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ENGINEERING EVALUATION AND INTERIM REMOVAL REMEDIAL WORK PLAN/INTERIM MEASURE WORK PLAN SITE 45 DRY CLEANERS FACILITY BUILDING 193 MCRD PARRIS ISLAND SC

9/23/1997

BECHTEL ENVIRONMENTAL INC

ENGINEERING EVALUATION
AND
INTERIM REMOVAL REMEDIAL WORK PLAN/INTERIM MEASURE WORK PLAN

SITE 45/SWMU 45
DRY CLEANERS FACILITY
BUILDING 193

MARINE CORPS RECRUITING DEPOT
PARRIS ISLAND, SOUTH CAROLINA
EPA I. D. No. SC6 170 022 762

Prepared for
DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
Under Contract No. N62467-93-D-0936

Prepared by
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REVISION 0

Bechtel Job No. 22567

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ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2 Dichloroethene
Bechtel	Bechtel Environmental, Inc.
EE/WP	Engineering Evaluation and Interim Remedial Work Plan/Interim Measure Work Plan
EPA	U.S. Environmental Protection Agency
FOTW	federally owned treatment works
IRA	interim removal action
MCRD	Marine Corps Recruit Depot
PCE	tetrachloroethene
PPs	project procedures
QC	quality control
RAC	Response Action Contractor
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHDIV	Naval Facilities Engineering Command, Southern Division
TCE	trichloroethene
VOC	volatile organic compounds

UNITS OF MEASURE

cm/sec	centimeter per second
ft	foot (feet)
in.	inch (inches)
gal	gallon (gallons)
mg/L	milligrams per liter
mil	1/1,000 of an inch
mm	millimeters
MSL	mean sea level
ppb	parts per billion
psi	pounds per square inch
scfm	standard cubic feet per minute

1. INTRODUCTION

Bechtel Environmental, Inc. (Bechtel) has been contracted by the Department of the Navy, Naval Facilities Engineering Command, Southern Division (SOUTHDIV), to provide remedial services as the Navy's Environmental Response Action Contractor (RAC). Under Delivery Order 0048 of Prime Contract N62467-93-D-0936, Bechtel has been contracted to prepare an Engineering Evaluation and Interim Removal Work Plan/Interim Measures Work Plan (EE/WP) to implement an interim removal action (IRA) at Site 45/SWMU 45, the Dry Cleaners Facility, Building 193, Marines Corps Recruit Depot (MCRD), Parris Island, South Carolina. This is an active recruit basic training facility located in southeast South Carolina (Fig. 1.1).

A spill of tetrachloroethlene (PCE) occurred at the dry cleaning facility on March 11, 1994. This spill occurred to inadvertent overfilling of the aboveground storage located adjacent to the north side of the Dry Cleaners Facility. See Attachment 1 for a copy of the spill report. A contamination assessment was performed in the summer of 1994 to evaluate the impact of the reported spill. This initial assessment concluded that soil and groundwater in the vicinity of the dry cleaning facility had been adversely affected due to the spill (Ref. 6).

During the summer of 1996, groundwater samples were collected to determine the extent of the contamination at the site. This sampling effort was performed using direct push technology. Analytical results of these samples indicated that a plume of groundwater contaminated with PCE, trichloroethene (TCE), and 1,2-Dichloroethene (1,2-DCE) exists at concentrations exceeding the regulatory levels at the site (Ref. 1). Based on this information, a decision was made to conduct an IRA to remove the source of contamination to minimize further degradation of the groundwater.

This EE/WP identifies the proposed IRA alternative as part of the remediation at the dry cleaner facility. It addresses the implementability, effectiveness, and cost of the IRA. This EE/WP is being issued to facilitate public involvement in the decision making process. The public is encouraged to review and comment on this document.

1.1 SITE CHARACTERIZATION

The MCRD is located within the Parris Island Quadrangle, S. C., USGS 7.5 min topographic map. The subject dry cleaning facility is bounded between Panama Street to the north, Kyushu Street to the south, and Samoa Street to the east. Immediately to the west of the existing facility is the new Dry Cleaners Facility which also includes a laundry, tailor, and a cobbler shop.

1.1.1 Regional Hydrogeology

The area is characterized by flat terrain dissected by rivers and streams which flow into the Atlantic Ocean. Drainage is provided by the Broad and Beaufort Rivers. The area averages 47 to 50 in. of rainfall per year. Average well yields are reported to be from less than 50 to 1,500 gal per minute from wells in Beaufort County. Soil types in this area are typically clayey and sandy. These are underlain by unconsolidated to poorly consolidated interbedded clays and sands and marls which range in age from Late Cretaceous to Holocene (Ref. 5).

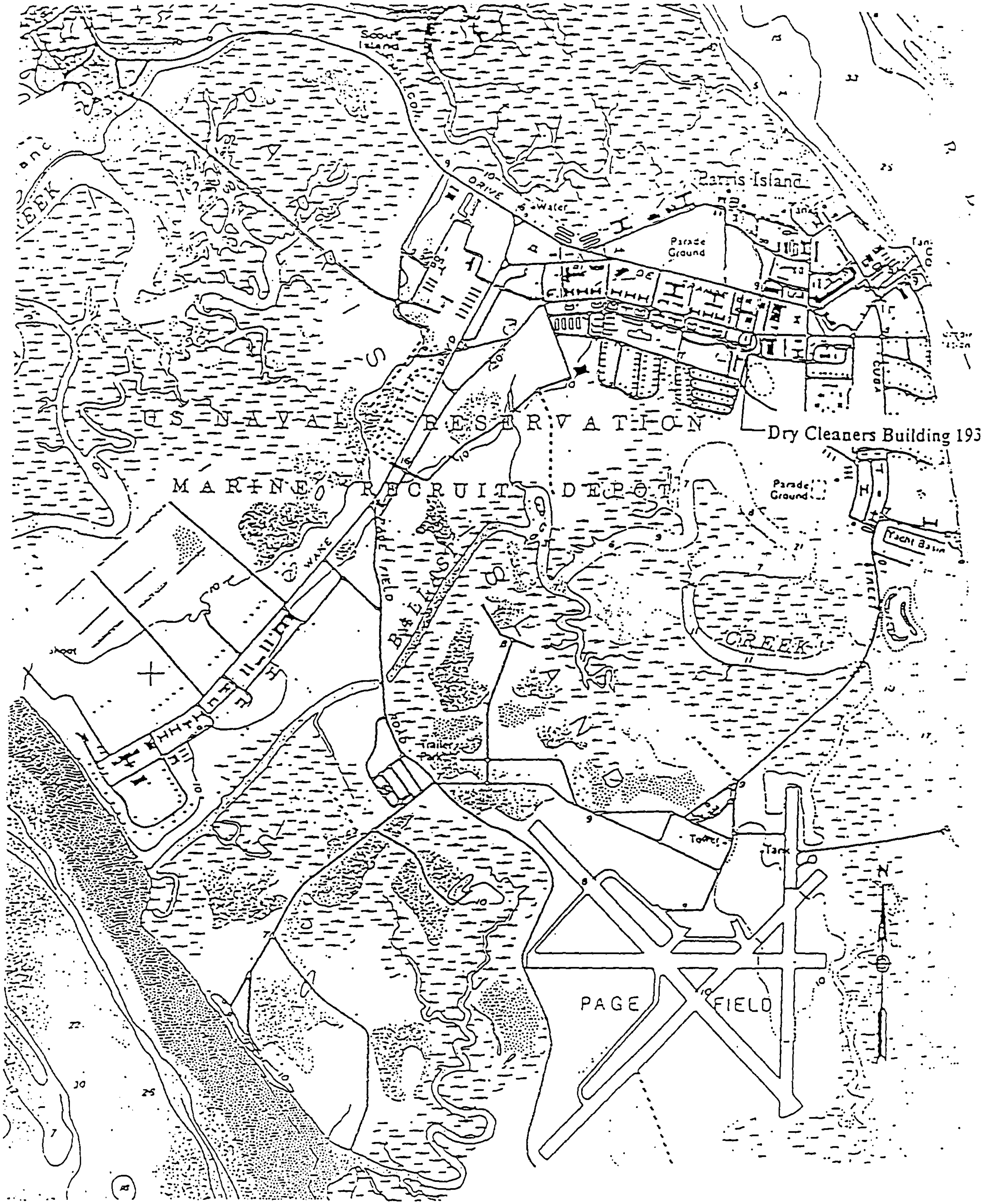


Figure 1.1
Marine Corps Recuit Depot, Parris Island, SC

1.1.1.1 Floridan Aquifer

The principal source of groundwater in the Beaufort County area is the Floridan Aquifer. This aquifer system has a total depth of approximately 900 ft and divided into the Upper Unit and the Lower Unit. The Upper Floridan Aquifer is contained within the late Eocene Age Ocala Limestone. Most wells which tap this aquifer system are from 50 to 250 ft deep (Ref. 5).

The lithology of the upper portion of the Ocala Limestone consists of bioclastic limestone and is highly permeable. The lower portion of the Ocala Limestone consists of sandy to clayey limestone and marl and hydraulically separates the Upper Floridan Aquifer from the Lower Floridan. In the Parris Island vicinity, the top of the Ocala Limestone has a reported transmissivity of about 20,000 ft^2/day (Ref. 5).

The Lower Floridan Aquifer is contained within the middle Eocene age Santee Limestone. In the study area, the Santee is reported to be a massive, calcarenitic limestone. Permeability within the Santee Limestone is reported to be low (Ref. 5).

1.1.1.2 Surficial Aquifer

The surficial or water table aquifer in the study area is restricted to the shallow Pliocene to Holocene age sedimentary deposits of the Pamplico and Waccamaw Formations. The hydraulic characteristics of these formations are not particularly well known. A few shallow monitoring wells in St. Helena and Ladies Islands have been hydraulically tested. An estimated transmissivity of 1,300 ft^2/day was reported for coarse sands within the shallow deposits. A storage coefficient of 0.20 has also been reported for these deposits (Ref. 5).

1.1.1.3 Confining Units

The shallow deposits are underlain by the Miocene Hawthorn Formation. Some researchers have defined another Miocene formation (Duplin Marl). These formations are significant because they hydraulically separate the unconfined surficial aquifer from the underlying artesian Floridan aquifer. The elevation at the top of the Hawthorn is reported be approximately 30 ft below mean sea level (MSL) at Parris Island. Thickness of the Hawthorn Formation in this area is reported to range from about 25 ft to as much as 40 ft near the confluence of the Beaufort and Broad Rivers. Previous regional studies have indicated a wide range of vertical hydraulic conductivity values for samples obtained from the Hawthorn Formation. Using an average formation thickness of 30 ft and vertical hydraulic conductivity of 0.006 ft/day, it was calculated that the leakance through the Hawthorn Formation is 0.0002 ft^3/day for every one foot of head difference (Ref. 5).

The Hawthorn Formation is breached in numerous locations throughout Beaufort County. Immediately adjacent to Parris Island, tidal scour and stream erosion (during lowered sea level stands) have probably breached the Hawthorn Formation beneath the Beaufort and Broad Rivers. A small area of recharge to the Upper Floridan is reported at the southeastern end of Parris Island. Sampling has confirmed that the Hawthorn layer exists at the Dry Cleaner Facility Site (Ref. 1).

1.1.2 Site Hydrogeology

The upper 30 ft of sediment underlying MCRD Parris Island consists predominantly of very fine yellow-brown sand containing traces of clay and silt. Occasional thin (approximately 6-in. thick) layers of greenish-gray silty clay occur within the sands. These are the only distinct beds found in the superficial sediments of the activity. These clay layers appear to have prevented the migration of the bulk of the contamination from reaching deeper than 14 ft below grade. The IRA will only focus on the groundwater to a depth of 14 ft below grade. Onsite borehole data collected during well installation in December of 1996 confirm these findings as seen in Figures 1.2, 1.3, and 1.4. Water table elevations recorded during the same time range from a high of 5.02 ft (above MSL) at the northwest to a low of 4.04 ft (above MSL) in the southeast. Similar water table levels have been reported at other sites at Parris Island (Ref. 5). The general groundwater flow is to the southeast with a gradient of 0.003 ft/ft. (Ref. 3)

The regional hydrogeology and the data collected during the direct push sampling in the summer of 1996 indicates that the bottom of the surfical aquifer at the site is the top of the Hawthorn Formation which is approximately 30 ft below MSL.

1.2 SITE HISTORY

At one time the Dry Cleaning Facility maintained four above ground storage tanks in a concrete containment basin. These tanks have been in place since 1988 and stored PCE solvent used for dry-cleaning. These above ground tanks were constructed to replace an underground storage tank system containing petroleum-based solvent used prior to the use of PCE at the facility. On March 11, 1994, a reportable spill of PCE occurred at the dry cleaners when one of the tanks was inadvertently overfilled, spilling PCE into the concrete containment basin. It is also reported that the PCE was subsequently released onto the ground when the containment basin was drained following heavy rains. See Figure 1.6 for the location of the spill. The spill was reported to South Carolina Department of Health and Environmental Control (SCDHEC). The use of the tanks for storing PCE was discontinued in the 1994-1996 time frame.

On March 14, 1994, Parris Island personnel collected soil and water samples along Panama Street. The analytical results of these samples indicated elevated levels of PCE in the samples, requiring excavation of the contaminated soils. Parris Island personnel excavated and disposed of PCE-contaminated soils outside the containment basin. These PCE contaminated soils were incinerated by a licensed facility. Following this removal action, S&ME conducted a PCE-contamination assessment in June, 1994 to determine the extent of contaminated groundwater and to develop a conceptual remediation plan. As part of this effort, S&ME installed temporary piezometers to measure water levels and drilled boreholes to collect soil and groundwater samples (Ref. 6).

In the summer of 1996, Bechtel conducted a site investigation of the groundwater to define the current extent of contamination at the site. Groundwater samples were collected with direct push technology and analyzed with a field gas chromatograph. Results of these tests indicated that a plume of PCE, TCE, and 1,2 DCE contaminated groundwater exists with concentrations exceeding the regulatory limits. The results of this screening effort are presented in the report "Phase Two Sampling Effort" (Ref. 1).

