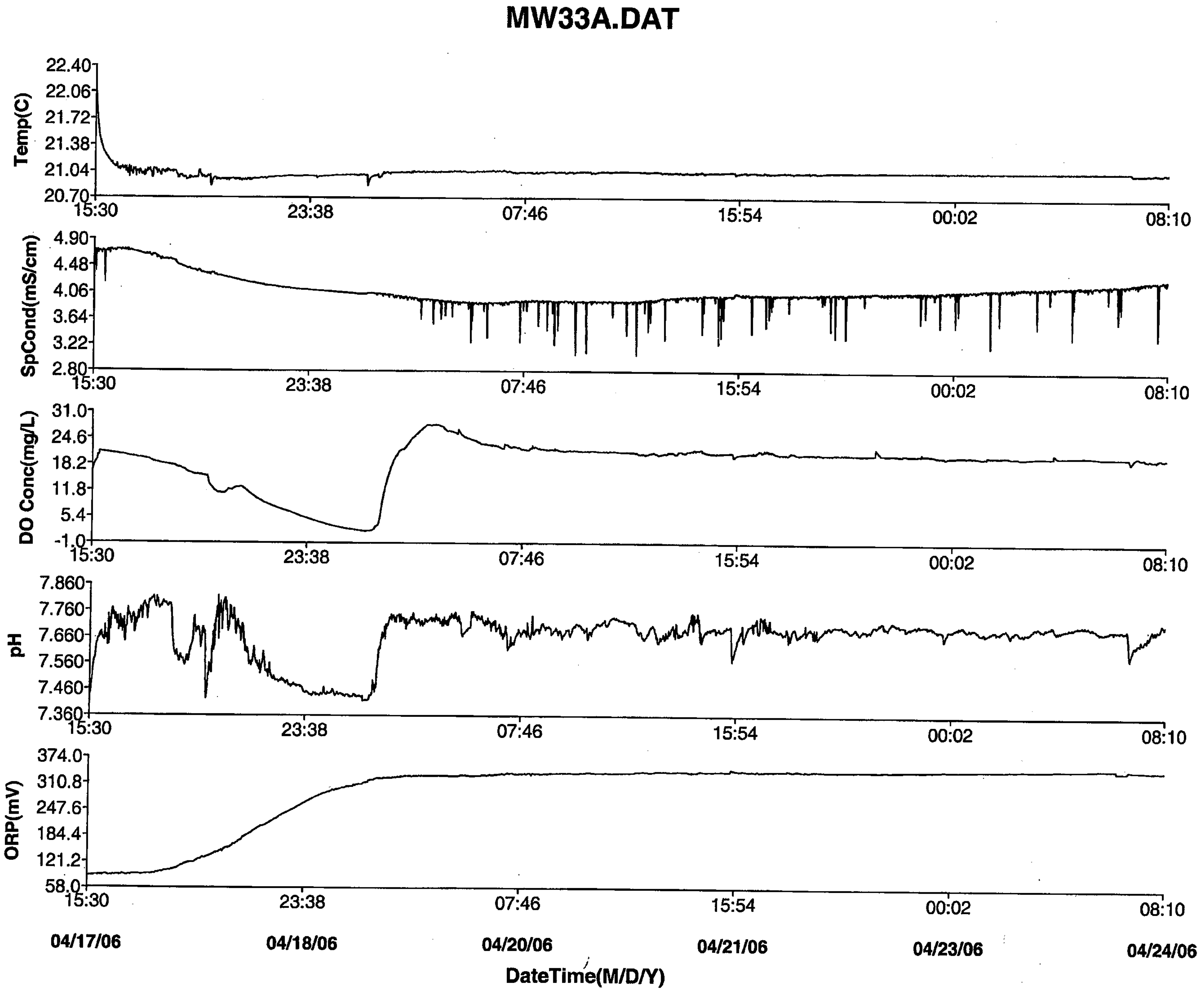
1B & 2B
only @ 0956
30min. cycle

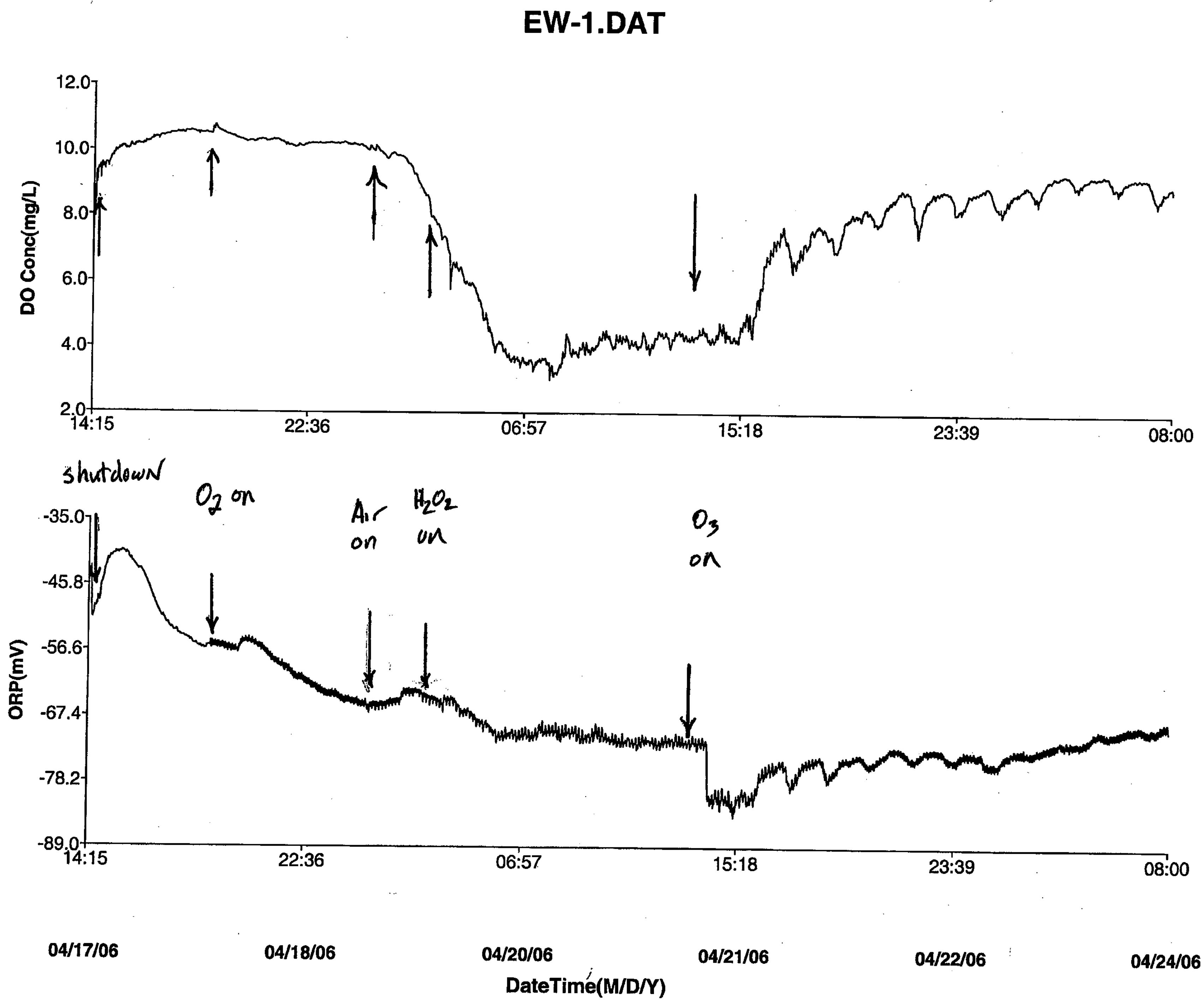
1A & 1B, 2A & B
on @ 0700
30min. cycle

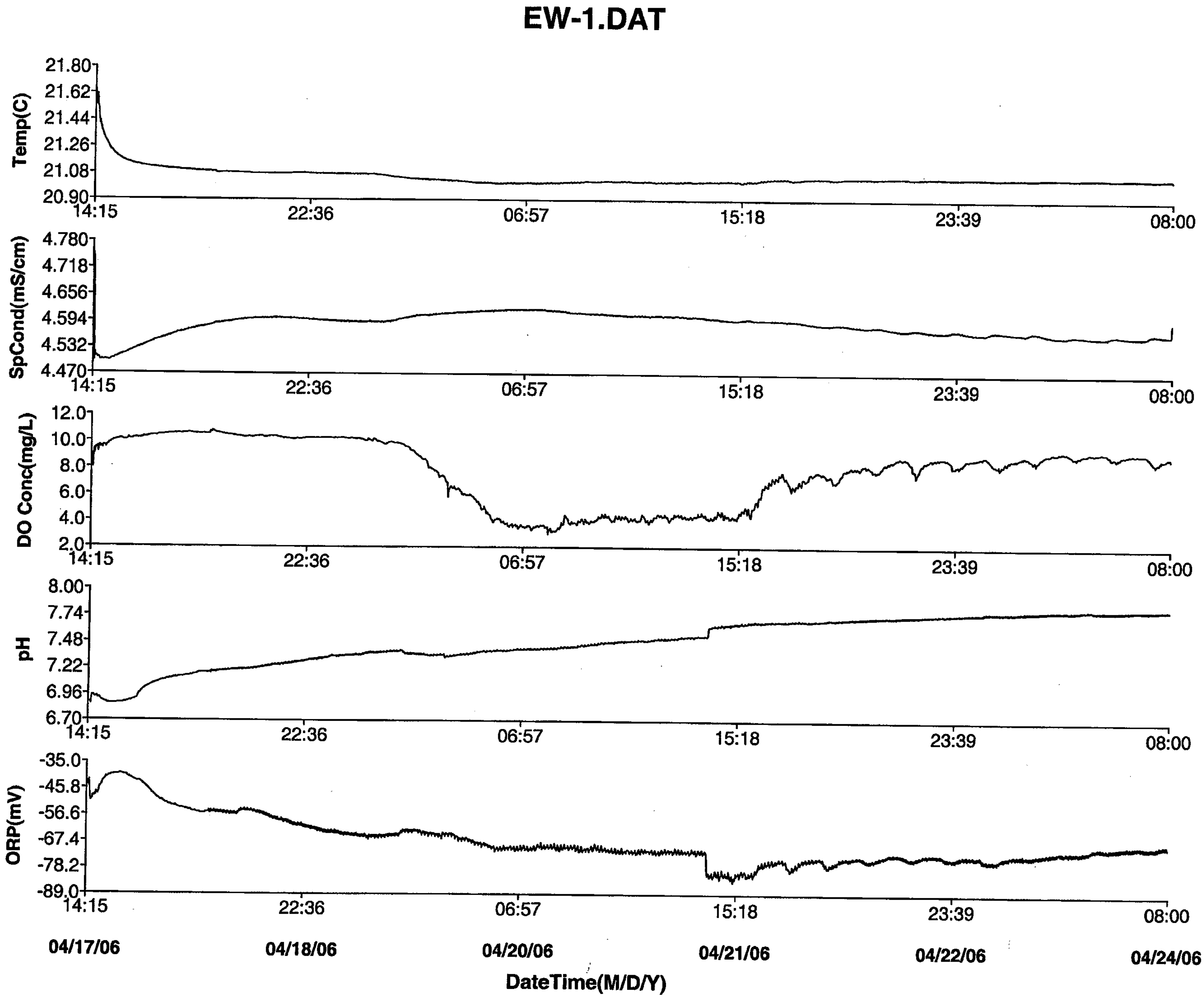
H_2O_2 shutoff
@18:00 all wells
(back on @ 1640 3/31)

