

APPENDIX A
PREVIOUS REPORTS

14

714

COMPREHENSIVE SITE ASSESSMENT

R & T Grocery
U.S. Route 158
Belcross, North Carolina

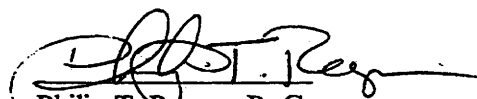
Incident No. 12711

April 4, 1995

Prepared For:

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Prepared by:



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EXECUTIVE SUMMARY

The R & T site is located in a rural area in Camden County, North Carolina and is surrounded mostly by farm fields. A few businesses and residences are located along U.S. Route 158 to the west, and a few residences are located to the east along State Route 1145.

The contaminant source at the R & T Grocery site appears to have been a single gasoline underground storage tank (UST) located at the front of the site, along US 158. Evidence of contamination such as petroleum odors in the excavated soils and a sheen on the groundwater was identified during excavation of the tank. Petroleum contamination was confirmed by laboratory analysis of one soil and one ground water sample collected in conjunction with the removal of the tank. The amount of release is unknown. Initial abatement effectively consisted of removal of the UST. No recoverable amount of free product was identified during the tank removal or later during ground water monitoring. therefore, no free product recovery has been conducted.

Five monitoring wells were installed in order to determine the water table elevation and hydraulic gradient at the site and to collect water samples to determine the presence and extent of possible ground water contamination. In addition, a sixth well was installed and screened below the water table. This well was used to conduct a slug test. Well gauging indicated that there is a slight groundwater mound in the former UST area. This mounding produces a radial groundwater flow pattern away from the UST area. This mounding is interpreted to be a short-term feature possibly due to recent rains and infiltration through the backfilled material in the excavated area. This feature is not considered to be representative of the longer-term local groundwater gradient or flow direction.

Soil and groundwater samples were collected to determine the extent of adsorbed-phase and dissolved-phase contamination at the site. Laboratory analysis of soil samples showed that soil contamination is confined primarily to the site itself but appears to extend below the building. Analysis of water samples indicated that dissolved-phase contamination is present in an elongate plume that trends approximately east-west. The highest concentrations appear to be centered in the area of the previously removed UST. The plume appears to extend westward below U. S. 158 and eastward below the building. Contaminant concentrations are significantly lower a short distance to the north in MW#2 and to the south in MW#4.

Any remedial technology employed at the site must address both adsorbed-phase and dissolved-phase contamination. The technology must also be appropriate for existing site-specific conditions, such as the shallow water table, which can limit the effectiveness of various technologies. The proposed corrective action at this site is a combination of in-situ bioremediation to address adsorbed-phase contaminants and a groundwater pump-and-treat system to address the dissolved-phase contaminants. In addition, the lowering of the water table by the pump-and-treat system may aid the implementation and effectiveness of soil bioremediation.

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1.0 SITE BACKGROUND AND SOURCE CHARACTERIZATION

This report presents the results of a comprehensive site assessment (CSA) conducted at R & T Grocery. The CSA was prepared in fulfillment of North Carolina Division of Environmental Management (DEM) requirements as specified in NCAC 15A 2N .0706. A CSA was required by the DEM after confirmation of release by field evidence and laboratory analysis of soil and ground water samples collected during the removal of three underground storage tanks (USTs) from the site on September 6, 1994.

1.1 Site Location and Background

The R & T Grocery site is located in Belcross, Camden County, North Carolina. The site is located on the northeast corner of the intersection of State Route 1145 and U.S. Route 158 (Figure 1). R & T Grocery is currently operating as a small antique store. The site was used as a gasoline station at one time, but the station is out of operation. The potential sources of contamination are three 1,000-gallon USTs which were located on the site. UST#1 was located adjacent to the old pump island in front of the building. UST#2 and UST#3 were located adjacent to each other and in a grassy area to the south of the building. No other chemicals or hazardous substances were observed onsite. Figure 2 is a general site map showing areas where the USTs and supply lines were located.

The three USTs were closed and removed from the site on September 6, 1994. One soil sample was collected from below each of the USTs as part of the closure assessment. The samples were transferred to an independent laboratory for laboratory analysis. The laboratory results were reported in the tank closure report dated September 26, 1994.

Laboratory analysis indicated the presence of some residual petroleum contamination in the soils in and around the excavation for UST #1. However, no recoverable amount of free product was present in the excavation at the time of removal.

Removal of the UST effectively removed any potential source for the further release of free product. In addition, no fire, explosion or vapor hazards were identified during the UST removal. Therefore, no immediate preventative measures required by 15A NCAC 2N .0702 were necessary.

No recoverable amount of free product was present and no initial abatement measures other than removal of the USTs were implemented. A report satisfying the requirements of 15A NCAC 2N .0703 was sent to the DEM by Mr. Rufus Abeyounis.

1.2 Purpose of Investigation

The purpose of this report is to present the results of the comprehensive site assessment (CSA) as required by the DEM under 15A NCAC 2N.0706.

1.3 Scope of Work

The scope of work for the site characterization included the following:

1. Installation of six monitoring wells around the UST area and soil sampling during monitoring well installation;
2. Collection of ground water samples from the wells;
3. Measurement of ground water elevation;
4. A slug test to determine aquifer characteristics;
5. Sample analysis by an independent laboratory;
6. Preparation of the comprehensive site assessment report.

2.0 POTENTIAL RECEPTORS AND MIGRATION PATHWAYS

This section discusses potential receptors such as water supplies and surface water intakes for public water supplies, and possible migration pathways to these receptors.

2.1 Potential Receptors

Petroleum contamination is present in the subsurface. Except for a small area of backfill material where the USTs and supply lines were removed, the area is covered by asphalt pavement. Therefore, there is little to no present risk to humans by ingestion of contaminated soil, inhalation of vapors, or other direct contact with the contaminants.

The site is located in a rural area. The predominant land use within a one-half mile radius of the site is as farmland. A few residences and small businesses are located along U. S. 158, and a few residences are located to the east along S. R. 1145.

In general, the potential receptors of most concern affecting humans are drinking water supplies to residences and surface water intakes for public water supplies. The environmental receptors of most concern in the area are surface water bodies including Sawyers Creek to the west; a small tributary to Sawyers Creek, which curves around the site from the east to the north and then into Saywers Creek; and wetlands or marshes bordering the creek and tributary.

The site is served by a domestic water supply well which is located behind the building. Although no samples of the well water were collected, the current operators have not mentioned any noticeable impact on their water. No other domestic water supply wells were identified within a 1,500 foot radius of the site, and no surface water supplies for public water are located within one-half mile of the site. Because the area is rural, it is possible that most of the residences may have domestic water wells. However, there is no evidence that any potential wells within a 1,500 foot radius of the site have been impacted. In addition, contamination at the site is present



at shallow levels in the soil and affect a very small portion of the shallow, unconfined aquifer. Any potential domestic wells in the area would most likely be completed either deeper in the surficial, unconfined aquifer or in a deeper, confined or semiconfined aquifer which may not be hydraulically connected to the surficial aquifer. The potential for the minor residual contamination at the site to impact a deeper aquifer is considered negligible.

The closest surface water receptors are Sawyers Creek to the west; a small tributary to Sawyers Creek, which curves around the site from the east to the north and then into Sawyers Creek; and wetlands or marshes bordering the creek and tributary. Sawyers Creek is located approximately 2,500 feet west of the site and is not considered a potential receptor. The tributary creek's closest approach to the site is approximately 300 feet to the east. It passes the approximately 600 feet to the north then continues to the west where it drains into Sawyers Creek.

2.2 Migration Pathways

The only significant migration pathways at the site are through the soil and with ground water. The only known underground utility is a fiber-optic cable that crosses the front of the site and roughly parallel to U. S. 158. The only other utilities identified at the site are electricity and phone service, both of which are above ground.

3.0 SOILS INVESTIGATION

3.1 Geologic Setting

The site is located in the Coastal Plain physiographic province of eastern North Carolina. The Coastal Plain province in this area is characterized by estuarine and shallow marine deposits consisting of sands silts and clays. The Coastal Plain province in this area is also characterized by a shallow ground water table due to the proximity of the tidally influenced Pasquotank River and the Albemarle Sound. Ground water at the site was encountered at a depth of approximately 2 feet below ground surface.

3.2 Sample Collection

The soil investigation consisted of the installation and logging of six soil borings which were used for the installation of monitoring wells. Borehole logs are contained in Appendix A.

During installation, one soil sample was collected from each of the boreholes for laboratory analysis. Samples were collected using a 24-inch split spoon which was decontaminated prior to sampling. All soil samples were collected in an 8-ounce glass sample jar and capped with a teflon-lined lid. The samples were stored on ice and transported to the analytical lab with the proper chain-of-custody. The soil boring locations are shown in Figure 3.

The soil boring logs were used to prepare a lithologic cross-section of the site (Figure 4). The location of cross-section is shown as line A-A' in Figure 3. The cross-section shows that soil at the site are predominantly fine to medium sands.

Because of the shallow ground water table, each soil sample was collected from the two-foot interval from 4 to 6 feet to check the condition of soils close to or in contact with ground water. Soil samples were transferred to an independent laboratory for total petroleum fuel

hydrocarbons (TPFH) analysis. Soil samples were analyzed for TPFH via EPA method 5030 only because the suspect UST contained gasoline.

3.3 Analytical Results

The reportable concentrations in North Carolina for TPFH via EPA method 5030 is 10 mg/kg. The analytical results are presented in Figure 3 and Table 1. Soil boring locations are the same as the monitoring well locations shown in Figure 3. Table 1 shows that TPFH concentrations in the soil were above 10 mg/kg in Soil Borings 1, 3, and 5. The TPFH concentrations were 188 mg/kg, 901 mg/kg, and 239 mg/kg respectively. The results were below 10 mg/kg in Soil Borings 2, 4, and 6. Copies of the laboratory analytical report sheets and the chain-of-custody sheets are included as Appendix B.

3.4 Extent of Soil Contamination

The extent of soil contamination is shown in Figure 5. This figure shows that soil contamination is present in the area adjacent to the former UST location and is limited in extent to the north, south, and west. However, the highest TPFH concentration is in monitoring well Soil Boring #3, located closest to the building. The plume is not well constrained in this direction and appears to extend beneath the building.

Fumes in building

3.5 Migration and Attenuation of Contaminants

The migration of the adsorbed-phase contaminants appears to be eastward. Because no free product has been identified which could be a future source of adsorbed-phase contaminant migration, the migration rate is expected to be very low. The attenuation of contaminants is difficult to address because high concentrations are present directly in front of the building in the apparent migration direction.

4.0 GROUNDWATER INVESTIGATION

4.1 Monitoring Well Installation

Six monitoring wells were installed around the UST area to determine the local hydrologic conditions at the site and investigate the condition of the ground water. Five of the wells were screened from 12 feet below ground surface (BGS) to two feet BGS. The two-foot BGS depth for the elevation of the top of the well screen was chosen because of the shallow ground water table, and a casing length of two feet is considered a minimum acceptable length to allow for the placement of the filter pack above the screen and still leave enough room for a bentonite seal, cement grout backfill, and a protective cover. The shallow screen depth was chosen so that the water table would intersect the well screen; screening across the water table allows for the measurement of water table depth and the entry of any potential free product phase floating on top of the water table. The sixth well was screened from eighteen feet BGS to six feet BGS. Because this well was to be used for a slug test, the top of the well screen was installed below the groundwater table. Well construction diagrams are in Appendix C.

Each well was developed using a gas-powered pump and removing a minimum of 20 gallons per well. Wells were considered to be properly developed when the water became clear.

The elevation of each well was surveyed from an assumed temporary bench mark of 10 feet, and the wells were surveyed to within ± 0.01 feet. The well survey report and observation well monitoring results are given in Appendix D.

After the wells were surveyed they were checked with an oil-water interface probe to measure water table elevations and to check for the presence of free product. No free product was encountered in any of the wells. However, the water table elevation was above the top of the well screen in at least three of the wells. Therefore, it is possible that some free product may be present but may not have been able to enter the wells. *

4.2 Site Hydrogeology

Depth to water was measured in all wells to determine the groundwater table gradient and groundwater flow direction. A water table contour diagram is shown in Figure 6. This figure shows that there is a slight groundwater mound in the former UST area. This mounding produces a radial groundwater flow pattern away from the UST area. This mounding is interpreted to be a short-term feature possibly due to recent rains and infiltration through the backfilled material in the excavated area.