Based on this information, monitoring wells were installed and an air sparging pilot test was conducted as presented in the "Technical Memorandum For Well Installation and Air Sparging Pilot Test" (Ref. 2). The objectives of this investigation conducted in December 1996 were as follows:

- Installing a well monitoring network
- Soil sampling to determine lithology and geological stratigraphy
- Sampling and analysis to establish baseline soil and groundwater contamination levels
- Conducting an air sparging pilot study

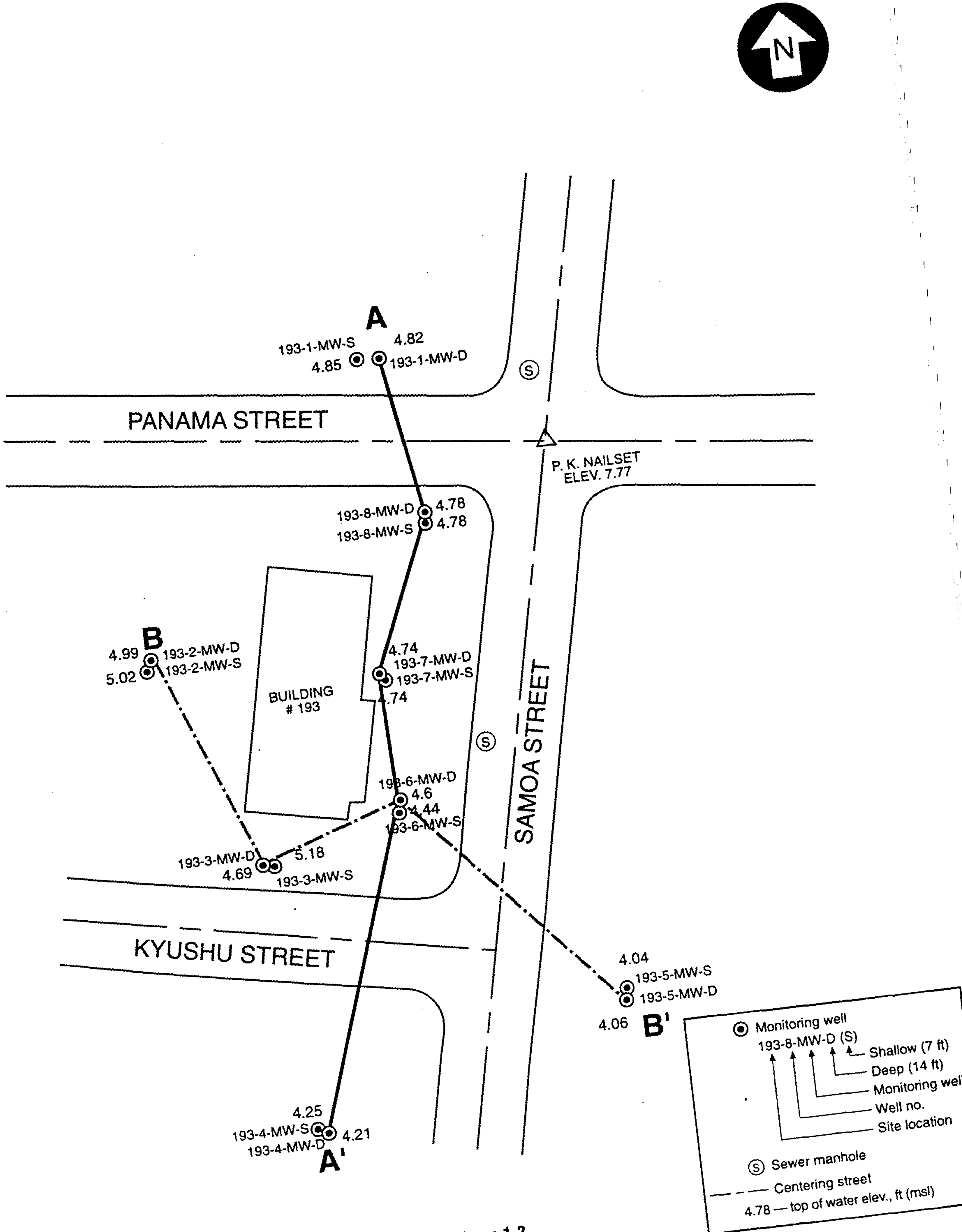
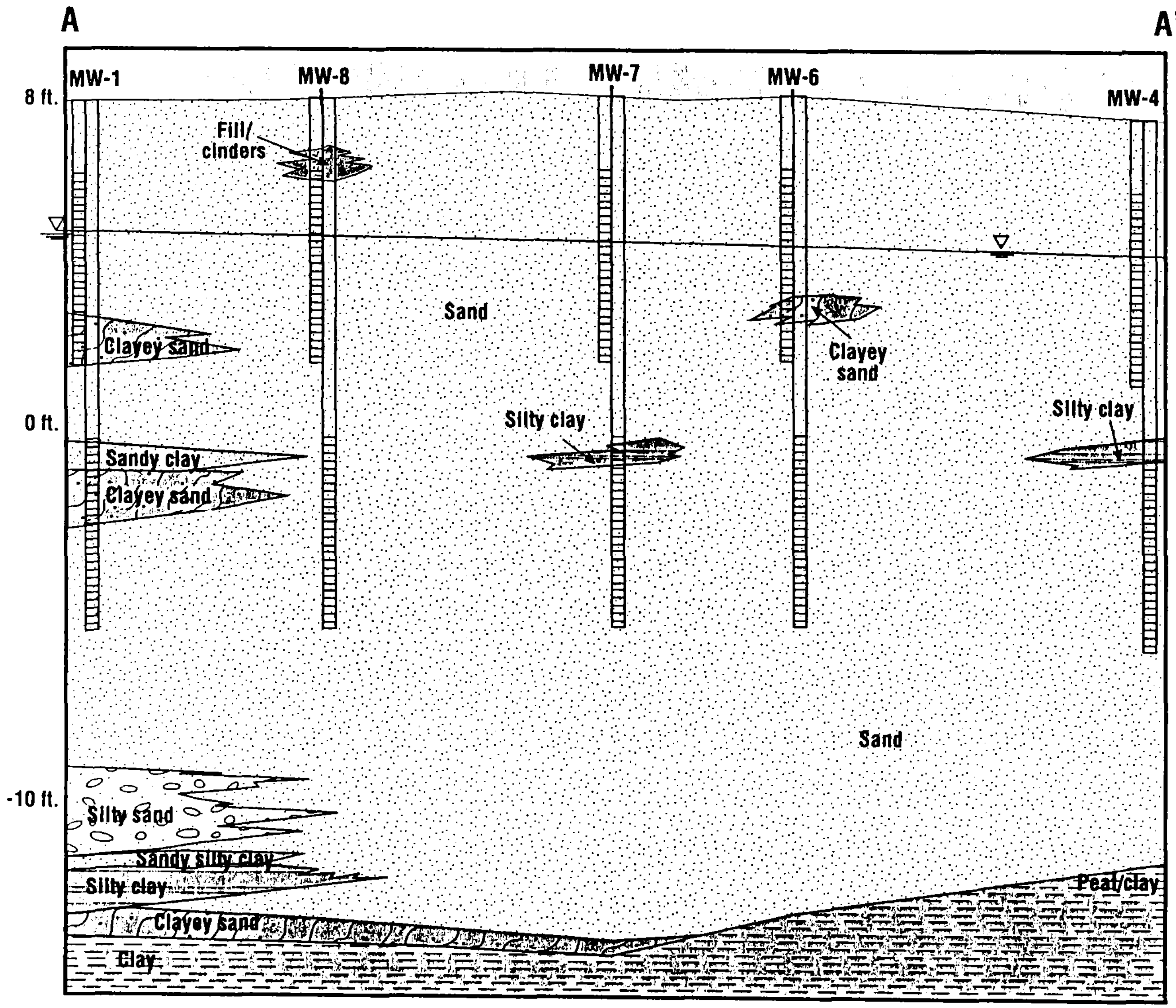


Figure 1.2
Geological Section Transect Map
Site 45/SWMU 45
MCRD Dry Cleaners Facility

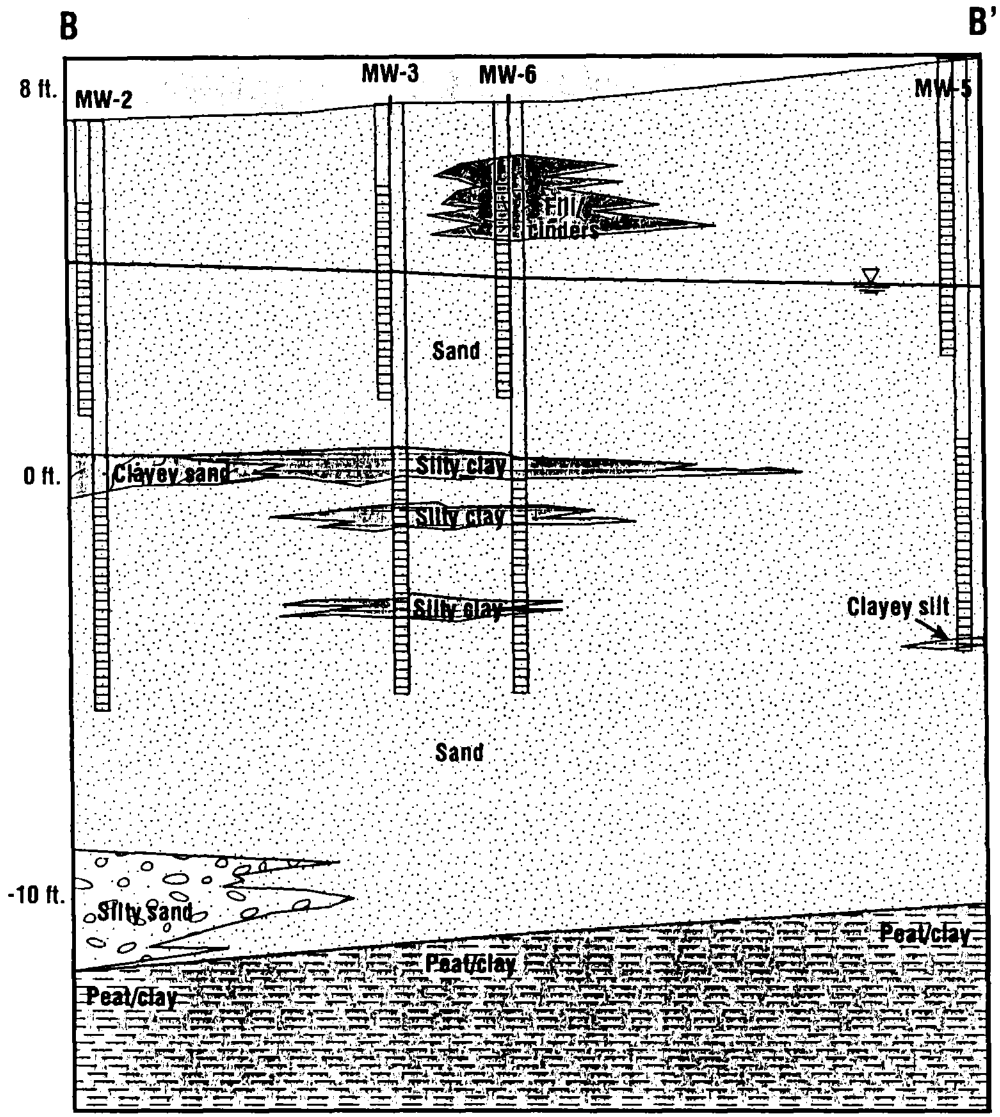
Z1.9 0545.1



Vertical scale: 1" = 4'
Horizontal scale: 1" = 75'

Figure 1.3
Generalized Geological Section of Site 45/SWMU 45 MCRD Dry Cleaners Facility; A - A'

Z1.9 0545



Vertical scale: 1" = 4'
Horizontal scale: 1" = 75'

Figure 1.4
Generalized Geological Section of Site 45/SWMU 45 MCRD Dry Cleaners Facility; B - B'

Z1.9 0545.2

The well monitoring network was comprised of sixteen wells placed at eight locations around the Dry Cleaners Facility. At each location, a shallow well was installed to a depth of 7 ft and a deep well was installed to a depth of 14 ft. Figure 1.5 shows the locations of these monitoring wells. Details of this investigation and the findings are presented in the "Technical Memorandum For Groundwater Evaluation and Air Sparging Pilot Study, Building 193, Parris Island, SC" (Ref. 4).

1.3 NATURE AND EXTENT OF CONTAMINATION

1.3.1 Soil Sampling Results

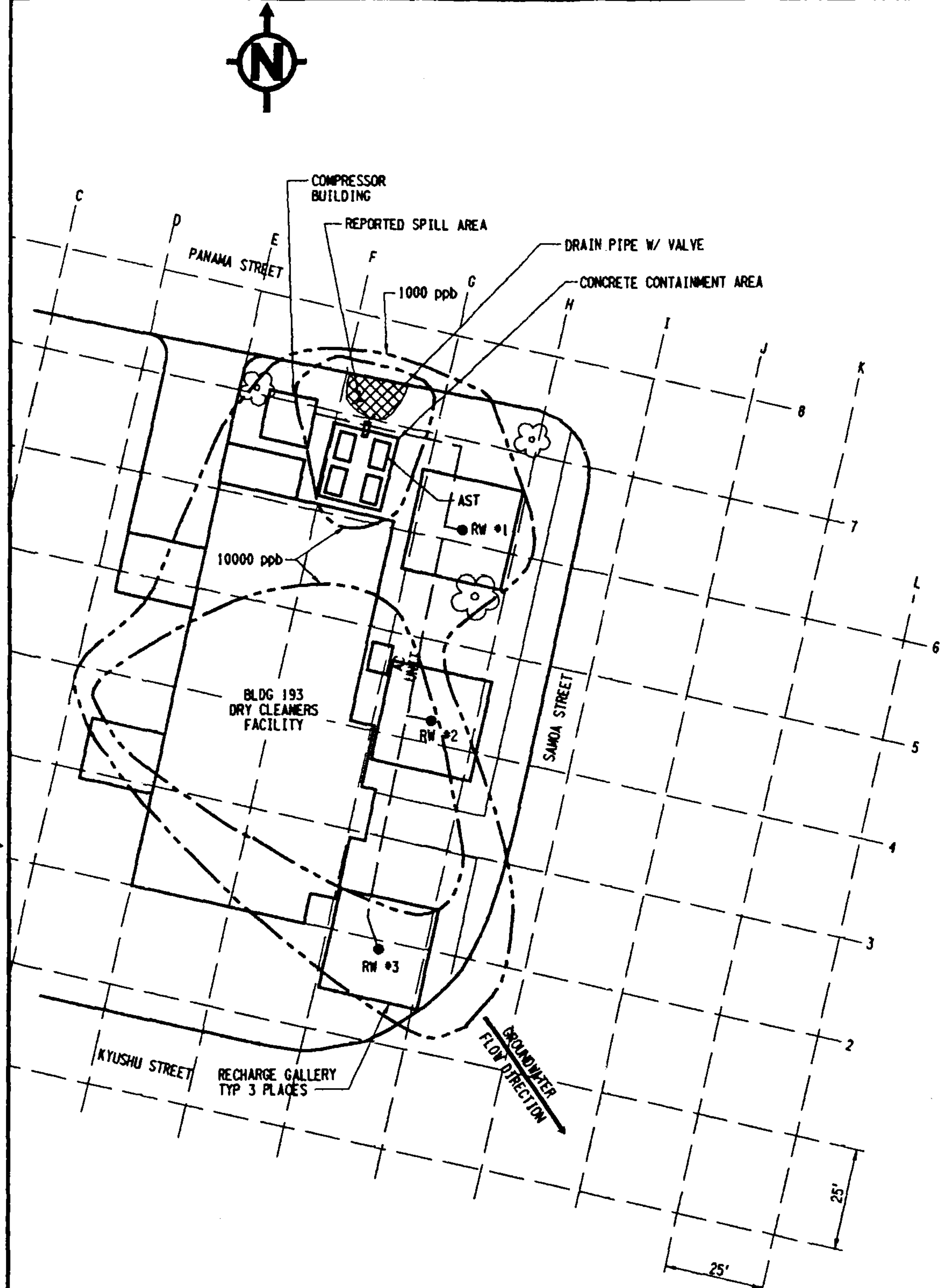
Soil samples were collected from 1-3 ft and 5-7 ft intervals during drilling for monitoring wells 193-6MW-D, 193-7MW-D, and 193-8MW-D and were analyzed for volatile organic compounds (VOCs). These three wells were placed within the highest concentration of the contaminated groundwater based on the direct-push technology results. The analytical results of the soil samples (except for one) indicate that no significant concentrations of the contaminants of concern are present in the soil matrix. However, a soil sample collected from 5-7 ft interval at monitoring well 193-8MW-D was found contaminated with PCE at 1,100 ppb. This location is to the north of the dry cleaner in the area of the reported spill.