MW33A.DAT

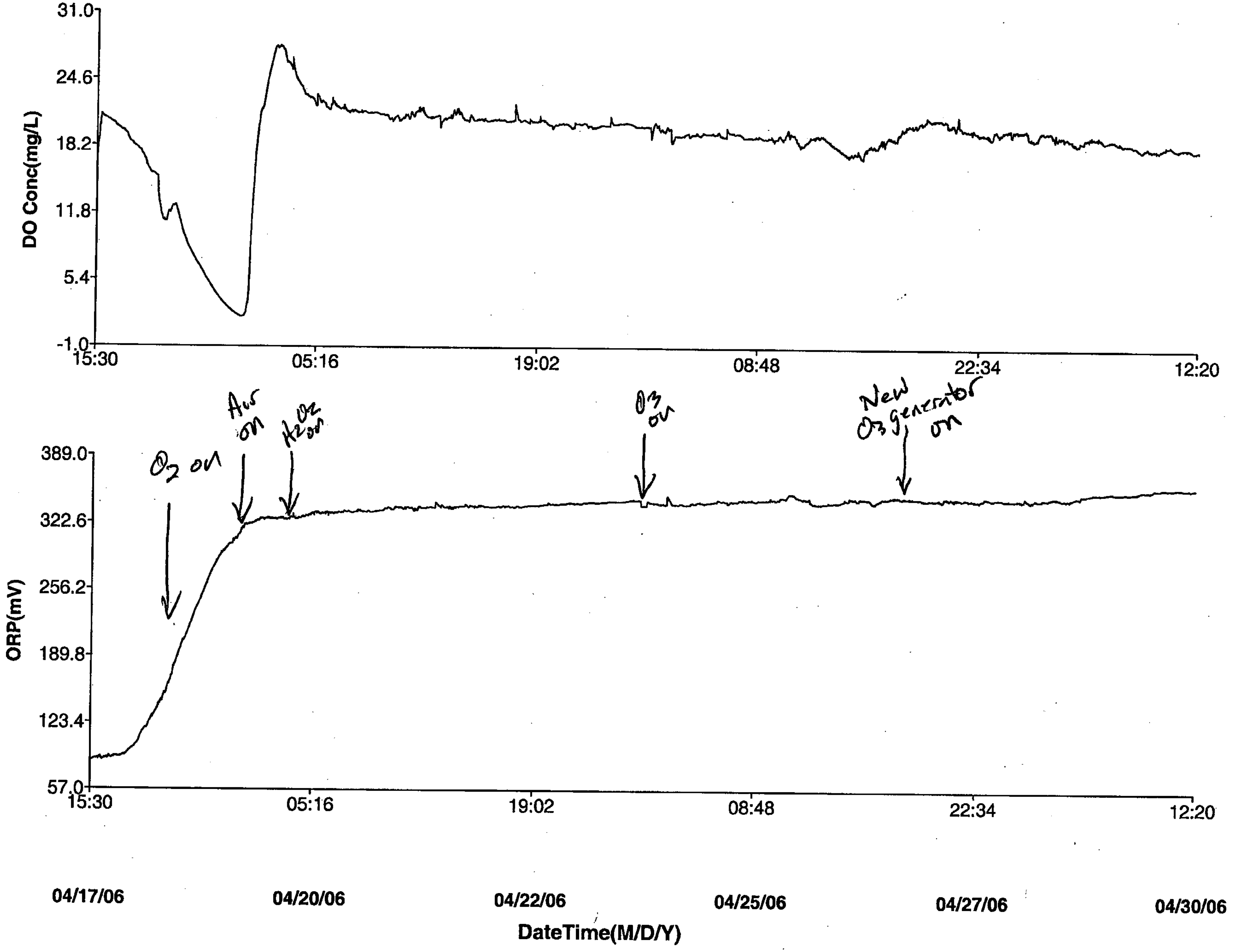

DO Conc(mg/L)
31.0
24.6
18.2
11.8
5.4
-1.0
15:30
23:38
07:46
15:54
00:02
08:10
Air on
H2O2 on
O3 on
ORP(mV)
374.0
310.8
247.6
184.4
121.2
58.0
O2 on
shutdown
15:30
23:38
07:46
15:54
00:02
08:10
04/17/06
04/18/06
04/20/06
04/21/06
04/23/06
04/24/06
DateTime(M/D/Y)


MW33A.DAT
Temp(C)
22.40
22.06
21.72
21.38
21.04
20.70
SpCond(mS/cm)
4.90
4.48
4.06
3.64
3.22
2.80
DO Conc(mg/L)
31.0
24.6
18.2
11.8
5.4
-1.0
pH
7.860
7.760
7.660
7.560
7.460
7.360
ORP(mV)
374.0
310.8
247.6
184.4
121.2
58.0
15:30
23:38
07:46
15:54
00:02
08:10
04/17/06
04/18/06
04/20/06
04/21/06
04/23/06
04/24/06
DateTime(M/D/Y)

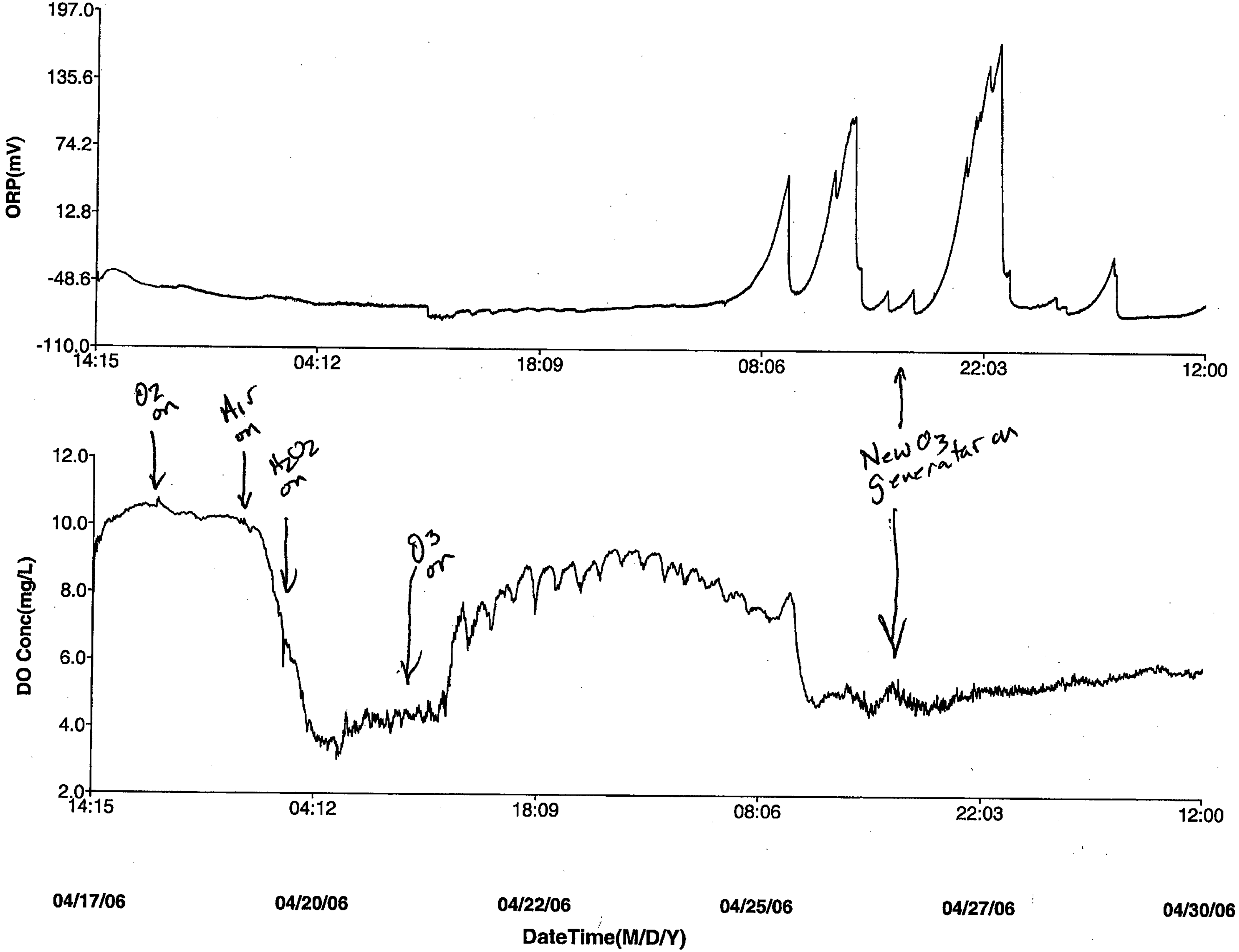

EW-1.DAT
DO Conc(mg/L)
12.0
10.0
8.0
6.0
4.0
2.0
14:15
22:36
06:57
15:18
23:39
08:00
shutdown
O_2 on
Air on
H_2O_2 on
O_3 on
ORP(mV)
-35.0
-45.8
-56.6
-67.4
-78.2
-89.0
14:15
22:36
06:57
15:18
23:39
08:00
04/17/06
04/18/06
04/20/06
04/21/06
04/22/06
04/24/06
DateTime(M/D/Y)

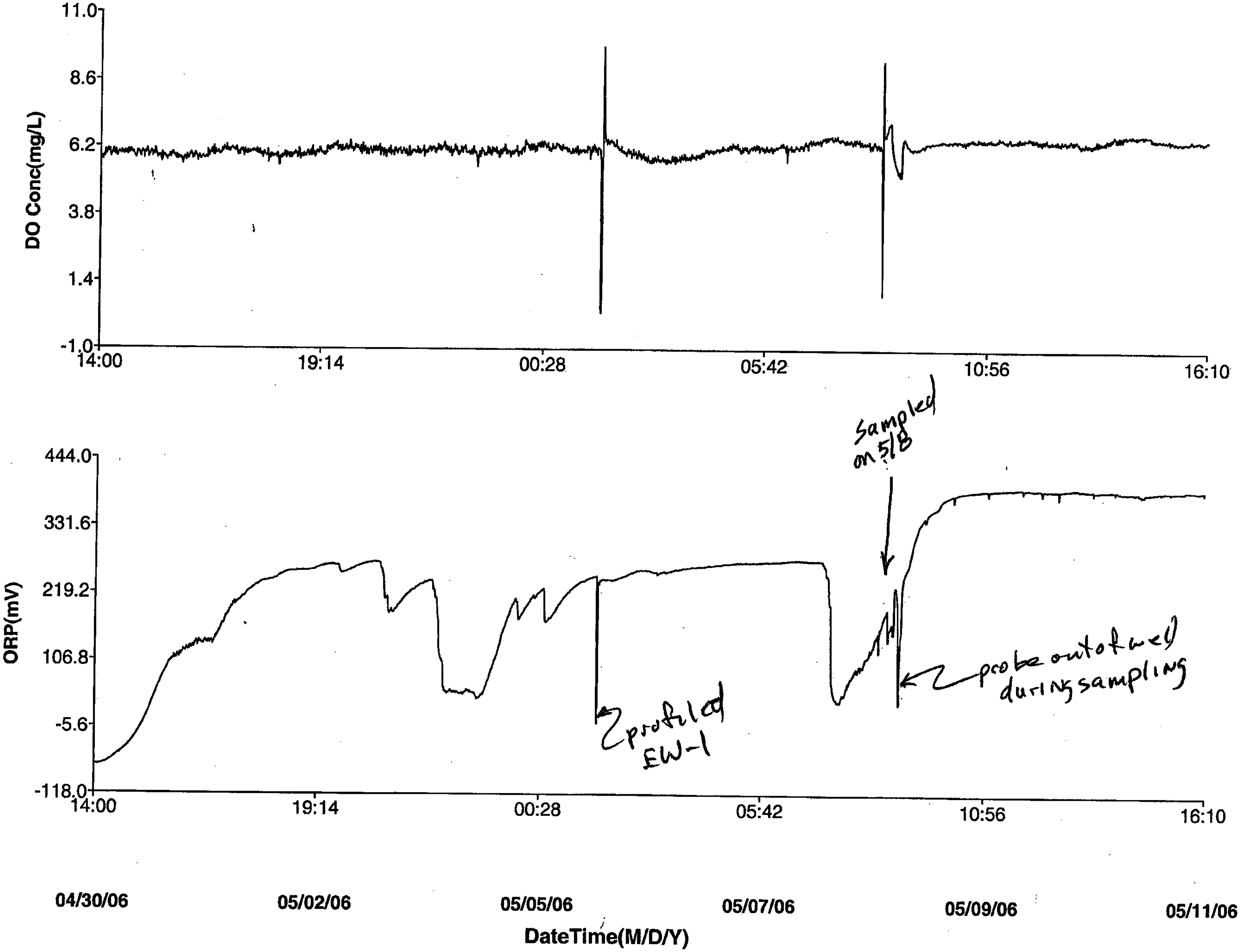

EW-1.DAT
Temp(C)
21.80
21.62
21.44
21.26
21.08
20.90
SpCond(mS/cm)
4.780
4.718
4.656
4.594
4.532
4.470
DO Conc(mg/L)
12.0
10.0
8.0
6.0
4.0
2.0
pH
8.00
7.74
7.48
7.22
6.96
6.70
ORP(mV)
-35.0
-45.8
-56.6
-67.4
-78.2
-89.0
14:15
22:36
06:57
15:18
23:39
08:00
04/17/06
04/18/06
04/20/06
04/21/06
04/22/06
04/24/06
DateTime(M/D/Y)

MW33A.DAT


31.0
24.6
18.2
11.8
5.4
-1.0
DO Conc(mg/L)
15:30
05:16
19:02
08:48
22:34
12:20
389.0
322.6
256.2
189.8
123.4
57.0
ORP(mV)
O_2 on
Air on
H_2O_2 on
O_3 on
New O_3 generator on
15:30
05:16
19:02
08:48
22:34
12:20
04/17/06
04/20/06
04/22/06
04/25/06
04/27/06
04/30/06
DateTime(M/D/Y)

