MALCOLM PIRNIE

RECEIVED
OCT - 7 1992
HAZARDOUS WASTE REMEDIATION
NYSDEC REGION 1

NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS

FIREMAN'S TRAINING CENTER
BETHPAGE, NEW YORK

FEASIBILITY STUDY REPORT

October 1992

MALCOLM PIRNIE, INC.

One International Boulevard
Mahwah, New Jersey 07495

2 Corporate Park Drive
P.O. Box 751
White Plains, New York 10602

MALCOLM PIRNIE

NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS

FIREMAN'S TRAINING CENTER
BETHPAGE, NEW YORK

FEASIBILITY STUDY REPORT

October 1992

RECEIVED
OCT - 7 1992
HAZARDOUS WASTE REMEDIATION
NYSDEC REGION 1

MALCOLM PIRNIE, INC.

One International Boulevard
Mahwah, New Jersey 07495

2 Corporate Park Drive
P.O. Box 751
White Plains, New York 10602

ACKNOWLEDGEMENTS

The project team of Malcolm Pirnie is indebted to Peter J. Witkowski, Director of Hazardous Waste Services, and Kenneth Arnold, Nassau County Department of Public Works (NCDPW) for technical guidance in the development of this Feasibility Study. Also, the technical assistance and information provided by Michael Flaherty, Joseph Murtha, and Dena Miller, NCDPW, proved invaluable.

We acknowledge the support provided by other staff of NCDPW, especially Ludwig C. Hasl, Former Commissioner, Steven A. Fangmann, Deputy Commissioner, James A. Oliva, Acting Division Head Director of Environmental Operations, John Waltz, Acting Commissioner of Public Works, and Mary A. Pickard, Counsel.

We acknowledge the cooperation and information provided by the staff of the Fireman's Training Center, especially Chief of Instruction, Robert Lincoln, Jr.; Assistant Chief of Instruction, James Bugler; and Chief of Operations, John Baroni.

We would also like to acknowledge the technical assistance provided by George Heitzman, NYSDEC, Gail Suchman, NYS Department of Law and Ronald Tramonton, NYS Department of Health.

MALCOLM PIRNIE

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS

Page

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

Page

MALCOLM PIRNIE

Page

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

Page

Page

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

Page

Page

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

Page

MALCOLM PIRNIE

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

NCFTC FEASIBILITY STUDY
TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

1.0 INTRODUCTION

In February 1989, Malcolm Pirnie, Inc. was retained by the Nassau County Department of Public Works (NCDPW) to assist them in conducting a New York State Superfund Remedial Investigation/Feasibility Study (RI/FS) at the Fireman's Training Center (FTC) in Bethpage, New York. The work is being conducted under a Consent Order between Nassau County and New York State dated February 9, 1989.

A description of the scope of work for the FTC RI/FS is included in the RI/FS Work Plan dated July 1989. The draft RI was submitted to the New York Department of Environmental Conservation in September 1991. This FS evaluates alternatives for implementing a remedy for the contamination resulting from former operations at the FTC. The FS also satisfies one of the submittals required by the Consent Order.

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this report is to select and evaluate the appropriate measure(s) for remediation of contamination at the FTC. The selection is based on the results of field investigations conducted during the RI which determined the geologic, hydrogeologic, and chemical characteristics at the FTC. Based on information obtained during the RI, the following areas of contamination are associated with the FTC:

- Three bodies of liquid petroleum product were found floating on the water table at various times in the past at the FTC. The former product areas are currently submerged approximately six feet below the water table.
- Soil contaminated with adsorbed petroleum product in the areas of the floating product as seen in October 1989.
- Ground water at the FTC contaminated with soluble fractions of liquid petroleum product and dissolved solvents, principally chlorinated hydrocarbons, acetone and methyl ethyl ketone.
- Ground water downgradient of the site containing low concentrations of dissolved chlorinated hydrocarbons.

Those remedial measures found to be appropriate for application to the above areas of contamination are developed into viable alternatives in this FS. Remedial alternatives are then evaluated according to nine criteria specified by the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan, NCP). These nine criteria include:

- Overall protection of human health and the environment
- Overall compliance with applicable, relevant and appropriate requirements
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance
- State acceptance

The first section of the report presents the site description and history, the geologic and hydrogeologic characteristics of the site, and the nature and extent of contamination found on and adjacent to the site, and a summary of the endangerment assessment. The second section describes the remedial objectives for the project, and discusses the standards, criteria, and guidelines (SCGS) that must be considered during the remedial alternative selection process.

The third section of the report identifies remedial technologies applicable to the FTC contamination. Remedial measures for ground water, soil, and floating product are developed. These measures consider remedial technologies which consist of one or more of the following: extraction, treatment, disposal, and no action. Remedial technologies are described and screened in terms of effectiveness. Alternatives are developed from the effective technologies to address site contamination. The no action alternative is discussed as a baseline against which the other remedial alternatives are measured. A preliminary screening of the technologies is presented.

The fourth section develops the remedial alternatives that survived the screening. This section summarizes each alternative according to the nine evaluation criteria, as stipulated by the NCP, and compares the remaining alternatives.

1.2 SITE DESCRIPTION

The FTC is located in Bethpage, New York, adjacent to the Bethpage State Park near the Nassau/Suffolk County border. The FTC site is an active site on a 16.5-acre tract located on the west side of Winding Road, about 750 feet northeast of the junction of Winding Road and Round Swamp Road, and is bounded on the east, south, and southwest by the golf courses and wooded areas of Bethpage State Park.

The Oyster Bay Solid Waste Disposal Complex (OBSWDC) is located immediately north and northwest of the FTC. The OBSWDC was a 105-acre landfill operated by the Town of Oyster Bay, but has been closed. The OBSWDC is a New York State Superfund site. The OBSWDC has implemented both a perimeter gas collection system to control landfill gas migration and a series of extraction wells to collect contaminated ground water. The Claremont Industrial Park, another ground water contamination site, which is a listed Federal Superfund site, is located about 2,000 feet northeast of the FTC. Figure 1-1 provides the site location.

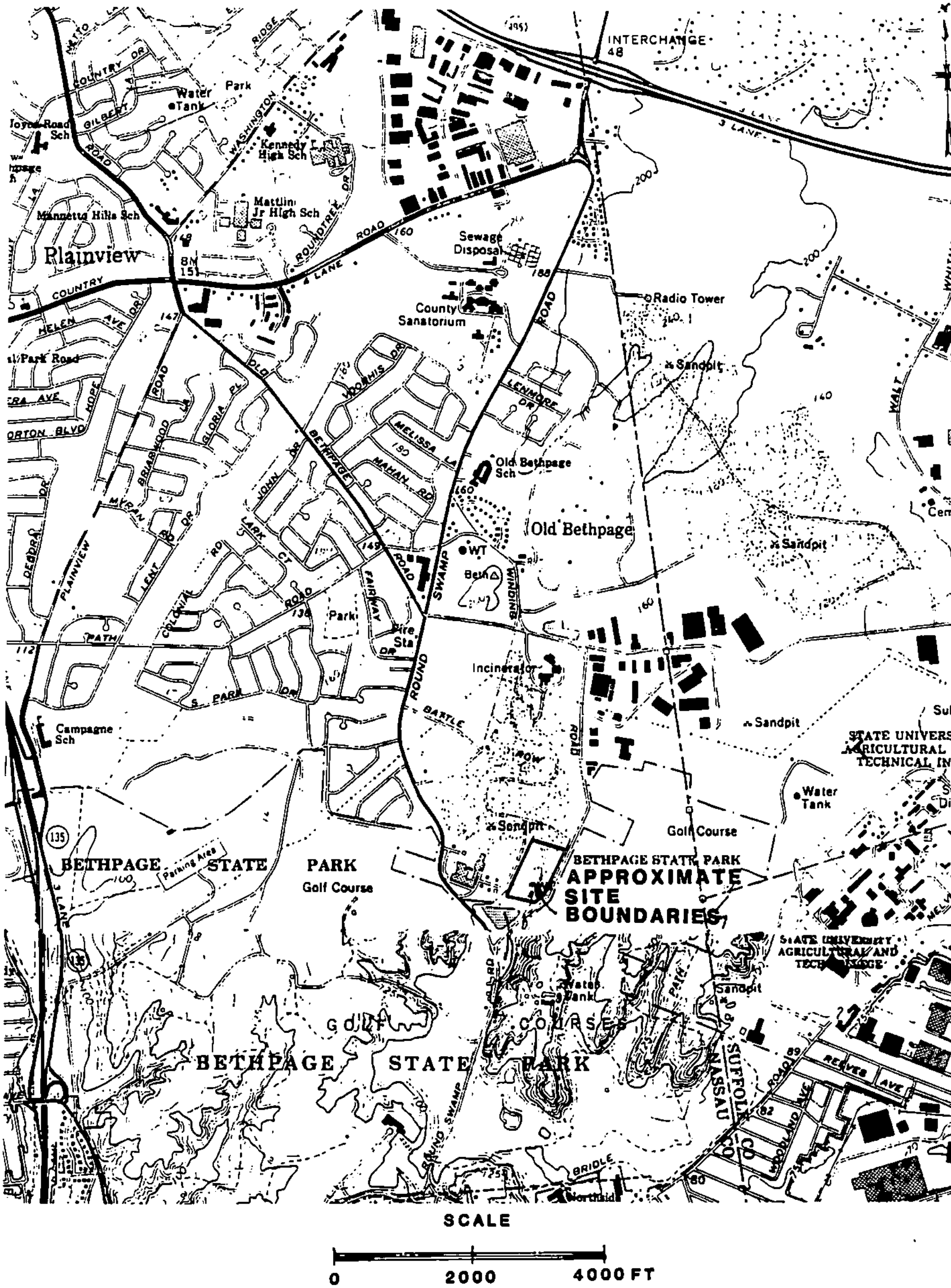
The FTC site consists of office and classroom buildings, mock-up buildings used for test burns, an oil-water separator, open burn areas, and an undeveloped section. The site plan is shown on Figure 1-2, with additional detail provided on Plate 1.

The land surface on the FTC is relatively flat with surface elevations ranging from about 95 to 110 feet above sea level. The southern two-thirds of the site is almost entirely paved and the undeveloped northern third of the site is unpaved. However, the undeveloped portion is scheduled for new construction over the next few years.

The area downgradient of the site is shown on Figure 1-3.

1.3 SITE HISTORY

The FTC has conducted fire training activities for Nassau County firemen from 71 volunteer fire districts since 1960. The site and the facilities are owned by Nassau County, and the training activities and administrative functions are directed by the Vocational Education and Extension Board of Nassau County. Site operations have consisted of fire fighting exercises in open burn areas and building mock-ups. No. 2 fuel oil and gasoline are the primary sources of ignition for the training fires. However, from about 1970 to 1980, various combustible organic chemicals were also reported to have been mixed with the oil

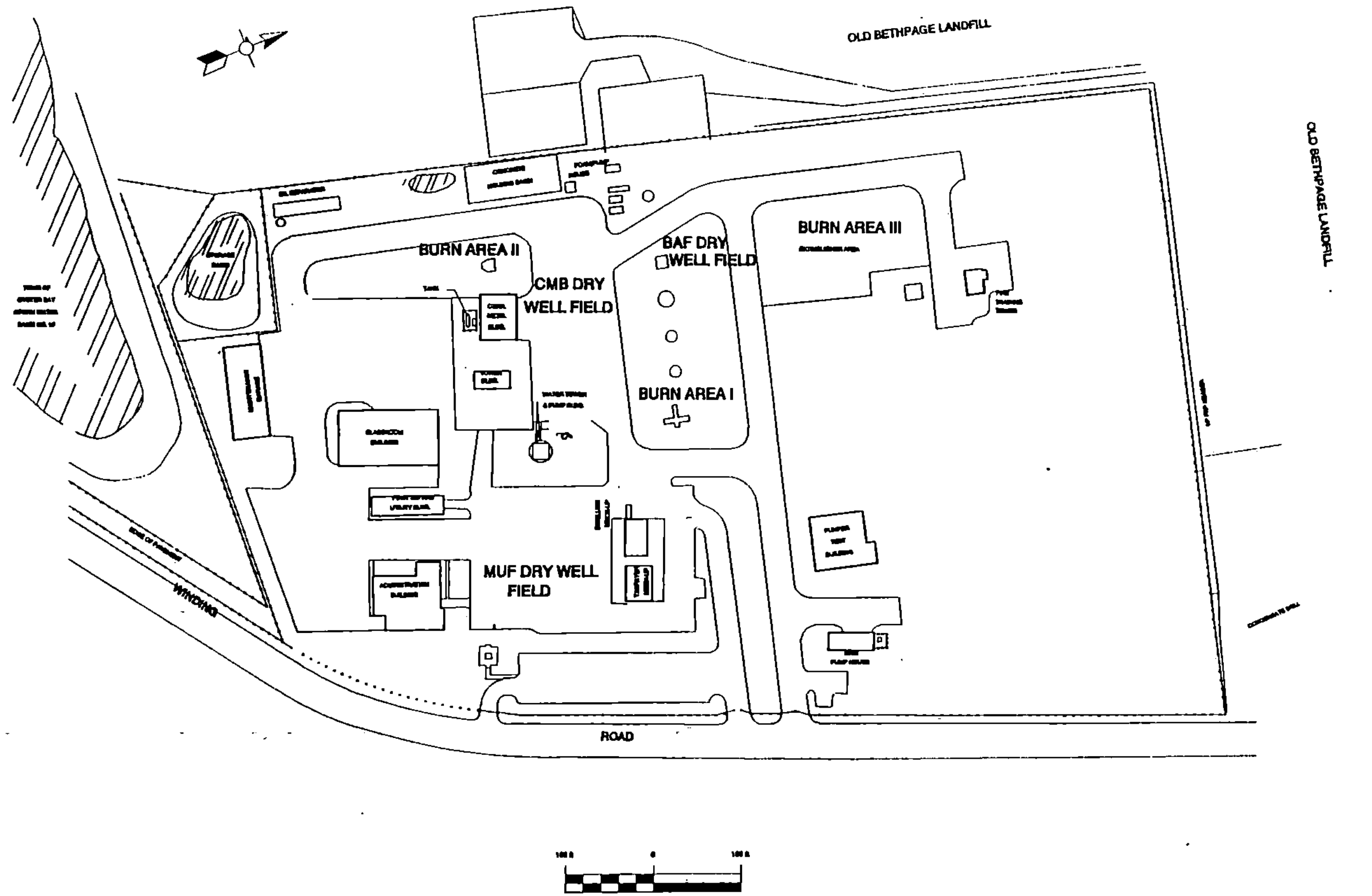


MALCOLM PIRNIE

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
FIREMEN'S TRAINING CENTER
SITE LOCATION MAP

MALCOLM PIRNIE, INC.

FIGURE 1-1



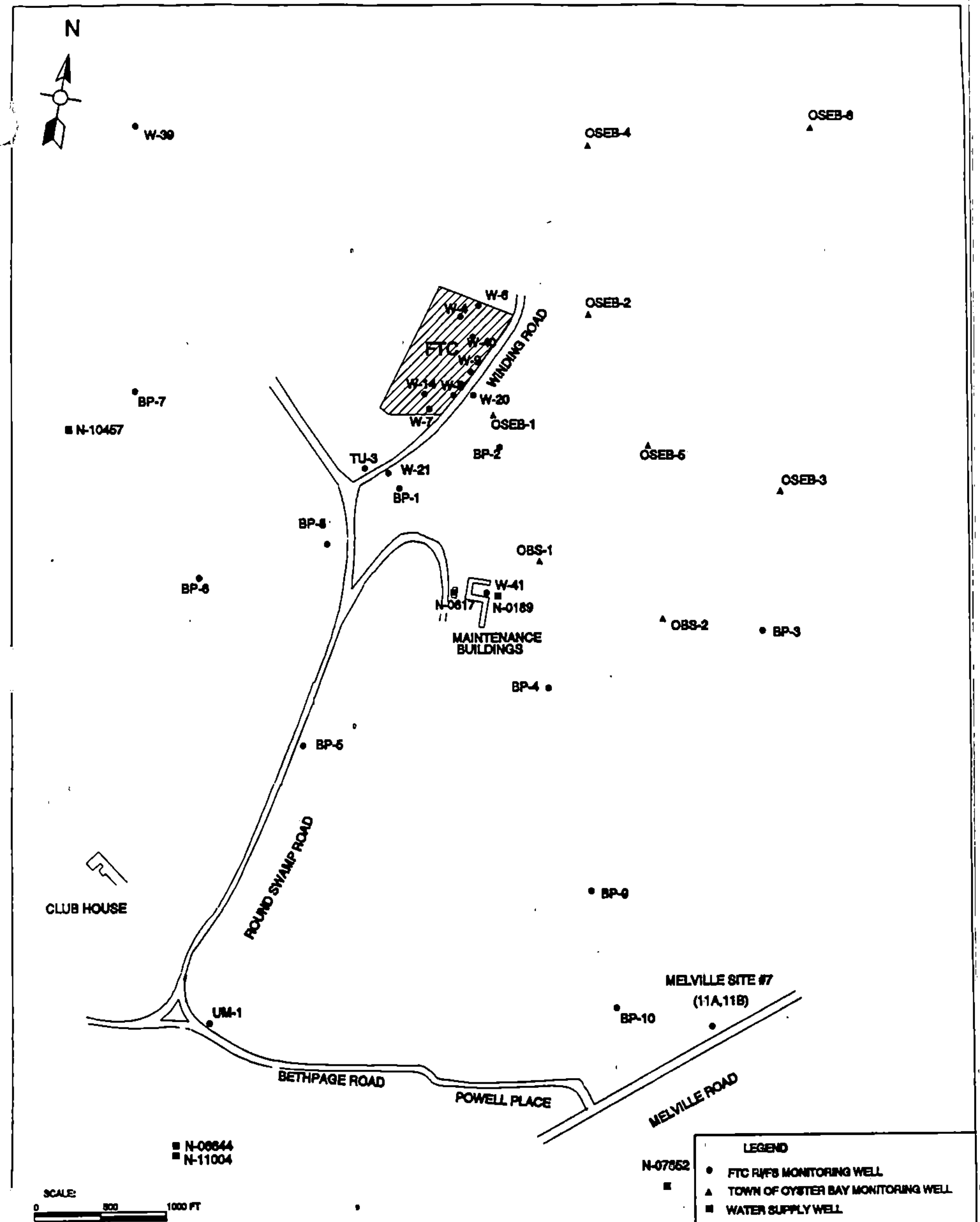
MALCOLM PIRNIE

NASSAU COUNTY FIREMAN'S TRAINING CENTER

SITE PLAN

MALCOLM PIRNIE, INC.

FIGURE 1-2



MALCOLM PIRNIE

NASSAU COUNTY FIREMANS TRAINING CENTER
AREA DOWNGRADIENT OF FTC
SHOWING MONITORING WELLS

MALCOLM PIRNIE, INC.

FIGURE 1-3

and used in the structures burned. The fires are further fueled with wooden pallets and straw. The firemen use high-pressure water hoses or chemical fire extinguishers to put out the fires. Training is presently conducted in three building mock-ups and three open burn areas.

Until 1984, unburned fuel and organic chemicals mixed with fire fighting water were washed over the FTC surface into nearby drywells. The drywells were constructed with unlined, open bottoms and were conduits for downward migration of the liquids into the subsurface soils and ground water. Additional subsurface contamination may have occurred by leakage of gasoline and fuel oil from shallow underground pipes used to supply fuels to some of the burn areas.

1.4 GEOLOGIC AND HYDROGEOLOGIC CHARACTERISTICS

1.4.1 On-Site Geology

Geologic and geophysical logs prepared by Malcolm Pirnie and geologic logs from previous studies on the site indicate that the FTC is underlain by sand, gravel, and silt and/or clay in alternating and sometimes discontinuous layers. Near the ground surface is fill material consisting of blacktop, concrete, and fine to coarse sand and gravel, which is found at most locations. The fill is generally no more than two to three feet thick, with a maximum thickness of five feet. Below the fill at all locations is a medium brown to orange brown, fine to coarse sand and gravel. This unit has little silt and/or clay, and varies in thickness from 7 feet to 13 feet. Geologic logs from wells located in the northwestern part of the site show that below the sand and gravel unit, a continuous, dense gray to brown clay layer occurs. The top of the clay is at a depth of approximately 10 to 15 feet below grade. Information from the RI and previous studies on the FTC indicate that the clay layer extends approximately 700 feet in the north-south direction and ranges from 0 to 15 feet in thickness.

Below the clay unit (where found) and the fine to coarse sand and gravel unit (where the clay is absent), is a fine to medium sand layer that generally contains little to trace amounts of silt and/or clay. This sand has been found in a variety of colors including cream, orange, tan and brown. It may be the upper most sediments of the Magothy Formation on the FTC. This unit is found at depths varying from 10 feet below grade and 25 feet below grade and occurs continuously to the bottom of all shallow on site borings, to a maximum depth of 55 feet below grade. In the deepest on-site boring (240 feet below grade), fine to medium sand extends throughout its depth.

1.4.2 Off-Site Geology

The geology of the area downgradient of the FTC is characterized from the pilot hole borings drilled for each well cluster. The geology here is similar to the upper glacial deposits, being relatively coarse (sand and gravel) when compared to the underlying Magothy. The Magothy contains discontinuous beds of silt, clay, sandy clay, and clayey sand. Some of these beds are continuous throughout the study area.

The geology in Bethpage State Park is the same as that found on the FTC and in the region. The shallow deposit is glacial outwash, which was deposited by meltwater streams flowing from the retreating ice front during the Pleistocene Epoch. The outwash deposits are typically characterized by stratified beds of brown to tan moderate to well-sorted, fine to coarse sand and gravel occasionally interbedded with thin layers of silt and clay. The Matawan Group-Magothy Formation Undifferentiated (Magothy) underlies the glacial deposits at a depth of about 34 to 108 feet below ground surface. This formation is upper Cretaceous in age and typically consists of moderate to well-sorted, very fine to medium sand with varying amounts of silt and clay. Discontinuous beds and layers of coarse sand and sandy, silty, and solid clay are common in the Magothy. The upper part of the Magothy was reworked during the Pleistocene Epoch by glacial streams and the contact with the overlying glacial deposits is obscured in some places. As a result of this stream action, the Magothy surface is extensively eroded and can vary in elevation by as much as 50 feet in the Bethpage area.

The Pleistocene deposits are designated as the Upper Glacial Aquifer and the total thickness of the Magothy comprises the Magothy aquifer. Collectively, these two units are the major water supply source in Nassau County and other parts of Long Island.

1.4.3 On-Site Water Level Measurements and Hydrogeology

Synoptic water level measurements in on-site monitoring wells were collected monthly during the onsite investigation phase of the RI. Ground water movement on the FTC, based on the water level measurements, is predominantly to the south-southeast in an arcuate pattern. Ground water enters the FTC from the north and moves south through the FTC, and leaves the site at the southeastern property line into Bethpage State Park.

The potentiometric surface defined by measurements made in wells screened approximately 80 to 100 feet below the ground surface indicate that to the east of the site, water in this deeper zone is also generally moving south to southeast. Comparisons of water levels in the shallow and deeper zones indicate a general downward vertical hydraulic gradient.

The hydraulic gradient on the FTC is relatively low, on the order of $1.1x10^{-3}$ feet/foot, indicating that ground water movement is on the order of approximately one foot per day.

A recovery well, RW-1, has been installed on-site. Analysis of the pumping test data from RW-1 showed that the zone it taps is unconfined. The cone of depression which developed during the test was nearly circular and had a radius of 290 feet. This response indicates a relatively homogeneous and isotropic aquifer. The transmissivity of the aquifer is on the order of 70,000 gpd/ft^2 and the storage coefficient is on the order of 0.23. Delayed yield effects dominate within 50 feet from the well.

1.4.4 Off-Site Water Level Measurements and Hydrogeology

Ground water in the vicinity of the FTC occurs in the basal part of the Upper Glacial Aquifer and in the entire thickness of the Magothy Aquifer. The upper part of the saturated zone is a thick sequence of sand with varying amounts of gravel, silt, and clay. Locally, the numerous interbedded clay and silt layers, which are usually of limited areal extent, impede vertical ground water movement, resulting in increasingly confined conditions with increased depth.

Synoptic water level measurements were made in the monitoring wells in Bethpage State Park on a monthly basis from their completion through the investigation phase of the RI.

Based on the depth of the wells contaminated, three zones have been identified for means of evaluating ground water movement. The "A" Zone is the water table, the "B" Zone includes wells screened from at least 20 feet below the water table to a depth of approximately 200 feet below grade. The "C" Zone includes wells screened approximately 200 to 300 feet below grade.

Water level contour maps show ground water elevations in the "A" Zone to be consistent with ground water moving to the south and southeast under an average hydraulic gradient of approximately 1.8×10^{-3} feet/foot.

Potentiometric elevations in the "B" Zone indicate that the horizontal component of ground water movement in this zone is predominantly south-southeast through the FTC and into Bethpage State Park, similar to the water table. The average hydraulic gradient in the "B" Zone is approximately 1.5×10^{-3} feet/foot. Flow in the "C" Zone was similar to the "B" Zone.

A comparison of elevations in the zones shows a general downward hydraulic gradient averaging 3.0×10^{-6} feet/foot and thus, a potential for a downward component of ground water movement. Water level data was recorded in wells BP-10B and BP-10C from July 22 to August 11, 1992 using Stevens water level recorders. Water levels measured in BP-10C fluctuated up to 1.5 feet during the study period. The high amplitude and frequency of the fluctuations is characteristic of influences caused by pumping. During the study period, water levels in BP-10B fluctuated over 0.2 feet but the changes occurred gradually without the spikes seen in the water level record of BP-10C. Gradual water level decline occurred in BP-10B during periods of sharp decline in BP-10C implying slight, but possible, communication across the semi-confining layer separating the B and C zones. For example, from August 4 to August 8, intermittent pumping in the C zone depressed the daily high water level in BP-10C, a total of 0.45 feet. During the same period, the water level in BP-10B decreased 0.16 feet.

The similarity in the water level records suggest that the two zones are being influenced by the same source; probably the Farmingdale Well N-07852. The influence is greater in the C zone showing that the source is in that zone. Correlation of the water level records with pumpage records does not conclusively show which well or wells are affecting the zones. Although some hydraulic communication may exist between the two zones, the small degree of correlation in water level changes between BP-10B and BP-10C implies that two separate hydraulic zones exist.

1.5 NATURE AND EXTENT OF ON-SITE CONTAMINATION

Sources of contamination identified on the FTC include contaminated soil, former floating bodies of gasoline and No. 2 heating oil, and contaminated ground water. Three areas of soil contamination have been identified in the Mock-up Field (MUF), Corrugated Metal Building (CMB), and Burn Area Field (BAF) drywell fields. The extent of soil contamination is shown on Plate 2. Soils in the vicinity of the MUF and BAF fields are contaminated with total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX) from the bottoms of the drywells down to the water table. In the MUF area, TPH concentrations range from greater than 100 mg/kg to 130,000 mg/kg and BTEX concentrations range from greater than 100 mg/kg to 7,830 mg/kg. In the BAF area, TPH ranged from 110 mg/kg to 19,000 mg/kg and BTEX from greater than 100 mg/kg to 9,600 mg/kg. In the CMB area, TPH concentrations range from 61 mg/kg to 1,500 mg/kg and BTEX concentrations range from not detected to 110,000 mg/kg. The areas of contaminated soil extend laterally about six feet from each MUF drywell and about 12 feet from each BAF drywell. In the CMB area, soil contaminated with TPH and BTEX extends to a depth of eight feet below the bottoms of the drywells and eight feet laterally.

The volume of contaminated soil has been estimated at 2,200 cubic yards in the MUF drywell area, 5,100 cubic yards in the CMB drywell area, and 5,500 cubic yards in the BAF drywell area. In each area, the contaminated soil occurs in columns extending vertically downward from the bottoms of the drywells.

In addition to the three drywell fields, an estimated 7,500 cubic yards of contaminated soil has been identified beneath the three burn area fields, BAF I, BAF II, and BAF III. Most of this soil contamination occurs between land surface and a depth of five feet.