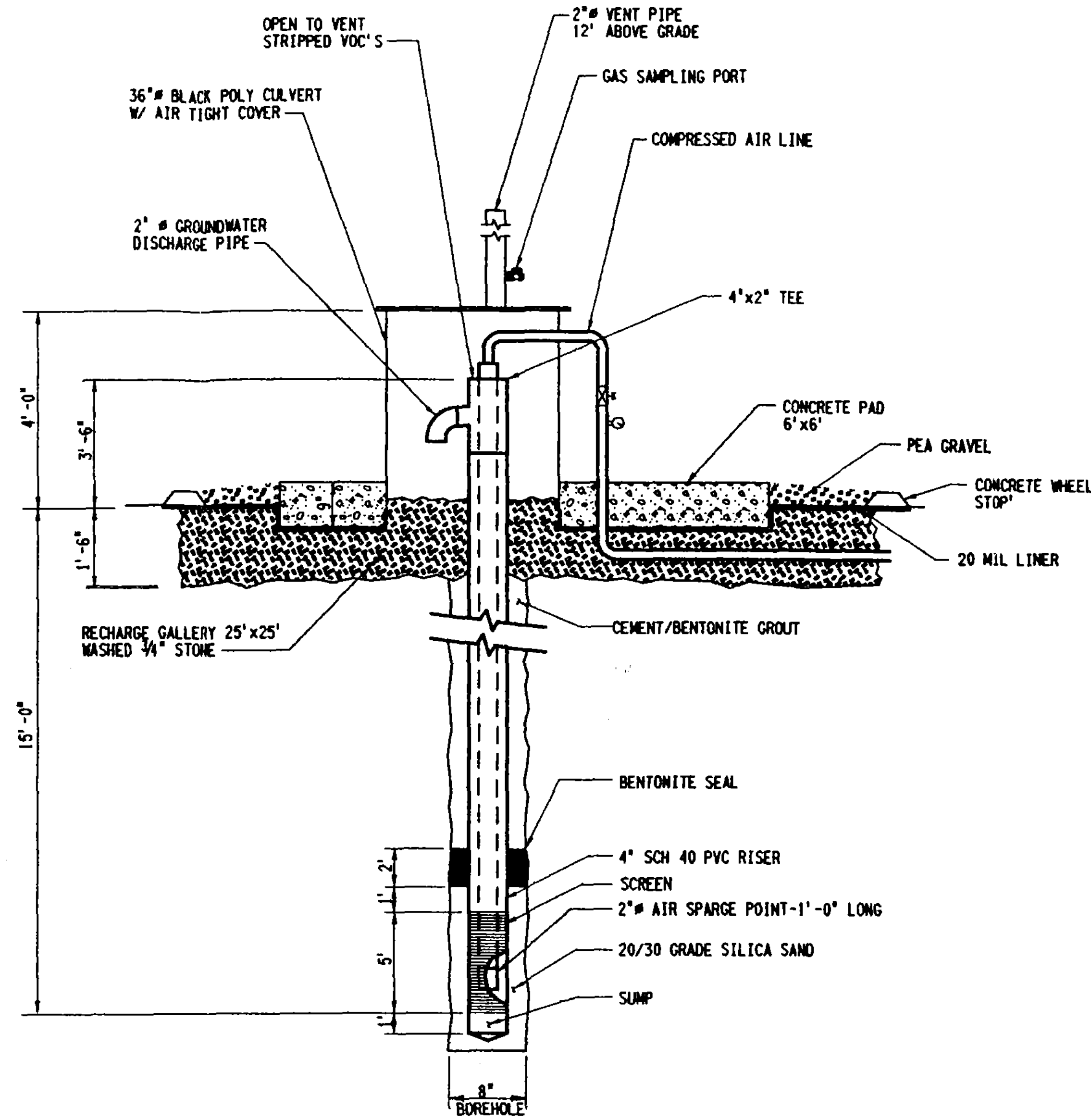
1.3.2 Groundwater Sample Results

The direct push sampling indicated that low levels of groundwater contamination had spread down to the Hawthorn, but the groundwater contamination levels below the 14 foot clay layer were several orders of magnitude lower than those above this layer. The focus of the IRA is the groundwater above the 14-ft clay layer. Monitoring wells were not installed through the 14-ft clay layer to prevent the further migration of contamination.

Groundwater samples were collected from each monitoring well and analyzed for VOCs, chloride, sulfate, and nitrate. Figure 1.5 shows the sampling results and the extent of the solvent contamination at the site. The results from this phase of the investigation correlated closely with the results from the direct push sampling. Figure 1.6 combines the results from the direct push sampling and the monitoring wells. The analytical results are presented in the technical memorandum (Ref. 4).

During the direct-push sampling, water samples were collected and analyzed for total iron at a South Carolina Certified offsite laboratory . The total iron concentrations of these samples were high (at times as high as 100 mg/L). It was thought that the samples exhibited elevated iron levels because the direct push samples were turbid. Ferric iron normally precipitates; therefore, representative groundwater samples were collected from all the monitoring wells and analyzed onsite for ferrous iron using a Hach test kit. The highest ferrous iron detected was only 2.2 mg/L and should not be a concern for iron fouling of any remediation system.





RECOVERY WELL (3 REQ'D)
NTS

NOTES

1. DEPTH OF SCREEN WILL BE ADJUSTED TO SET SCREEN ABOVE EXISTING CLAY LAYER.
2. PRIOR TO ADVANCING DRILL AUGERS THE DRILL HOLE SHALL BE ADVANCED 4' BELOW LAND SURFACE USING HAND TOOLS TO VERIFY THE ABSENCE OF UNDERGROUND INDUSTRIAL OR UTITLIY LINES.
3. LOCATIONS SHOWN FOR RECOVERY WELLS ARE APPROXIMATE. THEIR LOCATION WILL BE ADJUSTED TO AVOID CONFLICT WITH UNDERGROUND UTILITIES.
4. SCALE SHOWN ON THIS DRAWING IS BASED ON A DRAWING SIZE OF 22" X 34"; ANY REDUCTION IN DRAWING SIZE WILL REQUIRE AN APPROPRIATE ADJUSTMENT IN THE SCALE.
5. EACH WELL WILL BE OPERATED AT A FLOW RATE OF 2 GPM.

LEGEND

— —	GRID LINE
●	RECOVERY WELL RW #
— — —	UNDERGROUND AIR LINE
- - —	GROUNDWATER CONTAMINATION CONTOUR
ppb	PARTS PER BILLION

0 20 40 60
1"=20'

NO.	DATE	REVISIONS	BY	CHKR		ENGR	PROJ ENGR	
B		ISSUED FOR REVIEW IN WELL VAPOR STRIPPING						
A	3/12/97	ISSUED FOR REVIEW	RGB	WEH	FMB	FMB	JRM	

SCALE 1"=20' 22567 145 145D002.DGN

BECHTEL ENVIRONMENTAL INC.

OAK RIDGE, TENNESSEE

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA

MARINE CORPS RECRUIT DEPOT, PARRIS ISLAND, S.C.
SITE 45, DRY CLEANERS BUILDING 193
IN WELL VAPOR STRIPPING WELL LOCATIONS AND DETAILS

JOB NO.	DRAWING NO.	REV
22567	145-D000-002	B

22567/145/145D002.RDA

1.4 IDENTIFICATION OF INTERIM REMOVAL ACTION OBJECTIVES

1.4.1 Determination Of Scope

Chlorinated aliphatic compounds, including PCE, TCE, and 1,2-DCE (and vinyl chloride to a limited degree), pose a risk to human receptors at their elevated concentrations in the groundwater in the vicinity of the dry cleaning facility at the Parris Island MCRD. The scope of the IRA at the Dry Cleaners is to minimize further degradation to the groundwater and treat the source of contamination at the center of the plume. The proposed IRA will gain control over the groundwater contaminant source loading and reduce the concentrations of contaminants in the groundwater.

1.4.2 Schedule

This EE/RWP identifies and recommends the selected alternative and will be available for public review and comments for 30 days. The proposed interim removal action is expected to start after incorporating responses to public comments on the EE/RWP. Since the chlorinated aliphatic compounds of concern at the Parris Island Site are highly volatile, considerable reduction in concentration is anticipated immediately after the installation and operation of the treatment system. However, the removal rate will start declining soon after startup and level off over a period of time. The goal of the removal action is for groundwater concentrations to reach equilibrium. It is anticipated that equilibrium will be reached in approximately two years.

1.4.3 Interim Removal Action Objectives

The objectives of the proposed interim removal action are to:

- Minimize further migration of groundwater containing VOCs around the dry cleaning facility.
- Reduce concentrations of the contaminants in groundwater in the area of concern.
- Operate the remedial system until the equilibrium is reached.

1.5 COMPARATIVE ANALYSIS OF INTERIM REMOVAL ACTION ALTERNATIVES

Based on the objectives of the proposed interim removal action presented in the previous section, several alternatives were considered at the Parris Island Site as presented in Table 1.1. These alternatives are described briefly in the table and are evaluated based on effectiveness, implementability, and qualitative cost. To evaluate the effectiveness, consideration was given to the overall protection of human health and environment and both long term and short term effectiveness of the alternative. Evaluation of the implementability of each alternative included consideration of the technical feasibility, commercial availability, administrative feasibility, and public acceptance. The cost comparison estimate is qualitative in that costs are based on orders of magnitude estimates for capital costs, annual operation, and maintenance costs.

Table 1-1 Comparative Analysis of Alternatives

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
No Action	None	None	No further response actions of any type.	Does not remove site-related contamination or control contaminant migration; therefore, does not meet remedial action objectives.	Does not entail any action.	No direct costs.	Not retained as a Interim Removal Action Alternative
Institutional Controls	Land Use Restrictions	Deed Restrictions	Deed restriction issued for property within potentially contaminated areas to restrict future uses that may result in exposures to contaminated groundwater.	Effective for prevention of human contact with contaminated water; reliability is dependent upon long-term enforcement. Does not remove site-related contamination or control contaminant migration.	Easily implemented; however, may impact future land uses.	Negligible capital and O&M costs.	Not retained as a Interim Removal Action Alternative
	Monitoring	Groundwater Sampling and Analysis	Periodic sampling and analysis of groundwater to monitor contaminant extent and migration.	Effective means to monitor contaminant movement, intrinsic bioremediation processes, and/or progress of remedial action. Does not remove site-related contamination or control contaminant migration.	Readily implementable. Some groundwater monitoring wells would be in place when remediation starts.	Low capital and moderate O&M costs.	Retain as support technology.
Natural Attenuation	None	Oxic/ Anoxic Redox Conditions	Naturally-occurring attenuation mechanisms (biodegradation, adsorption, dispersion, volatilization, diffusion & dilution) reduce contaminant concentrations.	Contaminants ultimately transformed to innocuous byproducts; requires extended duration.	Readily implementable. Some groundwater monitoring wells would be in place when remediation starts.	Low capital and moderate O&M costs.	Not Retained as a Interim Removal Action Alternative, could be used for final remedial action.
Containment	Vertical Barriers	Slurry Wall	Trench backfilled with a soil-bentonite or cement-bentonite mix to restrict or divert groundwater flow.	Widely used and generally effective for containing groundwater plumes, however site-specific conditions would may not lend themselves suitable for construction of slurry walls.	Readily implementable at the site, given that contamination plume is shallow and fairly small.	High capital costs and low O&M costs.	Not retained as a Interim Removal Action Alternative
		Sheet Piling	Drive interlocking sheet piles to construct a vertical low permeability barrier; restricts groundwater flow.	Effectively restricts flow of groundwater. Piling may be negatively impacted by high TDS concentrations in groundwater. Also, vertical barriers would not provide for long-term containment.	Readily implementable in sites with unconsolidated soils such as occur at the Parris Island site	High capital costs and low O&M costs.	Eliminate from further consideration on the basis of effectiveness.
		Grout Curtains	A cement grout is pressure-injected along contamination boundaries using an overlapping pattern of drilled holes to form barrier to restrict groundwater flow.	Potentially effective in creating low-permeability barrier to inhibit groundwater flow; however not likely to provide for long-term.	Uses standard construction/ drilling and grouting equipment. Limited data showing successful implementation at contaminated sites.	High capital and low O&M costs.	Eliminate based on effectiveness, implementability, and costs.
	Capping	RCRA-Type Cap/ Non-RCRA Cap	Low-permeability multimedia cap with vegetative cover (RCRA-cap); or single or multilayered soil, clay, and/or pavement cap (non-RCRA) designed to prevent infiltration of precipitation.	Capping can effectively reduce infiltration, thereby decreasing the loading of contaminants to groundwater if vadose zone is contaminated. Contamination is in the groundwater not in the vadose zone. Capping would not be effective.	Non-RCRA caps are readily constructed with common construction equipment/ methods. Capping may limit/ restrict future land uses.	Moderate to high capital and O&M costs.	Eliminate based on effectiveness, implementability, and costs.
	Hydraulic Controls	Extraction/ Injection	Control of groundwater flow/contaminant transport via the use of extraction and/or injection wells to modify hydraulic gradient.	Effectively controls groundwater flow by creating mounds or depressions through groundwater injection or extraction.	Readily implementable. Potential for biofouling and scaling in injection wells.	Low capital and moderate O&M costs.	Not retained as a Interim Removal Action Alternative Same as Pump and Treat

Table 1-1 Comparative Analysis of Alternatives (continued)

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
In Situ Treatment	Biological Treatment	Anaerobic Bioremediation	Delivering precultured dechlorinating anaerobic granules to the subsurface to effectively remediate the chlorinated aliphatics. These granules are self-immobilized microbial consortium.	Given the permeable nature of both saturated and vadose zones, MCRD is a good candidate site for insitu bioremediation.	Pilot Study needs to be conducted to determine if this technology is applicable at this site. Implementability decreases as the area of contamination increases	Moderate capital and O&M costs.	Not retained as a Interim Removal Action Alternative.
		Aerobic Bioremediation	A mixture of methane (substrate), air, and nutrients injected into the subsurface through new / existing wells placed beneath contaminated zone and harnessing the indigenous microbes to remediate the plume.	Given the permeable nature of both saturated and vadose zones, MCRD is a good candidate site for insitu bioremediation.	Remediation of chlorinated aliphatic plumes using insitu bioremediation are being implemented at several sites. Pilot study required	Moderate capital and O&M costs	Not retained as a Interim Removal Action Alternative
		Insitu microbial filter	Placing insitu microbial filter consisting of permeable wall of TCE degrading microorganisms in the subsurface.	Given the permeable nature of both saturated and vadose zones and that the preliminary data indicate ongoing biodegradation of PCE/ TCE, MCRD is a good candidate site for insitu microbial filters.	Has been successfully demonstrated at two other similar sites. Problems associated with nutrient addition is minimal. Flat watertable at the site may make passive hydraulic control difficult.	Moderate capital and O&M costs.	Not retained as a Interim Removal Action Alternative
	Physical Treatment	Air Sparging / Soil Vapor Extraction	Compressed air injected into lower portion of contaminated aquifer percolates up through saturated zone causing transfer of VOCs from aqueous to vapor phases, which migrate upward to vadose zone and are collected with SVE system.	Require air injection, contaminated vapor stream extraction, the vapor stream might need treatment prior to discharge.	Pilot Study determined that this technology is applicable at this site. Implementability decreases as the area of contamination increases.	Moderate capital and O&M costs. Interference with existing utilities could increase costs	Retain for further consideration
		Hydrofracturing	Pressurized water is injected into the subsurface to increase the permeability of subsurface materials and enhance the recovery of contaminants from vadose or saturated zone.	Current permeability of the subsurface should be adequate	Requires specialized drilling/injection equipment; limited full-scale demonstrations for contaminated sites.	Moderate capital and no O&M costs (*one-time action*).	Eliminate based on implementability
		In-Well Vapor Stripping	Involves preferentially extracting VOCs dissolved in groundwater by converting them to vapor phase and treating the vapor. The system involves the combination of air lift pumping and aeration within the borehole to strip volatiles from the groundwater.	Effectively removes the contaminants at the vapor phase without elaborate aboveground water treatment.	In well Vapor stripping requires recovery wells to be installed and the system is powered by an air compressor. Permeabilities at MCRD site support this technology.	Moderate capital and O&M costs.	Retain for further consideration.
	Chemical Treatment	Permeable Reaction Walls (Iron Filings Wall with funnel and gate system)	Permeable reaction wall installed across flowpath of contaminant plume; treatment occurs as groundwater flows through wall under natural or enhanced gradient. Potentially effective for removal of inorganics from groundwater.	Limited applications to date; reported to be successful in degrading greater than 90% of TCE in groundwater. Limited data concerning effectiveness in attaining final cleanup goals, but technology is generally viewed as promising.	Limited full-scale applications. Would require treatability testing (bench and potentially pilot-scale) to support design and optimize performance. Flat watertable at the site may make passive hydraulic control difficult.	Moderate capital and O&M costs. Interference with existing utilities could increase costs.	Eliminate based on implementability

