

APPENDIX A
PREVIOUS REPORTS

**COMPREHENSIVE SITE ASSESSMENT
ADDENDUM II**

**Hollowell Site
Hwy. 158 & Hwy. 343
Camden, North Carolina**

**Ground Water Incident No. 6309
Incident Rank: 185/B**

Prepared for:

**Mr. Russell Hollowell
Hollowell Oil Company
Post Office Box 237
Winfall, North Carolina 27985**

Submitted to:

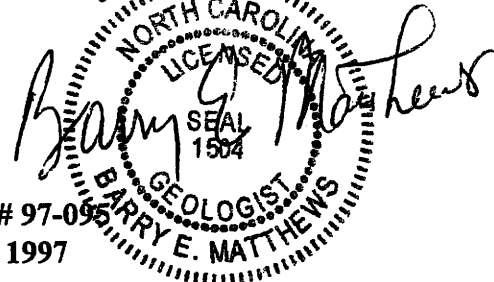
**North Carolina Division of Water Quality
Washington Regional Office
943 Washington Square Mall
Washington, North Carolina 27889**

Prepared by:

**Jason Johnson
Omega Environmental Services
205 Stage Coach Trail
Greensboro, North Carolina 27409**

Sealed by:

Barry E. Matthews, P.G.



**Omega Project # 97-095
December 3, 1997**

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EXECUTIVE SUMMARY

The subject property is owned by Mr. Glenn Gordon. The property was leased to Hollowell Oil Company, which maintained a self-service gasoline dispensing operation from 1977 to 1989. The gasoline dispensing system included three gasoline USTs, piping and a pump island. The three gasoline USTs utilized on this site by Hollowell Oil Company were removed from the site in 1989. Solutions Environmental Associates, Inc. investigated the site in 1991 and in 1992. These investigations revealed the presence of petroleum constituents in the soils surrounding the removed USTs and the former pump island. Solutions also conducted soil excavation activities at the site to remove the petroleum impacted soils in 1991. At that time, Solutions discovered two "orphan" USTs. Law Engineering and Environmental Services, Inc. was contracted by the State of North Carolina to conduct further investigations at this site. In November 1996, Law submitted an "Environmental Assessment Activities" report and in January 1997, Law submitted an Underground Storage Tank Closure report.

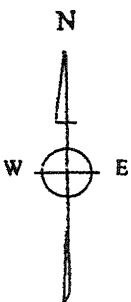
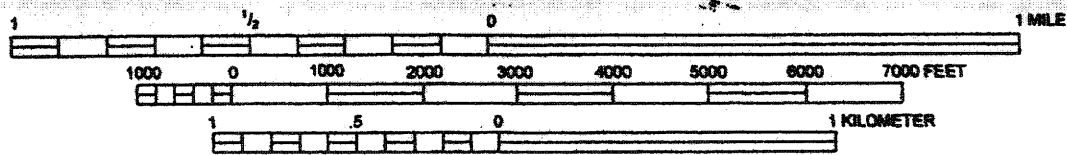
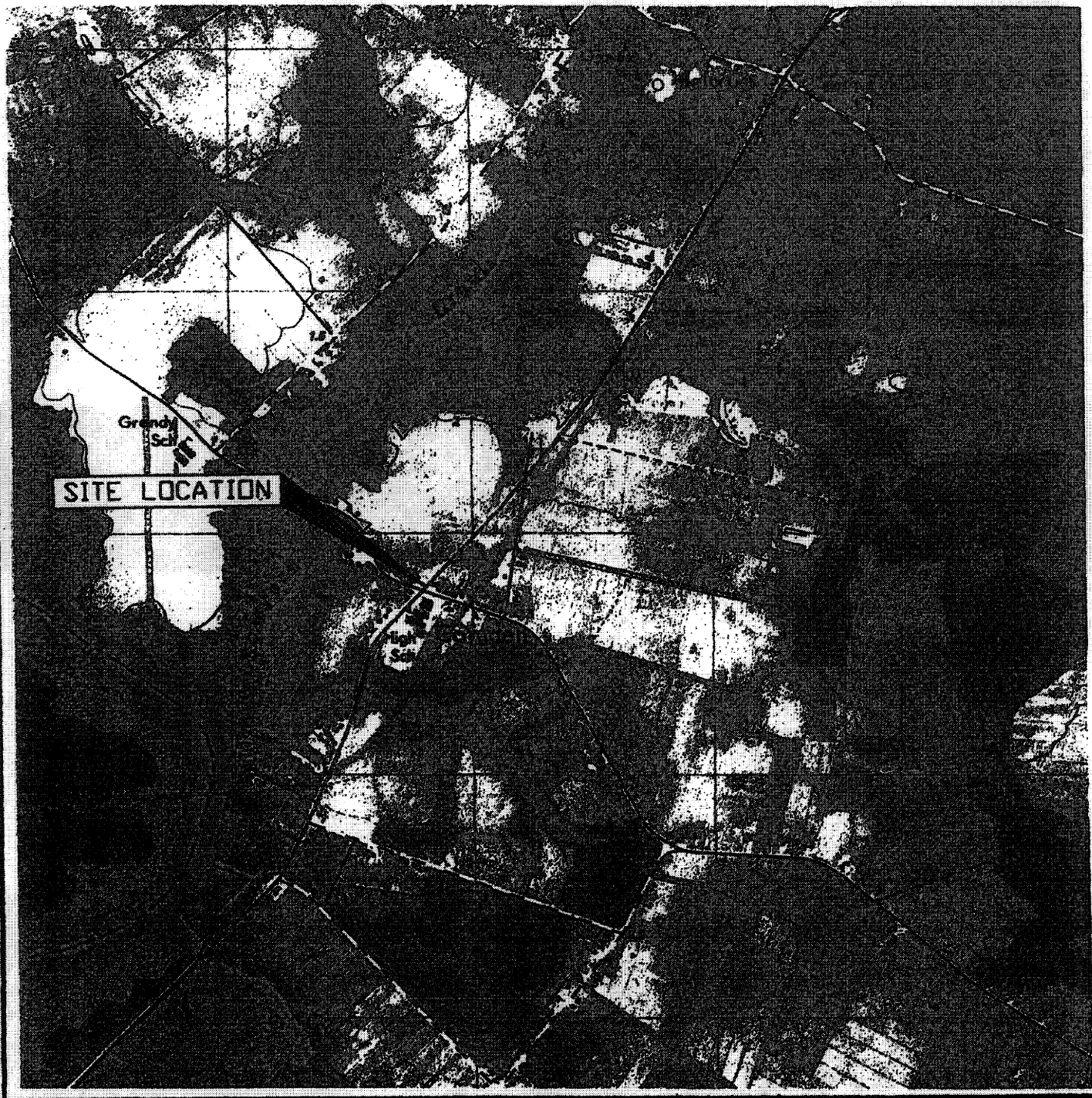
This site has impact from petroleum hydrocarbons which could impact local area potable wells. The MTBE dissolved plume has already migrated off-site. The other petroleum compounds appear to be limited to the sub-surface under the site. Omega concludes that the MTBE constituents date a release to the late seventies or later. However, additional release(s) have occurred on this site unrelated to the USTs owned and operated by Hollowell Oil Company. Evidence of this fact is: extensive impact around the orphan gasoline UST which is up-gradient from an apparent release point at the former pump islands, the presence of diesel range organics (diesel or kerosene) and the historic use of the property as a petroleum distribution retail facility.

The investigations conducted for the CSA Addendum revealed that the MTBE plume has migrated further down-gradient than the data from the CSA revealed. Monitoring Well MW-16 is located approximately 300 feet from the former pump island and had a reported MTBE concentration of 253 ug/L. At the request of the DWQ, on October 13, 1997 Omega installed MW-17, 45 feet down-gradient from MW-16, to further define the extent of the MTBE plume. Analytical results obtained from sampling MW-17 and supply well SW-1 indicated MTBE and BTEX concentrations below detection limits. Additionally, the area around MW-7 and MW-7A (the location of the "orphan" gasoline UST) is impacted with elevated concentrations of residual (76.9 mg/Kg TPH-volatiles) and dissolved phase petroleum hydrocarbons (53,240 ug/L Total BTEX). This UST was unrelated to Hollowell Oil ownership and appears to be a significant source of dissolved phase petroleum hydrocarbons.

In November 1997, Omega conducted a Dual Phase Extraction Pilot Study to determine the feasibility of utilizing the technology at the site. During the four hour event approximately 100 gallons of petroleum contaminated water were recovered. The material manifest for the disposed water is included in the appendices. During the event free product measuring 0.02' was located at MW-8. Based on gauging results the free product appears to be limited to the area of MW-8.

Utilizing calibrated Magnehelic™ gauges placed at perimeter monitoring wells, Omega determined an approximate vacuum influence radius for the four hour event. Other data collected during the event included relative humidity, temperature, exhaust flow velocity, and field measured concentrations. These parameters were used to calculate average Pollutant Mass

Removal Rate for the event. Based upon field recorded humidity, temperature, exhaust velocity and vapor concentration, the removal rate was calculated to be approximately 0.061 gallons/hour for the four hour event. System exhaust concentrations averaged 10,000+ for the duration of the event. For development and design of a remediation technology Tedlar bag air samples were collected and water samples were taken from the holding tank. The collected air samples were analyzed for TPH, BTEX and the water samples were analyzed for THP, BTEX, hardness with iron and calcium. Results obtained from these samples indicate high iron concentrations within the ground water. Any dual phase system designed for the remediation of this site will need bag filters to eliminate fouling due to iron build up.

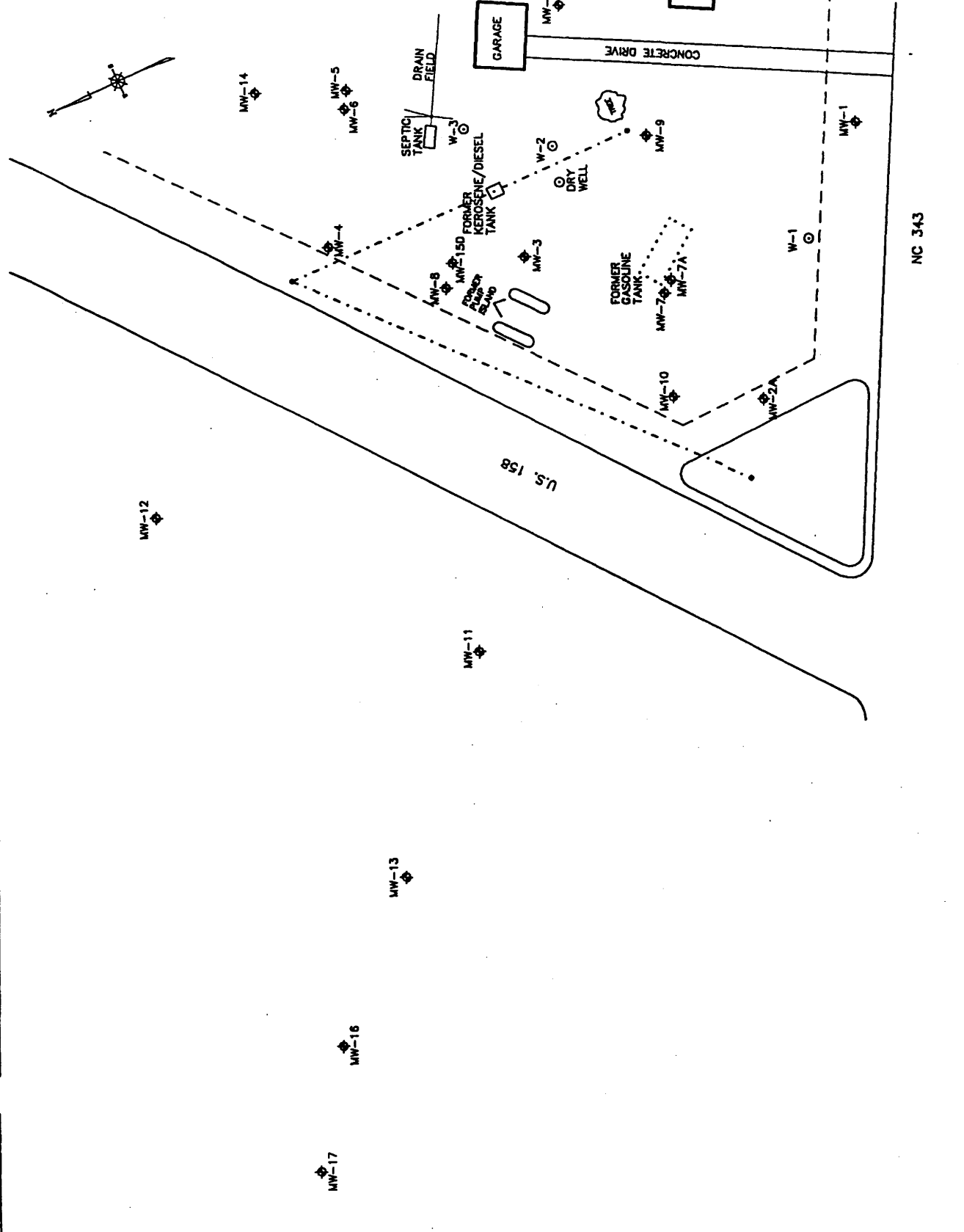


USGS 7.5 MINUTE TOPOGRAPHIC SURVEY MAP OF ELIZABETH CITY, N.C. QUADRANGLE, PHOTO REVISED 1982

| | | | |
|--------------|---------------|-------------------|--------|
| FIGURE NO.: | | FIGURE 1 | |
| FIGURE NAME: | | SITE VICINITY MAP | |
| CLIENT: | HOLLOWELL OIL | JOB NO.: | 97-095 |
| SITE: | CAMDEN, N.C. | DATE: | 7/97 |

END

- MW-1 ◆ MONITORING WELL
 - W-1 ⊙ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
0 50 FT



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FIGURE NO. 2
FIGURE NAME: DETAILED SITE MAP

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 11/18/97

In September, 1996, the NCDEHNR (North Carolina Department of Environment, Health and Natural Resources) requested Law Engineering and Environmental Services, Inc. to conduct an investigation of the property under the Lead Trust Fund Program. Law submitted the results of the investigation, "Environmental Assessment Activities" to the NCDEHNR on November 5, 1996. The investigation included the installation of three shallow monitor wells (MW-7, MW-8 and MW-9). TPH was identified in the soils samples from two of the wells. Ground water was sampled and four samples from the wells contained petroleum hydrocarbon compounds in excess of the North Carolina Ground Water Standards.

The orphan tanks were excavated and removed on December 10, 1996. Law supervised the removal and submitted an "Underground Storage Tank Closure" report on January 14, 1997. During the removals, soils samples were collected from beneath the kerosene UST. These soil samples were reported by the laboratory to contain diesel range organics in excess of the NCDEHNR's guidelines. No soil sample was collected from beneath the gasoline UST due to the presence of ground water in the excavation. A ground water sample was collected and was reported by the laboratory to contain gasoline and diesel range organics in excess of NCDEHNR's Ground Water Standards.

In June 1997, Omega Environmental Services was contracted by Hollowell Oil Company to complete a Comprehensive Site Assessment. NCDEHNR reviewed this report and requested that additional wells be installed and additional samples be collected. Omega installed four additional monitoring wells (MW-2A, MW-7A, MW-15 and MW-16). Monitoring well MW-2A replaces the lost well MW-2. Monitoring well MW-7A was installed to replace MW-7, not located until after the drilling event at the site was completed. Monitoring well MW-15 was installed up-gradient of the release area because the flow in the area appeared to have radial characteristics and because a potable well is located proximate to the area where the monitoring well was installed. Monitoring well MW-16 was installed down-gradient of MW-13 due to a potable well being located in this direction and because the CSA revealed that the water sample MW-13 had trace amounts of MTBE.

In September of 1997, Omega submitted the CSA Addendum further characterizing the MTBE plume. NCDEHNR reviewed this report and requested that an additional monitoring well be installed and additional samples be taken from the newly installed well as well as from the potable wells on the northwest corner of N.C. 343 and U.S. 158. During this sampling event, Omega discovered that the Widow's Son Lodge was supplied with municipal water. Omega attempted to collect a sample directly from the well pump, but was unable to achieve a water flow from the pump system. According to Mr. Gordon, the Gordon property located at 100 North 343 (Table 2) is also connected to municipal water supply and has not utilized the potable well for over a year. Omega attempted to sample this well; however, the well was covered with debris and appeared to be abandoned.

After obtaining a drilling permit, Omega installed MW-17 approximately 45 feet down-gradient of MW-16. On October 22, 1997, Omega collected samples from MW-17 and supply well SW-1 (Mary Gordon Well). Results from this sampling event indicated concentrations in MW-17 and SW-1 below the detection limits.

2.0 POTENTIAL RECEPTORS AND MIGRATION PATHWAYS

2.1 WATER SUPPLY WELLS

Municipal water supply piping and meters have been installed in the area around the intersection of Hwy. 158 and Hwy. 343 in Camden, North Carolina. Every property owner/tenant Omega interviewed indicated that a water meter had been installed on the property, but that they were not connected to the municipal water system. Three residents were not interviewed; however, Omega anticipates that these residents are not connected to municipal water. Therefore, except for the Camden High School, the Gordon property, and The Widow's Son lodge, all businesses and residents are supplied water from wells on their property.

| Table 1. Supply Well Summary | | | | | |
|------------------------------|--------------------------|--------------------------|--------------------|----------------|---------------|
| Address | Owner | Occupant | Gradient (Up/Down) | Well/Municipal | Comments |
| 102 South 343 | Glen Gordon | Farm Bureau | Up | Well | Bottled water |
| 104 South 343 | Unknown | Not Home | Up | Well | |
| 106 South 343 | Unknown | Not Home | Up | Well | |
| 108 South 343 | Unknown | Not Home | Up | Well | |
| 110 South 343 | Albemarle LP Gas | Albemarle LP Gas | Up | Well | |
| 109 South 343 | Jackie Huddle | Ken Browne | Up | Well | |
| 101 South 343 | Camden Co. School Board | Camden High School | Up | Well | |
| 100 North 343 | Glen Gordon | | Down | Municipal | |
| 104 North 343 | Mary Gordon | Mary Gordon | Down | Well | |
| 106 North 343 | Widow's Son Lodge No. 75 | Widow's Son Lodge No. 75 | Down | Municipal | |
| 109 North 343 | Mr. Euthrell | Mr. Euthrell | Up | Well | |
| 102 West 158 | Unknown | Charlie's Store | Up | Well | |
| 104 West 158 | Unknown | H & R Block | Up | Well | |
| 108 West 158 | Mr. Hastings | Mr. Hastings | Up | Well | |
| | Glen Gordon | U.S. Post Office | Down | Well | |
| | Glen Gordon | Bicycle Shop | Down | Well | |

2.2 SURFACE WATERS

Several surface water bodies are located around the subject site. The closest body of water is an unnamed tributary to Sawyers Creek, located north of the site approximately 350 feet. The ground water flow direction is apparently in a northerly direction and; therefore, this surface body of water is assumed to be the surface water receptor. The next closest body of water is an unnamed tributary of the Pasquotank River, located approximately 1,600 feet south southeast of the site. This is apparently not the direction of ground water flow in the area of this site and is not

considered the surface water receptor. The Pasquotank River is located southwest of the site approximately 3,500 feet and is not considered a surface water receptor.

2.3 ADJACENT PROPERTY OWNERS

| | | |
|---------------|--------------------------|--------------------------|
| 102 South 343 | Glen Gordon | Farm Bureau |
| 104 South 343 | Unknown | Not Home |
| 106 South 343 | Unknown | Not Home |
| 108 South 343 | Unknown | Not Home |
| 110 South 343 | Albemarle LP Gas | Albemarle LP Gas |
| 109 South 343 | Jackie Huddle | Ken Browne |
| 101 South 343 | Camden Co. School Board | Camden High School |
| 100 North 343 | Glen Gordon | |
| 104 North 343 | Mary Gordon | Mary Gordon |
| 106 North 343 | Widow's Son Lodge No. 75 | Widow's Son Lodge No. 75 |
| 109 North 343 | Mr. Euthrell | Mr. Euthrell |
| 102 West 158 | Unknown | Charlie's Store |
| 104 West 158 | Unknown | H & R Block |
| 108 West 158 | Mr. Hastings | Mr. Hastings |
| | Glen Gordon | U.S. Post Office |
| | Glen Gordon | Bicycle Shop |

There are several property owners in the vicinity of the site who utilize the ground water as a source of potable water. Figure 3 - Area Water Well Users is based on the local tax map and depicts the location of property owners, their names (when obtained) and the type of potable water utilized. Only the High School, the Gordon property and the Widow's Son Lodge was confirmed as being connected to the municipal water system.

2.4 MIGRATION PATHWAYS

Utilities are located along both Hwy. 158 and Hwy. 343 fronting this property. Omega is not aware of any reports of vapors, staining or other evidence of impact to the utilities in the area. The residual phase, and the dissolved phase petroleum hydrocarbons could possibly intersect the recently installed water lines. The area is apparently not provided with sanitary sewer. The backfill of the water lines is most likely a sand fill similar to the native soils of the area. Therefore, if the backfill was compacted during water line installation, this probably would not cause a preferential migration pathway for the dissolved phase.

LEGEND

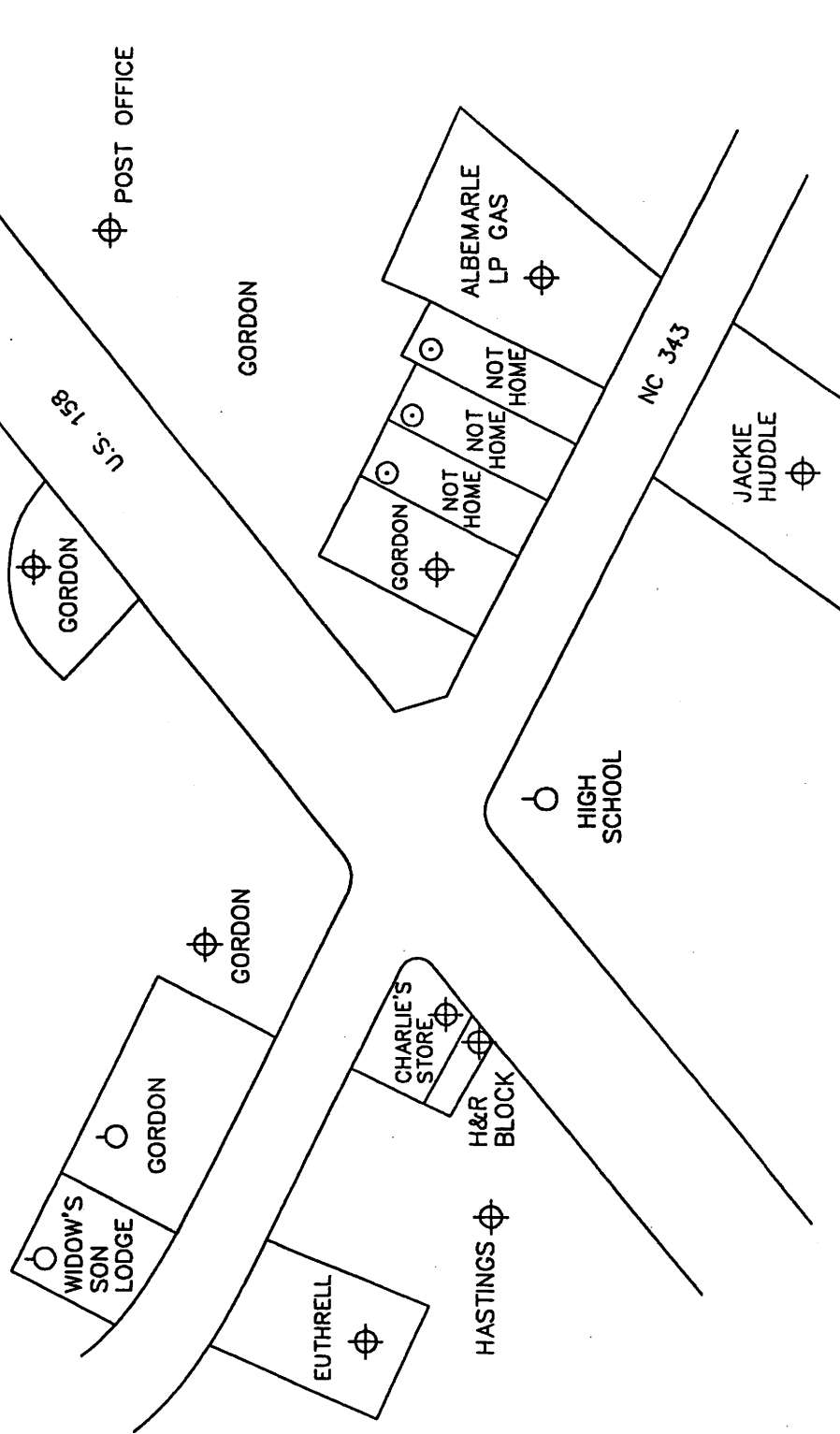
MUNICIPAL WATER CONNECTION

WELL WATER

WELL WATER (LIKELY)



APPROX. SCALE



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FIGURE NO. 1.3

FIGURE NAME: AREA WATER WELL USERS

CLIENT: HOLLOWELL OIL COMPANY

SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO. 97-095

DATE: 11/18/97

3.0 SOILS INVESTIGATION

3.1 SITE GEOLOGY

The soils collected from the seven monitor wells installed during this investigation reveal a variable surface soil, ranging from a brown clay to a poorly graded sand, with silty sands and sandy silts. At a depth of from 3 to 7 feet, the soil becomes a sand with silt, coarsening downward. At a depth of 35 feet, a marine clay was encountered in MW-15D. These findings are generally consistent with those of previous studies. Omega's Statement of Quality Assurance and Quality Control is located in Appendix A - QA/QC.

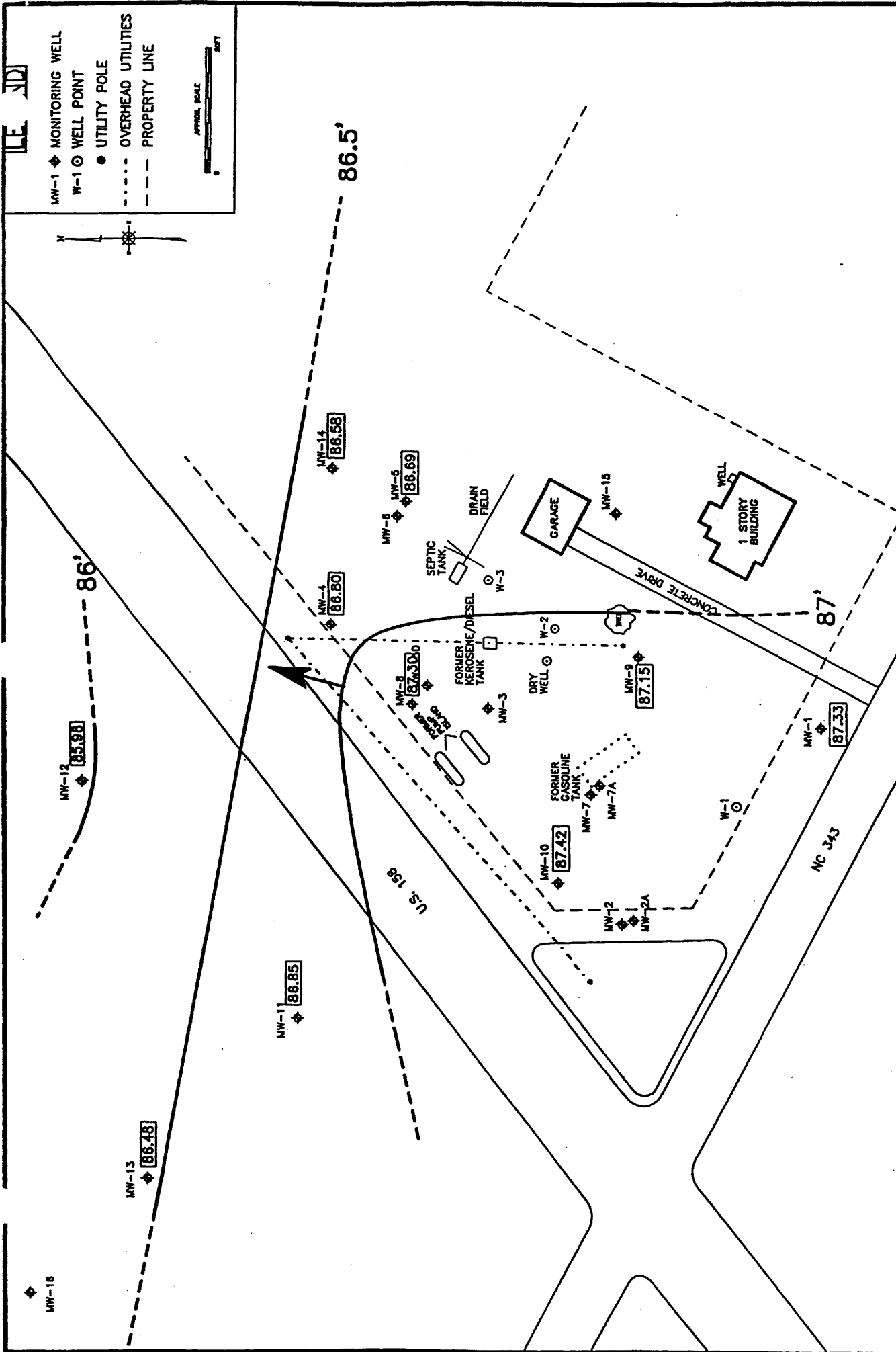
3.2 REGIONAL GEOLOGY

The Hollowell site, located at the northeast corner of the intersection of Highways 158 and 343, lies within the Atlantic Coastal Plain Province of North Carolina. This physiographic province is characterized as topographically flat, with a gentle regional slope to the southeast. In the area of this site, the coastal plain consists of approximately 4,000 feet of unconsolidated sediments resting unconformably on top of crystalline basement rock. The upper 100 feet of unconsolidated material is reported as quaternary sediments. Underlying these sands, clays, silts is the Yorktown Formation. The Yorktown is reportedly 300 feet thick in the area of this site and is comprised of fossiliferous clays to fossiliferous sands. Underlying the Yorktown are the Pungo River, Beaufort, Castle Hayne, Black Creek and Cape Fear Formations.

3.3 GEOLOGIC EFFECTS ON FATE AND TRANSPORT

The high permeability of the soils in the area of the site, coupled with the apparent lack of soil organics (carbon) allows the petroleum hydrocarbons to migrate moderate distances without decaying. However, the lack of topographic relief and the low gradient of the water table does not transport the compounds rapidly away from the site. These factors would predict that dissolved phase hydrocarbons would be persistent in the sub-surface on-site, with only the most mobile compounds being transported at any distance. MTBE and Benzene are the most mobile of the petroleum hydrocarbons in gasoline and would be predicted to have the largest dissolved phase plumes.

The ground water flow has been determined to be in a northerly direction. The geology of the area appears to be horizontally layered, with some interfingering, but would not apparently affect the flow path of the ground water (Figure 4 - Potentiometric Surface Map).



4.0 GROUND WATER INVESTIGATION

4.1 MONITOR WELLS

One additional monitoring well was installed off-site for this investigation (MW-17). The off-site monitoring well was installed down-gradient of the site, across Hwy. 158. This shallow monitoring well was installed to a depth of 15 feet with a 10 foot of screened interval, and is located approximately 45 feet down-gradient of MW-16. The construction of the off-site shallow monitor well is depicted in Appendix B - Boring Logs and Monitor Well Diagrams.

4.2 PHYSICAL AND CHEMICAL CHARACTERISTICS

Gasoline consists of a mixture of C₄ to C₁₂ hydrocarbons. It is a highly flammable liquid, is insoluble in water, and dissolves fats, oil and resins. Gasoline has a UEL (upper explosive limit) of 6.0 percent and LEL (lower explosive limit) of 1.3 percent. Exposure to gasoline can cause dizziness, vomiting and a burning sensation in the lungs.

The chemicals of primary concern with respect to a gasoline release are the naturally-occurring constituents of gasoline, benzene, toluene, ethylbenzene, and xylenes, known collectively by the acronym BTEX. Benzene is the chemical of greatest concern because it is reported to be a human carcinogen and is acutely toxic. Toluene, ethylbenzene and xylenes are not reported as carcinogenic, and are considerably less toxic than benzene. These chemicals and their relative toxicities are discussed individually below:

Benzene - a colorless liquid with a strong but pleasant odor. It is slightly soluble in water, has a specific gravity of 0.72 to 0.76 (Merck Index, 1976), and floats on water. Benzene has a UEL of 7.1 percent and a LEL of 1.3 percent. It is a known human carcinogen used in the manufacture of many products. It is acutely toxic, and affects the central nervous system (i.e., dizziness, vomiting, headache, loss of balance, narcosis, and coma) in high concentrations (Virginia Department of Health Fact Sheet, 1985).

Toluene - a clear, colorless, non-corrosive, flammable liquid with a sweet, pungent odor, and is insoluble in water. Toluene is not carcinogenic to humans, and causes mild depression of the central nervous system (mild fatigue, weakness, confusion, lacrimation and paresthesia) at lower concentrations. At higher concentration, Toluene causes; lightheadedness, dizziness, and unconsciousness (Virginia Department of Health Fact Sheet, 1987).

Ethylbenzene - a clear, colorless, flammable liquid with an aromatic, gasoline-like odor. It is insoluble in, and floats on water. Exposure to ethylbenzene can cause headache, sleepiness, eye and skin irritations, and difficulty in breathing, but is not carcinogenic to humans (Virginia Department of Health Fact Sheet, 1984).

Xylenes - refers to any mixture of three xylene isomers, ortho (O), meta (M), and para (P), which have varying densities and boiling points. All are clear, colorless, flammable, non-corrosive liquids with a sweet, aromatic odor. All isomers of xylene are insoluble in water. Human

exposure to xylenes can cause headaches, weakness, nausea, vomiting, abdominal pain, irritability, dizziness and slowed reaction time.