The water table mound is not considered to be representative of the longer-term local groundwater gradient or flow direction, and prevented the determination of the gradient and flow direction at this site. A better determination of the gradient and flow direction can be made during a period of drier weather when the water table mound may not be so pronounced. However, the relatively close approach of the Sawyers Creek tributary to the east of the site suggests that local groundwater flow is towards the east. Eastward flow is also supported by the soil sample analytical results where the highest concentration was located to the east of the former UST location and adjacent to the building.

A rising head slug test was conducted in MW#5. Slug tests are used to determine the hydraulic conductivity and average groundwater flow velocity of an aquifer. The slug test was conducted by removing a volume of water and measuring the rate of recovery with a data logger. The data logger was programmed to collect data using a log scale because well recovery varies with time; the well recovers quickly when the initial slug of water is removed, and recovers more slowly as the rising water level in the well approaches the static water level. The computer program AQTESOLV by Geraghty & Miller, Inc. was used to calculate the hydraulic conductivity from the slug test data. The slug test data and AQTESOLV graphical solutions are presented in Appendix E.

Two separate tests were conducted and the hydraulic conductivity was calculated using the Bouwer and Rice method for an unconfined aquifer. The calculated hydraulic conductivity ranged from 1.37×10^{-4} ft/min to 1.544×10^{-4} ft/min. The hydraulic gradient varied from 0.005 to 0.016. Assuming a porosity for the material at the site (sand) to be 0.3, the average ground water flow velocity can be calculated from the following equation:

$$v = ki/n$$

where v = average ground water flow velocity, k = hydraulic conductivity, i = hydraulic gradient, and n = estimated porosity. Substituting the values listed above, the average ground water flow velocity at the time of this investigation varied from 1.2 feet/year to 4.3 feet/year in a radial direction from the UST#1 excavation area.

4.3 Ground Water Sampling and analysis

One ground water sample was collected from each well and transferred to an independent laboratory for analysis. Ground water samples were analyzed via EPA methods 601, 602. In addition, samples were analyzed for total xylenes, methyl tertiary butyl ether (MTBE), ethylene dibromide (EDB), isopropyl ether, and lead via EPA method 3030c. The analytical results for benzene, toluene, ethylbenzene, and total xylenes (BTEX) are presented in Table 2. The analytical results for methyl tertiary butyl ether (MTBE), isopropyl ether, ethylene dibromide (EDB), and lead are presented in Table 3. Copies of the laboratory analytical report sheets and the chain-of-custody sheets are included with the soil analytical results in Appendix B.

4.4 Extent of Contamination

North Carolina considers the method detection limit (MDL) to be the reportable concentration (RC) for petroleum compounds in groundwater. The BTEX compounds were above the groundwater quality standards in all monitoring wells. A benzene contaminant plume

diagram is shown in figure 7. Figure 8 shows the extent of contamination as delineated by total BTEX.

The RC for MTBE was exceeded in all wells. The RC for isopropyl ether was exceeded in all wells except MW#4, and the RC for lead was exceeded in all wells except MW#2 and MW#6. Ethylene dibromide was not detected in any of the wells. Figure 9 shows the extent of MTBE contamination in groundwater, and the extent of lead contamination is shown in Figure 10.

The soil and groundwater contaminant plume diagrams delineate an elongate plume which is approximately centered on the excavated area around the former UST#1 location and trends roughly east-west. Although the shape of the plume is fairly well defined, the extent of the contaminant plume based on groundwater quality standards has not been delimited for some compounds, e.g. benzene. The benzene plume appears to extend both westward below U. S. 158 and eastward below the building. From the tank pit area the benzene concentration decreases rapidly towards MW#4 and MW#2, but the groundwater quality standard for benzene was still exceeded in these two wells.

5.0 SUMMARY AND RECOMMENDATIONS

Three 1,000-gallon gasoline USTs were removed from the R & T Grocery site on September 6, 1994. Field evidence observed during removal of one UST located at the front of the site indicated that a petroleum release had occurred. A release in this area was confirmed by laboratory analysis of a soil sample collected in conjunction with the removal this UST. However, no distinct free product layer was observed at the time of removal or during later site characterization.

Laboratory analysis of soil and ground water samples collected as part of the CSA confirmed the presence of both adsorbed-phase contamination in the soil and dissolved-phase contamination in the groundwater. The contaminant plume is elongate in shape and trends east-west. The adsorbed-phase plume appears to extend to the east and below the building while the dissolved-phase plume appears to extend below both U. S. 158 to the west and the building to the east. Additional monitoring wells and soil and groundwater sampling may be required to better delineate the contaminant plume to the east and west where higher concentrations of certain compounds still exist. The north-south extent is better-defined by generally significantly lower contaminant concentrations in MW#2 and MW#4. However, concentrations of some compounds still exceed the groundwater quality standards in these wells. If required, additional wells to the north and south would provide a more accurate delineation of the plume in this direction.

Corrective action at this site must address both adsorbed-phase contamination in the soil and dissolved-phase contamination in the groundwater. Because the contaminant plume is relatively high in volatile constituents, air sparging and soil vapor extraction would normally be an option for corrective action. However, it is not considered an appropriate method for this site because of the extremely shallow water table.

Soil excavation may be a viable option but the total volume of contaminated soil cannot be determined at present because of the elevated TPFH concentration near the building. However, an estimate for the minimum volume of soil can be made with the assumption that soil contamination does not extend very far beneath the building. Estimating a rectangular area of roughly 45 x 55 feet and a depth of 5 feet, the minimum volume of contaminated soil would be in excess of 450 cubic yards. In reality, the volume of contaminated soil may be much greater.

In-situ bioremediation is another corrective action technology which may be applicable to this site. The advantages of bioremediation are that it is one of the least expensive methods of treating contaminated soil based on a per ton cost when compared to other technologies, and large volumes of contaminated soils do not have to be excavated, disposed of, or otherwise handled or disturbed. One potential problem with bioremediation at this site is the shallow groundwater table. However, lowering the water table, e. g. with a groundwater pump-and-treat system, may facilitate the implementation of bioremediation.

The groundwater contamination is characterized by relatively high concentrations of volatile compounds, and the plume extends over a relatively large area. Although air sparging and soil vapor extraction technologies are effective, they are not appropriate for this site because of the very shallow water table.

The most common remediation technology for contaminated groundwater is a groundwater pump-and-treat system. Contaminated groundwater is removed from a recovery well or a series of wells and treated above-ground to remove the contaminants. Treated groundwater can then be reinjected into the ground, discharged, or disposed of, depending on applicable Federal, State and local regulations and site-specific conditions.

Once the contaminated groundwater is removed, it can be treated by a variety of methods such as air stripping, granular activated charcoal filtration, or a combination of methods.

A pump-and-treat system not only treats contaminated groundwater but can also control the migration of contaminated water. This is accomplished by creating a cone of depression in the water table around the recovery well. Contaminated groundwater within the radius of influence of the cone of depression will flow to the well and be pumped to the treatment system. The lowering of the water table by groundwater recovery may also benefit bioremediation used in soil remediation.

Site-specific conditions such as a very shallow water table are limiting factors to the remedial technologies which may be applicable to this site. The recommended plan for remediation at this site is a combination of bioremediation to address adsorbed-phase contamination in the soil and a groundwater pump-and-treat system to address dissolved-phase contamination in the groundwater. Lowering of the groundwater table by the pumping system may also increase the effectiveness of bioremediation in the soils.



Figure 1. A portion of the USGS 7.5-minute Elizabeth City, North Carolina topographic quadrangle showing the location of the site.

EXPLANATION:

--- FUEL SUPPLY LINES

APPROXIMATE SCALE:

1 INCH = 20 FEET

PROJECT NUMBER:

G-138-95

FIGURE NUMBER:

2 OF 10

DRAWN BY:

T. COFFEY

DATE:

3-14-95

TITLE:

GENERAL SITE MAP

R & T GROCERY
267 EAST U.S. ROUTE 158
BELCROSS, NORTH CAROLINA

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Norfolk, Virginia 23501
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US 158

ASPHALT ISLAND

ASPHALT

ASPHALT

EXCAVATION PIT #1

SUPPLY LINES

UST-1

PUMP ISLAND

CONCRETE COVER

ASPHALT

TELEPHONE BOOTH

GRASS

280 GALLON
KEROSENE AST

R & T GROCERY

GRASS

EXCAVATION PIT #2

UST-2

UST-3

☐ WATER SUPPLY WELL

SR 1145

EXPLANATION:

① INSTALLED MONITORING WELLS

⌈ ⌋ FORMER UST LOCATION

Note: A - A' is the area of the cross section.

APPROXIMATE SCALE (FT):



PROJECT NUMBER:
G-138-95

FIGURE NUMBER:
3 OF 10

DRAWN BY:
T. COFFEY

DATE:
3-14-95

TITLE:

WELL LOCATION MAP
R&T GROCERY
267 EAST U.S. ROUTE 158
BELCROSS, NORTH CAROLINA

PetroChem
RECOVERY SERVICES
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Norfolk, Virginia 23504
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Fax: (804) 640-1261



US 158



ASPHALT ISLAND

MW#6

ASPHALT

ASPHALT



MW#4

MW#1

MW#5

MW#2

TELEPHONE BOOTH



GRASS

GRASS

R&T GROCERY

Water Well



Table 1. Analytical results for soil samples collected from R & T Grocery. Analytical results are reported in mg/kg.

Soil Sample No.	TPH (Method 3550)	TPH (Method 5030)
S#1	188	NA*
S#2	U**	NA
S#3	901	NA
S#4	2	NA
S#5	239	NA
S#6	4	NA
Detection Limits	1	NA

* NA = not analyzed

** U = not detected above quantitation limit

Table 2. Analytical results for ground water samples collected from R&T Grocery on March 20, 1995. Analytical results are reported in µg/L.

Sample No.	Benzene	Toluene	Ethylbenzene	Xylenes
MW#1	1080	7490	912	5900
MW#2	6.67	4.77	25.9	69.9
MW#3	842	3890	504	4060
MW#4	6.88	5	29	29.5
MW#5	1250	14300	1270	9270
MW#6	1160	5410	1720	7120
Detection Limits	0.3	2	4	6.03

Table 3. Analytical results for ground water samples collected from R&T Grocery on March 20, 1995. Analytical results are reported in µg/L except Total Lead which is reported in mg/L.

Sample No.	MTBE	Isopropyl Ether	Total Lead	Ethylene dibromide
MW#1	121	249	0.031	U
MW#2	8.56	15	U	U
MW#3	30	133	0.034	U
MW#4	22.2	U	0.026	U
MW#5	81.7	430	0.042	U
MW#6	469	127	U	U
Detection Limits	1	5	0.023	0.5

* Note: U = not detected above quantitation limit.

1070

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CORRECTIVE ACTION PLAN

R & T Grocery
U.S. Route 158
Belcross, North Carolina

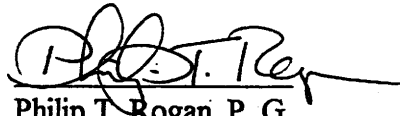
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1.0 INTRODUCTION

This report presents the corrective action plan (CAP) for the remediation of contaminated soil and groundwater at R & T Grocery. The R & T Grocery site is located at the eastern corner of the intersection of U. S. 158 and S. R. 1145 in Belcross, Camden County (Figure 1). The site is in a rural area of Camden County, approximately 5.2 miles northeast of Elizabeth City. A generalized site map is shown in Figure 2. The Responsible Party is Crystal Enterprises. The incident number is 12711.

1.1 Purpose of CAP

This CAP is in response to a Notice of Regulatory Requirements (NORR) which was sent to Crystal Enterprises after confirmation of a release from a gasoline underground storage tank (UST) at the site. The CAP was prepared in fulfillment of North Carolina Division of Environmental Management (DEM) requirements as specified in 15A NCAC 2N .0707 and 15A NCAC 2L .0106.