Additional soil contamination has resulted from contact of the three former floating bodies of petroleum product with soil. Monthly water levels collected from April 1990 to April 1991 indicate that water levels fluctuated during that period by approximately two feet, as measured in wells W-7A, W-27, and W-35. Historical data from well W-7A shows that the water level in it has increased 8.48 feet from November 1988 to March 1991. These fluctuations result in exposing the soil to contamination from the former bodies of floating product. The RI report estimated that a 10 foot thick band of contaminated soil (currently masked by the higher water table) above the water table exists in the areas on the FTC which were identified as containing product bodies. This results in an estimated 17,000 cubic yards of contaminated soil. Therefore, the total extent of soil contamination has been estimated as 37,300 cubic yards.

Three bodies of floating petroleum compounds have been detected at various times in the past on the FTC. One body is located in the BAF area, a second is in the MUF area, and the third is associated with the CMB drywell field. The BAF and MUF bodies are No. 2 fuel oil and in the CMB area the floating compound is gasoline. The extent of these former product plumes is shown on Plate 3. The CMB and BAF bodies (October 1989) merge and their combined length is about 480 feet and the greatest width is 210 feet. The volume of floating fuel oil in the MUF and BAF bodies (October 1989) has been estimated at 128,000 gallons and the gasoline body in the CMB area at 20,000 gallons.

The water table on the FTC has risen up to 10 feet in 1990 and 1991 due to increased precipitation. The rising water table has trapped a considerable amount of the floating oil and gasoline in the interstices of the soils below the water table. Therefore, the free-phase product layer does not currently exist and free-phase product cannot be recovered using a single recovery well. This information is further described in the Nassau County's July 1992 report entitled "FTC/IRM Water Quality Pump Test," which is contained in Appendix D. Therefore, the petroleum product volume estimates are approximate and are based on measurements of product and the water table made in October, 1989.

The floating oil in the BAF area is contaminated with methyl ethyl ketone (MEK) and BTEX compounds. MEK was detected at a concentration of 76,300 ug/l and BTEX in concentrations ranging from 540 to 38,700 ug/l.

Contaminated ground water has been detected on the FTC in two areas which are shown on Plate 3. An isolated plume with low concentrations of BTEX has been detected beneath, and associated with, the floating oil body in the MUF area. This plume is approximately 300 feet long by 150 feet wide with BTEX concentrations ranging from 0.6 ug/l to 63 ug/l. The larger plume of contaminated ground water originates in the BAF and CMB areas and extends downgradient of the FTC. In the larger plume, which is approximately 780 feet long and 380 feet wide where it exits the FTC at the southern boundary, BTEX concentrations range from 27 ug/l to 27,850 ug/l. The large plume also contains concentrations of MEK ranging from 1 ug/l to 1,200 ug/l, and acetone at concentrations ranging from 6 ug/l to 6,050 ug/l.

The large plume also contains concentrations of chlorinated hydrocarbons. Some of the chlorinated hydrocarbons may be coming onto the FTC from the OBSWDC. Chlorinated hydrocarbons were detected in more onsite wells than any other contaminants, and are the principal constituents in the off-site plume, which extends downgradient from the FTC into Bethpage State Park. Chlorinated hydrocarbons are found in ground water across the entire width of the site at the southern boundary covering an area approximately 850 feet long by 300 feet wide. The highest concentrations of chlorinated hydrocarbons (up to 2,807 ug/l) were detected in wells located downgradient of the CMB drywell field and the body of floating gasoline. A smaller area of chlorinated hydrocarbons estimated at approximately 150 feet by 75 feet is associated with the floating oil body in the MUF area. There was a single detection of trichloroethene at a concentration of 920 ug/l in well W-15.

Specific chlorinated hydrocarbons that have been detected on the FTC are vinyl chloride, methylene chloride, 1,1-dichloroethene, 1,1-dichloroethane, trans-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene. These chemicals, which are believed to have been used on the FTC to promote ignition in the live burn training areas, have entered the ground with hose and washwater. 1,1,1-Trichloroethane was detected south of the CMB area and the highest concentrations of 1,2-dichloroethene are found in the same area. 1,2-Trichloroethane has been detected in both shallow and deep wells on the FTC. In the deeper wells, concentrations as high as 13.0 ug/l were detected. Tetrachloroethene was detected in the CMB and the BAF areas at concentrations of 6.2 ug/l in water table wells and 5 ug/l in the deeper wells. Vinyl chloride was detected in concentrations ranging from 4 ug/l to 210 ug/l in the shallow wells. Methylene chloride concentrations ranged from 1 ug/l to 370 ug/l in the shallow wells.

Semi-volatile compounds have also been detected on the FTC. The contamination occurs mostly near the No. 2 fuel oil bodies in the MUF and BAF areas, but some semi-volatile compounds were detected associated with the former floating gasoline body in the CMB area. Semi-volatile compounds that have been detected include phenanthrene, fluorene, naphthalene, di-n-octyl-phthlate, and methylnaphthalene. Naphthalene and methyna-phthalene were detected most frequently and are distributed throughout the southern part of the FTC. The polycyclic aromatic hydrocarbons (PAHs) including fluorene, phenanthrene, and pyrene have been detected chiefly in or near the live burn areas. The highest concentrations of PAHs were fluorene (220 ug/l) and phenanthrene (440 ug/l).

The FTC also contains ground water contaminated by leachate from the OBSWDC, which is located north and northwest of the FTC. Landfill indicator parameters detected on the FTC include specific conductance, alkalinity, chloride, hardness, ammonia, and some chlorinated organic compounds. Ammonia concentrations range from greater than 0.02 ug/l to 65 ug/l. Generally, the highest concentrations of these parameters were found in the northern part of the FTC closer to the landfill. However, with the exception of chlorides, the landfill indicator parameters have been detected at concentrations above the landfill's action levels in a large portion of the FTC extending from the northwest corner to the southeast corner.

1.6 NATURE AND EXTENT OF OFF-SITE CONTAMINATION

The plume of contaminated ground water that originates on the FTC extends downgradient in a south, southeasterly direction and contains low concentrations of dissolved organic chemicals. The off-site plume extends across Winding Road into Bethpage State Park. Figure 1-3 provides a plan of the area downgradient of the FTC.

In October 1990, the water table elevation ranged from 70 feet above msl at the northern boundary of the FTC to 65 feet above mean sea level (msl) in Bethpage State Park. The elevations were similar in April 1960, and in May 1943, indicating no long-term change in elevation. However, hydrographs of nearby monitoring wells starting in 1940 indicate that short-term fluctuations of 5 feet to as much as 14 feet seasonally have occurred as a result of drought. Measurements of the water table on the FTC made in July 1986 indicated elevations ranging from 64.5 feet at the northern end of the FTC to 63 feet at the southern boundary. These elevations are lower than historic levels and may be the result of low precipitation which prevailed in 1985.

The OBSWDC has caused a small local mound to form on the water table beneath the landfill, which may affect water table elevations in the northern part of the FTC. However, when the landfill is fully capped, this mound should decay and water levels drop. The direction of ground water movement at the water table is generally to the south and the horizontal hydraulic gradient is about two feet per mile.

Wells screened at a depth of more than 30 feet below the water table generally have water levels 0.5 to one foot lower than the water table, showing a small downward hydraulic gradient. The FTC is about three miles south of the ground water divide and over the long term, the direction of ground water movement is chiefly horizontal with only a small downward component. The contaminated plume, therefore, deepens as it moves in a southerly direction from the FTC.

Based on the concentrations of contaminants detected in the wells downgradient of the FTC, the leading edge of the contaminated plume is about 4,600 feet downgradient of the FTC and about 2,000 feet wide in Bethpage State Park near the leading edge. The plume occurs in the depth interval of about 35 feet to 55 feet below land surface at the southern boundary of the FTC but deepens to the interval of about 185 feet to 305 feet below land surface at its leading edge on Bethpage State Park. The plume is shown on Plates 3 and 4.

The contaminated plume downgradient of the FTC contains chiefly dissolved chlorinated hydrocarbons. The compounds detected include 1,2-dichloroethene (11 to 350 ug/l), tetrachloroethene (1 to 510 ug/l), 1,1,1-trichloroethane (1 to 150 ug/l), trichloroethene (1 to 44 ug/l), vinyl chloride (11 to 75 ug/l) and benzene (1.5 to 410 ug/l). Most of the contamination was detected in the "B" Zone which extends from approximately 20 feet below the water table to a depth of 200 feet below the ground surface. Contamination in the "C" Zone (200 to 300 feet below the ground surface) is limited to concentrations of less than 20 ppb of chlorinated hydrocarbons detected in only two wells.

The two Bethpage State Park supply wells downgradient of the FTC have shown contamination of chlorinated hydrocarbons since 1976. The contamination detected in these wells is the same as the contamination detected in the downgradient monitoring wells. Therefore, based on the pumping record of these two wells, the chemical quality data, and ground water modeling, wells N-00189 and N-00617 are believed to have captured and retarded contamination migrating downgradient from the FTC prior to 1980 when the wells were in use. After well N-00189 was shut down and pumping was reduced in well N-00617, the plume again began to migrate downgradient. This information, combined with the modelling and predicted contaminant flow rates, provides the basis for determining the location of the downgradient extent of contamination (approximately 2,300 feet south of well N-00189). This analysis is supported by the absence of contamination in the monitoring wells located at the southern boundary of Bethpage State Park (BP10B and BP10C) and on Melville Road (wells 11A, 11B, and UM-1).

1.7 ENDANGERMENT ASSESSMENT

An endangerment assessment was performed as part of the original RI, and is further detailed in that report. The endangerment assessment addressed the consequences of "reasonable maximum exposure" to site contaminants. The USEPA recommends use of this approach, which yields the maximum exposure that is reasonably expected to occur on a site. The concentrations selected for the evaluation of exposure were either the 95th percent upper confidence limit on the mean, or the maximum concentration detected. Also, frequent exposure to on and off-site contaminants was considered, even though exposures may be only on a one-time basis. This conservative approach is consistent with that recommended by the USEPA.

In the evaluation of non-cancer risks, naphthalene is the principal contaminant of concern related to on-site soils. Naphthalene and trans-1,2-dichloroethene are the main contributors to the hazard indices for ingestion and dermal contact with ground water. Exposures to xylenes and toluene are the largest contributors to the hazard index calculated for the inhalation of vapor phase chemicals during showering.

The cancer risk analysis which was performed in accordance with the USEPA Risk Assessment Guidance for Superfund, Volume I (Part. A), indicated that 3,3-dichlorobenzidine, PCBs (detected below detection limits in a single soil sample) and trichloroethene are the main contributors to risk from the on-site soils. Levels of vinyl chloride and 1,1-dichloroethene lead to the highest risk estimates of those calculated for the inhalation of vapor phase organic chemicals in ground water by future hypothetical residents. Exposure to trichloroethene, vinyl chloride, 1,1 dichloroethene, benzene, tetrachlorothene, and bis (2-ethylhexyl) phthalate via the ingestion of contaminated ground water have been shown to pose the highest future risk (total pathway risk = 4.6×10^{-4}).

The magnitude of the estimated potential cancer risk and the potential non-cancer hazard index may be related to USEPA Superfund site remediation goals, that is, a target cancer risk range of 10^{-4} to 10^{-6} and a target non-cancer hazard index of 1.0 (The NYSDEC cancer risk is 10^{-6}). Under the assumption of exposure to the maximum contaminant concentrations detected in on-site soils, the incremental cancer risk is just outside the target risk range for remediation (i.e., a risk of 3 in 10^{-4} or three in ten thousand). The exposure scenario evaluating potential future use of ground water similarly indicated a incremental cancer risk slightly greater than the target risk range for remediation as shown above. The hazard indices for exposure to contaminants in soil indicated concern. The hazard indices for exposure to contaminated ground water indicated minimal concern for inhalation and dermal contact, and potential concern associated with ingestion.

The potential exposure levels and associated risks estimated in the endangerment assessment were based on an assumption that no additional site remediation would occur. This assumption was made to meet the objective of the endangerment assessment, i.e., to evaluate baseline risks in the absence of any major action to control or mitigate site contamination, and to assist in determining the need for and the extent of remediation. The analysis indicated potential concern associated with long term consumption of ground water at or near the site, and potential concern with contaminated subsurface soils on-site in the event that these are disturbed. The overall conclusion of the Endangerment Assessment was that the need for remediation was warranted.

Because additional data was obtained during the supplemental RI, the endangerment assessment is being revised and updated, and will be sent to NYSDEC when it is completed.

2.0 REMEDIAL ACTION OBJECTIVES

2.1 IDENTIFICATION OF SITE-SPECIFIC CLEANUP CRITERIA

This section presents the site-specific cleanup criteria used to determine the remediation goals for the contaminated media at the Nassau County FTC. Two cleanup criteria are reviewed for this remediation: standards, criteria, and guidelines (SCGs), and criteria to be considered (TBCs).

Chemical-specific SCGs are described by the New York State Department of Environmental Conservation as federal or state standards, requirements, criteria, or limitations that are generally applicable for site conditions. SCGs derived from state regulations that are more stringent than comparable federal SCGs will be used in accordance with the requirements of the National Contingency Plan, 40 CFR 300.5. Criteria to be considered (TBCs) category, as defined in 40 CFR 300.400, consist of advisories, criteria, or guidance that were developed by federal or state agencies that may be useful in developing site remedies.

Cleanup criteria are presented for the following four media: soil, ground water, air, and surface water.

2.1.1 Soil

Four TBC criteria are identified for the FTC site, and are presented in Table 2-1. A TBC criterion which provides action levels for soils is the Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities (40 CFR Parts 264, 265, 270 and 271), known as the RCRA Corrective Action rule. This rule is a TBC criterion as it was proposed on July 27, 1990, and has not yet been promulgated. Compounds affected by these TBCs are toluene, ethyl benzene, xylenes, and 2-hexanone. The proposed corrective action levels for these compounds are presented in Table 2-1.

The three remaining TBCs are New York State Department of Environmental Conservation (NYSDEC) draft guidance values. The first is a NYSDEC, Division of Hazardous Waste Remediation, Proposed Division Technical and Administrative Guidance Memorandum (TAGM) titled "Determination of Cleanup Goals". The purpose of this draft document is to provide a basis and procedure to determine soil cleanup levels at Federal

MALCOLM PIRNIE

TABLE 2-1 NASSAU COUNTY FTC TO BE CONSIDERED SOIL CRITERIA				
Constituents Potentially Present Onsite	RCRA Corrective Action Levels Requiring Action 40 CRF Parts 264, 265, 270, & 271 (mg/kg)	Draft NYSDEC Draft Hazardous Waste Remediation Division Technical and Administrative Guidance Memorandum (TAGM) (mg/kg)(1)	NYSDEC Proposed Petroleum Contaminated Soil Guidance (mg/kg)(2)	Draft NYS DEC Div. of Hazardous Waste Remediation Soil Cleanup Goals For Nassau County FTC (mg/kg)
VOLATILE COMPOUNDS				
chlorobenzene				1.6
benzene		0.4	0.0015	0.5
toluene	2000	2	0.0375	1.5
ethyl benzene	8000	6	0.138	5.5
xylenes	200000	4	0.03	1.2
acetone		0.1		
methyl ethyl ketone				
carbon disulfide				
vinyl chloride				
methylene chloride		0.04		
1,1-dichloroethene				
1,1-dichloroethane		0.2		
trans-1,2-dichloroethene				
1,1,1-trichloroethane		1		1.0
trichloroethene		1		1.0
tetrachloroethene		2		1.5
2-hexanone	4000	7		
SEMIVOLATILE COMPOUNDS				
phenanthrene		12	10	
fluorene		4	9.13	
naphthalene		2	0.325	
di-n-octyl pthalate		1.2		
2-methylnaphthalene		22	10	
dibenzofuran				
METALS				
antimony				
arsenic				
beryllium				

TABLE 2-1
NASSAU COUNTY FTC
TO BE CONSIDERED SOIL CRITERIA

Constituents Potentially Present Onsite	RCRA Corrective Action Levels Requiring Action 40 CRF Parts 264, 265, 270, & 271 (mg/kg)	Draft NYSDEC Draft Hazardous Waste Remediation Division Technical and Administrative Guidance Memorandum (TAGM) (mg/kg)(1)	NYSDEC Proposed Petroleum Contaminated Soil Guidance (mg/kg)(2)	Draft NYS DEC Div. of Hazardous Waste Remediation Soil Cleanup Goals For Nassau County FTC (mg/kg)
cadmium				
chromium				
copper				
lead				
mercury				
nickel				
selenium				
silver				
thallium				
zinc				

Notes: (1) Calculations assume a total orgnaic carbon content of 1%.

(2) Calculations assume a total organic carbon content of 2.5%.

Superfund, State Superfund, and Potentially Responsible Party (PRP) sites to be used in developing cleanup levels for the Records of Decisions at these sites. This TAGM provides the following four elements to be used to determine soil cleanup goals:

1. Human health based criteria that correspond to excess lifetime cancer risks of one in a million for Class A and B carcinogens, or one in 100,000 for Class C carcinogens;

2. Human health based criteria for system toxicants, calculated from Reference Doses (RfDs);

3. Background values for heavy metals;

4. Environmental concentrations which would be protective of ground water/drinking water quality, based on a model for organics.

The first two items are risk-based cleanup criteria for soils. According to the TAGM, usage of background values for heavy metals is based on the analysis of background soil samples. The samples are to be collected near the site at a location which is free from the influences of the site and any other source of contaminants. The fourth element, the model for organics, predicts allowable soil concentrations based on the organic carbon content of the soil, the partition coefficient between water and soil, solubility, and the ground water/drinking water standards. Based on an organic carbon content of 1%, which is a common value for sand aquifers, soil cleanup goals were calculated for the contaminants at the site. These calculated values, which are presented in Table 2-1, are estimated values based on an assumed organic carbon content of 1%. These numbers will be refined during the remedial design following the sampling and analysis of the soil at the FTC for total organic carbon.

The second NYSDEC criterion is a draft document titled "Proposed New York State Petroleum Contaminated Soil Guidance" which provides guidance to identify conditions by which nonhazardous petroleum contaminated soil can be declassified as a solid waste and to establish criteria by which the declassified soil can be considered acceptable to remain on-site, or disposed of in accordance with acceptable disposal practices. Two methods for determining if a soil can be declassified are presented in this document: the Toxicity Leaching Procedure (TCLP) method and the water-soil partition model. For the TCLP method, if the concentrations in the TCLP extract are below the New York State ground water standards, the soil is considered acceptable. The water-soil partition model predicts the maximum contaminant concentration which is allowed in soil such that if the soil were exposed to ground water, it would not leach in excess of the New York State ground water standards. This model is similar to the model presented in the TAGM, with the exception that solubility is not taken into account. This guidance document calculated petroleum contaminated soil guidance values for volatile and semi volatile compounds, based on an organic carbon content of 2.5%. The values calculated by the NYSDEC guidance document are presented in Table 2-1. As previously discussed, these values will need to be recalculated using the actual organic carbon content of the soil at the site during the remedial design.

The third TBC set of NYSDEC criteria are soil cleanup goals for the FTC determined by the NYSDEC Division of Hazardous Waste Remediation, Bureau of Technical Services. As enumerated in a NYSDEC letter dated December 20, 1991, these recommended soil goals were determined by NYSDEC evaluating three factors:

1. The level necessary to protect ground water.
2. The level necessary to protect human health by direct exposure.
3. Levels which are detectable under the Contract Laboratory Program.

The NYDEC letter, which is contained in Appendix A, also recommended a general cleanup goal of 500 mg/kg total semivolatiles and 10 mg/kg total volatiles.

2.1.2 Ground Water

Several federal and state requirements, treatment standards, goals, and guidance are established for the ground water parameters identified at the site. These criteria have been derived from drinking water and aquifer protection programs, corrective action programs, and health/risk-based determinations. Table 2-2 presents the State and Federal ground water SCGs for the parameters of significance at the FTC. The ground water TBC criteria are presented in Table 2-3. As enumerated in the Nassau County Sewer Ordinance, dated June 1985, ground water is prohibited from being discharged into any of the County's sanitary sewers. Therefore, SCGs associated with discharge to any Nassau County Publicly Owned Treatment Works have not been included.

MALCOLM PIRNIE

TABLE 2-2 NASSAU COUNTY FTC GROUND WATER SCGs			
Constituents Identified In Risk Assessment	NY State Drinking Water Standards 10 NYCRR 5-1 (ug/1)	NY State Ground Water Standards 6 NYCRR 703.5 (a)(2) (ug/1)	Federal Drinking Water Standards 40 CFR 141 (ug/1)
VOLATILE COMPOUNDS			
benzene	5	ND(1)	5
toluene	5		1000
ethyl benzene	5		700
xylenes (each isomer)	5(2)		10000(2)
acetone	50		
methyl ethyl ketone	50		
carbon disulfide	50		
vinyl chloride	2	5	2
methylene chloride	5		5(3)
1,1-dichloroethene	5		7
1,1-dichloroethane	5		
trans-1,2-dichloroethene	50		100
1,1,1-trichloroethane	5		200
trichloroethene	5	10	5
tetrachloroethene	5		5
2-hexanone	50		
SEMIVOLATILE COMPOUNDS			
phenanthrene	50		
fluorene	50		
naphthalene	50		
di-n-octyl phthalate	50		4(3)(4)
2-methylnaphthalene	50		
SECONDARY COMPOUNDS			
chloride		250000	250000
ammonia (as N)			
pH (Standard units)	6.5-8.5		6.5-8.5

MALCOLM PIRNIE

TABLE 2-2 NASSAU COUNTY FTC GROUND WATER SCGs			
Constituents Identified In Risk Assessment	NY State Drinking Water Standards 10 NYCRR 5-1 (ug/1)	NY State Ground Water Standards 6 NYCRR 703.5 (a)(2) (ug/1)	Federal Drinking Water Standards 40 CFR 141 (ug/1)
METALS			
aluminum			50(3)
arsenic	50	25	50
barium	1000	1000	1000
cadmium	10	10	5(3)
chromium	50	50	100(3)
copper	1000	1000	1300 TT
iron	300	300	
lead	50	25	15 TT
manganese	300	300	50
mercury	2	2	2
nickel			100(3)
silver	50	50	50
zinc	500	500	500
NOTES: 1 - Not Detectable; 2- For each xylene isomer; 3- Proposed; 4- For total phthalates			

MALCOLM PIRNIE

TABLE 2-3
NASSAU COUNTY FTC
TO BE CONSIDERED GROUND WATER CRITERIA

Constituents Potentially Present Onsite	RCRA Corrective Action Levels Requiring Action 40 CFR Parts 264, 265, 270 and 271 (ug/l)	NYS Division of Water Technical Operational Guidance Series (ug/l)	Federal Drinking Water Goals 40 CFR 141 (ug/l)
VOLATILE COMPOUNDS			
benzene		ND	0
toluene	10000(3)	5	1000
ethyl benzene	4000(3)	5	700
xylenes	70000(3)	5	10000(2)
acetone	4000(3)		
methyl ethyl ketone	2000(3)		
carbon disulfide	4000(3)		
vinyl chloride		2	0
methylene chloride	5(3)	5	0(3)
1,1-dichloroethene		5	7
1,1-dichloroethane		5	
trans-1,2-dichloroethene		5	
1,1,1-trichloroethane	3000(3)	5	200
trichloroethene		5	0
tetrachloroethene	0.7(3)	5	0
2-hexanone	2000(3)		
SEMIVOLATILE COMPOUNDS			
phenanthrene			
fluorene			
naphthalene			
di-n-octyl phthalate		50	0(3)(4)
2-methylnaphthalene			
dibenzofuran			
SECONDARY COMPOUNDS			
chloride			
ammonia (as N)		250.000	

MALCOLM PIRNIE

TABLE 2-3 NASSAU COUNTY FTC TO BE CONSIDERED GROUND WATER CRITERIA			
Constituents Potentially Present Onsite	RCRA Corrective Action Levels Requiring Action 40 CFR Parts 264, 265, 270 and 271 (ug/l)	NYS Division of Water Technical Operational Guidance Series (ug/l)	Federal Drinking Water Goals 40 CFR 141 (ug/l)
pH		2000	
oil and grease			
METALS			
arsenic		25	
barium		1000	
cadmium	10		5
chromium	50		100
copper	200		1300
iron	300		
lead	500	25	0
manganese	300		0
mercury	2		2
nickel	50		
silver	300		
zinc			
NOTES: 1 - Not Detectable; 2- For each xylene isomer; 3- Proposed; 4- For total phthalates			

The New York State Water Quality Regulations - Ground Water Classifications and Standards for aquifer classification GA, (6 NYCRR Part 703.5), are used to protect human health and the environment. These standards, determined to be appropriate requirements for this site, identify Class GA ground water as fresh ground water within the unconsolidated zone or consolidated rock or bedrock that is suitable as a potable water supply source. Section 703.5(a) provides standards for some of the contaminants found in the ground water at this site based on the GA classification. Section 703.5(a)(3) does not provide standards for specific contaminants, however, Section 703.5(a)(2) requires the use of the state Maximum Contaminant Level (MCL). Standards under 703.5(a)(2) are available for benzene and trichloroethene.

The New York State Sanitary Code for Drinking Water Supplies (10 NYCRR Subpart 5-1) provides standards for the treatment of New York State ground water and surface water for public potable water supplies. The State has established MCLs for public potable water supplies. These State MCLs are required under the ground water standards described above. Most of the MCLs are chemical-specific SCGs for each of the contaminants of concern identified in the RI. However, the benzene standard of non-detectable for ground waters, under 6 NYCRR 703.5(a)(3) is more stringent.

The Federal Safe Drinking Water Act MCLs provide standards for the treatment of ground water and surface water for public potable water supplies. These standards are relevant and applicable requirements for this site. All but one of these standards are the same as or less stringent than the New York ground water and MCL standards described above. The Federal MCL for total phthalates of 4 ug/l is more stringent than the State MCL for an unspecified organic contaminant concentration of 50 ug/l.

Ground water TBCs are derived from three sources: NYSDEC Division of Water Technical Operational Guidance Series (TOGS) water quality guidance values, the proposed federal RCRA Corrective Action Rule values, and federal MCL Goal values. The NYSDEC TOGS memorandum, dated September 25, 1990, provides a compilation of water quality guidance concentrations for toxic and non-conventional pollutants to be used in New York regulatory programs in lieu of promulgated standards. TBCs derived from these above-mentioned sources will be considered during the selection of remedial technologies.

2.1.3 Air

Since the FTC is almost entirely paved or covered with buildings, exposure to volatilized contamination from the soil and/or ground water is unlikely. However, when the ground water and soil are remediated, a potential exists for volatilization of organics depending on the remediation technique selected. The New York State Air Pollution Control Regulations (6 NYCRR parts 201 and 202) require a permit to construct and a certificate to operate an air contaminant source, such as an on-site treatment facility for ground water. If an air contaminant source (e.g., air stripping tower, vapor extraction system) were constructed as part of a remedial measure, these regulations would be relevant and appropriate. Ambient air quality standards for volatile organic compounds and air regulations that will apply during remediation are identified in Tables 2-4 and 2-5.

The Occupational Safety and Health Administration (OSHA) establishes limits and ambient air guideline concentrations (AGC) for individual volatile organic compounds which are listed in Table 2-4. These AGCs were obtained from the 1991 Edition of the New York State Air Guide-1 Guidelines for the Control of Toxic Ambient Air Contaminants. One-half the AGC is the level for continuous monitoring.

As a result of detection of soil and ground water contamination and combustible gases at the FTC and OBSWDC, the NCDPW became concerned about the effects on people at the FTC of exposure to toxic vapor or gases and the potential for explosive conditions due to the build-up of combustible gases in buildings on the FTC. To address these concerns an air quality study was done at the site and a Site Utilization Plan was prepared. The air quality study found that concentrations of organic gases in FTC buildings were below regulatory levels and were not significantly elevated relative to ambient air. Concentrations of combustible gases were below lower explosive limits. The study concluded that engineering controls were not necessary on the FTC. Subsequently, an expansion of the landfill perimeter combustible gas control system is being undertaken.

2.1.4 Surface Water

No surface water pathway exists on-site or in close proximity of the site. In addition, ground water recharge to surface water under existing conditions has not been shown on-site or within the downgradient extent of the study area. Therefore, cleanup criteria for surface water have not been evaluated.