4.3 PLUME EXTENT

The dissolved phase benzene is centered around the area of the "orphan" UST basin and the former pump islands. The sample from MW-7 contained 20,600 ug/L benzene, while the sample from MW-7A contained 17,000 ug/L benzene. Monitoring well MW-8's sample contained 21,900 ug/L benzene. MW-9 (1,239 ug/L) and MW-10 (13.0 ug/l) were the other sampled monitoring wells with detectable benzene (Figure 5 - Dissolved Benzene Iso-Concentration Map (ug/L)).

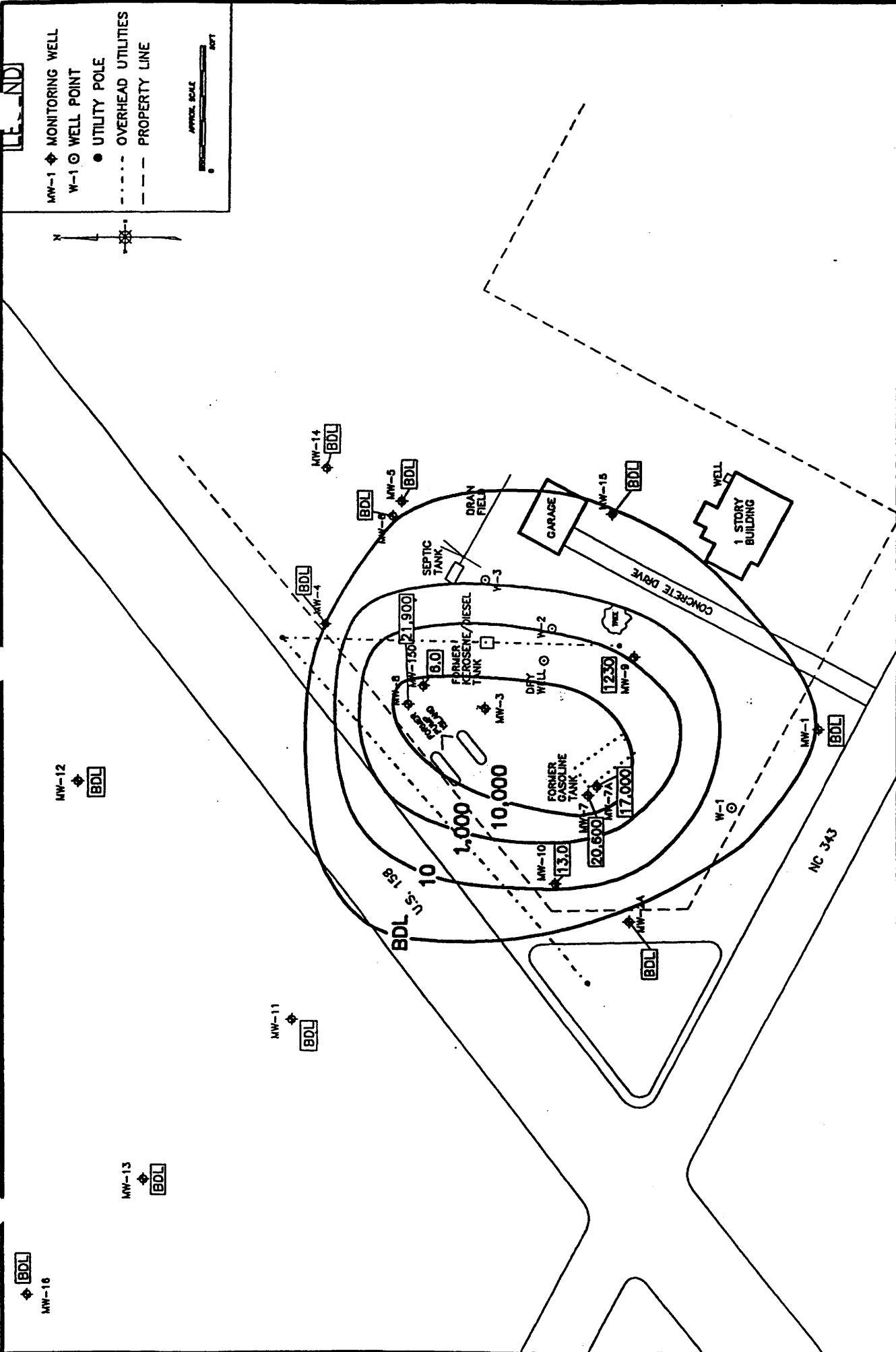
The dissolved phase toluene is centered around the area of the "orphan" UST basin and the former pump islands. The sample from MW-7 contained 23,100 ug/L toluene, while the sample from MW-7A contained 21,600 ug/L toluene. The sample from monitoring well MW-8 contained 27,800 ug/L toluene. MW-15D (13.9 ug/L), MW-10 (2.2ug/L), and MW-9 (5,530ug/L) were the other sampled monitoring wells with detectable toluene (Figure 6 - Dissolved Toluene Iso-Concentration Map (ug/L)).

The different dissolved phase plumes essentially cover the same aerial extent, with the exception of the MTBE dissolved phase plume. The MTBE plume fingers out across U.S. 158 towards MW-16. Monitoring well MW-11 had 72 ug/L MTBE, MW-13 has 170 ug/L MTBE and MW-16 had 253 ug/L MTBE. MW-17 was installed to further define the extent of the MTBE plume. Ground water analytical results indicate for the sample collected at MW-17 MTBE concentrations are BDL. Monitoring well MW-8, near the assumed release point had 12,300 ug/l MTBE (Figure 7 - MTBE Iso-Concentration Map (ug/L)).

The dissolved phase BTEX is centered around the area of the "orphan" UST basin and the former pump islands. The sample collected from MW-7 contained 57,960 ug/L BTEX, while the sample from MW-7A contained 53,740 ug/L BTEX. The sample from monitoring well MW-8 contained 63,700 ug/L BTEX. MW-15D (29.6 ug/L), MW-10 (91.6 ug/L), MW-9 (10,435 ug/L) and MW-2A (4.0 ug/L) were the other sampled monitoring wells with detectable BTEX (Figure 8 - Dissolved BTEX Iso-Concentration Map (ug/L)).

The vertical extent of the dissolved Benzene phase extends to the deep well screened interval at 37 feet to 47 feet. However, the reported concentration of 6.0 ug/L (parts per billion) is just slightly above the drinking water standard of 5.0 ug/L.

The residual phase mirrors the dissolved phase in aerial extent. Soil samples from the borings advanced for MW-15D and MW-7A contained 797 mg/Kg TPH and 245 mg/Kg TPH, respectively. No other soil samples collected during the CSA or CSA Addendum on-site work contained detectable concentrations of residual petroleum hydrocarbons (Figure 9 - Residual phase Total Petroleum Hydrocarbon Plume Map).



| | | | |
|--|--|---|--|
| <p>OMEGA ENVIRONMENTAL SERVICES</p> | <p>FIGURE NO.: 5</p> <p>FIGURE NAME: DISSOLVED BENZENE ISOCONCENTRATION MAP (ug/L)</p> | <p>CLIENT: HOLLOWELL OIL COMPANY</p> <p>SITE: HOLLOWELL OIL CO., CAMDEN, NC</p> | <p>JDB NO.: 97-095</p> <p>DATE: 9/97</p> |
|--|--|---|--|

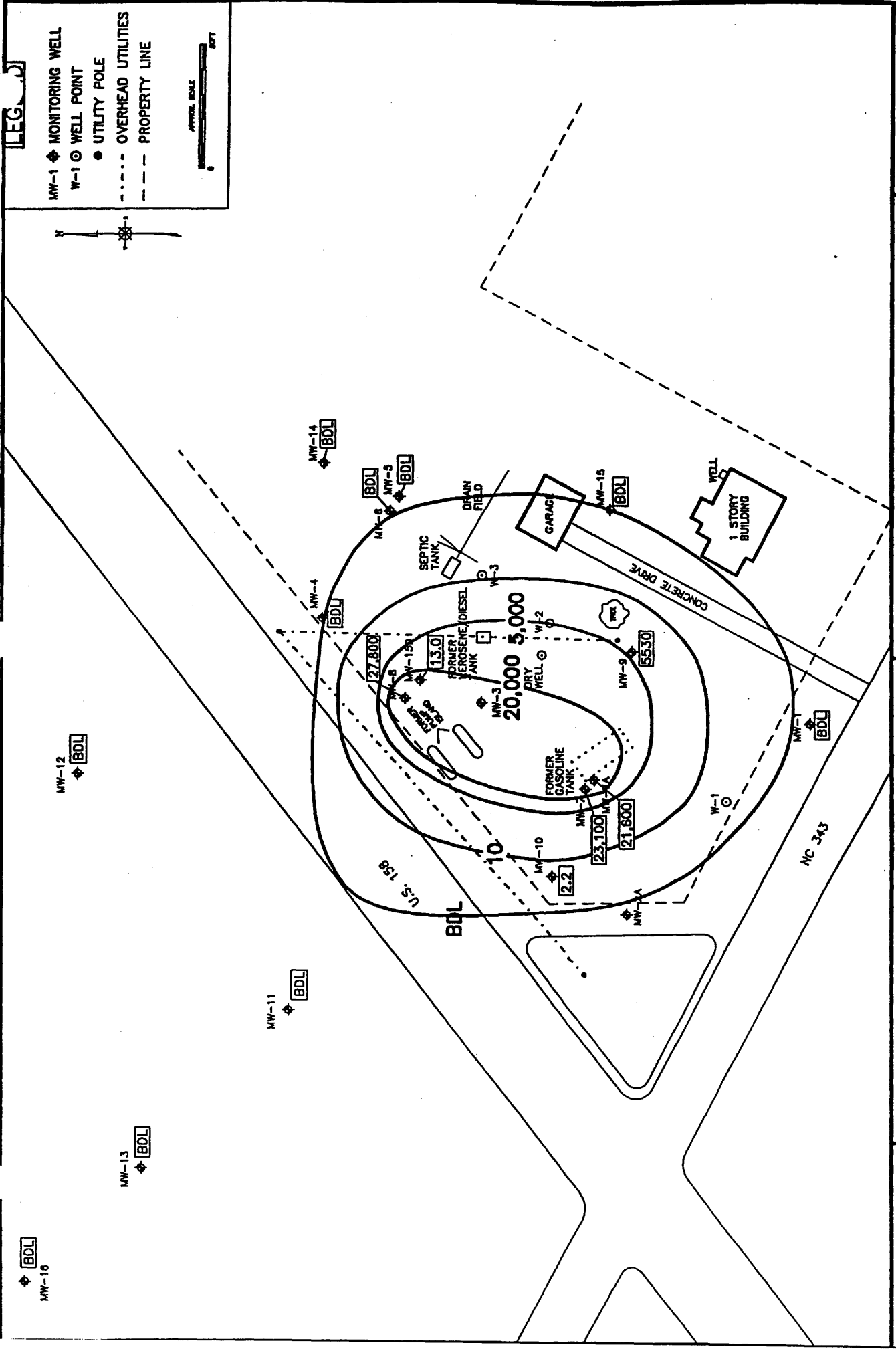
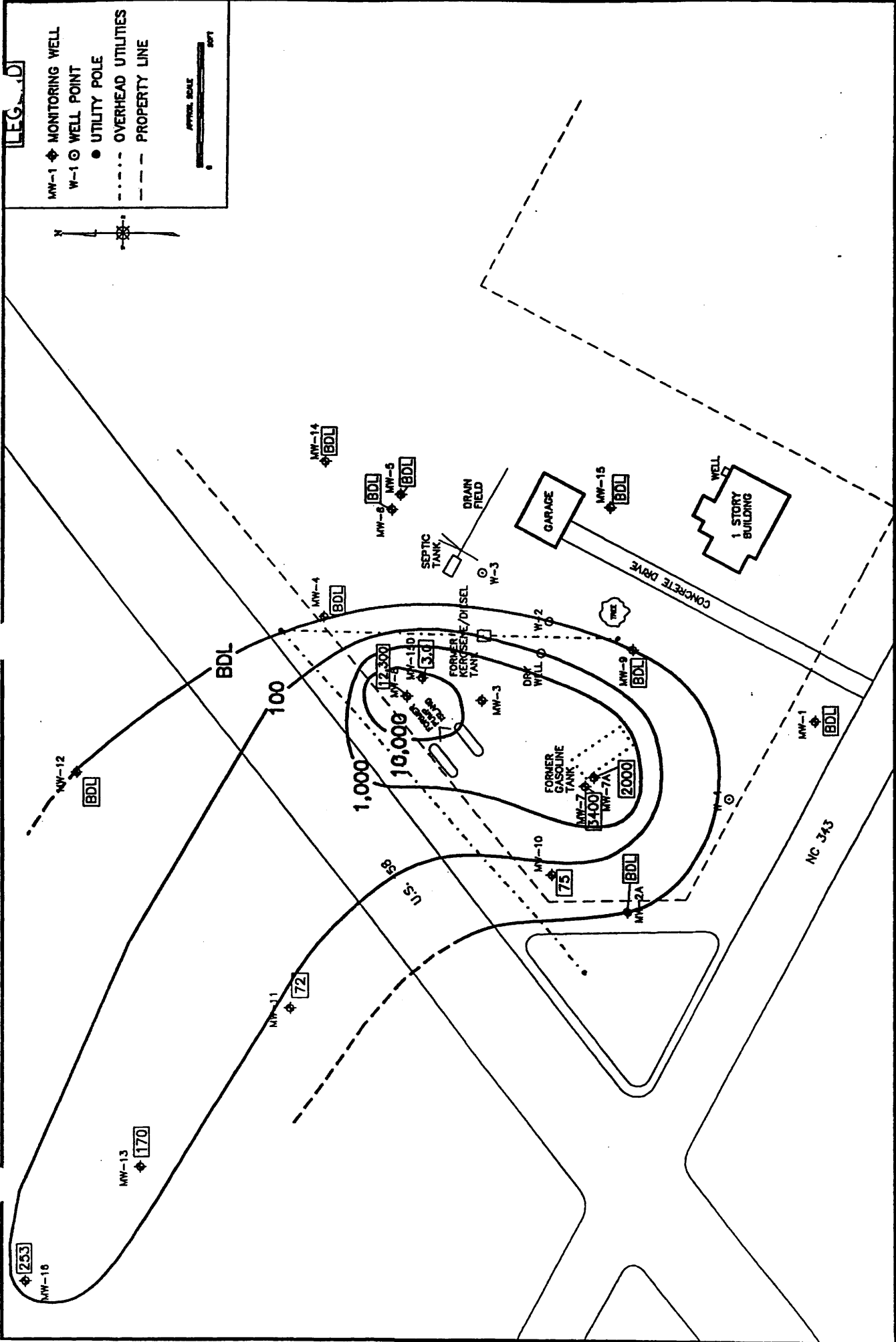


FIGURE NO.: 6
FIGURE NAME: DISSOLVED TOLUENE ISOCONCENTRATION
MAP (ug/L)

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC




JOB NO: 97-095
DATE: 9/97

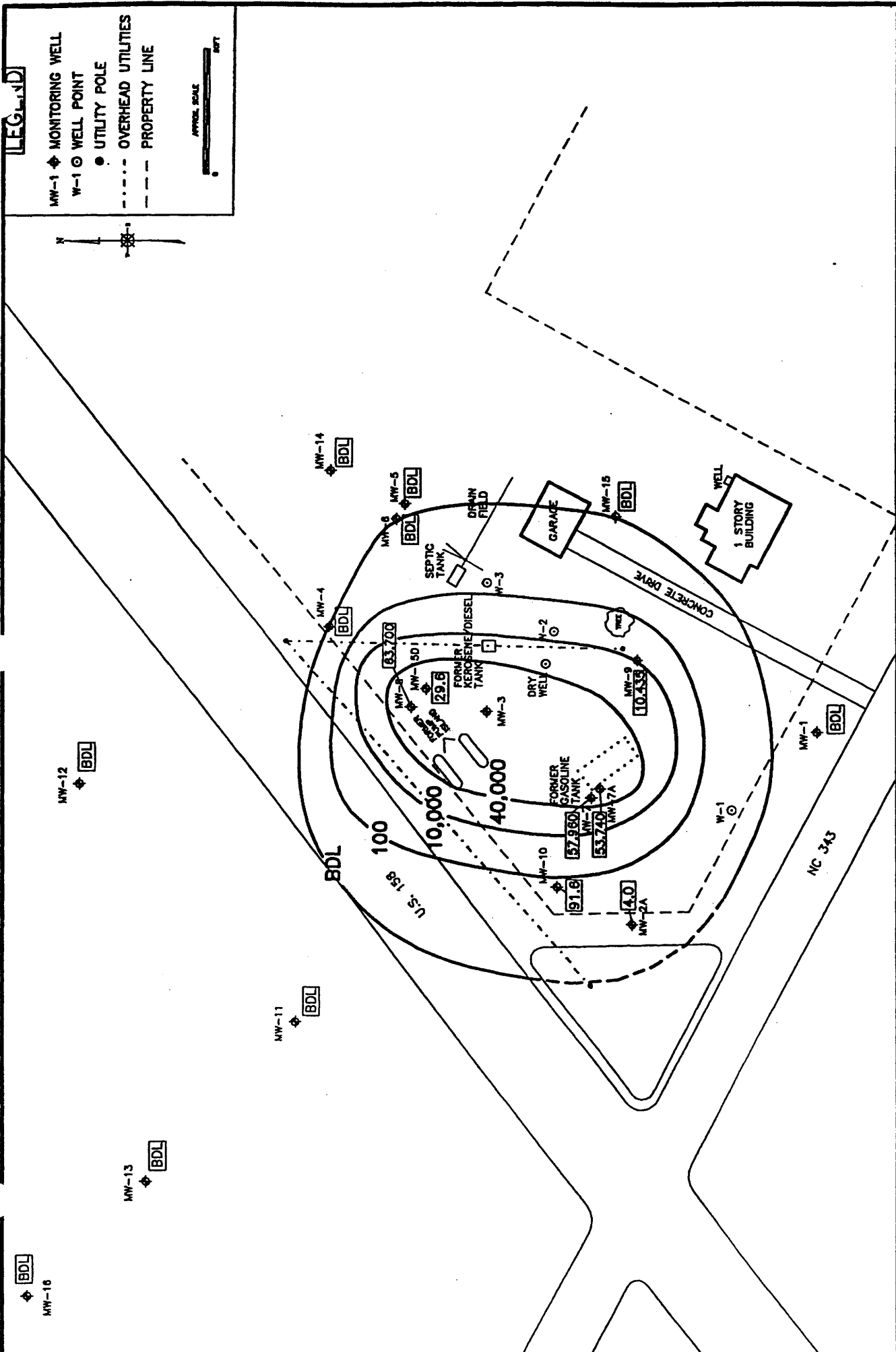
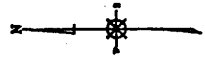
CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO. 7
FIGURE NAME: DISSOLVED MTBE ISOCONCENTRATION MAP (ug/L)

OMEGA ENVIRONMENTAL SERVICES

LEGEND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE


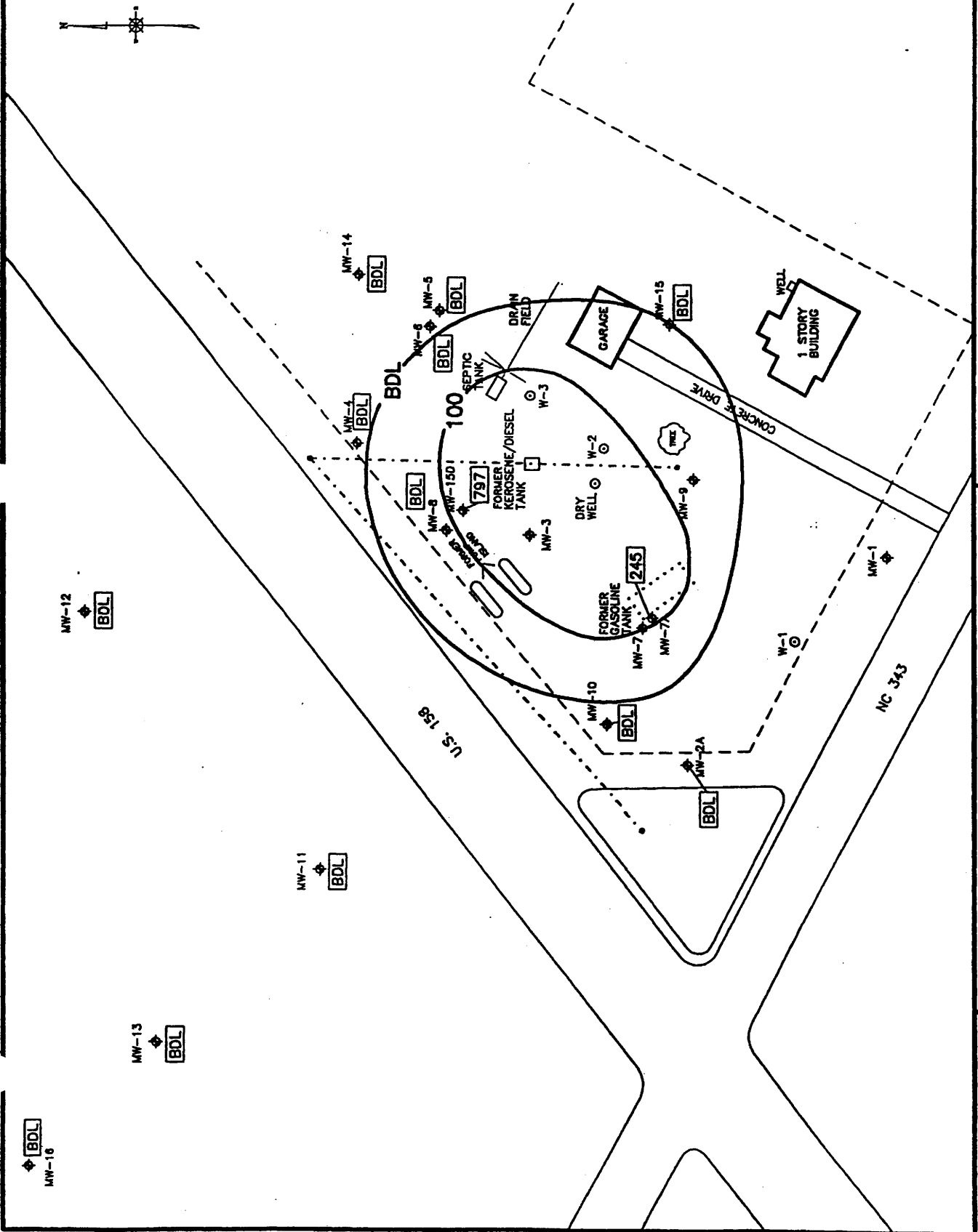
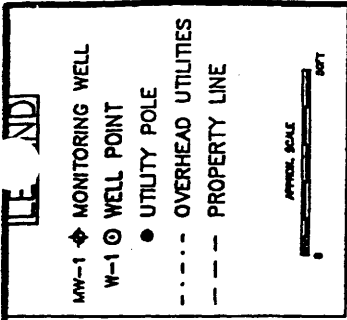


OMEGA
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 SERVICES

FIGURE NO.: 8
 FIGURE NAME: DISSOLVED BTEX ISOCONCENTRATION
 MAP (ug/L)

CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
 DATE: 9/97



JOB NO: 97-095
DATE: 9/97

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 9
FIGURE NAME: RESIDUAL PHASE TOTAL PETROLEUM HYDROCARBON PLUME MAP

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| Table 3. Ground Water Analytical Results | | | | | |
|--|---------------------|---------------------|--------------------------|---------------------------|----------------------|
| Location | Benzene** (ug/l) | Toluene** (ug/l) | Ethylbenzene** (ug/l) | Xylenes** (ug/l) | Total BTEX (ug/l) |
| MW - 1 | BDL | BDL | BDL | BDL | BDL |
| MW-2A | BDL | BDL | BDL | BDL | BDL |
| MW - 4 | BDL | BDL | BDL | BDL | BDL |
| MW - 5 | BDL | BDL | BDL | BDL | BDL |
| MW-7 | 20.600* | 23.100* | 2.560* | 11.700* | 57.960 |
| MW-7A | 17.100* | 21.600* | 1.840* | 13.200* | 41.860 |
| MW - 8 | 21.900* | 27.800* | 1.800* | 12.200* | 63.700 |
| MW - 9 | 1.230* | 5.530* | 765* | 2.910* | 10.435 |
| MW - 10 | 13.0* | 2.2 | 20.3 | 56.1 | 91.6 |
| MW - 11 | BDL | BDL | BDL | BDL | BDL |
| MW - 12 | BDL | BDL | BDL | BDL | BDL |
| MW - 13 | BDL | BDL | BDL | BDL | BDL |
| MW - 14 | BDL | BDL | BDL | BDL | BDL |
| MW-15 | BDL | BDL | BDL | BDL | BDL |
| MW - 15D | 6.0* | 13.0 | 1.6 | 9.0 | 29.60 |
| MW-16 | BDL | BDL | BDL | BDL | BDL |
| MW-17 | BDL | BDL | BDL | BDL | BDL |
| SW-1 | BDL | BDL | BDL | BDL | BDL |
| Location | MPBE** (ug/L) | Lead** (mg/L) | Naphthalene (ug/L) | Isopropyl Ether (ug/L) | |
| MW-1 | BDL | BDL | BDL | BDL | |
| MW-2A | BDL | 0.074* | 620 | BDL | |
| MW-4 | BDL | BDL | BDL | BDL | |
| MW-5 | BDL | BDL | BDL | BDL | |
| MW-7 | 3.400* | 0.013 | 710 | BDL | |
| MW-7A | 2.000* | 0.019* | BDL | BDL | |
| MW-8 | 12.300* | 0.200* | 425 | BDL | |
| MW-9 | BDL | BDL | 100 | BDL | |
| MW-10 | 75 | BDL | 10 | BDL | |
| MW-11 | 72 | BDL | BDL | BDL | |
| MW-12 | BDL | BDL | BDL | BDL | |
| MW-13 | 170 | BDL | BDL | BDL | |
| MW-14 | BDL | BDL | BDL | BDL | |
| MW-15 | BDL | 0.023* | BDL | BDL | |
| MW-15D | 3.0 | BDL | BDL | BDL | |
| MW-16 | 253 | 0.151* | BDL | BDL | |
| MW-17 | BDL | BDL | BDL | BDL | |
| SW-1 | BDL | BDL | BDL | BDL | |

Note: ug/l = micrograms per liter. Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

Appendix C - Laboratory Reports and Chains of Custody provides the back-up information and documentation from the laboratory for the above table.

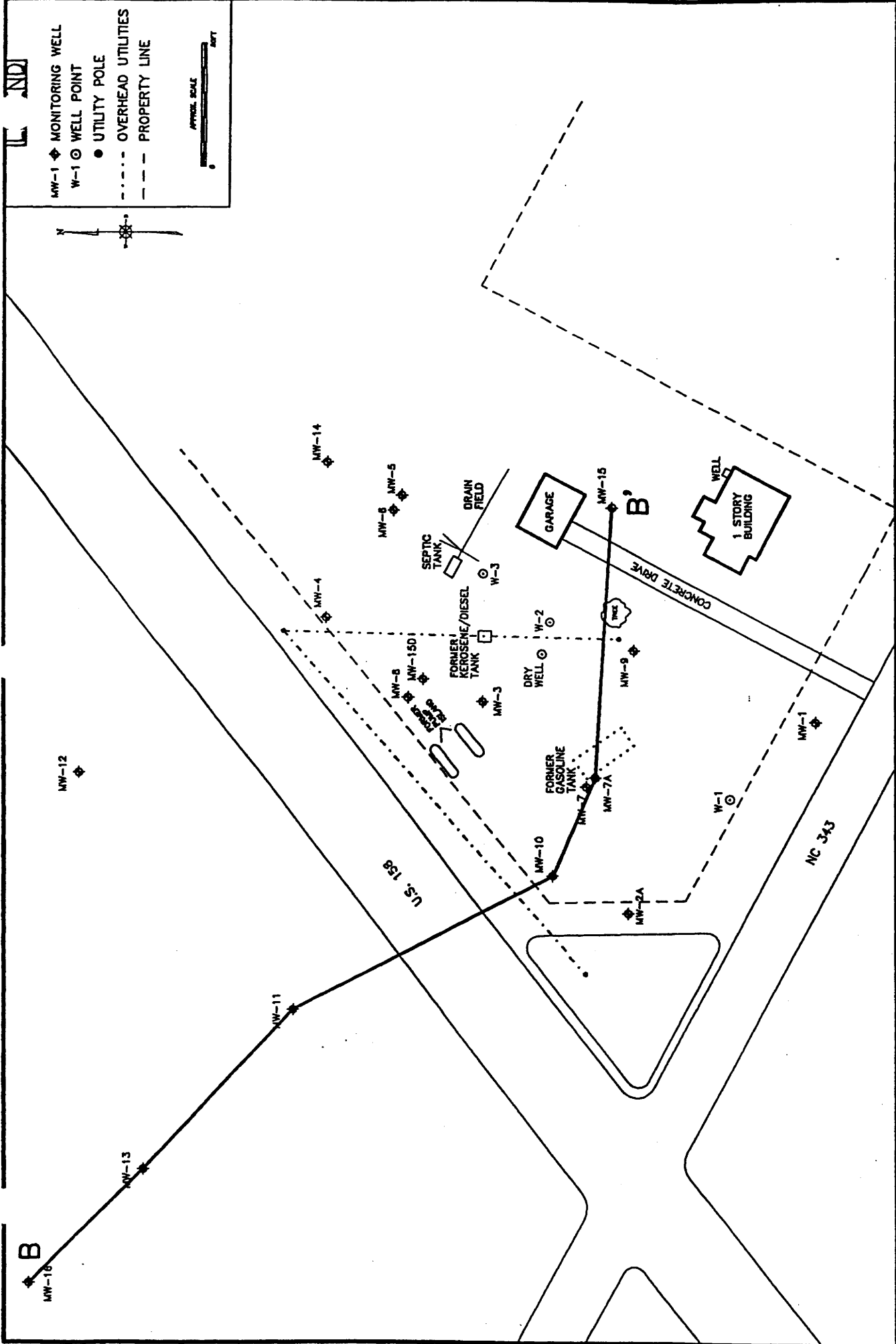
For the purposes of representing the relationships of geology to the vertical extent of the petroleum hydrocarbon plumes, a second cross-section of the site perpendicular to the direction of ground water flow was prepared. Figure 10 - Aerial View of Cross-Section B-B' depicts horizontal location of the vertical cross-sections. Figure 11 - Cross-Section B-B' depicts the geology without the plume overlay.

The residual phase has previously been described in other investigations. Most notably in the Site Assessment Report prepared by Solutions and submitted to the Hollowell Oil Company in December 1992. Appendix D - Previous Analytical Results contains information from previous investigations. Omega collected soil samples from the split spoons advanced during drilling; however, only the composite sample collected from the deep well (MW-15) contained detectable concentrations of TPH-GRO or TPH-DRO. Omega did not feel that comparing residual soil analytical results across a five year time span would be representative of the residual phase on-site currently. Furthermore, excavation of soils in the area of the Hollowell USTs and the orphan USTs has occurred since Solutions prepared their 1992 report.

4.4 DUAL PHASE EXTRACTION PILOT STUDY

The Dual Phase Extraction technology utilizes a liquid ring pump (oil sealed) generating high vacuum pressures (20-29 inches of mercury) to simultaneously extract dissolved phase, free phase and vapor phase hydrocarbon contaminants from the vadose and saturated zones utilizing multiple extraction wells. Capital expenditures for Dual Phase Extraction technology is typically half that of pump and treat systems. Guidelines suggest in many cases this technology has proven to be an effective and efficient means of remediation for sites with multiple phase petroleum contamination. According to North Carolina Guidelines, depending on depth to water and conductivity of the aquifer, Dual Phase Extraction technology may enhance ground water yield 2 to 6 fold compared to conventional stand alone pumping systems. This is accomplished by utilizing water and air as a medium of constituent transport and extraction under an applied high pressure vacuum. The extracted ground water is treated above ground by conventional air-stripping methods while soil gas is vented to the atmosphere.