The analysis of soil and groundwater samples collected during site assessment activities identified several compounds which exceeded groundwater standards and soil remediation guidelines. Substances that exceeded the groundwater standards included: benzene, toluene, ethylbenzene, and total xylenes (BTEX); methyl tert-butyl ether (MTBE); and lead. The soil remediation guideline of 10 mg/kg total petroleum fuel hydrocarbons (gasoline range) was exceeded in three of the six soil samples collected during the comprehensive site assessment (CSA).

Adsorbed-phase petroleum contamination in the soil and dissolved-phase petroleum contamination in the groundwater were identified during the CSA; no free product or significant amount of vapor-phase contamination was identified at this site. Therefore, the purpose of this

CAP is to recommend corrective action for the remediation of contaminated soils and groundwater.

1.2 Remedial Actions to Date

Three 1,000-gallon gasoline USTs were removed from the site on September 6, 1994. Two of the USTs were located adjacent to each other in a grassy area on the southern side of the site (Figure 2). The third UST was located adjacent to the pump island in the parking lot in front of the building. The two adjacent USTs were five years old and the UST in front was six years old. All three USTs were STI-p3 tanks with cathodic protection. Visual inspection indicated that all three were in excellent condition with no obvious rusting, pitting, or holes, and the original labels and markings were still clearly visible. No release was identified by field observation or laboratory analysis of soil samples in the area of the two adjacent USTs south of the building. However, field evidence indicated that a release had occurred in the area of the single UST in front of the building. A release was confirmed by laboratory analysis of soil samples collected from the excavation for this UST.

Although a release was confirmed during the removal of a 1,000-gallon gasoline UST in September 1994, field evidence observed during the removal (i.e., excellent condition of the removed tank; no free product layer) and historical information suggest that the actual release may have occurred prior to the installation of this UST approximately six to seven years ago (see UST Closure report, and CSA Addendum).

Removal of the original UST six to seven years ago effectively removed the original source of contamination, and removal of the newer UST in September removed any potential source for continued or future release. No recoverable amount of free product was present and no fire, explosion or other hazards were identified. Therefore, no additional remedial actions have been conducted to date.

1.3 Previous Reports

The removal and closure of the USTs and associated site investigations have been discussed in previous reports. The following reports have been submitted to the DEM to date: 1) UST Closure Report, September 26, 1994; 2) Initial Site Characterization Report, December 20, 1994; 3) Comprehensive Site Assessment (CSA), April 19, 1995; and 4) CSA Addendum, July 27, 1995. Figures 3-7 are diagrams originally included in the CSA and CSA Addendum. Figure 3 shows the the extent of TPFH contamination as delineated in the CSA. Figures 4-6 show the extent of contamination by total BTEX, MTBE, and lead, respectively. These figures are based on the combined data from the CSA and CSA Addendum. Figure 7 is a cross-section of the site.

2.0 OBJECTIVES OF CAP

2.1 Cleanup Goals

Petroleum contamination is present at this site as adsorbed-phase contamination in the soils and dissolved-phase contamination in groundwater. No significant free product or vapor-phase contamination was identified in the previous investigations. The CSA and CSA Addendum indicated that the extent of both the adsorbed-phase contamination in the soil and the dissolved-phase contamination in the groundwater is located primarily onsite and has not migrated to adjacent properties. Subsequent well installation and sampling conducted in conjunction with the CSA Addendum better delineated the areal extent of the groundwater contamination and demonstrated that dissolved-phase contamination is limited to the near surface groundwater. For these reasons, the main cleanup goals are reduction of contaminant concentrations in the soil and groundwater, reduction in extent of the contaminant plume, and protection of a water supply well located onsite.

2.2 Target Cleanup Concentrations

The procedure for the determination of target cleanup levels for soil contamination is given in the Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater (DEM, 1993). Target cleanup concentrations for soils are determined by a Site Sensitivity Survey (SSE), or if an SSE is not required, cleanup levels are specified in the Guidelines as 10 ppm TPFH (EPA Method 5030) and 40 ppm TPFH (EPA Method 3550). The site is classified as a Category B site because at least one known water supply well is located within 1500 feet of the site, the well is not known to be contaminated, and the property is not served by a public water supply.

An SSE is not required at this site because groundwater is located less than five feet from contaminated soils. Therefore, the soil cleanup levels specified above apply to this site.

Groundwater cleanup levels are specified in 15A NCAC 2L .0106 (J). This paragraph specifies that groundwater quality must be restored to the level of the standards. Therefore, the target cleanup levels for groundwater are the groundwater standards specified in 15A NCAC 2L .0202.

2.3 Target Startup and Completion Dates of Corrective Action Plan

No active corrective action other than soil excavation is anticipated and no remediation systems are being recommended. Therefore, no pilot tests have been conducted, and there are no target dates for system installation, activation, or shutdown. The target date for commencement of remedial actions would be within 60 days of the date of CAP approval. It is estimated that remediation by in-situ natural degradation and attenuation would take 2-3 years.

3.0 EXPOSURE ASSESSMENT

Six monitoring wells were installed during the CSA to collect groundwater samples for laboratory analysis and determine the site hydrogeologic conditions. One soil sample was collected from each of monitoring well soil boring. Five additional groundwater samples were collected as part of the CSA addendum. The analytical results for the soil samples collected as part of the CSA are presented in Table 1. The analytical results for the groundwater samples collected as part of the CSA are presented in Tables 2 and 3. The analytical results for groundwater samples collected as part of the CSA Addendum are presented in Tables 5 and 6. A complete set of quarterly groundwater samples were collected from all wells on September 22, 1995. The analytical results for BTEX and lead are presented in Table 7.

Substances that exceeded the groundwater standards included: benzene, toluene, ethylbenzene, and total xylenes (BTEX); methyl tert-butyl ether (MTBE); and lead. The soil remediation guideline of 10 mg/kg total petroleum fuel hydrocarbons (gasoline range) was exceeded in three of the six soil samples collected during the comprehensive site assessment (CSA).

3.1 Contaminant Physical and Chemical Characteristics

Gasoline is composed of over 100 organic compounds, however most of the compounds in gasoline are relatively volatile and are composed of lighter-molecular-weight compounds generally in the C₄-C₁₀ range. Soil and groundwater samples are commonly analyzed for benzene, toluene, ethylbenzene, and total xylenes because these are common gasoline constituents. In addition, these are compounds of concern because of potential health impacts to humans. The following discussion of some of the organic compounds is summarized from Sax and Lewis, 1987.

Benzene is a clear, colorless flammable liquid. The molecular formula for benzene is C_6H_6 , and the molecular weight is 78.12. Benzene has a melting point of 5.51° and a boiling point of approximately 80° . Benzene has a flash point of $12^\circ F$. Benzene is a known carcinogen and can also affect the central nervous system. The most common exposure route is via inhalation although benzene can also be absorbed through the skin.

Toluene is a colorless, flammable liquid. The molecular formula for benzene is C_7H_8 , and the molecular weight is 92.15. Benzene has a melting point of -95° and a boiling point of 110.4° . Toluene has a flash point of $40^\circ F$. Toluene is a skin and eye irritant. Human exposure can occur via an intraperitoneal route where exposure is poisonous, and by inhalation and subcutaneous routes, where exposure is moderately toxic.

Ethylbenzene is a colorless, flammable liquid. The molecular formula for ethylbenzene is C_8H_{10} , and the molecular weight is 106.18. Ethylbenzene has a melting point of -94.8° and a boiling point of 146.2° . Ethylbenzene has a flash point of $59^\circ F$. The main exposure routes for ethylbenzene are by ingestion and inhalation. Ethylbenzene is moderately toxic and causes irritation of the skin, eyes, and mucous membranes.

Xylene is a clear liquid. The molecular formula for xylene is C_8H_{10} , and the molecular weight is 106.18. Xylene has a boiling point of 138.5° and a flash point of $100^\circ F$. The main exposure routes for xylene are by inhalation, ingestion, and subcutaneous where it is moderately toxic.

3.2 Human Exposure Pathways

Human exposure pathways are mainly through inhalation, ingestion, and dermal absorption. Exposure by inhalation can occur by breathing airborne (e.g., windblown) contaminated dusts or vapors. The primary method of exposure by ingestion is by swallowing airborne dusts or drinking contaminated water. Dermal absorption is generally limited to direct

contact of skin with the contaminants. Because the contamination is localized and is present only in the subsurface, and the contaminated area is mostly covered by asphalt, the risk of human exposure by these various pathways is considered negligible. The greatest potential for exposure would exist if contaminated soils were to be excavated for treatment or disposal. However, excavation workers should be made aware of the potential exposure risks and should wear appropriate protective equipment, thus minimizing risk of exposure. In summary, there is little to no identified risk of human exposure to contaminated soil or groundwater due to present site conditions.

3.3 Contaminant Fate and Transport

Petroleum compounds are subject to a variety of physical and chemical processes that occur in the subsurface that can degrade or attenuate adsorbed-phase and dissolved-phase petroleum over time and result in the reduction of contaminant concentrations. These processes include volatilization, oxidation, microbial degradation, sorption, dilution, advection, and dispersion. The primary compounds resulting from the degradation of hydrocarbons is carbon dioxide and water. Because many petroleum compounds are subject to natural degradation processes, in-situ, or natural degradation can be a viable and cost-effective alternative for corrective action when risks to humans or environmental receptors are negligible.

Results for BTEX for the CSA and CSA Addendum are given in Tables 2 and 4. The results for the September quarterly monitoring are given in Table 6. The initial extent of the dissolved-phase plume is shown in Figure 4, and Figure 8 shows the extent of the dissolved-phase plume at the time of the September quarterly monitoring. A comparison of the BTEX data and the contaminant plume diagrams shows that a significant reduction in dissolved-phase contamination has already occurred in the six months since the original groundwater samples were collected for the CSA. A reduction of contaminant concentrations is demonstrated for all contaminated wells except MW#1 which is located in the tank pit where the highest contaminant

levels are present. Except in MW#1, the percent reduction in total BTEX in the most contaminated wells (MW#2- MW#6) over a six month period ranged from 73% to 99%.

Of particular interest is the fact that no plume migration has been observed (i.e., contaminants have not appeared in outer wells), which indicates that contaminant concentrations are being reduced by natural, in-situ processes, and not simply being removed or transported elsewhere by groundwater flow. These site specific observations combined with the fact that the hydrocarbon components of gasoline are subject to degradation by a variety of naturally occurring processes indicate that remediation of the dissolved-phase plume by in-situ natural degradation and attenuation would be an efficient and cost-effective strategy for groundwater remediation at this site.

The migration of petroleum hydrocarbons through the subsurface can occur in several phases. Following a spill or underground release of petroleum, gravity causes the free product to migrate downward through the unsaturated zone, or vadose zone, of the soil. During migration, free product may be held in soil pore spaces or adsorbed to soil particles (adsorbed phase). Because petroleum products contain volatile compounds, a vapor phase may also be present in the vadose zone. As the soil becomes saturated with petroleum, the product may continue to migrate downwards and eventually reach the water table. This free liquid may ultimately accumulate on the water table surface and form a separate free product layer, also known as a light non-aqueous phase liquid (LNAPL). Once an LNAPL layer forms, free product migration is typically controlled by the water table gradient.

Compounds from the LNAPL layer that are in direct contact with the water table may dissolve in the groundwater, thereby forming a dissolved phase plume. This dissolved-phase plume can migrate in the direction of groundwater flow, and it can also migrate by diffusion. Contaminant diffusion is controlled by a contaminant concentration gradient and can allow the contaminant plume to migrate radially, or even against groundwater flow to some extent.

Contaminant migration controlled predominantly by groundwater flow should show an elongate contaminant plume with the bulk of the plume extending downgradient from the source. Contaminant migration controlled predominantly by diffusion with little or no influence by groundwater flow should show a more or less concentric plume with the highest concentrations near the source area and contaminant concentrations decreasing outward from the plume. The generally circular shape of the contaminant plume with its center coincident with the tank pit suggests that contaminant migration at this site occurs predominantly by diffusion and that the average linear groundwater flow velocity is low at this site. Irregularities in the general shape of the plume are probably due to effects by groundwater flow.