TABLE 2-4

NASSAU COUNTY FTC
TO BE CONSIDERED AMBIENT AIR GUIDELINE CONCENTRATIONS (1)

Constituents Identified In Risk Assessment	SCG (2) (ug/cu m)	AGC (3) (ug/cu m)
VOLATILE COMPOUNDS		
benzene	30	0.12
toluene	89,000	2,000
ethyl benzene	100,000	1,000
xylenes	100,000	300
acetone	140,000	14,000
methyl ethyl ketone (2-butanone)	140,000	300
carbon disulfide	710	7
vinyl chloride	1,300	0.02
methylene chloride	41,000	27
1,1 - dichloroethane	190,000	500
trans-1,2-dichloroethene	--	360
1,1,1 - trichloroethane	450,000	1,000
trichloroethene	33,000	0.45
tetrachloroethene	81,000	0.075
1,1-dichloroethene	2,000	0.02
1,2-dichloroethene	190,000	1,900
SEMIVOLATILE COMPOUNDS		
naphthalene	12,000	120
SECONDARY COMPOUNDS		
ammonia (as N)	4,000	360

(1) From the draft New York State Air Guide -1, 1991 Edition

(2) Short-term Guideline Concentration

(3) Annual Guideline Concentration

TABLE 2-5

NASSAU COUNTY FTC
AMBIENT AIR SCGs

CITATION	COMMENTS
FEDERAL REGULATIONS	
40 CFR 50.9	The primary and secondary ambient air quality standards for ozone based on a averaging time of one hour is 240 ug/cu m or 0.12 ppm.
55 CFR 25454 (June 21, 1990)	Process vents associated with equipment managing hazardous waste with organic concentrations of at least 10 ppmv shall either: reduce total volatile organic emissions for all vents below 3 pounds per hour and 3.1 tons per year; or reduce, by use of a control device, by 95 weight percent. This regulation applies to processes located on RCRA facilities, and can be applied to superfund sites. Since FTC is not a RCRA site, this is a To Be Considered (TBC) criterion.
Clean Air Act Part D Section 173	Nassau County is a non-attainment area for ozone. If a source of air pollutants, located in a non-attainment area, emits or has the potential to emit 100 tons per year or more of any air pollutant, the source may be required to obtain the lowest achievable emission rate (LAER) for that particular source category, and comply with offset requirements.
CITATION	**COMMENTS**
STATE REGULATIONS	
6 NYCRR Part 257-5	The ambient air quality standard for photochemical oxidants based on a averaging time of one hour is 160 ug/cu m or 0.08 ppm.
6NYCRR Part 212	Standard for air emissions from new and/or existing emission sources and/or emission points from process, exhaust, and/or ventilation systems. Emission limits and degree of control required for gas, liquid and solid particles and VOC emissions are based on the potential emission rate and process weight in addition to the potential environmental impacts of the air contaminant.
6NYCRR Part 231	If emission for particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, or VOC (except methane, ethane, 1,1,1-trichloroethane, trichlorotrifluoroethane, or methylene chloride(for air contaminant sources located in a nonattainment area, exceed 50 tons per year, 1,000 pounds per day or 100 pounds per hour, whichever is most restrictive, the source would be subject to employ the Best Available Control Technology (BACT) and/or LAER. Emission offsets are required for any air contaminant for which the area is designated as non-attainment when the net increase in annual actual emissions exceed the deminimus emission limit which is 40 tons per year.

2.2 REMEDIAL ACTION OBJECTIVES

2.2.1 Introduction

As required under the Superfund Amendment and Reauthorization Act (SARA), the remedial action alternatives developed for the Nassau County FTC will be protective of human health and the environment. The remedial action objectives at the FTC will be achieved by controlling the sources of contamination at the site, eliminating potential exposure pathways where possible, and restoring lost resources, where feasible.

The primary constituents of concern at the FTC are volatile and semi-volatile organic compounds. The principal media of concern at the FTC are soil and ground water. Surface water is not considered to be a medium of concern as discussed in Section 2.1.4. Presently there is little possibility of the organic chemicals in the soil and ground water volatilizing directly to the air since most of the site is paved. However, air emissions will result from remedial actions and air will therefore be considered a medium of concern.

2.2.2 Interim Remedial Measures

Previously, Interim Remedial Measures (IRM) were developed and partially implemented at the FTC for remediation of the floating gasoline body and associated soil and ground water contamination. The planned IRM for the gasoline area consisted of in-situ vacuum extraction, collection of ground water and free phase gasoline product, and the treatment of contaminated ground water. The IRM was designed to remove the free phase gasoline body, to treat the contaminated ground water, and to remediate the soils above the gasoline body which are contaminated with volatile organic compounds. One extraction well, RW-1, has been installed and developed, and several pumping tests, including specific capacity tests, a step drawdown test, and a constant rate test, were performed. Analysis of the pumping test data showed that the zone tapped by RW-1 is unconfined and is relatively homogeneous and isotropic. However, water level measurements made during the RI have shown that the water table has risen several feet at the site. The higher water table masks the presence of the former petroleum body, and removal of separate phase product is no longer feasible. In addition, the ground water contains high concentrations of iron and manganese, which must be precipitated out of the water before the water can be treated to remove organic constituents.

Because of this, the IRM will not proceed as originally designed. However, the IRM design for free product removal will remain as a contingency plan in the event that the water table ever drops sufficiently to allow the removal of a separate phase.

2.2.3 Remedial Action Objectives for Soil

Soil contamination exists at various locations on-site and is primarily the result of unburned fuel and organic chemicals infiltrating into previously unpaved portions of the site (burn areas) or from direct discharge into unlined drywells. These locations include Burn Area I, Burn Area II and Burn Area III and the BAF, MUF, and CMB drywell fields which are shown on Figure 1-2.

The contaminated soil in the three burn areas was approximately delineated in the RI, and is shown on Plate 2. The soil in Burn Area I is contaminated with No. 2 fuel oil, the soil in Burn Area II is contaminated with gasoline, and the soil in Burn Area III is contaminated with No. 2 fuel oil. The soil contamination in the three burn areas appears to extend from ground surface to a depth of approximately five feet.

The soil contamination associated with the networks of drywells, previously used for on-site drainage of fire-fighting waters used during training exercises, has resulted in soil contamination extending from a depth of approximately 10 feet to 40 feet below the surface. Soil contamination extends horizontally approximately six to eight feet from the perimeter of each drywell.

The migration of free product and contaminated ground water from these source areas had resulted in bodies of floating product, mainly gasoline and No. 2 fuel oil on the water table. The fluctuating water table caused product adsorption/desorption from the soil above the water table in the past.

Since soil contamination areas are presently covered with asphalt and/or concrete, there is extremely little chance of ingestion or direct contact with the contaminated soil unless there is disruption from construction activities. If vapors were released possible receptors could include FTC administrative personnel and firemen undergoing training at the facility. Because of concern about possible exposure, air quality at the site was monitored and a Site Utilization Plan with regard to contaminant gases was prepared for the FTC. The study concluded that organic compounds and combustible gases are present at the FTC well below concentrations of concern, and that the use of emergency controls is not necessary at this time. However, it is likely that some contaminated soil acts as a continuing source of ground water contamination. This is especially true for the soil contamination associated with the former bodies of floating product. This soil acts as a source of ground water contamination through the continuous leaching and dissolution of chemicals.

The remedial action objectives for the soil contamination will be directed at two zones defined as a shallow soil zone from the surface to a depth of 5 feet, and a deep soil zone defined as below 10 feet to the existing water table, which occurs at depths between 35 and 40 feet below grade. The remedial action objectives for the shallow zone will be to isolate contaminants, wherever necessary, from direct contact with persons disturbing the site through construction activities. Additionally, the objective will be to prevent the migration of contamination downward into the deeper soil zones and into the ground water table. The remedial objectives for the shallow soil can be met by a combination of institutional and/or remedial treatment techniques.

Remedial objectives for the deeper soil zone will be to mitigate continued contact with and degradation of the ground water by soil contaminants. These objectives can be accomplished by soil treatment, and the control and treatment of ground water.

2.2.4 Remedial Action Objectives for Ground Water

Ground water contamination at the site resulted from the infiltration of unburned fuel and other organic chemicals into the previously unpaved portions of the site through the on-site drywells and a system of leaking pipes.

The on-site ground water contamination consists of bodies of petroleum products, mainly gasoline and No. 2 fuel oil, and high concentrations of the soluble fraction of the liquid products and solvents in the ground water. The extent of on-site ground water contamination is shown on Plate 3. The ground water downgradient of the site is also contaminated with dissolved organic chemicals.

The lack of a continuous confining unit separating the water table zone and the deeper portions of the aquifer, and the presence of a downward hydraulic gradient effect the sole-source aquifer with the contamination from the FTC. Therefore, the primary potential pathway of exposure is ingestion of the contaminated ground water by consumers of ground waters from public wells located downgradient of the site.

The contaminant concentrations in the off-site ground water downgradient of the FTC, although high enough to be of concern, are much lower than the concentrations detected in the on-site ground water. The on-site ground waters are affected by the presence of petroleum product and by residual soil contamination. Fluctuating water table levels have caused the ground water to be in contact with former free product bodies and contaminated soil, which are both sources of contamination. The on-site ground water contamination acts as a source of the off-site downgradient ground water contamination. Thus, the remediation of on-site ground water, which is a source control measure, and the remediation of the off-site ground water will be handled separately in this FS.

A remedial objective for the on-site ground water will be to reduce contaminant migration to the extent practicable. A second remedial objective will be to remediate the on-site ground water through treatment. A third remedial objective for the on-site ground water was to remove free product bodies. However, under current ground water table conditions, the removal of free product is not feasible. It remains as a contingency objective in the event that removal of free product ever becomes feasible. These ground water remedial objectives will have several degrees of attainment. The highest degree of attainment will be to meet ground water SCGs. The next degree of attainment will be to reduce the ground water contaminant levels to the extent to which the on-site ground water is not further contaminating the off-site ground water. If the ground water SCGs are not met after a certain period of time, the feasibility of meeting the SCGs will be assessed. This assessment will include a consideration of possible alternatives to enhance recovery and treatment of the contaminated ground water. One possible alternative is the use of pulse pumping, which involves alternating periods of pumping with periods when the water table is allowed to recovery to its former elevation. Other possibilities include the addition of surfactants to the ground water and flushing the area with clean water. If the attainment of the SCG is determined to be infeasible, Alternate Concentration Limits (ACLs) will be examined for use at the site on a technical feasibility and human health risk basis.

A remedial objective for the off-site ground water will be to control the downgradient and the downward movement of contaminants towards a potable water supply. A second remedial objective will be to capture and treat the off-site ground water to the extent practicable. A third remedial objective will be to remediate all contaminated off-site ground water through treatment. These ground water remedial objectives will have several degrees of attainment. The highest degree of attainment will be to meet ground water SCGs in all off-site ground waters. The next degree of attainment will be to provide maximum contaminant removal in the most contaminated areas, to levels which will not meet the

SCGs, but which will be protective of human health at the public water supply. The levels in the off-site ground water which can remain which are above the SCGs will be determined through modeling, which will be performed in the design phase of the project.

2.2.5 Remedial Action Objectives for Air

Although the release of volatilized contaminants from soil and contaminated ground water is unlikely during current site operations because FTC is mostly paved or covered with buildings, there is potential for volatilization of organics to occur when the ground water and soil are remediated. The emissions that will be generated during the soil remedial actions will be monitored. Remedial action objectives for air during soil remediation will be to prevent exposure through inhalation by potential receptors. The remedial action objectives for air also include source-specific treatments for emissions generated during operation of soil or ground water treatment actions.

The Old Bethpage Landfill generates methane which is collected by a series of collector wells and pipes at the perimeter of the landfill. It is expected that an upgraded methane control system will be installed at the boundary between the FTC and the landfill by the time full scale remediation begins at the FTC.

MALCOLM PIRNIE

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 INTRODUCTION

This section of the report provides a summary of the soil and ground water contamination identified with the FTC site and also summarizes the findings of pre-design studies for the IRM. These findings were used to help identify remedial technologies applicable to the FTC contamination. Remedial technologies are described and then screened in terms of effectiveness, implementability and cost.

3.1.1 Soil

The known soil contamination at the FTC site consists of two zones of contamination: the shallow zone, resulting from surface infiltration of unburned fuel and organic chemicals; and the deep zone, resulting from discharge to the drywells and the adsorption of the floating product to the soil above the water table. The shallow soil zone extends from the surface to a depth of 5 feet and the deep zone extends from a depth of about 10 feet to the water table (approximately 40 feet). As described in Section 1.5, the total extent of soil contamination has been estimated as 37,300 cubic yards. The extent of soil contamination is shown on Plate 2.

3.1.2 Ground Water

On-site and off-site ground water contamination has been identified at the FTC. The on-site ground water contamination consists of soluble fractions of liquid petroleum products and other dissolved organic compounds in the ground water. In 1989, three bodies of floating product were identified. Since that time, there has been a regional rise in the water table which has caused the floating product bodies to be trapped in the interstices of the soil. The former floating product bodies consisted of a gasoline body and two separate No. 2 Fuel oil bodies. The on-site ground water also contains elevated levels of manganese, iron, and aluminum, which could affect the type of ground water treatment selected. The extent of ground water contamination is shown on Plate 3. The off-site ground water contains lower concentrations of the organic constituents in the dissolved form, and inorganics do not appear to be a concern. Ground water modelling data for the off-site ground water is contained in Appendix B.

3.1.3 Effect of Interim Remedial Measures

As described in Section 2.2.2, an Interim Remedial Measure (IRM) was developed for the FTC to prevent further contaminant releases from the gasoline area (CMB area) to both the on-site and off-site ground water. The purpose of the IRM was to remediate on-site soil and ground water contamination in the gasoline area through vacuum extraction and free product and ground water recovery and treatment. However, due to the rise in the water table, product removal is no longer feasible, and the IRM will not be implemented. The following studies were performed for the design of the IRM, and these are summarized below.

- Vacuum Extraction System (VES) Pilot Test
- Bench scale testing for inorganic removal
- Green Sand Filter Pilot Test
- Pumping test for Recovery Well RW-1
- FTC/IRM Water Quality pumping test
- Product Recovery Equipment Review

Vacuum Extraction System (VES) Pilot Test

In December 1990, a pilot test of the VES was conducted at the FTC to collect the data required to evaluate the effectiveness of a VES for the removal of VOCs from the vadose zone in the CMB area and to provide the information required for the design of a permanent engineered vacuum extraction and treatment system. The study indicated that for the deep zone, a vacuum extraction system operating between 50-75 cfm at the location of GW-6D would provide an effective capture area for the VOC contaminated soils in the CMB area. The study also found that the soil gas results were lower than expected, probably due to the rise in the water table which bound the contamination in the saturated zone, but concluded that contaminant concentrations in soil gas would be likely to increase as the water table was lowered due to ground water remediation activities. Finally, the report recommended that the vacuum extraction contaminant stream be added to the air stripping vapor stream in a single air treatment system when the remediation system goes on-line. The complete report is included in Appendix B.

Bench Scale Testing Inorganic Removal Report

Two series of bench scale tests were performed in September and November 1990 to evaluate processes that would most efficiently remove inorganic constituents from ground water from the FTC. As part of the IRM, a ground water pump and treat system was proposed. A test recovery well was installed to obtain information on the hydraulics of the aquifer and the expectant influent quality to the treatment plant. Based on the results of the bench scale tests, a recommendation was made for a several step treatment process which included:

- Filtration to remove aluminum and organic matter
- Increasing the pH of the water to 9-10 to remove iron and manganese
- Air stripping
- GAC

The complete report is included in Appendix C.

Greensand Filter Pilot Test

A pilot test was performed in February 1991 to test whether greensand filtration was an effective alternative to a two-step coagulation process for the removal of metals from ground water at the FTC. The test showed that the greensand filter provided 99% removal of both iron and manganese for all three test runs, and it was concluded that the filter was an effective alternative from a process determination. However, further investigation indicated that greensand filtration is not effective from an operations standpoint because of the number of backwashes required. The complete report is included in Appendix C.

Pumping Test for Recovery Well RW-1

To obtain hydraulic characteristics of the aquifer, a constant rate pumping test was conducted by pumping well RW-1 at a rate of 250 gpm for 47 hours in February 1991. The test results indicate that the zone tapped by RW-1 is unconfined. The cone of depression developed during the test was nearly circular and had a radius of 290 feet, which indicates a relatively homogeneous and isotropic aquifer. The transmissivity of the aquifer was found to be approximately 70,000 gpd/ft^2 and the storativity approximately 0.23. Operating the well at 60 gpm will produce the desired drawdown to collect dissolved product, to induce the movement of free phase gasoline into the well for skimming, and to expose the adsorped gasoline to be removed by the vacuum extraction system. The complete report on the pumping test is included as Section 3.3

of the RI report.

FTC/IRM Water Quality Pumping Test

In late May and early June 1992, pumping tests were done on well RW-1 to obtain information on the expectant influent quality to the treatment plant. These pumping tests were designed to collect water quality and water level data at pumping rates of 60 gpm and 85 gpm (based on the findings of the RW-1 pump test) to respond to technical concerns regarding the treatability of the contaminated ground water and the recoverability of petroleum product. The water quality data, collected during the 60 gpm test at four times (1 hour, 8 hours, 27 hours, and 49 hours), indicated that the primary contaminants in the ground water were toluene, ethylbenzene, and xylene, with lower concentrations of naphthalene and 2-methylnaphthalene. It was concluded that these organic contaminants could be easily removed using the proposed treatment. High concentrations of iron were detected which would require additional pretreatment. A regional rise in ground water levels has resulted in a condition where on-site product is no longer observed in most of the on-site wells, and none was observed in RW-1. The water level information collected during both pumping tests indicated that product recovery cannot be effectively conducted with a single recovery well under current water table conditions. The report concluded that the IRM should be re-evaluated in light of the pumping test results. The complete report is included in Appendix C.

Product Recovery Equipment Review

As part of the preparation for the IRM, Malcolm Pirnie conducted a review of various pump systems, and compared each to a set of operation and maintenance criteria. Recommendations were made for both ground water pumps and hydrocarbon recovery pumps. The complete report is included in Appendix C.

The results of pre-design studies for the IRM were used to help identify applicable remedial alternatives. Soil and ground water remedial technologies are identified in the following section. Soil remediation technologies include no action, capping, in-situ bioremediation excavation and disposal, soil washing, low temperature thermal treatment, vacuum extraction, flushing, and air sparging.

Ground water collection, treatment, and discharge technologies are also identified in this section. Ground water collection options will include subsurface drains, product and ground water recovery wells, and optimum well locations and pumping rates. Ground water treatment options will address the dissolved contamination present in the on-site and off-site ground water and as a contingency product. Recovery and removal technologies will be identified. On-site and off-site ground water discharge technologies will also be identified.

3.2 IDENTIFICATION OF TECHNOLOGIES

Due to the complexity of the site, several types of technologies are identified in this section. The following technologies are included:

Type of Technology

Shallow Soil Treatment
Deep Soil Treatment
On-site Ground Water Collection
On-site Ground Water Treatment
On-site Ground Water Discharge
Off-site Ground Water Collection
Off-site Ground Water Treatment
Off-site Ground Water Discharge

3.2.1 Shallow Soil Treatment Technologies

The shallow soil treatment technologies would be implemented in the areas of the facility affected by burns and drainage as shown on Plate 2. Treatment of soils in these areas would be limited to a depth of five feet. It is estimated from soil investigations that the volume of soil included in the shallow soil treatment technologies is approximately 7,500 cubic yards. Final delineation of the shallow soil contamination will be determined during excavation.

3.2.1.1 Capping

Approximately 90% of the active site is currently covered by either asphalt or concrete. Capping would include paving those areas which are not already paved. The pavement acts to slow migration of contaminants from the soil in two ways. First, the pavement seals the soil away from the air, preventing migration of volatile compounds from the soil to the atmosphere. Second, the pavement prevents percolation of water through the soil, preventing the leaching of contaminants from the soil. Because of the asphalt and concrete "cap", the potential for migration of contaminants from the soils to air or ground water is significantly reduced. Capping also provides some protection against contact and ingestion.

3.2.1.2 In-situ Bioremediation

In-situ bioremediation uses indigenous or introduced aerobic, anaerobic, or heterotrophic bacteria to biodegrade organic compounds in soil. It is often used in conjunction with a ground water pumping and reinjection system to circulate nutrients and electron acceptors, such as oxygen, through a contaminated aquifer and the associated soil. This technology requires pilot testing prior to implementation to determine its effects on the soil at the FTC.

Enhanced biodegradation is one of the in-situ methods which is engineered to create favorable aerobic conditions in soil. Moisture is essential for microbial life and is a significant factor in the success of biodegradation. Moisture also serves as the transport medium through which many nutrients and organic constituents diffuse to the microbial cell, and through which metabolic waste products are removed. Moisture also affects soil aeration status, nature and amount of soluble materials, soil water osmotic pressure, and the pH of the soil solution. Therefore, water is injected into the soil matrix as part of this technology. A major rate limiting factor for in-situ biodegradation is the concentration of dissolved oxygen. To increase the amount of dissolved oxygen, hydrogen peroxide is often injected with the water as an oxygen source.

Several byproducts of in-situ biodegradation may be created during the treatment. Volatile emissions should be monitored and controlled, if necessary, to mitigate impacts. Incomplete and possibly hazardous degradation products may be produced and should be monitored through soil and ground water sampling.

For shallow contamination this technology involves construction of infiltration galleries to supply nutrients and oxygen to the microorganisms. Since most of the areas of shallow soil contamination at the FTC are paved and underlain by a network of fuel supply and drainage pipes and actively used, it may be difficult to construct the infiltration galleries without disrupting the current site operations. In-situ bioremediation may also be difficult to employ on the shallow soil contamination because of the necessity to maintain optimum saturated conditions in the shallow soil. If the infiltration galleries do not maintain uniformly saturated conditions, injected water may channel through the soil and may prevent complete remediation. Also, this technology may not be suitable for soil with a high metals content, which could present a toxic environment for the micro-organisms.

3.2.1.3 Bioventing

Bioventing is a combination of enhanced bioremediation and vacuum extraction. It uses the biodegradation in soil and physical removal of VOCs by induced air flow.

Microorganisms existing in the subsurface soil can biodegrade specific compounds in the subsurface environment. As described for in-situ bioremediation, enhanced bioremediation involves augmentation of soil biochemical mechanisms by supplying oxygen and nutrients for accomplishing the degradation, detoxification, and mineralization of chemical contamination in soil systems. The rate of biodegradation is primarily limited by the delivery method of oxygen and nutrients, and the type of organics present.

Vacuum extraction is used to remove VOCs from the vadose zone. A vacuum pump draws the volatile subsurface contaminants in the interstices of the soil through a vacuum well and through an air treatment system prior to discharge to the atmosphere. Vacuum extraction provides the opportunity to circulate air in the soil thereby causing effective oxygen delivery. Bioventing uses the effective oxygen delivery offered by vacuum extraction to enhance the biodegradation rates in the soil. There are three basic steps in the bioventing system. First, air is pumped from the atmosphere to subsurface soil by injection wells and moisture and nutrients are added to the soil by either infiltration galleries or injection wells. Second, the induced air flow sweeps VOCs from the contaminated soils. Lastly, oxygen supplied by the induced air enhances biodegradation of non-volatile components remaining in the soil.

This technology is innovative and has been recently developed. Bioventing would be applicable to shallow as well as deep soil contamination, provided sufficient soil moisture can be maintained. Although bioventing appears very promising, there is insufficient documentation at this time to effectively evaluate this technology. A treatability study would be required to evaluate the applicability of this treatment at the site. This study would determine the feasibility of using bioventing at the site based on measured biodegradation rates at incremental depths. Research is currently being conducted in bioventing and this technology is expected to be readily available in the near future.

3.2.1.4 Solid-Phase Bioremediation

Solid-phase bioremediation is a process that uses conventional soil management practices to enhance the microbial degradation of contaminants. In solid-phase bioremediation the soil is the treatment medium rather than an aqueous solution. This technology involves soil excavation and is applicable only for shallow soil contamination. This technology requires a pilot test to determine its effectiveness.

A typical system consists of a treatment bed lined with high density impermeable liner. A clean sand layer may be placed on the liner to protect the liner and provide controlled drainage for the leachate. Batches of contaminated soil are mixed with nutrients, soil conditioners and, in some cases, special strains of bacteria, and placed in the treatment bed. The treatment bed is supplied with water to increase moisture content and nutrients to enhance the biological degradation of contaminants. The contaminated soil is regularly tilled to provide nutrients and oxygen to the microorganisms at various depths. The basic microbial principles are the same as those described in section 3.2.1.2. Leachate is generated from the application of water to the contaminated soil and must be collected for treatment. After completion of the treatment of the contaminated soil, the treated soil is removed from the bed and a new batch of contaminated soil is applied. A large area is needed for soil treatment using this technology, which would not be available for an extended time period, since this is an active site.

Several byproducts of bioremediation may be created during the treatment. Volatile emissions should be monitored during the tilling operations to assess the concentrations of such emissions. If emissions are hazardous or otherwise unacceptable to the regulatory agencies, an emission collection system should be constructed. Incomplete and possibly hazardous degradation products may be produced and should be monitored through soil sampling. Unless the system is covered, seasonal impacts from temperature may occur and cause ineffective degradation. Leachate may also contain hazardous constituents or other constituents at unacceptable levels and must be analyzed. If the leachate contains constituents at unacceptable levels, it must be collected and treated before discharge.

3.2.1.5 Excavation and Off-Site Disposal

This technology involves the excavation and off-site disposal of the soil. Although an accurate determination of the hazardous characteristics of the contaminated soil at the FTC can not be made without analyzing the contaminated soil samples for RCRA hazardous waste characteristics, based on the concentrations of contaminants in the soils at the FTC, it appears that the contaminated soil will not be classified as a hazardous waste. If this is the case, the contaminated soil would be disposed of in a nonhazardous waste landfill. Wastes accepted by nonhazardous landfills are typically positioned within a lined disposal cell. Treatment byproducts such as gases and leachate are collected and monitored to prevent byproducts from contaminating other areas. The nonhazardous landfills require permits and regular maintenance of their treatment cells; therefore, none of these requirements will be the responsibility of the FTC. However, excavation will interfere with the infrastructure at the FTC.

3.2.1.6 Excavation and Soil Washing

Soil washing also involves soil excavation. The soil washing process extracts contaminants from the soil matrix using a liquid solution. Soil washing solutions generally include water, acidic and basic solutions, surfactants, and solvents. Depending on the contaminants present, appropriate solutions are selected. The solutions partition the contaminant from the solid phase into the liquid phase.

In a typical surfactant solution washing system, contaminated soil is excavated and screened to remove oversized soil particles greater than one-half inch in diameter. Sometimes these oversized particles are crushed and then rescreened. Once the oversized particles are removed, the contaminated soil is fed to the soil washing system, where it is slurried with water. A 30 percent solids slurry is fed to a froth flotation tank where contaminants are removed from the soil and transferred to the froth. The contaminant-rich surficial froth is then removed by skimming. The froth and clean soil are each directed to their own dewatering areas where they are prepared for final disposition. The washed soil is returned to the excavation. The contaminated froth is further treated either through incineration, biodegradation, or disposal in a landfill. Process water and all water recovered during dewatering operations is recycled.

Several limitations exist with the soil washing technology. This technology involves excavation which would disturb the infrastructure at the FTC, which contains a large piping network. Some froths exhibit poor treatability and may hinder the technology's overall effectiveness.

3.2.1.7 Excavation and On-Site Thermal Treatment

Low temperature thermal treatment involves heating excavated contaminated soils to remove organic contaminants from the soil. The volatile organic compounds are vaporized and can either be destroyed through subsequent high-temperature incineration or recovered via condensation and adsorption onto activated carbon. This technology involves soil excavation which would disturb the infrastructure at the site and is applicable only for shallow soil contamination.

Typically the soil is first screened to remove the oversized soil particles and protect the mechanical processing equipment from damage. The prescreened soil is transported to a hopper at the feed inlet of the thermal heating unit. The thermal heating unit consists of heating coils that circulate hot oil to indirectly heat the soil or propane burners which heat the unit from outside.