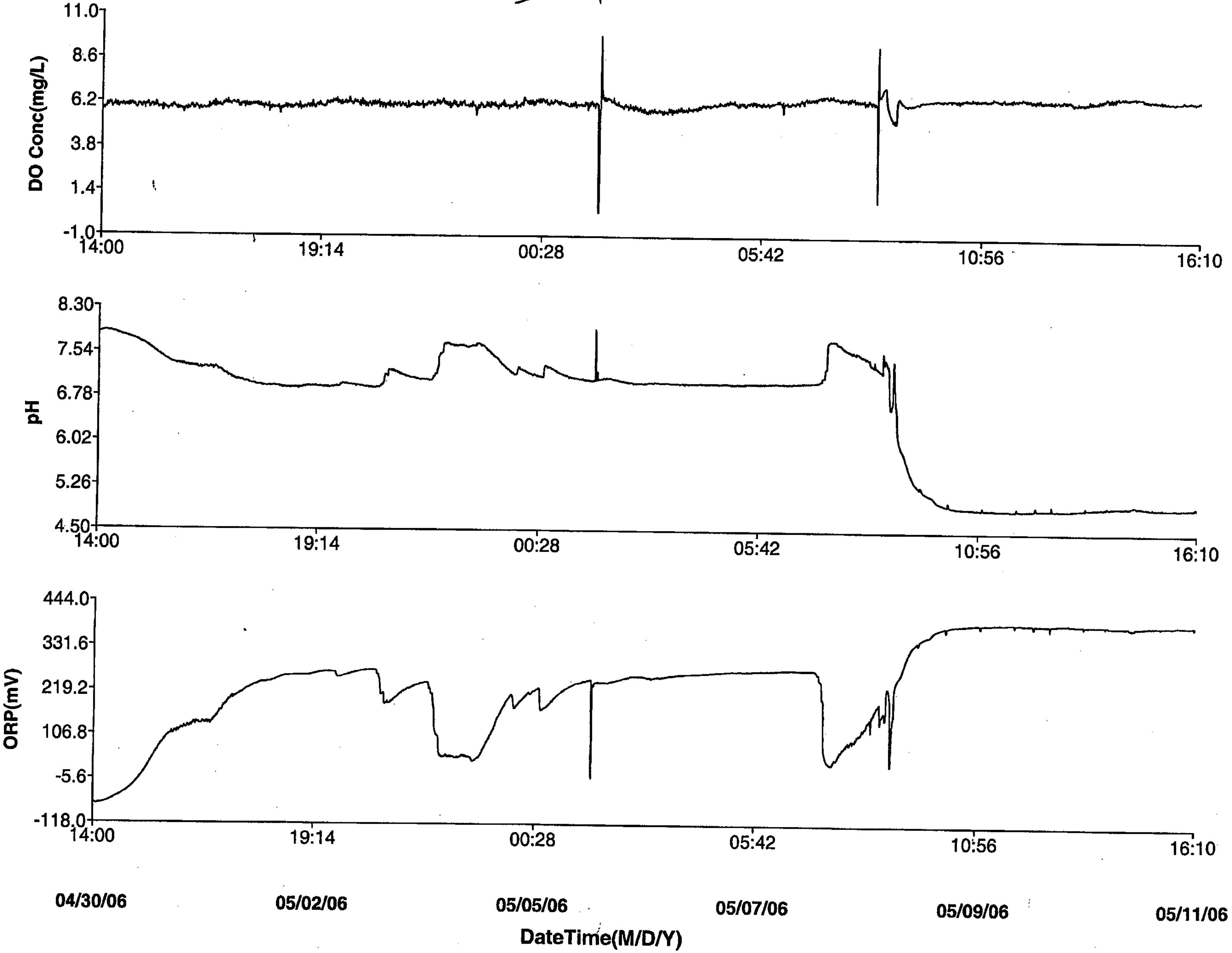
EWIDAT.DAT


ORP(mV)
197.0
135.6
74.2
12.8
-48.6
-110.0
14:15
04:12
18:09
08:06
22:03
12:00
O2 on
Air on
H2O2 on
O3 on
New O3 Generator on
DO Conc(mg/L)
12.0
10.0
8.0
6.0
4.0
2.0
14:15
04:12
18:09
08:06
22:03
12:00
04/17/06
04/20/06
04/22/06
04/25/06
04/27/06
04/30/06
DateTime(M/D/Y)