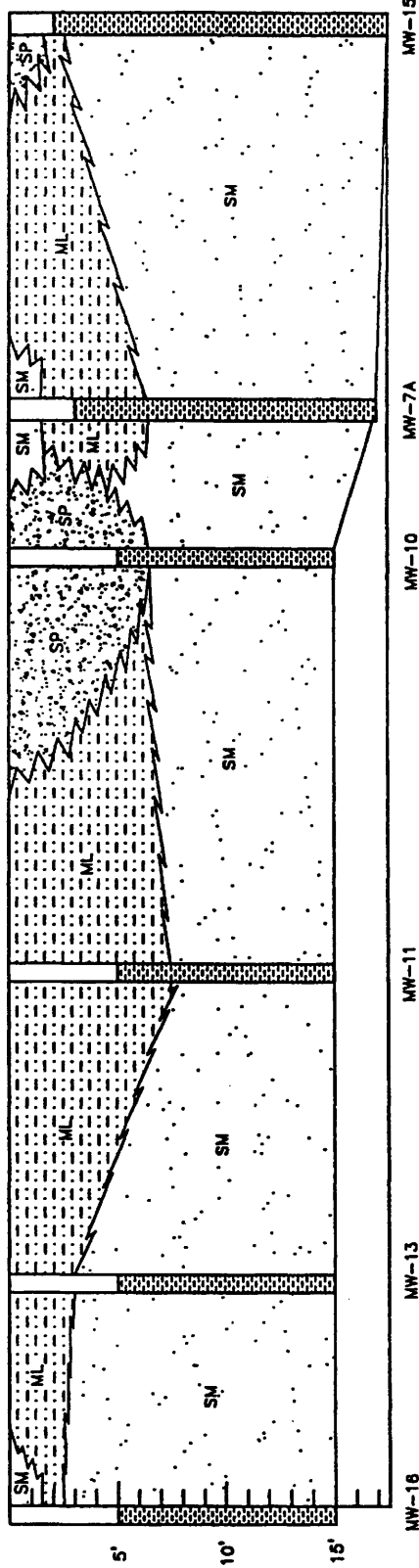
On November 11, 1997, Omega mobilized to the Camden site to perform the Dual Phase Extraction Pilot Study. Results of the pilot study indicated conditions suitable for utilization of the Dual Phase Extraction technology. Data obtained during the pilot study indicated influenced vacuum pressures up to 2.4 inches of H₂O approximately 25 feet up-gradient, 0.70 inches of H₂O approximately 55 feet up-gradient and 0.015 inches of H₂O approximately 30 feet down-gradient from the vacuum source. Approximately 100 gallons of product/water mix was recovered during the four hour event. An average value of 10,000 + PPM was recorded throughout the duration of the event. Using the calculation for PMR given in the North Carolina Soil and Ground Water Guidelines, a calculated 0.244 gallons of product was emitted from the system's exhaust during the event, at a rate of 0.061 gallons per hour. Additional information obtained during the pilot study should be utilized in the development of a Corrective Action Plan for this site.



| | | | |
|--|---|--|--------------------------------------|
| <p>OMEGA ENVIRONMENTAL SERVICES</p> | <p>FIGURE NO. 10 FIGURE NAME: AERIAL VIEW OF CROSS-SECTION B-B'</p> | <p>CLIENT: HOLLOWELL OIL COMPANY SITE: HOLLOWELL OIL CO., CAMDEN, NC</p> | <p>JOB NO: 97-095 DATE: 9/97</p> |
|--|---|--|--------------------------------------|

KEY
 SP - - POURLY GRADED SAND
 SM - - SILTY SAND
 ML - - SILT

APPROX. HORIZONTAL
 SCALE
 0 50



| RESIDUAL TPH (mg/Kg) | RESIDUAL BENZENE (ug/L) | MW-18 | MW-13 | MW-11 | MW-10 | MW-7A | MW-15 |
|-------------------------|----------------------------|-------|-------|-------|-------|--------|-------|
| BDL | BDL | BDL | BDL | BDL | BDL | 244.9 | BDL |
| BDL | BDL | BDL | BDL | BDL | 13.0 | 17,100 | BDL |

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FIGURE NO.: 11

FIGURE NAME: CROSS SECTIONAL AREA B - B'

CLIENT: HOLLOWELL OIL COMPANY

SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095

DATE: 9/97

During the Dual Phase Extraction pilot study, free product was observed in MW-8. The free product measured approximately 0.02' and appears to be limited to the area of MW-8. Using the Dual Phase Extraction technology free product will be recovered along with other dissolved and residual phase petroleum compounds. Appendix E - Dual Phase Extraction Pilot Study-Pollutant Mass Removal (PMR) Calculations, Field Data and Disposal Manifests, contains the supporting information regarding the pilot study. Figure 12 - Radius of Influence Map depicts the observed vacuums at the monitoring well points during the Dual Phase Extraction Pilot Study.

4.5 HYDROGEOLOGY

On May 19, 1997 Omega received a Well Construction Permit (Permit #WM0700314) from the Division of Water Quality (Appendix F - Permits). On June 12, 1997 a rising head slug test was performed on monitor wells MW-9 and MW-13 during on-site investigations to help define aquifer characteristics at the site. Aquifer characteristics were evaluated using the AQTESOLV™ Program utilizing equations by Bouwer-Rice for partially penetrating wells in an unconfined aquifer system. Input data for AQTESOLV™ and a graph of the slug test data are included in Appendix G - Slug Test Data. Hydraulic conductivity (K) in feet per year (ft./yr.) was calculated (Table 4):

$$K = \frac{r_c^2 \ln(R_e / R_w)}{2L_e} \frac{1}{T} \ln \frac{y_o}{y_t}$$

where:

| | | |
|-------------------|---|---|
| K | = | Hydraulic Conductivity (ft./year) |
| r _c | = | Radius of well casing (ft.) |
| R _e | = | Effective Radial distance of drawdown |
| R _w | = | Radius of bore hole (ft.) |
| L _e | = | Length of screened portion of aquifer (ft.) |
| y _o | = | Initial drawdown of water in well (ft.) |
| y _t | = | Drawdown of water in well at time t (ft.) |
| ln R _e | = | Calculated from graphs, Bouwer & Rice |
| T | = | Time |

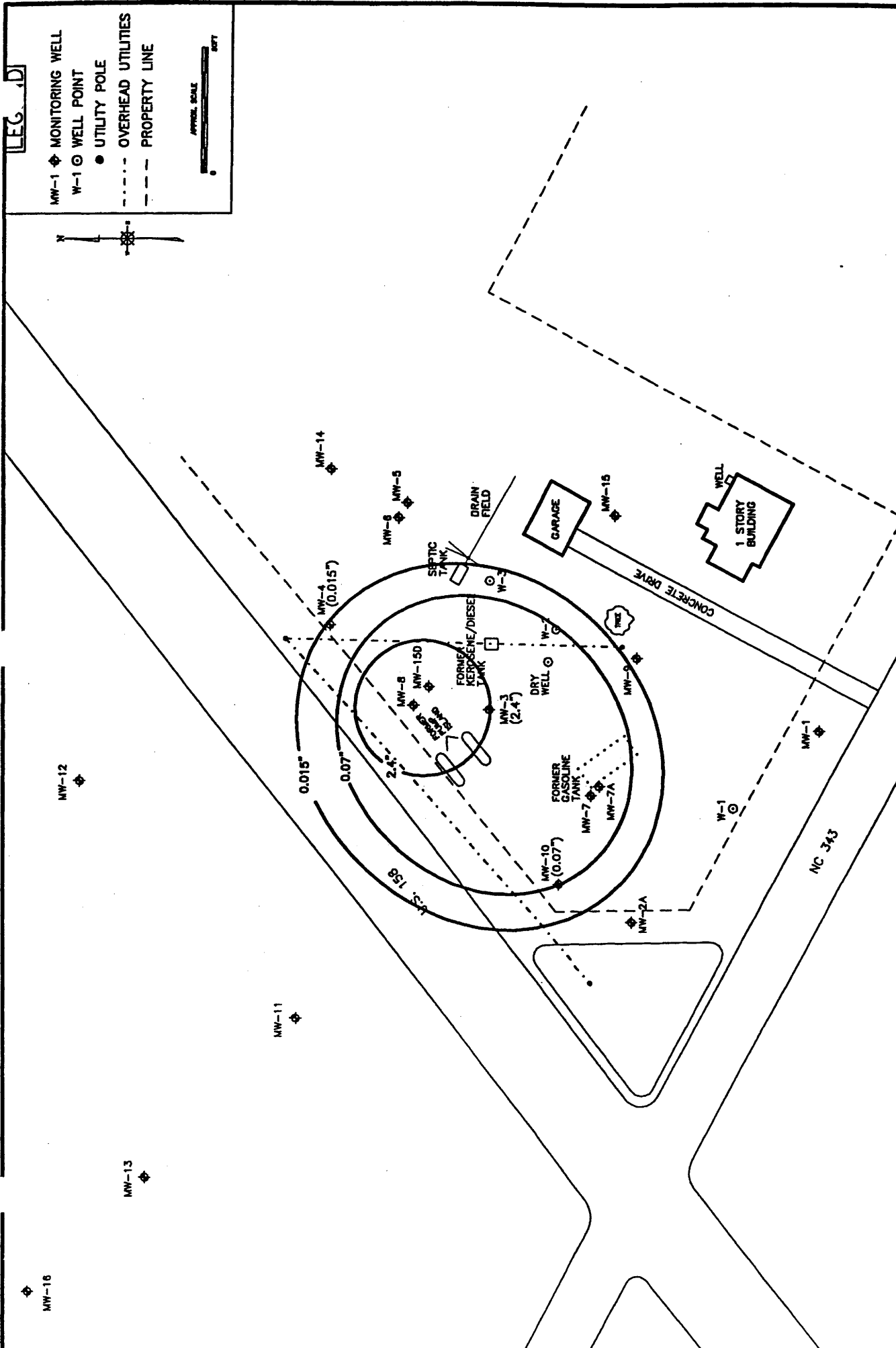
| TABLE 4. Data for Calculating Hydraulic Conductivity (K) | | | | | | |
|--|----------------|----------------|----------------|----------------|----------------|------------|
| Well | r _c | R _w | L _e | y _o | y _t | time (min) |
| MW-9 | 0.083 ft. | 0.33 ft. | 10.0 ft. | 5.56 ft. | 3.66 | 20.0 |
| MW-13 | 0.083 ft. | 0.33 ft. | 10.0 ft. | 1.63 ft. | 0.04 | 12.5 |

Utilizing this formula, the average hydraulic conductivity was determined to be 297.6 ft./yr. The transmissivity (T) of the aquifer is equivalent to 1.49 x 10⁴ ft.²/yr. (with a saturated zone of 50.0 feet). The hydraulic gradient for the site is approximately 0.014 ft./ft., sloping towards the north northeast.

The velocity of ground water movement in the aquifer was calculated using the following equation (Freeze & Cherry, 1979):

LEG. D

- MW-1 ◆ MONITORING WELL
 - W-1 ⊙ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
50 FT



JOB NO: 97-095

DATE: 11/18/97

CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 12
 FIGURE NAME: RADIUS OF INFLUENCE MAP
 (2.4', 0.07', 0.015" H₂O)

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$$V = \frac{K}{n} \frac{dh}{dl}$$

where: V = rate of ground water flow (ft/yr.)
 $\frac{dh}{dl}$ = water table gradient (ft/ft)
 K = hydraulic conductivity (ft/yr.)
 n = estimated porosity factor (unitless)

The ground water flow rate (interstitial velocity) at the site was calculated using a typical porosity of 30 percent for sand ("Basic Ground Water Hydrology," Water Supply Paper 220, U.S.G.S.). The flow rate was determined to be 13.9 ft/yr. Table 5 lists the calculated aquifer parameters.

| Parameter | Value |
|--|------------------------|
| Hydraulic Conductivity (ft/year) | 297.6 |
| Transmissivity (ft ² /year) | 1.49 x 10 ⁴ |
| Interstitial Velocity (ft/year) | 13.9 |
| Hydraulic Gradient (ft/ft) | 0.014 |

4.6 RISK MODELING

The software package SOLUTE, distributed by the International Groundwater Modeling Center at Boulder, Colorado, was selected to model the constituent transport and fate at the site, and to determine the dissolved phase constituent levels affecting potential receptors.

SOLUTE can model transport and fate in one or two dimensions. Because the length and width of an aquifer generally exceeds the thickness greatly, the aquifer thickness (third dimension) can be ignored in practicality. For the purposes here, a one-dimensional model was chosen. The one-dimensional model assumes that hydrocarbon transport is concentrated along a narrow path toward the receptor. Because no lateral dispersion is assumed, the result is a maximum constituent concentration at the receptor, and the result is a conservative worst-case scenario. One-dimensional transport can be modeled by the following equation (van Genuchten and Alves, 1982):

$$\frac{\partial c}{\partial t} = D * \frac{\partial^2 c}{\partial x^2} - V * \frac{\partial c}{\partial x} - k * c$$

where:

| | | |
|----------------|---|--|
| c | = | constituent concentration (Mg/L) |
| t | = | time |
| D* | = | D/R |
| R | = | 1 + K _D (ρ/e) |
| V* | = | V/R |
| k* | = | k/R |
| D | = | dispersion coefficient (ft ² /year) |
| V | = | average interstitial pore-water velocity (ft/year) |
| k | = | degradation rate coefficient (year ⁻¹) |
| ρ | = | bulk density (g/cm ³) |
| e | = | effective porosity |
| K _D | = | distribution coefficient of constituent |

R represents the retardation factor, which gives the transport rate of a given hydrocarbon relative to ground water flow. R is dependent upon the chemical characteristics of the hydrocarbon and, for non-polar organic compounds such as BTEX, the organic carbon content, f_{oc}, of the aquifer medium. K_D is calculated as follows:

$$K_D = f_{oc} (K_{oc}/0.63)$$

K_{oc} is the organic carbon distribution coefficient and is obtained from chemical tables in the literature. Some characteristics of the BTEX compounds are listed in Table 6. Benzene is selected as a conservative proxy to model TPH because it is on the more soluble and mobile end of the TPH hydrocarbon range.

| TABLE 6. Chemical Characteristics of Selected Hydrocarbons | | | |
|--|-------------------|------------------|-------------------|
| Compound | Solubility (Mg/L) | K _{oc} | Half-life (year) |
| Benzene | 1780 ¹ | 97 ¹ | 1.19 ² |
| Toluene | 500 ¹ | 242 ¹ | 0.39 ³ |
| Ethyl Benzene | 150 ¹ | 622 ¹ | - |
| O-Xylene | 170 ¹ | 363 ¹ | 0.32 ³ |
| P-Xylene | 156 ¹ | 552 ¹ | 0.17 ³ |
| M-Xylene | 146 ¹ | 588 ¹ | 0.29 ³ |
| References: ¹ Roy and Griffin (1985), ² Dragun (1988), ³ Sims, et al (1991) | | | |

Ground water velocity was calculated from slug test data as described above. The assumption is that the aquifer characteristics between the site and the receptor are similar to those on-site.

Dispersivity is a statistical parameter that accounts for inhomogeneities in the aquifer that could result in increased ground water transport, but at a correspondingly lower concentration at initial impact. Theoretically, the Dispersivity is equal to one-tenth of the hydrocarbon transport distance. In an attempt to produce an empirical relationship between Dispersivity and transport distance, Luckner and Schestakow (1991) presented the following equation:

$$\alpha = (0.03X^{+0.3})(X^{-0.075})$$

where X is the distance traveled by constituents.

In practice, the calculation of Dispersivity is about one-hundredth of the transport distance. The higher the value used for Dispersivity, the quicker the constituents move to the receptor, but the lower the maximum constituent level to impact the receptor. Not taking the Dispersivity into account results in a higher maximum impact at a later point in time.

Benzene is usually the compound modeled because published benzene characteristics are available for fate transport modeling, and because benzene is one of the most toxic compounds and the most mobile compound in gasoline. However, total BTEX concentrations are used in the SOLUTE modeling to present a model more representative of the site conditions.

The source in this model is well MW-8 which has the highest Benzene concentrations. Observation point one represents the property boundary located approximately 5 feet from the source; observation point three represents the Gordon's well located approximately 150 feet away from MW-8, while observation point four represents the unnamed tributary located approximately 350 feet from MW-8. Observation points two (50 feet) and five (500 feet) were chosen as arbitrary points to model (Table 7 - SOLUTE Transport and Fate Model Input Data).

Petroleum hydrocarbon transport and fate is often incorrectly modeled solely on ambient dissolved phase levels alone at a given site. This can yield implausibly low concentrations at a receptor because residual phase impact can serve as a continuing source even after more obvious sources, such as leaking tanks or line, have been removed. To account for this, the duration of the petroleum pulse was assumed to continue for the entire length of the observation time.

A hydrocarbon half-life of 1.19 years was chosen to model Benzene. Although biodegradation is expected to be effective at the hydrocarbon source as well, this parameter was ignored in the calculations to arrive at a more conservative result.

Any number of other reactions and transformations in the subsurface exist that will lower constituent concentrations. Given the amount and type of data available at a typical UST site, quantification of many of these parameters is not generally possible. Some of these include mechanical mixing of the BTEX plume with the non-impacted aquifer which will lower concentrations by dilution. Molecular diffusion is of such small scale compared with other processes that it may be effectively ignored. Adsorption and Absorption of constituents on aquifer material, including organic carbon, during transport will lower concentration levels. Chemical reactions include biochemical transformations, such as biodegradation, and physical transformations, such as hydrolysis. Not taking any or all of these processes into account yields a result that is more conservative than what would actually be expected, and therefore represents a worst case scenario. No natural subsurface processes exist that will cause constituent concentrations to increase.

Using the calculated ground water flow velocity of 13.9 ft./yr. obtained from the slug test conducted at the site, the Benzene plume will migrate past the property boundary as suggested by the SOLUTE model. The plume should migrate past the property boundary in the first year at a concentration of 17.68 Mg/L Benzene. The impact is predicted by the SOLUTE model to rise to a concentration of 17.9 Mg/L of Benzene at the property boundary. This concentration exceeds the NCGWS of 0.001 Mg/L for Benzene.

The SOLUTE model predicts that impact to the well receptor will occur at seven years at a concentration of 0.00004 Mg/L, well below the North Carolina Ground Water Standards. The maximum impact occurs in the sixteenth year at a concentration of 0.052 Mg/L, above the North Carolina Ground Water Standard.

The SOLUTE model predicts that impact to the surface water receptor will occur at twenty four years at a concentration of 0.00001 Mg/L, well below the North Carolina Ground Water Standards. The maximum impact occurs in the thirty-first year at a concentration of 0.000016 Mg/L, below the North Carolina Ground Water Standard. Table 7 lists the final input data and parameters used in the model.

| TABLE 7. SOLUTE Transport and Fate Model Input Data | | |
|---|-------------|-------|
| Parameter | Unit | Value |
| Ground water Velocity | (feet/year) | 13.9 |
| Longitudinal Dispersivity | (feet) | 1 |
| Retardation Factor | - | 1 |
| Initial Concentration at Receptor | (Mg/L) | 0.0 |
| Concentration at Source | (Mg/L) | 21.9 |
| Length of Time Step | (year) | 1 |
| Number of Time Steps | - | 50 |
| Number of Observation Points | - | 5 |
| Observation Point 1 Distance (Property Boundary) | (feet) | 5 |
| Observation Point 2 Distance (Arbitrary) | (feet) | 50 |
| Observation Point 3 Distance (Gordon Well) | (feet) | 150 |
| Observation Point 4 Distance (Unnamed Tributary) | (feet) | 350 |
| Observation Point 5 Distance (Arbitrary) | (feet) | 500 |
| Petroleum Pulse Duration | (year) | 50 |
| Constituent Half-Life | (year) | 1.19 |

Using a ground water velocity obtained from the slug test, Benzene concentrations in MW-8 are representative of actual field conditions. In addition, the model suggests that impact to the Gordon well will occur; however, the dissolved phase Benzene plume is not likely to migrate to the unnamed tributary at a concentration greater than the NCGWS (Table 8. Potential Receptors and Levels of Impact). SOLUTE output is included in Appendix H - SOLUTE Fate and Transport Modeling Results.

| TABLE 8. Potential Receptors and Levels of Impact | | | | | |
|--|----------|----------|----------|----------|----------|
| Observation Points | 1 | 2 | 3 | 4 | 5 |
| Distance (feet) from Source (MW-8) | 5 | 50 | 150 | 350 | 500 |
| Initial Impact (year) | 1 | 2 | 7 | 24 | NI* |
| Maximum Impact (year) | 3 | 7 | 16 | 31 | NI* |
| Maximum Benzene Concentration (Mg/L) | 17.90 | 2.92 | 0.052 | 0.000016 | NI* |
| *NI - No Impact | | | | | |

Appendix I - Copies of Correspondence contains pertinent letters from the NCDEHNR. Appendix J - GW-100 (CSA) has the signed GW-100 form and Appendix K - Limitations states Omega acceptable liability regarding this report.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This site has impact from petroleum hydrocarbons which could impact local area potable wells. The MTBE dissolved plume has migrated off-site to within 100 feet of a potable well. Analytical results indicated that the off-site potable well (SW-1) has not been impacted by the MTBE plume. The other petroleum compounds appear to be limited to the sub-surface under the site. Free product appears to be limited to the area of MW-8. Omega concludes that the MTBE constituents date a release to the late seventies or later. However, additional release(s) have occurred on this site unrelated to the USTs owned and operated by Hollowell Oil Company. Evidence of this fact is: extensive impact around the orphan gasoline UST which is up-gradient from an apparent release point at the former pump islands, the presence of diesel range organics (diesel or kerosene) and the historic use of the property as a petroleum distribution retail facility.

Based on data obtained during the Dual Phase Extraction Pilot Study, Omega recommends implementation of Dual Phase Extraction technology. This recommendation is based upon an effective vacuum influence, high PPM emission concentrations and lower capital costs associated with the technology. Implementation of this technology would effectively recover the free product at MW-8 as well as address the dissolved and residual phase petroleum compounds limited to the subsurface under the site. Additional information obtained during the pilot study should be utilized in the design and development of a corrective action plan for the site.

Preliminarily, Omega is considering the use of a mobile Dual Phase Extraction system to remediate the site. The advantages of this type of system are:

1. Low capital costs,
2. no installation time required,
3. limited permitting is necessary,
4. residual, vapor, and dissolved phase are remediated simultaneously,
5. free product, if present, can also be collected.



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D. E. M.

CORRECTIVE ACTION PLAN

**Hollowell Site
Hwy. 158 & Hwy. 343
Camden, North Carolina
Groundwater Incident No. 6309
Incident Rank "185-B"**

Submitted to:

**Scott Bullock
NCDENR - Division of Water Quality
Washington Regional Office
943 Washington Square Mall
Washington, North Carolina 27889
(919) 946-6481**

Prepared for:

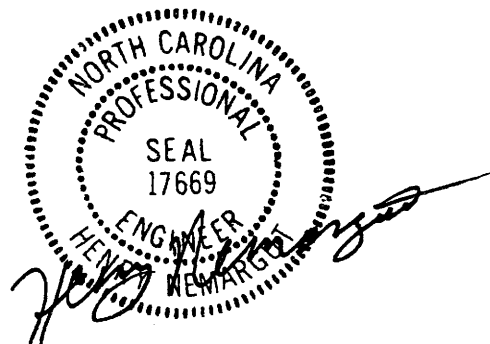
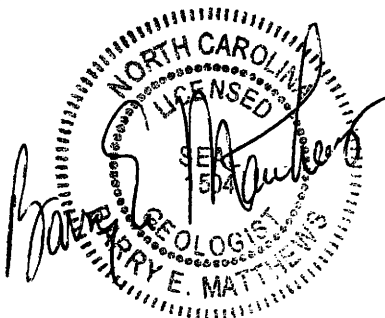
**Mr. Russell Hollowell
Hollowell Oil Company
P.O. Box 237
Winfall, North Carolina 27429
(919) 426-5745**

Prepared by:

**Jason Johnson
Omega Environmental Services
3619 Hobbs Road
Greensboro, North Carolina 27410
(336) 286-3337**

Omega Project # 97-095

May 10, 1998





May 10, 1998
Omega Project # 97-095

Mr. Russell Hollowell
Hollowell Oil Company
P.O. Box 237
Winfall, North Carolina 27985

Reference: Corrective Action Plan
Hollowell Site
Highway 158 and Highway 343
Camden, North Carolina
PIRF # 6309

Dear Mr. Hollowell:

Omega Environmental Services has completed a Corrective Action Plan for the Hollowell site located at the above-referenced location.

Please find enclosed a copy of the Corrective Action Plan which fully details the technical services and findings of the investigation. If you have questions regarding the report, or if we can be of further assistance, please contact the undersigned at (336) 286-3337.

Sincerely,

OMEGA ENVIRONMENTAL SERVICES

Jason Johnson
Project Geologist

Barry Matthews, P.G.
Senior Project Geologist

cc: Scott Bullock, NCDWQ

EXECUTIVE SUMMARY

The subject property is owned by Mr. Glenn Gordon. The property was leased to Hollowell Oil Company, which maintained a self-service gasoline dispensing operation from 1977 to 1989. The gasoline dispensing system included three gasoline UST's, piping and a pump island. The three gasoline UST's utilized on this site by Hollowell Oil Company were removed from the site in 1989. Solutions Environmental Associates, investigated the site in 1991 and in 1992. These investigations revealed the presence of petroleum constituents in the soils surrounding the removed UST's and the former pump island. In 1991, Solutions conducted soil excavation activities at the site to remove petroleum impacted soils. At that time, Solutions discovered two "orphan" UST's. Law Engineering and Environmental Services was contracted by the State of North Carolina to conduct further investigations at this site. In November 1996, Law submitted an "Environmental Assessment Activities" report and in January 1997, Law submitted an Underground Storage Tank Closure report.

This site has impact from petroleum hydrocarbons which could impact local area potable wells. The MTBE and Benzene dissolved plumes have already migrated off-site. The other petroleum compounds appear to be limited to the sub-surface under the site. Omega concludes that the MTBE constituents date a release to the late seventies or later. However, additional release(s) have occurred on this site unrelated to the UST's owned and operated by Hollowell Oil Company. Evidence of this fact is: extensive impact around the orphan gasoline UST which is up-grading from an apparent release point at the former gasoline pump islands, the presence of diesel range organics (diesel or kerosene) and the historic use of the property as a petroleum distribution retail facility.

The investigations conducted for the CSA Addendum revealed that the MTBE plume has migrated further down-gradient than the data from the CSA revealed. Monitoring Well MW-16 is located approximately 300 feet from the former pump island and had a reported concentration of MTBE of 253 ug/L. At the request of the DWQ on 10/13/97 Omega installed MW-17 approximately 45 feet further down-gradient from MW-16 to define the extent of the MTBE plume. Analytical results obtained from sampling MW-17 and supply well SW-1 indicated BDL MTBE concentrations. Results from the CSA and Addendum's investigations also revealed, the area around MW-7 and MW-7A, the location of the "orphan" gasoline UST, is impacted with elevated concentrations of residual (797 mg/Kg TPH-volatiles) and dissolved phase petroleum hydrocarbons (53,240 ug/L Total BTEX). This UST was unrelated to Hollowell Oil ownership, and appears to be a significant source of dissolved phase petroleum hydrocarbons.

Regardless of the responsible party or the number of releases which have occurred at this site, Omega recommends implementation of Dual Phase Extraction (DPE) utilizing Liquid Ring technology. The pilot study conducted on November 11, 1997, showed effective vacuum influence while yielding high PPM emission concentrations. The technical advantages and feasibility of DPE technology suggests a favorable remedy for the soil and groundwater contamination at the Hollowell site. Implementation of this technology would effectively recover the free product at MW-8 as well as address the dissolved and residual phase petroleum compounds limited to the subsurface under the site. Regarding the off-site and deeper contamination Omega, recommends remediation by natural attenuation and degradation. Natural attenuation appears to be the most cost effective approach for remediating the off-site and deeper contamination.

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- Appendix D - Equipment Information and Specifications
- Appendix E - Certified Letters for Public Notification
- Appendix F - Limitations
- Appendix G - Certification for Submittal of a Corrective Action Plan

1.0 INTRODUCTION

1.1 SITE LOCATION AND DESCRIPTION

The subject property is owned by Mr. Glenn Gordon. Mr. Gordon has owned the property approximately ten years. According to Mr. Gordon his family has owned the property since the turn of the century. Local residents have indicated that several retail gasoline facilities have operated at this site since the late 20s. Mr. Gordon indicated that "Texaco" may have had a service station on the site in the 20s or 30s.

The "Hollowell Site" is located at the intersection of Hwy. 158 and Hwy. 343 in Camden, North Carolina (Figure 1 - Site Vicinity Map). The property was leased to Hollowell Oil Company, which maintained a self-service gasoline dispensing operation from 1977 to 1989 (Figure 2 - Detailed Site Map). The gasoline dispensing system included three gasoline UST's (underground storage tanks), piping and a pump island. The three gasoline UST's utilized on this site owned by Hollowell Oil Company were removed in 1989. Solutions Environmental Associates investigated the site in 1991 and in 1992. These investigations revealed the presence of petroleum constituents in the soils surrounding the removed UST's and the former pump island. In 1991, Solutions also conducted soil excavation activities at the site to remove the petroleum impacted soils. At that time, Solutions discovered two "orphan" UST's.

1.2 PURPOSE OF THIS CAP

The purpose of this CAP is to respond to the soil and ground water contamination found beneath the site, which have exceeded the North Carolina Reportable Limits for soils and the North Carolina Ground Water Standards (NCGWS).

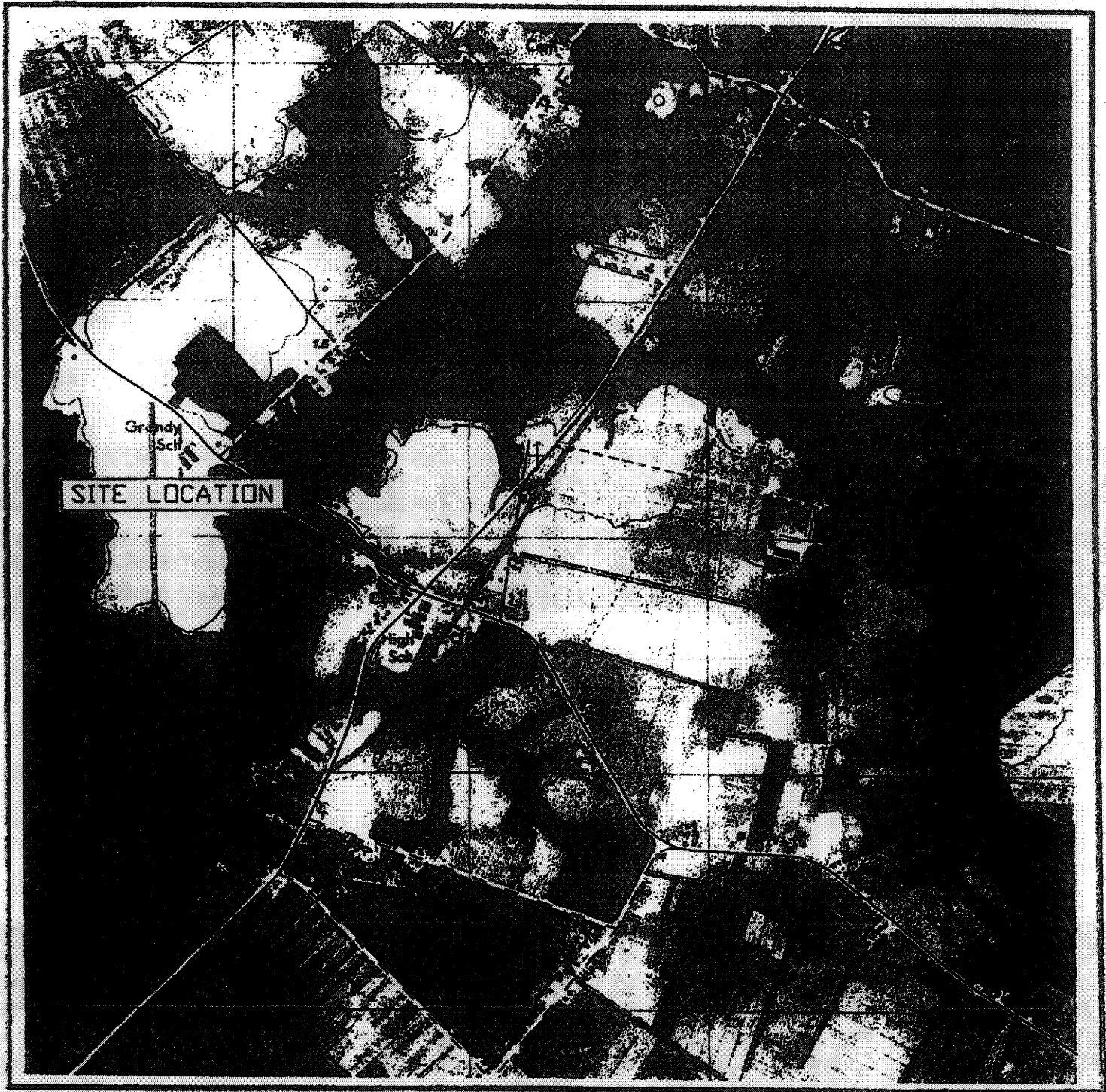
The source of the contamination is the UST basin and the area around the dispensers. During follow-up investigations additional contamination was located around two suspect "orphan" UST's not associated with Hollowell Oil Co.

Groundwater contaminants exceeding 2L standards include benzene, (concentrations up to 21,900 ug/l, at MW-8) toluene, (concentrations up to 27,800 at MW-8) MTBE, (concentrations up to 12,300) BTEX, (concentrations up to 63,700 at MW-8) and lead (concentrations up to .0200 at MW-8). During the most recent sampling event, free product was located at MW-8 at a measurable thickness of approximately 1/8 of an inch. Hydrocarbon concentrations also exceed NCGWS in MW-7a, MW-3, MW-11 and MW-15D

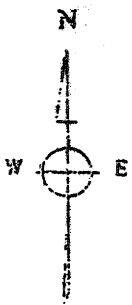
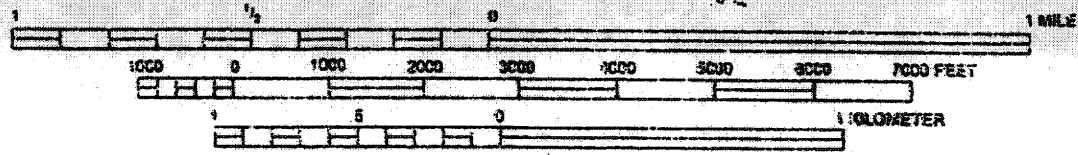
The ground water in the vicinity of the site is used as a water supply for humans. Therefore, the ground water impacted by incident # 6309 would be classified as GA ground waters.