The soil is heated to a temperature of 500 to 800°F. Volatile organic compounds are stripped from the contaminated soils in the thermal heating unit. Organic contaminants and water vapor driven from the soil are transported from the heating unit by an inert carrier gas. After processing, the treated soil is sprayed with water for cooling and dust control. Condensation in the units is avoided by routing a portion of the flue gas though the thermal heating unit.

Vaporized water, VOCs, and combustion gases are drawn from the thermal heating unit and passed through a baghouse filter to reduce particulate emissions. The particulates collected can be removed from the baghouse and recycled for treatment. Gases from the baghouse are directed to a two-stage condenser where water vapor is condensed and cooled to about 140°F. Any remaining gases are routed to an afterburner where they are thermally treated or passed through carbon adsorption drums and discharged to the atmosphere. The cooled liquid from the condenser is treated with unit processes such as product separation, air stripping, or other processes as needed. Treated water is then used to moisten and cool the treated soil.

3.2.2 Deep Soil Treatment Technologies

The deep soil treatment technologies would be implemented in the drywell areas and the areas of soil affected by the former floating product. Treatment of soils would be from a depth of approximately 10 feet to the water table. The estimated volume of soil included in the deep soil treatment technologies is approximately 29,800 cubic yards, which includes an estimated 12,800 cubic yards of soil from the three drywell areas, and 17,000 cubic yards from the product contaminated soils. Some of the deep soil technologies contain treatment of the drywell soils only. Final delineation of the deep soil contamination will be determined during excavation.

3.2.2.1 Capping

As described in Section 3.2.1.1, this technology would involve paving those contaminated areas which are not already paved. Capping would reduce infiltration caused by rain water, thereby reducing contaminant transport through the soil to the ground water. Since capping will have no influence over the ground water contamination caused by the fluctuation of the water table, capping will have little effect on the deep zone of soil contamination.

3.2.2.2 In-situ Bioremediation

As described in Section 3.2.1.2, in-situ bioremediation uses indigenous or introduced aerobic, anaerobic, or heterotrophic bacteria to biodegrade organic compounds in soil. In-situ bioremediation is effective in conjunction with ground water treatment for remediation of the deep zone of soil contamination. Nutrients and electron acceptors such as oxygen are circulated through a contaminated aquifer and the associated soil. This alternative can be applied to the deep zone of soil contamination since it does not require soil excavation.

This technology may not be suitable for soil with a high metals content. Metals of concern at the FTC are iron, manganese, and aluminum. However, limited information exists regarding the metals content in the deep soil. However, elevated levels of metals have been detected in the ground water on-site, due to the proximity of the adjacent landfill. The fluctuation of the water table may cause an increase of metals in the deep zone soils as a result of elevated metal levels in the surrounding ground water. In addition, the elevated levels of metals, particularly iron, may cause a plugging problem during implementatin of in-situ bioremediation. Also, the rise and fall of the water table would aggravate the contacting of oxygen and nutrients required for treatment with the soil.

3.2.2.3 Bioventing

As described in Section 3.2.1.3, bioventing is a combination of enhanced bioremediation and soil venting. It uses the biodegradation in soil and physical removal of VOCs by induced air flow.

Bioventing uses the effective oxygen delivery offered by soil venting to enhance the biodegradation rates in the soil. There are three basic steps in the bioventing system. First, air is induced from the atmosphere to subsurface soil by injection wells. Also, moisture and nutrients may be needed for optimal degradation rates. The nutrients and moisture would be added to the soil by either infiltration galleries or injection wells. Second, the induced air flow sweeps VOCs from the contaminated soils. Lastly, oxygen supplied by the induced air enhances biodegradation of non-volatile components remaining in the soil.

Bioventing is a new and innovative technology. A treatability study would be required to evaluate the applicability of this treatment at the FTC. This test would determine the feasibility of using bioventing at the FTC based on measured biodegradation rates at incremental depths. Unless a treatability study is performed, the effectiveness of bioventing on the deep soil is uncertain.

3.2.2.4 Flushing

Soil flushing involves applying a liquid flushing agent to contaminated soil to physically or chemically remove contaminants. The flushing agent is allowed to percolate into the soil and enhance the transport of contaminants to ground water extraction wells for recovery. The flushing agent may then be treated and recycled. Water is normally used as the flushing agent; however, other solvents or surfactants may be used for contaminants that are tightly held or only slightly soluble in water. Solvents/surfactants are selected on the basis of their ability to solubilize the contaminants and their environmental and human health effects. It is also important that contaminants are extracted once they are mobilized. This technology is applicable for remediation of soils containing soluble organics and metals that are distributed over a wide horizontal area. This technology can be used in conjunction with an alternative for ground water treatment to reduce the time required to complete ground-water cleanup.

3.2.2.5 Drywell Excavation and Off-Site Disposal

This technology would involve excavation of the soils in the drywell areas. Only the deep soils associated with the drywells would be excavated and transported to a landfill for disposal. As described in Section 3.2.1.5, the soil would probably be disposed in a nonhazardous landfill.

This technology will not be feasible for the soil associated with the floating bodies of petroleum product, since this area is too extensive and difficult to excavate.

3.2.2.6 Drywell Excavation and On-Site Treatment

This technology is the same except that the soils associated with the drywells would be excavated and treated by low temperature thermal treatment, which is described in Section 3.2.1.7. This technology would only be feasible for the soils associated with the drywells, and not for the soils associated with the floating product bodies.

3.2.2.7 Air Sparging

Air sparging is a technique used to remove VOCs from the contaminated saturated zone in-situ. Air sparging is essentially air stripping in the subsurface, with the saturated soil column acting as the packing. Injected air flows through the water column over the packing (soil), and the air bubbles contact either the dissolved or adsorbed contaminants, which cause the VOCs to volatilize. The contaminants are then carried by the air bubbles to the vadose zone where they are captured by a vapor extraction system. An air treatment system is a necessary part of the vacuum extraction system. In addition, the sparged air maintains a high dissolved oxygen concentration in the ground water, which enhances natural biodegradation.

Air sparging has been shown to effectively remove VOCs from ground water. However, semi-volatile compounds, such as naphthalene and its derivatives, which are present in the saturated zone at the FTC, cannot be removed effectively by air-sparging. Air sparging would not be effected in the unsaturated soils in the drywell fields.

This technique has been taken from the initial concept to application without significant laboratory research, and is being used primarily at smaller sites. Although it appears to be promising technology, additional research on large-scale applications is necessary. A pilot study would be required at the FTC prior to a full-scale system, if air sparging were used for remediation of the saturated zone.

3.2.2.8 Vacuum Extraction

Vacuum extraction is an in-situ soil treatment technology used to remove VOCs from the vadose zone. Using this technology a vacuum is drawn on the contaminated soil to extract VOC contaminated vapors in the interstices of the soil through the vacuum well. The vapors are then either vented directly to the atmosphere or controlled with carbon adsorption or catalytic oxidation prior to venting. Vacuum extraction works well in sandy soils. Vacuum extraction is effective for removing VOCs from soils. However, the semi-volatile organic compounds are not effectively removed using the vacuum extraction technology.

3.2.3 On-Site Ground Water Collection Technologies

3.2.3.1 Subsurface Drains

This technology involves the construction of three subsurface drains along the downgradient edge of each hydrocarbon product body. One drain would be constructed on the downgradient edge of the Mock-up Field Product body, a second drain would be constructed on the downgradient edge of the gasoline product body, and a third drain would be constructed in the area of the Corrugated Metal Building drywell field. To effectively recover free product and contaminated ground water, the drains would need to be constructed at least forty feet below land surface.

3.2.3.2 Two Recovery Wells Collecting Dissolved Contamination in the Gasoline and Solvent Contaminated Areas

This technology involves the use of two recovery wells. The first well, RW-1, was installed in January 1991. The second well, RW-2, will have to be installed. Well RW-1 is constructed with 50 feet of 0.040 inch slot stainless steel screen, at a depth of 20-70 feet below land surface and is located immediately east of the corrugated metal building. RW-1 will be used to collect contaminated ground water and free product (if recoverable). Recovery well RW-2 will be installed near monitoring well cluster number 7. RW-2 will differ from RW-1 in that it will not be designed to recover product, but will recover contaminated ground water from the downgradient edge of the plume, near the border of the FTC property. These two wells will capture the plume of contaminated ground water.

3.2.3.3 Three Recovery Wells Collecting Dissolved Contamination in the Gasoline, Solvent, and Fuel Oil Contaminated Areas

This technology would use the same two recovery wells discussed above plus one additional dual phase recovery well. The additional well, RW-3 would be located within or at the downgradient edges of the former Mockup Field product body. The installation of this additional well would restrict the migration of contaminants from this area and collect free product if encountered and contaminated ground water.

3.2.3.4 Product Skimming and Recovery Wells in the Gasoline and Solvent Contaminated Areas

This technology adds the use of product skimmers in up to 10 existing on-site monitoring wells as a contingency. The skimmers would be placed in monitoring wells in each No. 2 fuel oil product body if free product is encountered again. As the product enters the well, the skimmer will collect the product. The product will then be pumped to the surface to an oil/water separator.

In the Burn Area Field product body, skimmers would be placed in monitoring wells W-10, W-30, and W-31. In the Mockup Field product body, skimmers would be placed in wells W-17, W-1, W-18, W-25, W-24, W-15 and W-33. The determination of skimmer placement will be made based on the amount of free petroleum product measured in the wells at the time of design.

3.2.4 On-Site Ground Water Treatment Technologies

Since the ground water at the FTC contains elevated levels of organic compounds and metals, several ground water treatment technologies are necessary to effectively remediate the ground water at the site. Therefore, ground water treatment technologies are first identified in this section, and then technologies are grouped together for remediation.

3.2.4.1 Technology - Free Product Separation

We have included this technology as a contingency in the event free product becomes present in the wells again. Free product separation can be accomplished using an enhanced gravity separator. The separator uses the differences in the specific gravity between two or three different immiscible components of a liquid stream for separation. Influent enters a basin and, depending on the design, the free product is either collected on a disposable filter or filter cartridge, or is removed by passing through a separator plate and disposed into a storage drum. Disposal cost of the collected free product will depend on the waste classification of removed free product.

3.2.4.2 Liquid Phase Bioremediation

Bioremediation is a technique that can be used to treat dissolved organic contaminants in water. Bioremediation of ground water can be performed either in-situ or above ground. Bioremediation stimulates naturally occurring bacteria in the ground water by the addition of nutrients to metabolize organic contaminants. Nutrient requirements and optimum conditions for biodegradation are determined by laboratory simulation of existing conditions.

To accomplish in-situ bioremediation, nutrient amended ground water is injected through injection wells or infiltration galleries. A hydrogen peroxide solution provides an oxygen source and is also injected through the injection wells or infiltration galleries. The microorganisms in the ground water then accomplish the biodegradation of the organic contaminants in the ground water.

For external, above ground bioremediation, nutrients are added to the extracted ground water, and the nutrient rich ground water goes to a reactor where the contaminants are biodegraded and the ground water is oxygenated. The microorganisms which perform the degradation are immobilized in a submerged, fixed film bioreactor. As the extracted ground water passes through the bioreactor, the contaminants are degraded to carbon dioxide, water, and chloride ion.

Bioremediation can be sensitive to fluctuations in influent organic levels and by metals. Metals such as manganese may inhibit the biological activity in one or two ways. The metals may interfere with the microorganisms which perform the biological degradation. The metals may also interfere with the nutrients, which would inhibit the biological activity. Since the ground water at the FTC contains metals including iron, manganese, and aluminum, bioremediation may be somewhat inhibited. Also, plugging of wells may be caused by the high levels of iron as well as chlorinated hydrocarbons in the onsite ground water. Another factor which could limit the use of bioremediation at the FTC is a possible insufficient nutrient supply (Nitrogen and phosphorous) in the ground water for microorganisms to operate efficiently. High concentrations of nutrients would have to be injected into the ground water to compensate for the lack of naturally occurring nutrients at the FTC to effectively use bioremediation.

3.2.4.3 Metals Removal

The metals of concern at the FTC are iron, manganese and aluminum. Removal of these metals can be accomplished by precipitation and flocculation. Precipitation is a physicochemical process whereby some or all of a substance in solution is transformed into a solid phase. Precipitation is based on alteration of the chemical equilibrium relationships affecting the solubility of inorganic species. Generally, a chemical such as lime or sodium sulfide is added to the water in a rapid mixing tank along with flocculating agents. The water flows to a flocculation chamber in which adequate mixing and retention time is provided for agglomeration of precipitate particles. Agglomerated particles are separated from the liquid phase by settling in a sedimentation chamber, and/or by other physical processes such as filtration.

Metals precipitation can also be accomplished by oxidation via aeration. Two types of aerators can be used, either slat tray or a diffused bubble. The slat-tray aerator is preferable because it requires less maintenance and costs less. Precipitate will likely build up on the slat trays, and the trays will have to be periodically cleaned. Any precipitate formed will be collected and disposed. Since high levels of VOCs exist in the ground water, an off-gas collection and treatment system may be necessary. Sludge from either sedimentation chambers and/or aerators would be collected, dewatered, and disposed. The process of aeration and/or coagulation may capture VOCs and/or metals in the sludge. The levels of VOCs and/or metals captured would affect sludge disposal locations and costs.

Filtration is a physical process whereby suspended solids are removed from solution by pressing the fluid through a porous medium. Granular media filtration is typically used for treating aqueous waste streams, such as ground water. The filter media consists of a bed of granular particles (typically sand or sand with anthracite). The bed is contained within a basin and is supported by an underdrain system which allows the filtered liquid to be drawn off while retaining the filter media in place. As ground water laden with suspended solids passes through the bed of filter medium, the particles become trapped on top of and within the bed. This either reduces the filtration rate at a constant pressure or increases the amount of pressure needed to force the ground water through the filter. In order to prevent plugging, the filter is backwashed at high velocity to dislodge the particles. The backwash water contains high concentrations of solids and requires further treatment.

Filtration is a reliable and effective means of removing low levels of solids from ground water provided the solids content is less than 50 to 100 mg/l and does not vary greatly. Greensand filtration is one type of technology investigated for this site. Filtration by itself will not adequately remove the soluble metals from the ground water at the FTC. To achieve metals removal, additional steps such as metals precipitation (described in the previous section) would have to be employed.

3.2.4.4 Mass Transfer Air Stripping

Air stripping is a proven technology for removing volatile organic compounds (VOCs). In the air stripping unit, the contaminated ground water flows down the unit, while air is blown up through the unit. The contaminants are transferred from the liquid phase to the gaseous phase as the water and air make contact in the unit. To increase mass transfer between air and water, packing may be used in air stripping units such as packed columns. The packing increases the surface area over which the two phases come in contact. In other air stripping units, such as aerators, shallow trays can be used to increase mass transfer. Treated ground water flows out of the bottom of the unit while air containing contaminants is vented out of the top of the column. The vented air will require air emission controls to capture the VOCs.

The on-site ground water at the FTC also contains high concentrations of metals which would lead to a buildup of metals precipitate on the trays of a shallow tray aerator, or in the air stripping column. Therefore, a metals removal step prior to air stripping could be used, otherwise frequent cleaning of the units would be necessary. If necessary, air and water temperature can be increased to enhance contaminant removal effectiveness. However, since air stripping removes only the VOCs from the ground water, additional treatment such as granular activated carbon (GAC) treatment may be required to remove other organics present in the ground water.

3.2.4.5 Steam Stripping

Steam stripping uses the same principles as air stripping, except that steam is used rather than air to evaporate organics from the influent ground water stream. Steam stripping removes contaminants which are less volatile and can handle a high concentration range (e.g., from less than 100 ppm to about 10 percent organics). The resulting condensate will require off-site disposal. In addition, the steam stripping process requires some type of air pollution control mechanism to reduce emissions. Utilization of a steam stripping system would require the construction and installation of a steam supply source such as a boiler. Steam stripping is energy intensive.

Steam stripping is used to treat aqueous wastes contaminated with chlorinated hydrocarbons, aromatics and alcohols. However, certain base neutral organic compounds, such as phthalates, are not removed by steam stripping. Steam stripping is a viable alternative process for the following two cases: 1) when air stripping could not achieve desired results due to high organic concentrations in ground water, or 2) if steam stripping could be used in place of a combination of air stripping and carbon adsorption. However, at the FTC the levels of volatile organic compounds can be removed effectively by air stripping. Additionally, the use of carbon adsorption cannot be eliminated by steam stripping, since the ground water at the FTC contains base neutral compounds which are not removed by steam stripping.

3.2.4.6 Granular Activated Carbon

Granular activated carbon (GAC) is effective in removing a wide range of organic compounds. The activated carbon selectively adsorbs constituents by a surface attraction phenomenon in which organic molecules are attracted to the internal micropores of the carbon granules. The removal of contaminants is often determined by rate of adsorption during contact with the GAC.

This process involves adsorption units typically operating in a downflow mode, either in series or parallel. Operating units in series has been found to be generally the most cost effective and produces the lowest effluent concentrations compared to a parallel configuration.

Once the micropore surfaces of the carbon are saturated, the carbon is considered "spent" and must be replaced with virgin or regenerated carbon. The spent carbon must either be thermally regenerated or disposed off-site. The time to reach this "breakthrough" point is the most critical operating parameter in GAC treatment. Pretreatment steps such as air stripping can greatly enhance the carbon's life and reduce the need for carbon replacement.

3.2.4.7 Ultraviolet Light/Peroxide System

This technology uses hydrogen peroxide to oxidize the contaminants with ultraviolet (UV) light as a catalyst. The UV light converts hydrogen peroxide into hydroxyl radicals, which are strong oxidants. Process variables include UV energy dose, hydrogen peroxide dose, pH level, temperature and mixing efficiency. Bench-scale studies must be conducted to estimate these variables and the size of the reactor.

In this process, ground water is pumped through a heat exchanger which regulates inlet temperature. Hydrogen peroxide is added to the feed as it proceeds to the reactor, which is equipped with UV lamps. Following mixing, the treated ground water is then discharged from the reactor. An emission control system may be necessary since the agitation in the reactor volatilizes organic compounds in the ground water.

The operational costs associated with a UV/peroxide system are high due to the great amount of energy required to operate the system. Based on the levels of ground water contaminants at the FTC, the UV/peroxide system would be expensive. In addition, the high concentrations of metals would require pretreatment prior to the UV/peroxide system.

3.2.4.8 Grouping of On-Site Ground Water Treatment Technologies

At present, the rise in the water table has resulted in the former free product bodies being masked by the saturated zone. If the water table ever drops to its previous level, free product may be observed on the FTC. Because of this possibility, the grouped treatment technologies include free product separation as a contingency. The ground water treatment technologies described above are grouped as follows:

- Metals Removal: Air Stripping; Filtration; Granular Activated Carbon
- Metals Removal; Filtration; Steam Stripping; Granular Activated Carbon
- Metals Removal; Liquid Phase Bioremediation; Filtration
- Metals Removal; Filtration; Ultraviolet Light/Peroxide System

3.2.5 On-Site Ground Water Discharge Technologies

3.2.5.1 Discharge to Ground Water Using Recharge Basins

In this technology, treated ground water would be discharged into the recharge basin located on site.

3.2.5.2 Discharge to Ground Water Using Injection Wells

In this technology, treated water would be injected back into the Magothy using a system of injection wells. If the ground water is injected upgradient of the collection wells, the hydraulic gradient will be increased which will increase the hydraulic head which will decrease the time required for cleanup. However, the volume of water extracted that will require treatment would be increased. To eliminate this problem, the injection wells could be located downgradient (off-site) of recovery wells, if access were obtainable.

3.2.5.3 Alternative OND3 - Discharge to POTW

In this technology, treated water would be discharged directly into the Nassau County sanitary sewer system and sent to the Publicly-Owned Treatment Works (POTW). However, the County's policy is not to allow treatment effluent into the POTW.

3.2.5.4 Discharge to a Shallow Infiltration System

For this technology, a shallow infiltration system would be built either on-site or adjacent to the site. The system would allow for treated water to infiltrate rapidly into the aquifer. This system would consist of a series of trenches to a depth of less than 10 feet. The trenches would be excavated near the southwest, northwest, and western property boundaries. The total length of the trenches would be on the order of 600 feet.

3.2.5.5 Discharge to the Existing Drywell System

For this technology treated water would be discharged into the existing on-site drywell systems. The drywells, which range in depth from approximately 10 to 30 feet, were one of the primary sources of contamination and soil contamination is also associated with them. Ground water discharged into the drywells should aid in flushing contaminants from the unsaturated zone. This flushing would aid in decreasing the time to remediate soil and ground water. This would also increase the volume of ground water to be captured for treatment.

3.2.6 Off-Site Ground Water Collection Downgradient of the FTC

3.2.6.1 No Action

For this technology, no remedial action will be conducted on the ground water downgradient of the FTC. The no-action alternative is developed to comply with the requirements of CERCLA and for the purpose of comparison with other alternatives.

3.2.6.2 Maximum Contaminant Recovery (Hot Spot)

This technology assumes that there will be control of the contaminant sources on-site, and involves the installation of two recovery wells in the hot spot area of the plume (defined as the area where the average concentration of total volatile organic compounds exceeds 500 ug/L) (Plate 2) in order to remove the maximum amount of highly contaminated ground water as quickly as possible. The wells will pump at a rate of 150 gpm each, for a combined pumping rate of 300 gpm. The contaminated ground water recovered will be piped to the treatment area.

This technology was modelled using GPTRAC in its semi-analytical option, which assumes a homogeneous aquifer but is able to accommodate a wide range of aquifer and boundary conditions. A detailed report on the modelling effort is given in Appendix B. The modelling results indicate that with the operating parameters described above, it will take one year to remove one pore volume of contaminated ground water from only that portion of the off site plume where the total volatile organics are 500 ug/l or greater. That portion of the plume where total volatile organic compounds are less than 500 ug/l will not be captured, except immediately upgradient of the two wells. This will fulfill the remedial objective of remediating the most highly contaminated water, but will allow ground water containing lower concentrations of contaminants to continue to migrate downgradient.

Contaminant transport was modelled using Analytical Random Walk. The modelling results indicated that all ground water with a concentration of 50 ug/l or greater VOCs would have to be removed in order to keep the concentration at well N-07852, as indicated on Figure 1-3, less than 10 ug/l. This would include almost the entire plume, and is technologically infeasible.

3.2.6.3 Hot Spot Removal and Plume Recovery, Option 1

This technology assumes that there will be control of the contaminant sources on-site and involves ground water collection using five recovery wells at the locations shown on Figure B-1 in Appendix B. Two wells will be located within the hot spot area to remove highly contaminated water as quickly as possible. This will prevent the migration of the highly contaminated ground water (total organic compounds greater than 500 ug/l) through the aquifer to the downgradient recovery wells. These wells will each pump at a rate of 150 gpm. Three wells will be located at the downgradient edge of the plume to create a hydraulic barrier which will eventually capture the entire plume and prevent further downgradient migration of the plume. Each well will pump at a rate of 300 gpm. The total pumping rate for this alternative is 1200 gpm. Contaminated ground water will be piped to the treatment area.

This was modelled using GPTRAC in its semi-analytical option. The modelling results indicate that with the operating parameters described above, it will take two years to create a hydraulic barrier and ten years to remove one pore volume of contaminated ground water. As shown by the modelling, this alternative will capture the contaminated water in the plume and will fulfill the two remedial objectives of remediating contaminated ground water and preventing further downgradient migration of the plume.

3.2.6.4 Hot Spot Removal and Plume Recovery, Option 2

This technology assumes that there will be control of the contaminant sources on-site. It involves the installation of seven recovery wells at the locations shown on Figure B-3 in Appendix B. Two wells will be installed in the hot spot area to remove highly contaminated water as quickly as possible, and will each pump at a rate of 150 gpm. Five wells will be installed at the downgradient edge of the plume to form a hydraulic barrier and prevent further downgradient migration of the plume. Two of these wells will pump at a rate of 150 gpm, the other three will pump at a rate of 100 gpm. The total pumping rate will be 900 gpm. The recovered water will be piped to the treatment area on the FTC.

This was modelled using GPTRAC in its semi-analytical option. The modelling results indicate that it will take two years to create a hydraulic barrier and 10 years to remove one pore volume of contaminated water. This technology will capture the contaminated water in the plume and will meet the stated objectives of preventing further downgradient migration of contaminants and remediating ground water.

3.2.6.5 Hot Spot Removal and Total Plume Recovery

This technology assumes that there will be control of the contaminant sources on-site. It involves the installation of twelve recovery wells at the locations shown on Figure B-5 in Appendix B. Two wells will be installed in the hot spot area to capture the most highly contaminated water as quickly as possible. Five wells will be installed at the downgradient edge of the plume to establish a hydraulic barrier to prevent further downgradient migration of the plume, and five wells will be installed at locations within the plume to remove contaminated ground water as quickly as possible. All twelve wells will pump at a rate of 150 gpm, for a combined pumping rate of 1800 gpm. The recovered water will be pumped to the treatment area.

This was modelled using GPTRAC, in its semi-analytical option, and the results indicate that this alternative will meet the objectives of preventing the further downgradient migration of the plume and the remediation of ground water. This will also reduce the time required to capture the plume. The modelling results indicate that it will take two years to establish a hydraulic barrier and four years to remove one pore water volume of contaminated ground water. This scenario was not model using GPTRAC. However, the similarity of the downgradient well placments suggests that a similar capture zone would be created and that it would take at least two years to create a hydraulic barrier and at least 10 years to remove one pore volume. This technology will meet the stated objectives of preventing further migration of contaminants and remediate the ground water.

3.2.6.6 Downgradient Edge Plume Recovery

This technology assumes that there will be control of the contaminant sources on-site. It involves the installation of five ground water recovery wells at the downgradient edge of the plume to form a hydraulic barrier and prevent further downgradient migration of the plume. This option does not have the advantage of removing the most highly contaminated ground water as quickly as possible. This technology will meet the stated objectives of preventing further migration of contaminants and remediate the ground water. Two of the wells would pump at a rate of 150 gpm, and three wells would pump 100 gpm, for a total pumping rate of 600 gpm. The recovered ground water would be transported to the FTC for treatment.

3.2.7 Off-Site Ground Water Treatment Technologies

The off-site ground water contains volatile organic compounds at levels which are lower than the levels detected in the on-site ground water. Semi-volatile organic compounds and metals were not detected at health-based levels of concern in the off-site ground water. Free product was not encountered in the off-site ground water. In addition, the metals were not detected in the off-site ground water at levels which would interfere with other ground water treatment alternatives. Therefore, only off-site ground water treatment technologies which will remove volatile organic compounds will be identified.

3.2.7.1 Liquid Phase Bioremediation

As described in Section 3.2.4.1, bioremediation stimulates naturally occurring bacteria in the ground water by the addition of nutrients to metabolize organic contaminants, and can be performed either in-situ or above ground. To accomplish in-situ bioremediation, nutrient amended ground water is injected through injection wells. The microorganisms in the ground water accomplish the biodegradation of the organic contaminants in the ground water. For external, above ground bioremediation, following ground water extraction, nutrients are added, and the ground water flows to a reactor where the contaminants are biodegraded and the ground water is oxygenated.

In-situ bioremediation of off-site ground water may not be a viable option since the off-site ground water has low TOC, COD, and BOD levels.

A factor which may limit the use of bioremediation is an insufficient nutrient supply (nitrogen and phosphorus) in the off-site ground water for microorganisms to operate efficiently. High concentrations of nutrients would have to be injected into the off-site ground water to effectively use bioremediation.

3.2.7.2 Air Stripping

As described in Section 3.2.4.3, this technology treats contaminated ground water by countercurrent flow of the contaminated water with an air stream. The contaminants are transferred from the liquid phase to the gaseous phase as the water and air make contact in the unit. Treated ground water flows out of the bottom of the unit while air containing contaminants is vented out of the top of the unit. The vented air will require air emission controls to capture VOCs and remain in compliance with the 1991 air guidelines.

3.2.7.3 Granular Activated Carbon

As described in Section 3.2.4.5, granular activated carbon (GAC) is effective in removing a wide range of organic compounds. The activated carbon selectively adsorbs constituents by a surface attraction phenomenon in which organic molecules are attracted to the internal micropores of the carbon granules. GAC is effective in removing volatile organic compounds and semi-volatile organic compounds. However, the off-site ground water contains primarily volatile organic compounds which are readily removed by air stripping. In this case, air stripping is recommended over GAC, since GAC involves comparatively high operational costs due to the carbon replacement expense.