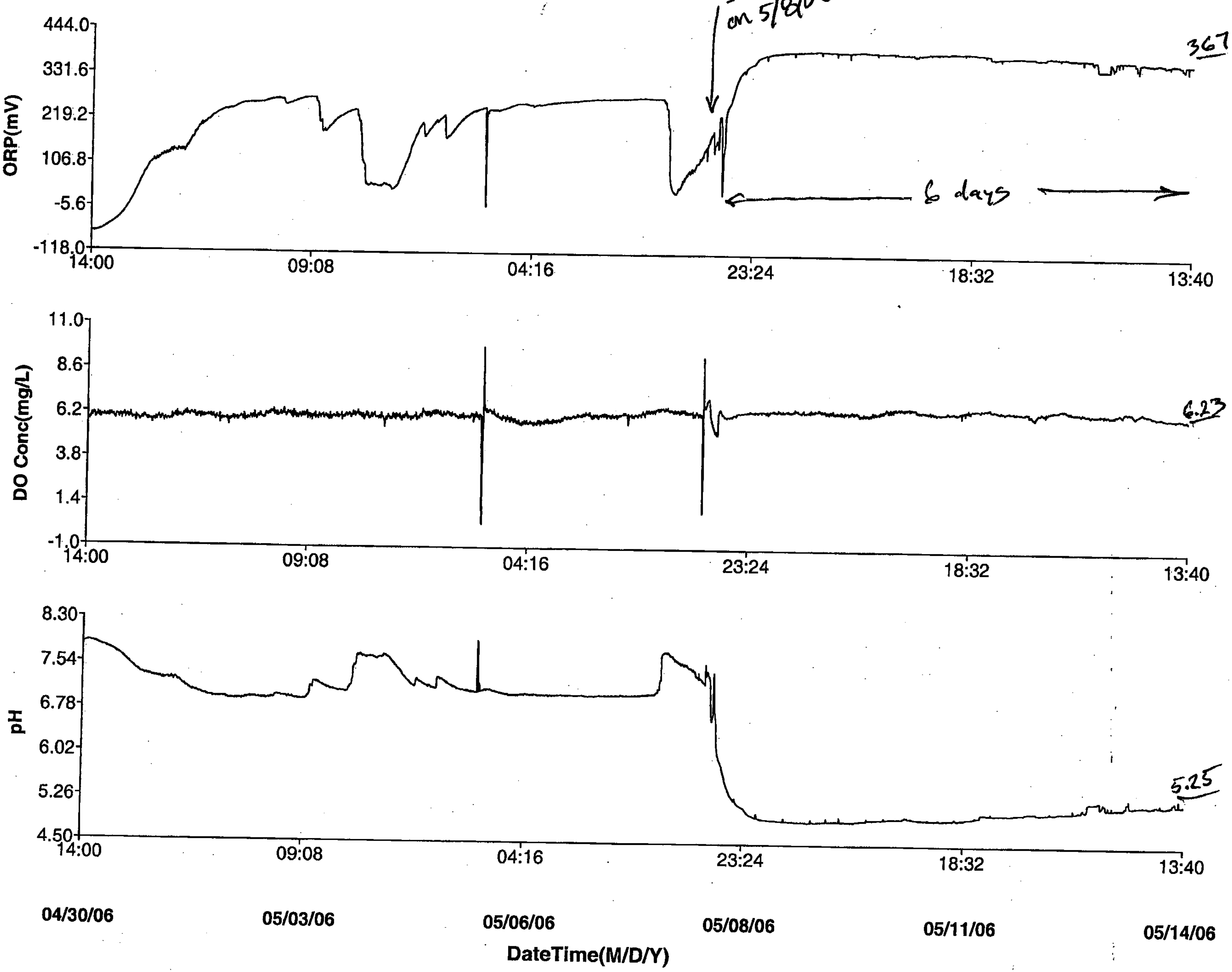
~~~6240193~~.DAT

EW-1


~~~

~~6240193~~.DAT

EW-1



EW1B.DAT



sampled on 5/8/06

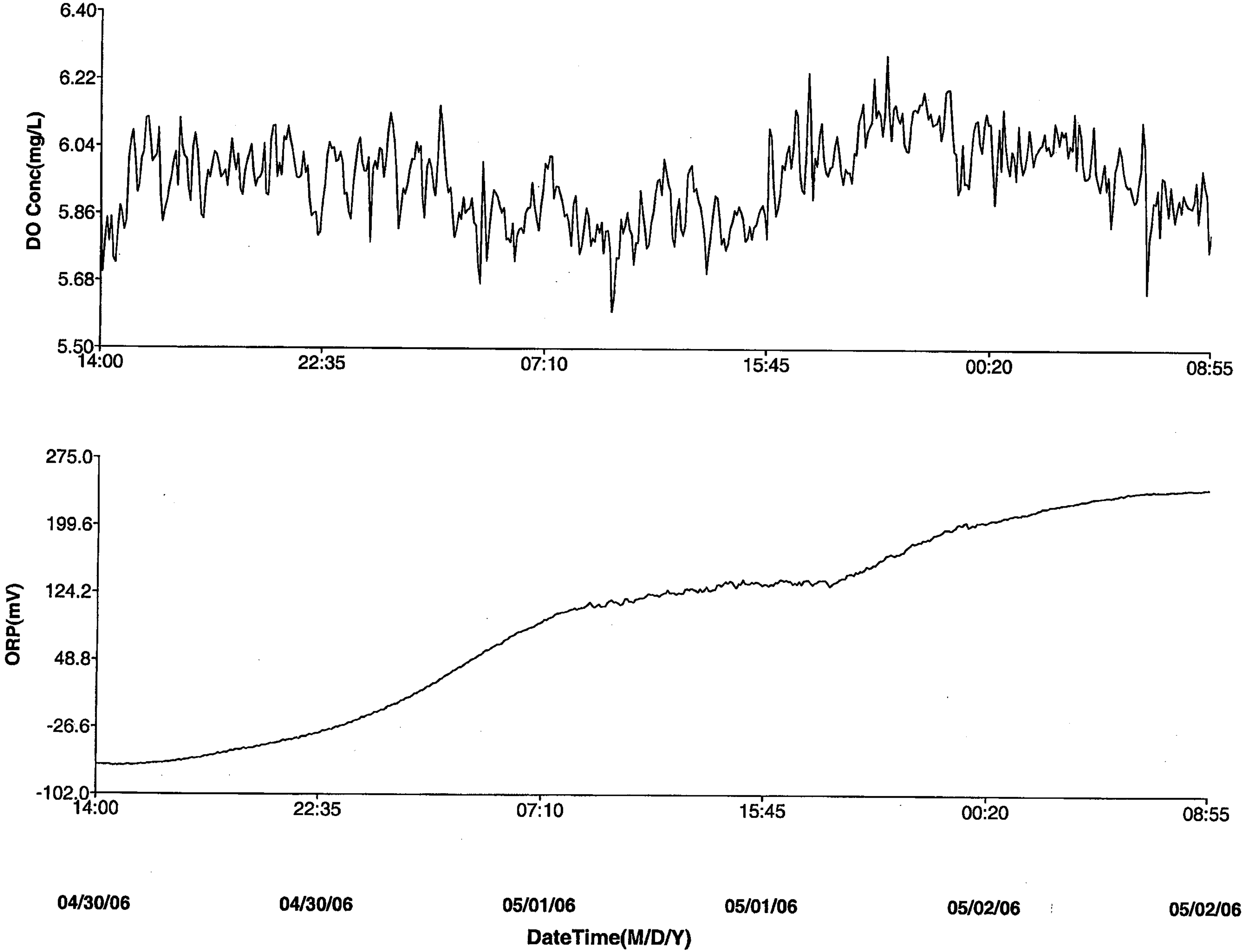
6 days

367

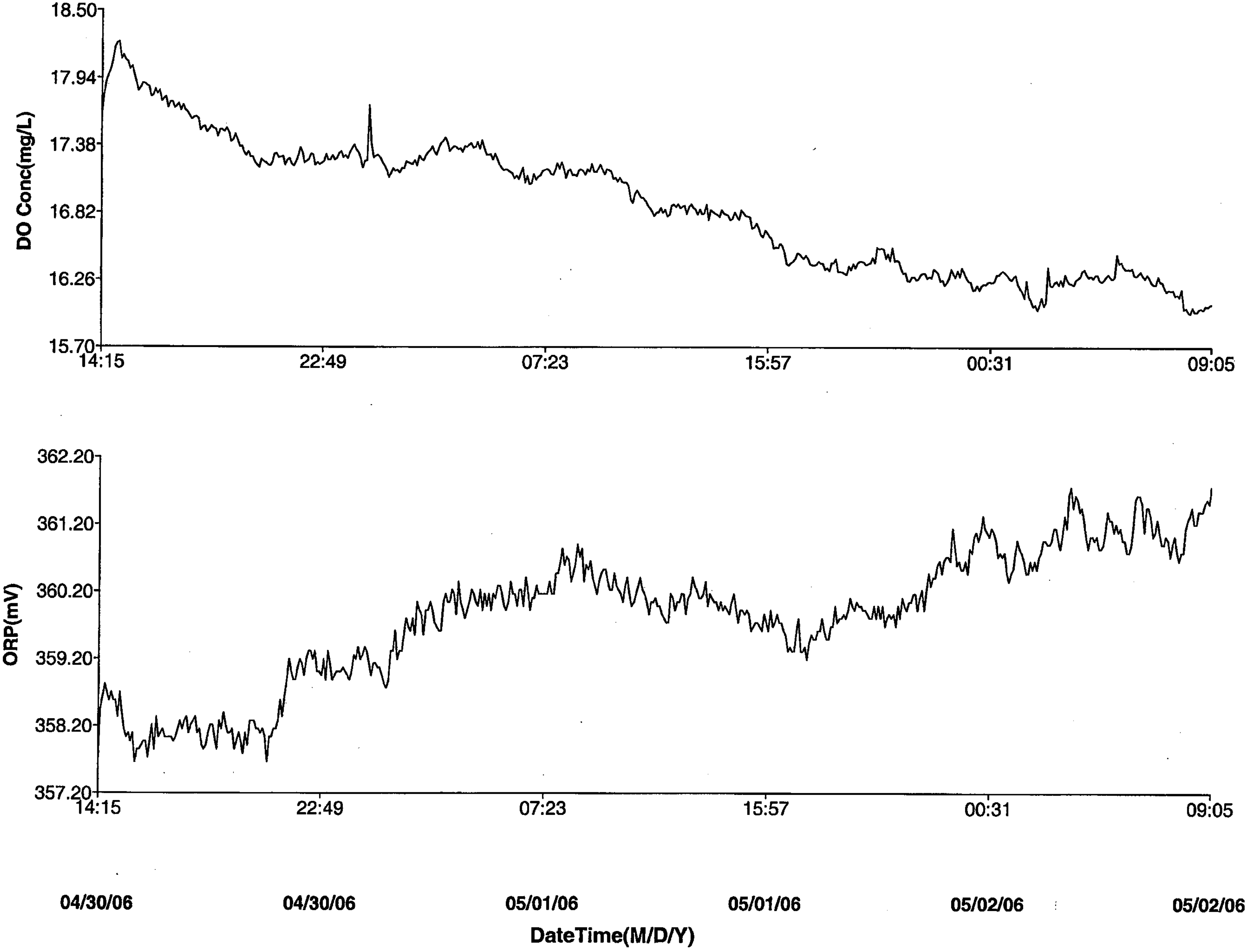
6.23

5.25

EW1B.DAT

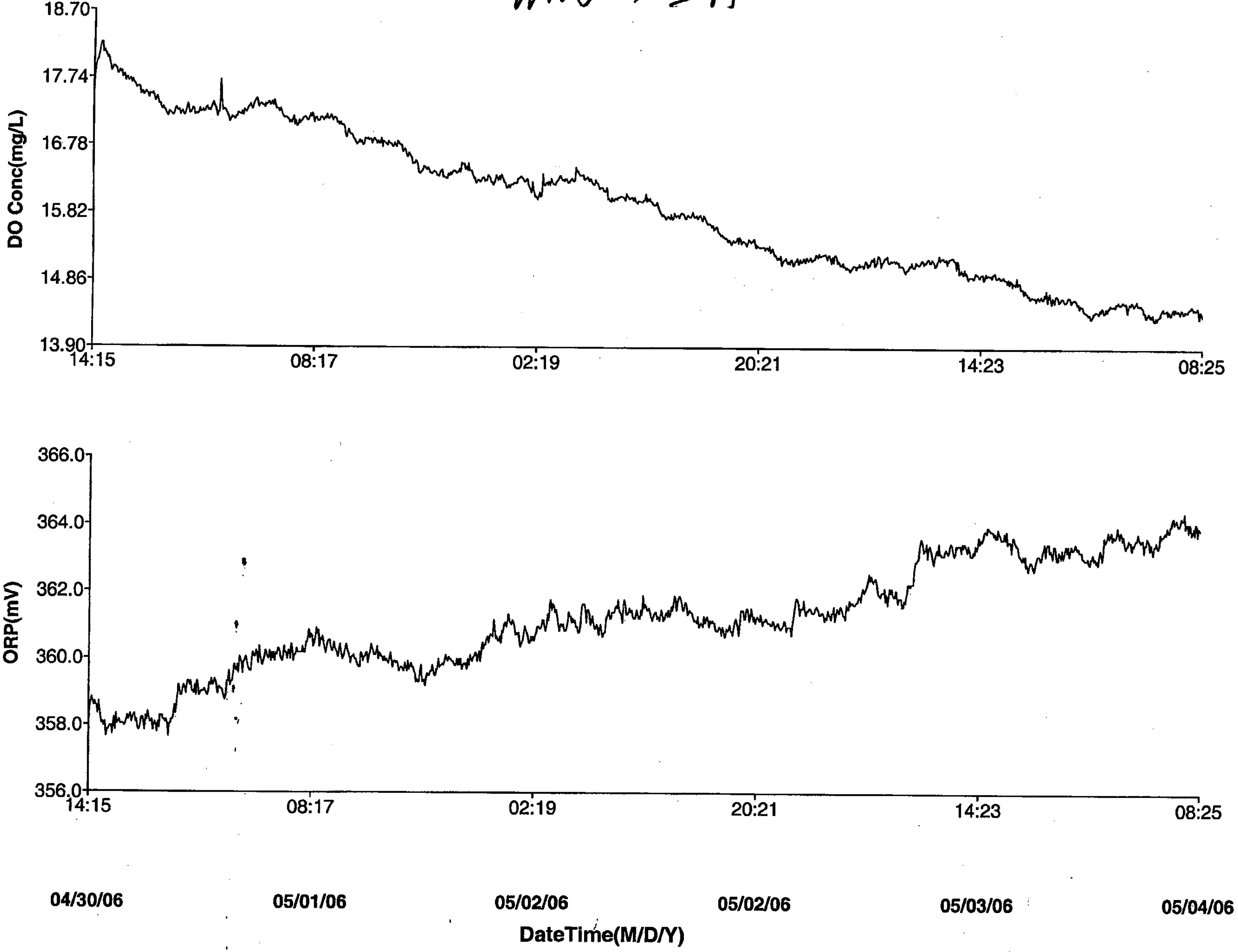

6.40
6.22
6.04
5.86
5.68
5.50
DO Conc(mg/L)
14:00
22:35
07:10
15:45
00:20
08:55
275.0
199.6
124.2
48.8
-26.6
-102.0
ORP(mV)
14:00
22:35
07:10
15:45
00:20
08:55
04/30/06
04/30/06
05/01/06
05/01/06
05/02/06
05/02/06
DateTime(M/D/Y)

MW33A2.DAT


18.50
17.94
17.38
16.82
16.26
15.70
DO Conc(mg/L)
14:15
22:49
07:23
15:57
00:31
09:05
362.20
361.20
360.20
359.20
358.20
357.20
ORP(mV)
14:15
22:49
07:23
15:57
00:31
09:05
04/30/06
04/30/06
05/01/06
05/01/06
05/02/06
05/02/06
DateTime(M/D/Y)

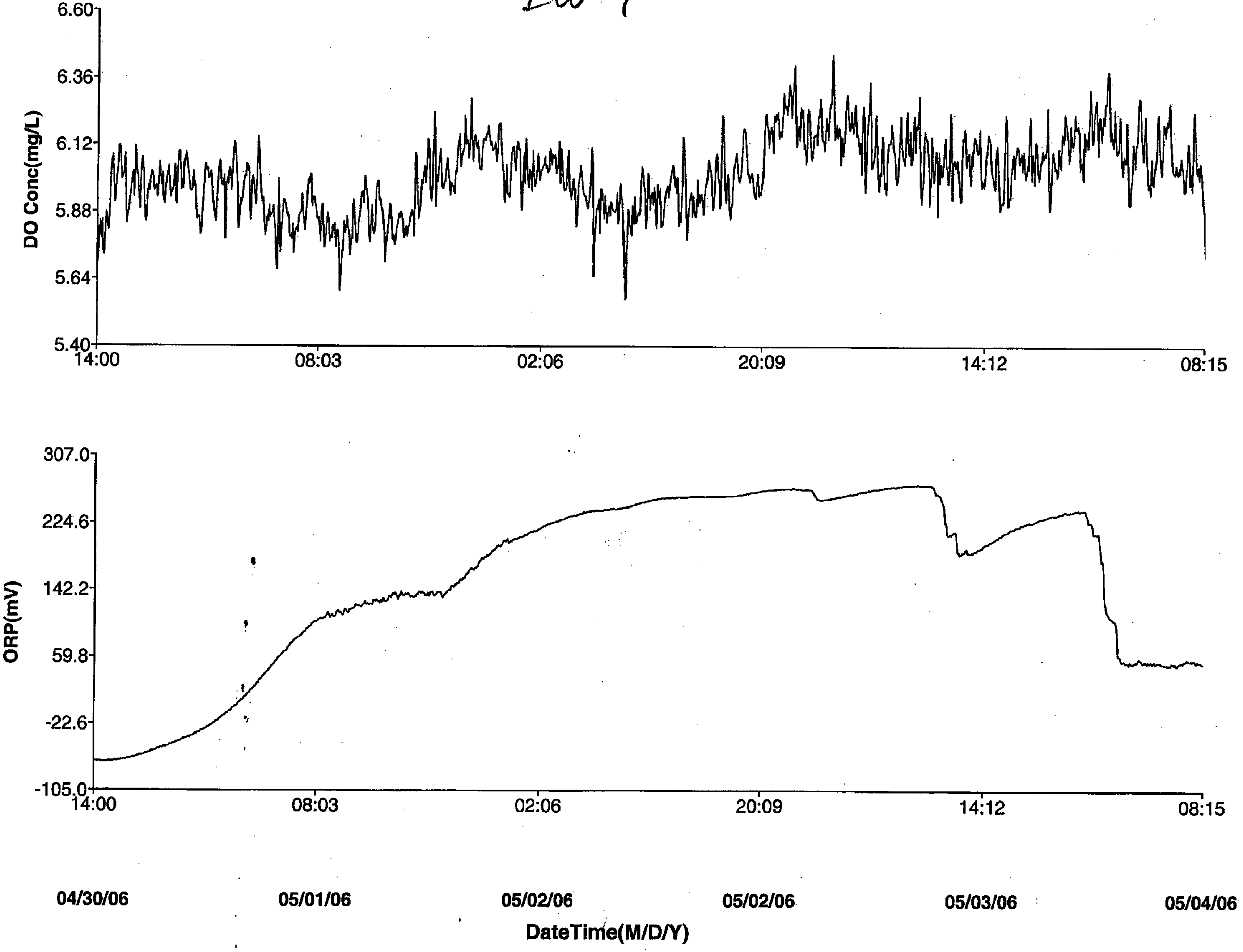
~~97[illegible].DAT~~

MW-33A


DO Conc(mg/L)
18.70
17.74
16.78
15.82
14.86
13.90
14:15
08:17
02:19
20:21
14:23
08:25
ORP(mV)
366.0
364.0
362.0
360.0
358.0
356.0
14:15
08:17
02:19
20:21
14:23
08:25
04/30/06
05/01/06
05/02/06
05/02/06
05/03/06
05/04/06
DateTime(M/D/Y)