3.4 Current and Future Uses of Affected Media

The site is located in a rural area in Camden County and is currently being used as an antique and crafts store. The affected area situated primarily below the asphalt parking area in front of the store, although adsorbed-phase contamination may extend to soils below the store and dissolved-phase contamination may extend below the store and below a small section of U. S. 158. No future change in operation or usage is expected. There is a water supply well located behind and south of the back southern corner of the building and close to the area where the two 1,000-gallon USTs were located (see Figure 2). However, the field observations and sample analysis obtained as part of the UST closure assessment did not identify any petroleum contamination in this area. A well water sample collected as part of the CSA confirmed that the well has not been impacted by petroleum contamination, and the CSA and CSA addendum showed that soil and groundwater contamination exists predominantly in the area in front of the building and does not currently threaten to impact the water supply well.

3.5 Potential Effects of Residual Contamination on Surface Water and Groundwater

One concern for any corrective action is the amount of residual (post-remedial) contamination and the potential for residual contamination to affect surface water and

groundwater, causing violations of the North Carolina Surface Water Quality Standards (15A NCAC 2B .0200). The potential for future impacts are related to the volume of the residual contaminated media, the contaminant concentrations, fate and transport of the contaminants, and the distance to the closest receptors. The nearest potential surface water receptor is a tributary to Sawyers Creek that is located approximately 400 feet northeast of the site.

A conservative estimate of the time required for the plume to impact the creek can be made by assuming no reduction in contaminant concentrations in the plume and that the plume travels with the groundwater at the maximum estimated average linear groundwater flow velocity of 4.3 ft/yr (see CSA). At this rate it would take over ninety years for the contaminant plume to impact the creek, even with no reduction or attenuation of contaminants during this time. However, as discussed in Section 3.3, significant reductions in dissolved-phase concentrations have already occurred over a six month period, and no significant migration of the plume has been observed. This indicates that there is negligible potential effect of the residual contamination on local surface water.

The primary concern is the potential for residual contamination in the soil to remain a source for dissolved-phase contamination in the groundwater. Again, the sampling results indicate a decrease in concentrations in all contaminated wells except MW#1 even though contaminated soils are still in place. These results indicate that the contaminated soils may have a very localized effect on the groundwater around MW#1 where the most contaminated soils are located, but in general are not significantly affecting the local groundwater at the site. These results and observations support the idea that excavation of the most heavily contaminated soils in and around the former UST pit will remove the main secondary source of contamination and residual petroleum contamination in the soil will have negligible effects on groundwater.

3.6 Potential Receptors at Greatest Risk

The potential receptor at greatest risk is the water supply well located on site. However, potential risk to the well is considered to be low for the following reasons: a) field and analytical evidence collected during the UST closure assessment indicates that the area surrounding the well has not been impacted by petroleum contamination; b) the site assessment has adequately defined the contaminant plume and shown that it is primarily located at the front of the property and away from the supply well; c) the hydrogeologic investigation indicated that the average linear groundwater flow velocity is low, ranging from 1.2 to 4.3 feet per year; and d) laboratory analysis of a well water sample collected during the CSA Addendum indicated that the well has not been impacted by petroleum contamination.

Although potential risk to the water supply well is considered low, a groundwater monitoring program will be established to assess the effectiveness of the remedial action and identify any potential migration of the contaminant plume long before the supply well is impacted. This program will include a monitoring well greater than one year's groundwater travel time upgradient from the water supply well. Figure 9 shows the maximum predicted extent of the contaminant plume after five years. This prediction is a conservative prediction based on the higher estimated groundwater flow velocity of 4.3 feet per year. This figure also shows the distance for one year's groundwater travel time upgradient from the water supply well and the proposed location of the monitoring well. As can be seen in the figure, the monitoring well will be two to three years' travel time upgradient from the supply well, thus providing an extra margin of safety.

4.0 EVALUATION OF REMEDIAL ALTERNATIVES

4.1 Remedial Options

This section discusses remedial options applicable for the cleanup of soil and groundwater at the site. Each contaminated medium is addressed separately.

4.1.1 Soils

This section discusses applicable remedial options for contaminated soils at the site. In general, remediation methods can be classified as active or passive. Active remedial methods involve physical treatment of the soil, either after removal of the contaminated soil or while the soil remains in place. Passive remedial methods (i.e., natural degradation) involve remediation by natural processes which degrade and attenuate organic compounds over time.

4.1.1.1 Bioremediation

Under the appropriate conditions, bioremediation has been shown to be very effective in remediating petroleum-contaminated soils. The effectiveness of bioremediation is dependent upon a number of factors including soil moisture, soil porosity, nutrient availability, soil pH, dissolved oxygen, and the presence of appropriate microbes. Extensive studies and pilot tests may be required to determine the existing conditions and the effectiveness of bioremediation before this method could be implemented at the site. In addition, initial startup and operation expenses could be very high. For these reasons, bioremediation is well suited for very large volumes of petroleum-contaminated soils where the relative cost per ton for remediation can be low to moderate. However, the costs associated with preliminary studies, pilot tests, and startup and operation would be high given the relatively small volume of contaminated soil at this site. Therefore, bioremediation is not recommended at this site.

4.1.1.2 Natural Degradation

Organic compounds in the soil are subject to a variety of natural processes that can break down the molecules and reduce their concentrations. These processes include volatilization, oxidation, microbial degradation, sorption, dilution and dispersion. These processes can degrade or attenuate adsorbed-phase petroleum contamination in the soil over time and result in the reduction of contaminant concentrations.

Natural degradation can be very effective in areas where little risk exists for human exposure or impact to potential receptors. Also, the associated costs for natural degradation are minimal. Most of the cost will be for periodic monitoring and report preparation and submittal. However, in-situ natural degradation and attenuation for remediation of soils is not applicable at this site because groundwater is less than five feet from contaminated soils.

4.1.1.3 Excavation

One remedial option is excavation of the contaminated soil and backfilling with clean fill. This can be an effective method at sites with small volumes of contaminated soils such as R & T Grocery. Once the soil is excavated, it may be disposed of in an appropriate landfill or treated to remove the contaminants. The primary reason to avoid landfilling contaminated material is that the generator of the contaminated soil can be held liable for future environmental problems resulting from contamination from the landfill. The best option for contaminated soil is treatment, for example by thermal stripping. Soil treatment breaks down or removes the organic contaminants and produces "clean" soil. Treatment of the soil can eliminate the generator's liability because the soil is no longer contaminated.

The cost per ton for excavation and treatment of contaminated soils can be very high when compared to other methods, but can be the best method for small volumes of soils. This

method is especially applicable at sites where receptors are known to be impacted or at risk and immediate action needs to be taken.

4.1.2 Groundwater

This section discusses applicable remedial options for contaminated groundwater at the site. In general, remediation methods can be classified as active or passive. Active remedial methods involve physical treatment of the groundwater, either after removal (e.g., pump-and-treat) or in-situ (e.g., air sparging). Passive remedial methods (i.e., natural degradation) involve remediation by natural processes which degrade and attenuate organic compounds over time.

4.1.2.1 Pump-and-Treat

Pump-and-treat systems generally involve the installation of a recovery well and pumping groundwater and through a treatment system. The general concept of a recovery well is relatively simple. A well is installed in the area where the contaminant plume is located and a pump is placed in the well. The pump removes water from the well and creates a depression in the water table. Continued pumping of groundwater produces a cone of depression around the well. The cone of depression induces the contaminant plume to migrate towards the well where it can be recovered from the water table surface.

The main advantage of a recovery well system is the ability to place a hydrologic control on the migration of the contaminant plume by creating a depression in the water table, which induces the plume to flow to the well. Under the appropriate site conditions, this recovery strategy is effective and capable of reversing the water table gradient to induce portions of the plume that may be downgradient from the well to flow back to it.

There are two basic drawbacks to pump-and-treat systems. Initial installation and set-up costs and subsequent operation and maintenance costs can be very expensive, and large volumes

of contaminated groundwater may be generated. A recovery well and pump-and-treat system for the site could include an oil/water separator, an air stripper, and charcoal adsorption units. A single-pump system will also require an oil/water separator at a minimum. In addition, there are costs associated with subsequent system operation, maintenance, and laboratory analysis of samples. The cost for the installation and operation of a single-well groundwater pump-and-treat system could exceed \$50,000 to \$100,00. Pump-and-treat systems may also generate large volumes of petroleum-contaminated water, which may require treatment and disposal and increase the total cost of recovery. The use of air strippers and charcoal adsorption units can escalate costs depending on the contaminant concentration, the volume of water treated, and the length of time required to reach system endpoints.

The costs associated with a pump-and-treat system cannot be justified by the small volume of contaminated groundwater and the low contaminant concentrations present. Therefore, a Pump-and-treat system is not recommended for this site.

4.1.2.2 Air Sparging

Under the appropriate conditions, air sparging has been shown to be very effective in remediating contaminated groundwater. However, as with other methods discussed, the feasibility of air sparging may require additional investigations to determine site conditions which can affect an air sparging system, and pilot studies may be required before an operating system can be installed. Again, because of the small volume of contaminated water and the low contaminant concentrations, this method cannot be justified and is not recommended for this site.

4.1.2.3 Natural Degradation

Organic compounds in groundwater are subject to a variety of natural processes that can break down the molecules and reduce their concentrations. These processes include volatilization, oxidation, microbial degradation, sorption, dilution and dispersion. These processes can degrade

or attenuate dissolved-phase petroleum contamination in groundwater over time and result in the reduction of contaminant concentrations (Fetter, 1993).

Natural degradation can be very effective in areas where little risk exists for human exposure or impact to potential receptors. Also, the associated costs for natural degradation are minimal. Most of the cost will be for periodic monitoring and report preparation and submittal.

4.2 Recommended Corrective Action

The recommended corrective action for contaminated soils is excavation and treatment. The recommended remedial action for contaminated groundwater at this site is natural degradation and attenuation.

5.0 PROPOSED CORRECTIVE ACTION PLAN

5.1 Overview

The proposed corrective action for contaminated soil is excavation and treatment. A photoionization detector (PID) will be used to screen the excavated soils. Once field screening indicates contaminated soils may have been removed, soil samples will be collected from the excavation and analyzed for TPFH via EPA Method 5030 to check for remaining contaminated soil. The most heavily contaminated soils are in an area approximately 45 feet by 35 feet by 4-6 feet deep. This results in an estimated volume of approximately 300 cubic yards of soil, or 450 tons. Estimated transportation and treatment costs, based on \$32.00/ton for treatment, are between \$15,000 and \$20,000.

Excavation will continue in the direction of the building as far as possible without endangering the structural integrity of the building, and the soil will be screened as described above. When soils pass the PID screen, confirmatory samples will be collected from the excavation for laboratory analysis as described above. It may not be possible to excavate some contaminated soils below the building. However, excavation of the soils in front of the building and in and around the former UST location and the pump island should remove the majority of the contaminated soil and the most heavily contaminated soil. As discussed in Section 3.5, potential risk to groundwater from residual soil contamination in isolated pockets should be negligible.

All contaminated soil will be stockpiled on plastic and covered with plastic in accordance with DEM guidelines. Once the excavation is completed, composite soil samples will be collected in accordance with DEM guidelines for characterization. The soils will then be treated by an approved method based on the results of the laboratory analysis. All transportation and treatment of the contaminated soils will be properly documented and manifested.

The proposed corrective action for contaminated groundwater at the R & T Grocery site is natural degradation and attenuation. By leaving the groundwater in place, some natural processes will degrade, or break down, the organic compounds into simpler compounds. The ultimate degradation products of petroleum hydrocarbons are methane or carbon dioxide and water (Fetter, 1993). While degradation processes are working to break down organic molecules, other processes such as volatilization, adsorption, dilution, and dispersion act to reduce the residual contaminant concentrations. Degradation and attenuation processes work together to break down organic compounds to simpler compounds and to reduce remaining contaminant levels.

5.2 Basis for Selection of Recommended Remediation

5.2.1 Soils

Excavation and treatment of the contaminated soils is recommended for the following reasons:

- 1) the costs will be relatively low compared to the other remedial actions described above;
- 2) excavation of the contaminated soils will result in soil remediation much quicker than any of the other options;
- 3) Contaminated soil may act as a continued source for groundwater contamination, especially in the area of the tank pit where the most heavily contaminated soils are located. Remediating the soils quickly by excavation will reduce the time required for groundwater remediation by degradation and attenuation; and

- 4) The efficiency or effectiveness of other remedial actions may be limited due to site specific factors such as the shallow depth of the water table.