3.2.7.4 Ultraviolet Light/Peroxide System

As described in Section 3.2.4.6, this alternative uses hydrogen peroxide to oxidize the contaminants with ultraviolet (UV) light as a catalyst. The UV light converts hydrogen peroxide into hydroxyl radicals, which are strong oxidants. Bench-scale studies must be conducted to estimate these variables and the size of the reactor.

The operational costs associated with a UV/peroxide system are high due to the great amount of energy and chemicals required to operate the system. The UV/peroxide system would be expensive for removal of volatile organic compounds from the off-site ground water.

3.2.8 Off-Site Ground Water Discharge Technologies

3.2.8.1 Discharge to Ground Water Using On-Site Basin

If the ground water collected from the off-site wells are treated on-site, it could be combined with the water extracted and treated from the on-site wells and discharged into the on-site retention basin.

3.2.8.2 Discharge to Ground Water Using Injection Wells

Treated ground water would be discharged into a system of injection wells either upgradient or downgradient of the site.

3.2.8.3 Discharge to POTW

In this technology, treated water would be discharged to the Nassau County Sanitary Sewer System and sent to the Nassau County POTW. However, the County's policy is not to allow treatment effluent into the POTW.

3.2.8.4 Discharge to Off-Site Recharge Basins

In this technology, treated water would be discharged to off-site recharge basins. However, approval from the Town is required. Another option would be discharge to a holding basin on a golf course in Bethpage State Park.

3.3 SCREENING CRITERIA FOR REMEDIAL TECHNOLOGIES

The screening of technologies will be performed on the basis of three criteria: effectiveness; implementability; and cost.

3.3.1 Effectiveness

Only those technologies that will meet the remedial action objectives, as well as contribute to the protection of human health and environment will be considered. This criterion focuses on the degree to which a technology reduces toxicity, mobility, or volume of hazardous substances. This assessment will determine if the technology minimizes residual risks, affords long-term protection, complies with site-specific cleanup criteria, minimizes short-term impacts, and how quickly it achieves protection. This evaluation is based on an assessment of demographic, geographic, physical, chemical and biological factors that contribute to the impact of hazardous substances to be remediated.

3.3.2 Implementability

Technical and administrative feasibility of construction, operation and maintenance will be evaluated under this criterion. Technologies which may prove extremely difficult to implement, which will not achieve the remedial action objectives in a reasonable period of time, or which are not reliable, will be eliminated from further consideration. Included in this criterion is the ability to obtain approvals from regulatory agencies as well as availability of required facilities and services.

3.3.3 Cost

Costs will be used to compare technologies that provide similar results in terms of effectiveness and implementability. Both construction and long-term operation and maintenance costs will evaluated. Estimated costs that are grossly excessive compared to the overall effectiveness and implementability of the alternatives may be considered as a factor for elimination of the alternative.

3.4 SCREENING OF REMEDIAL TECHNOLOGIES

3.4.1 Shallow Soil Treatment Technologies

3.4.1.1 No Action

An alternative consisting of no action is developed in accordance with the NCP which specifies that such an alternative be developed as a baseline for comparison to other alternatives. Under this alternative no remedial action would be taken. Therefore, shallow soil contamination would remain onsite. In the areas of the site which are not currently capped (about 10% of the contaminated areas) infiltration of rain water would cause migration of contaminants to ground water. Also, the risk of exposure through skin contact and ingestion would remain.

3.4.1.2 Capping

For this technology, no remedial action other than capping would be taken. The shallow soil contamination would be addressed by capping those contaminated areas currently uncapped and maintaining the cap (pavement and buildings) already installed over the majority of the affected areas on-site.

If no additional remedial action were implemented, it is expected that soil contamination would remain on-site. Mobility is somewhat reduced as the capping would almost eliminate infiltration of rain water or runoff. By eliminating infiltration, the contaminants from the shallow soil would not be easily transported to the ground water. Capping would also further reduce upward migration of soil gases to the atmosphere. Regular operation and maintenance of the capping would be required. The increase in paved areas would require a review of storm water runoff.

This technology is easy to implement because it does not involve any difficult construction and does not require special equipment or personnel. Capping is easily accomplished and has been done on the FTC in the past. The cost for this technology is relatively low. This technology will be retained for further analysis.

3.4.1.3 In-situ Bioremediation for Shallow Soil Contamination

Using this technology, the shallow soil contamination would be remediated through in-situ bioremediation. In-situ bioremediation would be effective in reducing the volume of contaminated soil affecting the ground water quality. Reduction in toxicity is expected as the contaminants biodegrade. In-situ biodegradation usually takes a long time for completion. A treatability study will be required to determine the environmental conditions most conducive to the microbes' metabolic activity for optimum degradation rates. A treatability study would also be required to determine the microbial degradation products and their respective toxicity. The treatability study will also determine whether the metals, such as manganese, present in the soil will hinder the biodegradation process.

The cost of implementing this technology are moderate; however, in-situ bioremediation may be difficult to implement on the shallow soil at the site since it would require the construction of infiltration galleries necessary to maintain saturated conditions in the shallow soil. Maintaining soil saturation would be difficult, even with the galleries. Construction of these galleries would be difficult to do without interfering with current underground piping or disrupting current site operations. Additionally, the construction may be difficult since there is a large network of underground piping which already exists at the site which would have to be avoided. Also, during construction of the infiltration galleries, exposure to contaminants by workers is possible. For these reasons, this technology has been screened from further analysis.

3.4.1.4 Bioventing for Shallow Soil Contamination

Bioventing accomplishes biodegradation in soil and removal of contaminants by a combination of enhanced bioremediation and vacuum extraction. If successfully operated, a bioventing system would reduce the volume and toxicity of contamination in the shallow soil. A treatability study would be required to evaluate the applicability of bioventing at the FTC. However, since bioventing is a new and innovative technology, its effectiveness is uncertain.

Bioventing may be difficult to implement at the FTC since this technology would require the construction of infiltration galleries necessary to maintain saturated conditions and add nutrients to the soil. As discussed in Section 3.4.1.3, construction may be difficult due to existing underground piping and possible worker exposure.

Bioventing may require a long time period to accomplish remediation, since it generally takes time to effect biodegradation. Costs for implementing bioventing are moderate. Bioventing has been screened from further analysis.

3.4.1.5 Solid Phase Bioremediation for Shallow Soil Contamination

Using this technology, the shallow soil would be excavated and remediated by solid-phase bioremediation. The volume and mobility of the contaminants in the shallow soil would be reduced to acceptable levels as the microbes consume the contaminants. The degradation byproducts and the leachate are collected above-grade for treatment. Reduction in toxicity is expected as the contaminants get biodegraded. However, a treatability study would be required to determine the microbial degradation products and their respective toxicity.

The large area required for this technology is prohibitive, since this site is actively used for fire training exercises. Excavation and aboveground treatment would require proper permit applications and involvement of regulatory agencies. This may lead to some difficulty in implementing this alternative. The small flow of leachate generated during the treatment would have to be analyzed to determine whether it could be effectively treated. Additionally, if the volatilization of VOCs from the excavated soil is significant, the treatment will have to be performed in an enclosure, and activated carbon adsorption may be needed to prevent VOCs from escaping into the air. This will require additional construction time for building of the treatment unit. It is assumed that the soil to be treated aboveground is not hazardous. Therefore, delisting is not required prior to placing it back in the excavation. The costs of this alternative are moderate. This technology has been screened from further analysis.

3.4.1.6 Excavation and Off-Site Disposal Shallow Soil Contamination

The shallow soil contamination will be excavated and disposed off-site in a nonhazardous landfill. There is no permanence in this remedial technology as the contaminated soils are only transported from one location to another. Although the landfill is equipped to capture and monitor the contamination byproducts, such as gas and leachate, it does not provide remediation of the wastes. The volume and toxicity of contamination may only be slightly reduced by natural degradation over time in the landfill, if at all. This technology is simple to implement. The time to implement this option is nominal. The costs to implement this technology are moderate. This technology will be retained for further analysis.

3.4.1.7 Soil Washing for Shallow Soil Contamination

Using this technology, the shallow soil would be excavated and washed using a liquid extraction process. Following the washing, the contaminants in the soil would be partitioned from the solid phase into the liquid phase.

In a typical soil washing system, the soil is slurred with water, which produces a froth. The contaminants in the soil are transferred to the froth. The froth is further treated either through incineration, biodegradation, or disposal. Based on the levels of contaminants in the soil at the site, the resulting wash water could be hazardous. If this were the case, this water would either require further treatment, or possibly off-site disposal. Therefore, this technology is significantly more costly than other technologies. Since some froths exhibit poor treatability, the overall effectiveness of this technology is uncertain. This technology has been screened from further consideration.

3.4.1.8 Excavation and On-Site Treatment for Shallow Soil Contamination

The shallow soil contamination will be excavated and remediated by low temperature thermal treatment. This treatment is effective as it would reduce the toxicity, mobility, and volume of the contaminated soil. The contaminants would be transferred from the soil to the gaseous phase or condensate, which would be treated prior to discharge.

A pilot test may be conducted to determine the optimum conditions for treatment. Additional air treatment may be required with this technology, such as a baghouse. Therefore, additional permit applications and involvement of regulatory agencies may be required and may lead to delays in implementing this treatment. It is assumed that the soil to be treated is not hazardous; therefore, delisting would not be required prior to replacement to the excavation. The costs to implement this technology are moderate. This technology has been retained for further analysis.

3.4.2 Deep Soil Treatment Technologies

3.4.2.1 No Action

An option consisting of no action is developed in accordance with the NCP which specifies that such an option be developed as a baseline for comparison to other technologies. Under this option no remedial action would be taken. Therefore, deep soil contamination would remain onsite. In the areas of the site which are not currently capped (about 10% of the contaminated areas) infiltration of rain water would cause migration of contaminants to ground water. No action is retained for further analysis.

3.4.2.2 Capping

This technology would involve paving those areas which are not already paved. Capping would reduce some of the mobility of contamination. Capping would reduce infiltration caused by rain water thereby somewhat reducing contaminant transport from the soil to the ground water. Capping would also further reduce the upward migration of soil gases to the atmosphere. However, capping will have no effect on the soil contamination caused by the fluctuation of the water table. Therefore, capping is not effective for the reduction of the volume and toxicity of the deep soil contamination. The costs to implement this technology are low. This technology is retained for further analysis.

3.4.2.3 In-situ Bioremediation for Deep Soil Contamination

The deep soil contamination will be remediated through in-situ bioremediation. In-situ bioremediation will likely be effective in reducing the volume of contaminated soil which affects the water quality. Reduction in toxicity is expected as the contaminants biodegrade. In-situ bioremediation usually requires a long time for completion.

In-situ bioremediation can be easily implemented since it involves common activities such as well installation. This technology has been successfully used to treat contaminants similar to those present at the FTC. This technology is readily available commercially. Water will be injected into the deep contaminated soil areas. Significant piping will be required to convey the water from its source to the injection points. The injected water will carry the dissolved oxygen and the nutrients to the microbes and also cause flushing action in the deep soil contamination. The contaminants flushed will be treated during the ground water treatment.

It is uncertain whether the metals present in the soils will inhibit the biodegradation of contaminants. A treatability study would be required to determine the microbial degradation products and their respective toxicity, as well as determine the effects of the metals. The treatability study will also be required to determine the environmental conditions most conducive to the microbes' metabolic activity for optimum degradation rates. The costs are high for this technology, due to the high operational costs. This technology is screened from further analysis.

3.4.2.4 Bioventing for Deep Soil Contamination

Bioventing accomplishes biodegradation in soil and removal of contaminants by a combination of enhanced bioremediation and vacuum extraction.

A treatability study would be required to determine if bioventing is a feasible technique for use at the FTC. It is uncertain if the metals would inhibit the biodegradation process.

The clay lenses at the FTC may create a problem implementing bioventing. The costs to implement bioventing are moderate. Since this technology is new and innovative, its effectiveness is uncertain. This technology is screened from further analysis.

3.4.2.5 Flushing for Deep Soil Contamination

This technology would involve the flushing of the contaminated soil at the FTC with a flushing agent such as water, a solvent, or a surfactant. The flushing agent would be flushed through the soil either through injection wells or the drywells at the site. Over time contaminants, primarily organic compounds and petroleum products, would be captured and flushed from the soil into the ground water. The ground water would be collected at a point downgradient of the injection points and treated using one of the ground water remedial alternatives. Relative to other technologies, this technology would require a greater time for remediation of the soil.

If a flushing agent other than water were used, an associated risk is that all of the flushing agent may not be extracted. Also, the toxicity and the degradation products of the flushing agent must be determined. This technology will not remove all soil contamination but will flush contaminants in the zone of deep soil contamination associated with the fluctuating water table and the drywells, which will reduce the time required to remediate the ground water. However, relative to other soils technology, this one would require a greater time for remediation of the soil.

If clean city-supplied water is used as the flushing agent, this technology can be easily implemented and cost effective. However, if the off-site ground water, which contains low levels of VOCs, were used as the flushing agent and piped to the FTC, State approval would be required for injection of the ground water and piping costs would be high. Due to the elevated levels of metals, plugging problems would render this technology infeasible. This technology is screened from further analysis.

3.4.2.6 Drywell Excavation and Off-Site Disposal for Deep Soil Contamination

This technology would involve excavation of the soils in the drywell areas. Only the deep soils associated with the drywells would be excavated and transported to a landfill for disposal. As previously described, the soil would probably be disposed in a nonhazardous landfill.

This technology would not be effective for the soil associated with the former floating bodies of product since these areas are too extensive and difficult to excavate. Therefore, this technology will only partially remove hazardous substances from the site. In addition, landfilling does not eliminate the contamination but it removes it to another location. The technology is easily implemented and cost effective, and is retained for further analysis

3.4.2.7 Drywell Excavation and On-Site Treatment for Deep Soil Contamination

This technology also involves the excavation of soils, but the excavated soils would be treated by low temperature thermal treatment and replaced on-site. This technology will reduce the volume and toxicity of the deep soil contamination associated with the drywells but would not affect the dry soil contamination associated with the free product bodies.

Implementing this technology would require permitting and regulatory involvement due to the on-site treatment, soil replacement, and air issues. This regulatory involvement may increase the time required to implement the technology. The costs are moderate. This technology is retained for further analysis.

3.4.2.8 Vacuum Extraction

Vacuum extraction is an in-situ remediation alternative for removal of soil contamination. The method involves removing air that contains VOCs from unsaturated soil. Fresh air is injected or flows into the subsurface at vacuum extraction well locations. The extraction wells are constructed similar to conventional four-inch ground water monitoring wells. The VOC-laden air is withdrawn under a vacuum from the extraction well and vented to the atmosphere or treated with conventional air emission control equipment, such as catalytic incineration or carbon adsorption, prior to atmospheric venting, the extent of influence of the vacuum is monitored by vapor probes, which are generally constructed of two-inch PVC.

The vacuum extraction technique has been performed successfully at numerous sites. The technology has been demonstrated at a large number of pilot and full scale operations. The vacuum extraction technology is a relatively simple concept which uses standard equipment. The technology causes minimal disturbance of contaminated soil and the costs for vacuum extraction are moderate.

Vacuum extraction is effective for removing VOCs from soil; but it is not effective for removing the semi-volatile compounds. A vacuum extraction pilot test conducted at the FTC indicated that one vacuum well operating at 50 to 75 cfm would provide an effective capture area for the VOC contaminated soils in the CMB area, for the deep soils. This technology has been retained for further consideration.

3.4.2.9 Air Sparging

Air sparging involves the installation of a well to inject air into the saturated zone and the installation of vapor extraction wells to collect air containing volatilized contaminants. The air recovered with the vapor extraction may have to be treated before being released to the atmosphere. Air sparging is a relatively new technique that has been used primarily on smaller projects.

If air treatment is used the short-term risks associated with air sparging are low and the costs to implement the alternative are moderate. Air sparging has been shown to effectively remove VOCs from soil and ground water. However, semi-volatile compounds, such as naphthalene and its derivatives, which are present in the ground water at the FTC, cannot be effectively removed by air sparging. This technology is retained for further analysis.

3.4.3 On-Site Ground Water Collection Technologies

3.4.3.1 No Action

Regulations require that no-action be evaluated at every site to establish a baseline for comparison. Under this, no remedial action would be taken at the site to restrict on-site migration of contaminated ground water. Monitoring would include collection of ground water samples from on-site and off-site wells to track the migration of the plume. This is retained for further analysis.

3.4.3.2 Subsurface Drains

Subsurface drains can be used effectively to recover free product and contaminated ground water. Drains could be constructed downgradient of the Mockup Field, the gasoline, and the Corrugated Metal Building product bodies. In order for subsurface drains to be effective at the FTC site, they would have to be constructed to forty feet below grade in order to capture the free product. However, installation of the drains at this depth would be difficult to implement and costly due to the machinery and operations required to reach this depth. Typical subsurface drains have been installed to depths of approximately 25 feet. Installation to 40 feet would be infeasible. Also, fluctuation of ground water would present problems. Therefore, subsurface drains have been screened from further evaluation.

3.4.3.3 Two Recovery Wells Collecting Dissolved Contamination in the Gasoline and Solvent Contaminated Areas

Extraction wells are a viable means of withdrawing ground water as a means of controlling migration of contaminated ground water. Extraction wells have been used successfully to control ground water flow on various other contaminated sites and the technology for implementing extraction wells is highly developed. Based upon yields achieved from the site during pump tests, it is estimated that properly located extraction wells will be able to capture sufficient ground water flow to restrict off-site migration of contaminants. This technology involves the use of two recovery wells. The first well, RW-1, was installed in January 1991. The second well, RW-2, will be installed prior to startup. This technology would recover contaminated ground water in the CMB area, but <u>not</u> in the MUF area. Extracted ground water would require treatment prior to disposal. Extraction wells have been demonstrated to be effective, implementable, and reasonable in cost (both capital and O&M). Therefore, on-site recovery wells have been retained for further evaluation.

3.4.3.4 Three Recovery Wells to Collect Dissolved Contamination in the Gasoline, Solvent and Fuel Oil Contaminated Areas

As described in Section 3.4.3.2, recovery wells have been demonstrated to be an effective means of extracting, containing, and recovering contaminated ground water bodies. This option involves the use of three recovery wells. This would include the two wells described above plus one well located within or at the downgradient edges of the former Mockup Field product body to collect contaminated ground water associated with this former product body. The exact locations of the wells would be based on capture zone analysis conducted during the remedial design. This technology would recover contaminated ground water on-site. Extraction wells have been demonstrated to be effective, implementable and reasonable in cost (both capital and O&M). Extracted ground water would require treatment prior to disposal. Therefore, this technology is retained for further analysis.

3.4.3.5 Product Skimming and Recovery Wells in the Gasoline and Solvent Contaminated Areas (Contingency)

Given the current conditions on-site, the product bodies are no longer present. However, as a contingency, this technology is identified and involves the use of four recovery wells equipped with skimmers. This technology would recover contaminated ground water on-site. These wells would include RW-1 and RW-2 as well as wells located within the former MUF and BAF product bodies. Extraction wells have been demonstrated to be effective, implementable and reasonable in cost (both capital and O&M). Extracted ground water would require treatment before disposal. In the event that the ground water table ever drops sufficiently to allow separate phase bodies to form, the recovery wells can be fitted with skimmers to remove free product. In addition, skimmers can be installed in existing monitoring wells to enhance product recovery, if needed. This technology has been screened from further analysis.

3.4.4 On-Site Ground Water Treatment Technologies

At present, the rise in the water table has resulted in the former free product bodies being masked by the saturated zone. If the water table ever drops to its previous level, free product may be observed on the FTC. Because of this possibility, the grouped treatment technologies include free product separation as a contingency.

3.4.4.1 Metals Removal; Air Stripping; Filtration; Granular Activated Carbon

This technology consists of several ground water treatment steps. The first step of the treatment train will consist of metals precipitation. Following metals precipitation, ground water will be treated using an air stripping column to remove VOCs. After the air stripping step, the ground water will be treated by sand filtration, and finally by GAC adsorption. The combination of air stripping and GAC is extremely effective for removing organic compounds from ground water. Air stripping will remove the volatile organic compounds from the water, and GAC will remove the semivolatile compounds.

This technology is highly effective for remediation of the ground water at the FTC site. All of the treatment steps included are proven, reliable technologies. Metals precipitation, air stripping, and granular activated carbon technologies have been used in municipal water and wastewater treatment plants for many years. For the constituents present in the ground water at the FTC site, the combination of air stripping and GAC would be effective for removal of the dissolved ground water contamination.

This technology will decrease the levels in the ground water to attain the SCGs for the FTC site which could protect the public from potential exposure to the ground water contamination. This technology is retained for further analysis.

3.4.4.2 Metals Removal; Steam Stripping; Filtration; Granular Activated Carbon

This technology is similar to that discussed in Section 3.4.4.1, with the exception that steam stripping would be used in place of air stripping. This alternative is effective for ground water remediation since the treatment steps are proven technologies. Steam stripping alone would only remove the chlorinated hydrocarbons and aromatics present in the ground water. However, naphthalene and its derivatives, as well as phthalates would not be removed by steam stripping. Granular activated carbon would still be necessary to remove these compounds. Therefore, steam stripping would not produce any benefits which are not achieved by air stripping. Steam stripping is more difficult to implement than air stripping, since it generally requires greater air pollution controls, and the off-site disposal of condensate. This technology has been screened from further analysis..

3.4.4.3 Metals Removal; Filtration; Liquid Phase Bioremediation

With this technology, metals would be removed as described in Section 3.4.4.1. Following this treatment, liquid phase bioremediation would be used to remove the organic compounds in the ground water. Bioremediation is inhibited by metals. Metals such as manganese may inhibit the biological activity. Since the on-site ground water at the FTC contains metals, including iron, manganese, and aluminum, bioremediation may not be feasible at this site. Also, the BOD, TOC, and COD levels in the ground water are probably too low and would be too costly to add them to the waste stream for bioremediation to be effective. However, this technology is retained, pending a pilot study, for further analysis.

3.4.4.4 Metals Removal; Filtration; Ultraviolet Light(UV)/Peroxide System

With this technology, metals would be removed as described in Section 3.4.4.1. Following this treatment, a UV/peroxide system would be used to remove the organic compounds in the ground water. The operational costs associated with a UV/peroxide system are very high due to the great amount of energy and chemicals required to operate the system. Based on the levels of organic compounds at the site, these costs would be prohibitively expensive, without yielding greater treatment benefits.

This technology is relatively new and innovative. Bench scale tests would have to be performed using the on-site ground water to determine the effectiveness of this alternative in attaining the SCGs for the site. Since this is an emerging technology, its ability to achieve the desired effectiveness on a full scale is not certain. This technology has been retained for further analysis.

3.4.5 On-Site Ground Water Discharge Technologies

3.4.5.1 Discharge to Ground Water Using Recharge Basin

Recharge basins have been demonstrated to be an effective and reliable means of returning treated ground water to the aquifer. Using this technology, treated ground water would be discharged into an infiltration recharge basin located on-site. Because the recharge basin already exists, capital costs would be low and the alternatives would be easily implemented. Therefore, recharge basins have not been screened from further evaluation.

3.4.5.2 Discharge to Ground Water Using Injection Wells

Treated water can be injected back into the aquifer using a system of injection wells. Injection of ground water will require compliance with the substantive requirements of Environmental Conservation Law Article 15, Section 1527. Injection wells have been used with success at other inactive hazardous waste sites. However, careful well design and operation and maintenance (O&M) would be critical. Characteristics that need to be considered in designing the injection wells include the chemistry of the injection zone, and chemical compatibility of the subsurface materials. Improper selection of the well location and injection zone has the potential to cause continued and exacerbated migration of contaminated ground water. Because of these concerns, injection wells would be installed in areas where the ground water quality is the most similar to that of the treated ground water to be injected, that is, in areas where the ground water is clean. However, the use of injection wells is a feasible technology. Therefore, their use has not been screened from further evaluation.

3.4.5.3 Discharge to POTW

Based upon information provided by the Nassau County Department of Public Works, conveyance of the treated water to the POTW is not a practical alternative. The County's policy is not to allow treatment effluent into the POTW. Therefore, this technology has been screened from further evaluation.

3.4.5.4 Discharge to Shallow Infiltration System

A shallow infiltration system can be built either on-site or adjacent to the site which would allow for treated water to infiltrate rapidly into the aquifer. The shallow infiltration system is similar in effectiveness to the recharge basins discussed in Section 3.4.5.1. The shallow infiltration system would not be as implementable at the site because it would require construction. This would also affect the costs associated with developing the shallow infiltration system. This technology is screened from further evaluation.

3.4.5.5 Discharge to Existing Drywell System

Using this technology, some treated water would be disposed of into the existing on-site drywell systems. The drywells, which range in depth from 8 to 34 feet, were also one of the primary sources of contamination. Ground water discharged into the drywells may flush the contaminants out of the unsaturated zone and into the ground water recovery wells, thereby decreasing the time for soil and ground water remediation. However, alternatively, the drywells may force ground water down and outward into the aquifer. Because the dry wells already exist on-site, this technology could be implemented easily. However, the dry wells do not have the capacity to handle the volume of water that will be generated by pumping the recovery wells. It would be more feasible to remove the drywells than to use them as a discharge location. Because of this, disposal to dry wells has been screened from further evaluation.

3.4.6 Off-Site Ground Water Collection Technologies

3.4.6.1 No Action

Regulations require that no-action be evaluated at every site to establish a baseline for comparison. Under this, no remedial action would be taken at the site to restrict off-site migration of contaminated ground water. This has been retained for further analysis.

3.4.6.2 Maximum Contaminant Recovery and Downgradient Edge Plume Recovery, Option 1

This technology involves the installation of five off-site recovery wells. Two wells will be installed in the maximum contaminated area to recover the most contaminated ground water, and three wells will be installed at the downgradient edge of the plume to restrict further migration of the plume. The recovered water will have to be treated before disposal. Recovery wells have been shown to be effective, implementable, and reasonable in cost (both capital and O&M). However, this option requires the pumping, transport, and treatment of 1200 gpm of contaminated ground water. Option 2, which is similar and is discussed in Section 3.4.6.3, requires the treatment of only 900 gpm of contaminated ground water, and is a more cost-effective means of achieving the same results. Therefore, this technology will not be evaluated in the detailed analysis.

3.4.6.3 Maximum Contaminant Recovery and Downgradient Edge Plume Recovery, Option 2

Option 2 involves the installation of seven off-site recovery wells. Two wells will be installed in the maximum contaminated area and five wells will be installed at the downgradient edge of the plume. The total pumping rate will be less than that proposed for Option 1. The recovered water will have to be treated at a rate of 900 gpm before disposal. Recovery wells have been shown to be effective, implementable, and reasonable in cost (both capital and O&M). Therefore, recovery wells have not been screened from further evaluation. This technology will be retained for the detailed analysis of alternatives.

3.4.6.4 Maximum Contaminant Recovery and Total Plume Recovery

This technology involves the installation of twelve off-site recovery wells. Two wells will be installed in the maximum contaminated area, five wells at the downgradient edge of the plume, and five wells within the body of the plume. The recovered water will have to be treated at a rate of 1800 gpm before disposal. Recovery wells have been shown to be effective, implementable, and reasonable in cost (both capital and O&M). Therefore, recovery wells have not been screened from further evaluation. This technology will be evaluated in the detailed analysis of alternatives.

3.4.6.5 Downgradient Edge Plume Recovery

This technology would be effective in preventing the further downgradient migration of the plume towards well N-07852. It would not prevent the movement of the most highly contaminated water from the maximum contaminated area to the area of the downgradient edge of the plume. The recovered water would have to be treated at a rate of 600 gpm. Time is the most limiting factor for this technology. Recovery wells have been shown to be effective, implementable, and reasonable in cost (both capital and O&M). Therefore, this technology will be evaluated in the detailed analysis of alternatives.