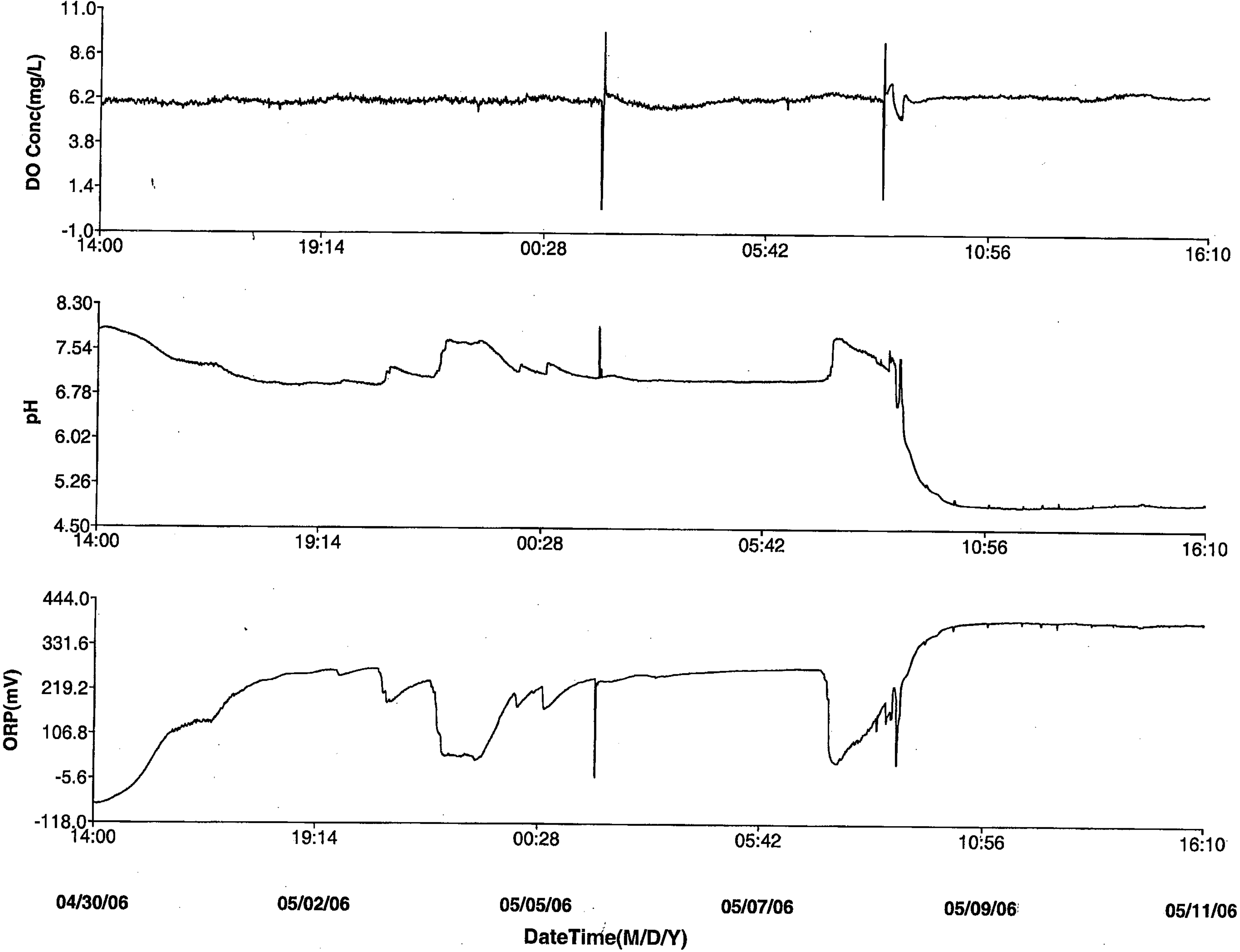
~~055[illegible].DAT~~

EW-1

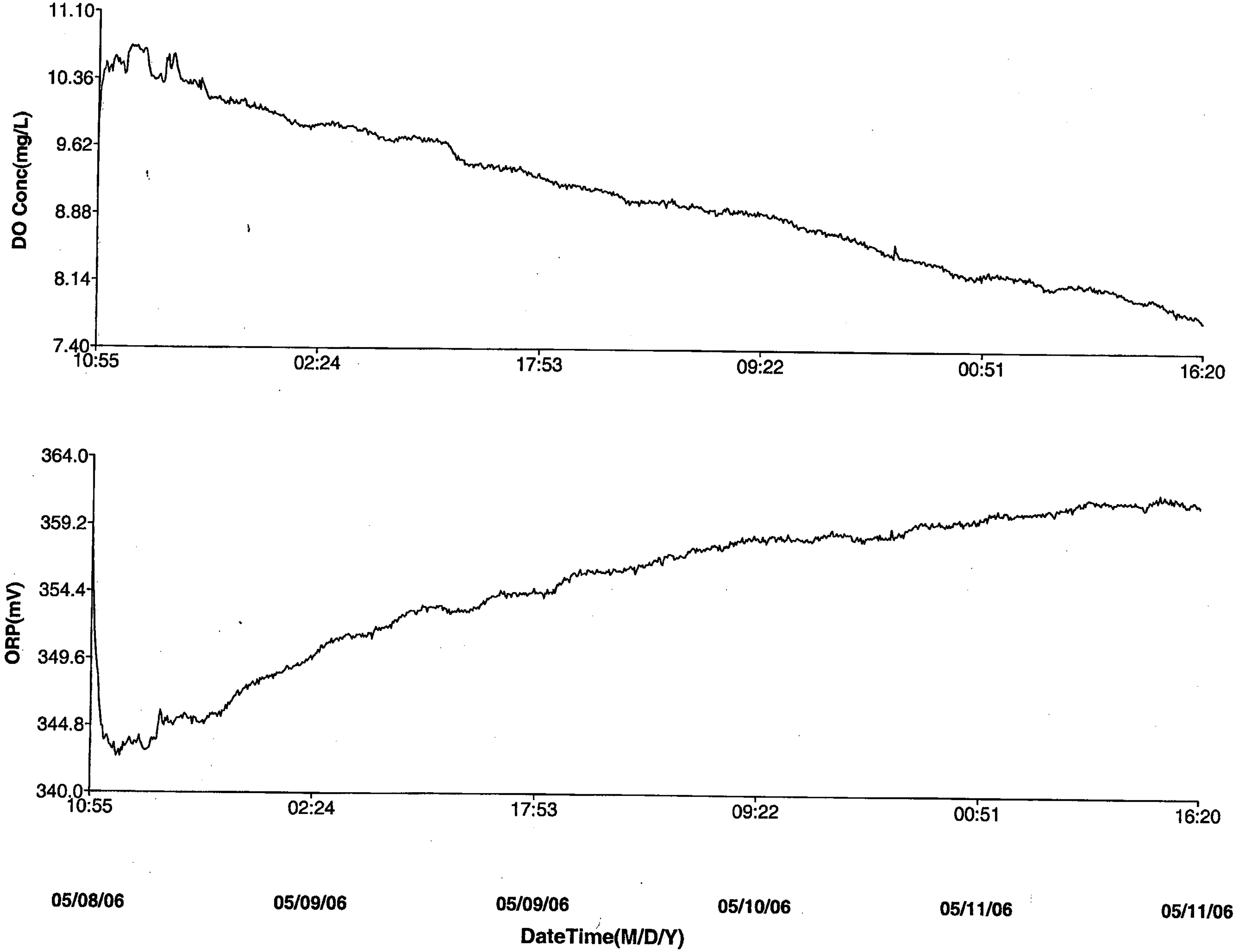

6.60
6.36
6.12
5.88
5.64
5.40
DO Conc(mg/L)
14:00
08:03
02:06
20:09
14:12
08:15
307.0
224.6
142.2
59.8
-22.6
-105.0
ORP(mV)
14:00
08:03
02:06
20:09
14:12
08:15
04/30/06
05/01/06
05/02/06
05/02/06
05/03/06
05/04/06
DateTime(M/D/Y)

~~6240193~~.DAT

EW-1

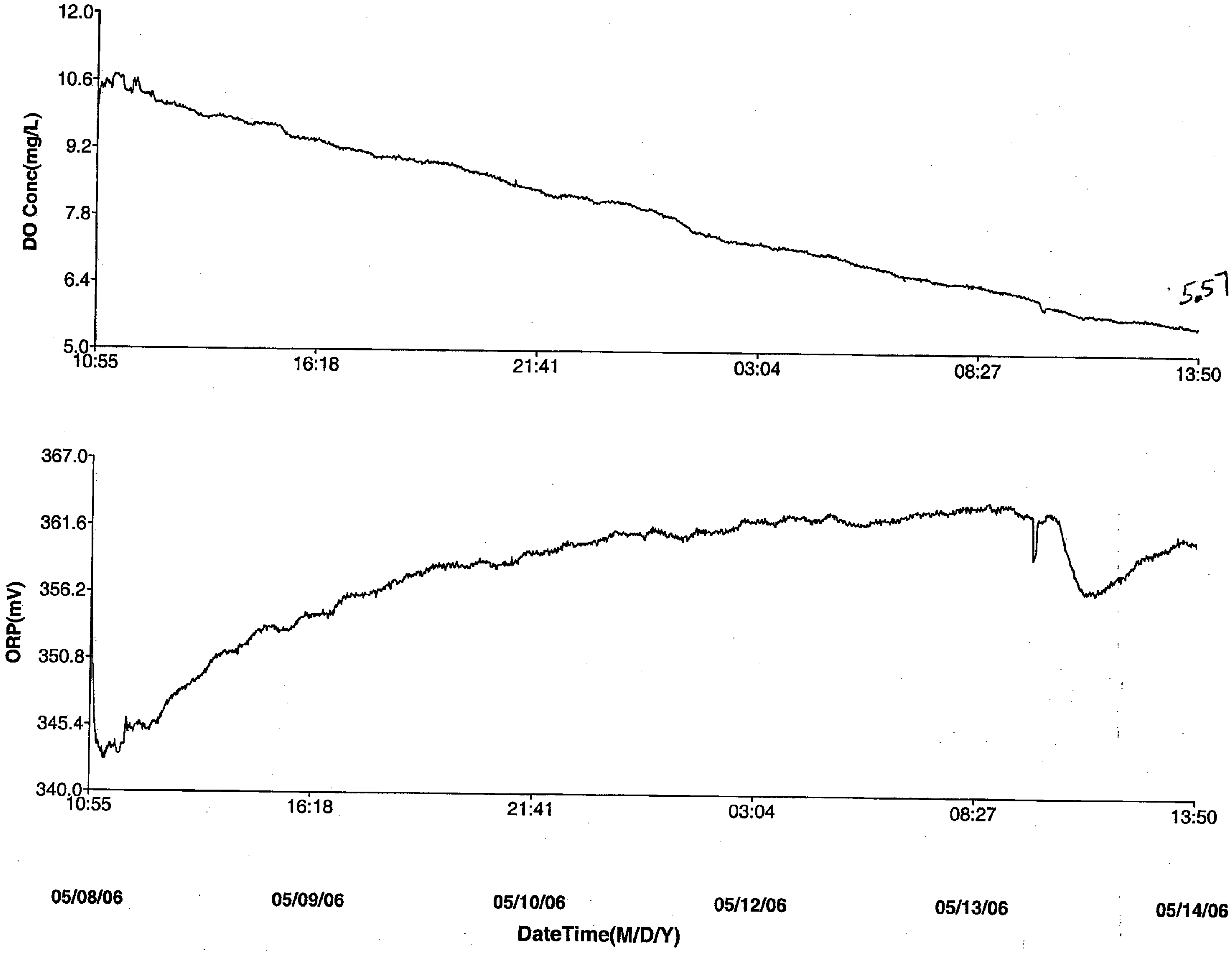


MW33A3.DAT



DO Conc(mg/L)
11.10
10.36
9.62
8.88
8.14
7.40
10:55
02:24
17:53
09:22
00:51
16:20
ORP(mV)
364.0
359.2
354.4
349.6
344.8
340.0
10:55
02:24
17:53
09:22
00:51
16:20
05/08/06
05/09/06
05/09/06
05/10/06
05/11/06
05/11/06
DateTime(M/D/Y)