5.2.2 Groundwater

The recommended remedial action for contaminated groundwater at this site is natural degradation and attenuation. This corrective action is recommended based on the following:

1. The site is located in a rural area and no public water supply sources or domestic water supply sources such as wells have been impacted or are currently threatened.
2. One water supply well is located onsite, but this CAP and previous investigations have shown that impact of the well by petroleum contamination is not a serious threat and the integrity of the well can be safeguarded.
3. The site is not used as a primary residence; it currently supports a small business, and site usage is unlikely to change in the future.
4. Soil and groundwater contamination occurs at very shallow depths and is limited in areal extent.
4. Contamination is the result of gasoline-range hydrocarbons which are susceptible to degradation and attenuation processes, and analytical data suggest that significant degradation has already occurred.
5. Given current site conditions, potential risk of human exposure to contamination by inhalation, ingestion, or dermal contact is considered negligible.

6. **Given current contaminant concentration levels and distance to the closest surface water bodies, potential risk to surface water bodies is considered negligible.**

Given the relatively small volume of contaminated soil and water, excavation and treatment of the soil and natural degradation and attenuation is the most efficient and cost-effective remedial action. Other methods such as excavation and treatment or disposal of soils, bioremediation of soils, air sparging, pump-and-treat, etc. would involve very high initial setup costs and continued operation and maintenance costs compared to the volume of contaminated media. In addition, no groundwater will be generated for treatment or disposal by a natural remediation process, and no discharge permits will be required.

5.3 Limitations

There are no major foreseeable limitations due to site restrictions for the overall implementation of this CAP. The main potential limitation is the possibility of not being able to excavate some of the contaminated soil below the building if, in fact, contaminated soil is present below the building.

5.4 Followup Monitoring, Corrective Action Evaluation, and Reporting

This section describes the groundwater monitoring and sampling plan for periodic monitoring. The purpose of the plan is to evaluate the effectiveness of the corrective action, to detect changes in groundwater movement, plume geometry, and qualitative characteristics of the plume, and to insure the groundwater quality for the water supply well onsite.

Sampling plan (locations, sampling methods, frequency, and analytical methods)

Depth to groundwater will be measured in all wells and groundwater samples will be collected from each well on a quarterly basis. The analytical results for groundwater samples

collected during previous investigations indicate that groundwater samples collected for monitoring purposes should be analyzed for benzene, toluene, ethylbenzene, and total xylenes via EPA Method 602 or 8020. In addition, the groundwater samples from the four wells in which lead was originally identified (MW#1, MW#3, MW#4, and MW#5) should also be analyzed for lead via EPA Method 3030c.

Quarterly reports will be prepared and submitted to the DEM. These reports will include well gauging results, groundwater flow direction, analytical results, and plume delineation diagrams. Reports will also include a written assessment of existing site conditions and note any significant changes from the previous quarter(s).

An annual report will be prepared which will summarize the quarterly monitoring and sampling reports and assess the effectiveness of the corrective action.



<p>FIGURE TITLE:</p> <p>SITE LOCATION MAP</p> <p>R&T GROCERY BELCROSS, NORTH CAROLINA</p>	<p>SOURCE:</p> <p>U.S.G.S. ELIZABETH CITY, NC 7.5 - MINUTE SERIES TOPOGRAPHIC QUADRANGLE</p>		<p>PetroChem RECOVERY SERVICES</p> <p>635 Maltby Ave. Norfolk, Virginia 23504 Tel. (804) 627-8791 Fax (804) 640-1261</p>
	<p>PROJECT NUMBER:</p> <p>G 140 95</p>	<p>FIGURE NUMBER:</p> <p>1</p>	
	<p>PREPARED BY:</p> <p>COFFEY</p>	<p>DATE:</p> <p>11/10/95</p>	

EXPLANATION:

APPROXIMATE SCALE:

1 INCH = 20 FEET

PROJECT NUMBER:

G-138-95

FIGURE NUMBER:

2

DRAWN BY:

T. COFFEY

DATE:

3-14-95

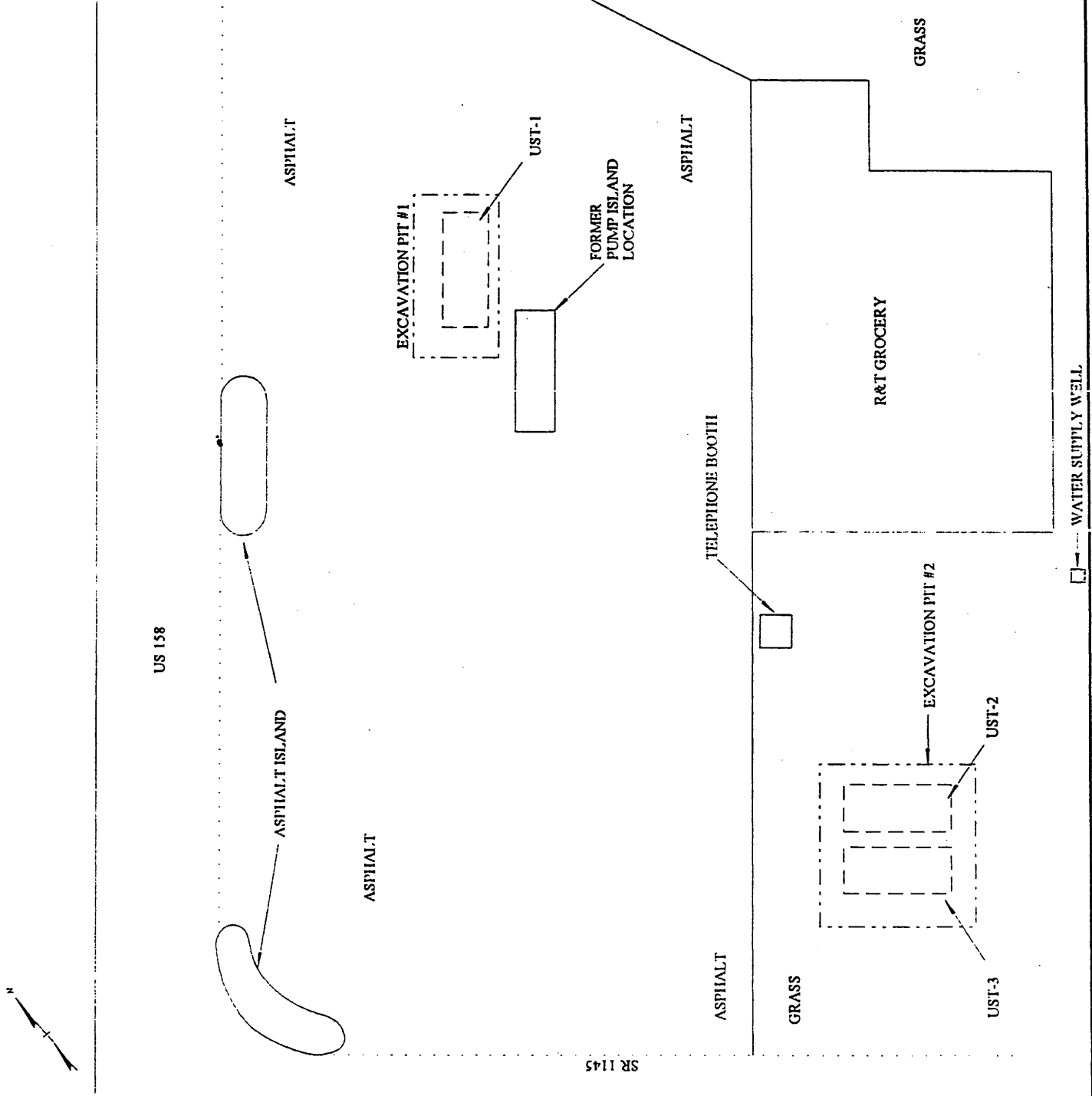
TITLE:

GENERAL SITE MAP

R & T GROCERY
267 EAST U.S. ROUTE 158
BELCROSS, NORTH CAROLINA

PetroChem
RECOVERY SERVICES

P.O. Box 1458
Norfolk, Virginia 23501
Tel. (804) 637-9791
Fax (804) 640-1261



SR 1145

EXPLANATION:

⊙ INSTALLED MONITORING WELLS

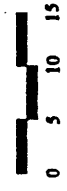
□ FORMER UST LOCATION

--- APPROXIMATE LOCATION OF CONTAMINANT PLUME

A-A' LINE OF CROSS SECTION

Note: All numbers are in mg/kg.

APPROXIMATE SCALE (FT):



PROJECT NUMBER:
G-138-95

PICTURE NUMBER:
3

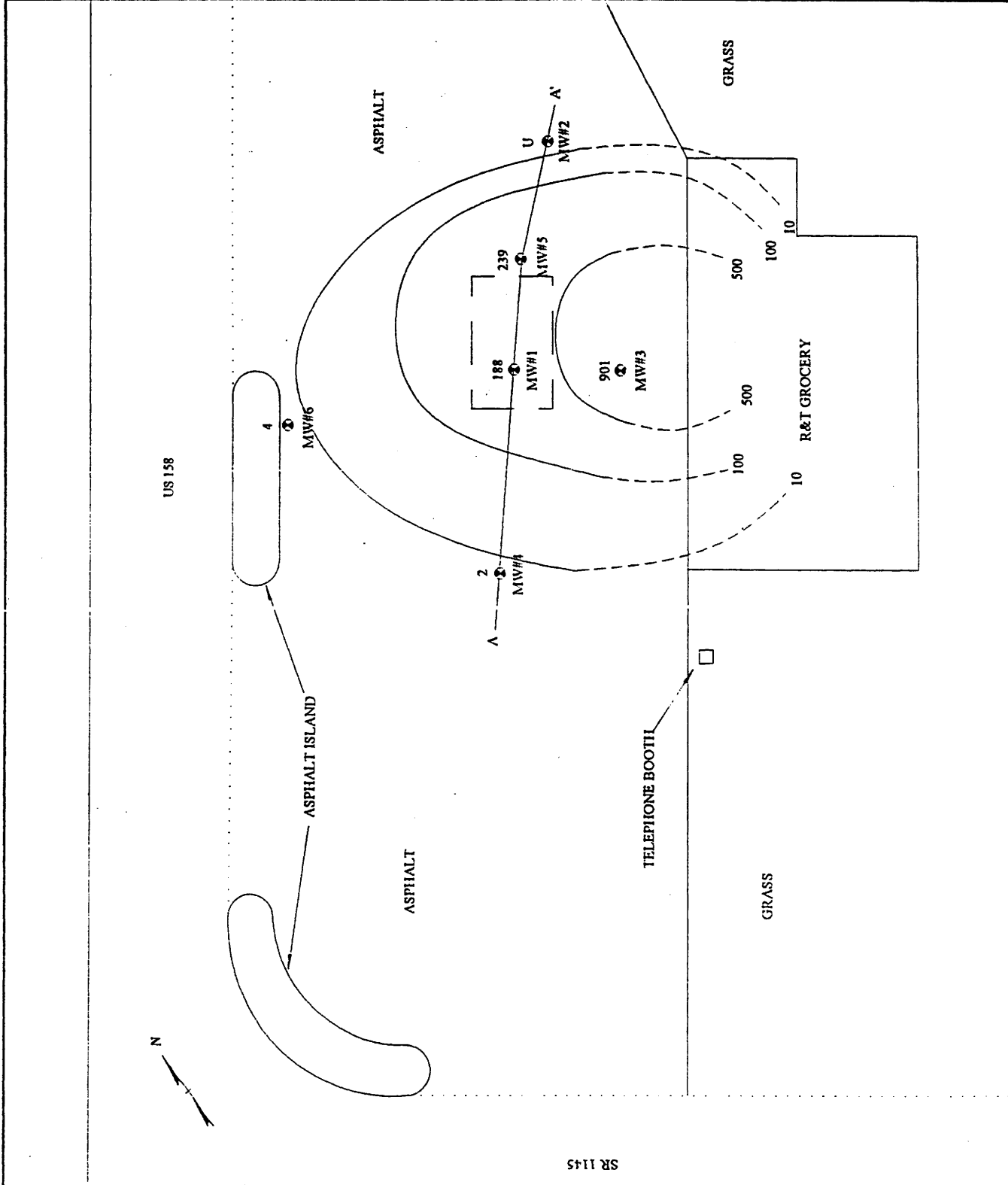
DRAWN BY:
T. COFFEY

DATE:
3-20-95

TITLE:

TPFH IN SOILS
R&T GROCERY
267 EAST U.S. ROUTE 158
BELCROSS, NORTH CAROLINA

PetroChem
RECOVERY SERVICES
635 Mathby Ave.
Norfolk, Virginia 23504
Tel. (804) 627-8791
Fax (804) 640-1261



SR 1145

EXPLANATION

● INSTALLED MONITORING WELLS

□ FORMER UST LOCATION

○ DOMESTIC SUPPLY WELL (approximate location)

Note: All concentrations in µg/l.