3.4.7 Off-Site Ground Water Treatment Technologies

The off-site ground water contaminants are primarily volatile organic compounds. Free product and metals are not of concern in the off-site ground water. The levels of metals in the off-site ground water would nor interfere with other ground water treatment technologies. Therefore, only technologies for the removal of volatile organic compounds are screened.

3.4.7.1 Liquid Phase Bioremediation

Liquid phase bioremediation is a viable technology for the removal of low levels of organic compounds from ground water. A pilot test would be required to determine optimal nutrient and oxygen conditions required for microorganism growth. The feasibility of this technology to remove the off-site ground water contaminants at the site can only be determined following a pilot test. However, research has shown that liquid phase bioremediation may not be feasible at the low concentrations of organic detected in the off-site ground water. However, this technology has been retained for further evaluation.

3.4.7.2 Air Stripping

This technology would use air stripping to remove volatile organic compounds from ground water. This technology is effective for remediation of the off-site ground water, and is a proven and reliable technology which has been used in municipal water and wastewater treatment plants for many years. Air stripping may require air treatment.

This technology will decrease the levels in the ground water to attain the SCGs for the FTC site which could protect the public from potential exposure to the ground water contamination. However, the reduction in contaminant levels will not be immediate. This technology is retained for further evaluation.

3.4.7.3 Granular Activated Carbon (GAC)

This technology would employ GAC to remove organic compounds from the off-site ground water. GAC will effectively remove the volatile and semi-volatile organic compounds in the off-site ground water. This technology is feasible as it has been effectively employed in water treatment plants and used for ground water remediation for many years. Over time, use of this technology will cause a reduction in the contaminant levels in the off-site ground water will attain the SCGs for the FTC site.

GAC is effective for removing organic compounds which are not readily removed by air stripping, such as the semi-volatile organic compounds. However, the off-site ground water contains primarily volatile organic compounds, and the semi-volatile organic compounds have not been detected at levels of concern in the off-site ground water. Since the volatile organic compounds detected in the off-site ground water can be removed by air stripping, GAC is not the preferred technology since GAC involves relatively high operational costs due to the expense of the carbon replacement. This technology has been retained for further analysis.

3.4.7.4 Ultraviolet Light/Peroxide System

With this technology, a UV/peroxide system would be used to remove the organic compounds in the off-site ground water. The operational costs associated with a UV/peroxide system are very high due to the great amount of energy required to operate the system. Based on the levels of organic compounds at the site, these costs would be prohibitively expensive, without yielding greater treatment benefits.

This is a relatively new and innovative technology. Bench scale tests would have to be performed using the on-site ground water to determine its effectiveness in attaining the SCGs for the site. Since this is an emerging technology, its ability to achieve the desired effectiveness on a full scale is not certain but it has been retained for further evaluation.

3.4.8 Off-Site Ground Water Discharge Technologies

3.4.8.1 Discharge to Ground Water Using On-Site Recharge Basin

Recharge basins have been demonstrated to be an effective and reliable means of returning treated ground water back into the aquifer. Using this technology, treated ground water would be discharged into an infiltration recharge basin located on-site. Because the recharge basin exists, capital costs would be low and the technology would be easily implemented. However, based on the amount of water to be discharged, and the fact that ground water mounding may occur in the area, this technology is not feasible, and has been screened from further evaluation.

3.4.8.2 Discharge to Ground Water Using Injection Wells

Using this technology, treated water would be injected back into the aquifer off-site using a system of injection wells. As discussed in Section 3.4.5.2, injection of ground water will require compliance with the substantive requirements of Environmental Conservation Law Article 15. Injection wells have been used with success at other contaminated sites. However, careful well design and operation and maintenance (O&M) would be critical. Characteristics that need to be considered in designing the wells include the chemistry of the injection zone and chemical compatibility of the subsurface materials. Improper selection of the well location and injection zone has the potential to cause continued and exacerbated migration of contaminated ground water. Testing would be required to fully evaluate the feasibility of reinjection. However, their use has not been screened from further evaluation.

3.4.8.3 Discharge to POTW

Based upon information provided by the Nassau County Department of Public Works, conveyance of the treated water to the POTW is not a practical alternative. The County's policy is not to allow treatment effluent into the POTW. Therefore, this alternative has been screened from further evaluation.

3.4.8.4 Discharge to Ground Water Using Off-Site Recharge Basins

Recharge basins have been demonstrated to be an effective and reliable means of returning treated ground water back into the aquifer. Using this technology, treated ground water would be discharged into off-site recharge basins. Because the recharge basins exist, capital costs would be low and the technology would be easily implemented. However, the Town must authorize use of the basins. Authorization to discharge to a basin on the golf course in Bethpage State Park requires that the maximum depth of the basin be limited to four feet which would require an extremely large surface area. This option is retained for further analysis.

3.5 SUMMARY OF SCREENING

Based on the screening of technologies with respect to effectiveness, implementability, and cost, the following technologies have been identified for further consideration under the detailed analysis:

<u>Shallow Soil Treatment Technologies</u>

SST1 - No Action
SST2 - Capping
SST3 - Excavation and Off-Site Disposal
SST4 - Excavation and On-Site Treatment

Deep Soil Treatment Technologies

DST1 - No Action
DST2 - Capping
DST3 - Vacuum Extraction
DST4 - Air Sparging
DST5 - Drywell Excavation and Off-Site Disposal
DST6 - Drywell Excavation and On-Site Treatment

On-Site Ground Water Collection Technologies

ONC1 - No Action
ONC2 - Two Recovery Wells Collecting Dissolved Contamination in the gasoline and solvent contaminated areas
ONC3 - Three Recovery Wells Collecting Dissolved Contamination in the gasoline, solvent and fuel oil contaminated areas

On-Site Ground Water Treatment Technologies

ONT1 - Metals Removal - Air Stripping - GAC - Air Treatment
ONT2 - Metals Removal - Bioremediation - Filtration - GAC
ONT3 - Metals Removal - UV - GAC

On-Site Ground Water Discharge Technologies

OND1 - On-Site Recharge Basin
OND2 - Injection Wells

Off-Site Ground Water Collection Technologies

OFC1 - No Action
OFC2 - Maximum Contaminant Recovery and Downgradient Edge Plume Recovery, Option Two
OFC3 - Maximum Contaminant Recovery and Total Plume Recovery
OFC4 - Downgradient Edge Plume Recovery

Off-Site Ground Water Treatment Technologies

OFT1 - Liquid Phase Bioremediation
OFT2 - Air Stripping
OFT3 - GAC
OFT4 - UV

Off-Site Ground Water Discharge Technologies

OFD1 - Injection Wells
OFD2 - Off-Site Recharge Basins

The ground water treatment technologies of bioremediation and ultraviolet light for both the on-site and off-site ground water and granular activated carbon for the off-site, although listed here, are not included in the detailed analysis in Section 4.0 because there are too many unknowns to adequately complete a detailed analysis. Additional information on these technologies could be acquired during the design phase by conducting appropriate, bench scale testing, treatability studies and/or pilot studies. Therefore, these treatment alternatives have not been excluded from consideration as potential treatment alternatives.

The technologies selected for detailed analysis and costing are representative conventional treatment technologies that will be used as a baseline to compare against the unproven technologies that require treatability work, which include liquid phase bioremediation and ultraviolet light for ground water treatment. Air sparging for the upper saturated zone also require a pilot test during the design phase to obtain more information as to whether or not it is a viable alternative.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 CRITERIA FOR DETAILED ANALYSIS OF ALTERNATIVES

Based on the information presented in Section 3.0, the technologies which passed the screening will be further analyzed as options for remediation of the facility. The NCP specifies that technologies considered for further investigation be evaluated by nine criteria, which are described in the following subsection. The following technologies are an exception to this:

ONT2 - Metals Removal - Bioremediation-Filtration-GAC
ONT3 - Metals Removal - UV-GAC
OFT1 - Liquid Phase Bioremediation
OFT3 - GAC
OFT4 - UV

These technologies, which are innovative, will be tested during the remedial design phase through bench scale testing, pilot tests or treatability studies.

4.1.1 Overall Protection of Human Health and the Environment

This criterion draws on the assessments of other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with SCGs. Technologies will be evaluated to determine whether they can adequately protect human health and the environment, both in the short and long-term by reducing potential risks posed by contaminants at the site. This criterion will evaluate whether the technologies will control potential exposures to levels developed as remediation goals.

4.1.2 Compliance with SCGs

The technologies will be evaluated as to whether they will attain the SCGs for the facility which are presented in Section 2.1. If the technologies will not result in compliance with the SCGs, the technologies will be evaluated as to whether it provides grounds for invoking one of the waivers for compliance with SCGs, as contained in the NCP.

4.1.3 Long-Term Effectiveness and Permanence

Technologies will be assessed for the long-term effectiveness and permanence of remediation they afford, along with the degree of certainty that the technology will prove successful. The magnitude of residual risk remaining from untreated waste or treatment residuals will be considered. The characteristics of the residuals will be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate. The adequacy of controls necessary to manage treatment residuals and untreated waste will also be considered. This factor addresses, in particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the technologies; and the potential exposure pathways and risks posed should the remedial action need replacement.

4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which technologies employ recycling or treatment that reduces toxicity, mobility, or volume will be assessed. The treatment or recycling processes employed by the alternatives will be assessed as to the amount of hazardous substances or contaminants destroyed, treated, or recycled; the degree of expected reduction in toxicity, mobility, or volume of the waste; the degree to which the treatment is irreversible; the type and quantity of residuals that will remain following treatment; and the degree to which treatment reduces the inherent hazards posed by the principal threats at the facility.

4.1.5 Short-Term Effectiveness and Permanence

The short-term effectiveness of the technologies will be assessed. The short-term risks that may be posed to the community during implementation of the technologies will be considered. The potential impacts on workers and the environment during remedial action, as well as the effectiveness of the protective measures, will be assessed.

4.1.6 Implementability

Each technology will be assessed for its ease or difficulty of implementation. This assessment includes the consideration of the following: technical feasibility, administrative feasibility, reliability, the ability to monitor the effectiveness of the remedy, and the availability of services and materials necessary to implement the technologies.

4.1.7 Cost

The cost analysis includes an estimate of the capital and operation and maintenance costs for each technology.

Capital costs include the following components:

- Construction costs including materials, labor, contractor overhead and profit.
- Equipment costs;
- Engineering expenses including costs of administration, design, drafting, construction supervision, reporting and sampling performed during remediation.
- Legal fees and permitting costs.

Operation and maintenance costs include the following components:

- Operation labor costs, including wages, training, overhead and benefits associated with the labor needed for post-construction operations;
- Maintenance costs, including costs for labor, parts, and other resources required for routine maintenance; and
- Expendable materials and energy required for operation of the remedial equipment.

A summary of cost estimates for technologies evaluated in detail is presented in Table 4-1. Backup information for cost estimates is provided in Appendix D.

4.1.8 State Acceptance

This RI/FS is required and supervised by the New York State Department of Environmental Conservation as a Superfund investigation. The work is being conducted under a Consent Order between Nassau County and New York State. Since this is a State-led project, State acceptance of the technologies is a prerequisite of this FS. Therefore, assessment of the state acceptance criteria is not included in the evaluation, until the proposed plan is accepted by the NYSDEC.

4.1.9 Fire Service Academy Acceptance

Because the FTC is a functioning facility, the selected remedial alternative may impact the usability of the facility. Shutting down the facility may have economic repercussions that would need to be addressed.

TABLE 4-1
SUMMARY OF COST ESTIMATES FOR REMEDIAL TECHNOLOGIES

TECHNOLOGIES	CAPITAL	O&M (Annual)	TOTAL PRESENT WORTH (30 yr, 6% interest)
SHALLOW SOIL			
SST1 - No Action	$ 0	$ 0	$ 0
SST2 - Capping	$ 150,000	$ 7,000	$ 246,000
SST3 - Excavation and Offsite Disposal	$ 2,978,000	$ 0	$ 2,978,000
SST4 - Excavation and Low Temperature Thermal Treatment	$ 2,440,000	$ 0	$ 2,440,000
DEEP SOIL			
DST1 - No Action	$ 0	$ 0	$ 0
DST2 - Capping	$ 150,000	$ 7,000	$ 246,000
DST3 - Vacuum Extraction (10 year operation)	$ 524,000	$ 165,000	$ 1,738,000
DST4 - Air sparging (10 year operation)	$ 1,299,000	$ 419,000	$ 4,383,000
DST5 - Hot Spot Excavation and Offsite Disposal	$ 9,423,000	$ 0	$ 9,423,000
DST6 - Hot Spot Excavation and Low Temperature Thermal Treatment	$ 8,372,000	$ 0	$ 8,372,000
ONSITE GROUND WATER COLLECTION			
ONC1 - No Action	$ 0	$ 0	$ 0
ONC2 - Recovery Wells in CMB (2)	$ 538,000	$ 97,000	$ 1,873,000
ONC3 - Recovery Wells in CMB and MUF(3)	$ 634,000	$ 100,000	$ 2,011,000
ONSITE GROUND WATER TREATMENT			
ONT1 - Metals Removal/Air Stripping/GAC	$ 3,683,000	$ 1,272,000	$21,192,000
ONSITE GROUND WATER DISCHARGE			
OND1 - On-Site Recharge Basin	$ 45,000	$ 6,000	$ 128,000
OND2 - Injection Wells (6)	$ 955,000	$ 20,000	$ 1,230,000
OFFSITE GROUND WATER COLLECTION			
OFC1 - No Action	$ 0	$ 0	$ 0
OFC2 - Hot Spot Rem/Plume Rec.	$ 3,571,000	$ 118,000	$ 5,195,000
OFC3 - Plume Recovery	$ 5,020,000	$ 135,000	$ 6,878,000
OFC4 - Downgradient Edge Recovery	$ 3,247,000	$ 110,000	$ 4,761,000
OFFSITE GROUND WATER TREATMENT			
OFT2 - Air Stripping	$ 2,637,000	$ 693,000	$12,176,000
OFFSITE GROUND WATER DISCHARGE			
OFD1 - Injection Wells (24)	$ 5,328,000	$ 88,000	$ 6,539,000
OFD2 - Offsite Recharge Basin	$ 105,000	$ 19,000	$ 370,000

MALCOLM PIRNIE

4.1.10 Community Acceptance

This assessment will not be completed until comments on the proposed plan are received.

A summary of the detailed evaluation of technologies is presented in Table 4-2.

4.2 DETAILED ANALYSIS OF SHALLOW SOIL TREATMENT TECHNOLOGIES

4.2.1 Technology SST1: No Action

Superfund regulations require that no action be evaluated at every site to establish a baseline for comparison of remedial technologies. Under no action, no remedial action would be taken at the site to remediate no-site contaminants in the shallow soil.

4.2.1.1 Overall Protection of Human Health and the Environment

Under no action, contaminants in the shallow soil would be allowed to remain. Current levels of risk would remain the same.

4.2.1.2 Compliance with SCGs

As described in Section 2.1, no SCGs exist for soil remediation at this facility. TCBs for soil remediation are provided by draft New York State guidance criteria. Since no soil remedial action is employed by this technology, no action does not comply with the TBCs for this facility.

4.2.1.3 Long-Term Effectiveness and Permanence

No action does not provide long-term effectiveness in the event of future excavations in the areas of shallow soil contamination.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

No action does not use any treatment to reduce the toxicity, mobility, or volume of contamination in the shallow soil.

4.2.1.5 Short-Term Effectiveness

No action does not offer any short-term effectiveness.

4.2.1.6 Implementability

No action is easily implementable. No additional work is required.

MALCOLM PIRNIE

TABLE 4-2
SUMMARY OF DETAILED ANALYSIS OF TECHNOLOGIES

Technology	Protect Human Health & Environment	Comply With ARARs/TBCs	Long-Term Effectiveness	Reduce Toxicity, Mobility, Volume	Short-Term Effectiveness	Implementability	Cost	Total
SHALLOW SOIL								
SST1- No Action	0	0	0	0	0	2	2	4
SST2- Capping	1	0	1	1	2	2	2	9
SST3- Excavation/Disposal	1	2	1	0	1	2	1	8
SST4- Excavation/LTTT	2	2	2	2	1	1	1	11
DEEP SOIL								
DST1- No Action	0	0	0	0	0	2	2	4
DST2- No Action w/Capping	0	0	0	0	1	2	2	5
DST3- Vacuum Extraction	1	1	1	1	1	1	1	7
DST4- Sparging	1	1	1	1	1	1	1	7
DST5- Hot Spot Excav/Disp.	1	1	1	0	1	2	1	7
DST6- Hot Spot Excav/LTTT	1	1	2	1	1	1	1	8
ON-SITE GW COLLECTION								
ONC1- No Action	0	0	0	0	2	2	2	6
ONC2- Recovery Wells (2)	0	1	0	1	1	1	1	5
ONC3- Recovery Wells (4)	1	1	1	1	1	1	1	7
ON-SITE GW TREATMENT								
ONT1- Metals Rem/Air Stripping/GAC	2	2	2	2	1	1	1	11
ON-SITE GW DISCHARGE								
OND1- On-Site Recharge Basin	2	2	2	2	2	2	2	14
OND2- Injection Wells	2	2	2	2	1	0	1	10
OFF-SITE GW COLLECTION								
OFC1- No Action	0	0	0	0	2	2	2	6
OFC4- Hot Spot Rem/Plume Recovery	2	1	1	2	1	1	1	9
OFC5- Plume Recovery	2	1	2	2	1	1	1	10
OFC6- Downgradient Edge/Plume Recovery	1	0	1	1	1	1	1	6

MALCOLM PIRNIE

TABLE 4-2
SUMMARY OF DETAILED ANALYSIS OF TECHNOLOGIES

Technology	Protect Human Health & Environment	Comply With ARARs/TBCs	Long-Term Effectiveness	Reduce Toxicity, Mobility, Volume	Short-Term Effectiveness	Implementability	Cost	Total
OFF-SITE GW TREATMENT								
OFT2- Air Stripping	2	2	2	2	1	1	1	11
OFF-SITE GW DISCHARGE								
OFD2- Injection Wells	1	2	1	2	1	0	1	8
OFD3- Off-Site Recharge Basin	2	2	2	2	1	2	2	13

KEY:

0 - **Lowest degree** of compliance with criteria.
1 - **Moderate degree** of compliance with criteria.
2 - **Highest degree** of compliance with criteria.

4.2.1.7 Cost

There are no costs associated with the alternative.

4.2.2 Technologies SST2: Capping for Shallow Soil Contamination

4.2.2.1 Description of Technologies

The unpaved contaminated soil areas on site will be paved with asphalt. The contaminated soil areas which are already paved will be checked for integrity of the pavement. The damages observed in the pavement, if any, will be repaired. No additional action is proposed for the contaminated soil areas other than regular maintenance of the pavement.

4.2.2.2 Overall Protection of Human Health and the Environment

The current levels of risk would be reduced by Technology SST2. The site is almost entirely paved. The increased paved area would reduce the potential for contact with shallow soil contamination during normal site operations. However, minor precautions during capping installation on-site will be necessary to minimize exposure.

Although some natural attenuation will occur, it will not result in measurable reduction in risk in the short-term. The presence of shallow contaminated soil would still exist. This technology would afford some protection of human health and environment since the potential for human contact with the contaminated soil would be reduced.

4.2.2.3 Compliance with SCGs

As described in Section 2.1, no SCGs exist for soil remediation at this facility. TBCs for soil remediation are provided by draft New York State guidance criteria. Since no direct soil remedial action is employed by this technology, these soil cleanup goals will not be attained by this alternative. Technology SST2 does not comply with the TBCs for this facility.

4.2.2.4 Long-Term Effectiveness and Permanence

Technology SST2 does not provide long-term effectiveness in the event of future excavations in the areas of shallow soil contamination. However, the proposed site expansion planned in the near future, as contained in the Draft Environmental Impact Statement, 1992, will not include subsurface construction in the areas of shallow soil contamination. If other construction is performed in the distant future, minor risks from exposure during construction to the contaminated soil remain. However, since the mobility of contaminants is reduced by the cap, the long-term risks associated with the contaminants, barring construction activities, are small. A minor reduction of leaching of soil contaminants to the ground water is afforded by Technology SST1. The cap is easy to maintain in the long-term.

4.2.2.5 Reduction of Toxicity, Mobility, or Volume Through Treatment or Recycling

No soil treatment is involved in Technology SST2. Hence, no reduction in toxicity or volume of contaminants is achieved through treatment. However, the increase in paved areas on the site would reduce the ability of precipitation to infiltrate into contaminated shallow soils. Therefore, some nominal reduction in mobility of shallow soil contamination can be expected.

The increase in paved areas may require a review of storm water runoff practices. Improper storm water runoff practices could lead to an increase in contaminants in the storm water.

4.2.2.6 Short-Term Effectiveness

The short-term risks from the shallow soil contamination will be reduced due to capping. The risk of exposure through skin contact and ingestion will be somewhat reduced by this alternative. A small amount of risk is associated with the installation of the cap. During cap installation, exposure to soil vapors also present a minimal risk. Precautions during cap installation activities will be necessary to minimize the risk of exposure by on-site workers.

4.2.2.7 Implementability

Technology SST2 is the easiest shallow soil treatment technology to implement. Conventional construction and construction equipment are required. Time to implement the remedy is relatively short as materials and labor are locally available.

4.2.2.8 Cost

Appendix D provides a detailed cost analysis for capping the soil in the areas not currently capped. The capital cost for Technology SST2 is estimated to be $150,000. Annual Operation and Maintenance (O & M) costs for Technology SST2 are estimated to be $7,000. Total present worth costs for Technology SST2 are calculated to be $246,000, based on a 30-year operation period at a 6% interest rate.

4.2.3 Technology SST3 - Excavation and Off-Site Disposal at a Landfill

4.2.3.1 Description of Technologies

The shallow soil contamination will be excavated in phases to minimize the interruption in the day to day operations at the FTC. The soil excavation will be performed using a backhoe. The soil will be transferred to staging areas using front end loaders and dump trucks. The excavation will be monitored to determine the final limits of contamination. The excavated areas will be backfilled with clean fill and paved to facilitate the continuation of operations at the FTC with minimum interruptions. Composite samples from the excavated soil from the staging area will be sampled for hazardous waste characteristics. If the sampling results indicate that the soil is hazardous, it will be transported to a hazardous waste landfill for disposal, otherwise the soil will be transported to a non-hazardous waste landfill for disposal. For the purpose of estimating the detailed costs for this technology, it is assumed that the soil will be characterized as non-hazardous.

4.2.3.2 Overall Protection of Human Health and the Environment

A somewhat increased protection of human health and the environment will be afforded by this technology. On-site shallow soil contamination will be reduced, and the TBC for this site will be attained by this alternative. However, the transference of the shallow soil contamination from one location to another will not provide a permanent reduction in toxicity, mobility, or volume of contamination except for minor biodegradation in the landfill. Permanent protection of the environment is not provided by this technology.

4.2.3.3 Compliance with SCGs

As described in Section 2.1, no SCGs exist for soil remediation at this facility. TBCs for soil remediation are provided by New York State guidance criteria. Remedial action for the shallow soil will consist of excavation and disposal. Through the implementation of this technology, the TBCs will be attained for the shallow soil.

4.2.3.4 Long-Term Effectiveness and Permanence

The shallow soil contamination is not treated but transported off-site for disposal in this technology. Therefore, uncertainties are associated with land disposal for providing long-term protection from residuals. This technology has no on-site long-term risks because the substances creating the unacceptable levels of risk are removed from the site. Technology SST3 can not be considered permanent because it does not involve treatment.

4.2.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment or Recycling

Due to the absence of treatment, minimal reduction of toxicity, mobility, and volume of the shallow soil contamination will be accomplished. Some minor degradation of the contaminants may occur when the soils are mixed with the landfill wastes.

4.2.3.6 Short-Term Effectiveness

The short-term risks posed by this technology include risks from exposure through skin contact and ingestion during excavation and the risks from the dust generated during excavation.

4.2.3.7 Implementability

The excavation of contaminated soils is a common alternative to treatment. This technology may cause some disruption of on-site activities. The excavation would be conducted in phases to minimize disruption of areas used. This excavation schedule would prolong the time required to implement the technology. Areas that are being excavated must be properly monitored and all trenches built to OSHA specifications. No new or untested techniques will be necessary to excavate soils.

4.2.3.8 Cost

The cost analysis for technology SST3 is provided in Appendix D. Assuming all sludges and wastes created are non-hazardous, capital cost is $2,978,000 and annual O&M costs are $0. Total present worth cost for this alternative is $3,074,000.

4.2.4 Technology SST4 - Excavation and Low Temperature Thermal Treatment

4.2.4.1 Description of Technology

The contaminated shallow soils would be excavated and remediated by low temperature thermal treatment conducted on-site. During this treatment, the soils would be heated to temperatures between 500 and 800°F. During heating, the contaminants would be transferred from the soil to the gaseous phase, and this gaseous phase would be treated or destroyed prior to discharge as appropriate. Following State approval, the soils would be placed on-site.

4.2.4.2 Overall Protection of Human Health and the Environment

An increased level of protection of human health and the environment would be attained by this technology since the contaminants will be reduced to levels which will meet the soils TBCs.

The toxicity, mobility, and volume of contaminated shallow soil on the FTC would be reduced.

4.2.4.3 Compliance with SCGs

Through the implementation of this alternative,the TBCs will be attained for the shallow soil. Low temperature thermal treatment would be effective in reducing the soil contaminants which are found at the FTC to levels which will meet the TBCs, since similar contaminant reductions have been achieved at other sites using low temperature thermal treatment.

4.2.4.4 Long-Term Effectiveness and Performance

This technology will act as a permanent remedy by reducing the soil contamination to levels which would reduce long-term risks associated with the contamination.

4.2.4.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

A reduction of the volume, toxicity, and mobility of soil contaminants can be achieved by this alternative. All soils which are excavated will be treated by low temperature thermal treatment which will reduce the levels of contamination as well as the mobility of contaminants.

4.2.4.6 Short-Term Effectiveness

The short-term risks posed by this technology include risks from exposure through skin contact and ingestion during excavation. Volatilization of untreated VOCs from stockpiled excavated soil prior to treatment as well as from off-gases generated during treatment would contribute to increased short-term risks from inhalation of VOCs.

4.2.4.7 Implementability

Implementing this technology would require permitting and regulatory involvement due to the on-site treatment, soil replacement, and air issues. A State air permit would be required for the treatment, and State approval would be required to replace the soil on the FTC following treatment.

4.2.4.8 Cost

A detailed cost analysis for Technology SST4 is provided in Appendix D. Capital and O&M costs are $2,440,000 and $0, respectively. Total present worth costs are $2,619,000.

4.3 DETAILED ANALYSIS OF DEEP SOIL TREATMENT TECHNOLOGIES

4.3.1 Technology DST1: No Action

Superfund regulations require that no action be evaluated at every site to establish a baseline for comparison of remedial technologies. Under no action, no remedial action would be taken at the site to remediate on-site contaminants in the deep soil.

4.3.1.1 Overall Protection of Human Health and the Environment

Under no action, contaminants in the deep soil would be allowed to remain. Current levels of risk would remain the same. The deep contaminated soil would provide a continuing source of ground water contamination.

4.3.1.2 Compliance with SCGs

As described in Section 2.1, no SCGs exist for soil remediation at this facility. TCBs for soil remediation are provided by draft New York State guidance criteria. Since no soil remedial action is employed by this technology, no action does not comply with the TBCs for this facility.

4.3.1.3 Long-Term Effectiveness and Permanence

No action does not provide long-term effectiveness and the contaminated deep soil will continue to contribute to the ground water contamination.

4.3.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

No action does not use any treatment to reduce the toxicity, mobility, or volume of contamination in the deep soil.

4.3.1.5 Short-Term Effectiveness

No action does not offer any short-term effectiveness and there will be no change in the risk posed by the deep soils.

4.3.1.6 Implementability

No action is easily implementable. No additional work is required.

4.3.1.7 Cost

There are no costs associated with the no action alternative.

4.3.2 Technology DST2: Capping for Deep Soil Contamination

4.3.2.1 Description of Technology

The unpaved contaminated soil areas on site will be paved with asphalt. The contaminated soil areas on site which are already paved will be checked for integrity. The damages observed in the pavement will be repaired. Other than regular maintenance of the paved areas, no additional action is proposed for the contaminated soil areas. This technology contains the same soil actions as those presented in Technology SST2.