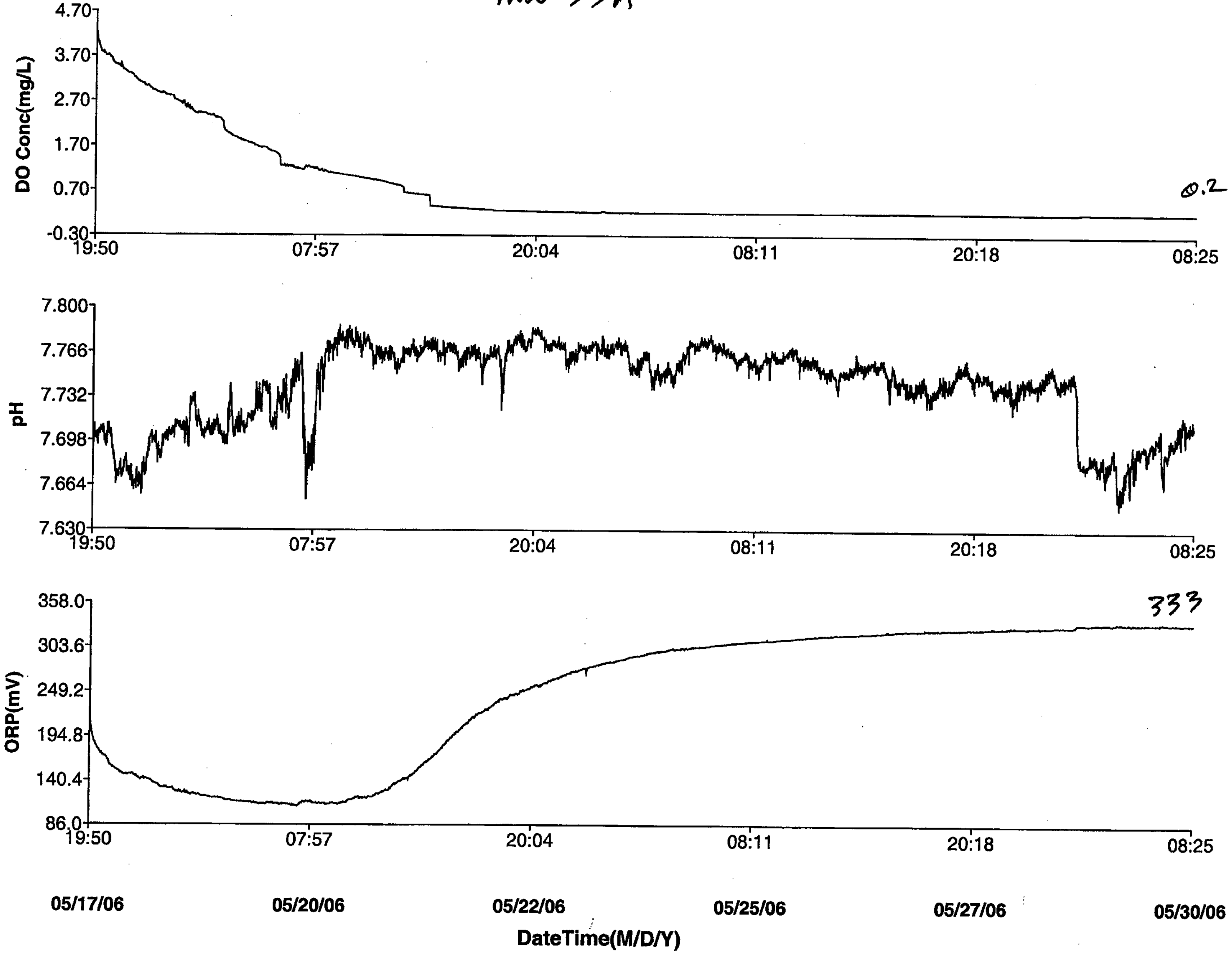
MW33A3.DAT



5.57

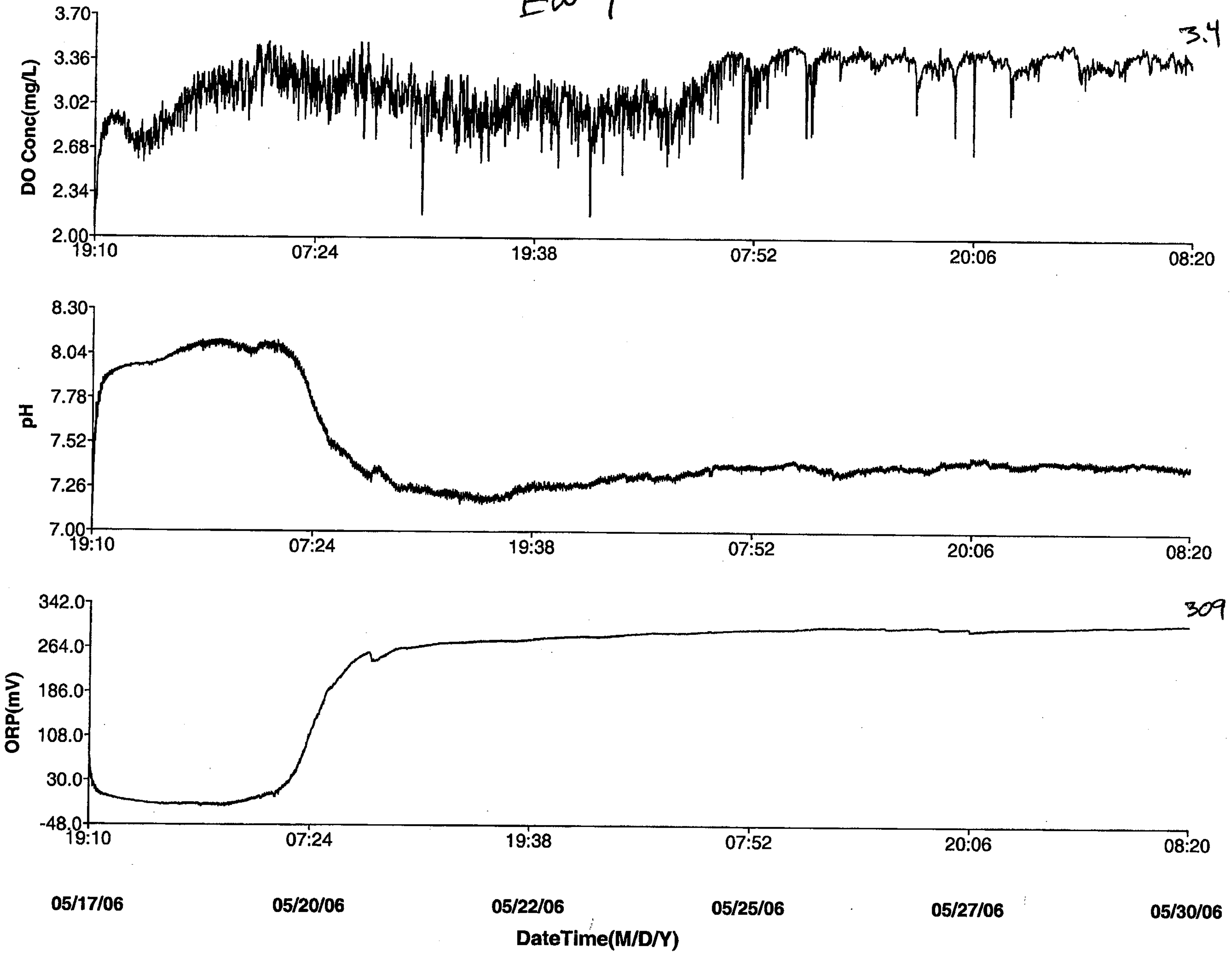
~~~1476463~~.DAT

MW-33A



~2957781.DAT

EW-1



12-14-05 YSI 600xlm Probe

Monitor Well Sampling Data (cont.)

MONITOR WELL NO: ______

us/cm 80.80 1.71

	Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
EW-1 90'	1400	20.08	~~8921~~	8.58		-29.6	~~2.76~~				
EW-1 63'		20.94	4408	8.57		22.70	7.27				
MW ~~20~~ 33A		20.67	3604	8.42		42.1	2.09				
MW ~~20B~~ 33		20.15	8393	8.74		-61.4	2.09				
MW 20B		20.17	8056	8.90		-77.2	1.52				
MW 2D		20.79	4780	8.88		2.2	6.50				ORP ↑ constantly
12-15-05											
EW-1 90'	0640	19.75	7011	8.55		-24.0	1.77				
EW-1-63'		20.71	4489	8.51		3.90	13.0				
MW 33A		20.78	3637	8.69		27.8	1.72				
MW33B		20.13	8273	8.67		-57.9	1.09				
MW 20B		20.14	8134	8.80		-66.6	1.35				
MW 2D		20.79	4844	8.65		6.5	1.28				

Page _____ of _____

MONITOR WELL NO: ________

Monitor Well Sampling Data

Project: **Cooper Drum**

Location No: ________

Job No: ________

Sample No(s): 2/2/06

Sampler(s): [redacted]/DG

Sampling Date: ________

Reviewer(s): ________

Date: 2/2/06

Sampling Method: **Direct from dedicated tubing**

Weather: ________

Sampling Time: ________

Ambient Temp. (F): ________

WATER ELEVATION DATA

Method of Measurement: Depth Sounder Y N

Other: ________

Screened interval:

1) Well Casing Elevation (WCE) ________ft
(from casing top as marked)

2) Depth to Water Surface (DTW________ft
(from casing top as marked)

3) Well Depth (WD): ________
(from casing top as marked)

4) Height of Water Column (H) ________ft
(from casing top as marked)

Product Obs: Y N

Depth to Product: ________

Method of Measurement: Interface Probe Y N

Other: ________

Well Diameter (in)	Casing Volume (CV)/ft (gals)
2	0.163
4	0.652
6	1.468
D	CV = (23.49) x [(D/24)^2]

CV = 3.14 [(D/2)/12 in.ft]^{2}h (7.48 gal/cu. Ft.)

WELL PURGE AND SAMPLING DATA

Purge Method: **2" Grundfos submersible pump**

Single Casing Volume of Water in Well (VW) ________ gals
(CV x H = VW)

Purge Date: ________

Number of Casing Volumes to Purge (NC) ________ gals

Was Well Pumped Dry? Y N

Total Volume of Water to Purge (TV) ________ gals
(VW x NC = TC)

Fe^2 (mg/L): ________

	Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
MW20	1410	20.66	8 uS/cm	7.19		290	2.07	}			
	1413	20.69	7	7.27		226.1	1.67	} Wrong cup on bottom redo			
	1416	20.72	7	7.23		209.1	1.38	}			
MW20B	~~1421~~	20.37	3985	7.23		-142.9	0.80	← Wrong cup on bottom redo			
	1427	20.38	7886	7.26		-155.3	0.94				@ 85'
	1430	20.35	7898	7.23		-134.8	0.77				
	1433	20.33	7902	7.21		-124.9	0.73				
MW20	1436	20.92	4495	7.20		147.2	2.21				@ 63'
	1439	20.88	4489	7.21		86.9	1.04				
	1442	20.89	4481	7.20		81.6	0.97				

INSTRUCTIONS AND COMMENTS

Purging/Sampling Remarks Model/Serial # 02D0578 BJ YSI 650 MDS

Probe Model 600XLM-M S/N 0010F86

Note: A complete list of containers and analyses used can be found in the associated sample log. The final row of readings should list the time sampling was completed and an estimate of the total valume of water removed. Water measurements should be re

MONITOR WELL NO:

2/2/06

Monitor Well Sampling Data (cont.)

	Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
mw33A	1447	20.85	3801	6.92		166.8	2.23				@63'
	1450	20.87	3797	6.89		136.9	1.18				
	1453	20.88	3795	6.89		135.8	1.18				
mw33B	1455	20.30	7406	6.92		-51.7	1.28				
	1458	20.31	7408	6.91		-60.9	1.01				@85'
	1501	20.28	7405	6.91		-64.4	0.94				
							~~101.2~~				
EW-1 63'	1510	20.84	4195	7.15		101.2	5.02				@63'
	1513	20.87	4203	7.10		91.6	4.35				
	1516	20.93	4208	7.09		97.3	3.99				
EW-1 90'	1518	20.16	7793	6.88		-2.9	~~-2.9~~ 1.17				@85'
	1521	20.17	7800	6.87		-12.9	1.04				
	1524	20.17	7802	6.87		-14.2	1.03				
MW21	1531	20.38	7089	6.93		-22.4	1.72				@63'
	1534	20.35	7090	6.93		-39.0	1.42				
	1537	20.34	7090	6.93		-41.8	1.25				
MW23	1543	20.36	9710	6.88		-60.0	1.51				@73'
	1546	20.37	9736	6.85		-67.0	1.20				
	1549	20.37	9745	6.85		-68.7	1.06				
EW-2 63'	1554	20.48	5355	7.03		-195.6	1.61				@63'
	1557	20.41	5352	7.03		-238.6	1.31				
	1400	20.41	5350	7.03		-244.3	1.23				
EW-2 77'	1402	20.18	5444	7.02		-252.5	0.95				@77'
	1405	20.18	5433	7.02		-265.8	0.92				
	1408	20.18	5424	7.02		-271.4	0.89				
mw-2	1412	20.08	9612	6.89		-176.7	1.23				65'
	1415	20.17	9608	6.85		-184.1	0.94				
	1418	20.11	9606	6.85		-183.9	0.88				

Cooper Drum

Monitor Well Sampling Data (cont.)

MONITOR WELL NO: 78

	2/22/06 Time	Temp (C)	uS/cm Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	TOC Observations Phys. App.
	0751										
EW-1	2/22/06					27.2	7.17				0751 63'
	754					27.4	7.27	47.88			68'
	0759					16.2	3.92				73'
	0801	20.26	6986	7.90	Δ70	15.9	3.81	Δ 0.7			78'
	0808					-54.8	4.50				83'
	0813	20.11	8700	7.02		-122	4.75				88'
	0833	20.95	4292	7.23		2.0	~~2.07~~ 7.45			-	63'
	0840	21.05	4270	7.26		10.7	8.31				58'
	0844	20.98	4287	7.23		11.5	7.88				63'
	0850	21.12	4113	7.39		21.1	11.34				53'
	0858	20.98	4289	7.23		17.0	7.99				63'
	0900	injection cycle @ 1A started									
	0906	20.97	4288	7.23		18.6	7.89				63'
	0913	20.97	4289	7.23		19.6	7.89				63'
											~~[illegible]~~
MW-33A	0927	20.92	3500	7.80		17.6	15.50	46.54			55'
	0933	20.86	3955	7.14		11.2	5.49				60'
	0940	20.86	3881	7.11		12.5	5.09				62' TD ~62.5'
MW-33B	0946	20.31	7352	7.01		-103	4.71	46.54			80' system call
	0953	20.19	7927	6.98		-106	5.01				85'
	0955	20.13	8690	6.96		-107	5.13				90'
				-		6					
MW20D	1009	20.89	4263	7.45		692	15.93	47.15	O_3 @ 0.3mg/L		55'
	1016	20.91	4432	7.27		275	5.95				60'
	1027	20.71	4500	7.24		156	3.67				65'
	1036	20.63	4512	7.23		106	3.45				68' TD
MW20B	1043	20.41	7878	7.36		-134	4.43	47.38			80' 3Bon
	1047	20.29	7899	7.13		-114	4.98				85'
	1051	20.22	7905	7.08		-111	5.10				89'

Set @ MW-20 @ 63' at 11:10 (12:20 device)

unplugged OV5 H_2O_2-5 & OV2 Note 1B has brn color

Restart @ 15:00 into 5 & 6

Note MW-33A- 18' from MAC 02 30' from MAC 03
33B 20 from MAC 02

Page 1 of 2

Cooper Drum

MONITOR WELL NO: ________

Monitor Well Sampling Data (cont.)

2/22/04

	Time	Temp (C)	µS/cm Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
mw20	1538	20.92	4400	7.27		47.6	3.91	@1500	~~C1440~~	Max O3 3A	10 min cycle
	1545	20.93	4402	7.28		49.2	5.55			3B	10 min
	1552	20.93	4403	7.29		48.7	4.35			H_2O_2	same as O_3
	1558	20.94	4405	7.27		46.2	4.20			@1600	shut air off
	@1600	pulled up to		55'	ORP	350	DO 11.	50	– returned to	63'	
	1605	20.96	4391	7.32		111.5	7.31		←	ORP/DO	steadily dropping
	1610	20.95	4397	7.29		90.5	7.08				
	1615	20.95	4402	7.27		78.3	6.95				
	1620	20.92	4419	7.30		71.9	6.71				
	1625	20.92	4419	7.30		66.8	6.77				
	1630	20.92	4417	7.30		63.2	6.77				
	1635	20.91	4417	7.30		59.8	6.74				
	1641	20.88	4421	7.30		54.3	~~7.32~~	6.59			
	1645	20.86	4421	7.30		53.2	6.34				
	1650	20.86	4424	7.29		49.9	6.30		shutdown	H_2O_2 –	
	1655	20.85	44.22	7.29		47.6	6.19		O_3 only	no air	
	1700	20.84	4421	7.29		45.8	5.99				
	1708	20.83	4422	7.29		44.2	5.86				
	1712	20.83	4423	7.28		43.1	5.77				