Table 1-1 Comparative Analysis of Alternatives (continued)

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
Removal/ Treatment/ Discharge (Pump and Treat)	Groundwater Extraction	Wells	Extraction wells and pumps installed to collect contaminated groundwater for subsequent conveyance to treatment facilities.	Potentially effective for removal of VOC contamination. May not achieve complete aquifer remediation.	Readily implementable. Will require treatment/disposal of extracted groundwater.	Low capital and high O&M costs.	Retain for further consideration.
	Physical Treatment	Air Stripping / Steam Stripping	TCE and other VOCs are stripped from water by coming in contact with air or stream usually in a packed column. Normally used ahead of activated carbon units	Effective for removal of VOCs from water; off-gas would be collected and require further treatment. Removal efficiencies > 99.9% could be achieved for VOCs.	Well-proven, reliable technology. SDHEC permit may be required for off-gas treatment; tower height and location may be restricted.	Moderate capital and O&M costs.	Retain for further consideration
		Carbon Adsorption (GAC)	Contaminants transfer to the activated carbon adsorbent due to the imbalance of forces in the pore walls of the adsorbent. Normally used as a secondary unit to air stripping	Widely demonstrated effectiveness for removal of low concentrations of VOCs.	Available and proven technology. Spent carbon must be regenerated or disposed. Mobile units available.	Low capital costs and high O&M costs.	Retain for further consideration as a support technology
	Chemical Treatment	Chemical Oxidation	Ultraviolet (UV) radiation in conjunction with ozone and/or hydrogen peroxide oxidizes TCE and related compounds to render them nonhazardous or to make them more amenable to subsequent removal or destruction processes.	Effective for oxidation and destruction of chlorinated hydrocarbons. May result in the formation of partially oxidized and undesirable byproducts. The high TDS and TSS at this site makes this treatment technology not applicable.	Use of UV radiation may require pretreatment to prevent fouling or scaling of UV lights.	High capital costs and O&M costs.	Eliminate based on cost; VOCs can be removed more cost-effectively by other means.
	Groundwater Discharge - *Treated*	Surface Outfall	Treated groundwater discharged to near-by surface water	Effective means of disposal for treated groundwater; discharge limits in NPDES permit would dictate treatment goals.	Technically feasible;. Potential administrative issues if permit to be prepared	Low capital and O&M costs.	Retain for further consideration as a support technology
		Publicly-Owned Treatment Works (POTW)	Treated groundwater discharged to POTW or subsequent treatment/discharge	Effective means to dispose of treated groundwater; discharge would have to meet POTW limits for industrial discharges.	Significant administrative problems with POTW acceptance of treated (or untreated) groundwater.	Low capital costs and O&M costs.	Retain for further consideration as a support technology
		Injection/ Infiltration	Treated groundwater discharged to the ground via an injection well or infiltration gallery.	Effective means of disposal of treated groundwater; additional treatment may be required to meet permit conditions for injection. Can be used to enhance hydraulic containment or contaminant removal.	Technically feasible; permit from SDHEC may be required	Low capital and moderate O&M costs.	Retain for further consideration as a support technology.
	Groundwater Discharge - *Treated*	RCRA TSD Facility	Untreated groundwater would be collected and transported to a RCRA-permitted facility for treatment/disposal; the receiving facility would determine treatment requirements.	Effective method for disposal of contaminated water.	Implementability dependent on the volume of water requiring off-site transport and geographic location of RCRA facility.	Low capital and high O&M costs.	Eliminate based on cost.
		Beneficial Uses	Treated groundwater would be used for landscape irrigation, pond or fountain replenishment, habitat maintenance or other non-consumptive uses.	Reuse of water maximizes overall benefit of remediation and is consistent with SDHEC policy of efficient utilization of water reuse	Technical feasibility depends on type of redevelopment in surrounding areas and ability to tie into infrastructure for distribution of water.	Low capital costs and low O&M costs.	Not selected as representative technology.

1.6 EVALUATION OF SELECTED REMEDIAL ALTERNATIVES

Three different technologies were considered as viable alternatives for the interim action at the dry cleaner facility:

- pump and treat
- air sparging
- in well vapor stripping

1.6.1 Pump and Treat

Historically pump and treat has proven to be expensive. Once extracted the contaminated groundwater has to be treated prior to disposal. Also, disposal of the treated groundwater would be a problem at Parris Island. There is limited space for a recharge gallery. The MCRD sewer treatment plant is able to accept water treated to meet the drinking water standards, but discharge to the plant would have to be controlled to accommodate plant capacities. Therefore, pump and treat does not appear to be a viable alternative and will not be considered further.

1.6.2 Air Sparging and Soil Vapor Extraction

Air Sparging was evaluated and the pilot study indicated that it could be a viable option. The design air flow rate from the pilot study was 2 standard cubic feet per minute (scfm). Higher flow rates were used during the pilot study, but they caused water to bubble from one of the observation wells and groundwater mounding in the other observation wells. If the higher flow rates were used for the remediation system, groundwater mounding and breaching the ground surface could become a concern.

The second concern for the system is the uncertainty associated with the capture of the emissions from the air sparging. A soil vapor extraction system (SVE) would need to be installed over the area of air sparging to collect emissions from the air sparging. Because of the fine layered silts and site conditions, all of the generated emissions might not be captured. This could be a health and safety concern to workers at the dry cleaning facility and the general public as well. The installation costs for this system are estimated to be $420,000.

1.6.2.1 Air Flow Dynamics

Recent research has demonstrated that at several sites, air flow through saturated soil is in the form of channels, not bubbles. Only sites with an average grain size of 2.0 mm or larger will form bubbles. The channel flow will not create the convection currents and the groundwater will not likely recirculate around the sparging wells thus limiting the effect of the sparging wells. The average grain size for soil sample from the site at Parris Island was 0.125 mm. Thus the flow regime is most likely to be channels. (Ref. 8)

1.6.2.2 Diffusion and Rate Limitations

Since channels are the most likely path for airflow, the groundwater and the contaminants are not all equally exposed to the airflow. The channels are likely to be several inches to several feet apart. The contaminants then must migrate this distance using molecular diffusion processes to reach the air channel to volatilize. This would mean that the remediation time at Parris Island could be long and the system effectiveness could be limited. (Ref. 8)

1.6.2.3 Minimum Permeability

The minimum permeability of $1x10^{-3}$ cm/sec is generally necessary to achieve an effective rate of air injection for air sparging. Slug tests have been conducted at several sites at Parris Island, but not at the Dry Cleaners. The permeability values from these tests range from $1.57x10^{-3}$ cm/sec to $4.71x10^{-3}$ cm/sec. (Ref. 7) These values are very close to the minimum recommended values. (Ref. 8)

1.6.2.4 Minimum Air Flow Recommendations

The Wisconsin Department of Natural Resources "Guidance for the Installation of Air Sparging Systems" recommends the air flow for an air sparging well to be at least 5 scfm per well. This rate has been revised from a recommended rate of 0.5 scfm in their 1993 guidance document. The selected design rate for an air sparging system was 2 scfm per well based on the pilot study results. This rate is below the Guideline's recommended minimum and could result in unsatisfactory results. (Ref. 8)

1.6.3 In Well Vapor Stripping

In well vapor stripping is a process that removes the volatiles by aerating the groundwater circulating through a recovery well. The flow of air results in an airlift pump effect that creates a circulation cell. The contaminated groundwater is treated as it passes through the well. This technology is currently being demonstrated at a number of sites.

Groundwater modeling was performed for in well vapor stripping at the dry cleaning facility. The program Visual Modlflow was used to simulate the effects of this technology on the aquifer. Both a two well system and a three system were modeled with flow rates of 2 gallons per minute per well. The three well system provided the best recovery pattern and was selected for this site. Attachment 2 provides additional information on the groundwater modeling effort.

Some of the advantages that this technology has over air sparging at this site are:

- The radius of influence of this method is reportedly larger and more uniform than air sparging.
- The treatment zone is more predictable than air sparging.
- The treatment zone is lower in the aquifer
- The capture of emissions is from the well and a separate vapor extraction system is not required. This technology has a higher likelihood that the vapors are captured and discharge is controlled.

Some of the disadvantages of this method include:

- The well can clog or scale from biological or mineral sources. This can be cleaned by high pressure cleaning or with chemical treatment.
- The depth of a recovery well at the dry cleaner facility would be shallow. This could affect the system's radius of influence and the ability to remove the contaminants in one cycle through the circulation cell. More cycles of the groundwater may be necessary because of the limited depth of the wells.
- The recharge of the groundwater at this site could be a problem (especially during the rainy season), because of the depth to groundwater across the site being only 2 to 3 feet.

The installation costs for this system are estimated to be $300,000.

1.7 RECOMMENDED INTERIM REMOVAL ACTION ALTERNATIVE

Detailed analysis of the technical evaluation and comparison of the costs leads us to select in well vapor stripping as the selected alternative for the IRA at the dry cleaning facility

1.7.1 In Well Vapor Stripping System

The in well vapor stripping system includes an air compressor which will provide the compressed air for the air lift pumps in each of the three recovery wells.

Each well head will have a discharge tank built around it and the pumped water will flow directly into a recharge gallery that will surround each well head. Two safety devices will be installed to ensure that the system does not pump water faster than it can be recharged into the ground. One will monitor the water levels in the recharge tank and one will monitor water levels in the recharge gallery. These safety devices will interrupt the air flow and thus stop pumping if water levels reach too high a level. Once the water levels drop, the air flow and pumping will resume.

1.7.2 Off-Gas Discharge

Off-gases collected by the in well vapor stripping system will be vented from each recharge tank. Treatment of the off-gases will not be required. The MCRD's air permit allows emissions up to 600 pounds per month per source. The maximum estimated emissions from the system are 150 pounds per month. During startup and optimization of the treatment system, operating data from the discharge points will be evaluated to ensure that off-gas emission limits are being met. If these limits are exceeded, the operating schedule of the system will be altered to ensure compliance.

2. REMOVAL ACTION ACTIVITIES

This section of the document provides guidance and direction to the Bechtel construction crew during the implementation of the EE/RWP, and serves to meet the contractual requirements between Bechtel and the Navy. This section also provides a more detailed description of the physical processes to be employed at the dry cleaning facility.

2.1 CONSTRUCTION DRAWINGS

After incorporating public comments into the EE/RWP and SOUTHDIV approval, Bechtel will prepare the final construction drawings. These drawings will serve as the basis for the Record Drawings and will be used in the procurement of treatment system equipment and materials. The preliminary construction drawings are included in Attachment 3. Additional details necessary for the field crew to implement the design will be included on the final construction drawings. Final construction drawings will be maintained at the site by the Bechtel Construction Site Superintendent. Red line construction drawings detailing the actual installation shall be provided to the Bechtel Project Engineer for incorporation into the Record Drawings.

2.2 EQUIPMENT PROCUREMENT

After approval of the EE/RWP, Bechtel will complete the procurement of the treatment system equipment and materials. This will include the air compressor unit and controls, valves, system control, a building, miscellaneous piping, recharge tanks, geomembrane, and stone.

2.3 SUBCONTRACTING

After approval of the EE/RWP, Bechtel will complete the subcontracting to support the work at the dry cleaning facility. These will include:

- Well Drilling
- Survey
- Transportation, Treatment, and Disposal Services
- Miscellaneous Site Services
- Analytical Services.
- Operation and Maintenance (O&M)

2.4 PERMITS

Necessary permits identified for the work at the site include a facility excavation permit, well installation permits, and well injection permits. The well permits will be obtained prior to mobilization.

2.5 MOBILIZATION

Once notice to proceed has been given to Bechtel by SOUTHDIV, Bechtel will mobilize a work force, support equipment, material, and subcontractors necessary to complete the work.

2.5.1 Pre-Construction Meeting

Before the physical work begins, a preconstruction meeting will be held with the Resident Officer in Charge of Construction (ROICC). This meeting will discuss execution of the work, site access, staging areas, transportation haul routes, and contact personnel for utilities, fire, environmental, safety and health, security, waste management, and public and troop interface.

2.5.2 Temporary Facilities

A hookup for minor use of potable water for decontamination, safety and health, and miscellaneous usage will be coordinated with the ROICC. A storage container for tools, small supplies, safety and health equipment, and other supplies will be staged to the site.

2.5.3 Utility and Excavation Interference Identification

Before the start of any excavation activities, the Bechtel Site Superintendent will perform all the necessary utility clearances and contacts. This will include contacting the MCRD Public Work Department, the ROICC, and facility personnel. Bechtel will also use utility locating equipment before any intrusive work in an area. The drilling subcontractor will be required to post-hole the first 4 ft of depth before drilling the borehole. Hand digging shall be used to excavate around all existing utilities.

2.6 IN WELL VAPOR STRIPPING SYSTEM INSTALLATION

The in well vapor stripping system installation consists of recovery well installation, equipment installation, and piping installation. The project drawings are included in attachment 3.

2.6.1 Recovery Well Installation

Recovery wells will be installed for the groundwater treatment system. Wells will be installed at the locations shown on project drawings. Well completion details are also included on the project drawings. Well screens will be installed above the clay layer located at approximately 14 feet below grade.

2.6.2 Equipment Installation

An air compressor will be installed in the equipment building. The system controls will allow the system to operate all the wells continuously. The normal groundwater pumping rate the air lift pumps will generate is 2 gallons per minute per well.

2.6.3 Piping Installation

Buried airline piping will be installed below ground from the equipment building to each recovery well at the locations shown on the drawing. Trenching will be of sufficient size to allow for the inspection of the work, but comply with the requirements of Occupational Safety and Health Administration Safety Standards, 29 CFR 1926.651, Subpart P. All existing utilities or other obstructions will be located before the start of excavation. Backfill shall be compacted to 85 percent of the maximum dry density in accordance with ASTM D1557. Spoils generated from excavation activities which are not used as backfill will be tested and dispositioned as described in Section 3.0, Waste Management.

Concrete pavement installation and repairs will require a sub-base consisting of a 6-in. layer of CR14 crushed stone compacted to 95 percent of the maximum dry density in accordance with ASTM D1557. Concrete shall be 4,000 psi, low water content to reduce shrinkage with fiber reinforcement. The minimum flexural strength shall be 650 psi at 28 days.

2.7 EQUIPMENT BUILDING

The air compressor, the electrical power distribution center, and control instrumentation will be centrally located within a pre-fabricated building. The location of the building is indicated in the project drawings. Vents and a temperature controlled forced air ventilation system will be provided. Color and style of the building shall be coordinated with the Navy. The final building drawings will be provided by the vendor.

2.8 ELECTRICAL SERVICE

Electrical service will be 1-phase supplied by overhead line from an existing power pole to the equipment building. All electrical services shall be performed by a South Carolina-licensed electrician. All systems and services shall conform to the National Electrical Code and the authority having jurisdiction. The main service location shall be coordinated with the MCRD personnel.

2.9 INSTRUMENTATION

The system installed as part of this IRA is designed to operate unattended. To accomplish this, sensors will be installed that send signals to the controller and/or local actuators to control system processes. In the event that the system operates outside of established parameters, the system will discontinue operation.