1.3 INITIAL REMEDIAL ACTIONS TO DATE

Solutions Environmental Associates conducted a "Preliminary Site Assessment" for this site in 1991. The report was submitted to Mr. Russell Hollowell on May 2, 1991. This investigation reported that petroleum hydrocarbons were detected in the soils at the site. These petroleum hydrocarbons were reported by the laboratory to be both diesel/kerosene and weathered gasoline. Solutions also excavated petroleum



SITE LOCATION

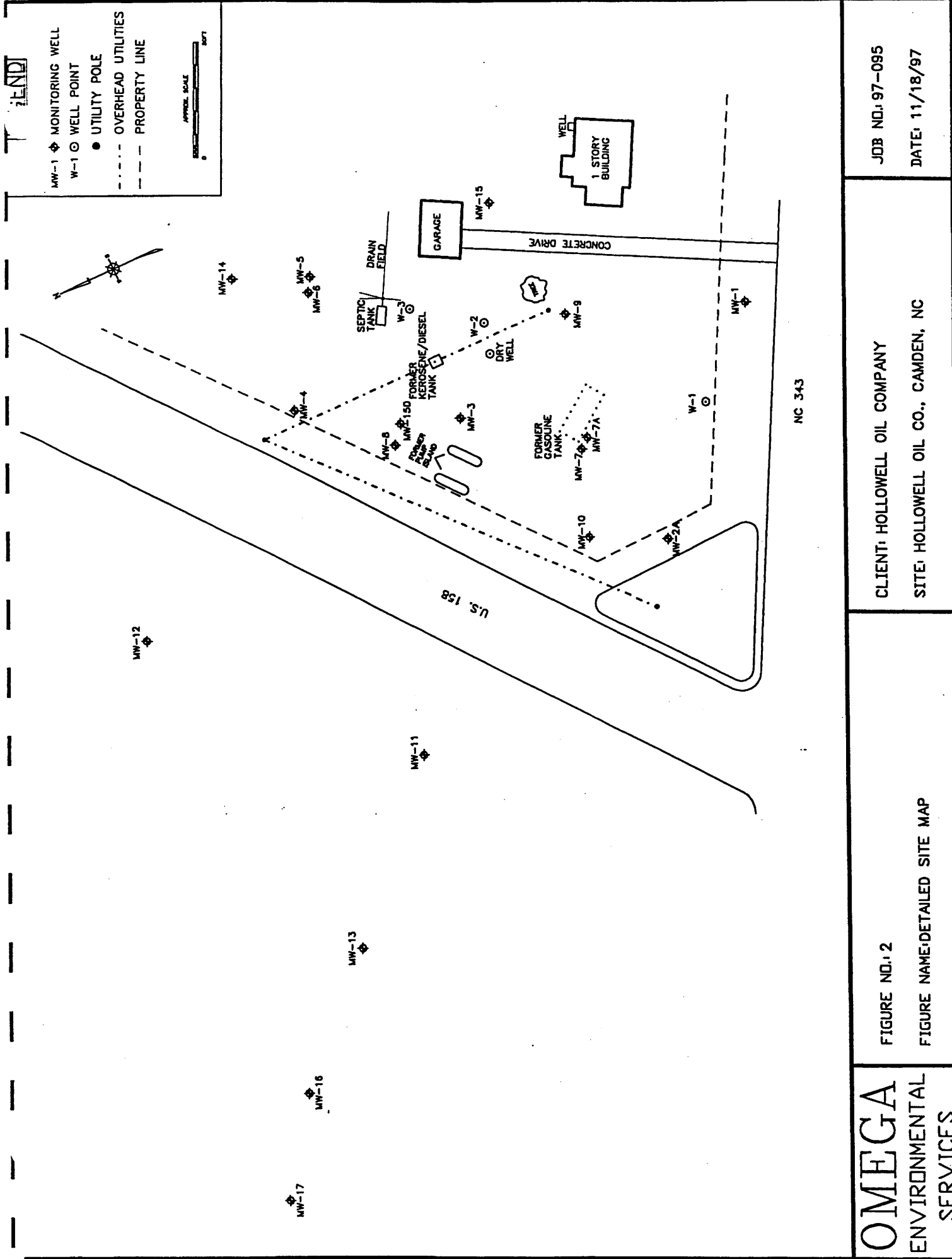


USGS 7.5 MINUTE TOPOGRAPHIC SURVEY MAP OF ELIZABETH CITY, N.C. QUADRANGLE, PHOTO REVISED 1982

| | | |
|-------------|-------------------|---------|
| FIGURE NO. | FIGURE 1 | |
| FIGURE NAME | SITE VICINITY MAP | |
| CLIENT | MOLLICWELL OIL | LOG NO. |
| | | 97-023 |
| SITE | CAMDEN, N.C. | DATE |
| | | 7/97 |

END

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
0 10 20 FT






JOB NO.: 97-095
DATE: 11/18/97

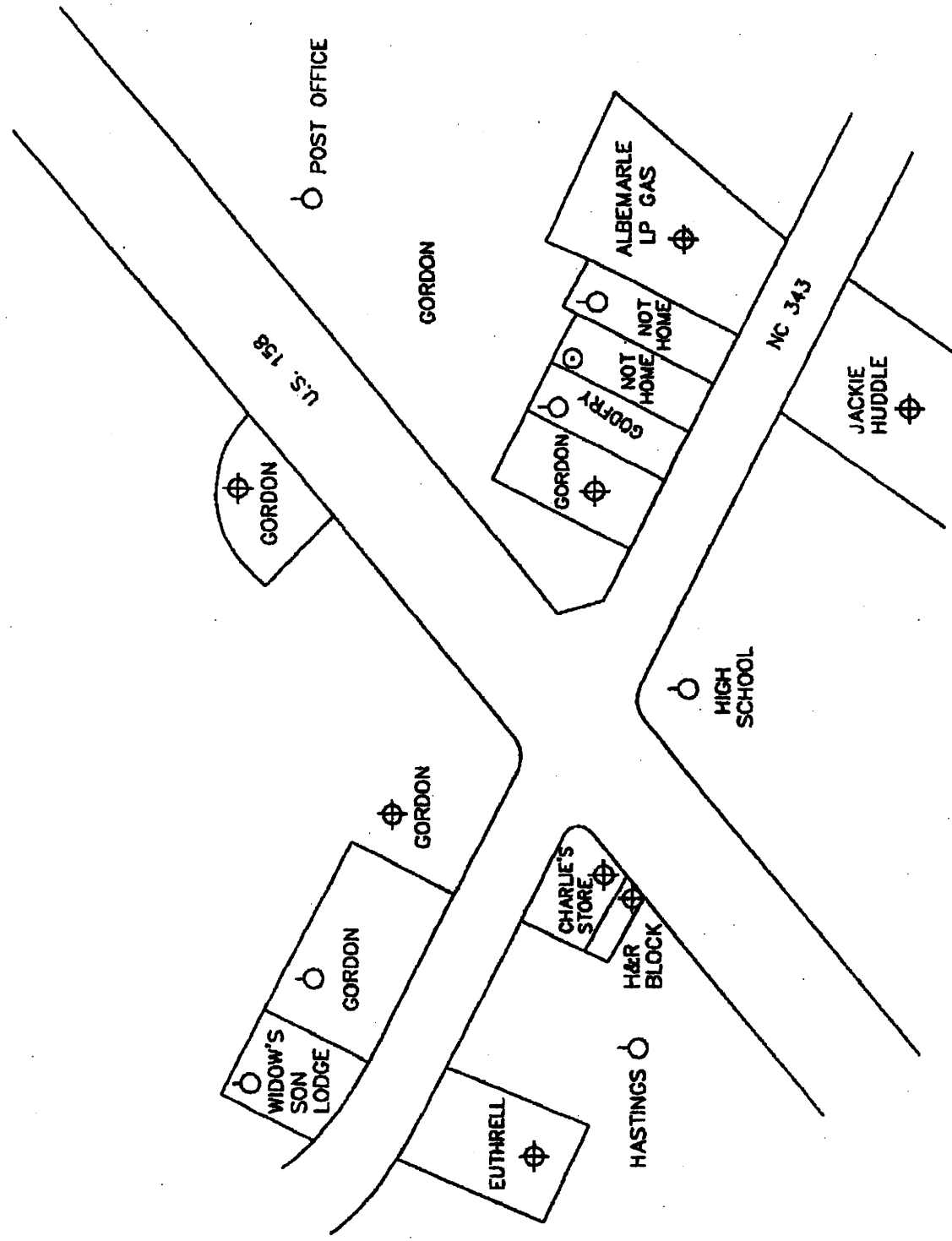
CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 2
FIGURE NAME: DETAILED SITE MAP

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-  MUNICIPAL WATER CONNECTION
-  WELL WATER
-  WELL WATER (LIKELY)



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FIGURE NO.: 3
FIGURE NAME: AREA WATER WELL USERS

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 6/97

contaminated soils in the vicinity of the former UST's. Based on dimensions obtained from the Preliminary Site Assessment Report, approximately 200 cubic yards of soil was excavated. During the excavation and investigation of the site, two additional orphan tanks were located using a "magnetic locator". These UST's were not removed at that time due to the UST's not being owned or operated by Hollowell Oil Company.

The 4,000 gallon and 280 gallon orphan tanks were excavated and removed on December 10, 1996. Law supervised the removal and submitted an "Underground Storage Tank Closure" report on January 14, 1997. During the removals, soils samples were collected from beneath the kerosene UST. These soil samples were reported by the laboratory to contain diesel range organics in excess of the NCDEHNR's guidelines. No soil sample was collected from beneath the gasoline UST due to the presence of ground water in the excavation. A ground water sample was collected and reported by the laboratory to contain gasoline and diesel range organics in excess of NCDEHNR's Ground Water Standards.

On November 11, 1997, Omega mobilized to the Camden site to perform the Liquid Ring Pilot Study. Data obtained during the pilot study indicated influenced vacuum pressures up to 2.4 inches of H₂O approximately 30 feet laterally gradient, 0.70 inches of H₂O approximately 85 feet up-gradient and 0.015 inches of H₂O approximately 45 feet down gradient from the vacuum source. Graphical representation of the radius of influence obtained during the event is included as Figure -12. Approximately 100 gallons of product/water mix was recovered during the four hour event. Using the calculation for PMR given in the North Carolina Soil and Groundwater Guidelines a calculated 14.63 pounds of product was emitted from the system's exhaust during the 4 hour event, at an average rate of 3.66 pounds per hour. Field data, disposal manifests and calculations for the event are included as Appendix H of this report.

1.4 PREVIOUS REPORTS

Solutions Environmental Associates conducted a "Preliminary Site Assessment" for this site in 1991. The report was submitted to Mr. Russell Hollowell on May 2, 1991. This investigation reported that petroleum hydrocarbons were detected in the soils at the site. These petroleum hydrocarbons were reported by the laboratory to be both diesel/kerosene and weathered gasoline.

Solutions conducted an additional investigation in 1992. This investigation resulted in the preparation and submittal of a "Site Assessment Report" dated December 14, 1992. The on-site investigations included the installation of 6 monitor wells; 5 shallow and one "deep" well. The laboratory reported samples from MW-4 and MW-6 had concentrations of petroleum compounds exceeding the North Carolina Ground Water Standards.

In September, 1996, the NCDEHNR (North Carolina Department of Environment, Health and Natural Resources) requested Law Engineering and Environmental Services, Inc. to conduct an investigation of the property under the Lead Trust Fund Program. Law submitted the results of the investigation, "Environmental Assessment Activities" to the NCDEHNR on November 5, 1996. The investigation included the installation of three shallow monitor wells (MW-7, MW-8 and MW-9). TPH was identified in the soils samples from two of the wells. Ground water was sampled and four samples from the wells contained petroleum hydrocarbon compounds in excess of the North Carolina Ground Water Standards.

The orphan tanks were excavated and removed on December 10, 1996. Law supervised the removal and submitted an "Underground Storage Tank Closure" report on January 14, 1997. During the removals, soils samples were collected from beneath the kerosene UST. These soil samples were reported by the

laboratory to contain diesel range organics in excess of the NCDEHNR's guidelines. No soil sample was collected from beneath the gasoline UST due to the presence of ground water in the excavation. A ground water sample was collected and reported by the laboratory to contain gasoline and diesel range organics in excess of NCDEHNR's Ground Water Standards.

In June 1997, Omega Environmental Services was contracted by Hollowell Oil Company to complete a Comprehensive Site Assessment. NCDENR's reviewed this report and requested that additional wells be installed and additional samples be collected. Omega installed four additional monitoring wells (MW-2A, MW-7A, MW-15 and MW-16). Monitoring well MW-2A replaces the lost well MW-2. Monitoring well MW-7A was installed to replace MW-7, not located until after the drilling event at the site was completed. Monitoring well MW-15 was installed up-gradient of the release area because the flow in the area appeared to have radial characteristics and because a potable well is located proximate to the area where the monitoring well was installed. Monitoring well MW-16 was installed down-gradient of MW-13 due to a potable well being located in this direction and because the CSA revealed that the water sample MW-13 had trace amounts of MTBE.

In September of 1997, Omega submitted the CSA Addendum further characterizing the MTBE plume. NCDENR reviewed this report and requested that an additional monitoring well be installed (MW-17) and additional samples be taken from the newly installed well as well as from the potable wells on the Northwest corner of N.C. 343 and U.S. 158. During this sampling event, Omega discovered that the Widow's Son Lodge was supplied with municipal water. Omega attempted to collect a sample directly from the well pump, but was unable to achieve a water flow from the pump system. According to Mr. Gordon, the Gordon property located at 100 North 343 (Table - 2) is also connected to municipal water supply and has not utilized the potable well for over a year. Omega attempted to sample this well, however the well was covered with debris and appeared to be abandoned.

After obtaining a permit Omega installed MW-17 approximately 45 feet down gradient of MW-16. On October 22, 1997, Omega collected samples from MW-17 and supply well SW-1 (Mary Gordon well). Results from this sampling event indicated BDL concentrations in MW-17 and SW-1.

This CAP has been prepared based on information gathered from the CSA dated and submitted to the Washington Regional Office on July 14, 1997 and two CSA Addendum's dated and submitted on September 15, 1997 and November 11, 1997. See CSA (1994) and CSA Addendum (1995) for subsurface conditions. Figures 6-14 illustrate the nature of the adsorb and dissolved phase plumes located beneath the site.

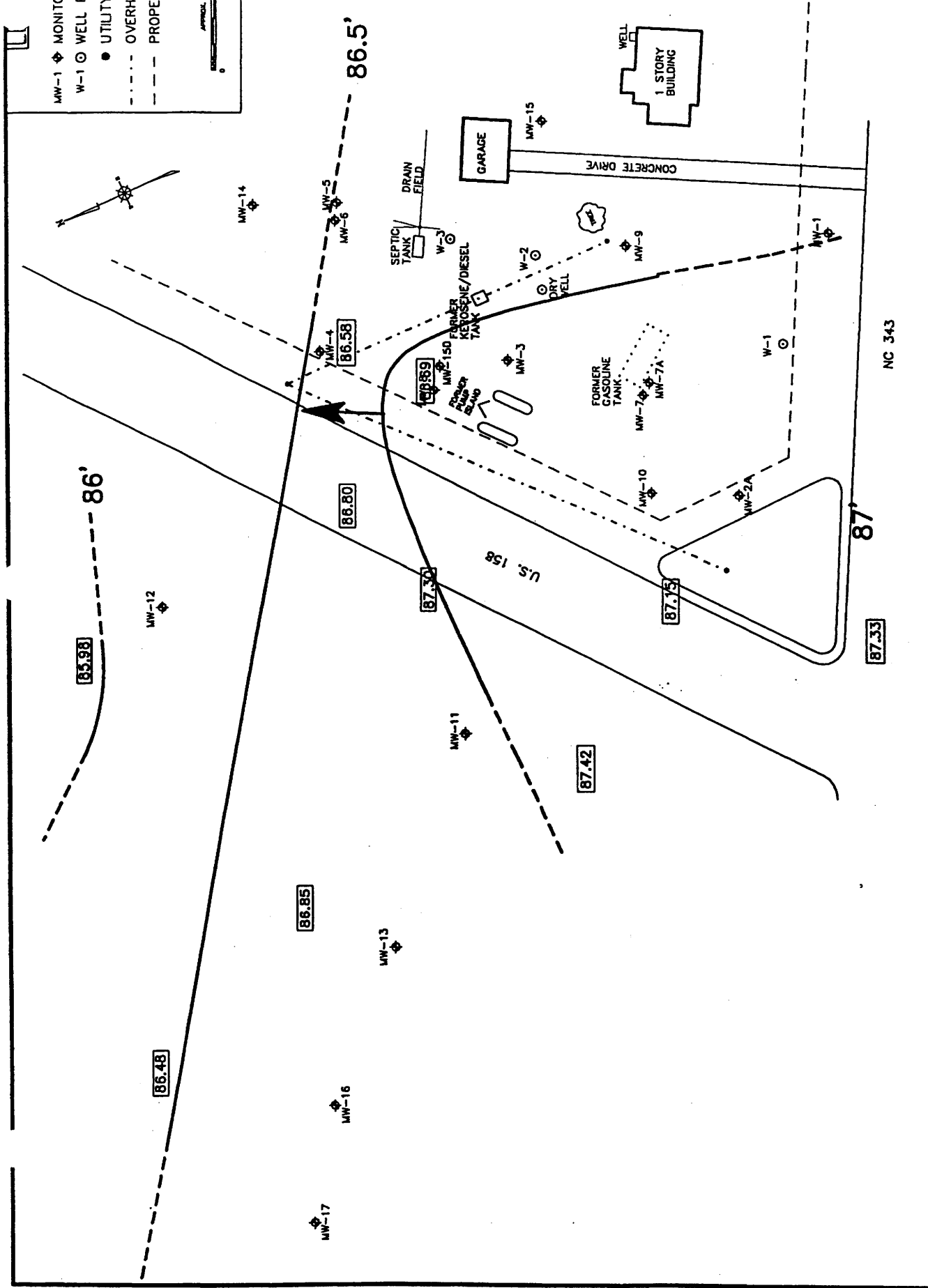
1.5 PERMITS / CERTIFICATES

Upon obtaining approval for the Corrective Action Plan, Omega will submit the required NPDES Permit application to the appropriate parties. The National Pollutant Discharge Elimination System Permit (NPDES) will be submitted upon completion of system design.

Regarding the systems air emissions, according to Kevin Miller with the NCDENR - Air Pollution Control Division, if emissions rates for the suggested remediation method fall below 6 pounds per hour then no permit or exemption filing would be needed for the systems emissions discharge.

LI ND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROPRIATE SCALE
0 50 FT



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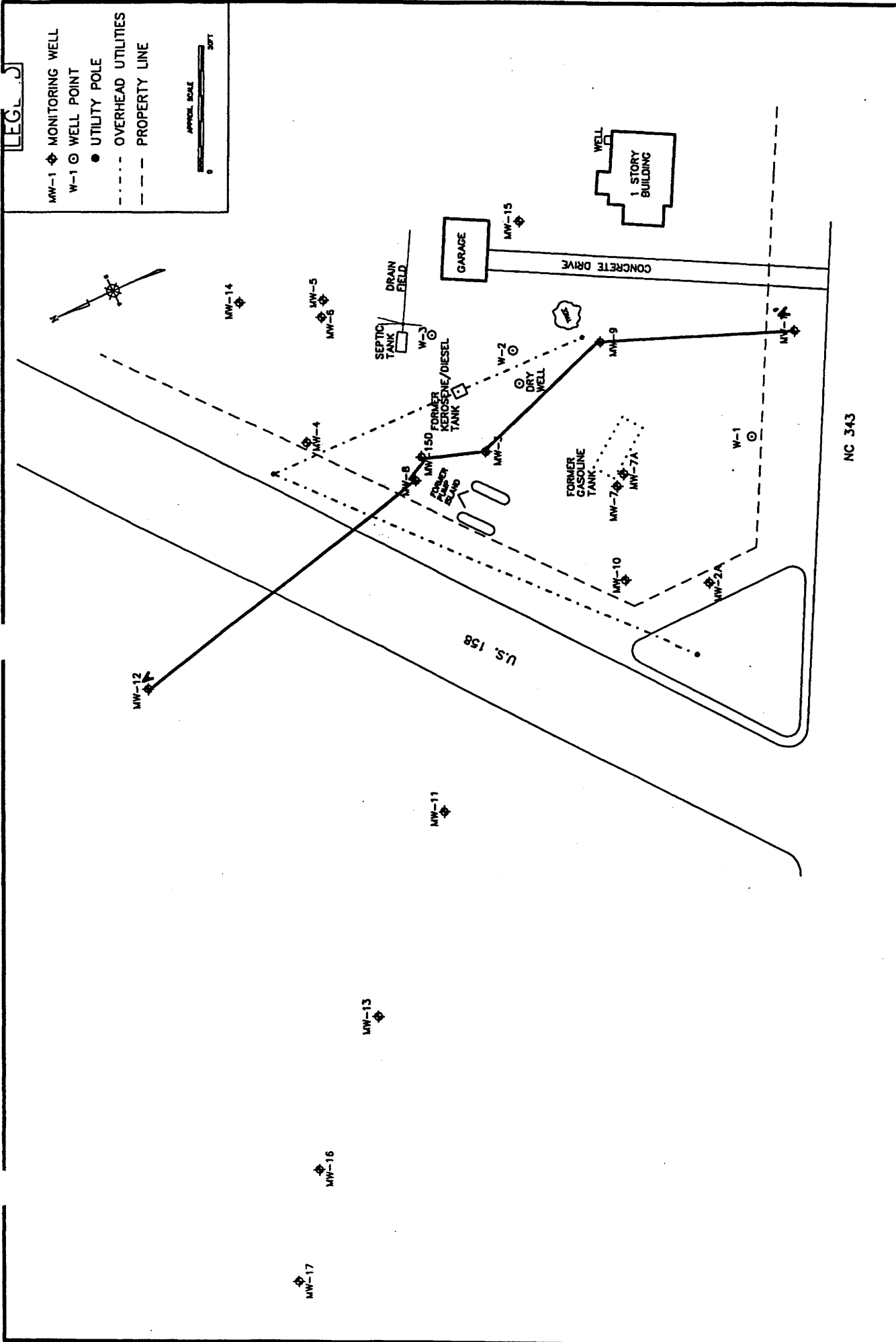
FIGURE NO. 4
FIGURE NAME: POTENTIOMETRIC SURFACE MAP

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 11/18/97

LEGEND

- MW-1 ◆ MONITORING WELL
- W-1 ⊙ WELL POINT
- UTILITY POLE
- - - - OVERHEAD UTILITIES
- - - - PROPERTY LINE



JOB NO.: 97-095

DATE: 11/18/97

CLIENT: HOLLOWELL OIL COMPANY

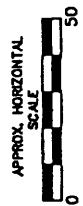
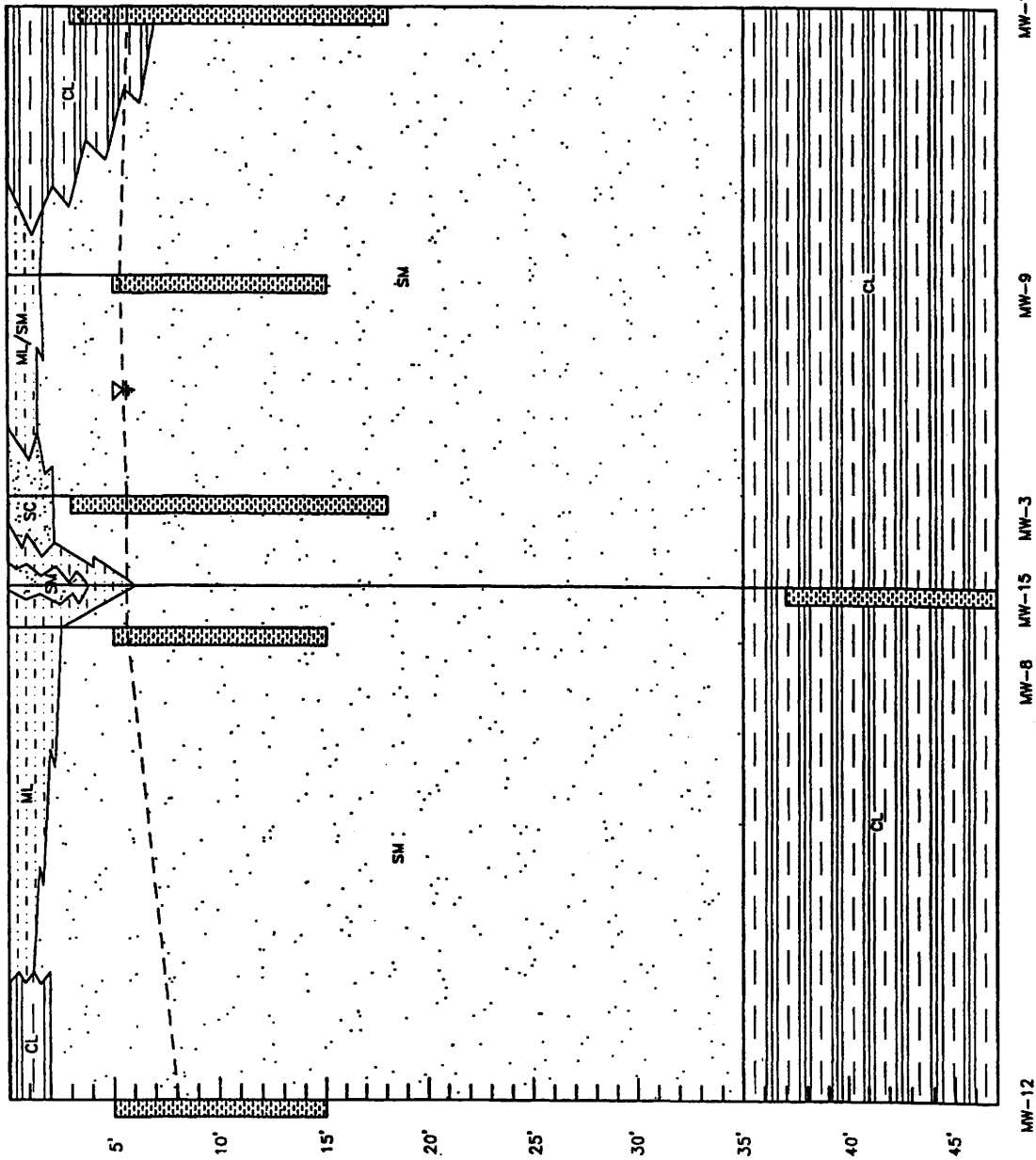
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO. 15

FIGURE NAME: AERIAL VIEW OF CROSS-SECTION A-A

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| KEY | |
|-----|-------------|
| CL | LEAN CLAY |
| SM | SILTY SAND |
| ML | SILT |
| SC | CLAYEY SAND |



JOB NO.: 97-095
DATE: 11/18/97

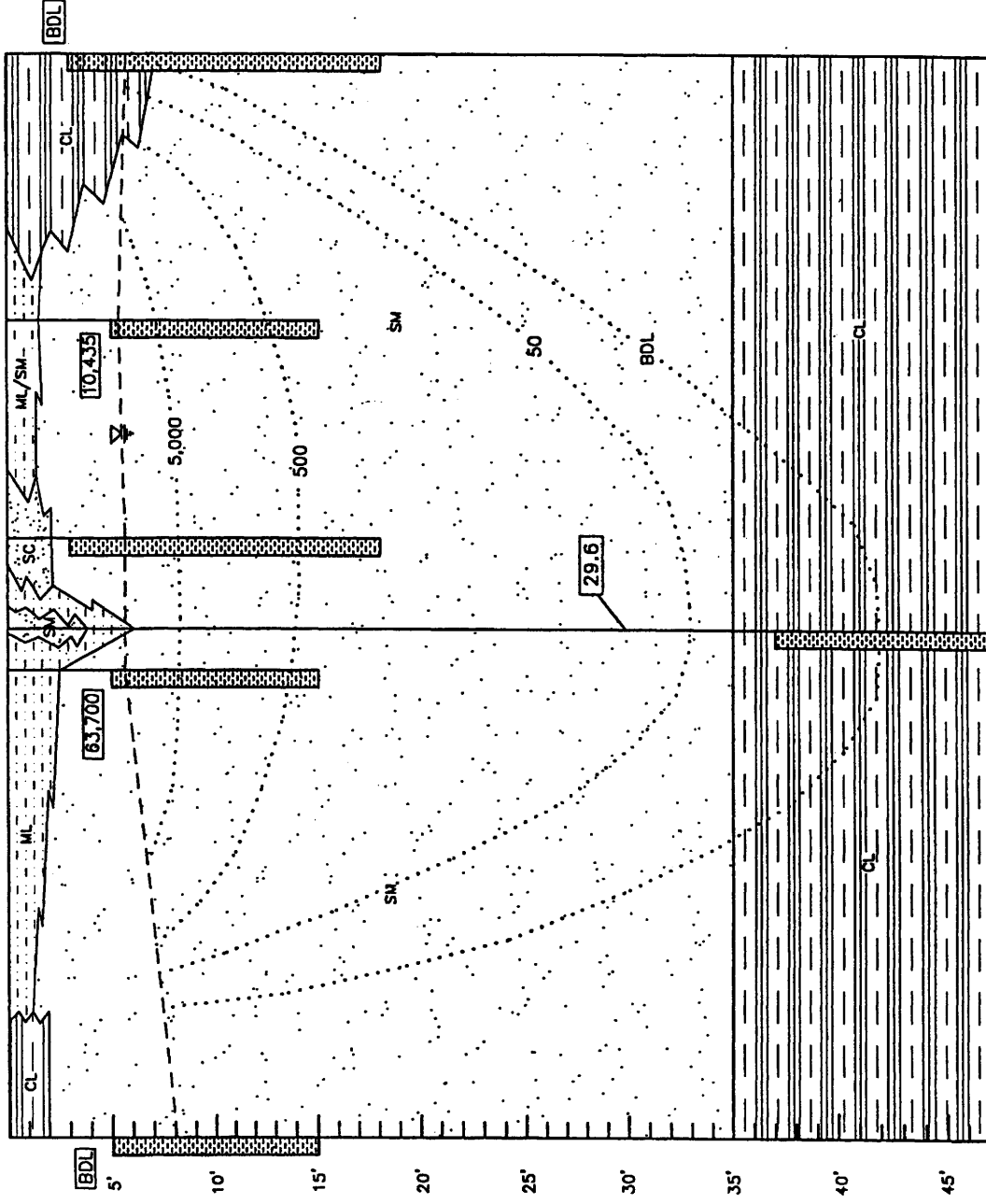
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SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 6
FIGURE NAME: CROSS-SECTION A-A'

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| KEY | |
|-----|---------------|
| CL | - LEAN CLAY |
| SM | - SILTY SAND |
| ML | - SILT |
| SC | - CLAYEY SAND |



MW-12 MW-8 MW-15 MW-3 MW-9 MW-1

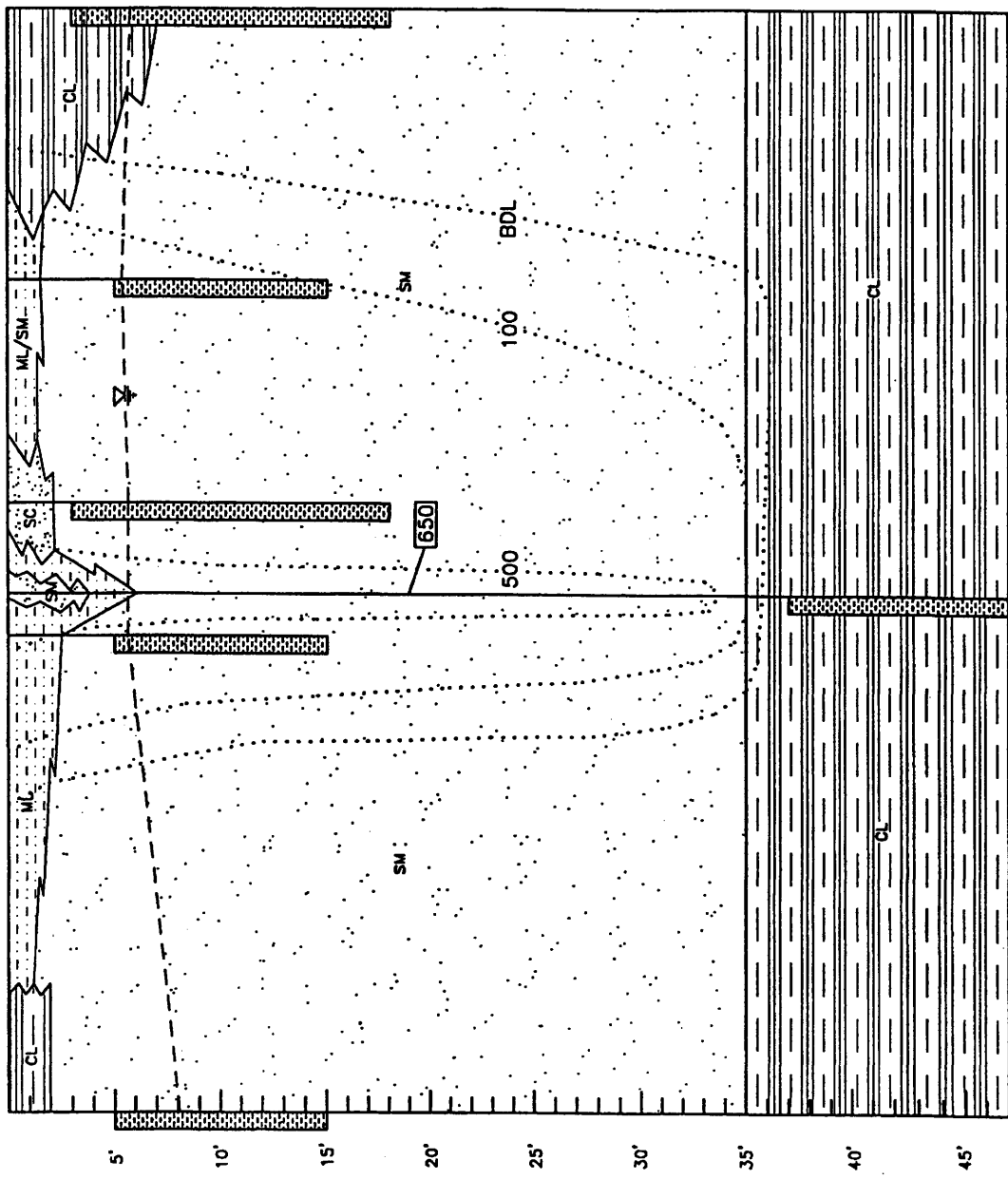
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FIGURE NO. 6A
FIGURE NAME: CROSS SECTION A-A'
DISSOLVED PHASE PLUME MAP (ug/L)

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 11/18/97

| KEY | |
|-----|-------------|
| CL | LEAN CLAY |
| SM | SILTY SAND |
| ML | SILT |
| SC | CLAYEY SAND |



JOB NO.: 97-095

DATE: 11/18/97

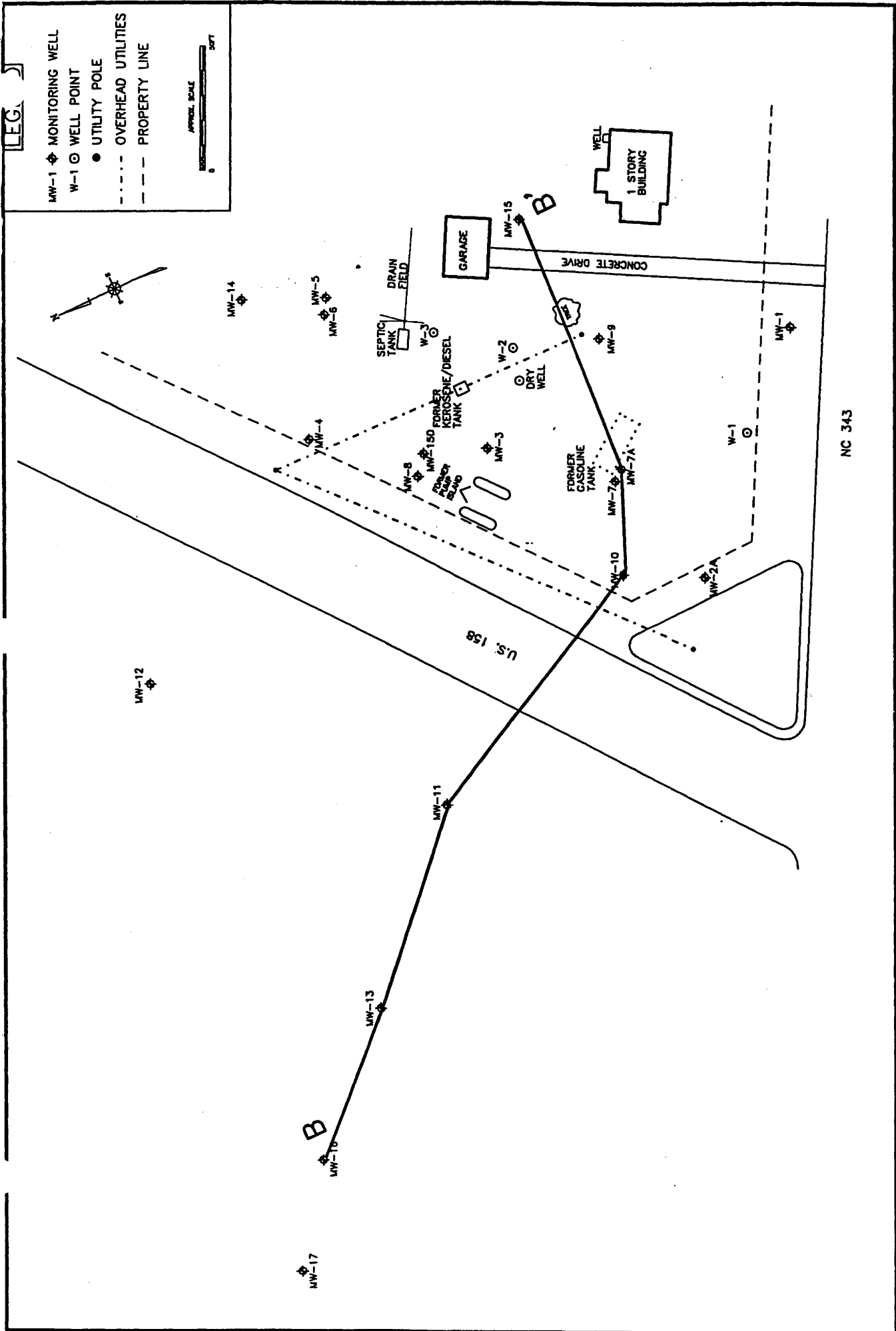
CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 6B
FIGURE NAME: CROSS-SECTION A-A'
RESIDUAL PHASE PLUME MAP (mg/kg)

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LEG.