APPROXIMATE SCALE (FT):



PROJECT NUMBER:
G-138-95

PICTURE NUMBER:
5

DRAWN BY:
T. COFFEY

DATE:
7-27-95

TITLE:

MTBE IN GROUNDWATER

MARCH 20, 1995

and

JULY 19, 1995

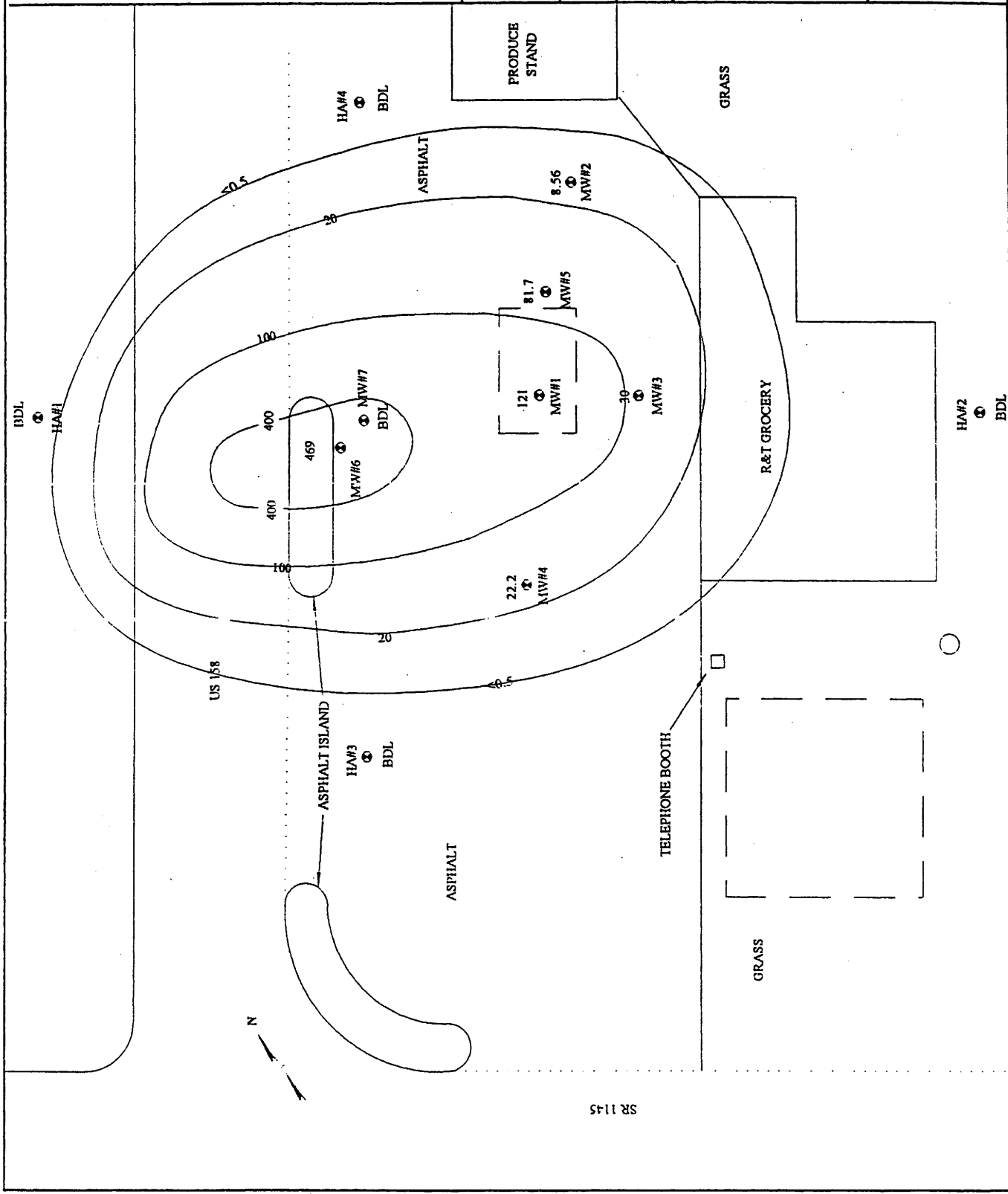
R&T GROCERY

267 EAST U.S. ROUTE 158

BELCROSS, NORTH CAROLINA

PetroChem
RECOVERY SERVICES

635 Malby Ave.
Norfolk, Virginia 23504
Tel. (804) 627-8791
Fax (804) 640-1261



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EXPLANATION:

● INSTALLED MONITORING WELLS

□ FORMER LIST LOCATION

○ DOMESTIC SUPPLY WELL (approximate location)

Note: All concentrations in mg/l

APPROXIMATE SCALE (FT):



PROJECT NUMBER: G-138-95

FOUR NUMBER: 6

DATE: 7-27-95

DRAWN BY: T. COFFEY

TITLE:

LEAD IN GROUNDWATER

MARCH 20, 1995

and

JULY 19, 1995

R&T GROCERY

267 EAST U.S. ROUTE 158

BELCROSS, NORTH CAROLINA

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RECOVERY SERVICES

635 Malby Ave.
Norfolk, Virginia 23504
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Fax (804) 640-1261

BDL
●
HA#1

US 158

ASPHALT ISLAND

HA#3
●
BDL

BDL
●
MW#6

BDL
●
MW#7

HA#4
●
BDL

ASPHALT

0.026
●
MW#4

0.031
●
MW#1

0.042
●
MW#5

0.034
●
MW#3

BDL
●
MW#2

PRODUCE STAND

GRASS

R&T GROCERY

TELEPHONE BOOTH

GRASS

HA#2
●
BDL



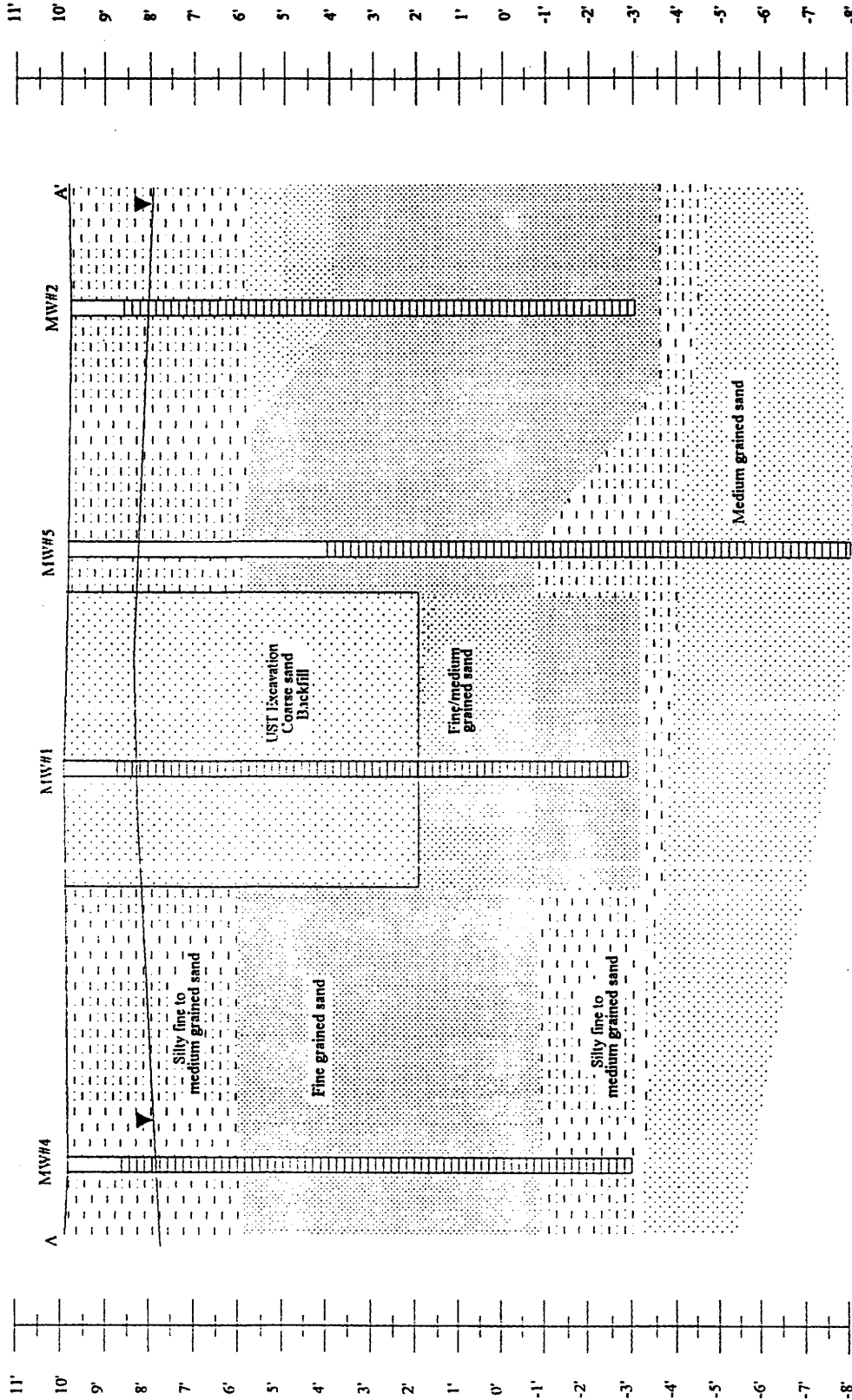


FIGURE TITLE:

CROSS SECTION A - A'

R&T GROCERY
 267 EAST U.S. ROUTE 158
 BELCROSS, NORTH CAROLINA

APPROXIMATE SCALE:



HORIZONTAL SCALE (FEET)
 0 15

PROJECT NUMBER: G 138 95	FIGURE NUMBER: 7	DATE: 3-14-95
DRAWN BY: T. COFFEY		

PetroChem
 RECOVERY SERVICES

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 Norfolk, Virginia 23504
 Tel. (804) 627-8791
 Fax (804) 640-1261

EXPLANATION

⊕ MONITORING WELLS

⌈ FORMER UST LOCATIONS

○ DOMESTIC SUPPLY WELL (approximate location)

Note: All concentrations in µg/l.