2.10 SURVEY

After the installation of the equipment, wells, and other utilities, a survey to document the final as-built locations will be performed. Reference points and elevations will be obtained as required to be consistent with data available for the other site monitoring wells. One existing monitoring well elevation will be verified during this survey.

2.11 INITIAL STARTUP TESTING

After installation of the physical system has been completed, startup testing of the equipment and the process can begin. All testing records and initial readings will be recorded in logbooks created by the Field Engineer. These logbooks will become the basic site visit guidelines. Included will be time, temperature, weather conditions, pressure readings at each gauge, flow readings at each well head, position of each solenoid valve, and water chemistry field measurements. Also included will be a list of sampling requirements and activities to be accomplished during each visit.

2.11.1 Equipment Testing

After the installation of the equipment and hookup of the electrical service, the equipment vendor will be brought to the site for a system inspection. The vendor will inspect wiring connections, motor anchorage, and any other primary items of concern. Once the vendor has approved installation and authorized power of the systems, motors will be initially bumped to ensure proper rotation. Sensors will be activated and deactivated to ensure signals to the controller are being received. The wiring of gauges and sensors to the panels will be validated.

Other equipment will be checked and inspected for orientation and working valves. Piping will be inspected to ensure it is secure and in place. Electrical conduits will be inspected to ensure they are properly installed.

Final inspection check lists and quality assurance requirements are discussed in Section 6.0, Quality Assurance.

2.12 OPERATIONS MONITORING AND OPTIMIZATION

After completion of the initial startup testing and evaluation, the initial operations monitoring and optimization will commence. The initial operations monitoring and optimization will occur during the first month of operations. Daily monitoring will be performed for the first week and weekly monitoring will be performed for the first month. After the first month of operation, the normal monthly O&M visits will start.

2.12.1 Record Keeping

A check list form will be generated to record pertinent information that will be used to evaluate system performance. This form will include information on pressures, flow rates, and field measurements and identify samples collected for laboratory analysis.

2.12.2 System Optimization

Using the data gathered during the first month of operations, the initial settings of flow rates and pressures at each recovery well will be established. Every quarter these parameters will be reviewed and evaluated.

3. WASTE MANAGEMENT

General waste management practices used by Bechtel on this project will be as defined in the *Environmental Response Action Contract Waste Management Plan.* There are several waste management activities that are anticipated during this remedial action, including disposal of:

- Construction debris
- Soils
- Decontamination water
- Well purge and development water
- Personal protective equipment and other incidentally contaminated materials
- Other non-hazardous solid wastes.
-

3.1 WASTE MINIMIZATION

Construction activities at this site will be controlled to minimize the amount of materials that must be disposed of. Waste minimization is an important goal and will be implemented during all site operations. These practices will include:

- Limiting extraneous materials taken into contaminated areas
- Decontamination of equipment used to support onsite activities
- Use of consumable items that can be compacted or otherwise volume reduced.

3.2 HAZARDOUS WASTE

On March 11, 1994 a reportable spill of PCE occurred at the dry cleaning facility at Building 193. The spill was noted by the MCRD Environmental Office and reported to SCDHEC and the National Response Center. Information regarding the spill was obtained from a *Fact Sheet* dated March 31, 1994 (Attachment 1.) The groundwater contamination at this site is most probably a result of the March 11, 1994 spill and other past practices at the dry cleaning facility. Based on this process knowledge, contaminated media containing PCE, TCE or vinyl chloride will be classified as Resource Conservation and Recovery Act (RCRA) listed wastes. Wastes generated as a result of the installation of the IRA system at this site will be sampled for these hazardous constituents.

Hazardous waste could be generated during the remedial actions at this site. When any hazardous wastes are identified, they will be managed in accordance with RCRA, 40 CFR Part 260, and related federal and state regulations. Bechtel will facilitate transport and disposal using waste profiles and manifests signed by the MCRD as the waste generator.

3.3 WASTE DISPOSAL

The following sections provide guidance for the decision process for disposal of the wastes generated at the site. The Bechtel Site Superintendent is responsible for filling in the Bechtel Navy RAC waste tracking logs and ensuring they are kept up to date. Manifests or shipping papers, as required, will be signed by the MCRD.

3.3.1 Construction Debris

Non hazardous construction debris will be checked for contamination and cleaned by brushing off visible soils. The material will then be disposed of at a licensed landfill or recycled.

3.3.2 Soils

Excavated soils will be sampled for disposition. All excavated material will be placed on liners and covered, until sampling results are known. If the excavated material is determined to be a RCRA hazardous waste, it will be containerized and disposed of as such. Excavated material determined to be non-hazardous will be used as backfill. Surplus backfill material will be deposited at the AS-18 site.

Drill cuttings generated during well installation will be containerized and sampled. If these drill cuttings are determined to be a RCRA hazardous waste, they will be disposed of as such.

3.3.3 Decontamination, Well Purge, Development, and Miscellaneous Water

Decontamination, well purge, and development water will be containerized in 55 gallon drums approved by the Department of Transportation or poly tanks. The water will be sampled for VOCs and will be characterized and disposed of as a RCRA hazardous waste if solvents are detected. If the water is non-hazardous, it will be discharged to the Parris Island federally-owned treatment works.

3.3.4 Personal Protective Equipment

Personal protective equipment will be cleaned of loose soil, double bagged and disposed of at a Subtitle D landfill.

3.4 SPILL PREVENTION PLAN

Activities associated with the refueling of equipment will be conducted in a manner to ensure that product or fuel is not released into the environment. When conducting operations which may result in possible fuel release, Bechtel's work will provide best management practices to preclude a spill. Provisions for spill prevention and control that will be used during transfer of fuel will include:

- Performing manual level checks in the portable fuel tank prior to refilling
- Performing manual level checks in the equipment tank prior to refueling
- Manual transfer of fuel

- Surveillance monitoring: All tanks will be checked during refueling operations to ensure overflow conditions do not occur
- Use of process controls where feasible
- Immediate availability of spill mitigation equipment (e.g., absorbent materials)
- Notification to the MCRD fire department, and then to MCRD Environmental personnel if a spill occurs.

Other provisions and procedures will be discussed with MCRD before implementation of the refueling operations. Daily inspections of the refueling operations will be performed by the Safety and Health representative to ensure availability of prevention controls.

4. SAMPLING AND ANALYSIS

Project Procedures (PP) based on the EPA and SCDHEC sample collection guidelines will be utilized throughout the data collection phase of this project. This section outlines the specific field methods and techniques that will be used to collect soil and water samples during the course of the activities outlined in this work plan. This section also provides an overview of the groundwater monitoring plan.

4.1 SAMPLING PROTOCOL

The following Bechtel Navy RAC Project Procedures will be utilized for this work:

• PP 6003	Sample Identification and Data Encoding
• PP 6004	Field Logbook Management
• PP 6005	Chain-of-Custody Record Procedures
• PP 6006	Sample Tracking
• PP 6010	Sample Containers, Preservation and Aliquot Requirements
• PP 6011	Sample Packaging and Shipment
• PP 6021	Water Sampling
• PP 6024	Decontamination of Field Sampling Equipment
• PP 6025	Soil Sampling.

4.2 FIELD SAMPLING AND ANALYSIS

Samples identified in this section will be collected in accordance with the previously identified project procedures. Analysis of these samples will be in accordance with EPA criteria for the defined method or by the procedure identified as appropriate. Sampling efforts can be segregated on the basis of data objectives:

- Soil Disposal Sampling
- Liquid Disposal Sampling
- Air Sampling
- System Startup Sampling
- Groundwater Monitoring
- System Performance Monitoring - Field Measurements

4.2.1 Soil Disposal Sampling

Excavated soils and drill cuttings will be sampled before disposal. Soils samples will be collected and analyzed as required by the transportation/disposal facility.

4.2.2 Liquid Disposal Sampling

Liquid disposal sampling will be conducted on water generated from decontamination water activities, injection well development, and monitoring well purging. This liquid will be sampled for VOCs and other analytes as required by the transportation/disposal facility.

4.2.3 Air Sampling

The off-gas generated during treatment system operations will be monitored. The stacks will have a sample port to allow for collection of air samples in Summa® canisters for analysis by EPA Method 18. These samples will be collected over a time period and the results interpreted into a pounds per day of total volatile organic compounds. The proposed frequency for sampling from the exhaust stack will be as follows:

- Beginning on the second day of operations, sampling will occur once a day for 5 consecutive days.
- Samples will be collected once a month thereafter.

The turnaround times for the samples will be 2 days for the daily samples and 14 days and for the monthly samples.

4.2.4 Groundwater Monitoring

One complete round of groundwater samples will be collected within one month before system startup. All 16 monitoring wells at the site will be sampled and the samples will be analyzed for VOCs.

During the implementation of the remedial action for groundwater treatment, groundwater samples will be collected from the monitoring wells on a quarterly basis. The following provides a description of the activities to be performed.

Water Levels

Water level measurements will be taken from 16 monitoring wells located around Building 193. The well cap will be removed for a period of not less than 10 minutes, after which the water level can be taken and recorded. All 16 monitoring well water levels will be taken within a four hour period.

Well Purge

After completion of the water level measurements, one technician will begin the purging activities. The purging regime will start with the uncontaminated or least contaminated wells and move toward the most contaminated. A low flow pump will be used to purge the monitoring wells. During the purging activities, the parameters of pH, temperature, and conductivity will be recorded at appropriate intervals based on estimated volume of purge water. Purging will be considered complete when a minimum of five well volumes have been removed and pH, conductivity, and temperature have stabilized. A final reading of pH, Eh, conductivity, temperature, and dissolved oxygen will be taken and recorded.

The purge volume will be calculated by taking the depth to water from the top of the well casing and subtracting it from the listed total well depth, then multiplying this number by the calculated volume of water per foot of well depth to provide the number of gallons. Purging will be completed following the Bechtel Navy RAC PP 6021, "Groundwater Sampling."

Monitoring Well Sampling

At the completion of monitoring well purging, sampling activities will begin. Sampling activities will start with the uncontaminated wells or least contaminated wells and move toward the most contaminated wells. Sample activities for the monitoring wells to be sampled will be completed within 24 hours of purging. Groundwater sampling will be conducted in accordance with the Bechtel Navy RAC PP 6021, "Groundwater Sampling." Samples will be analyzed for VOCs.

Discharge Water Sampling

Water samples will be collected from the recharge tanks and sampled for VOCs. These samples will be collected from each recharge tank. They will be collected twice during the first week of operation and monthly thereafter.

5. SYSTEM STARTUP, OPERATIONS AND MAINTENANCE

An operations and maintenance manual will be completed during the initial operations. At the end of the four week initial operations, normal O&M activities will begin, with monthly visits to the site. Bechtel will continue the system O&M for the first six months of operations after which time the system effectiveness will be evaluated. The following sections outline the general requirements of the operations, evaluation, sampling, reporting, and maintenance of the system.

5.1 STARTUP, OPERATIONS, AND MAINTENANCE MANUAL

A startup, operations, and maintenance manual will be created before system startup. This manual will include startup procedures, shutdown procedures, normal activities, monthly activities, quarterly activities, reporting requirements, maintenance requirements, and logs for data and maintenance activities.

5.2 SYSTEM MONITORING

The following is a description of system monitoring on a per visit basis:

- Upon arrival at the site, record the readings on the pressure indicators and flow meters.
- Monitor flow rates from each recovery wells.
- Collect water samples from recharge tanks.
- Collect water level readings and field chemistry data from monitoring wells.
- Collect monthly offgas samples
- Perform preventative maintenance.

- If appropriate, collect quarterly groundwater field chemistry data and samples from the monitoring wells.

5.3 SYSTEM EVALUATION

During the course of the normal operations and maintenance, the system will be periodically evaluated for effectiveness in reducing contaminant concentrations. Groundwater analytical data will be compared to the original baseline data. Parameters will be plotted to demonstrate changes in the system. Emission data will be evaluated to demonstrate compliance with emissions standards. Quarterly reports will be forwarded to SOUTHDIV.

6. QUALITY CONTROL

Appropriate quality control (QC) criteria are developed and included in the site-specific addendum to the Quality Control Plan. This site-specific plan, called the Quality Control Plan Addendum, is based on the Navy-approved QC Plan for the basic contract. Bechtel will implement, maintain, and comply with the Navy-approved basic contract Quality Control Plan and the site-specific Quality Control Plan Addendum.

The intent of this section is to provide general guidance to the field construction crew as to the items that require inspection during installation. In addition, this section identifies some of the items that require spot inspection. The following sections discuss the construction field inspection, testing requirements, and submittals. These sections will be revised as appropriate during actual field implementation based on equipment.

6.1 EXCAVATION

During excavation operations to install system piping, the QC Representative will ensure that the proper soil disposal sampling protocol is followed and the results are reported before the soil is transported from the site. Final disposition and final clean soil sampling shall also be noted on the tracking log for the soil, as will the notation of the proper number of post-treatment samples, based on permit and regulatory requirements.

6.2 SITE RESTORATION

During site restoration activities, the QC Representative will ensure, grading, and seeding. Additionally, erosion controls will be inspected for proper placement and usage to prevent sediment runoff.

6.3 PIPING

All pressure piping will be leak tested by pressuring the line to 100 psi with air and checking joints with soap for leaks. The QC Representative will fill in field inspection reports noting the testing and the results.

6.4 ELECTRICAL SERVICE

The QC Representative will verify that all electrical components and utilities are installed in accordance with the design drawings and specifications. This will include verification that wiring was pulled correctly, grounding is present, and conduit has been properly sealed. The QC Representative will verify before start-up or placement in service that all appropriate testing has been completed.

6.5 EQUIPMENT INSTALLATION

Equipment will be checked before installation for certificate of testing. After installation, the QC Representative will verify that equipment tests are conducted in accordance with the manufacturer's instruction. The oil level in the air compressor shall be verified prior to startup.

6.6 WELL INSTALLATION

The QC Representative will verify the drilling permit record keeping and materials used in well construction. Each recovery well will be logged as to depth, observations (including material retrieved by augers), and depth to groundwater. The wells where split spoons were taken will be noted on the well log forms. The Bechtel representative will be responsible for logging the well. The QC Representative will ensure that the well was developed to verify proper seating of the sand pack to prevent siltation of the well during use.

6.7 SYSTEM STARTUP AND OPERATIONS

The QC Representative will verify the air injection permit is in place and that the proper records are maintained to document startup and operation.

6.8 RECORD DRAWINGS

Record Drawings documenting system installation will be prepared and submitted to SOUTHDIV.

7. SAFETY AND HEALTH

A Program Safety and Health Plan defines the policies for the Navy RAC project. A Site Safety and Health Plan has been prepared for each of the Navy RAC bases. An addendum to the site specific plan which will be provided to the Navy under separate cover defines task-specific requirements for the activities at the dry cleaning facility.

A process hazards review of the safety hazards associated with the operation of the groundwater treatment system will be conducted prior to completion of the Remedial Design. The purpose of the process hazards review is to ensure that the procedures, instruments, equipment, and administrative controls required to prevent, mitigate, or control process hazards are in place.

8. PROJECT MANAGEMENT

8.1 PROJECT ORGANIZATION

As the Environmental RAC for the Navy, Bechtel provides management of the dry cleaning facility field activities, which include all activities necessary to implement field work delineated in work plans. Typically, these activities include the development and procurement of subcontract services; the development, implementation, and overview of plans; the collection and review of data, including sampling results, quality control submittals, and sample tracking and custody; technical guidance to onsite personnel; report preparation; cost management; and schedule control.