- MW-1 MONITORING WELL
- W-1 WELL POINT
- UTILITY POLE
- - - OVERHEAD UTILITIES
- - - PROPERTY LINE



JOB NO: 97-095

DATE: 11/18/97

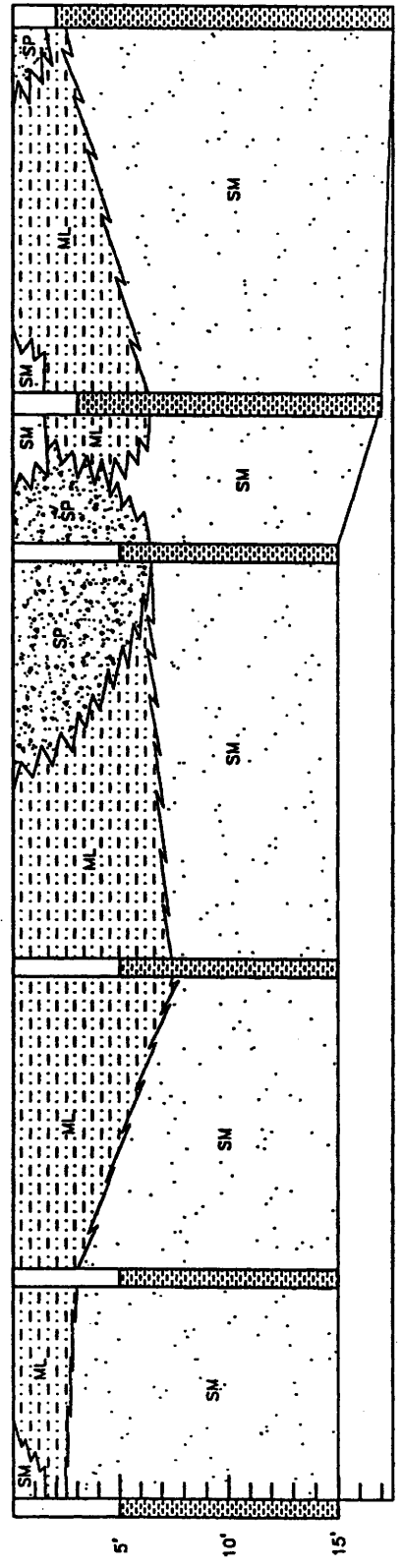
CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO. 7
 FIGURE NAME: AERIAL VIEW OF CROSS-SECTION B-B'

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KEY
 SP - POURLY GRADED SAND
 SM - SILTY SAND
 ML - SILT

APPROX. HORIZONTAL
 SCALE
 0 50



| RESIDUAL TPH (mg/Kg) | MW-16 | MW-13 | MW-11 | MW-10 | MW-7A | MW-15 |
|-----------------------------|-------|-------|-------|-------|--------|-------|
| DISSOLVED BENZENE (ug/L) | BDL | BDL | BDL | 13.0 | 17,100 | BDL |
| | BDL | BDL | BDL | BDL | 244.9 | BDL |

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FIGURE NO. 8

FIGURE NAME: CROSS SECTIONAL AREA B - B'

CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO: 97-095

DATE: 11/18/97

2.0 OBJECTIVES OF THE CAP

This CAP has been prepared to address the following objectives for ground water and soil remediation at the site:

- Create and maintain hydraulic control of the dissolved phase hydrocarbon plume exhibiting concentrations above gross contaminant levels.
- Reduce plume migration and size.
- Prevent further off-site impact.
- Reduce adsorbed and dissolved phase hydrocarbon concentrations from the unsaturated and saturated zones.
- Implement remediation of impacted soil and ground water until pre-determined clean up levels are reached.
- Perform remedial activities in compliance with all regulatory discharge and reporting limits.
- Recover any existing or potential NAPLs.

2.1 TARGET CLEAN-UP LEVELS

Target clean-up levels of residual phase hydrocarbons is 10 ppm for volatiles and 40 ppm for semi-volatiles. The residual phase appears to mirror the dissolved phase in aerial extent. Soil samples from the borings advanced for MW-15D and MW-7A contained 797 mg/Kg TPH and 245 mg/Kg TPH, respectively. No other soil samples collected during the CSA or the CSA Addendum on site work contained detectable concentrations of residual petroleum hydrocarbons (Figure 14 - Residual Phase Total Hydrocarbon Plume Map). Residual phase concentrations and target clean-up levels are included in Table-1. Soil cleanup values established by the Site Sensitivity Evaluation are not used since ground water has been impacted beneath the site.

2.2 TARGET START-UP AND COMPLETION DATES

| | |
|--|--|
| Submittal of CAP | May 9, 1998 (dates dependent on approval of CAP) |
| Development of Design Specifications | July 15, 1998 |
| Submittal of necessary permit applications | August 15, 1998 |
| System installation | October 1, 1998 to December 31, 1998 (dates dependent on approval of NPDES Permit) |
| System activation | January 1, 1999 |
| System shut-down | December 30, 2000 |
| Project completion date | January, 2001 |

Once the system is operational, the estimated time frame to achieve clean-up goals is 24 months.

See Sections 6.0 and 8.0 for schedules and reporting time frames.

| Table 1. Residual Phase Concentrations/Target Clean-up Levels | | | | |
|---|-------------|---------------------|----------------------------------|---------------------------------------|
| Location | Date | Depth (feet) | TPH (mg/kg) Volatiles | TPH (mg/kg) Semi-Volatiles |
| MW-2A | 8/14/97 | 4 | ND | ND |
| MW-7A | 8/14/97 | 4 | 245 | ND |
| MW-10 | 6/11/97 | 4 | ND | ND |
| MW-11 | 6/11/97 | 4 | ND | ND |
| MW-12 | 6/11/97 | 4 | ND | ND |
| MW-13 | 6/12/97 | 4 | ND | ND |
| MW-14 | 6/12/97 | 4 | ND | ND |
| MW-15D | 6/13/97 | Comp. | 797 | ND |
| MW-15 | 8/14/97 | 4 | ND | ND |
| MW-16 | 8/14/97 | 4 | ND | ND |
| MW-17 | 10/13/97 | 4 | ND | ND |
| Target Clean-up Levels | - | - | 10 | 40 |
| Note: ND = Not Detectable mg/kg = milligram per liter = parts per million | | | | |

Target clean-up levels for ground water will be the NCGWS. The dissolved phase concentrations and target clean-up levels are included in Tables 2 + 3.

Table 2. Dissolved Phase Concentrations/Target Clean-up Levels, February 1998

| Location | Benzene** (ug/L) | Toluene** (ug/L) | Ethylbenzene** (ug/L) | Xylenes** (ug/L) |
|------------------------|---------------------|---------------------|--------------------------|---------------------|
| MW - 1 | BDL | BDL | BDL | BDL |
| MW - 2A | BDL | BDL | BDL | BDL |
| MW - 3 | 13,700* | 3,720* | 2,470* | 5,330* |
| MW - 4 | BDL | BDL | BDL | BDL |
| MW - 5 | BDL | BDL | BDL | BDL |
| MW - 6 | BDL | BDL | BDL | BDL |
| MW - 7A | 10,600* | 2,260* | 1,530* | 3,370* |
| MW - 8 | FP | FP | FP | FP |
| MW - 9 | BDL | BDL | BDL | BDL |
| MW - 10 | BDL | BDL | BDL | BDL |
| MW - 11 | 720* | BDL | BDL | BDL |
| MW - 12 | BDL | BDL | BDL | BDL |
| MW - 13 | BDL | BDL | BDL | BDL |
| MW - 14 | BDL | BDL | BDL | BDL |
| MW - 15 | BDL | BDL | BDL | BDL |
| MW - 15D | 15.0* | 32.0 | 3.8 | 20.0 |
| MW - 16 | BDL | BDL | BDL | BDL |
| MW - 17 | BDL | BDL | BDL | BDL |
| Target Clean-up Levels | 1.0 | 1000.0 | 29.0 | 530.0 |

Note: ug/l = micrograms per liter
Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

| Table 3. Dissolved Phase Concentrations/Target Clean-up Levels (other), February 1998 | | | | |
|---|------------------|------------------|---------------|---------------------------|
| Location | MTBE** (ug/L) | Lead** (Mg/L) | EDB (ug/L) | Isopropyl Ether (ug/L) |
| MW-1 | BDL | BDL | BDL | BDL |
| MW-2A | BDL | BDL | BDL | BDL |
| MW-3 | 5,040* | BDL | 4.6 | 140 |
| MW-4 | BDL | BDL | BDL | BDL |
| MW-5 | BDL | BDL | BDL | BDL |
| MW-6 | BDL | BDL | BDL | BDL |
| MW-7A | 1,980* | BDL | 0.85 | BDL |
| MW-8 | FP | FP | FP | FP |
| MW-9 | BDL | BDL | BDL | BDL |
| MW-10 | 26 | BDL | BDL | BDL |
| MW-11 | 990* | BDL | BDL | BDL |
| MW-12 | BDL | BDL | BDL | BDL |
| MW-13 | 100 | BDL | BDL | 1.2 |
| MW-14 | BDL | BDL | BDL | BDL |
| MW-15 | BDL | BDL | BDL | BDL |
| MW-15D | 3.0 | BDL | BDL | BDL |
| MW-16 | BDL | BDL | BDL | BDL |
| MW-17 | BDL | BDL | BDL | BDL |
| Target Clean-up Levels | 200.0 | 0.015 | * | * |

Note: ug/l = micrograms per liter
Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

Appendix C - Laboratory Reports and Chains of Custody provides the back-up information and documentation from the laboratory for the above table.

3.0 EXPOSURE ASSESSMENT

3.1 HISTORICAL ANALYTICAL DATA

Ground water impact has occurred at the site, therefore cleanup values resulting from an SSE would not be applicable. The clean-up values were established using NCGWS and reportable concentrations for soils. The clean-up levels for soils are 10 ppm for volatiles and 40 ppm for semi-volatiles. During the last sampling event MW-8 was found to contain free product and therefore was not sampled. Laboratory analyses of soil borings collected during the CSA and CSA Addendum investigations indicated TPH concentrations exceeding target clean-up concentrations of 10 ppm for gasoline. Soil analytical results are included in Table 1.

Elevated benzene (13,700 ug/l), toluene (3,720 ug/l), ethylbenzene(2,470 ug/l), 1,2-dichloroethane (68 ug/l), isopropyl ether (IPE)(140 ug/l), xylenes(5,300 ug/l), methyl-t-butyl-ether(MTBE)(5,040 ug/l) and ethylene di-bromide (EDB) (4.6 ug/l) were detected in MW-3. The BTEX, MTBE and EDB exceed their NCGWS.

Elevated benzene (10,600 ug/l), toluene (2,260 ug/l), ethyl benzene (1,530 ug/l), xylenes (3,870 ug/l), MTBE (1,980) and EDB (0.85 ug/l) were detected in MW-7 during the recent sampling event. The BTEX, MTBE and EDB concentrations exceeded their NCGWS.

MTBE (26 ug/l) was detected in the most recent sampling event in MW-10. MTBE concentrations do not exceed the NCGWS.

Elevated benzene(720 ug/l) and MTBE(900 ug/l) were detected in MW-11 during the recent sampling event. The Benzene and MTBE concentrations exceed their NCGWS.

Elevated MTBE (100 ug/l) and IPE (1.2 ug/l) were detected in MW-13 during the recent event. Concentrations do not exceed their NCGWS.

Elevated benzene (15 ug/l) and toluene (32 ug/l), ethyl benzene (3.8 ug/l), xylenes(20.0 ug/l) and MTBE (3.0 ug/l) were detected in MW-15D during the last sampling event. Only the benzene concentration exceeded the NCGWS for benzene.

Hydrocarbon contaminants were not detected in MW-1, MW-2A, MW-4, MW-5, MW-6, MW-9, MW-12, MW-14, MW-15, MW-16 or MW-17 during the last sampling event.

Tables 4, 5 and 6 are the ground water analytical results from samples collected during the June 1997 and February 1998 sampling events.

Table 4. Dissolved Phase Concentrations with Geophysical Data, February 1998

| Location | Benzene** (ug/L) | Toluene** (ug/L) | Ethyl- benzene** (ug/L) | Xylenes** (ug/L) | Dissolved Oxygen (mg/L) | Temperature (Celsius) | pH |
|------------------------------|---------------------|---------------------|-------------------------------|---------------------|-------------------------------|--------------------------|------|
| MW - 1 | BDL | BDL | BDL | BDL | 3.2 | 12.7 | 4.87 |
| MW - 2A | BDL | BDL | BDL | BDL | 3.6 | 12.8 | 5.51 |
| MW - 3 | 13,700* | 3,720* | 2,470* | 5,330* | 2.6 | 12.9 | 5.63 |
| MW - 4 | BDL | BDL | BDL | BDL | 4.6 | 12.2 | 5.17 |
| MW - 5 | BDL | BDL | BDL | BDL | 2.6 | 12.3 | 5.14 |
| MW-6 | BDL | BDL | BDL | BDL | 4.6 | 13.0 | 5.06 |
| MW - 7A | 10,600* | 2,260* | 1,530* | 3,370* | 2.2 | 12.9 | 5.77 |
| MW - 8 | FP | FP | FP | FP | 1.8 | 15.2 | 6.08 |
| MW - 9 | BDL | BDL | BDL | BDL | 2.2 | 12.9 | 5.85 |
| MW - 10 | BDL | BDL | BDL | BDL | 4.0 | 13.2 | 5.40 |
| MW - 11 | 720* | BDL | BDL | BDL | 4.8 | 12.8 | 5.55 |
| MW - 12 | BDL | BDL | BDL | BDL | 4.2 | 13.4 | 5.20 |
| MW - 13 | BDL | BDL | BDL | BDL | 5.1 | 13.5 | 5.39 |
| MW - 14 | BDL | BDL | BDL | BDL | 3.0 | 12.9 | 5.43 |
| MW - 15 | BDL | BDL | BDL | BDL | 2.75 | 12.5 | 4.85 |
| MW-15D | 15.0* | 32.0 | 3.8 | 20.0 | 2.2 | 17.0 | 9.45 |
| MW - 16 | BDL | BDL | BDL | BDL | 5.0 | 13.5 | 5.53 |
| MW - 17 | BDL | BDL | BDL | BDL | 2.2 | 13.1 | 5.10 |
| Target Clean-up Levels | 1.0 | 1000.0 | 29.0 | 530.0 | N/A | N/A | N/A |

Note: ug/l = micrograms per liter
Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

Appendix C - Laboratory Reports and Chains of Custody provides the back-up information and documentation from the laboratory for the above tables.

Table 5. Dissolved Phase Concentrations with Geophysical Data (other), February 1998

| Location | MTBE** (ug/) | Lead** (ug/L) | EDB (ug/L) | IPE (ug/L) | Dissolved Oxygen (mg/L) | Temperature (Celsius) | pH |
|----------|-----------------|------------------|---------------|---------------|-------------------------------|--------------------------|------|
| MW-1 | BDL | BDL | BDL | BDL | 3.2 | 12.7 | 4.87 |
| MW-2A | BDL | BDL | 620 | BDL | 3.6 | 12.8 | 5.51 |
| MW - 3 | 5,400* | BDL | 4.6* | 140* | 2.6 | 12.9 | 5.63 |
| MW-4 | BDL | BDL | BDL | BDL | 4.6 | 12.2 | 5.17 |
| MW-5 | BDL | BDL | BDL | BDL | 2.6 | 12.3 | 5.14 |
| MW-6 | BDL | BDL | BDL | BDL | 4.6 | 13.0 | 5.06 |
| MW-7A | 1,980* | BDL | 0.85 | BDL | 2.2 | 12.9 | 5.77 |
| MW-8 | FP | FP | FP | FP | 1.8 | 15.2 | 6.08 |
| MW-9 | BDL | BDL | BDL | BDL | 2.2 | 12.9 | 5.85 |
| MW-10 | 26 | BDL | BDL | BDL | 4.0 | 13.2 | 5.40 |
| MW-11 | 990 | BDL | BDL | BDL | 4.8 | 12.8 | 5.55 |
| MW-12 | BDL | BDL | BDL | BDL | 4.2 | 13.4 | 5.20 |
| MW-13 | 100 | BDL | BDL | 1.2 | 5.1 | 13.5 | 5.39 |
| MW-14 | BDL | BDL | BDL | BDL | 3.0 | 12.9 | 5.43 |
| MW-15 | BDL | BDL | BDL | BDL | 2.75 | 12.5 | 4.85 |
| MW-15D | 3.0 | BDL | BDL | BDL | 2.2 | 17.0 | 9.45 |
| MW-16 | BDL | BDL | BDL | BDL | 5.0 | 13.5 | 5.53 |
| MW-17 | BDL | BDL | BDL | BDL | 2.2 | 13.1 | 5.10 |

Note: ug/l = micrograms per liter
Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

Appendix C - Laboratory Reports and Chains of Custody provides the back-up information and documentation from the laboratory for the above tables.

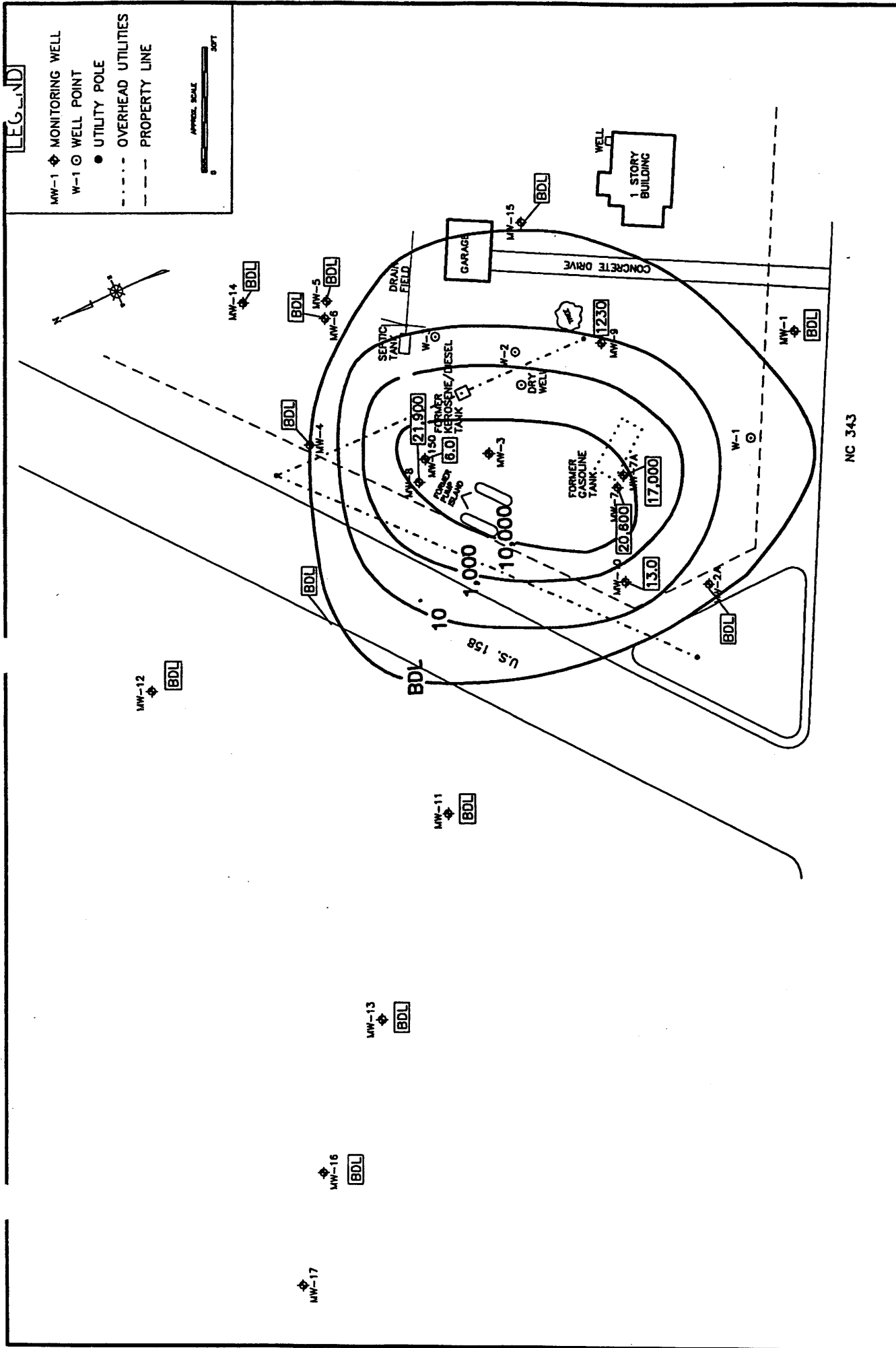
Table 6. Historical Ground Water Analytical Results, June 1997

| Location | Benzene** (Ug/L) | Toluene** (Ug/L) | Ethylbenzene** (Ug/L) | Xylenes** (Ug/L) | Total BTEX (Ug/L) |
|----------|---------------------|---------------------|--------------------------|---------------------------|----------------------|
| MW - 1 | BDL | BDL | BDL | BDL | BDL |
| MW-2A | BDL | BDL | BDL | BDL | BDL |
| MW - 4 | BDL | BDL | BDL | BDL | BDL |
| MW - 5 | BDL | BDL | BDL | BDL | BDL |
| MW-7 | 20,600* | 23,100* | 2,560* | 11,700* | 57,960 |
| MW-7A | 17,100* | 21,600* | 1,840* | 13,200* | 41,860 |
| MW - 8 | 21,900* | 27,800* | 1,800* | 12,200* | 63,700 |
| MW - 9 | 1,230* | 5,530* | 765* | 2,910* | 10,435 |
| MW - 10 | 13.0* | 2.2 | 20.3 | 56.1 | 91.6 |
| MW - 11 | BDL | BDL | BDL | BDL | BDL |
| MW - 12 | BDL | BDL | BDL | BDL | BDL |
| MW - 13 | BDL | BDL | BDL | BDL | BDL |
| MW - 14 | BDL | BDL | BDL | BDL | BDL |
| MW-15 | BDL | BDL | BDL | BDL | BDL |
| MW - 15D | 6.0* | 13.0 | 1.6 | 9.0 | 29.60 |
| MW-16 | BDL | BDL | BDL | BDL | BDL |
| Location | MTBE** (Ug/L) | Lead** (Mg/L) | Naphthalene (Ug/L) | Isopropyl Ether (Ug/L) | |
| MW-1 | BDL | BDL | BDL | BDL | |
| MW-2A | BDL | 0.074* | 620 | BDL | |
| MW-4 | BDL | BDL | BDL | BDL | |
| MW-5 | BDL | BDL | BDL | BDL | |
| MW-7 | 3,400* | 0.013 | 710 | BDL | |
| MW-7A | 2,000* | 0.019* | BDL | BDL | |
| MW-8 | 12,300* | 0.200* | 425 | BDL | |
| MW-9 | BDL | BDL | 100 | BDL | |
| MW-10 | 75 | BDL | 10 | BDL | |
| MW-11 | 72 | BDL | BDL | BDL | |
| MW-12 | BDL | BDL | BDL | BDL | |
| MW-13 | 170 | BDL | BDL | BDL | |
| MW-14 | BDL | BDL | BDL | BDL | |
| MW-15 | BDL | 0.023* | BDL | BDL | |
| MW-15D | 3.0 | BDL | BDL | BDL | |
| MW-16 | BDL | 0.151* | BDL | BDL | |

Note: ug/l = micrograms per liter
Mg/L = milligrams per liter
BDL = Below Detection Limit
* = Concentration above North Carolina Ground Water Standard
** = Parameter with North Carolina Ground Water Standard

LEGEND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - OVERHEAD UTILITIES
- - - PROPERTY LINE



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FIGURE NO.: 9A
 FIGURE NAME: DISSOLVED BENZENE ISOCONCENTRATION
 MAP (ug/L)

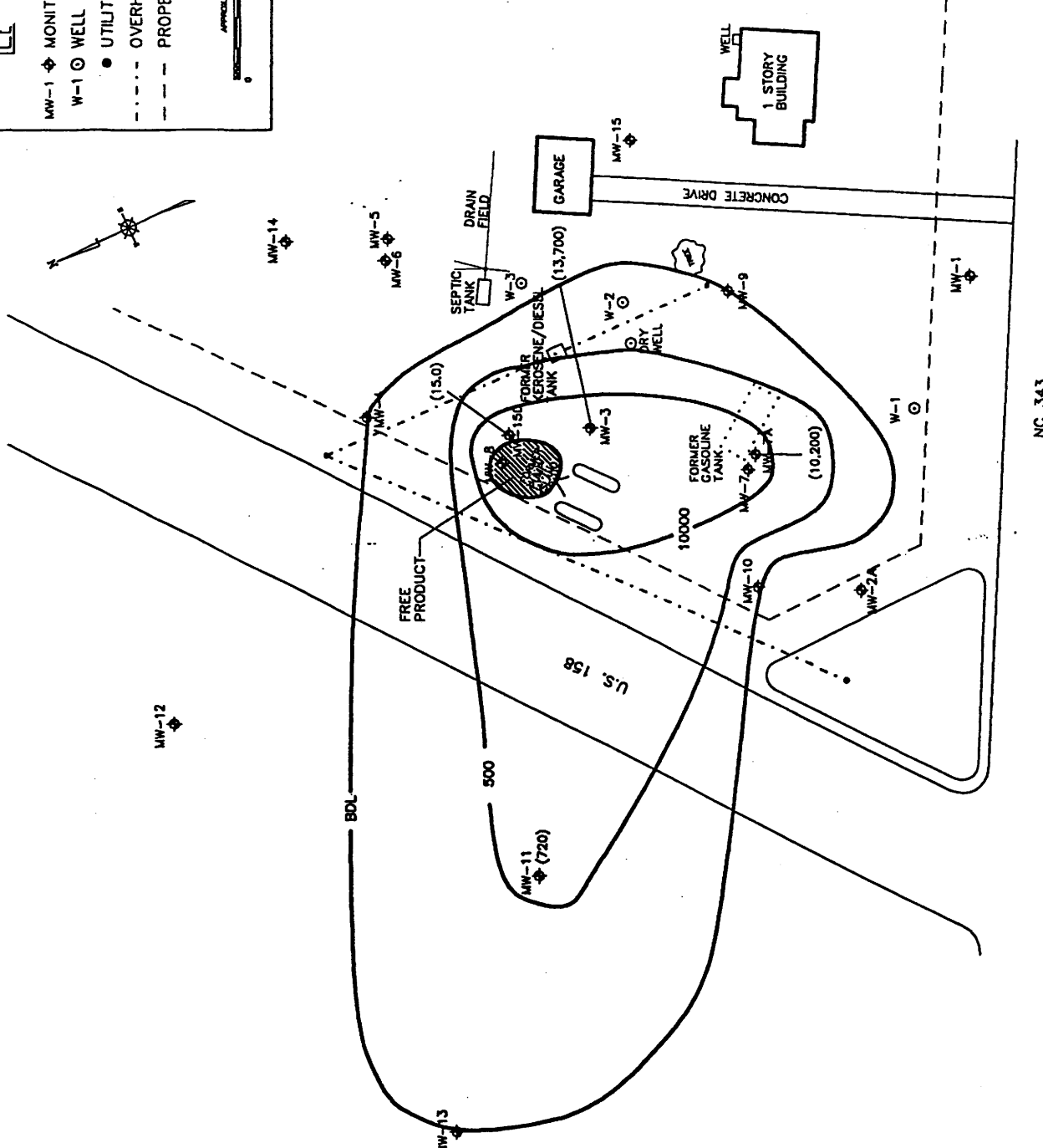
CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
 DATE: 11/18/97

LL ND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - - OVERHEAD UTILITIES
- - - - PROPERTY LINE

APPROX. SCALE
0 30 FT



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FIGURE ND.1 9B

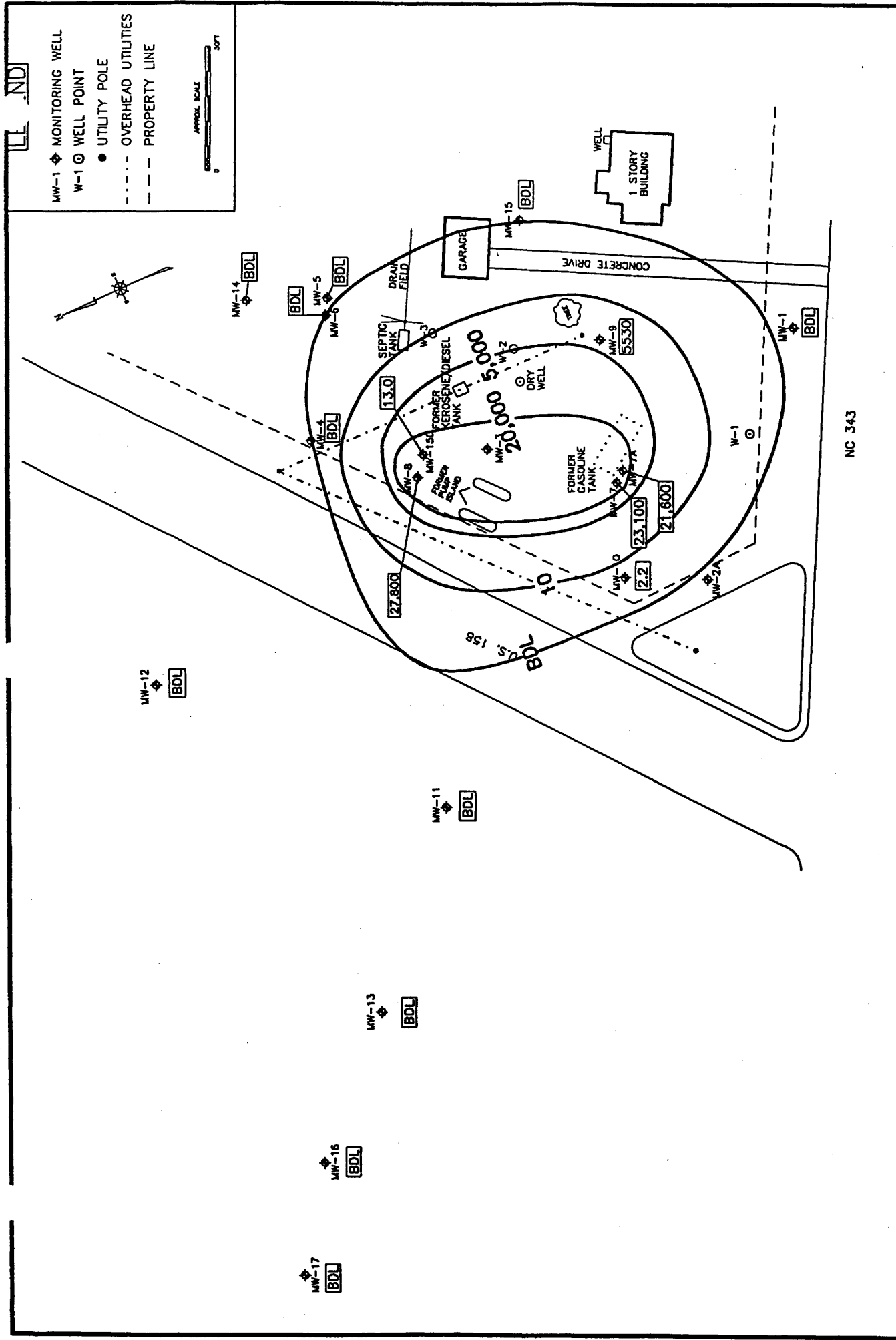
FIGURE NAME: DISSOLVED PHASE BENZENE
ISO-CONCENTRATION MAP (FEB. 98) (ug/L)