APPROXIMATE SCALE (FT):



PROJECT NUMBER: G-140-95

FIGURE NUMBER: 8

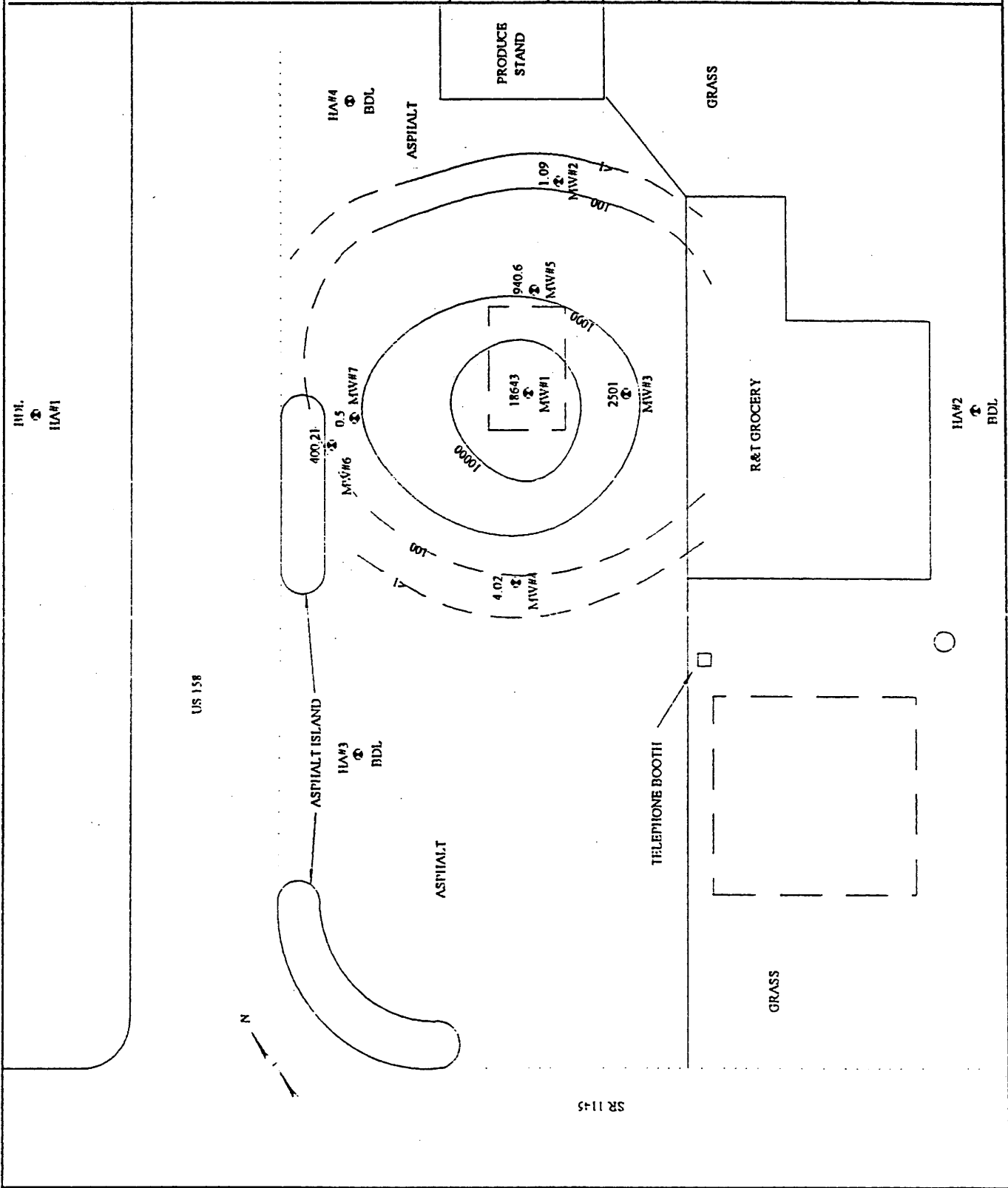
DIARY BY: T. COFFEY

DATE: 10-24-95

TITLE:

TOTAL BTEX IN GROUNDWATER
 SEPTEMBER 22, 1995
 R & T GROCERY
 267 EAST U.S. ROUTE 158
 BELCROSS, NORTH CAROLINA

PetroChem
 RECOVERY SERVICES
 635 Malby Ave.
 Norfolk, Virginia 23304
 Tel. (804) 627-8791
 Fax (804) 640-1261



SR 1145

EXPLANATION:

⊕ MONITORING WELLS

◻ FORMER LUST LOCATIONS

○ DOMESTIC SUPPLY WELL (approximate location)

⊕ PROPOSED DOWNGRADIENT MONITORING WELL

Note: All concentrations in µg/l.

APPROXIMATE SCALE (FT):



PROJECT NUMBER: G-140-95

FIGURE NUMBER: 9

DRAWN BY: T. COFFEY

DATE: 11-9-95

TITLE:

PREDICTED CONTAMINANT MIGRATION AND MONITORING PLAN

R&T GROCERY
267 EAST U.S. ROUTE 158
BELCROSS, NORTH CAROLINA

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RECOVERY SERVICES
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Norfolk, Virginia 23504
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Fax (804) 640-1261

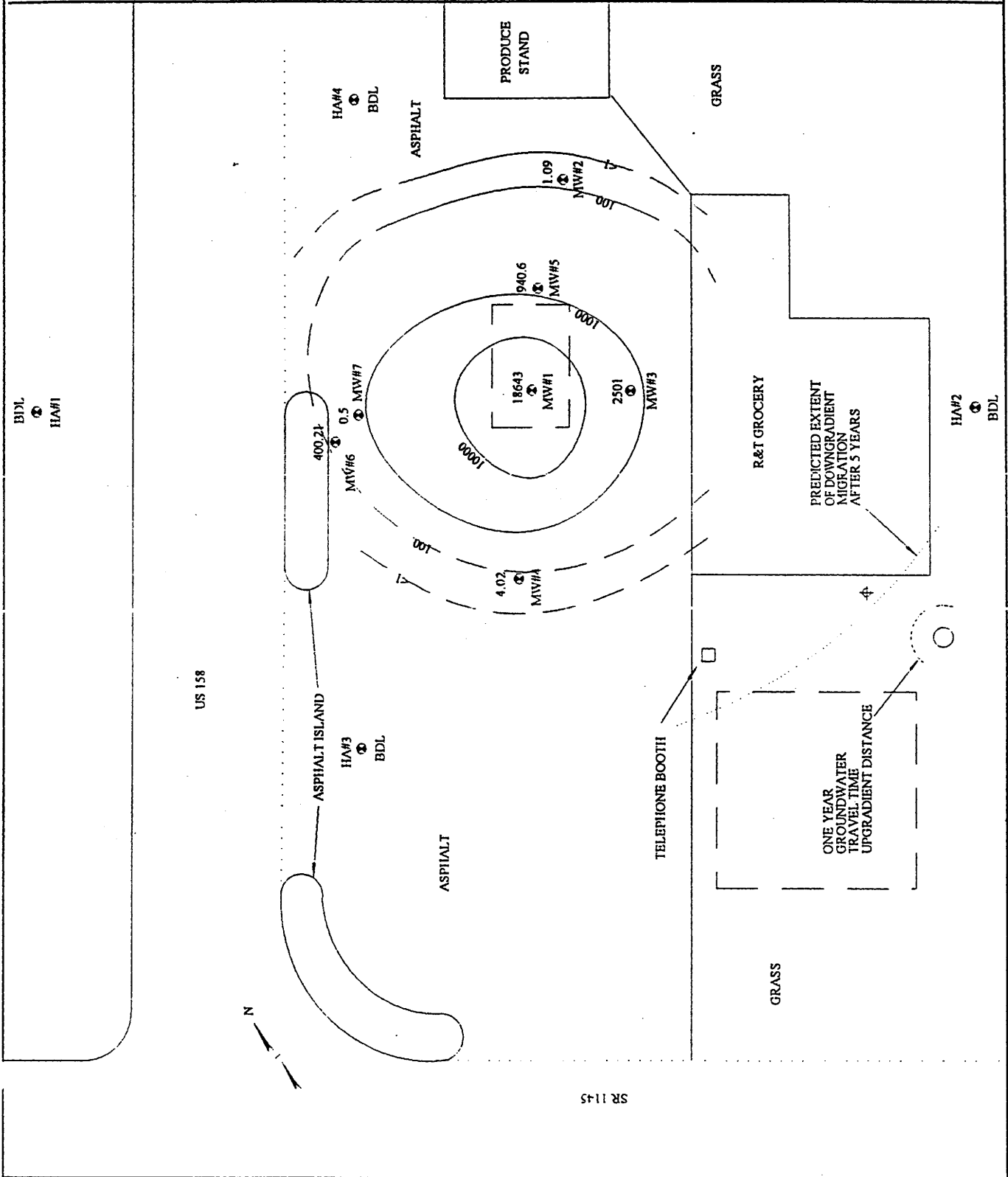


Table 1. Analytical results for CSA soil samples collected from R & T Grocery. Analytical results are reported in mg/kg.

Soil Sample No.	TPH (Method 3550)	TPH (Method 5030)
S#1	188	NA*
S#2	U**	NA
S#3	901	NA
S#4	2	NA
S#5	239	NA
S#6	4	NA
Detection Limits	1	NA

* NA = not analyzed

** U = not detected above quantitation limit

Table 2. Analytical results for CSA groundwater samples collected from R&T Grocery on March 20, 1995. Analytical results are reported in µg/L.

Sample No.	Benzene	Toluene	Ethylbenzene	Xylenes
MW#1	1080	7490	912	5900
MW#2	6.67	4.77	25.9	69.9
MW#3	842	3890	504	4060
MW#4	6.88	5	29	29.5
MW#5	1250	14300	1270	9270
MW#6	1160	5410	1720	7120
Detection Limits	0.3	2	4	6.03

Table 3. Analytical results for CSA groundwater samples collected from R&T Grocery on March 20, 1995. Analytical results are reported in $\mu\text{g/L}$ except Total Lead which is reported in mg/L .

Sample No.	MTBE	Isopropyl Ether	Total Lead	Ethylene dibromide
MW#1	121	249	0.031	U*
MW#2	8.56	15	U	U
MW#3	30	133	0.034	U
MW#4	22.2	U	0.026	U
MW#5	81.7	430	0.042	U
MW#6	469	127	U	U
Detection Limits	1	5	0.023	0.5

* U = not detected above quantitation limit.

Table 4. Analytical results for CSA Addendum groundwater samples collected on July 19, 1995. Analytical results are reported in $\mu\text{g/L}$.

Sample No.	Benzene	Toluene	Ethylbenzene	Xylenes
MW#7	U*	0.7	U	U
HA 1	U	U	U	U
HA 2	U	U	U	U
HA 3	U	U	U	U
HA 4	U	U	U	U
Domestic Well	U	U	U	U
Detection Limits	0.5	0.5	0.5	0.5

* U = not detected above quantitation limit.

Table 5. Analytical results for CSA Addendum groundwater samples collected from R&T Grocery on July 19, 1995. Analytical results are reported in $\mu\text{g/L}$ except Total Lead, which is reported in mg/L .

Sample No.	MTBE	Isopropyl Ether	Total Lead	Ethylene dibromide
MW#7	U*	U	U	U
HA 1	U	U	U	U
HA 2	U	U	U	U
HA 3	U	U	U	U
HA 4	U	U	U	U
Domestic Well	U	U	U	U
Detection Limits	0.5	0.5	0.08	0.5

* U = not detected above quantitation limit.

Table 6. Analytical results for CSA Addendum groundwater samples collected from R&T Grocery on September 22, 1995. Analytical results are reported in $\mu\text{g/L}$ except Total Lead, which is reported in mg/L .

Well No.	Benzene	Toluene	Ethylbenzene	Xylenes	Lead
MW1	1010	10920	1348	5365	U*
MW2	1.09	U	U	U	U
MW3	679	421	454	947	U
MW4	1.86	U	2.16	U	U
MW5	91.6	211	173	465	U
MW6	99.5	3.81	269	27.9	U
MW7	U	U	U	U	U
HA1	U	U	U	U	U
HA2	U	U	U	U	U
HA3	U	U	U	U	U
HA4	U	U	U	U	U

* U = not detected above quantitation limit.

9

2644

GROUNDWATER MONITORING REPORT

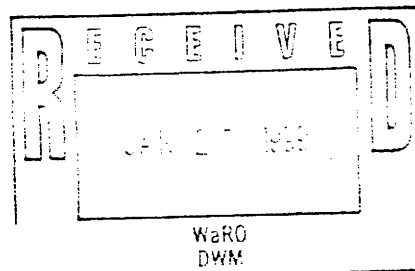
FOURTH QUARTER 1998

H

**R & T Grocery
Incident No. 12711
U.S. Route 158
Belcross, Camden County
North Carolina**

Prepared for:

**Mr. Rufus Abeyounis
Crystal Enterprises, Inc.
1003 Wilson Street
Elizabeth City, North Carolina 23909**



Prepared by:

**Jones Techn
813 Forrest J
Newport News
(757)**

Philip J

*No response
necessary
continue monitoring*

Janu

EXPLANATION

- ⊕ MONITORING WELL
- COVERED OR DESTROYED WELL
- FORMER UST LOCATION
- WATER TABLE CONTOUR
- RW-4 REPLACEMENT WELL
- ✓ GROUNDWATER FLOW DIRECTION

NOTE:
Water table elevations are in feet.