4.3.2.2 Overall Protection of Human Health and the Environment

The current levels of risk from the deep soil would be minimally reduced by Technology DST2 through the natural attenuation mechanism. Since the contaminant levels in the deep soil will not be significantly reduced by this technology, the deep contaminated soil would provide a continuing source of ground water contamination.

4.3.2.3 Compliance with SCGs

As described in Section 2.1, no SCGs exist for soil remediation at this facility. TBCs for soil remediation are provided by draft New York State guidance criteria. Since no direct soil remedial action is employed by this alternative, these soil cleanup goals will not be attained by this technology.

4.3.2.4 Long-Term Effectiveness and Permanence

Due to the absence of direct treatment, the contaminated deep soil will continue to contribute to the ground water contamination. Over a very long period of time this technology may lead to some reduction in the deep soil contaminant levels due to the dissolution of the contaminants caused by the fluctuating ground water table. However, the permanence of this technology is questionable. The cap is easy to maintain in the long-term.

4.3.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment for deep soil contamination is contained in Technology DST2. Limited reduction in toxicity and mobility of the deep soil contamination through the dissolution of the contaminants would be caused by the fluctuating ground water table.

4.3.2.6 Short-Term Effectiveness

The presence of deep soil contamination will provide a continuing source of ground water contamination. There will be no change in risk posed by the deep soils. A small risk is associated with the installation of the cap, which will require precautions during construction to minimize the risk of exposure by on-site workers.

4.3.2.7 Implementability

The capping of the contaminated soil is a technology that can be easily and quickly implemented. No special equipment or complicated construction techniques are necessary. The increase in paved areas may require a review of storm water runoff.

4.3.2.8 Cost

Appendix D provides a detailed cost analysis for Technology DST2. The capital cost for Technology DST2 is estimated to be $150,000 and annual costs O & M are estimated to be $7,000. Total present worth costs for Technology DST2 are calculated to be $246,000.

4.3.3 Technology DST3: Vacuum Extraction

4.3.3.1 Description of Technology

Vacuum extraction is an in-situ soil treatment technology used to remove VOCs from the vadose zone. Using this technology, a vacuum is drawn on the contaminated soil to extract the VOC-contaminated vapors in the interstices of the soil, through the vacuum well. The vapors are then either vented directly to the atmosphere, or are controlled with carbon adsorption or catalytic oxidation prior to venting. The extent, or influence of the vacuum is monitored by vapor probes.

4.3.3.2 Overall Protection of Human Health and the Environment

Vacuum extraction is an effective technology for the removal of VOCs from the vadose zone. During the IRM, a vacuum extraction pilot study was performed in the CMB area. The results of the pilot study indicated that vacuum extraction was somewhat effective in the deep soil in the CMB area, but was not effective for the shallow soils. During the pilot study, lower levels of VOCs were removed from the soil than were expected, probably because of the two following factors. A rise in the ground water table had bound the contamination in the saturated zone. In addition, neighboring landfill gas extraction system partially remediated the CMB area over its years of operation, thus reducing the level of contamination.

Based on the results of the pilot study, as well as a review of the applicability of this technology at the FTC, vacuum extraction would be somewhat protective of human health and the environment.

4.3.3.3 Compliance with SCGs

Through the use of vacuum extraction, the VOCs would be removed from the contaminated deep soil at the FTC. However, vacuum extraction will not remove the semi-volatile organic compounds from the deep soil. Therefore, all of the SCGs for this site will not be attained by the use of vacuum extraction.

4.3.3.4 Long-Term Effectiveness and Permanence

This technology will result in permanent removal of VOCs. Additionally, vacuum extraction works well in sandy soils which are present through much of the site. However, in one area of the site containing deep soil contamination, The Extinguisher Area, a 15 foot thick silty-clay unit exists, which would inhibit the effectiveness of vacuum extraction in this area.

4.3.3.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

If effective, vacuum extraction would reduce the toxicity of deep soil, by removing the VOCs. As discussed, the semi-volatile organic compounds will not be removed by vacuum extraction.

4.3.3.6 Short-Term Effectiveness

During the operation of a vacuum extraction system, a small amount of risk is imposed to onsite workers and the community from the volatilization of VOC-contaminated air. An air treatment system can be used to prevent these potential risks. Vacuum extraction will not be effective in a limited portion of the site which contains a confining silty-clay layer.

4.3.3.7 Implementability

Vacuum extraction involves the used of conventional equipment, including vacuum wells, vapor probes, and standard air treatment equipment. The technology can be implemented without major construction or disturbance to the site.

4.3.3.8 Cost

A detailed cost analysis for vacuum extraction is presented in Appendix D. The capital cost for this technology is estimated to be $524,000, and the annual O&M costs are estimated to be $165,000. Total present worth costs for a ten year operational period are calculated to be $1,738,000.

4.3.4 Technology DST4: Air Sparging

4.3.4.1 Description of Technology

Air sparging is an innovative soil and ground water remediation technology. The technology involves injection of uncontaminated air into the saturated zone. The air forms bubbles and carries VOCs in the saturated zone to the vadose zone. A vacuum extraction system will be used to remove VOCs from the vadose zone. VOCs will be either treated or released to atmosphere depending on the air emission regulations.

4.3.4.2 Overall Protection of Human Health and the Environment

Air sparging is an innovative technology with limited human health and environmental protection data. Air sparging application requires a low flow and low pressure air supply, and the threat to human health and environment is minimal. Air sparging may, if not monitored properly, cause migration of contaminants.

4.3.4.3 Compliance with SCGs

While it is expected that reduction of ground water contamination will be accomplished by this technology, it is unknown whether these levels will attain the SCGs for this facility.

4.3.4.4 Long-Term Effectiveness and Permanence

This technology is designed to reduce the volume of ground water to be treated and shorten the duration of ground water remediation. It is unknown if this technology will constitute a permanent remedy for the ground water contamination because of limited data.

4.3.4.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

If effective, air sparging would reduce the toxicity of VOCs from the ground water. However, semi-volatile compounds, such as naphthalene and its derivatives, which are present at the FTC are not effectively removed by air sparging. In addition, if not properly operated, the injection of air can cause migration of contaminants.

4.3.4.6 Short-Term Effectiveness

Air sparging is an enhancement technology which transports dissolved VOCs into the vadose zone, where they are collected by a vacuum extraction system. The effectiveness depends on the performance of the vacuum extraction system and soil profile. A pilot test is needed to evaluate the effectiveness.

4.3.4.7 Implementability

The air sparging can be implemented without major construction or disturbance to site usage except during equipment installation. Therefore, air sparging technology is implementable.

4.3.4.8 Cost

A detailed cost analysis for air sparging is presented in Appendix D. The capital cost is estimated to be $1,299,000, and the annual O & M costs are estimated to be $419,000. Total present worth costs are calculated to be $4,383,000.

4.3.5 Technology DST5 - Limited Hot Spot (Drywell) Excavation and Off-Site Disposal

4.3.5.1 Description of Technology

This technology will involve the excavation of the soils in the drywell areas. Only the deep soils associated with the drywells would be excavated and transported to a landfill for disposal or recycling.

4.3.5.2 Overall Protection of Human Health and the Environment

This technology would effectively protect human health and the environment for the soils associated with the drywells. However, the deep soil associated with the former free product bodies would remain and would continue to contribute to ground water contamination.

4.3.5.3 Compliance with SCGs

The TBCs will be attained for the deep soils associated with the drywells. The soils associated with the former free product bodies would not be treated to attain the TBCs.

4.3.5.4 Long-Term Effectiveness and Performance

This technology will provide a remedy for the drywell soils, but not for the soils associated with the former free product bodies. The deep soil contamination would not be treated but transported off-site for disposal. Therefore, this technology poses uncertainties associated with land disposal for providing long-term protection from residuals. The technology cannot be considered permanent because it does not involve treatment.

4.3.5.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Some reduction in toxicity, mobility and volume will be provided. Recycling would reduce mobility, if the material were recycled for use in asphalt production. However, if the soil were landfilled, minimal reduction of toxicity and mobility of contaminants would be accomplished. The volume of contaminated deep soil would be reduced by this technology.

4.3.5.6 Short-Term Effectiveness

Short-term exposure risks associated with excavation are associated with this technology.

4.3.5.7 Implementability

This technology is easily implemented with conventional construction and soil management practices.

4.3.5.8 Cost

A detailed cost for this technology is presented in Appendix D. The capital and O&M costs are $9,423,000 and $0, respectively. Total present worth costs are $9,423,000.

4.3.6 Technology DST6 - Limited Hot Spot (Drywell) Excavation and Low Temperature Thermal Treatment

4.3.6.1 Description of Technology

This technology is the same as DST5 except that the excavated soils would be treated by low temperature thermal treatment and replaced on-site.

4.3.6.2 Overall Protection of Human Health and the Environment

This technology would effectively protect human health and the environment for the soils associated with the drywells. However, the deep soil associated with the former free product bodies would remain. If combined with a ground water remediation technology, over time the soils associated with the former product bodies would be reduced.

4.3.6.3 Compliance with SCGs

The TBCs will be attained for the deep soils on-site associated with the drywells. Low temperature thermal treatment has been effective in remediating the contaminants found in the soil at the FTC at other sites.

4.3.6.4 Long-Term Effectiveness and Performance

This technology will provide a permanent remedy for the drywell soils, but not for the soils associated with the free product bodies. Combined with a ground water remedial technology, in the long-term this alternative would be effective for remediating all deep soils.

4.3.6.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction in toxicity, mobility, and volume of the drywell soils will be provided by this technology.

4.3.6.6 Short-Term Effectiveness

Short-term exposure risks associated with excavation are associated with this technology. Volatilization of VOCs from stockpiled soil prior to treatment as well as from off-gases generated during treatment pose a risk of inhalation during treatment. Low temperature thermal treatment involves heating excavated soils to remove organic contaminants from the soil. The volatile organics are vaporized and can either be destroyed through subsequent high temperature, incineration or recovered via condensation and adsorption onto activated carbon. There is minimal risk associated with the treatment.

4.3.6.7 Implementability

Implementing this technology would require permitting and regulatory involvement due to the on-site treatment, soil replacement, and air issues.

4.3.6.8 Cost

A detailed cost analysis for Technology DST6 is provided in Appendix D. Capital and O&M

costs are $8,372,000 and $0, respectively. Total present worth costs are $8,372,000.

4.4 DETAILED ANALYSIS OF ON-SITE GROUND WATER COLLECTION TECHNOLOGIES

4.4.1 Technology ONC1: No Action

Superfund regulations require that no action be evaluated at every site to establish a baseline for comparison of remedial alternatives. Under no action, no remedial action would be taken at the site to restrict further migration of on-site contaminants in the ground water.

4.4.1.1 Overall Protection of Human Health and the Environment

Under no action, contaminated ground water would continue to migrate. Contaminants in the ground water could pose risks to persons who come in contact with or consume the water. The aquifer downgradient is a valuable drinking water source and is consumed by area residents. The contaminated ground water on-site is found to exceed drinking water standards. Under no action, the on-site and off-site ground water drinking water resource could be further contaminated to levels above drinking water standards. Therefore, no action would not be protective of human health and the environment.

4.4.1.2 Compliance with SCGs

Present contaminant concentrations in the ground water exceed Federal and State drinking water standards. No action would not result in an improvement of ground water quality to drinking water standards. Therefore, no action would not comply with SCGs.

4.4.1.3 Long-Term Effectiveness and Permanence

Implementation of no action would not address the remedial objective of shallow aquifer restoration or prevention of further off-site migration of constituents detected in ground water. The potential health hazards, identified in the risk assessment, would remain for the future without reduction. Therefore, no action is neither permanent nor effective in the long-term.

4.4.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

No action does not utilize any treatment to reduce the toxicity, mobility, or volume of contaminants in the ground water.

4.4.1.5 Short-Term Effectiveness

No action does not offer any short-term effectiveness. Ground water contaminants would continue to migrate off-site unrestricted.

4.4.1.6 Implementability

No action would be easily implementable. No additional construction would be required.

4.4.1.7 Cost

There are no costs associated with the no action alternative.

4.4.2 Technology ONC2 - Recovery Wells in the Gasoline and Solvent Contaminated Areas

Under Technology ONC2, two recovery wells, RW-1 and RW-2, would be used to contain the on-site contaminant plume and collect contaminated ground water. RW-1 was installed in January 1992 as part of the IRM design. RW-1 is located immediately east of the corrugated metal building and RW-2 would be located near monitoring Well Cluster 7. The placement of these two wells and their associated design parameters such as pumping rate, screened interval, depth, and diameter will be developed to redirect the ground water flow direction, such that the further migration of on-site contaminants is minimized. However, these two wells alone will not capture all on-site contaminated ground water. Under the present site condition, no free product is present in the ground water. As a contingency, RW-1 can also be used to recover free product if it becomes present in the future.

4.4.2.1 Overall Protection of Human Health and the Environment

The wells RW-1 and RW-2 are intended to redirect the ground water flow direction, such that the further migration of on-site contaminants will be minimized. However, these two wells alone will not recover all on-site contaminated ground water. Contaminants that are now in the ground water which are not within the capture zone of these two recovery wells will continue to migrate downgradient. These contaminants could pose risks to persons who come in contact with or consume the ground water. The contaminated ground water on-site is found to exceed drinking water standards. Under Technology ONC2, the off-site ground water drinking water resource could be further contaminated to levels above drinking water standards. Therefore, Technology ONC2 is not protective of human health and the environment.

4.4.2.2 Compliance with SCGs

Present contaminant concentrations in the ground water at the FTC exceed Federal and State drinking water standards. Technology ONC2 would recover contaminated ground water and would result in an improvement in ground water quality. However, this technology would not assure that ground water quality would meet drinking water standards. Therefore, Technology ONC2 would be only partly in compliance with SCGs.

4.4.2.3 Long-Term Effectiveness and Permanence

Implementation of Technology ONC2 would not address the remedial objectives of shallow aquifer restoration or source control. While the existing plume may be contained, additional zones of the aquifer could become contaminated without adequate source control. Therefore, the potential health hazard of drinking ground water contaminated to levels above drinking water requirements would remain. Therefore, Technology ONC2 would neither be effective in the long-term or permanent.

4.4.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology ONC2 would result in the reduction of toxicity and partial mobility of contaminants in the ground water via treatment. However, it would not result in the full reduction of volume of contaminants since noT ALL of the contaminated ground water would be collected by this technology. The ground water in the MUF is not collected under this technology. Also, without full source control, dissolved contaminants are still available to become mobile.

4.4.2.5 Short-Term Effectiveness

Recovery well RW-1 has been installed on-site at the FTC. Technology ONC2 requires one additional recovery well (RW-2) so there will be little exposure to hazardous materials due to implementation of this alternative. Technology ONC2 is partially effective in the short-term because it would contain only part of the existing on-site ground water contamination.

4.4.2.6 Implementability

Technology ONC2 is highly implementable. Recovery well RW-1 is in place. RW-2 can be installed easily.

4.4.2.7 Cost

Costs for this technology would be comprised of well installation and maintenance costs and costs associated with conveyance of the contaminated ground water to the treatment system. The Capital, Annual Operation and Maintenance (O&M) and Present Worth costs for this technology are estimated as follows:

Capital Cost:	$ 538,000
Annual O&M Cost:	$ 97,000
Present Worth:	$1,873,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology ONC2.

4.4.3 Technology ONC3: Recovery Wells in the Gasoline, Solvent and Fuel Oil Contaminated Areas

Under Technology ONC3, three recovery wells would be installed. These three wells would include RW-1 and RW-2 as described in Section 4.4.2 and would be augmented with well RW-3. RW-3 would be located at the downgradient edges of the former Mockup Field product body. These wells will capture the on-site contaminated ground water.

4.4.3.1 Overall Protection of Human Health and the Environment

The three wells would be effective in controlling the migration of ground water contaminants and capturing the existing plume and would, therefore, offer protection of human health and the environment.

4.4.3.2 Compliance with SCGs

Present contaminant concentrations in the ground water exceed Federal and State drinking water standards. Technology ONC3 would result in an improvement of ground water quality to drinking water standards for portions of the aquifer affected by the FTC.

4.4.3.3 Long-Term Effectiveness and Permanence

Implementation of ONC3 would prevent further off-site migration of contamination and would collect contaminated ground water. Since source control is provided by this alternative, it is effective in the long-term. Since Technology ONC3 would contain the contaminant plume, as identified now and would restore the aquifer. The potential health hazards, identified in the Risk Assessment, would be reduced in the long-term. Therefore, Technology ONC3 would be effective in the long-term and would be permanent.

4.4.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology ONC3 would result in the reduction of toxicity and volume of contamination in the ground water through treatment.

4.4.3.5 Short-Term Effectiveness

Technology ONC3 requires the installation of a total of three recovery wells at the FTC. Standard health and safety procedures will be implemented during the installation of the additional wells. Exposure of workers and the general public to hazardous materials will be minimal. Technology ONC3 is effective in the short-term because it would prevent further off-site migration of contamination and contaminated ground water would be collected for treatment.

4.4.3.6 Implementability

The implementation of Technology ONC3 involves installing extraction wells RW-2 and RW-3 (RW-1 is in place). Therefore, Technology ONC3 is highly implementable.

4.4.3.7 Cost

Costs for this technology would be comprised of well installation costs and costs associated with transporting the extracted ground water to the treatment system. The Capital, Annual Operation and Maintenance (O&M) and Present Worth costs for this alternative are estimated as follows:

Capital Cost:	$ 634,000
Annual O&M Cost:	$ 100,000
Present Worth:	$2,011,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology ONC3.

4.5 DETAILED ANALYSIS OF ON-SITE GROUND WATER TREATMENT

4.5.1 Technology ONT1 -Free Product Separation (Contingency); Metals Removal; Air Stripping; Filtration; Granular Activated Carbon

4.5.1.1 Description of Technology

This technology involves three major steps; the removal of free floating product (as a contingency), metals, and organic compounds from contaminated ground water. These steps will be accomplished by precipitation of metals and the use of air stripping and activated carbon to remove organic compounds.

If encountered, free product will be recovered in the wells by skimming, if required. An enhanced gravity separator will remove the free product from the ground water. The free product will be pumped into a storage tank. The floating product will be classified and appropriately disposed.

The collected ground water will then be treated with a metals precipitation process to remove the dissolved metals.

Following metals removal, the ground water will be treated in an air stripping column. The treated water will flow out of the air stripping column and will be sent to a sand filter. Air monitoring and emissions control on the column will be necessary to comply with NYSDEC air standards for VOC.

Water leaving the sand filter will be pumped through a granular activated carbon (GAC) unit to remove organic compounds that were not readily removed using air stripping. The GAC unit consists of two absorber vessels lined for corrosion resistance. Monitoring the discharge from GAC unit is necessary to determining when the carbon is spent, or no longer able to remove contaminants. When the carbon is spent, it would be replaced or regenerated. Based on the contaminants at the site, the regeneration would be required approximately once a year. However, the regeneration will be more frequent initially.

4.5.1.2 Overall Protection of Human Health and the Environment

Free product recovery, if necessary, will increase overall protection of human health and the environment by reducing the source material of ground water contamination. Ground water treatment will provide protection of human health from contaminants currently in the on-site ground water.

4.5.1.3 Compliance with SCGs

SCGs and TBCs for ground water consist of levels for metals and organic compounds. This technology contains a treatment train which contains units for the removal of the metals and organic compounds from the on-site ground water at the facility. Proper implementation of this technology will achieve the SCGs and TBCs for ground water.

4.5.1.4 Long-Term Effectiveness and Permanence

The removal of floating free product, if necessary, will reduce the continuing contribution to soil and ground water contamination. This technology will eventually lead to a permanent remedy from ground water treatment and reduction in the deep soil contaminant levels due to the dissolution of the contaminants in the ground water.

4.5.1.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction in toxicity, mobility and volume of both deep soils and ground water through treatment is achieved by the removal of free product, if encountered, and the operation of the ground water treatment system. In the long-term, the dissolution of contaminants from the deep soil followed by the ground water treatment would also lead to a reduction in toxicity, mobility, and volume of contaminants in the deep soil.

4.5.1.6 Short-Term Effectiveness

The risk of exposure through skin contact and ingestion from potable wells downgradient of the site will be reduced due to the ground water pump and treat operation.

4.5.1.7 Implementability

Removal of free floating product involves a unit process which has been employed for many years, and will be easily implemented, if necessary. Ground water treatment for reduction of metals by chemical precipitation is a proven technology that can be readily implemented. Metals precipitation is a practical technique for removal of iron, manganese, and aluminum, the three major inorganic contaminants present in the ground water. A small enclosed treatment building must be constructed to house the necessary equipment.

The effectiveness and performance of using air stripping and granular activated carbon (GAC) has been well documented, having been used in water treatment and industrial plants for many years. Air stripping will effectively reduce volatile organic compounds present on-site. GAC will be used to remove semi-volatile compounds. This treatment process will require daily maintenance.

4.5.1.8 Cost

Appendix D provides a detailed cost analysis for Technology ONT1. The capital cost for Technology ONT1 is estimated to be $3,683,000, and the annual O & M costs are estimated to be $1,272,000. Total present worth costs for Technology ONT1 are calculated to be $21,192,000.

4.6 DETAILED ANALYSIS OF ON-SITE GROUND WATER DISCHARGE TECHNOLOGIES

4.6.1 Technology OND1: Discharge to Ground Water Using Recharge Basins

In Technology OND1, treated ground water would be discharged into an infiltration recharge basin located on the site.

4.6.1.1 Overall Protection of Human Health and the Environment

The use of a recharge basin would be protective of human health and the environment. The treated ground water would meet the New York State drinking water standards. Also, it has been demonstrated that the hydrogeologic impact of the recharge basins may cause a positive hydraulic gradient toward the extraction wells, which could positively influence the remediation time. Also, the recharge basins are already constructed. Therefore, minimal risks to workers would be incurred during construction.

4.6.1.2 Compliance with SCGs

Under Technology OND1, treated ground water would be returned to the ground water aquifer. Water would be treated to New York State drinking water standards. By restoring water to the ground water resource via recharge basins, a positive hydraulic gradient may be established, thereby decreasing the overall remediation schedule. Therefore, this technology would be in compliance with SCGs for the treated water.

4.6.1.3 Long-Term Effectiveness and Performance

Recharge basins require minimal maintenance and are reliable once in place. They are an effective and permanent means of discharging of treated ground water and would thus be effective in the long-term.

4.6.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Ground water entering the recharge basins will meet drinking water standards via the ground water treatment plant (on-site). Therefore, both toxicity and volume of contaminants will be reduced. The hydraulic head that will be established because of the recharge basins will contribute to the tendency for contaminated ground water to migrate to the extraction wells. Also, the hydraulic curtain that might be established due to the presence of the recharge basins would assist in preventing the further migration of contaminants and thereby decreasing contaminant mobility.

4.6.1.5 Short-Term Effectiveness

The recharge basin is already on-site and can accommodate the extracted ground water from within the site boundary. Some capital improvements would be required. Therefore, use of the on-site recharge basins would be immediately available and immediately effective and would thus be effective in the short-term.

4.6.1.6 Implementability

Technology OND1 would be highly implementable. The recharge basins are in place and could become operational with minimal effort. Monitoring of the ground water would be utilized to verify effectiveness. All required services and materials are easily available. Therefore, use of the on-site recharge basins would be highly implementable.

4.6.1.7 Cost

Costs for this technology would be associated with conveyance of the treated water to the recharge basins and minor upgrade and O&M costs for the basin. The Capital, Annual Operation and Maintenance (O&M) and Present Worth costs for this alternative are estimated as follows:

Capital Cost:	$ 45,000
Annual O&M Cost:	$ 6,000
Present Worth:	$ 128,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology OND1.

4.6.2 Technology OND2: Discharge to Ground Water Using Injection Wells

In Technology OND2, treated water would be injected into the aquifer using a system of injection wells. If the ground water is injected upgradient of the collection wells, the hydraulic gradient will be increased which will increase the hydraulic head and this will decrease the time required for cleanup. However, the volume of water extracted that will require treatment would be increased. To eliminate this problem wells could be located downgradient of recovery wells, if access were obtainable. If the wells were located off-site in an area of "clean" ground water, this would also eliminate the potential problem of plugging caused by the influence of the adjacent landfill leachate constituents in the ground water, particularly iron.

4.6.2.1 Overall Protection of Human Heath and the Environment

The effectiveness of the injection wells for disposal of the treated ground water would have to be demonstrated during pilot testing. In general, injection wells are an effective means of disposing of treated ground water. The use of injection wells would contribute to containment of the contaminated aquifer and to restoration. Very little, if any, risk would be posed to workers during installation of the injection wells. Therefore, the injection wells are found to be protective of human health and the environment.

4.6.2.2 Compliance with SCGs

With Technology OND2, treated ground water would be returned to the ground water aquifer. Water would be treated to New York State drinking water standards. By restoring water to the ground water resource via recharge basins, a positive hydraulic gradient may be established, thereby decreasing the overall remediation schedule. Therefore, this technology would be in compliance with SCGs with regards to the on-site ground water.

4.6.2.3 Long-Term Effectiveness and Permanence

It is assumed that the injection wells would be used over the course of the remedial action as an effective and permanent means of discharging of the treated ground water. Injection wells require some maintenance. Therefore, this technology would be effective in the long-term.

4.6.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology OND2 involves the treatment of contaminated ground water to drinking water standards and reinjecting the water to the aquifer. Therefore, both toxicity and volume of contaminants will be reduced. The hydraulic head that will be established because of the reinjection wells will contribute to the tendency for contaminated ground water to migrate to the extraction wells. Also, the hydraulic curtain that would be established due to the presence of the injection wells would assist in preventing the further migration of contaminants and would somewhat decrease contaminant mobility.

4.6.2.5 Short-Term Effectiveness

The use of injection wells, in general, requires that some pilot testing and design be conducted. Therefore, the use of injection wells is partially effective in the short-term.

4.6.2.6 Implementability

This technology would be implementable. Some testing of the aquifer would have to be conducted prior to finalizing the design of the reinjection system. However, reinjection into sandy soils has been demonstrated to be feasible.

4.6.2.7 Cost

Costs for this technology would be comprised of well installation and pilot testing and costs associated with conveyance of extracted ground water from the treatment system. The Capital, Annual Operation and Maintenance (O&M) and Present Worth costs for this technology are estimated as follows for six injection wells:

For six injection wells:

Capital Cost:	$ 955,000
Annual O&M Cost:	$ 20,000
Present Worth:	$1,230,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology OND2.

4.7 DETAILED ANALYSIS OF OFF-SITE GROUND WATER COLLECTION TECHNOLOGIES

4.7.1 Technology OFC1: No Action

Superfund regulations required that no action be evaluated at every site to establish a baseline for comparison of remedial alternatives. Under no action, no remedial action would be taken to the site to restrict further migration of off-site contaminants in the ground water.

4.7.1.1 Overall Protection of Human Health and the Environment

With no action, contaminated ground water off-site would continue to migrate downgradient. Contaminants in the ground water could pose risks to persons who come in contact with or consume the water. The aquifer downgradient is a valuable drinking water resource and is consumed by area residents. The contaminated ground water off-site is found to exceed drinking water standards. Under no action, the downgradient ground water drinking water resource could be further contaminated to levels above drinking water standards. Therefore, no action would not be protective of human health and the environment.

4.7.1.2 Compliance with SCGs

Present contaminant concentrations in the ground water exceed Federal and State drinking water standards. No action would not result in an improvement of ground water quality to drinking water standards. Therefore, no action would not comply with SCGs.

4.7.1.3 Long-Term Effectiveness and Permanence

No action would not address the remedial objective of shallow aquifer restoration or prevention of further migration of constituents detected in ground water. Contaminant transport was modelled using Analytical Random Walk. The modelling results indicated that all ground water with a concentration of 50 ppb or greater VOCs would have to be removed in order to keep the concentration at well N-07852, as indicated on Plate 2, less than 10 ppb. This would include almost the entire plume. The potential health hazards identified in the risk assessment would remain for the future without reduction. Well head treatment would be required as the contaminant plume reached the public supply wells. Therefore, no action is neither effective in the long-term or permanent.