CLIENT: HOLLOWELL OIL COMPANY

SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO. 97-095

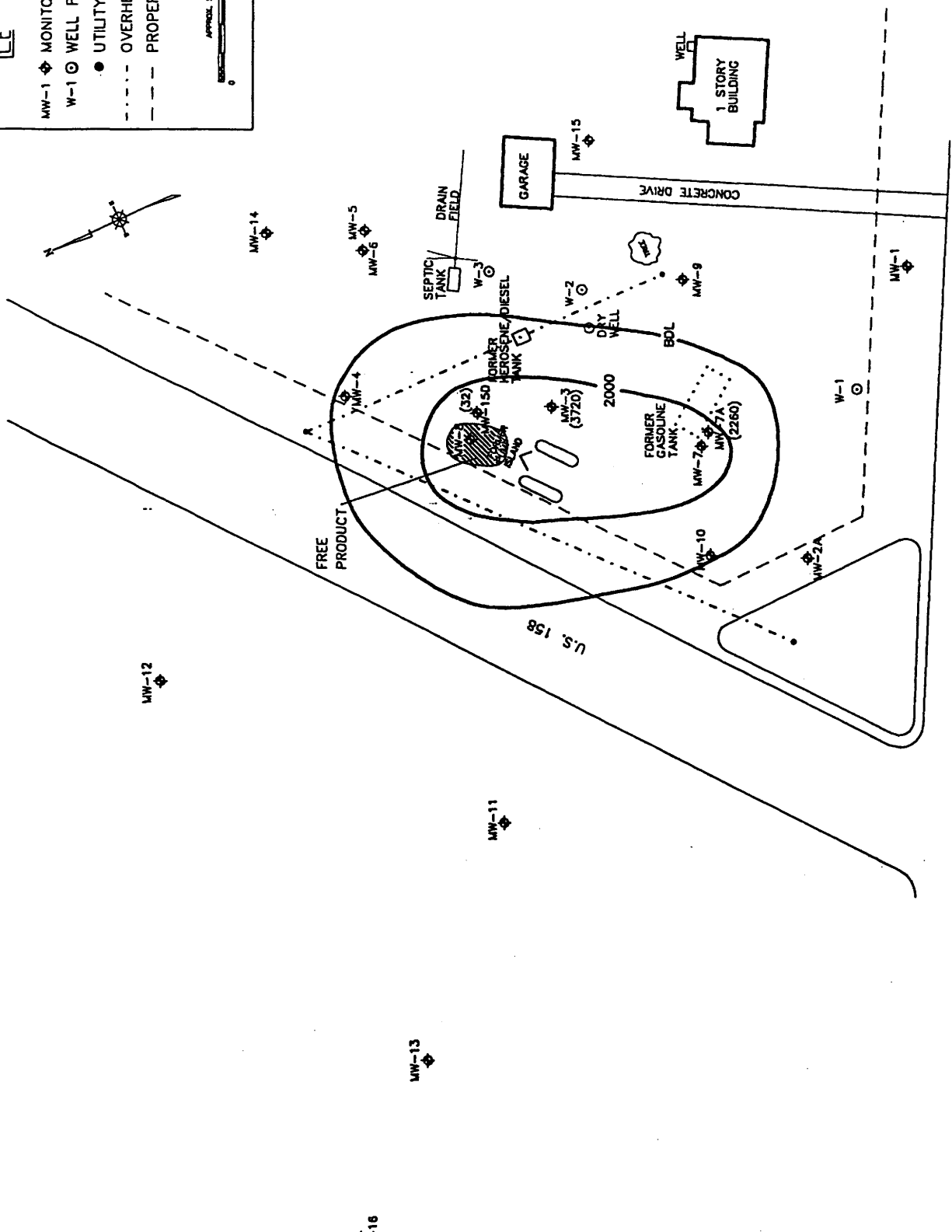
DATE: 2/27/98



| | | | |
|---------------------------------------|--|---|--|
| <p>JOB NO.: 97-095 DATE: 9/97</p> | <p>CLIENT: HOLLOWELL OIL COMPANY SITE: HOLLOWELL OIL CO., CAMDEN, NC</p> | <p>FIGURE NO.: 10A FIGURE NAME: DISSOLVED TOLUENE ISOCONCENTRATION MAP (ug/L)</p> | <p>OMEGA ENVIRONMENTAL SERVICES</p> |
|---------------------------------------|--|---|--|

LE ND

- MW-1 ◆ MONITORING WELL
 - W-1 ⊙ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
0 50 FT



NC 343

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FIGURE NO.: 108

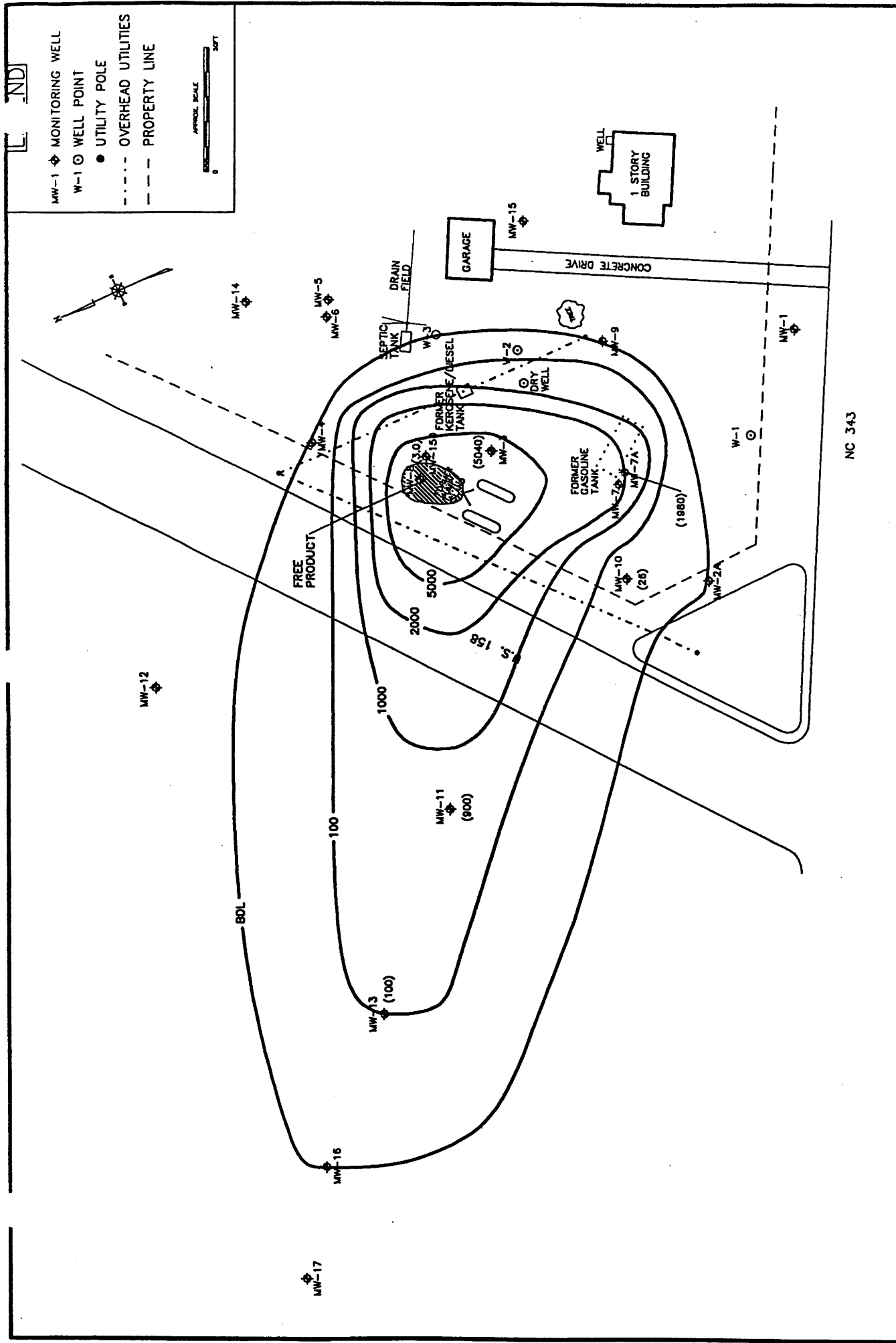
FIGURE NAME: DISSOLVED PHASE TOLUENE
150--CONCENTRATION MAP (ug/L) (FEB. 98)

CLIENT: HOLLOWELL OIL COMPANY

SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095

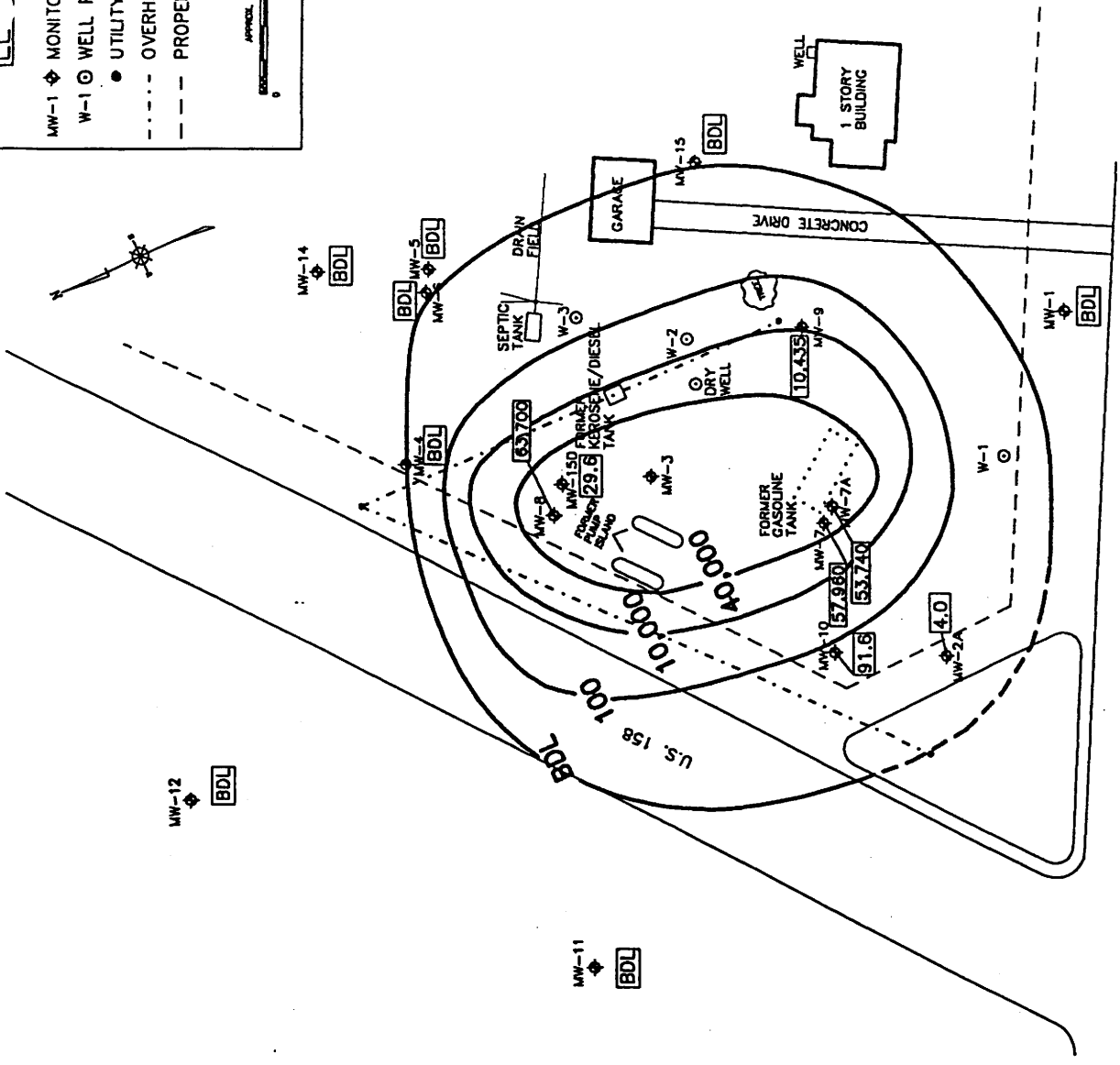
DATE: 2/27/98



| | | | |
|--|--|--|---|
| <p>OMEGA ENVIRONMENTAL SERVICES</p> | <p>FIGURE NO. 11B FIGURE NAME: DISSOLVED PHASE MTBE ISO-CONCENTRATION MAP (ug/L) (FEB. 98)</p> | <p>CLIENT: HOLLOWELL OIL COMPANY SITE: HOLLOWELL OIL CO., CAMDEN, NC</p> | <p>JOB NO. 97-095 DATE: 2/27/98</p> |
|--|--|--|---|

LE ND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROP. SCALE
0 50 FT



NC 343

JOB NO.: 97-095

DATE: 9/97

CLIENT: HOLLOWELL OIL COMPANY

SITE: HOLLOWELL OIL CO., CAMDEN, NC

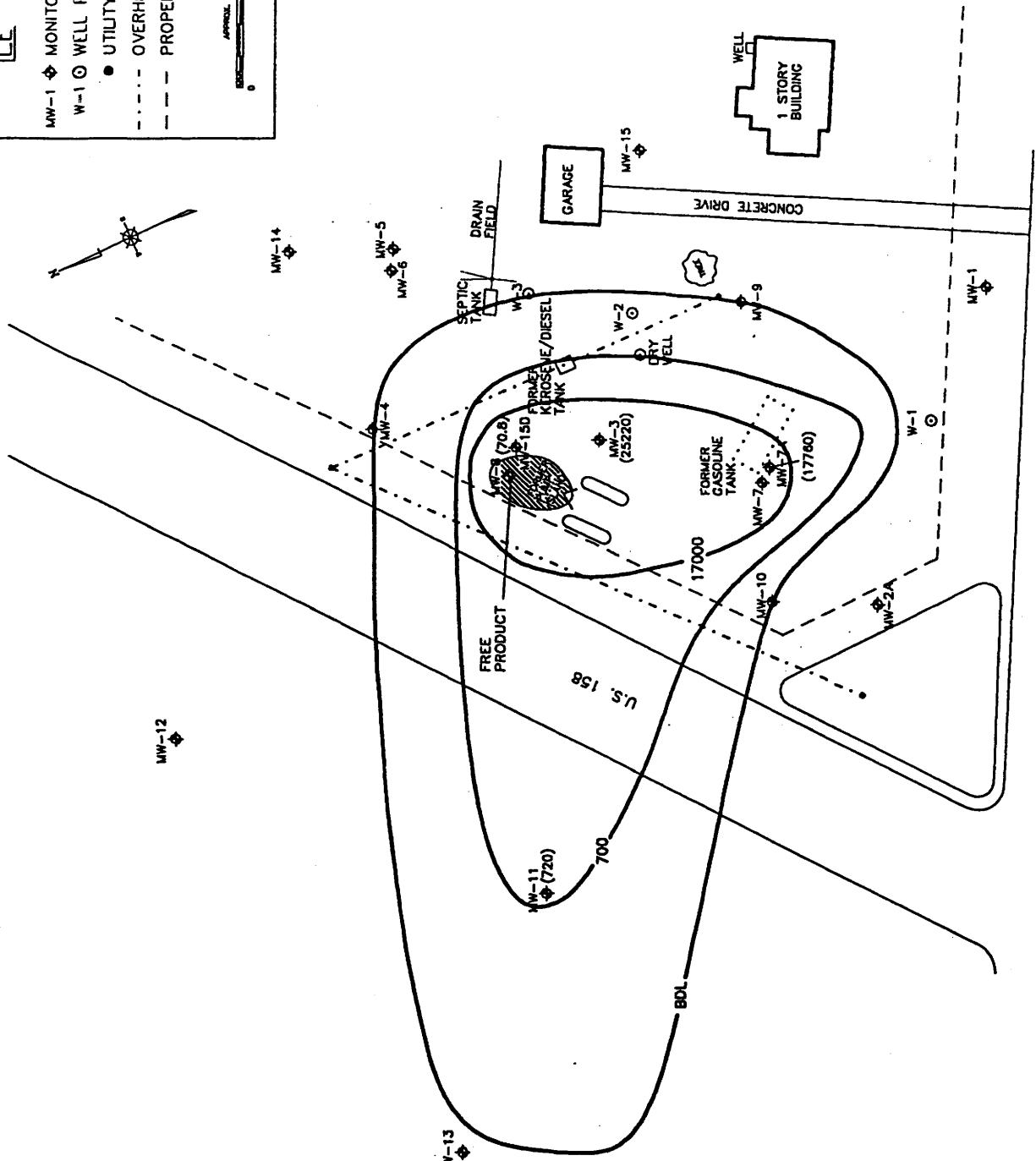
FIGURE NO.: 12A

FIGURE NAME: DISSOLVED BTEX ISOCONCENTRATION MAP (ug/L)

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LE ND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
0 50 FT



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FIGURE NO.: 12B

FIGURE NAME: DISSOLVED PHASE TOTAL BTEX
(ug/L) (FEB. 98)

CLIENT: HOLLOWELL OIL COMPANY

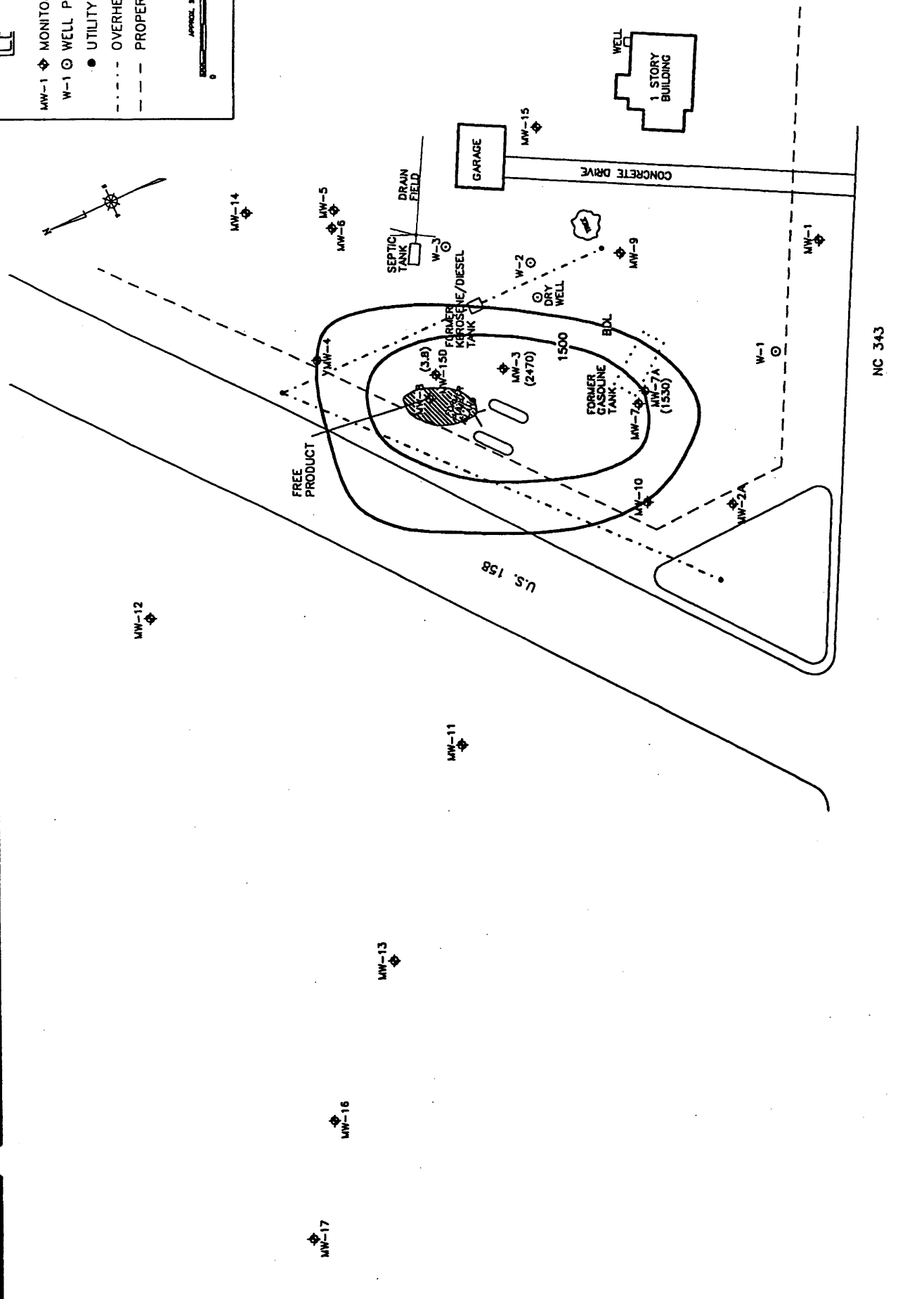
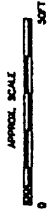
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095

DATE: 2/27/98

LE ND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - - OVERHEAD UTILITIES
- - - - PROPERTY LINE



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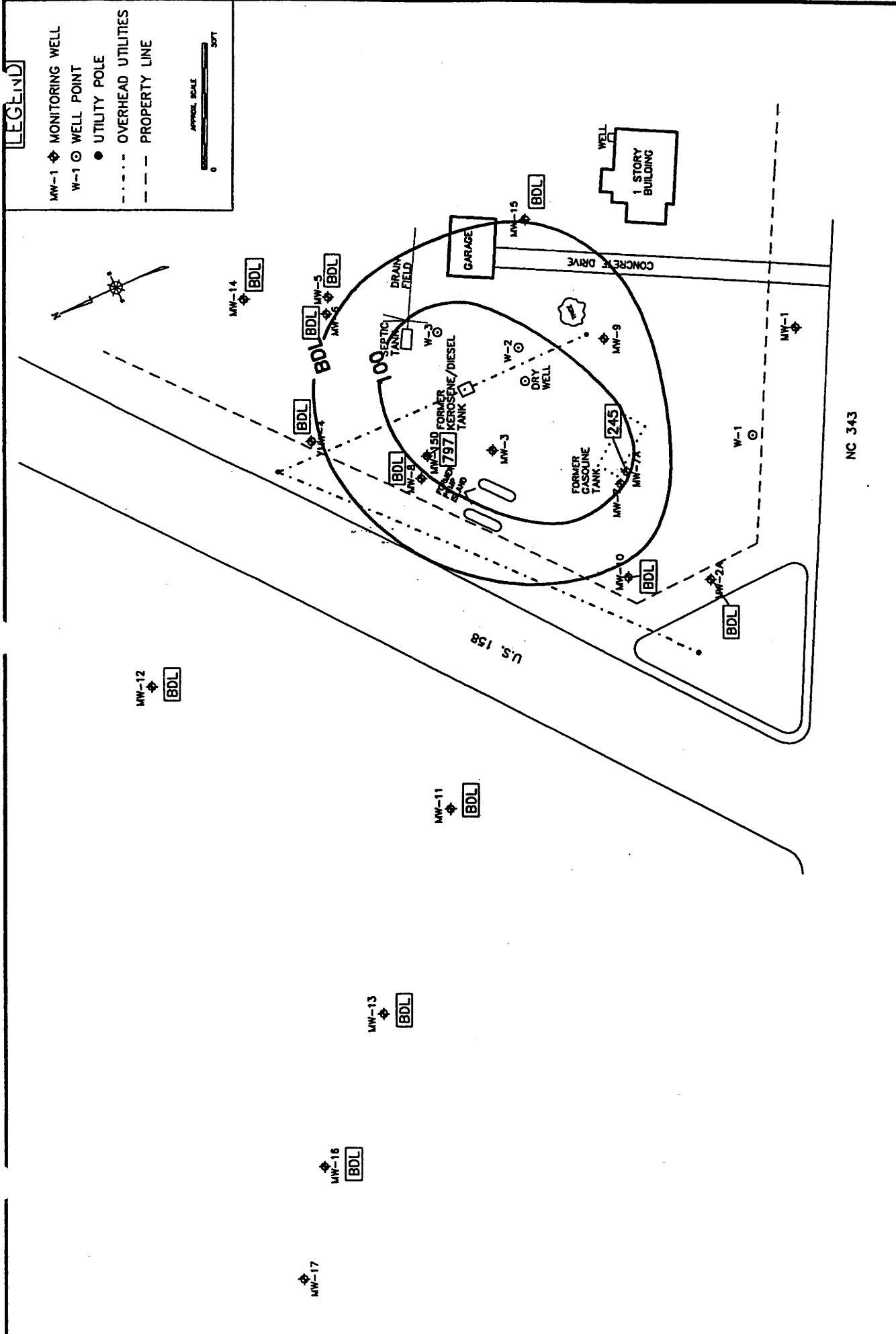
FIGURE NO. 13
FIGURE NAME: DISSOLVED PHASE ETHYLBENZENE
ISO-CONCENTRATION MAP (ug/L) (FEB. 98)

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 2/27/98

LEGEND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - OVERHEAD UTILITIES
- - - PROPERTY LINE



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FIGURE NO.: 14
FIGURE NAME: RESIDUAL PHASE TOTAL PETROLEUM
HYDROCARBON PLUME MAP

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 9/97

3.2 HYDROCARBON CHARACTERIZATION

Based on the information obtained to date, it is apparent that petroleum releases consisting of gasoline, kerosene and diesel have occurred at the site. The exact quantity of the kerosene and diesel releases are unknown, but based on semi-volatile(kerosene/diesel) hydrocarbon concentrations detected during this investigation appears to be small. The exact quantity of the gasoline release is also unknown, but based upon volatile hydrocarbon concentrations appears to be significant.

Gasoline consists of a mixture of C₄ to C₁₂ hydrocarbons. It is a highly flammable liquid, insoluble in water, and dissolves fats, oil and resins. Gasoline has a UEL (upper explosive limit) of 6.0 percent and LEL (lower explosive limit) of 1.3 percent. Exposure to gasoline can cause dizziness, vomiting and a burning sensation in the lungs.

The chemicals of primary concern with respect to a gasoline release are the naturally-occurring constituents of gasoline, benzene, toluene, ethylbenzene, and xylenes, known collectively by the acronym BTEX. Benzene is the chemical of greatest concern because it is reported to be a human carcinogen and is acutely toxic. Toluene, ethylbenzene and xylenes are not reported as carcinogenic, and are considerably less toxic than benzene. These chemicals and their relative toxicity's are discussed individually below:

Benzene - a colorless liquid with a strong but pleasant odor. It is slightly soluble in water, has a specific gravity of 0.72 to 0.76 (Merck Index, 1976), and floats on water. Benzene has a UEL of 7.1 percent and a LEL of 1.3 percent. It is a known human carcinogen used in the manufacture of many products. It is acutely toxic, and affects the central nervous system (i.e., dizziness, vomiting, headache, loss of balance, narcosis, and coma) in high concentrations (Virginia Department of Health Fact Sheet, 1985).

Toluene - a clear, colorless, non-corrosive, flammable liquid with a sweet, pungent odor, and is insoluble in water. Toluene is not carcinogenic to humans, and causes mild depression of the central nervous system (mild fatigue, weakness, confusion, lacrimation and paresthesia) at lower concentrations. At higher concentrations, it causes lightheadedness, dizziness, and unconsciousness (Virginia Department of Health Fact Sheet, 1987).

Ethylbenzene - a clear, colorless, flammable liquid with an aromatic, gasoline-like odor. It is insoluble in, and floats on water. Exposure to ethylbenzene can cause headache, sleepiness, eye and skin irritations, and difficulty in breathing, but is not carcinogenic to humans (Virginia Department of Health Fact Sheet, 1984).

Xylenes - refers to any mixture of three xylene isomers, ortho (O), meta (M), and para (P), which have varying densities and boiling points. All are clear, colorless, flammable, non-corrosive liquids with a sweet, aromatic odor. All isomers of xylene are insoluble in water. Human exposure to xylenes can cause headaches, weakness, nausea, vomiting, abdominal pain, irritability, dizziness and slowed reaction time.

Table 7 list the chemical characteristics of BTEX.

| Table 7. Chemical Characteristics of Selected Hydrocarbons | | | |
|---|-------------------|-------------------|-------------------|
| Compound | Solubility (mg/L) | K _{oc} | Half-Life (year) |
| Benzene | 1780 ¹ | 97 ¹ | 1.19 ² |
| Toluene | 500 ¹ | 242 ¹ | 0.39 ³ |
| Ethyl Benzene | 150 ¹ | 622 ¹ | - |
| O-Xylene | 170 ¹ | 363 ¹ | 0.32 ³ |
| P-Xylene | 156 ¹ | 552 ¹ | 0.17 ³ |
| M-Xylene | 146 ¹ | 588 ¹ | 0.29 ³ |
| N-Hexane | 9.5 ⁴ | 5900 ⁴ | 5 |
| References: ¹ Roy and Griffin (1985); ² Dragun (1988); ³ Sims, et al (1991); ⁴ Chiou, et al (1977) | | | |

3.3 EXPOSURE PATHWAYS/RECEPTOR IDENTIFICATION

Exposure pathways qualitatively connect a hydrocarbon source through one or more natural and man-made media to human and non-human receptor populations. Both on-site and off-site exposure pathways can include the following:

1. direct human exposure
 - a) ingestion of soil
 - b) ingestion of ground water
 - c) inhalation of air
 - 1) particulate
 - 2) vapor
 - d) absorption through skin from dermal contact
 - 1) soil
 - 2) ground water
2. indirect human exposure
 - a) bioaccumulation in fish (aquatic life)
 - b) bioaccumulation in game and livestock
3. non-human exposure
 - a) plants
 - b) fish (aquatic life)
 - c) game and livestock
 - d) real estate

The potential for contaminant exposure via ingestion and absorption is low as no adsorbed phase is exposed to the surface. However, future excavation activities may pose a threat as adsorbed phase hydrocarbons may be exposed. Vapor concentrations may pose a threat to the utility lines as these lines are located near the vapor plume. Presently, no petroleum odors have been noted in the vicinity of the utility lines. Omega is not aware of any reports of vapors, staining or other evidence of impact to the utilities in the area. The residual and dissolved phase petroleum hydrocarbons could possibly intersect the recently installed water lines. The back-fill of the water lines is most likely a sand fill similar to the native

soils of the area. Therefore, if the back-fill was compacted during the water line installation, this probably would not cause a preferential migration pathway for the dissolved phase contaminants. The area is not provided with sanitary sewer.

Since ground water is used as a potable water source; threat to human health via ground water consumption is possible. Except for the properties of Mr. Euthrell and Mr. Huddle, (Figure - 3) municipal water supply piping and meters have been installed at each residence and business in the area around the intersection of HWY 158 and HWY 343 in Camden, North Carolina. Although municipal water is available, many of the residents in the direct vicinity of the site continue to utilize their wells as a drinking water supply. Since the CSA and Addendum's were submitted, a number of properties have been connected to municipal water supply (Table-9). The installation of the new municipal water lines in the area, indicate that water usage in the area is likely to change. The down gradient supply well (Mary Gordon well) located in the apparent direction of plume migration has been sampled and showed no hydro-carbon impact.

Several surface water bodies are located around the subject site. The nearest surface water body is an unnamed tributary to Sawyers Creek, located approximately 350 feet north of the site. The ground water flow is apparently in a northerly direction and therefore this surface body of water is assumed to be the surface water receptor. The next closest is an unnamed tributary of the Pasquotank River, located approximately 1,600 feet south southeast of the site. This is apparently not the direction of ground water flow in the area of this site and is therefore not considered a surface water receptor.

3.4 POST REMEDIAL RESIDUAL CONTAMINATION

The residual phase petroleum hydrocarbons are above reportable limits. Therefore, soil remediation is necessary. No post remedial impact is expected to effect ground water quality. Utilizing the proposed technology the residual concentrations should fall below the target clean up levels per the discussion in Section 2.1. Once the contaminated soils are remediated, further ground water contamination via contaminated soils is unlikely.