9. REFERENCES

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2. Bechtel, 1996b. "Technical Memorandum For Well Installation and Air Sparging Pilot Test", December. (CCN000060)

3. Bechtel, 1997a. "Summary Report For Air Sparging Pilot Test Dry Cleaner Site MCRD Parris Island", February. (CCN000076)

4. Bechtel, 1997b. "Technical Memorandum For Groundwater Evaluation and Air Sparging Pilot Study, Building 193, Parris Island, SC", February. (CCN000076)

5. RUST Environment, 1993. " Remedial Action Plan- MCRD Parris Island South Carolina", August. (CCN000025)

6. S&ME, 1994. "Tetrachloroethylene Contamination Assessment and Conceptual Corrective Action Plan, US Marine Corps Recruit Depot Dry Cleaning Facility", June. (CCN000079)

7. Sirrine Environmental Consultants, 1991, "Final Contamination Assessment Report, Marine Corps Recruit Depot, Parris Island, South Carolina." April

8. Wisconsin Department of Natural Resources "Guidance for Design, Installation and Operation of In Situ Air Sparging Systems", Publ-SW186-93 September 1993 and errata Sheet dated August 11, 1995.

ATTACHMENT 1

SPILL FACT SHEET

6280
NREAO
31 Mar 94

FACT SHEET

Subject: SPILL 11 MARCH 1994 DRY CLEANING PLANT

On 11 March 1994, a reportable spill of Tetrachloroethylene at the MWR Dry Cleaners was noted by the Environmental Office and reported to SCDHEC.

On 14 March 1994, samples were taken from the water in the containment basin and soil by the discharge line and sent off for analysis. The results were positive. The allowable limits under RCRA is 0.7 ppm (parts per million). Sample 1 (containment basin) indicated 2000 ppm. Sample 2 (berm/road) indicated 3000 ppm, (Encl 1).

On 15 March 1994, the National Response Center was notifed. As required by regulation one pound of contaminants discharged into the environment is reportable.

On 18 March 1994, the Environmental Officer, Mr. Clark, surveyed the ground to identify the extent of contamination.

On 19 March 1994, seventeen samples were taken from the ground along the side of the road some of which were taken through holes bored in the road surface to quantify the contamination. Results indicated contamination has leached through the cracks in the road to the subsurface in excess of RCRA limits (Encl 2).

Mr. Russell Berry of the South Carolina Department of Health and Environmental Control Office inspected the site on March 14, 1994. He expressed concerns of clean up to meet the RCRA limits of 0.7 ppm.

Mr. Clark has been advised by the DRMO who administers the HW contract that a roll-off container can be obtained for $2000. The containerized material would go out at fifty cents per pound.

Johnsie A. Nabors
NREAO Ext. 2779

ATTACHMENT 2

IN WELL VAPOR STRIPPING
GROUNDWATER MODELING

GROUNDWATER MODELING FOR PARRIS ISLAND DRY CLEANERS IN WELL STRIPPING

The model Visual Modflow Version 2.5 from Waterloo Hydrogeologic was used for this model. Runs are provided for both a two well model and a three well model.

The following parameters were used for the model.

Grid Properties

A 400 ft. by 400 ft area was modeled. The overall grid was a 10 ft. by 10 ft. The grid spacing was reduced to 5 ft. by 5 ft. in the area of the wells.

The model used five layers. The bottom two were set to match the 5 ft. well screen. The total depth of the model was 18 feet.

Constant Head Boundaries

Constant head boundaries were used on all sides. The heads were sloped to match the gradient at the site of 0.003 ft/ft. This gave a water table drop of 1.7 feet across the model.

Aquifer Properties

Sirrine Environmental performed slug test on several wells across the Depot. These were used for an approximate K value.

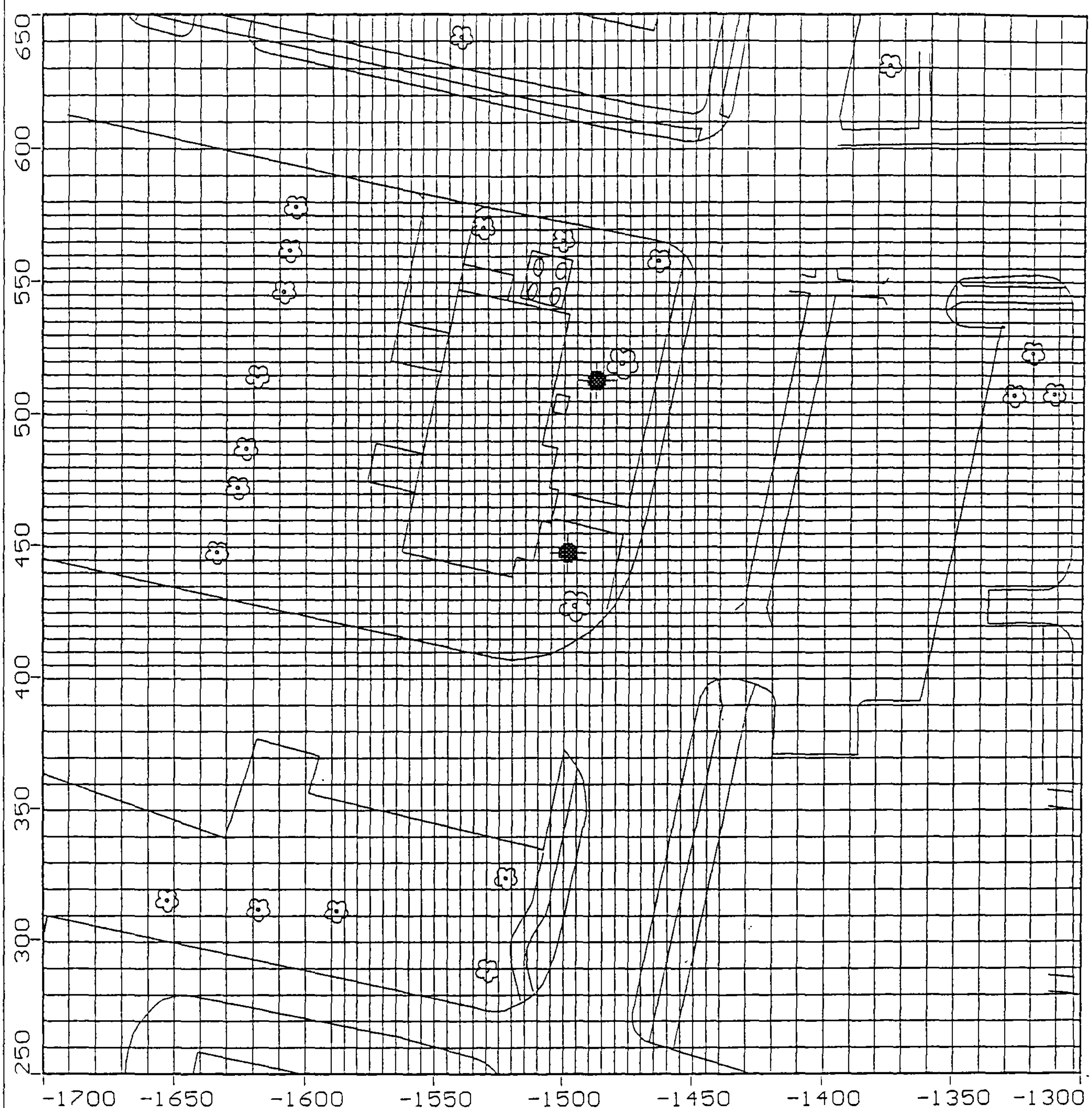
The properties used in the model were
Kx - 0.003 cm/sec
Ky - 0.003 cm/sec
Kz - 0.0003 cm/sec
Ss - 0.001 1/ft
Sy - 0.2
Eff. porosity - 0.2
Total porosity - 0.35

Wells

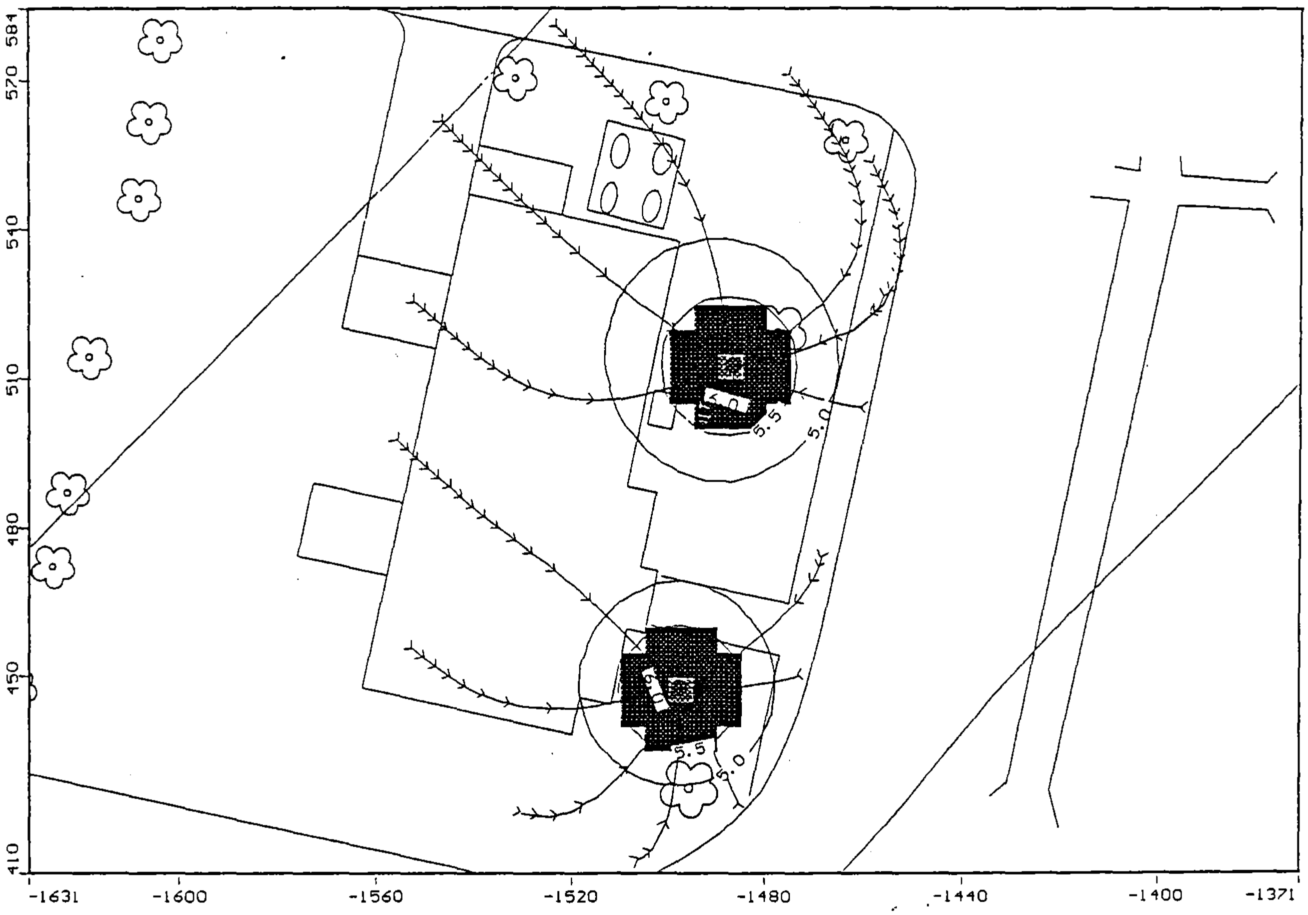
Wells were input into the model as 4" diameter with a five foot screen. The flow rates used for the wells were 2 gpm.

Recharge

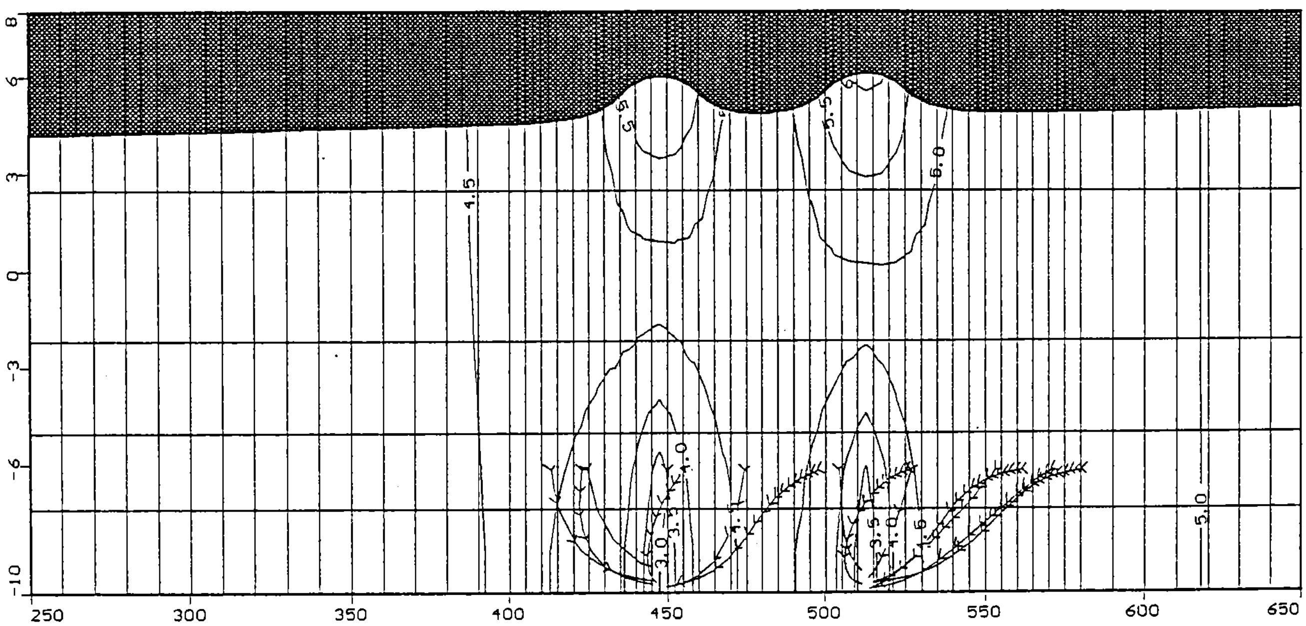
The recharge gallery was modeled by imputing a recharge value in feet/day across the area of the recharge gallery around each well.