	1718	20.81	4425	7.28		41.5	5.64				
	1720	20.81	4427	7.28		40.7	5.53				
	1725	20.80	4431	7.28		38.4	5.20				
	$										
2/23/06											
mw20	0740	20.83	4481	7.23		-5.2	2.03				
	0745	20.81	4481	7.23		-5.5	2.14				

returned probe

note raised to 55' ORP↑

URS

Job Cooper Drum
Description Water Quality Measurements
Project No.
Computed by A Dickeson
Checked by
Page ____ of ____
Sheet 1 of 3
Date 3-20-06
Date
Reference

WELL EW 1

Depth	Time	Temp °C	Cond us/cm	DO mg/L	pH	ORP
90'	1331	20.04	6490	0.86	7.69	-177.3
	1336	20.04	5975	0.79	7.70	-179.7
	1341	20.04	5980	0.77	7.70	-180.9
85'	1341	20.10	6000	0.78	7.70	-182.9
	1344	20.10	6007	0.83	7.68	-183.6
	1347	20.10	~~6602~~ 6625	0.83	7.68	-183.8
	1352	20.11	6624	1.04	7.69	-184.5
80'	1353	20.17	6541	0.83	7.68	-184.3
	1355	20.17	6539	0.81	7.68	-184.4
	1400	20.17	6550	0.81	7.68	-184.7
75'	1401	20.23	6486	0.81	7.68	-184.7
	1408	20.24	6474	0.81	7.68	-185.2
	1411	20.24	6466	0.81	7.68	-185.4
70'	1412	20.43	5794	2.79	7.74	-186.3
	1413	20.46	5800	5.25	7.49	-75.9
	1415	20.46	5798	5.70	7.43	-62.1
	1417	20.45	5794	5.76	7.41	-54.0
	1423	20.45	5779	5.13	7.41	-51.7
65'	1424	20.79	5602	7.18	7.42	-43.3
	1427	20.78	5627	7.95	7.42	-40.0
	1430	20.80	5628	7.62	7.42	-38.6
	1434	20.81	5621	7.72	7.42	-38.0
60'	1434	20.93	5504	8.16	7.44	-37.5
	1438	20.94	5517	8.64	7.44	-38.2
	1440	20.94	5516	8.57	7.45	-37.3
	1444	20.95	5514	8.37	7.44	-37.0
55'	1446	21.02	5381	9.37	7.48	-34.9
	1448	21.01	5400	10.41	7.49	-33.0
	1451	21.02	5401	10.30	7.49	-33.4
	1456	21.02	5403	10.48	7.50	-33.2
50'	1457	21.05	5376	12.92	7.59	-32.6
	1500	21.05	5364	13.39	7.62	-30.7
	1503	21.06	5249	13.42	7.63	-31.1
	1507	21.06	5309	13.42	7.64	-30.6

URS

Page ____ of ____

Job Cooper Drum Project No. ____ Sheet 2 of 3

Description Water Quality Measurements Computed by A Dickeson Date 3-20-06

Checked by ____ Date ____

WELL 33B

Depth	Time	Temp °C	Cond $\mu S/cm^3$	DO mg/L	pH	Reference ORP
90'	1517	20.06	9121	1.11	7.70	-234.6
	1520	20.06	9121	1.06	7.67	-232.4
	1523	20.06	9122	1.05	7.66	-228.2
	1527	20.06	9125	1.03	7.64	-222.6
85'	1528	20.12	8237	1.05	7.64	-211.4
	1531	20.11	8250	1.03	7.59	-202.7
	1535	20.12	8257	1.03	7.57	-197.9
	1539	20.12	8222	1.00	7.56	-195.7
80'	1540	20.21	7748	1.01	7.58	-195.5
	1543	20.21	7747	1.01	7.57	-190.8
	1545	20.21	7747	1.00	7.56	-187.8
	1548	20.21	7743	1.01	7.55	-184.0
	1550	20.21	7742	1.01	7.54	-182.4

WELL 33A

60'	1555	20.76	4116	11.63	7.31	-58.4
	1559	20.77	4139	11.18	7.29	-50.0
	1602	20.78	4132	11.61	7.32	-46.6
	1605	20.79	4124	12.07	7.34	-43.7
55'	1606	20.87	varying	*	8.08	
	1613	20.90	varying	18.54	8.07	-43.7
	1616	20.91	3000-3200	18.63	8.07	-42.6

* Checked water level - 46.5' - Conductivity varying widely. Feels like bubbles in well - not injecting nearby!

URS

Job Cooper Drum
Description Water Quality Measurements
Project No.
Computed by A Dickeson
Checked by
Page ____ of ____
Sheet 3 of 3
Date 3-20-06
Date

MW-20B

Depth	Time	Temp °C	Cond µS/cm³	DO mg/L	pH	Reference ORP
90'	1626	20.13	4967	0.48	7.87	-248.8
	1631	20.05	4970	0.93	7.80	-238.1
85'	1633	20.23	7929	0.97	7.75	-211.5
	1638	20.24	8170	0.97	7.67	-196.4
80'	1639	20.32	8205	0.88	7.96	-240.7
	1644	20.33	8216	0.85	7.97	-234.5
65'	1649 20.75	4420		1.36	7.54	-103.4
	1653	20.75	4406	0.96	7.60	-119.7
	1656	20.73	4440	0.92	7.60	-120.6
60	1657	20.90	3282	5.33	7.58	-73.1
	1702	20.91	3136	11.60	7.43	-49.7
55'	1703	20.91	2500-3000	17.96	7.32	106
	1706	20.91	2500-2900	18.53	7.19	187.5
	1708	20.92	26-2800	18.55	7.14	226
63'	17:13	20.81	4169	3.64	7.24	74.7

3A&B

3/20/06 5:38 PM

Injection Cycle time	20
H_2O_2 inj on/off	60 - 120
H_2O_2 16 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	0 - 10	5 -- 11	0 - 10
6	10--20	0 -- 5	10--20
7	-	-	-
8	-	-	-

3 A & B

20-Mar 9:30 PM

Injection Cycle time	30
H_2O_2 inj on/off	60 - 120
H_2O_2 16 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	0 - 10	7 -- 12	0 - 10
6	10--30	0 -- 7	10--30
7	-	-	-
8	-	-	-

3 A & B

21-Mar 7:00 AM

Injection Cycle time	30
H_2O_2 inj on/off	60 - 120
H_2O_2 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	0 - 5	2 -- 7	0 - 10
6	5 -- 30	25 -- 2	10 -- 30
7	-	-	-
8	-	-	-

3 A & B

21-Mar 10:00 AM

Injection Cycle time	30
H_2O_2 inj on/off	60 - 120
H_2O_2 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	0 - 5	2 -- 7	0 - 10
6	5 -- 30	25 -- 2	10 -- 30
7	-	-	-
8	-	-	-

1 A & B

21-Mar 12:48

Injection Cycle time	20
H_2O_2 inj on/off	60 - 120
H_2O_2 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	0 - 10	5 -- 11	0 - 10
2	10--20	0 -- 5	10--20
3	-	-	-
4	-	-	-
5	-	-	-
6	-	-	-
7	-	-	-
8	-	-	-

1 A & B

22-Mar 9:05

Injection Cycle time	15
H_2O_2 inj on/off	60 - 120
H_2O_2 %	

O_3 / Air / H_2O_2 valve timing

	on O_3 off	on Air off	on H_2O_2 off
1	0 - 5	5 -- 11	0 - 7
2	5--15	0 -- 5	7--15
3	-	-	-
4	-	-	-
5	-	-	-
6	-	-	-
7	-	-	-
8	-	-	-

1 & 2 A & B

1 & 2 A & B

15/15 O_3
15/15 H_2O_2
(pm)

22-Mar 17:00

Injection Cycle time		30	
H_2O_2 inj on/off		60 - 120	
H_2O_2 %			
O_3 / Air / H_2O_2 valve timing			
on O_3 off	on Air off	on H_2O_2 off	
0 - 5	4 -- 7	0 - 7	1
5 --15	15 -- 20	7 -- 15	2
15 -- 20	24 -- 27	15 -- 22	3
20 -- 30	0 -- 4	22 - 30	4
-	-	-	5
-	-	-	6
-	-	-	7
-	-	-	8

3/26/2006 Deep wells only

Injection Cycle time		30	
H_2O_2 inj on/off		60 - 120	
H_2O_2 %			
O_3 / Air / H_2O_2 valve timing			
on O_3 off	on Air off	on H_2O_2 off	
Disable	5 -- 8	0 - 7	1
0 -- 15	15 -- 20	7 -- 15	2
Disable	20 -- 23	15 -- 22	3
15 -- 0	0 -- 5	22 -- 30	4
-	-	-	5
-	-	-	6
-	-	-	7
-	-	-	8

15/15 O_3
8/8 H_2O_2

1 & 2 A & B
3/26/2006 Shallow wells only

Injection Cycle time		20	
H_2O_2 inj on/off		60 - 120	
H_2O_2 %			
O_3 / Air / H_2O_2 valve timing			
on O_3 off	on Air off	on H_2O_2 off	
0 --10	6 -- 11	0 - 5	1
Disable	11 -- 15	5 -- 10	2
10 -- 0	16 -- 1	10 --15	3
Disable	1 -- 5	15 -- 0	4
-	-	-	5
-	-	-	6
-	-	-	7
-	-	-	8

10/10 O_3
10/10 H_2O_2

URS

Job Cooper Drum
Project No.
Page ____ of ____
Sheet 1 of 1
Description Water Parameter Measurements
Computed by A Dickeson
Date 3-21-06
Checked by
Date
Reference

WELL EW1 * Was pressure on well when we opened it *

DEPTH	TIME *	Temp °C	Cond. µS/cm°	DO mg/L	pH	ORP
85	00:39	20.10	8654	0.59	7.31	-83.3
	00:42	20.09	8648	0.54	7.33	-88.0
	00:45	20.09	8649	0.65	7.35	-91.0
	00:46	20.09	8649	0.63	7.35	-91.1
75	00:47	20.20	7946	0.52	7.37	-89.3
	00:49	20.20	7887	0.52	7.36	-88.1
	00:52	20.21	7869	0.62	7.35	-84.8
65	00:53	20.40	6844	0.53	7.40	-86.6
	00:55	20.40	8618	0.56	7.41	-85.8
	00:59	20.41	10802	0.60	7.39	-75.2
63	01:00	20.47	6657	0.55	7.41	-84.7
	01:04	20.48	6632	0.64	7.41	-85.8
55	01:06	20.97	4293	11.28	7.55	-2.8
	01:11	20.97	4297	11.90	7.57	-1.4
63	01:12	20.57	6588	6.05	7.38	-24.8

Left in well to auto-sample

* Time as measured by sonde clock - 650 clock is correct
Sonde clock =0046 when 650 clock = 12:44

URS

Job Cooper Drum
Description Daily Log + Measurements
Project No.
Computed by A Dickeson
Checked by
Page ___ of ___
Sheet 1 of 1
Date 3-22-06
Date
Reference

1630 - Return to site to check cable. It definitely does not fit. Called Equipco + described end of 100' cable. They will ship cable to connect that to laptop → straight to Tony's.