3.5 EVALUATION OF RISK TO POTENTIAL RECEPTORS

As discussed in the CSA, the SOLUTE Fate and Transport model results indicate that impact to the down-gradient well receptor will occur at seven years at a concentration 0.00004 Mg/L Benzene, well below the North Carolina Ground Water Standard. The model indicates maximum impact will occur in the seventeenth year at a concentration of 0.052 Mg/L. The SOLUTE model predicts that impact to the nearest surface water receptor will occur at twenty four years, at a concentration of 0.00001 Mg/L. The maximum impact will occur in the thirty first year at a concentration of 0.000016 Mg/L, below the North Carolina Ground Water Standard. Impact to the supply wells up gradient or laterally gradient is unlikely. Quarterly monitoring of the wells between the contaminant plume and supply wells should confirm this fact. Potential receptors and levels of impact from the CSA are included in Table 8.

| Observation Points | 1 | 2 | 3 | 4 | 5 |
|---|----------|----------|----------|----------|----------|
| Distance (feet) from Source (MW-8) | 5 | 50 | 150 | 350 | 500 |
| Initial Impact (year) | 1 | 2 | 7 | 24 | NI* |
| Maximum Impact (year) | 3 | 7 | 16 | 31 | NI* |
| Maximum Benzene Concentration (Mg/L) | 17.90 | 2.92 | 0.052 | 0.000016 | NI* |

* NI - No Impact

| Address | Owner / Address | Occupant | Gradient (Up/Down) | Well / Municipal |
|----------------|---|--------------------------|---------------------------|-------------------------|
| 102 South 343 | Glen Gordon / 301 Magnolia Drive, Camden, NC, 27921 | Farm Bureau | Up | Well * |
| 104 South 343 | Lennon Godfry / 104 US 343 South, Camden, NC 27921 | Lennon Godfry | Up | Municipal |
| 106 South 343 | Minnie Sivills, PO Box 4, Camden, NC. 27921 | Unoccupied | Up | Well * |
| 108 South 343 | Jackie Huddle / 10680 Southeast Jupiter Narrow Drive, Hobe Sound, FL. 33455 | Unoccupied | Up | Municipal |
| 110 South 343 | Raymond Evans / PO Box 71, Camden, NC. 27921 | Albemarle LP Gas | Up | Well* |
| 109 South 343 | Jackie Huddle / Same as above | Ken Browne | Up | Well |
| 101 South 343 | Camden Co. School Board | Camden High School | Up | Municipal |
| 100 North 343 | Glen Gordon / Same as above | not available | Down | Municipal |
| 104 North 343 | Mary Gordon / 104 North 343, Camden, NC 27921 | Mary Gordon | Down | Well* |
| 106 North 343 | Widow's Son Lodge No. 75 | Widow's Son Lodge No. 75 | Down | Municipal |
| 109 North 343 | Mr. Euthrell / 109 North 343, Camden, NC. 27921 | Mr. Euthrell | Up | Well |
| 102 West 158 | Charles Hodges / 118 US 158 West, Camden, NC. 27921 | Charlie's Store | Up | Well* |
| 104 West 158 | Charles Hodges / Same as above | H & R Block | Up | Well* |
| 108 West 158 | Mr. Hastings | Mr. Hastings | Up | Municipal |
| Not Available | Glen Gordon / Same as above | U.S. Post Office | Down | Municipal |
| Not Available | Glen Gordon / Same as above | Bicycle Shop | Down | Well |

*Serviced properties awaiting connection

4.0 EVALUATION OF REMEDIATION ALTERNATIVES

When considering applicable remediation technologies, a comprehensive study of the available technologies is necessary. The actual remediation technology chosen will depend upon the phase(s) of hydrocarbons present. There are potentially four phases of petroleum hydrocarbons which may affect a site. These four include:

(1) Residual Phase: When a subsurface petroleum release occurs from a UST or AST, the product migrates downward via gravity through the unsaturated soils (vadose zone). As the product migrates downward, it is adsorbed to the soil matrix. The exact amount of petroleum product that is adsorbed to the soil is dependent upon several factors including the thickness of the unsaturated zone, pore size, grain size, and adsorptive capacity of the soil.

(2) Free Phase: When petroleum product reaches the water table aquifer, free-floating product will form on top of the water table due to the differences in density between petroleum and water. Under static conditions, the free phase plume will migrate in the direction of ground water flow.

(3) Dissolved Phase: When petroleum product comes into direct contact with the water table, the product slowly alters and may dissolve into the ground water. Additionally, dissolved phase petroleum located in the vadose zone can be transported downward via percolation of water from the ground surface. Under static conditions, the dissolved phase plume will migrate in the direction of ground water flow.

(4) Vapor Phase: Based on the volatility of certain petroleum products, vapor phase hydrocarbons may result from the presence of each of the aforementioned phases of hydrocarbons.

Remediation alternatives for hydrocarbon affected sites will usually fall into one of the following categories:

1. In-situ containment (no remediation)
2. In-situ remediation (in-place treatment)
3. Ex-situ remediation (removal and treatment)

4.1 IN-SITU CONTAINMENT

In-situ containment methods are used to provide a barrier that prevents the migration of hydrocarbons off-site. In-situ containment is not intended for the removal of hydrocarbons, but is practical for sites where it is deemed necessary to leave the hydrocarbon-affected soils and ground water in place. In-situ technologies include slurry walls, grouting, sheet piles, and hydraulic barriers.

Costs associated with these methods are extremely high and are generally only utilized for extremely large projects where soil and ground water removal are not practical.

4.2 IN-SITU REMEDIATION

In-situ treatment of hydrocarbons resulting from an AST/UST leak offers an alternative to ex-situ treatment. In-situ treatment methods can generally be divided into three categories: biological, chemical,

and physical. In-situ bio-degradation is based on the concept of stimulating microorganisms to decompose the hydrocarbon(s) of concern. In-situ chemical treatment involves the injection of a specific chemical(s) into the subsurface to break down chemical(s) or to flush the hydrocarbons. Physical treatments involve the manipulation of the soil by the use of air, steam, heat, freezing, etc. These methods may also be used in conjunction with each other.

4.2.1 In-situ Bioremediation

In-situ bioremediation utilizes naturally occurring soil microorganisms that are stimulated to biodegrade the hydrocarbon of concern. The most developed and feasible method of biodegradation involves aerobic (requires oxygen) microbial processes. This method involves optimizing the site conditions by providing oxygen and nutrients delivered through an injection well or infiltration system for the enhancement of microbial activity. This method can be utilized for both soil and ground water hydrocarbons. The use of surfactant can also enhance the efficiency of this method. However, this option is a long term passive way of remediating soil and ground water.

Estimated costs utilizing this method for the remediation of a typical 300 gallon gasoline spill will run from \$50,000 to \$150,000.

4.2.2 In-situ Chemical Remediation

In-situ chemical remediation technologies involve the injection of chemicals into the subsurface to 1) immobilize, 2) mobilize for extraction or 3) detoxify organic and inorganic compounds. Technologies used for immobilization include precipitation, chelation and polymerization. Methods utilized for mobilization of compounds include various methods of soil flushing. Detoxification is performed utilizing oxidation, reduction, neutralization and hydrolysis technologies.

Costs for chemical in-situ treatment technologies are not readily available because these methods of remediation have not been demonstrated and actual costs have not been documented.

4.2.3 In-situ Physical Remediation

In-situ physical remediation technologies involve the physical manipulation of the subsurface to immobilize or detoxify the hydrocarbon of concern. These technologies include in-situ heating, vitrification, and ground freezing.

In-situ heating involves the thermal breakdown, vaporization and/or distillation of the hydrocarbon. Steam injection and radio frequency (RF) heating are typically the recommended heating methods. The process utilizes horizontal conductors that are "excited" using an RF generator. The process requires approximately two weeks to complete and is accomplished at a temperature of approximately 300° to 400° F.

In-situ vitrification is based on "electric meter technology" which passes an electric current through a molten mass. This process transforms the affected soil into glass and crystallizes the hydrocarbons.

In-situ ground freezing involves the installation of "freezing loops" in the ground. The system pumps coolant through the loop and freezes the soil, thus creating a temporary impermeable zone.

The costs involved with these methods range from approximately \$300/cubic yard for vitrification to \$5,000,000 for RF heating for a one acre site.

4.3 EX-SITU REMEDIATION

Ex-situ remediation of affected soil includes excavation, and treatment using physical, biological or chemical methods and disposal. Ex-situ treatments can be accomplished by mobile treatment units constructed on-site or at other off-site treatment facilities.

4.3.1 Mechanical Excavation

This method includes the mechanical removal of affected soil from the ground. The exact quantity of soil removal will be dependent on site-specific conditions. Soil excavation costs range from \$1,500 to \$2,500 a day depending upon the size and quantity of the equipment used. This amount includes equipment and labor, but does not include transportation and disposal.

4.3.2 Ex-situ Thermal Treatment

The thermal destruction of hydrocarbons is performed using various incinerators (i.e. liquid-injection, rotary-kiln, fluidized-beds and multiple-hearth). The destruction is performed at high temperatures under controlled conditions of time, temperature, and turbulence.

Typical costs for thermal treatment of hydrocarbons range from \$65 to \$150 per ton, depending on the type of waste and transportation distances. Hauling cost is additional and is dependent on transportation distances.

4.3.3 Vapor Extraction

Vapor Extraction is used to remove volatile organic compounds and lightweight hydrocarbons from the unsaturated (vadose) zone. Air is mechanically drawn or vented through the unsaturated soil causing the volatilization of organic and evaporation of soil moisture. The actual rate of removal is affected by soil permeability and moisture content, applied suction pressures, air flow rate, temperatures, vapor pressures of the hydrocarbon and external boundary conditions. The vapor extraction systems may be active or passive by design. Vacuum extraction systems are most efficient if used at depth of >10 feet while passive venting systems rely on the mobility of air through the soil without the introduction of pressure gradients. Vapors are typically treated using activated carbon prior to discharge into the air.

Vapor extraction systems typically cost a minimum of \$25,000 for the initial installation of the system.

4.3.4 Air Sparging

Air Sparging involves mechanically pumping air into the water table aquifer causing the aquifer to "bubble". This process allows volatile organic chemicals to travel up through the aquifer to the vadose zone through adsorption to the induced air bubbles. This effectiveness of this method is dependent on several factors including soil types, contaminant type, and permeability. Air Sparging is typically used in conjunction with vapor extraction to more effectively remove the contaminants. Air Sparging also increases the oxygen content of the ground water thus enhancing natural and artificially induced biodegradation.

Air Sparging systems typically cost a minimum of \$75,000 for the initial installation of the system.

4.3.5 Ex-situ Biological Treatment

Biological treatment of affected soils can be performed on-site or off-site. The soils are excavated and placed in a lined treatment basin where bacteria and nutrients are applied and the soil is cultivated to increase the oxygen content, which in turn speeds the aerobic treatment. The bacteria may stabilize, absorb, alter or destroy the hydrocarbons.

The cost for performing bioremediation of soils will vary, depending on soil type, quantity of soil, temperature and initial hydrocarbon concentrations. Typical bioremediation services will cost \$20 to \$40 a ton. Hauling cost is additional and is dependent on distances.

4.3.6 Landfill Disposal

Petroleum-affected soils may be disposed of in permitted sanitary landfills or industrial landfills if the soils meet specified analytical criteria. These criteria will vary depending on the individual landfill or the state. Additional chemical analyses may be required by the individual landfills. This method is not feasible since very few North Carolina landfills accept petroleum contaminated soils.

4.3.7 Ground Water Pumping

Ground water pumping systems are used to remove ground water affected by dissolved or free phase hydrocarbons and to prevent the migration of hydrocarbon plumes. Pump and treat systems can also be used in conjunction with in-situ remediation schemes such as bioremediation. Ground water pumping is a method used to contain and recover the free phase, dissolved, residual and vapor hydrocarbons in the event of migration. In this scenario, pumping of ground water will create a "cone of depression," allowing the free phase product and ground water with dissolved phase hydrocarbons to move towards the recovery well.

Typical installation costs for a pump and treat system will range from \$75,000 to \$200,000.

4.3.8 Dual-phase Extraction (Liquid Ring)

Vacuum de-watering technology has been utilized in the construction industry for many years. A modification of this technology coupled with the use of high vacuum extraction pumps has been adapted for remediation of low permeability formations containing petroleum hydrocarbon constituents.

The recovery well for Liquid Ring remediation is constructed similar to a conventional pumped remediation well. However, water and vapor withdrawal are achieved through the use of a small diameter suction tube extending to the liquid control point. The suction tube is sealed at the well cap and connected via a manifold to an extraction pump capable of simultaneously processing both liquid and vapor.

Where transmissivity of a formation is very low; resulting pumping rates and influence zones can be quite small. The disadvantages of a traditional pump and treat approach are a large number of wells would be required and the long time frame required to complete remediation. Additionally, when drawing down

groundwater where free phase petroleum hydrocarbons are present in low permeability formations, the free product is not recovered, simply smeared throughout the new vadose zone created by the pumping action. Once the pump is shut off, the free product returns.

By vacuuming the free product, groundwater and vapors directly out of the recovery wells, the impacting material is eliminated from the subsurface at the point closest to where it occurs. Liquid Ring technology is limited to a practical maximum water lift of approximately 25 feet.

4.4 RECOMMENDATION AND RATIONALE FOR SELECTION

Due to the sandy nature of the soils, limited extent of residual phase contamination, and the shallow ground water table; Dual Phase Extraction is the most cost-effective method of remediating the residual and vapor phase contamination.

Since the contaminant concentrations (BTEX) are elevated on-site and off-site, impact has occurred. Active ground water remediation via Dual Phase Extraction is recommended. Dual Phase Extraction is the most effective remedial option that would best create and maintain hydraulic control of the grossly contaminated portions of the dissolved phase plume and recover dissolved phase hydro-carbons from the saturated zone.

5.0 PROPOSED CORRECTIVE ACTION PLAN

5.1 CONCEPTUAL DESIGN/PROCESS FLOW

The conceptual design for remediation of the Hollowell Site warrants a technology which will remove free product, along with dissolved and vapor phase directly from the ground without significant lateral transport. The technology Omega recommends for the site is a combination of active remediation, Dual Phase Extraction(DPE) utilizing a Liquid Ring Recovery System, combined with natural attenuation for the off-site and deeper contamination. Omega's recommendation for natural attenuation of the off-site and deeper contamination is based upon current and past monitoring data. This data suggests that the site specific conditions can result in natural degradation and attenuation. Utilizing DPE cleans up the vadose zone by drawing air through the pore spaces thereby evaporating volatiles and contributing to the aerobic biodegradation of other organic compounds. Omega also suggests that by removing the source of the off-site and deeper contamination, natural degradation will be even more effective.

Omega's recommendation for DPE at the site is based upon data gathered during the 11/11/1997 pilot test. This test concluded that Dual Phase Extraction (Liquid Ring technology) would be an effective and efficient means for remediation at the site. During the pilot study vacuum pressures of up to .70 inches of H₂O could be obtained 85 feet from the vacuum source.

Based on data collected during the Dual Phase Extraction Pilot Test, Dual Phase Extraction(DPE) utilizing an oil sealed Liquid Ring Recovery system or Aggressive Fluid Vapor Recovery (AFVR) utilizing a vacuum truck appear to be suitable remediation methods. Both technologies are essentially the same, utilizing a high vacuum, high flow pump to recover free product, dissolved phase and vapors simultaneously from the site. In the case of AFVR, a vacuum truck is mobilized to the site for recovery events and recovered fluids are transported and disposed at an approved facility. The proposed Liquid Ring recovery system utilizes an oil sealed Liquid Ring pump, transfer pumps, and conventional treatment methods to recover and treat free product, dissolved phase and vapor phase contaminants(Appendix D - Equipment Information and Specifications).

Omega proposes to utilize a Liquid Ring system versus a vacuum truck for the following reasons:

- 1) A Liquid Ring system is designed to operate for longer periods of time versus a vacuum truck,
- 2) A Liquid Ring system can be adjusted to site conditions more easily than a vacuum truck,
- 3) If necessary, vapors can be treated more easily with a Liquid Ring system versus a vacuum truck.
- 4) The proposed Liquid Ring system (DPE) utilizes an in-place system recognized as an approved soil and groundwater remediation method.

Omega proposes to utilize a DPE Liquid Ring system instead of the conventional pump and treat system for the following reasons:

- 1) A DPE Liquid Ring system can utilize existing wells as recovery points.

- 2) A Liquid Ring system can be adjusted to site conditions more easily than pump and treat.
- 3) Utilizing DPE has been shown to increase ground water yield 2 to 6 fold compared to pump and treat.
- 4) DPE remediates contaminated groundwater and soil.
- 5) Eliminates need for in wells pumps

Omega proposes an in place Liquid Ring system that will run 24 hours per day recovering liquids and vapors from monitoring wells MW-3, MW-7a, and MW-8. The liquids will be treated using conventional air stripping methods and then discharged to a surface drainage feature under a NPDES permit. If acceptable effluent discharge levels can not be achieved and permits can not be attained the liquids will be stored in a container on-site and pick-up by a disposal facility for proper disposal. During the Liquid Ring recovery events, quarterly monitoring will be conducted to determine the effectiveness of the technology. Based on the presence of free phase product at the site Omega will report the status of the free product on a quarterly basis.

The first monitoring event should be utilized to determine if the schedule and time frames suggested in this CAP are feasible. A report detailing the first event will be submitted to the NCDWQ along with any revisions or alterations to this CAP.

5.2 LIQUID RING PILOT STUDY

The mobile Liquid Ring recovery system used for the pilot study is essentially the same as an in place Liquid Ring DPE system because it utilizes a liquid ring pump, transfer pumps, filtering media and a liquids collection tank to recover free product, dissolved phase and vapors. Data collected during the Liquid Ring pilot study include; groundwater extraction rate, rate of contaminant removal, radius of influence, vacuum pressure and emissions flow rate.

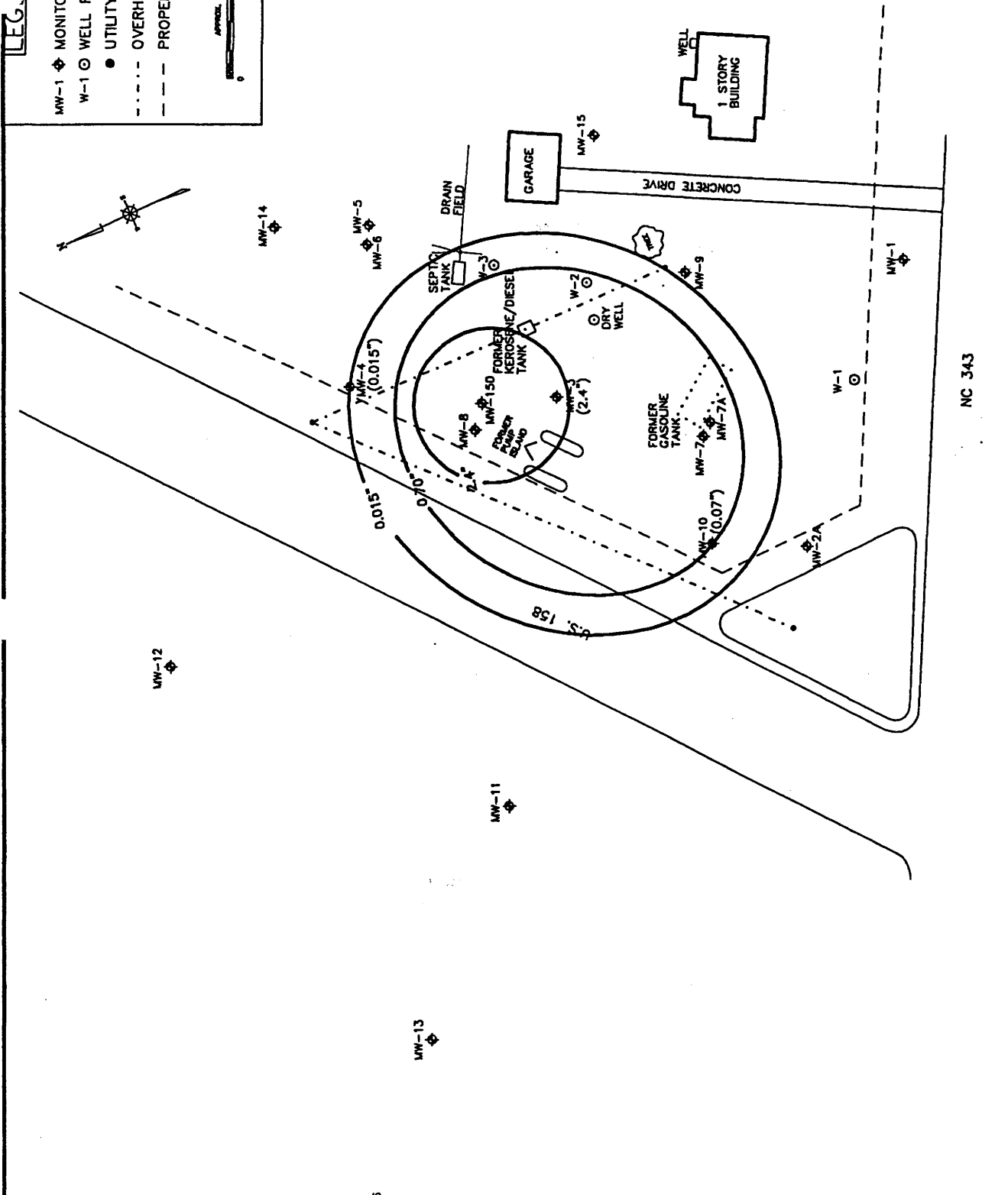
Addressing residual phase contamination, Omega suggests that the liquid ring technology with its radial influence will successfully recover hydrocarbon vapors from soil units lying within and around the screened intervals of the proposed of monitoring or recovery type wells. Residual phase data collected during preparation of the CSA and CSA Addendum's indicated detectable TPH concentrations in the area of MW-15D and MW-7A. Earlier investigations conducted by Law Engineering and Solutions Environmental depicted similar residual phase plumes. Due to the time that has passed, the accuracy of the data collected during the Law and Solutions investigations would be questionable. However, based upon data collected during the liquid ring pilot study, the residual phase depicted in these investigations would be remediated using the DPE method.

5.2.1 Field Methodology

On November 11, 1997, Omega mobilized to the site to conduct a Dual-Phase Extraction (Liquid Ring) pilot study. Omega utilized an mobile oil-sealed liquid ring recovery unit to perform the pilot study. Fluids recovered during the pilot study were collected in a 1000 gallon storage tank. Omega then utilized a vacuum truck to collect the recovered fluid and transport it to an approved facility for disposal. Disposal manifests are included in Appendix-A of this report.

LEGEND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - - OVERHEAD UTILITIES
 - - - - PROPERTY LINE
- APPROP. SCALE
0 50 FT



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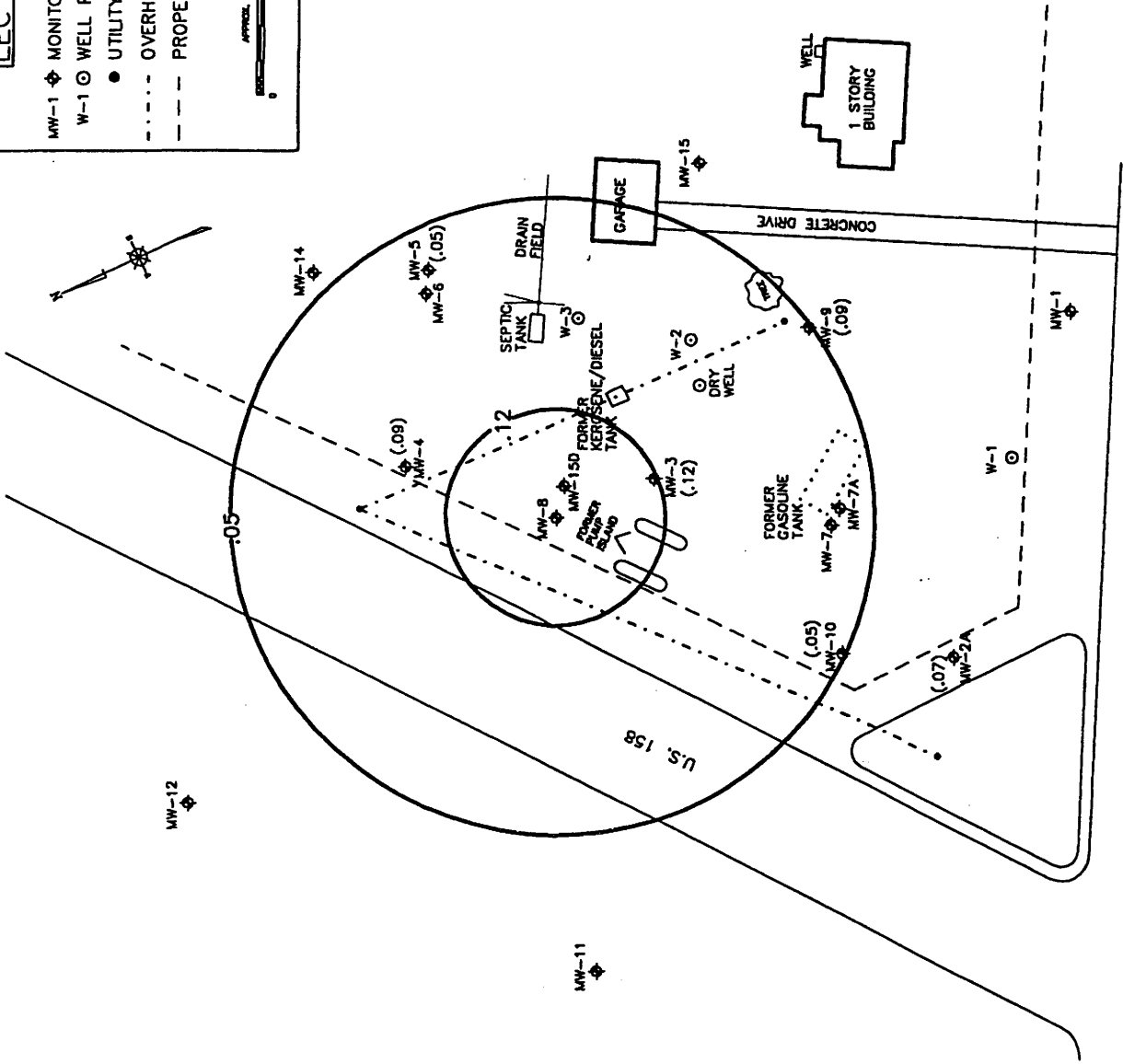
FIGURE NO. 15
FIGURE NAME: RADIUS OF INFLUENCE MAP
(2.4', 0.70', 0.015" H₂O) (11/97)

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO. 97-095
DATE: 11/18/97

LEC AND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROPRIATE SCALE
0 50 FT



NC 343

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FIGURE NO. 16

FIGURE NAME: GROUNDWATER CONE OF INFLUENCE MAP
(.05' + .12') (11/97)

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095

DATE: 6/97

The purpose of conducting a dual-phase pilot test is to determine the feasibility of utilizing liquid ring technology. Effectiveness of the technology is based vacuum performance, radius of influence, contaminant removal rates and other site specific characteristics and conditions. The pilot study was conducted to determine vacuum influence radius, vapor extraction rate, groundwater extraction rate and the rate of contaminant removal during the event. Data collected during the event included measuring exhaust temperature, relative humidity, TPH in parts per million (PPM), and exhaust velocity every 30 minutes for the duration of the event. Other data collected during the event included taking water-levels prior to, during and following the event. Water levels were collected at 30-minute intervals during the pilot study, using an oil/water interface probe at perimeter monitoring wells. Influence radius was obtained by utilizing three Minihelic™ gauges . The vacuum pressure gauges were positioned at perimeter monitoring wells at varying distances from the vacuum source. The minihelic gauges were used to monitor the vacuum influence at 30 minute intervals during the pilot study. To monitor the system performance, vacuum pressure readings were also taken from the system mounted gauges at 30 minute intervals during the event. Following the pilot study, total fluids recovered and total product recovered were recorded by gauging the system holding tank and flow meter.

5.2.2 Data Analysis

Data collected from the pilot test indicate conditions suitable for AF/VR or DPE (Liquid Ring) remediation methods. Vacuum influence up to .70 inch (H₂O) was detected in MW-10 located approximately 85 feet up gradient from the vacuum source (MW-8) and influence up to 0.15 inch (Hg) was detected in MW-4 approximately 45 feet down grade from the source. Graphical representation of the radius of influence is included as Figure - 15. Vacuum influence gauged during the pilot study extended partially, outside the limits of the dissolved phase plume. Measurable draw-down was recorded by gauging water levels of perimeter wells at thirty minute intervals during the pilot study. Draw-down up to 0.05' was recorded at a distance of approximately 85 feet from the vacuum source. Draw-down up to 0.12' was recorded at a distance of approximately 30 feet from the vacuum source. Omega field personnel measured PPM on 30 minute intervals using an OVA. This data was used to calculate the average pollutant mass removal rate(PMR). Average emissions concentration of 10,000 + PPM was recorded throughout the duration of the event. To ensure accurate removal rate calculations, Tedlar bag air samples were taken and analyzed for THP. By utilizing the formula found in the Groundwater Section Guidelines, rate of contaminant removal was established by calculating emissions data collected during the Liquid Ring pilot study. Other data obtained from the event includes area draw-down (Figure -16), and groundwater extraction rates.

The average groundwater extraction rate for the Liquid Ring pilot study was calculated to be approximately 24.95 gallons per hour. This rate was calculated by subtracting the amount of water in the subject well (MW-8), prior to pumping, from the total water recovered (gallons) and dividing by the duration of the event (hours).

Groundwater Extraction Rate Calculation

| | |
|-------------------------------|----------------------|
| Total water recovered: | 101.1 gallons |
| Water in well prior to event: | <u>- 1.3 gallons</u> |
| Groundwater recovered: | = 99.8 gallons |

Water recovered by vacuum ÷ duration of event = ground water extraction rate
 99.8 gallons ÷ 4 hours = 24.95 gallons recovered/hour

Using the equation for Pollutant Mass Removal Rate (PMR) the average contaminant removal rate from the Liquid Ring pilot study was calculated to be 3.65 pounds of product emitted from the exhaust stack per hour. This rate was determined by dividing the total product recovered, 14.62 pounds by the duration of the event, 4 hours. The product recovery rate of 3.65 gallons per hour is actually a conservative figure for the pilot study because some hydrocarbons remain in the dissolved phase, within the liquids recovered during the event. This rate of contaminant removal suggests successful contaminant recovery of multi-phase volatile organics. A humidity gauge, temperature gauge, OVA, Tedlar bag air samples and an anemometer were used to collect the data needed to calculate the PMR. During the four hour pilot study, eight readings of each parameter were taken then averaged. Tedlar bag air samples were analyzed and the results were averaged for PPM concentration. The averaged values were then used in calculating the PMR equation.

| Air Sample (PPM) | Average Temperature (°F) | Average Vapor Extraction flow rate (ft/sec) | Average Relative Humidity (%) |
|------------------|--------------------------|---|-------------------------------|
| 35,300 | 83.6 | 43.12 | 96.2 |

| Time | MW-3 | MW-4 | MW-5 | MW-10 |
|-------|------|-------|------|-------|
| Start | 0.00 | 0.00 | 0.00 | 0.00 |
| 13:30 | 1.2 | 0.015 | 0.00 | - |
| 14:00 | 2.4 | 0.015 | 0.00 | 0.7 |
| 14:30 | 2.4 | 0.015 | 0.00 | 0.7 |
| 15:00 | 2.3 | 0.01 | - | 0.7 |
| 15:30 | 2.2 | 0.01 | - | 0.7 |
| 16:00 | 2.2 | 0.01 | - | 0.7 |
| 16:30 | 2.2 | 0.01 | - | 0.7 |
| 17:00 | 2.2 | 0.01 | - | 0.7 |

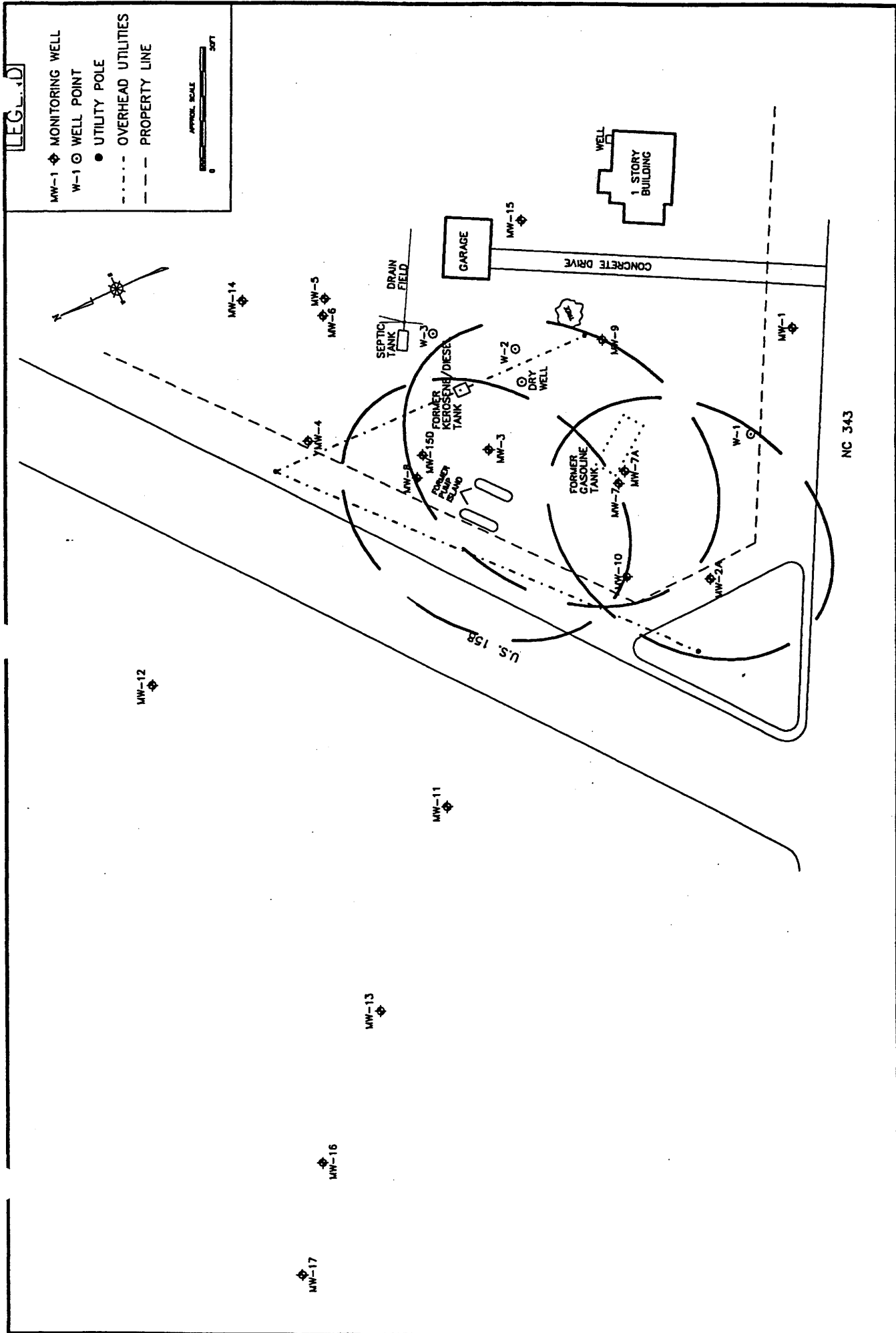
Note: (-) = No reading taken

| Time | MW-2a | MW-3 | MW-4 | MW-5 | MW-9 | MW-10 | MW-11 |
|--------|-------|------|------|------|------|-------|-------|
| 13:15 | - | 7.01 | 6.38 | 5.62 | - | - | 6.84 |
| 13:30 | 6.30 | - | - | - | - | - | 6.84 |
| 14:00 | 6.30 | - | - | - | 6.63 | - | 6.84 |
| 14:30 | 6.32 | - | - | - | 6.65 | 6.37 | 6.84 |
| 15:00 | 6.32 | - | - | - | 6.67 | - | 6.84 |
| 15:30 | 6.32 | - | - | - | 6.69 | - | 6.84 |
| 16:00 | 6.32 | - | - | - | 6.70 | 6.41 | 6.84 |
| 16:30 | 6.32 | - | - | - | 6.70 | 12.9 | 6.84 |
| 17:00 | 6.33 | 7.13 | 6.47 | 5.67 | 6.72 | 6.41 | 6.87 |
| Change | 0.03 | 0.12 | 0.09 | 0.05 | 0.09 | 0.04 | 0.03 |