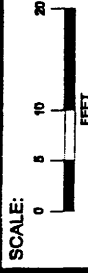
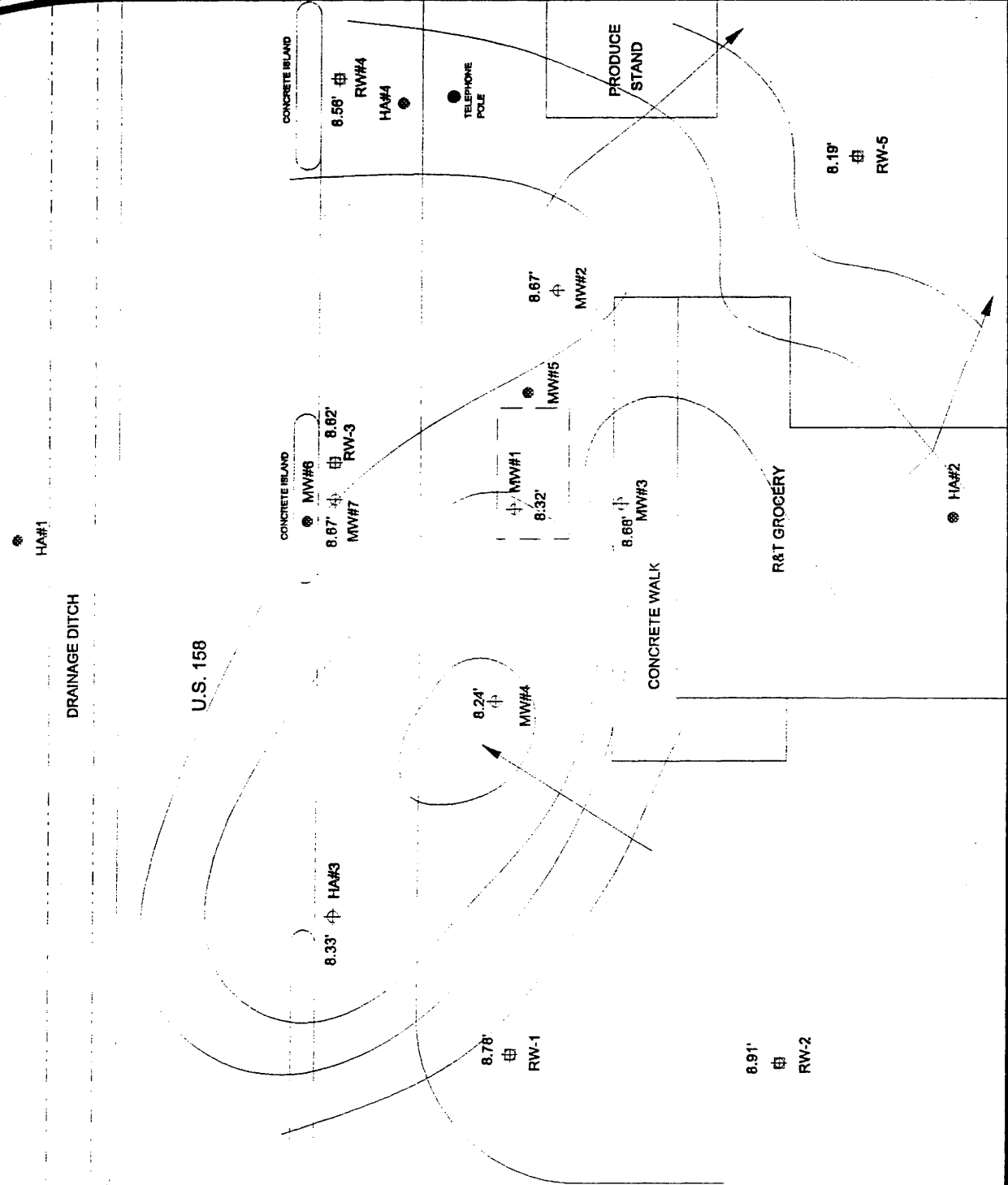


FIGURE 3

POTENTIOMETRIC SURFACE DIAGRAM

R&T Grocery
267 East U.S. Route 158
Belcross, North Carolina

JONES TECHNOLOGIES, INC.
813 Forrest Drive, Suite C
Newport News, Virginia 23606
Phone: (757) 598-5203
Fax: (757) 598-5204



S.R. 1145

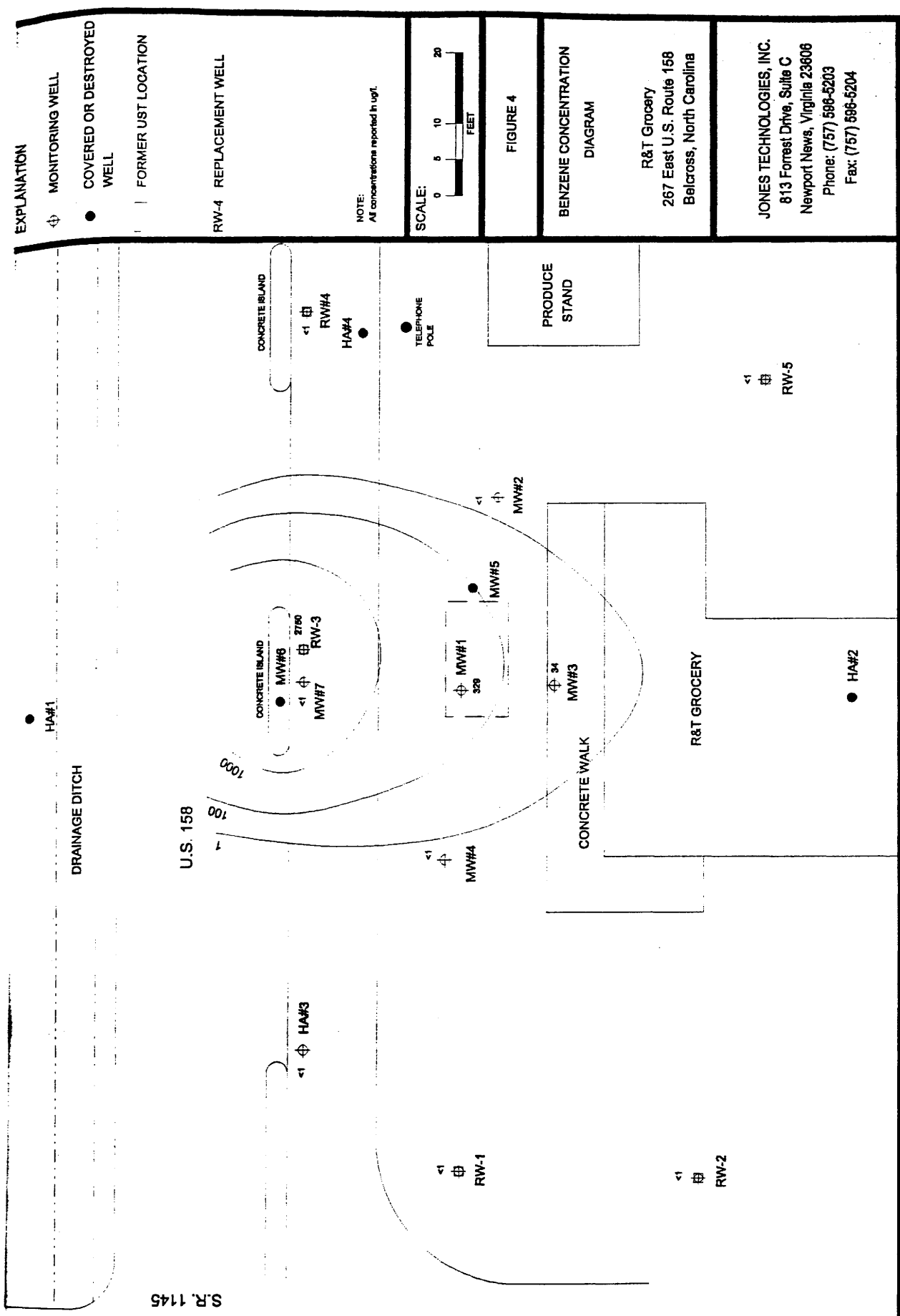


Table 1. Fourth quarter 1998 monitoring well gauging results for R&T Grocery, Belcross, North Carolina. Wells gauged on December 22, 1998.

Well No.	Water Cut ¹	Fuel Cut ¹	Fuel Thickness ¹	Casing Elevation ¹	Water Table Elev. ¹	Purge Volume ²
MW#1	1.68	ND ³	0	10.00	8.32	5
MW#2	1.30	ND	0	9.97	8.67	5.75
MW#3	1.45	ND	0	10.13	8.68	5.5
MW#4	1.70	ND	0	9.94	8.24	4.75
MW#5	Covered	Covered	Covered	9.95	Covered	Covered
MW#6	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
MW#7	1.44	ND	0	10.11	8.67	8
HA#1	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
HA#2	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
HA#3	1.81	ND	0	10.14	8.33	1.25
HA#4	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed	Destroyed
W#1	1.35	ND	0	10.13	8.78	6
RW#2	1.00	ND	0	9.91	8.91	6
RW#3	1.48	ND	0	10.10	8.62	6
RW#4	1.40	ND	0	9.96	8.56	6
RW#5	1.76	ND	0	9.95	8.19	5.5

NOTES:

¹. Measurements are in feet.

². Purge volume is in gallons.

³. ND = None detected.

Table 2. Analytical results for the fourth quarter 1' groundwater monitoring at R&T Grocery. Samples were collected on December 22, 1998.

Well No.	Benzene (µg/l)	Ethylbenzene (µg/l)	Toluene (µg/l)	Xylenes (µg/l)	MTBE (µg/l)	Lead (mg/l)
MW#1	329	566	1830	2300	120	0.005
MW#2	<1	<1	2	<1	<2	NS
MW#3	34	131	7	69	2	0.005
MW#4	<1	<1	2	<1	<2	0.008
MW#5	NS	NS	NS	NS	NS	NS
MW#7	<1	<1	4	<1	<2	NS
HA#3	<1	<1	3	<1	49	NS
RW#1	<1	<1	<1	<1	<2	NS
RW#2	<1	<1	<1	<1	<2	NS
RW#3	2750	830	7650	2720	385	NS
RW#4	<1	<1	<1	<1	<2	NS
RW#5	<1	<1	2	<1	<2	NS
T. B. ³	<0.5	<0.5	<0.5	<0.5	<1.00	NA
D. L. ⁴	0.5	0.5	0.5	1.5	1.00	0.001
GWQS ⁵	1	29	1000	530	200	0.015

NOTES:

1. NA = not analyzed.
2. NS = not sampled.
3. T. B. = trip blank.

⁴. D. L. = detection limits.
⁵. GWQS = North Carolina Groundwater Quality Standards.

Year	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(mg/l)
Q4/1996	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Q1/1997	9.09	BDL	BDL	BDL	BDL	BDL	BDL
Q2/1997	164.519	11.029	7.166	28.211	28.211	28.211	28.211
Q3/1997	77.00	39.101	5.15	22.57	22.57	22.57	22.57
Q4/1997	7.18	1.42	3.93	4.61	4.61	4.61	4.61
Q1/1998	8.4	10.4	BDL	BDL	BDL	BDL	BDL
Q2/1998	11.4	BDL	BDL	BDL	BDL	BDL	BDL
Q3/1998	2	2	BDL3	BDL	BDL	BDL	BDL
Q4/1998	<1	3	<1	<1	<1	<1	<1
RW#1	<1	<1	<1	<1	<1	<1	<1
RW#2	<1	<1	<1	<1	<1	<1	<1
RW#3	2750	7650	830	2720	2720	2720	2720
RW#4	<1	<1	<1	<1	<1	<1	<1
RW#5	<1	2	<1	<1	<1	<1	<1
GWQS ⁵	1	1000	29	530	530	200	0.015

NOTES:

1. Dates represent analytical results obtained during the CSA (3/20/95) and CSA Addendum (7/19/95; 9/22/95).
2. BDL = below detection limits.
3. NA = not analyzed.
4. NS = not sampled. Monitoring well either covered or destroyed.
5. GWQS = North Carolina Groundwater Quality Standards.