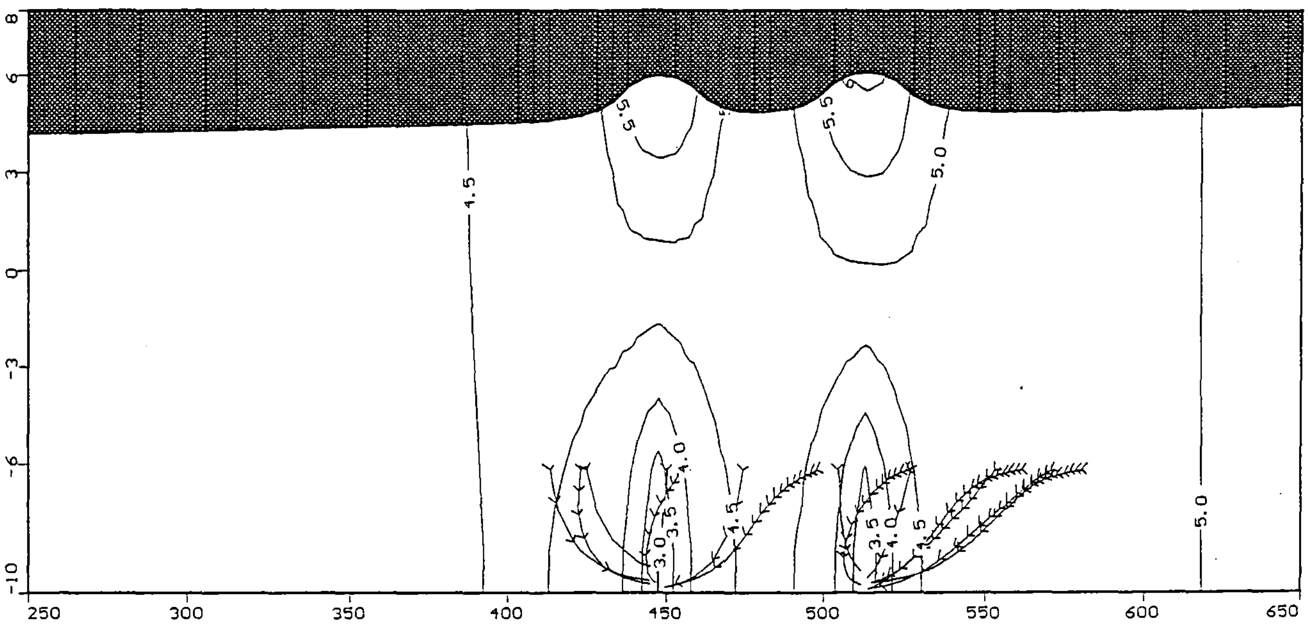
Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners - 2 wells Modeller: Roy Hoekstra 6 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1



Bechtel National Inc. – Oak Ridge, TN 30 Apr 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1

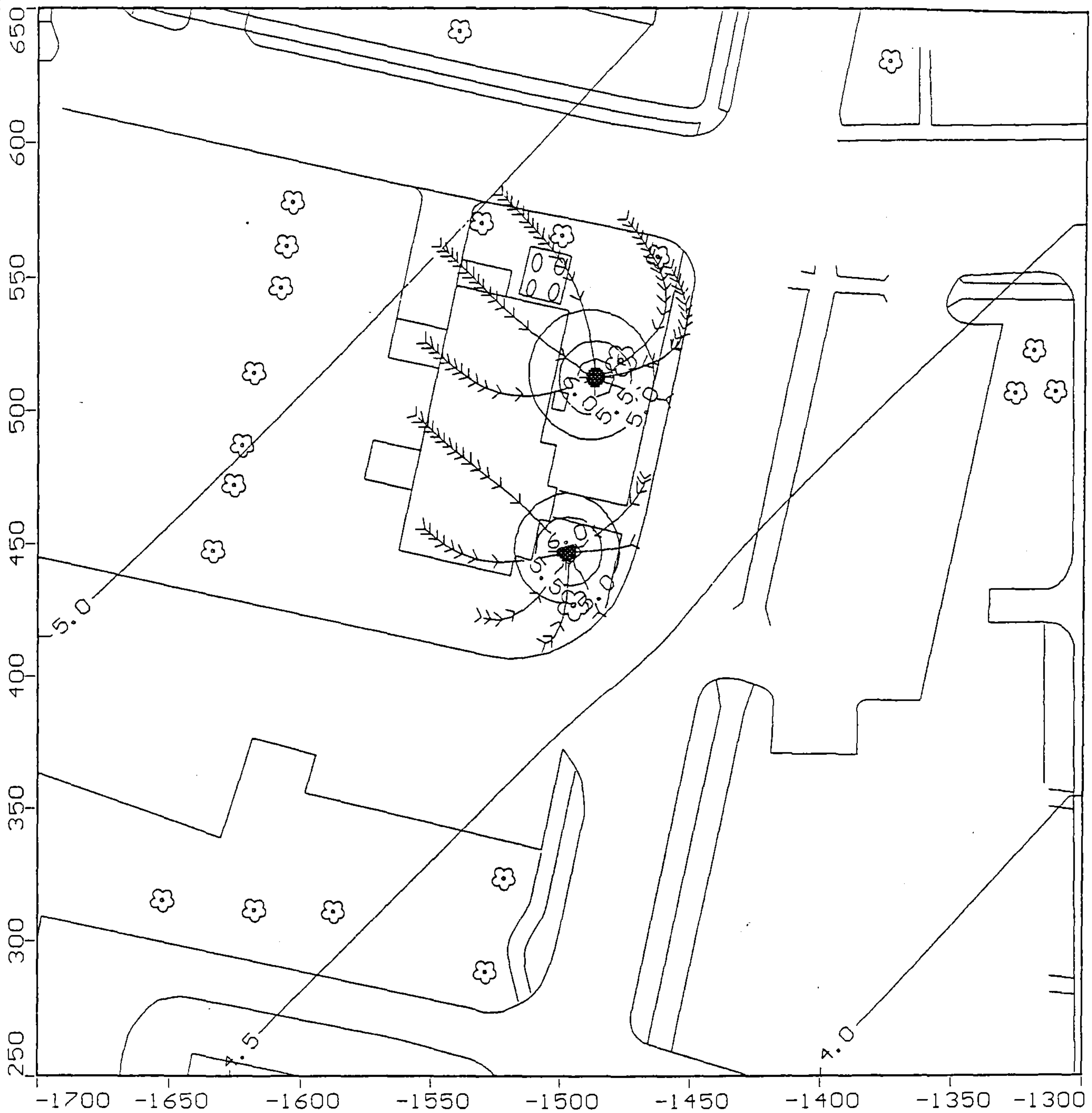


Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 2 wells Modeller: Roy Hoekstra 6 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Column: 31

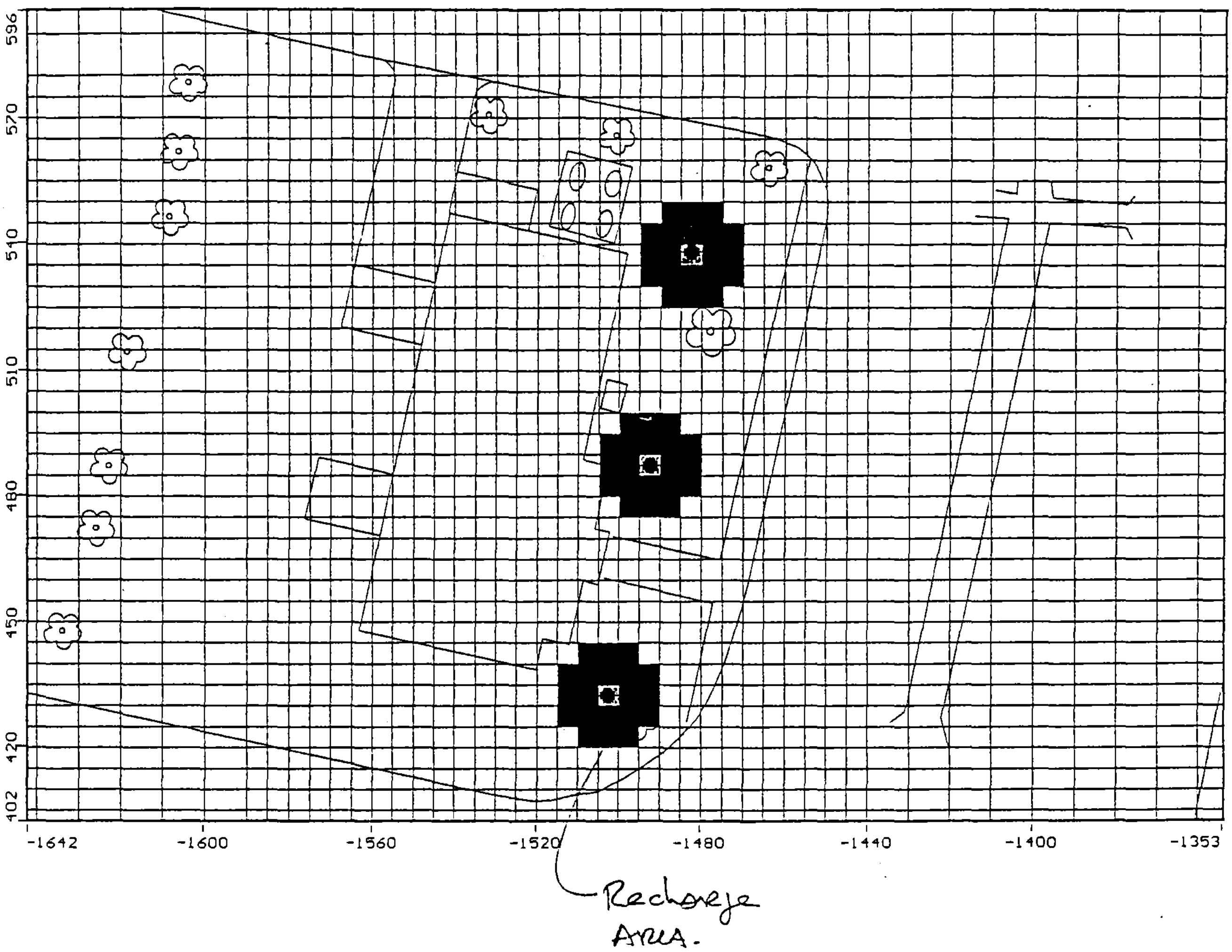


Bechtel National Inc. – Oak Ridge, TN
Project: Parris Island
Description: Dry Cleaners – 2 wells
Modeller: Roy Hoekstra
6 May 97

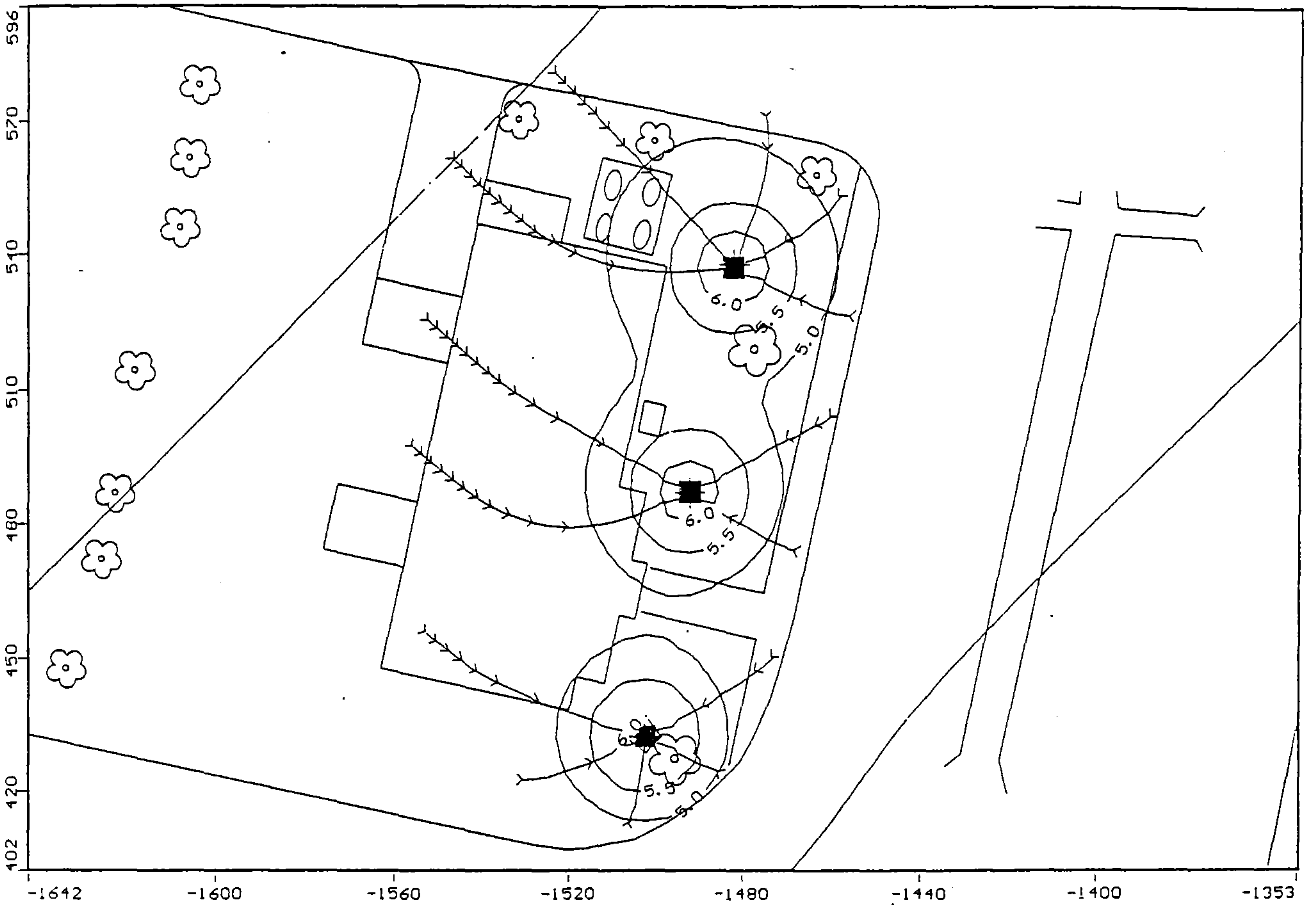
Visual MODFLOW v.2.50, (C) 1995–1997
Waterloo Hydrogeologic Software
NC: 55 NR: 58 NL: 5
Current Column: 31



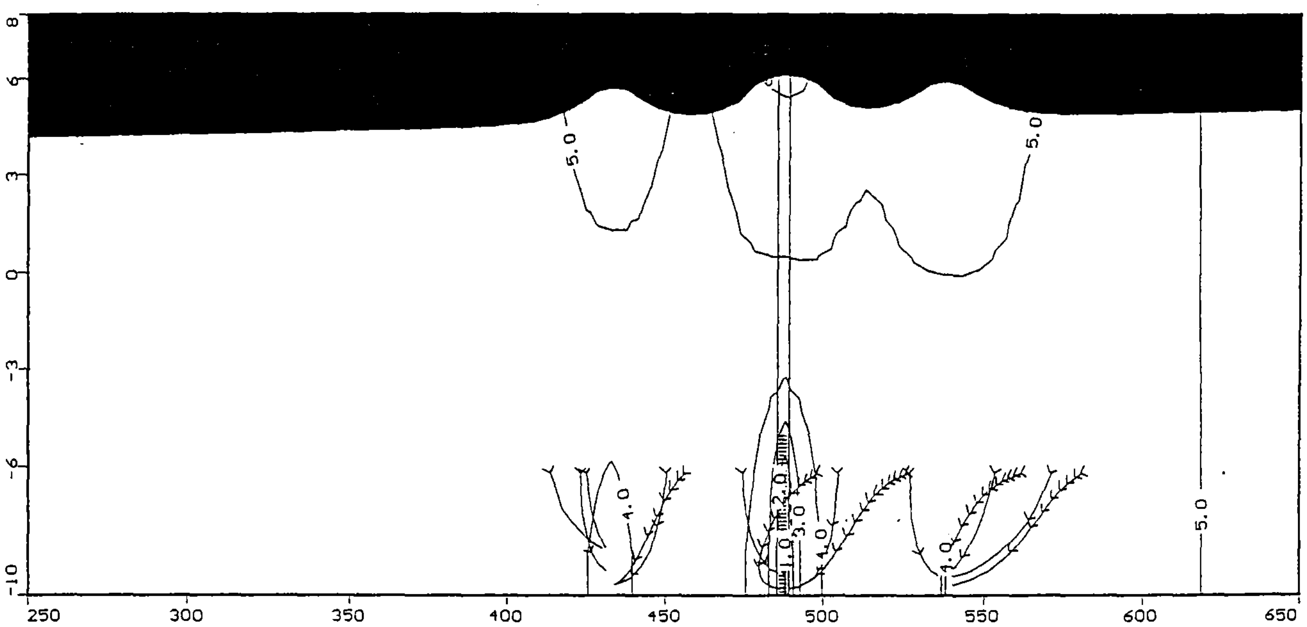
Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 2 wells Modeller: Roy Hoekstra 6 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1