Note: (-) = No reading taken

LEGEND

- MW-1 ◆ MONITORING WELL
 - W-1 ○ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
- APPROX. SCALE
0 10 20 FT



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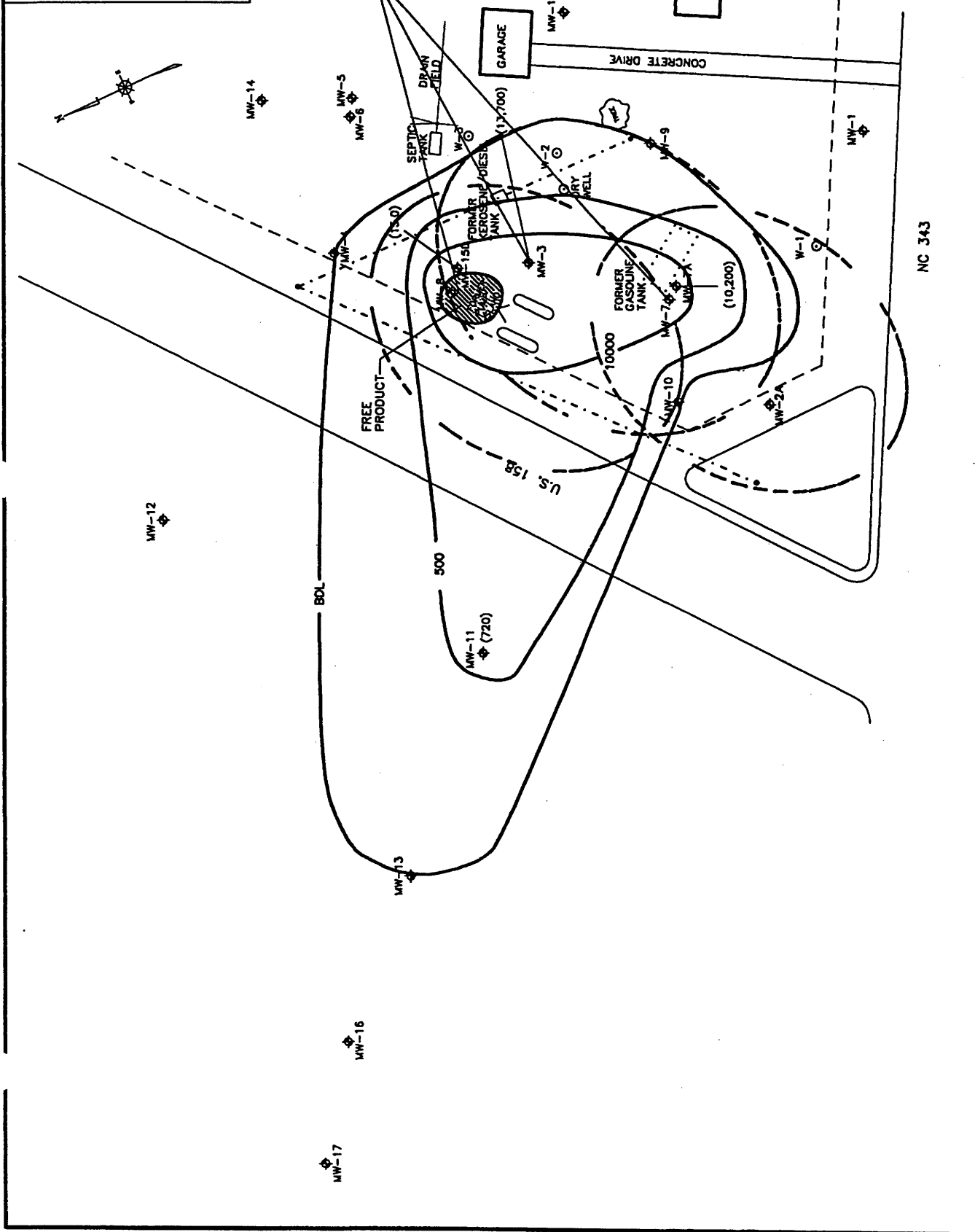
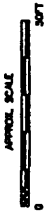
FIGURE NO.: 17
RADIUS OF INFLUENCE MAP FROM
FIGURE NAME, RECOVERY POINTS MW-3, MW-8, MW-7A
AT 0.70" WATER

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

JOB NO.: 97-095
DATE: 11/18/97

LEGEND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - OVERHEAD UTILITIES
- - - PROPERTY LINE



JOB NO.: 97-095

DATE: 6/97

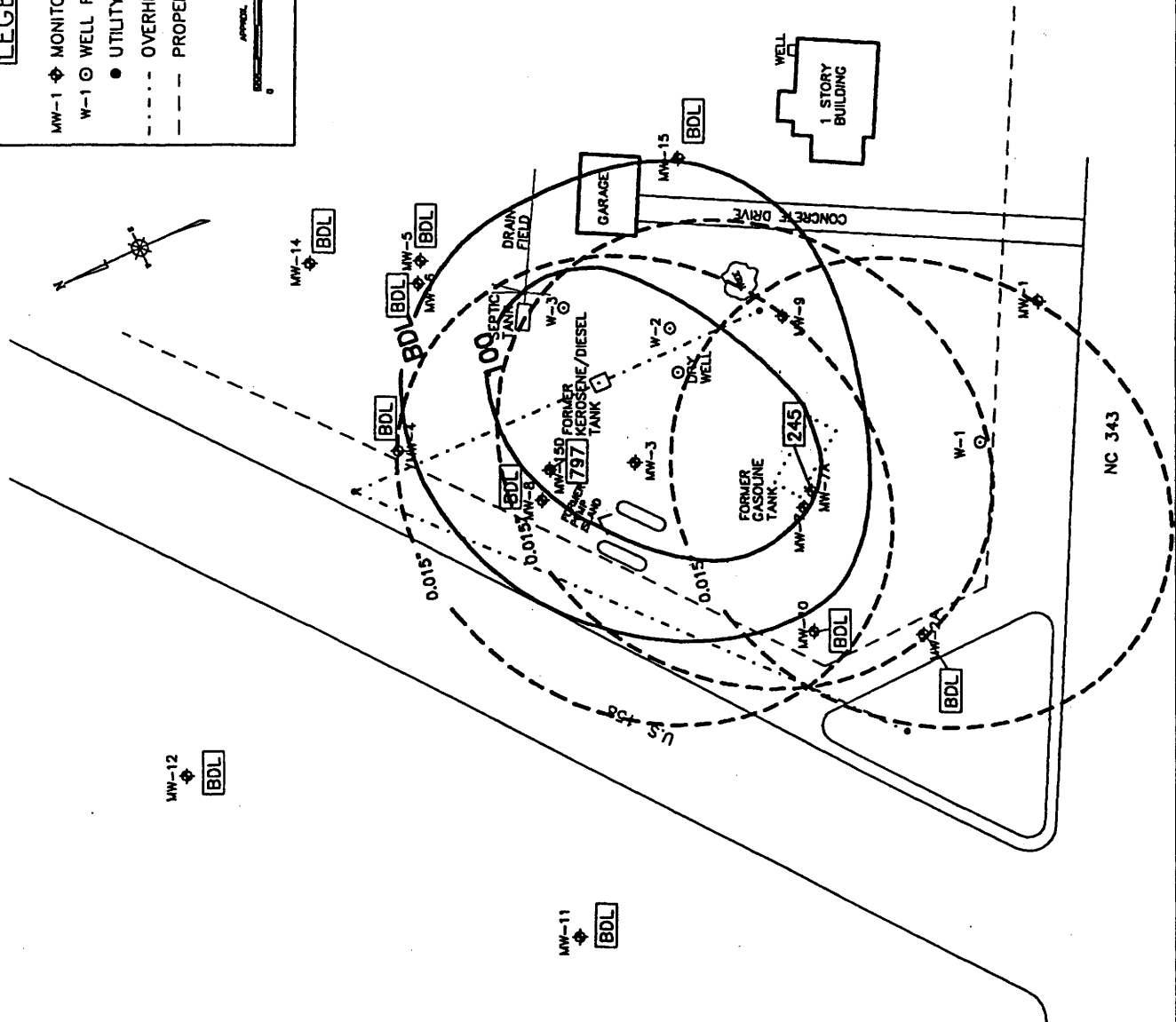
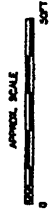
CLIENT: HOLLOWELL OIL COMPANY
 SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 18
 PROPOSED 3 POINT RADIUS OF INFLUENCE
 FIGURE NAME: (.70" H2O) WITH DISSOLVED PHASE
 BENZENE ISO-CONCENTRATION MAP (ug/L)

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LEGEND

- MW-1 ◆ MONITORING WELL
- W-1 ○ WELL POINT
- UTILITY POLE
- - - OVERHEAD UTILITIES
- - - PROPERTY LINE



JOB NO.: 97-095
DATE: 6/97

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC

FIGURE NO.: 19
PROPOSED 3 POINT RADIUS OF INFLUENCE (.015" H2O)
FIGURE NAME: RESIDUAL PHASE TOTAL PETROLEUM
HYDROCARBON PLUME MAP

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Based on data and calculation obtained during the pilot study; Omega proposes that the Liquid Ring technology(DPE) be utilized at the site to recover the dissolved, free phase and residual phase hydrocarbon contamination at the site.

Because the exact quantity of contaminant at the site is unknown, exact determination of a time frame for reaching target clean up levels is unlikely. Pollutant removal rates using Liquid Ring technology will vary throughout the duration of use as the rate will depend upon contaminant concentrations. Using the Liquid Ring technology, pollutant removal rates will decrease as contaminant concentrations decrease throughout the duration of the remediation method. Because the proposed technology recovers contaminants from multiple phases; determination of concentrations recovered from each phase is difficult.

5.3 EQUIPMENT SPECIFICATIONS AND INFORMATION

Conceptual process flow diagrams are included in Appendix D - Equipment Information and Specifications. Equipment information, function, and operation are reviewed. Manufacturer supplied information is provided in Appendix D.

5.3.1 Dual Extraction System

The DPE oil sealed Liquid Ring recovery system consists of a liquid/vapor separator, an automatic groundwater pump-out package, an air dilution valve assembly, an inline air filter, an oil sealed liquid ring pump package, duct and gauges.

5.3.2 DPE System Piping and Trenching

The Hollowell Site system will incorporate a series of trenches to interconnect the system housing to the three DPE wells, electric service and discharge piping. Figure 20 illustrates the piping and trenching layout at the site.

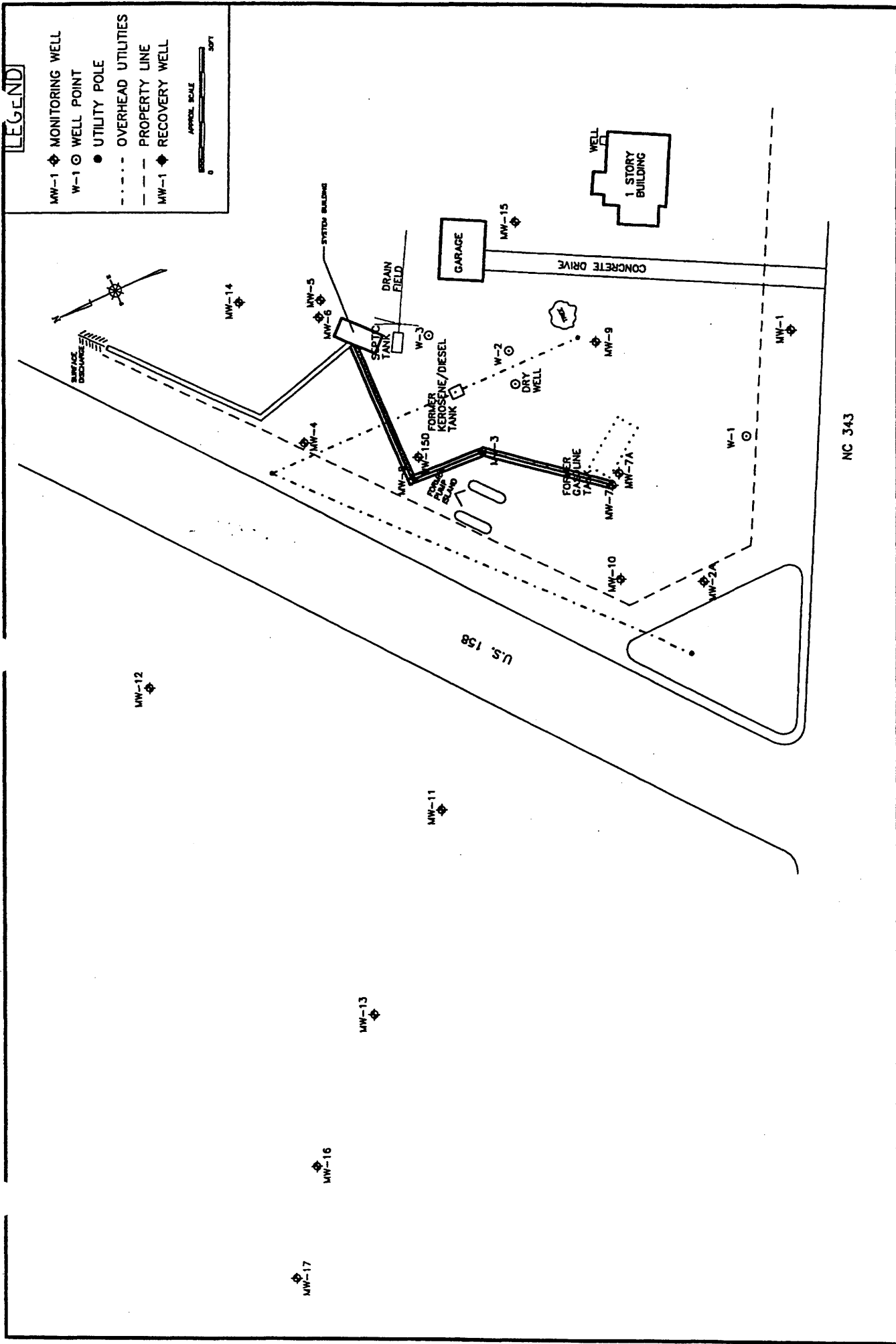
Trenches approximately 2 feet deep by 18 inches wide will be excavated for the piping which run from the system buildings to MW-3, MW-7 and MW-8 and to the system electrical and discharge piping. Asphalt will be saw cut where necessary. The proposed piping will be 2 inch schedule 80 PVC. The piping will be set in the bottom of the trench and the remaining excavation will be back-filled with native clean soils which will be compacted in six inch lifts. At a depth of one foot below grade, caution tape bearing the legend "CAUTION: BURIED UTILITY BELOW" will be placed along the length of the trench. After back-filling and compacting, the surface will be completed to match the existing surface treatment. The layout of the trenches for the underground piping are shown on Figure 20 - System Building, Pipe and Trench Layout.

Trenching Specifications:

- Asphalt will be cut with jackhammers or saw-cut to ensure clean, straight edges.
- Piping trenches will be 18 inches, 2 feet deep, and dug by a backhoe with a 2-foot wide bucket.
- Trenches will be barricaded or closed at the end of each day.

LEGEND

- MW-1 ◆ MONITORING WELL
 - W-1 ⊙ WELL POINT
 - UTILITY POLE
 - - - OVERHEAD UTILITIES
 - - - PROPERTY LINE
 - MW-1 ◆ RECOVERY WELL
- APPROX. SCALE
0 50 FT



OMEGA
ENVIRONMENTAL
SERVICES

FIGURE NO. 20
FIGURE NAME: SYSTEM BUILDING, PIPING AND TRENCH LAYOUT

CLIENT: HOLLOWELL OIL COMPANY
SITE: HOLLOWELL OIL CO., CAMDEN, NC
JOB NO: 97-095
DATE: 11/18/97

- Backfill will be placed in 6 inch lifts and compacted.
- All surfacing will be replaced to original conditions in accordance with standard engineering practices.

5.3.3 Extraction Wells

Three existing points will be utilized for recovery using DPE. These points (extraction wells) MW-3, MW-7a and MW-8 are each properly designed with 2" diameter PVC, .010 slot, construction. MW-3 is eighteen feet deep with a fifteen foot screened interval. MW-7a is seventeen feet deep with a fifteen foot screened interval. MW-8 is 13 feet deep and has a ten foot screened interval. The construction of these wells appears to be ideal for the recovery the residual contamination, as the most concentrated residual contamination lies at a depth of approximately 2 to 3 feet below surface. The screened interval on each of the wells extends up to two to three feet from the surface. The location of the wells (MW-3, MW-7a, MW-8) and the proposed radius of influence are depicted in Figure 17 - Radius of Influence. The relationship of the extraction wells to the Benzene plume is depicted in Figure 18 - Proposed Three Point Radius of Influence with Dissolved Phase Benzene Iso-Concentration Map.

5.3.4 Recovery Piping

The electrical service and the discharge piping will be buried below the frost line in the soil, estimated in this region to be approximately 24 inches. The discharge piping will be connected to prevent leaks and provide adequately for the pressures expected.

5.3.5 Electric Service

The system will require three phase, 60Hz, 230 volt service.

5.3.6 Groundwater Treatment System

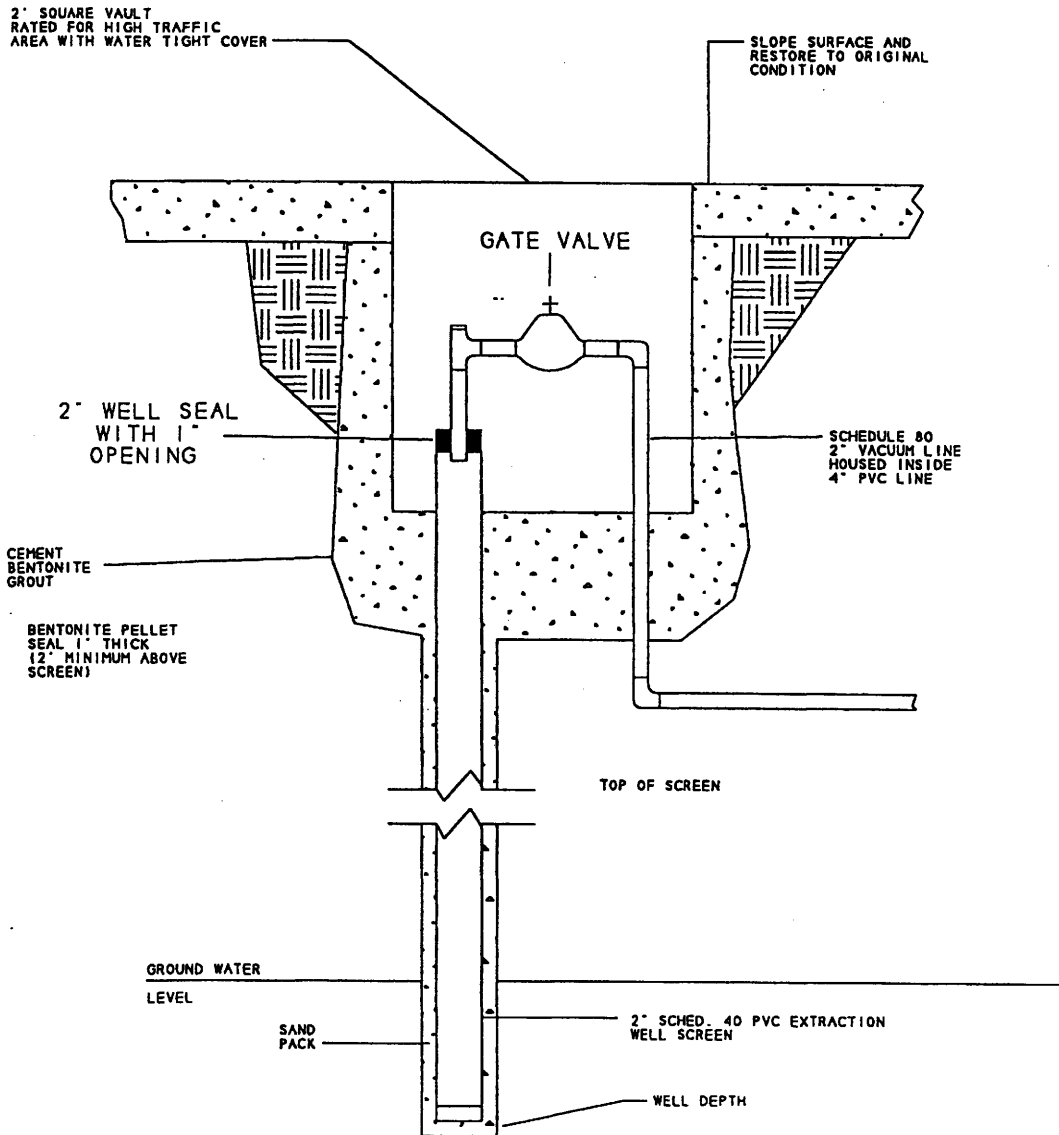
The OWS (Oil-Water Separator) will separate any recovered free product from the water stream and direct it to the recovery tank under gravity flow. The OWS uses a dense coalescing pack to remove the hydrocarbons. A high level probe in the 250 gallon recovery tank will shut down the system when the recovery tank is full. Required maintenance for the OWS will include: a monthly check of the fittings and piping for leaks, and a quarterly check and cleaning of the coalescing pack as necessary.

The transfer pumps are centrifugal pumps with explosion proof motors used to pump ground water through the Shallow Tray Air Stripper and the activated carbon units. These pumps require maintenance bi-monthly to verify proper operation.

5.3.7 System Control Panel and Telemetry

A central control and instrumentation panel will be designed to operate the dual phase extraction system and the groundwater treatment system. The control panel will be housed in a NEMA 4 enclosure for mounting outside of any hazardous, potentially hazardous or NEC classified area. Fail-safe controls are included to shut down the system if alarm conditions occur. The system panel requires regular maintenance for continued operation of motor starters, fuses and lights. The instrumentation will be intrinsically safe, and all motors will be explosion proof. The system will also be equipped with an ESO Proview remote telemetry control package. A designated phone line is required.

WELL HEAD CONFIGURATION



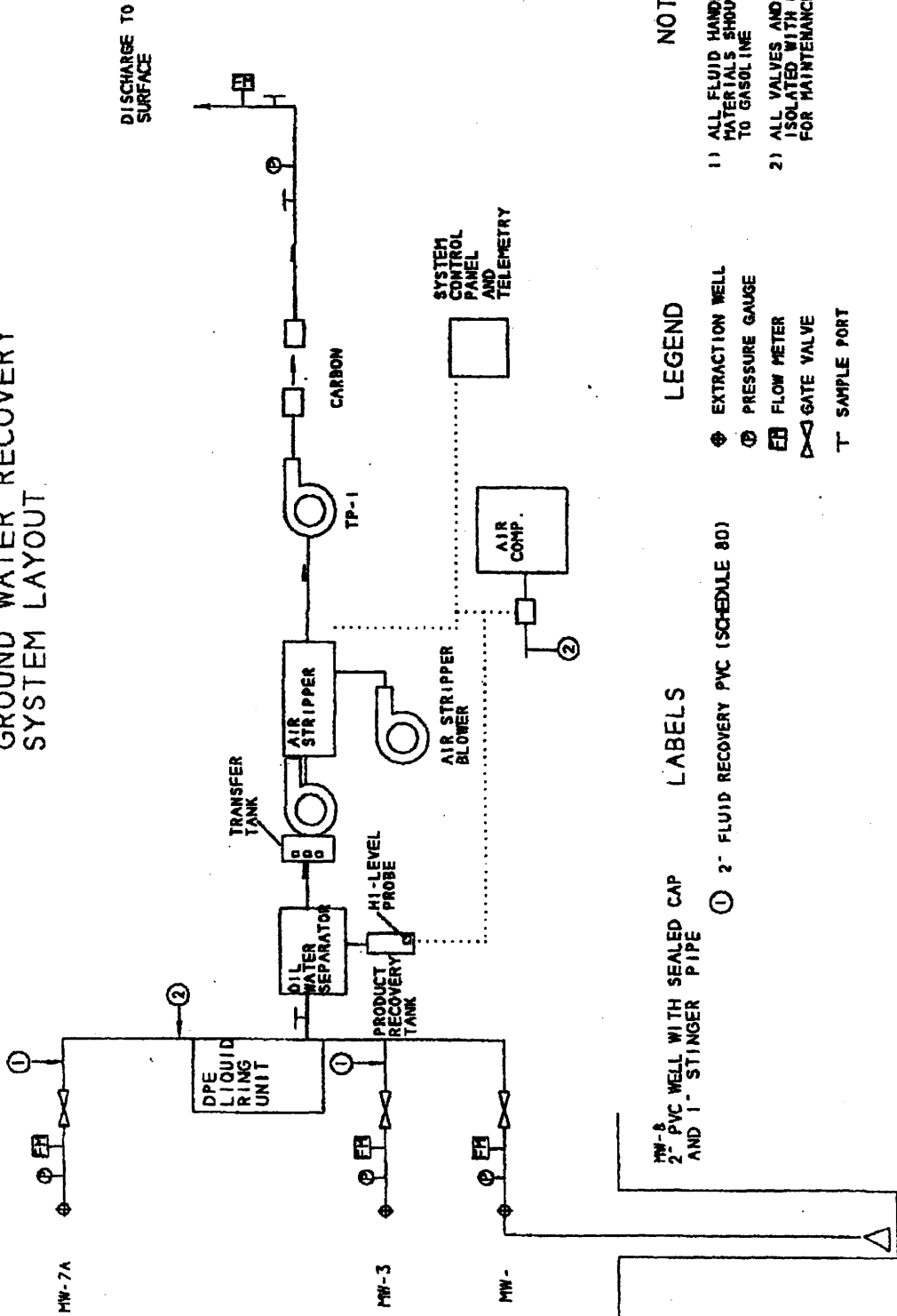
MW-3 - (15' SCREEN, 3' RISER)
 MW-7A - (15' SCREEN, 2' RISER)
 MW-8 - (10' SCREEN, 3' RISER)

JOB NO.: 97-095
 DATE: 4/1/98

CLIENT: ABERCROMBIE OIL
 SITE: HOLLOWELL SITE / CAMDEN, NC.

FIGURE NO.: 21
 FIGURE NAME: RECOVERY WELL CONSTRUCTION

GROUND WATER RECOVERY SYSTEM LAYOUT



MW-8
2" PVC WELL WITH SEALED CAP
AND 1" STINGER PIPE

① 2" FLUID RECOVERY PVC (SCHEDULE 80)

LABELS

LEGEND

- ⊕ EXTRACTION WELL
- ⊙ PRESSURE GAUGE
- ⊞ FLOW METER
- ⊘ GATE VALVE
- T SAMPLE PORT

NOTES

- 1) ALL FLUID HANDLING EQUIPMENT AND MATERIALS SHOULD BE RESISTANT TO GASOLINE
- 2) ALL VALVES AND EQUIPMENT SHOULD BE ISOLATED WITH UNIONS TO ALLOW ACCESS FOR MAINTENANCE

5.3.8 Structures

The remedial system will be housed in a wood framed shed approximately 10' x 20'. The system shed will be located on the southeast side of the property as depicted in the Horizontal Vapor Extraction Piping Layout diagram as System Building. The recovery system shed will be provided with overhead lighting and flow through ventilation. The sheds will also be equipped with a heater for freeze protection.

5.4 REMEDIATION BY NATURAL ATTENUATION

Based on economic considerations, remediation of off-site and deeper contamination using natural attenuation appears to be the most feasible method. To effectively utilize natural attenuation, the source of the current or potential contamination must be eliminated. Additionally, it must be demonstrated that the contaminants have the capacity to degrade under site specific conditions. Finally, when utilizing natural attenuation all receptors must be protected as required in 15A NCAC 2L .0106(L).

5.4.1 Elimination of Current or Potential Sources

Remediating soil contamination and gross groundwater contamination using DPE will eliminate future contamination sources to the off-site and deeper ground water. Utilizing the DPE method to remediate the soils would eliminate the leaching effect currently impacting ground water beneath the site. Additionally, utilizing DPE to effectively control and remediate the most grossly contaminated portions of the dissolved phase plume would result in decreased off-site and deeper contamination concentrations.

5.4.2 Process and Indicators of Natural Degradation and Natural Attenuation

Based on data collected during previous sampling events, effective degradation of the off-site and deeper contamination can be achieved using natural attenuation as the remediation method. This is demonstrated by comparing data from earlier sampling events to data from the most recent sampling event (Tables 1 and 2). Data collected during the most recent sampling event indicate decreasing contaminant concentrations in monitoring wells MW-3, MW-9, MW-10, MW-13, MW-7A and MW-2A..

Geo-chemical data collected during the sampling event also indicated conditions suitable for growth of micro-organisms. Generally, optimal pH ranges for the growth of bacteria is between 6.5-7.5. Geo-chemical data at the site indicated pH values between 5.0 and 6.0. Dissolved oxygen levels collected during the most recent sampling event, indicated lower values in dissolved oxygen content in the areas of higher hydrocarbon concentrations. Dissolved oxygen content in the contaminated areas ranged from 1.8 mg/L to 2.6 mg/L. While dissolved oxygen concentrations in non impacted areas ranged from 2.75 to 5.20 mg/L

The combination of all of these factors means that the organic compounds that have been released to the environment are undergoing natural degradation and have the ability to degrade under site specific conditions. Because sampling results indicate decreases in contaminant concentrations, and geo-chemical data indicate conditions suitable for microbial activity, Omega suggests natural de-gradation and attenuation as the remediation method for the off-site and deeper aquifer contamination.

Omega suggests that by eliminating current or future sources utilizing active remediation, dissolved phase contaminant concentrations can be expected to decline to below NCGWS. Confirmation of lowered concentrations will be depicted in future quarterly monitoring reports.

5.4.3 Protection of Receptors

Based on solute fate modeling shown in the Comprehensive Site Assessment, up gradient supply wells do not appear to be at risk from the on-site contamination. Quarterly monitoring should confirm this fact. Since the submittal of the CSA and Addendum's additional properties in the vicinity have been connected to the municipal water supply (Figure -3). Connecting the down-gradient properties to recently installed municipal water supply will eliminate the potential for future impact to receptors. Following connection of potentially impactable properties to public water supply, the risk of additional receptors becoming impacted is unlikely. Based upon information obtained during the supply well survey it appears that most of the nearby or adjacent properties have been equipped for future service. Based on solute fate modeling, contamination is not expected to intercept any surface waters. Additional water supplies are located within 1,500 feet; however based on site topography and solute fate modeling do not appear to be future receptors.

5.5 ESTIMATED COST OF SELECTED CAP IMPLEMENTATION

Costs for natural attenuation of the off-site and deeper aquifer contamination includes quarterly sampling and report preparation costs. Monitoring costs associated with the off-site and deeper contamination are included in the estimation of system monitoring. The estimated capital cost to install the selected remediation system is \$113,030.00. The estimated cost to operate, maintain, and monitor the system and site is \$72,480.00 annually. These costs include installing recovery trenching, equipment, site restoration, laboratory analytical costs, and all professional labor involved in CAP implementation. The following is a cost breakdown for system installation and O&M.

System Installation

Consultant

Permitting, construction oversight, final design plan set and as-builts, equipment procurement, equipment installation
(300 hours @ \$75/hour) \$22,500

Mechanical Contractor

Trenching 250 feet, install pipe and materials \$20,000

Electrical Contractor

Install new electric service for recovery system, install panel and supply materials, wire and conduit to connect all recovery equipment, install lights and heater in building, all work explosion proof or to meet all applicable codes \$12,000

Equipment

| | |
|--|-----------|
| One Travaini™ Oil Sealed Liquid Ring System model TRO 300v with 20HP 3/60/230, explosion proof blower, with pressure relief valve, duct and gauges, condensate removal package, pressure gauge, filter and capture tank..... | \$17,870 |
| Groundwater Treatment System; to include OWS, air stripper, granulated activated carbon canisters, process pumps, lines..... | \$13,115 |
| Controls, Alarms, Instrumentation and Telemetry; | \$8,858 |
| System Enclosure 10'x10'x20', HVAC, Electrical System, Vents and Ducts, Liquid piping system | \$18,687 |
| Subtotal..... | \$113,030 |

O&M and Monitoring (Annual)

Consultant

| | |
|--|----------|
| System break in, 40 hours a week 1st month @ \$55/hr | \$8,800 |
| Monthly site check, 16 hours, 11 months @ \$55/hr..... | \$9680 |
| Sampling equipment and supplies..... | \$4,000 |
| Laboratory cost, effluent, wells, other analyses | \$50,000 |
| Subtotal..... | \$72,480 |

TOTAL.....\$185,510

5.6 TARGET START-UP AND COMPLETION DATES

| | |
|--|--|
| Submittal of CAP | May 9, 1998 |
| Local agency and proper party notification. | May 15, 1998 |
| | (dates dependent on approval of CAP) |
| Development of Design Specifications | July 15, 1998 |
| Submittal of necessary permit applications | August 15, 1998 |
| System installation | October 1, 1998 to December 31, 1998 |
| | (dates dependent on approval of NPDES Permit) |
| System activation | January 1, 1999 |
| Commencement of Groundwater Monitoring..... | January 1, 1999 |
| 1st Quarter Corrective Action Status Report Due to NCDWQ | March 15, 1999 |

2nd Quarter Corrective Action Status Report Due to NCDWQ June 15, 1999
3rd Quarter Corrective Action Status Report Due to NCDWQ.....September 15, 1999
4th Quarter Corrective Action Status Report Due to NCDWQ..... December 15, 1999

System shut-down December 30, 2000
Project completion date January, 2001

Once the system is operational, the estimated time frame to achieve clean-up goals is 24 months.

See Sections 6.0 and 8.0 for schedules and reporting time frames.