Check parameters w/ 650.

	DO $^{mg/L}$	ORP
2:50	16.20	-24.7
3:00	16.05	-24.9
3:10	15.97	-24.8
3:20	15.76	-24.7
3:30	15.85	-24.6
3:40	16.05	-23.9
3:50	16.03	-22.9
4:00	16.31	-22.3
4:10	16.78	-21.5
4:20	16.80	-21.4
4:30	17.41	-20.7
4:40	17.07	-21.5

1650 Stop logging. Change time on sonde
Restart logging in file COOPER2.DAT

Shut off system. Reprogram timing per Doug's "3-22 pm" instructions.

1655 Start up system
1700 Off site

URS

Job Cooper Drum
Description System adjustment
Project No.
Computed by A Dickeson
Checked by
Page of
Sheet 1 of 1
Date 3-24-06
Date
Reference

0801 Air Valve AV1 flow - 1.25
outlet pressure - 17
inlet pressure - 36

Dialed back to 1 scfm
outlet pressure - ~~15~~ 14
inlet pressure - 37

Air valve AV2 flow - 0.7
outlet pressure - 24 → dropped to 23.5
inlet pressure - 37.5

0830 Download cooper2, leave site

URS

Job Cooper Drum
Description Readings + daily notes
Project No.
Computed by A Dickeson
Checked by
Page ___ of ___
Sheet 1 of 1
Date 3-29-06
Date
Reference

* MW20 is bubbling through the puddle that's on the well box. EW1 has much pressure (no ozone smell).

0745 Arr site. Open well, d/l cooper 3, stop logging clear memory in sonde.
Pull up probe to 58'

	Temp	Cond µS/cm°	DO mg/L	pH	ORP
0805	20.96	1362	22.45	7.82	169.4
0809	20.99	1312	22.52	7.83	167.9
0812	20.96	1290	22.50	7.83	167.5

Pull out probe, decon. Offsite for new sonde batteries. Indicator still flashes after installation (?!?)

EW1 Profile

Depth	Time	Temp	Cond	DO	pH	ORP
90'	0858	20.01	9378	0.94	7.72	-201.8
	0902	20.00	9367	0.70	7.76	-231.8
	0905	20.00	9362	0.74	7.81	-248.4
80'	0907	20.22	7944	4.71	7.52	-106.5
	0912	20.20	7934	6.38	7.32	-30.0
	0916	20.20	7930	5.98	7.29	-18.1
70'	0917	20.57	4453	7.66	7.40	-7.5
	0920	20.56	4430	8.10	7.41	-2.2
	0923	20.58	4427	8.12	7.42	0.6
60'	0924	20.91	4355	8.78	7.44	4.2
	0928	20.89	4357	8.97	7.45	4.5
	0932	20.89	4359	8.90	7.46	5.7
50'	0933	21.02	4280	13.79	7.58	15.1
	0938	21.02	4286	14.50	7.61	18.4
	0941	21.02	4283	14.53	7.62	18.2

Hang probe @ 63' in EW1 start logging cooper 4.

0950 Start system on deep wells only test.

10 ish - Offsite

MONITOR WELL NO: [redacted]

Monitor Well Sampling Data (cont.)

4/17/06 uS/cm

	Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
EW-1	1055	21.1	4045	5.67	~~1400~~	91	14.00				55'
	1056	21.1	4046	5.71		89.5	13.43				58'
	1057	21.04	4151	5.9		60.0	11.39				60'
	1059	21.05	4151	5.93		58.6	10.49				60'
	1100	20.94	4170	6.56		22.0	9.68				65'
	1102	20.95	4170	6.76		-36.5	9.47				65'
	1103	20.83	4171	6.86		-47.5	9.64				70'
	1105	20.83	4171	6.91		-52.4	9.55				70'
	1106	20.60	4236	6.94		-55.3	9.54				75'
	1108	20.58	4278	6.96		-56.9	9.36				75'
	1109	20.35	7033	6.85		-55.0	4.33				80'
	1111	20.36	7062	6.86		-56.0	3.85				80'
	1112	20.33	7126	6.91		-62.8	3.44	47.88			85'
	1114	20.33	7425	6.96		-67.5	3.32				85'
	1115	20.97	4162	6.99		-55.6	9.18				63'
	1129	20.96	4160	6.95		-51.6	9.45	file name	EWI DAT		63'
	1531	21.37	4185	6.97		-49.7	9.69	- from pub start			63'
MW-33A	1152	21.03	3800	7.90		31.1	18.28	- hear water bubbling			55'
	1155	21.04	3100	7.92		33.4	18.34	in well			55'
	1158	20.97	4161	7.61		41.0	19.08				60'
	1200	20.97	4131	7.58		42.1	19.10				60'
	1201	20.97	4207	7.36		46.3	18.98	47.14	TD 62.5'		63.5'
	1529	22.29	4472	7.42		88.0	16.42	—	started logging		@ 61.5'

MW-33A sampled + for H_2O_2 +20 mg/L

negative for O_3

EW-1 Sampled + for H_2O_2

no titration performed.

Negative for O_3

Pulled VOC's & 1-4 Dioxane sample from both wells

& shipped to R9 Lab

Page _____ of _____

URS

Job Cooper Drum
Description Profile notes
Project No.
Computed by A Dickson
Checked by
Page ___ of ___
Sheet 1 of ___
Date 5-5-06
Date
Reference

48-78' EW 1 Profile
hook @ 63

Depth	Time	Temp °C	Cond µS/cm²	DO mg/L	pH	ORP
85' 1st yellow mark (deepest)	1409	20.34	7200	0.47	7.94	7.2
	1411	20.33	7281	0.37	7.89	8.8
	1413	20.33	7298	0.32	7.88	4.1
	1415	20.33	7304	0.30	7.88	0.1
80' 2nd	1416	20.39	5709	0.57	7.28	189.7
	1418	20.39	5629	1.06	7.11	217.2
	1421	20.39	5700	1.17	7.05	227.2
	1423	20.38	5794	1.08	7.04	228.8
75' 3rd	1424	20.64	4147	4.45	7.07	236.0
	1426	20.63	4110	5.48	7.08	237.2
	1428	20.65	4099	5.50	7.08	237.7
	1430	20.67	41094	5.49	7.09	237.7
70' 4th	1431	20.90	4085	6.00	7.09	238.8
	1435	20.87	4086	6.00	7.11	238.4
65' 5th	1435	20.99	4083	6.26	7.11	238.6
	1438	20.99	4081	6.33	7.11	238.6
hook → 60'	1439	21.05	4069	7.04	7.14	237.7
	1442	21.05	4071	7.41	7.15	237.3
55'	1443	21.09	3973	9.30	7.22	233.5
	1445	21.10	3973	9.80	7.22	234.2
	1447	21.10	3970	9.73	7.23	233.5

end of water

MONITOR WELL NO: ____________

Monitor Well Sampling Data (cont.)

5/8/06

	Time	Temp (C)	Cond (umhos)	pH	Turbidity (NTU)	ORP (mV)	D.O. (mg/L)	Water Level (ft. bgs)	Removed (L)	Flow Rate (L/min)	Observations Phys. App.
mw33A	910					364	10.65				Prior to sampling
			Reset Probe back in 33A after sampling ~11:00 File 33A3								
EW-1	1930	21.03	4051	7.36		152.3	6.23				63'
	0938		7304	7.75		10.2	0.65				85
	0940		5764	7.39		130	1.20				80'
	0942		4117	7.36		149.8	5.53				75'
	0944		4087	7.35		149.0	6.23				70'
	0946		4083	7.34		150.7	6.52				65'
	0948		4065	7.35		154.7	6.94				60'
			3971	7.39		156.5	8.81				55'
	0949		31	7.38		158.1	8.70				50
EW-1	1142					194	7.2				@63' Pulled Probe still logging
	1412		returned probe into well @ 63'								

URS

Page 1 of 4
Job Cooper Drum
Project No.
Sheet of
Description Daily Notes
Computed by A Dickuson
Date 6-1-06
Checked by
Date
Reference

MW 20 Profile (w/ new DO membrane)

Depth	Time	Temp °C	Cond uS/cm	DO mg/L	pH	ORP
70'	1015	20.64	5780	0.05	7.15	-54.7
	1019	20.65	5781	0.11	7.15	-57.4
65'	1020	20.79	4977	0.29	7.17	-33.7
	1022	20.76	5045	[illegible]	7.16	-37.3
	1024	20.77	5050	0.23	7.16	-38.7
60	1026	20.95	3412	1.60	7.57	31.6
	1028	20.97	4385	2.34	7.58	54.6
	1030	20.98	4221	2.30	7.59	58.7
55	1032	20.98	±3600 *fluctuating	2.21	7.61	58.9
	1034	20.99	4181	2.20	7.60	58.3
	1036	20.99	4602	2.18	7.61	58.5
85'	1040	20.31	7971	0.11	7.06	-93.8
	1042	20.32	7986	0.10	7.06	-92.1
	1044	20.33	7988	0.09	7.06	-91.2

* Conductivity values fluctuate wildly @ 55 & 60'

System off - Sequal in disrepair.

6-11-06

EW1 Profile

Depth	Time	Temp °C	Cond µS/cm	DO mg/L	pH	ORP
50'	1341	21.26	4400	13.52	7.69	-0.7
	1346	21.24	4404	12.62	7.76	9.0
55'	1348	21.12	4391	12.72	7.83	0.7
	1350	21.12	4392	12.68	7.87	-0.7
60'	1351	20.99	4374	12.83	7.93	-11.9
	1353	20.97	4373	12.89	7.95	-11.0
65'	1354	20.70	6665	6.24	7.72	-26.1
	1356	20.70	6685	3.83	7.76	-30.5
70'	1357	20.49	6702	1.79	7.82	-43.0
	1359	20.50	6708	1.57	7.81	-41.5
75'	1400	20.45	6813	1.27	7.83	-48.0
	1402	20.44	6817	1.17	7.82	-45.5
80'	1403	20.39	6942	1.05	7.86	-55.4
	1405	20.38	6981	1.05	7.86	-53.9
85'	1406	20.32	7781	1.00	7.86	-60.9
	1408	20.32	7871	1.03	7.86	-58.9

well sanded up to 60.5 feet

0-11-04

MW 33A Profile

[illegible]	Time	Temp °C	Cond µS/cm	DO mg/L	pH	ORP
60'	14:21	21.01	3884	6.01	8.12	-43.9
	1423	21.01	3889	4.90	8.09	-42.1
	1425	21.01	3888	4.83	8.10	-40.2
55'	1427	21.10	3958	5.83	8.09	-34.8
	1429	21.10	3960	5.85	8.08	-34.0