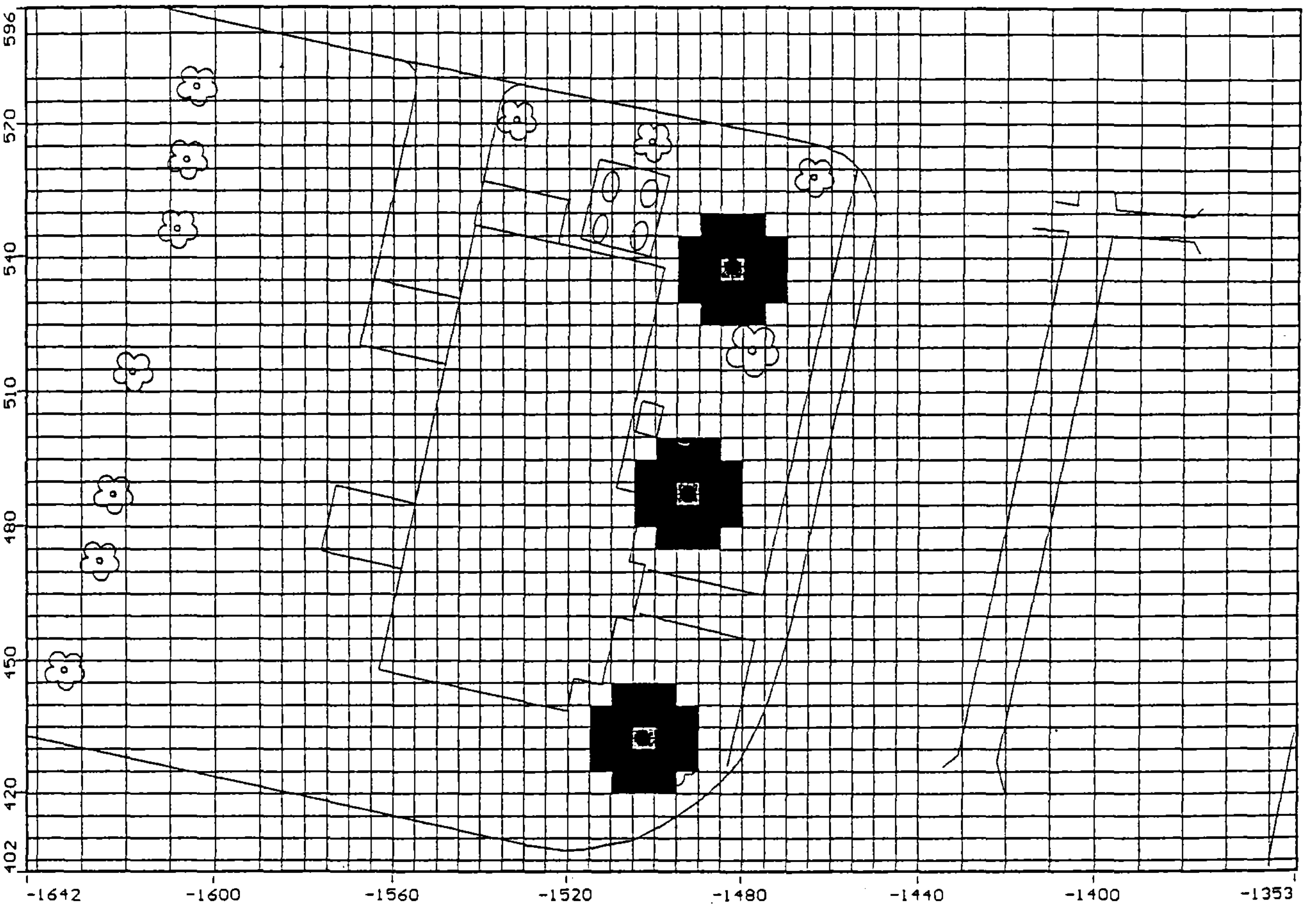
Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 3 wells Modeller: Roy Hoekstra 7 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1



Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 3 wells Modeller: Roy Hoekstra 7 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1



Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 3 wells Modeller: Roy Hoekstra 7 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Column: 31



Bechtel National Inc. – Oak Ridge, TN Project: Parris Island Description: Dry Cleaners – 3 wells Modeller: Roy Hoekstra 7 May 97	Visual MODFLOW v.2.50, (C) 1995–1997 Waterloo Hydrogeologic Software NC: 55 NR: 58 NL: 5 Current Layer: 1

ATTACHMENT 3

PRELIMINARY CONSTRUCTION DRAWINGS

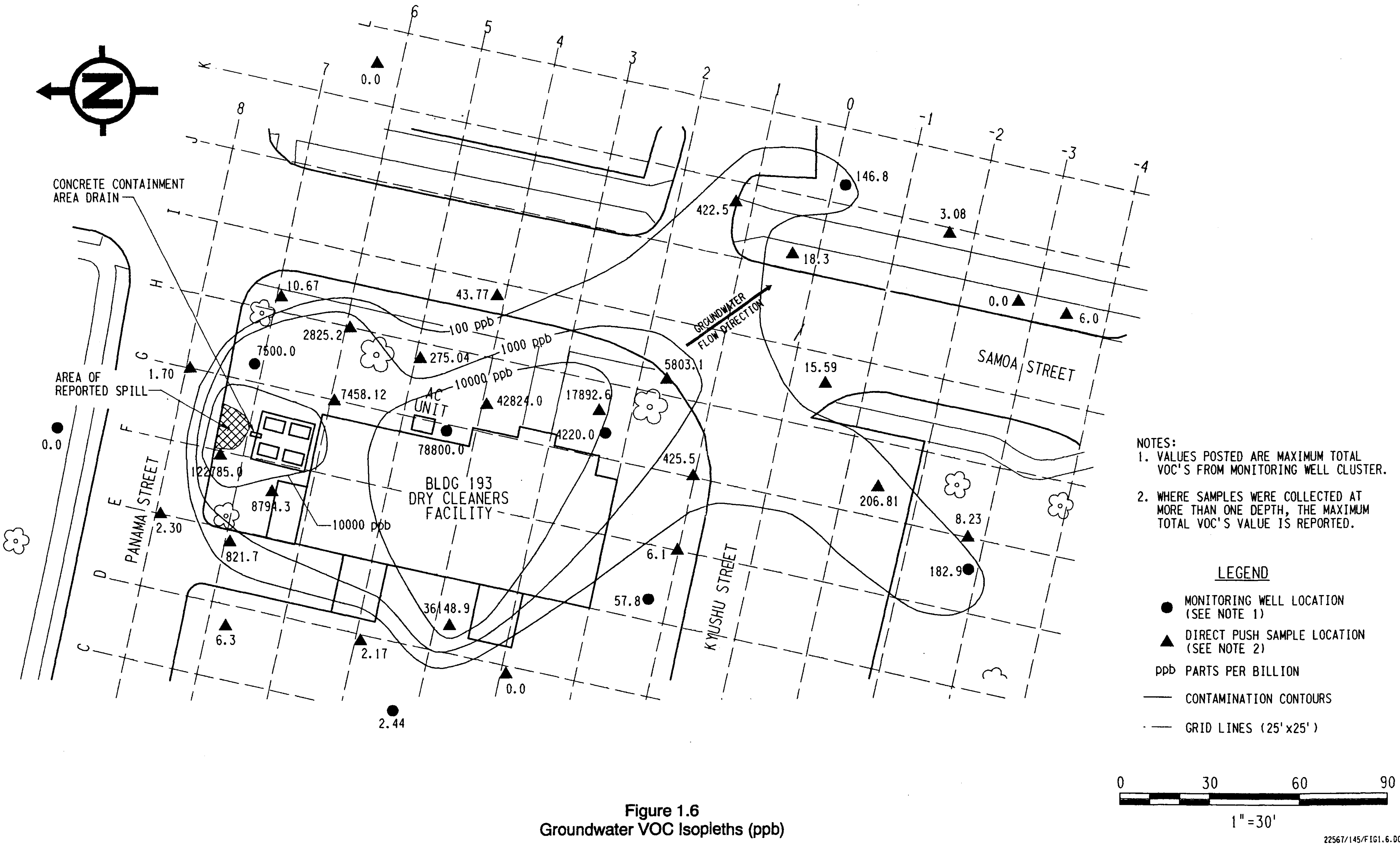
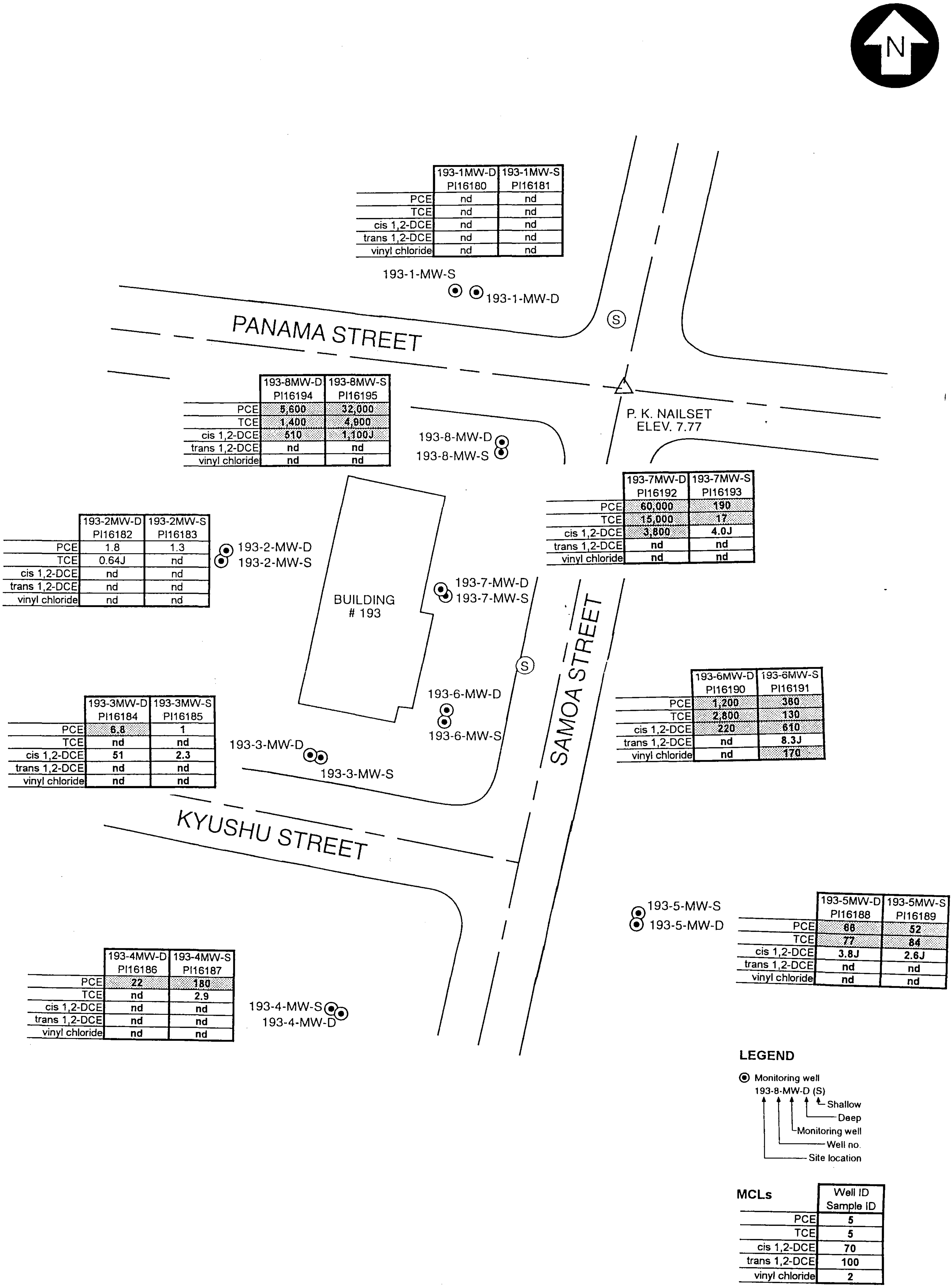


Figure 1.6
Groundwater VOC Isopleths (ppb)



	193-1MW-D PI16180	193-1MW-S PI16181
PCE	nd	nd
TCE	nd	nd
cis 1,2-DCE	nd	nd
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-8MW-D PI16194	193-8MW-S PI16195
PCE	5,600	32,000
TCE	1,400	4,800
cis 1,2-DCE	510	1,100J
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-7MW-D PI16192	193-7MW-S PI16193
PCE	60,000	190
TCE	15,000	17
cis 1,2-DCE	3,800	4.0J
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-2MW-D PI16182	193-2MW-S PI16183
PCE	1.8	1.3
TCE	0.64J	nd
cis 1,2-DCE	nd	nd
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-6MW-D PI16190	193-6MW-S PI16191
PCE	1,200	360
TCE	2,800	130
cis 1,2-DCE	220	610
trans 1,2-DCE	nd	8.3J
vinyl chloride	nd	170

	193-3MW-D PI16184	193-3MW-S PI16185
PCE	6.8	1
TCE	nd	nd
cis 1,2-DCE	51	2.3
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-5MW-D PI16188	193-5MW-S PI16189
PCE	66	52
TCE	77	84
cis 1,2-DCE	3.8J	2.6J
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

	193-4MW-D PI16186	193-4MW-S PI16187
PCE	22	180
TCE	nd	2.9
cis 1,2-DCE	nd	nd
trans 1,2-DCE	nd	nd
vinyl chloride	nd	nd

MCLs	Well ID Sample ID
PCE	5
TCE	5
cis 1,2-DCE	70
trans 1,2-DCE	100
vinyl chloride	2

All detections above MCLs are shaded.

Figure 1.5
Groundwater Analytical Results (ppb)

The well monitoring network was comprised of sixteen wells placed at eight locations around the Dry Cleaners Facility. At each location , a shallow well was installed to a depth of seven feet and a deep well was installed to a depth of 14 ft. Figure 1.5 shows the locations of these monitoring wells. Details of this investigation and the findings are presented in the "Technical Memorandum For Groundwater Evaluation and Air Sparging Pilot Study, Building 193, Parris Island, SC" (Ref. 4).

1.3 NATURE AND EXTENT OF CONTAMINATION

1.3.1 Soil Sampling Results

Soil samples were collected from 1-3 ft and 5-7 ft intervals during drilling for monitoring wells 193-6MW-D, 193-7MW-D, and 193-8MW-D and were analyzed for volatile organic compounds (VOCs). These three wells were placed within the highest concentration of the contaminated groundwater based on the direct-push technology results. The analytical results of the soil samples (except for one) indicate that no significant concentrations of the contaminants of concern are present in the soil matrix.. However, a soil sample collected from 5-7 ft interval at monitoring well 193-8MW-D was found contaminated with PCE at 1,100 ppb. This location is to the north of the dry cleaner in the area of the reported spill.

1.3.2 Groundwater Sample Results

The direct push sampling indicated that low levels of groundwater contamination had spread down to the Hawthorn, but the groundwater contamination levels below the 14 foot clay layer were several orders of magnitude lower than those above this layer. The focus of the IRA is the groundwater above the 14 foot clay layer. Monitoring wells were not installed through the 14 foot clay layer to prevent the further migration of contamination.

Groundwater samples were collected from each monitoring well and analyzed for VOCs, chloride, sulfate and nitrate. Figure 1.5 shows the sampling results and the extent of the solvent contamination at the site. The results from this phase of the investigation correlated closely with the results from the direct push sampling. Figure 1.6 combines the results from the direct push sampling and the monitoring wells. The analytical results are presented in the technical memorandum (Ref. 4).

During the direct-push sampling, water samples were collected and analyzed for total iron at an offsite laboratory. The total iron concentrations of these samples were high (at times as high as 100 mg/L). It was thought that the samples exhibited elevated iron levels because the direct push samples were turbid. Ferric iron normally precipitates; therefore, representative groundwater samples were collected from all the monitoring wells and analyzed onsite for ferrous iron using a Hach test kit. The highest ferrous iron detected was only 2.2 mg/L and should not be a concern for iron fouling of any remediation system.