4.7.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

No action does not provide any treatment to reduce the toxicity, mobility, or volume of contaminants in the ground water.

4.7.1.5 Short-Term Effectiveness

No action does not offer any short-term effectiveness. Ground water contaminants would continue to migrate unrestricted.

4.7.1.6 Implementability

No action would be easily implementable. No additional constructions would be required.

4.7.1.7 Cost

There are no costs associated with the no action alternative.

4.7.2 Technology OFC2: Maximum Contaminant Removal and Downgradient Edge Plume Recovery, Option 2

Technology OFC2 assumes that there will be control of the on-site contaminant source. This technology involves the installation of seven recovery wells , two in the hot spot area to capture the most contaminated ground water, and five at the downgradient edge of the plume to prevent further migration of the contaminant plume.

4.7.2.1 Overall Protection of Human Health and the Environment

Under this technology, the two wells located in the hot spot area would recover the most highly contaminated ground water. The five wells at the downgradient edge of the plume would prevent the further migration of the plume. Therefore, this technology would be protective of human health and the environment.

4.7.2.2 Compliance with SCGs

Contaminant concentrations in the ground water currently exceed Federal and State drinking water standards. Technology OFC2 will provide significant removal of contaminants from the ground water, but may not result in restoring the aquifer to drinking water standards. Therefore, Technology OFC2 may not result in complete compliance with current SCGs. If, after the system has been in operation for a period of time, standards have not been met, the technical feasibility of meeting the current standards will be reevaluated, and new cleanup levels may be proposed.

4.7.2.3 Long-Term Effectiveness and Permanence

Technology OFC2 will be effective in removing contaminated ground water from the aquifer through pumping, and effective in removing it from the ground water through treatment so long as the recovery wells and treatment units are in operation. This technology will also be effective in preventing the downgradient migration of the contaminant plume so long as the capture zones are maintained.

4.7.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology OFC2 would result in the reduction of both the toxicity and the volume of contaminated ground water through treatment. This technology would also lower the mobility of the contaminants in the plume by preventing further downgradient migration of the plume.

4.7.2.5 Short-Term Effectiveness

Technology OFC2 involves the installation of seven recovery wells off-site from the FTC. Standard health and safety procedures will be used during the installation of the seven wells and all waste produced during the installation of the seven wells will be disposed of properly. Exposure of workers and the general public to hazardous materials will be minimal.

Technology OFC2 is effective in the short-term, as the hydraulic barrier will be established two years after the installation of the five wells at the downgradient edge of the plume. Figure B-4 shows the extent of the capture zones that are predicted to be developed after ten years of pumping.

4.7.2.6 Implementability

The implementation of Technology OFC2 involves the installation of seven off-site wells. This technology can be easily implemented.

4.7.2.7 Cost

Costs for Technology OFC2 would include the cost of installing seven wells, costs for transporting the recovered ground water to the treatment system, and the costs of maintaining the recovery and treatment systems. The capital, annual operating and maintenance (O&M), and present worth costs for Technology OFC2 are estimated are listed below.

Capital Cost:	$ 3,571,000
Annual O&M Cost:	$ 118,000
Present Worth:	$ 5,195,000

Appendix D provides a detailed summary of the estimated capital and O & M costs to implement Technology OFC2.

4.7.3 Technology OFC3: Maximum Contaminant Recovery and Total Plume Recovery

Technology OFC3 assumes that there will be control of the on-site contaminant sources. This technology involves the installation of twelve recovery wells throughout the area of the contaminant plume. Two wells will be installed in the hot spot area to recover the most highly contaminated ground water; five wells will be installed at the downgradient edge of the plume to prevent further migration of the plume, and five wells will be installed in the body of the plume to recover less contaminated ground water from the plume. This alternative will fulfill the remedial objectives of remediating contaminated ground water and preventing further migration of the plume.

4.7.3.1 Overall Protection of Human Health and the Environment

Under this technology, the two wells located in the hot spot area and the five wells located within the plume will remove much of the contaminated ground water from the aquifer. The five wells at the downgradient edge of the plume will prevent the further migration of the plume. Therefore, Technology OFC3 will be protective of human health and the environment.

4.7.3.2 Compliance with SCGs

Contaminant concentrations in the ground water currently exceed Federal and State drinking water standards. Technology OFC3 will remove significant contamination from the ground water, but it may not completely restore the aquifer to drinking water standards. Therefore, Technology OFC3 may not result in complete compliance with current SCGs. If, after the system has been in operation for a period of time, standards have not been met, the technical feasibility of meeting the current standards will be reevaluated, and new cleanup levels may be proposed.

4.7.3.3 Long-Term Effectiveness and Permanence

Technology OFC3 will be effective in removing contaminated ground water from the aquifer through pumping, and effective in removing contamination from the ground water through treatment so long as the recovery wells and treatment units are in operation. This technology will also be effective in preventing the downgradient migration of the off-site contaminant plume so long as the capture zones are maintained.

4.7.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology OFC3 would reduce the toxicity and the volume of contaminants through the ground water treatment. It would also reduce the mobility of contamination by preventing the further downgradient migration of contaminants in the plume.

4.7.3.5 Short-Term Effectiveness

Technology OFC3 involves the installation of twelve recovery wells downgradient from the FTC. Standard health and safety procedures will be used during installation of the wells, and all waste produced during well installation will be disposed of properly. Exposure of workers and the general public to hazardous materials will be minimal.

Technology OFC3 will be effective in the short-term, as the hydraulic barrier is expected to be formed within two years of the start of pumping. Figure B-5 in Appendix B shows the extent of the capture zone for this technology after four years of pumping.

4.7.3.6 Implementability

The implementation of Technology OFC3 involves the installation of twelve recovery wells. This technology can be implemented fairly easily.

4.7.3.7 Cost

Costs for this technology would include well installation costs, costs associated with the transport of the recovered ground water to the treatment system, and the cost of maintenance of the entire system. The capital, annual operating and maintenance (O&M), and present worth costs for this alternative are estimated as follows:

Capital Cost:	$ 5,020,000
Annual O&M Cost:	$ 135,000
Present Worth:	$ 6,878,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology OFC3.

4.7.4 Technology OFC4: Downgradient Edge Plume Recovery

Technology OFC4 assumes that there will be control of the on-site contaminant source. This technology involves the installation of five recovery wells at the downgradient edge of the plume to prevent further migration of the contaminant plume.

4.7.4.1 Overall Protection of Human Health and the Environment

Under this technology, the most highly contaminated ground water would not be recovered as quickly as in Technology OFC2, however, the five wells would prevent the further migration of the of the plume and would recover the most highly contaminated ground water when it reached the downgradient edge of the plume. This technology would be protective of human health and the environment.

4.7.4.2 Compliance with SCGs

Contaminant concentrations in the ground water currently exceed Federal and State drinking water standards. Technology OFC4 would provide removal of contaminants from the ground water, but may not result in restoring the aquifer to drinking water standards. Therefore, Technology OFC4 may not result in complete compliance with SCGs. If, after the system has been in operation for some time, standards have not been met, the technical feasibility of meeting the current standards will be reevaluated, and new cleanup levels may be proposed.

4.7.4.3 Long-Term Effectiveness and Permanence

Technology OFC4 would be effective in removing contaminated ground water from the aquifer at the downgradient edge of the plume through pumping, and effective in removing contamination from the ground water through treatment so long as the recovery wells and treatment units are in operation. This technology would be effective in preventing the downgradient migration of the plume so long as the recovery wells are pumping and the capture zones are maintained.

4.7.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology OFC4 would result in the reduction of both the toxicity and volume of contaminated ground water through treatment. Because the most highly contaminated ground water would be allowed to migrate to the downgradient edge of the plume through a portion of the aquifer that currently contains only less contaminated ground water, this alternative would not be as effective in reducing the mobility of contaminants as Technology OFC2. This technology would, however, lower the mobility of contamination by preventing further migration of the downgradient edge of the plume.

4.7.4.5 Short-Term Effectiveness

Technology OFC4 involves the installation of five recovery wells off-site from the FTC.

Standard health and safety procedures will be used during the installation of the five wells and all waste produced during the well installation will be disposed of properly. Exposure of workers and the general public to hazardous materials will be minimal. Technology OFC4 will be effective in the short term, as capture zones are projected to be established one year after the start of the pumping.

4.7.4.6 Implementability

The implementation of Technology OFC4 involves the installation of five off-site wells. This can be easily implemented.

4.7.4.7 Cost

Costs for Technology OFC4 would include the cost of installing five wells, transporting the recovered ground waster to the treatment system, and the cost of maintaining the recovery and treatment systems. The capital costs are estimated to be $3,247,000 the annual O & M costs are estimated to be $110,000, and the present worth cost is estimated to be $4,761,000. Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology OFC4.

4.8 DETAILED ANALYSIS OF OFF-SITE GROUND WATER TREATMENT

4.8.1 Technology OFT2 - Air Stripping Using Packed Column

4.8.1.1 Description of Technology

This technology involves the removal of organic compounds from contaminated ground water. Following collection, the off-site ground water will be treated by air stripping using a packed column. The air stripping removes VOCs from the water by the countercurrent flow of ground water with air. The ground water flows down through the air stripping column while air is blown up the column. Two 200 gpm air strippers with 4 foot diameters and 30 foot column height will be used. They can be used in series, parallel, or sequestered, depending upon evaluation performed during design. The VOCs transfer into the air as the water and air make contact in the column. Packing is placed in the tower to increase mass transfer between air and water. The packing increases the surface area over which the two phases come into contact. The air containing the volatile contaminants will be vented out of the top of the column. Air monitoring and possibly emissions control will be necessary to comply with NYSDEC air standards (1991) for VOCs.

However, initial calculations say that air controls are not needed.

4.8.1.2 Overall Protection of Human Health and the Environment

Ground water treatment via air striping will provide protection of human health from the volatile organic contaminants currently in the off-site ground water.

4.8.1.3 Compliance with SCGs

SCGs and TBCs for ground water consist of levels for organic compounds. This technology contains air stripping for the removal of organic compounds from the off-site ground water at the facility. Proper implementation of this technology will achieve the SCGs and TBCs for ground water.

4.8.1.4 Long-Term Effectiveness and Permanence

This technology will eventually lead to a permanent remedy for the removal of the contaminants in the off-site ground water.

4.8.1.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction in toxicity, mobility and volume of both deep soils and ground water through treatment is achieved by the removal of volatile organic compounds.

4.8.1.6 Short-Term Effectiveness

The risk of exposure through skin contact and ingestion from potable wells downgradient of the site will be reduced due to the air stripping operation.

4.8.1.7 Implementability

Air stripping involves a unit process which has been employed for many years, and will be easily implemented. The effectiveness and performance of air stripping has been well documented, having been used in water treatment and industrial plants for many years. Air stripping will effectively reduce volatile organic compounds present on-site. This treatment process will require daily maintenance.

4.8.1.8 Cost

Appendix D provides a detailed cost analysis for Technology OFT2. The capital cost for

Technology OFT2 is estimated to be $2,637,000, and the annual O & M costs are estimated to be $693,000. Total present worth costs for technology are calculated to be $12,176,000

4.9 DETAILED ANALYSIS OF OFF-SITE GROUND WATER DISCHARGE TECHNOLOGIES

4.9.1 Technology OFD1: Discharge to Ground Water Using Injection Wells

Technology OFD1 involves reinjection of treated ground water into the aquifer below Bethpage State Park. This technology would involve testing to determine acceptable injection rates, number of wells, placement of wells and design of wells. Ultimately, a series of injection wells would be installed.

4.9.1.1 Overall Protection of Human Health and the Environment

The effectiveness of the injection wells for disposal of the treated ground water would have to be demonstrated during pilot testing. In general, injection wells are an effective means of disposing of treated ground water. The use of injection wells would contribute to containment of the contaminated water in the aquifer and to restoration. Very little, if any, risk would be posed to workers during installation of the injection wells. Therefore, the injection wells are found to be protective of human health and the environment.

4.9.1.2 Compliance with SCGs

Under Technology OFD1, treated ground water would be returned to the ground water aquifer. Water would be treated to New York State drinking water standards. By restoring water to the ground water resource, a positive hydraulic gradient may be established, thereby decreasing the overall remediation schedule. Therefore, this technology would be in compliance with SCGs.

4.9.1.3 Long-Term Effectiveness and Performance

It is assumed that the injection wells would be used over the course of the remedial action as an effective and permanent means of discharging of the aqueous wastes. Injection wells require some minimum maintenance and have long operating lives. Therefore, this technology would be effective in the long-term.

4.9.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Technology OFD1 involves the treatment of contaminated ground water to drinking water standards and reinjecting the water to the aquifer. Therefore, both toxicity and volume of contaminants will be reduced. The hydraulic head that will be established because of the reinjection wells will contribute to the tendency for contaminated ground water to migrate to the extraction wells. Also, the hydraulic curtain that would be established due to the presence of the injection wells would assist in preventing the further migration of contaminants and would somewhat decrease contaminant mobility.

4.9.1.5 Short-Term Effectiveness

The use of injection wells, in general, requires that some pilot testing and design be conducted. This would result in some delays. Therefore, the use of injection wells is partially effective in the short-term.

4.9.1.6 Implementability

This technology would be fairly implementable. Some testing of the aquifer would have to be conducted prior to finalizing the design of the reinjection system. However, reinjection into sandy soils has been demonstrated to be feasible.

4.9.1.7 Cost

Costs for this technology would be comprised of well installation costs and costs associated with conveying the extracted ground water to the treatment system. The Capital, Annual Operation and Maintenance (O&M) and Present Worth costs for this alternative are estimated as follows:

Capital Costs:	$ 5,328,000
Annual O&M Cost:	$ 88,000
Present Worth:	$ 6,539,000

Appendix D provides a detailed summary of the estimated capital and O&M costs to implement Technology OFD1.

4.9.2 Technology OFD2: Discharge to Ground Water Using Off-Site Recharge Basins

Using this technology, the off-site ground water would be discharged into the recharge basins operated by the Town of Oyster Bay. The recharge basins may have to be upgraded to accommodate the increased capacity.

4.9.2.1 Overall Protection of Human Health and the Environment

The use of the recharge basins would be protective of human health and the environment. The treated ground water would meet the New York State drinking water standards. Also, it has been demonstrated that the hydrogeologic impact of the recharge basins may cause a positive hydraulic gradient toward the extraction wells, which could positively influence the remediation time. Also, the recharge basins are already constructed. Some construction would be required to handle the increased capacity, which would present some risks to workers during construction.

4.9.2.2 Compliance with SCGs

Under Technology OFD2, treated ground water would be returned to the ground water aquifer. Water would be treated to New York State drinking water standards. By restoring water to the ground water via recharge basins, a positive hydraulic gradient may be established, thereby decreasing the overall remediation schedule. Therefore, this technology would be in compliance with SCGs.

4.9.2.3 Long-Term Effectiveness and Permanence

Recharge basins require minimal maintenance and are reliable once in place. They are an effective and permanent means of discharging of treated ground water and would thus be effective in the long-term.

4.9.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The treated ground water entering the recharge basins will meet drinking water standards (see Section 4.8). Therefore, both toxicity and volume of contaminants will be reduced. The hydraulic head that will be established because of the recharge basins may contribute to the tendency for contaminated ground water to migrate to the extraction wells. Also, the hydraulic curtain that may be established due to the presence of the recharge basins would assist in preventing the further migration of contaminants thereby decreasing contaminant mobility.

4.9.2.5 Short-Term Effectiveness

The recharge basins already exist. The capacity of the basins would have to be upgraded to accommodate the extracted off-site ground water. The off-site recharge basins would be effective in the short-term. Minimal construction risks would be involved with the installation since the off-site basins are not contaminated.

4.9.2.6 Implementability

The off-site recharge basins are owned by the State and operated by the Town of Oyster Bay. Therefore, appropriate approvals would be required prior to using the basins, which could impact implementation of this technology.

4.9.2.7 Cost

Costs for this technology would be associated with conveying the extracted ground water to the recharge basins. The Capital, Annual Operation and Maintenance (O & M) and Present Worth costs for this technology are estimated as follows:

Capital Cost:	$ 105,000
Annual O&M Cost:	$ 19,000
Present Worth:	$ 370,000

Appendix D provides a detailed summary of the estimated capital O & M costs to implement Technology OFD2.

4.10 SUMMARY OF DETAILED ANALYSIS OF TECHNOLOGIES

The technologies listed in Section 3.5 are all those that were identified as selected treatment technologies following the initial screening. From those, representative technologies have been combined into remedial alternatives. These remedial alternatives are given below:

Deep Soil Alternatives

DS-1	DST1	No Action
DS-2	DST2	Capping
DS-3	DST5	Drywell Excavation and Off-Site Disposal
DS-4	DST3+DST5	Vacuum Extraction + Drywell Excavation and Off-Site Disposal
DS-5	DST4+DST5	Air Sparging + Drywell Excavation and Off-Site Disposal

Shallow Soil Alternatives

SS-1	SST1	No Action
SS-2	SST2	Capping
SS-3	SST3	Excavation and Off-Site Disposal

On-Site Ground Water Alternatives

ON-1	ONC1	No Action
ON-2	ONC2+ONT1+OND1	Collection in CMB w/Basin
ON-3	ONC3+ONT1+OND1 +OND2	Collection in CMB and MUF w/Basin & Injector Wells

Off-Site Ground Water Alternatives

OFF-1	OFC1	No Action
OFF-2	OFC2+OFT2+OFD1	Max. Cont. & Down Edge w/Wells
OFF-3	OFC3+OFT2+OFD1	Total Plume w/Injector Wells
OFF-4	OFC4+OFT2+OFD1	Down Edge w/Injector Wells
OFF-5	OFC2+OFT2+OFD2	Max. Cont. & Down Edge w/Basin
OFF-6	OFC3+OFT2+OFD2	Total Plume w/Basin
OFF-7	OFC4+OFT2+OFD2	Down Edge w/Basin

Section 4.0 provided a detailed analysis of remedial technologies. Based on this detailed analysis, representative technologies have been combined into representative conventional remedial alternatives to meet the remedial action objectives outlined in Section 2.2. These remedial alternatives are evaluated on their cost and overall effectiveness in protecting human health and the environment and will be used as a baseline to compare against the unproven technologies that require bench scale testing treatability work and/or pilot studies. The following is an evaluation of the alternatives which have been evaluated.

4.10.1 Evaluation of Alternatives

In this section, alternatives are evaluated for remediation of: shallow soil; deep soil; on-site ground water, and off-site ground water. A summary of cost estimates for these alternatives is presented in Table 4-3.

The detailed analysis of alternatives includes an evaluation of seven of the nine criteria specified by the NCP. The two remaining criteria, State and community acceptance, will not be evaluated until comments on the proposed plan area received. A summary of the detailed analysis

MALCOLM PIRNIE

TABLE 4-3
SUMMARY OF COST ESTIMATES FOR REMEDIAL ALTERNATIVES

ALTERNATIVE	CAPITAL	O&M (Annual)	TOTAL PRESENT WORTH (30 yr, 6% interest)
SHALLOW SOIL			
SS-1 - No Action	$ 0	$ 0	$ 0
SS-2 - Capping	$ 150,000	$ 7,000	$ 246,000
SS-3 - Excavation and Offsite Disposal	$ 2,978,000	$ 0	$ 2,978,000
SS-4 - Excavation and Low Temperature Thermal Treatment	$ 2,440,000	$ 0	$ 2,440,000
DEEP SOIL			
DS-1 - No Action	$ 0	$ 0	$ 0
DS-2 - Capping	$ 150,000	$ 7,000	$ 246,000
DS-3 - Drywell Excavation and Off-site Disposal	$ 9,423,000	$ 0	$ 9,423,000
DS-4 - Drywell Excavation and Low Temperature Thermal Treatment (LTTT)	$ 8,372,000	$ 0	$ 8,372,000
DS-5 - Vacuum Extraction and Drywell Excavation/ LTTT (Note 1)	$ 8,896,000	$ 165,000	$10,110,000
DS-6 - Air Sparging and Drywell Excavation/ LTTT (Note 2)	$ 9,671,000	$ 419,000	$12,755,000
ON-SITE GROUND WATER ALTERNATIVES			
ON-1 - No Action	$ 0	$ 0	$ 0
ON-2 - Recovery Wells in CMB, Treatment, Discharge to Basin	$ 4,266,000	$ 1,375,000	$12,193,000
ON-3 - Recovery Wells in CMB & MUF, Treatment, Discharge to Basin/Injection Wells	$ 4,671,000	$ 1,385,000	$23,736,000
OFF-SITE GROUND WATER ALTERNATIVES			
OFF-1- No Action	$ 0	$ 0	$ 0
OFF-2- Max. Contam/Downgrad. Edge Recovery, Treatment, Injection Wells	$11,536,000	$ 899,000	$23,910,000
OFF-3- Plume Recovery, Treatment, Injection Wells	$12,985,000	$ 916,000	$25,594,000
OFF-4- Downgrad. Edge Recovery, Treatment, Injection Wells	$11,212,000	$ 891,000	$23,447,000
OFF-5- Max. Contam/Downgrad. Edge Recovery, Treatment, Discharge to Basin	$ 6,313,000	$ 830,000	$17,738,000
OFF-6- Plume Recovery, Treatment, Discharge to Basin	$ 7,762,000	$ 847,000	$19,421,000
OFF-7- Downgrad. Edge Recovery, Treatment, Discharge to Basin	$ 5,989,000	$ 822,000	$17,304,000

NOTES: Note 1: 10 year operation of vacuum extraction
Note 2: 10 year operation of air sparging

is presented in Table 4-4. In this table, the seven criteria are scored for each alternative. A score of 0, 1, or 2 is given for each criteria, with 0 being the lowest degree of compliance with the criteria, and 2 being the highest degree of compliance. The scores were totaled, and the highest scores represent the alternatives which are the most protective overall of human health and the environment.

4.10.2 Summary of Shallow Soil Alternatives

Four shallow soil alternatives were evaluated. As presented in Table 4-4, Alternative SS-4, Excavation and Low Temperature Thermal Treatment received the highest score, and Alternative SS-2, capping. received the second highest score. Although the capping alternative did not receive the highest score, this alternative would provide significant protection of human health and the environment since the risks of human contact with the shallow soil would be reduced by the cap. In addition, mobility of soil contaminants would be reduced by capping. Therefore, the shallow soil would remain on the FTC, but would not contribute to ground water contamination. Barring construction, following installation of the cap, the shallow soil would not present a significant threat to human health or the environment. As discussed in Section 3.0, construction in the near future is not planned in the shallow soil contaminated areas.

4.10.3 Summary of Deep Soil Alternatives

Six deep soil treatment alternatives were evaluated. Alternative DST5, Vacuum Extraction and Low Temperature Thermal Treatment, and Alternative DST-6, Air Sparging and Drywell Excavation and Low Temperature Thermal Treatment, both scored the highest. This alternative will effectively protect human health and the environment. Using one of these alternatives, the soils in the drywell areas will be excavated, treated with low temperature thermal treatment, and replaced on-site. Either air sparging or vacuum extraction will be used to remediate the remaining deep soils, which are those associated with the fluctuating ground water in the areas of the former floating product bodies. Both alternatives will reduce the toxicity of the contaminants in the deep soils to attain the soil TBCs for the FTC. Implementing this alternative will require regulatory approvals for the air, treatment, and soil replacement issues.

The deep soils associated with the drywells are the most highly contaminated soils, since former fire training exercises involved the discharge of contaminated water into the drywells. Combined with either air sparging or vacuum extraction, the most highly contaminated drywell soils will first be treated by low temperature thermal treatment, and over time, the deep soil

TABLE 4-4
SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES

Alternatives	Protect Human Health & Environment	Comply With SCGs/TBCs	Long-Term Effectiveness	Reduce Toxicity, Mobility, Volume	Short-Term Effectiveness	Implementability	Cost	Total
SHALLOW SOIL								
SS1- No Action	0	0	0	0	0	2	2	4
SS2- Capping	1	0	1	1	2	2	2	9
SS3- Excavation/Disposal	1	2	1	1	1	1	0	7
SS4- Excavation/LTTT	2	2	2	2	1	1	1	11
DEEP SOIL								
DS1- No Action	0	0	0	0	0	2	2	4
DS2- Capping	0	0	0	0	1	2	2	5
DS3- Drywell Excavation/Disposal	1	1	1	0	1	2	1	7
DS4- Drywell Excavation/LTTT	1	1	1	1	1	1	1	7
DS5- Vacuum Extraction and Drywell Excavation/ LTTT (Note 1)	2	1	1	1	1	1	1	8
DS6- Air Sparging and Drywell Excavation/LTTT (Note 2)	2	1	1	1	1	1	1	8
ON-SITE GW ALTERNATIVES								
ON1- No Action	0	0	0	0	0	2	2	4
ON2- Recovery Wells in CMB, Treatment, Discharge to Basin	1	1	1	1	1	1	1	7
ON3- Recovery Wells in CMB & MUF, Discharge to Basin/Injection Wells	2	2	2	2	1	1	1	11
OFF-SITE GROUND WATER ALTERNATIVES								
OFF-1- No Action with Monitoring	0	0	0	0	0	2	2	4
OFF-2- Max. Contam/Downgradient, Edge Recovery, Treatment, Injection Wells	1	1	1	2	1	1	1	8
OFF-3- Plume Recovery, Treatment, Injection Wells	2	2	2	2	2	1	0	11
OFF-4- Downgradient. Edge Recovery, Treatment, Injection Wells	1	0	1	2	1	1	1	7
OFF-5- Max. Contam/Downgrad. Edge Recovery Treatment, Discharge to Basin	1	1	1	2	1	2	1	9
OFF-6- Plume Recovery, Treatment, Discharge to Basin	2	2	2	2	2	2	1	13
OFF-7- Downgrad. Edge Recovery, Treatment Discharge to Basin	1	0	1	2	1	2	1	8

contamination associated with the fluctuating ground water in the areas of free product body contamination will be remediated by one of the technologies. Air sparging will likely require pilot testing prior to full scale operation. Since a pilot test has already been performed for vacuum extraction, a savings in costs would be realized by using vacuum extraction. Also, vacuum extraction is considered to be a more established technology than air sparging at this time. However, both vacuum extraction and air sparging will not remove the heavier semi-volatile organic compounds from the deep soil or the on-site ground water.

4.10.4 Summary of On-Site Ground Water Alternatives

Three on-site ground water alternatives were evaluated. Alternative ON-3 scored the highest. This alternative will provide source control and remediation of the contaminated ground water by a combination of three recovery wells, and ground water treatment and discharge. All of the contaminated ground water plumes would be extracted for treatment using this alternative. The series of ground water treatment processes posed by this alternative will effectively reduce all types of specific ground water contaminants at the FTC, including: VOCs, semivolatile organic compounds, and metals. The processes contained in this alternative are conventional treatment processes which have been used effectively at other sites for years.

Using this alternative, the treated on-site ground water will be discharged into the recharge basin on the FTC and, if necessary, injection wells. Since the basin is already existing, implementation of this alternative is easy, and will be effective in the long-term. Also, the hydrogeologic impact of the recharge basin may cause a positive hydraulic gradient toward the extraction wells, which could reduce remediation time, if ground water recovery wells were used for ground water collection. The combination of ground water extraction, treatment, and discharge is protective of human health and the environment.

4.10.5 Summary of Off-Site Ground Water Alternatives

Seven off-site ground water alternatives were evaluated. Alternative OF-6, Plume Recovery, Treatment, and Discharge to Off-site Basin, scored the highest. Using this alternative, twelve ground water recovery wells would be installed throughout the area of the contaminated plume. By proper placement of the recovery wells, this alternative will remediate contaminated ground water, and will also prevent the migration of contaminated ground water further downgradient. Using this alternative, the entire plume would be remediated, rather than remediating only the highly contaminated areas and providing a hydraulic barrier, as was the intention of other off-site ground water collection alternatives.

The extracted off-site ground water will be treated using air stripping. Air stripping is a common unit process which has been used for many years, and its effectiveness is well documented. Based on the ground water contaminants in the off-site ground water, using air stripping, all ground water which is extracted would meet ground water SCGs prior to discharge. The treated on-site ground water will be discharged into an off-site recharge basin. Since the off-site recharge basins are owned by the State, and operated by the town, appropriate approvals would be required, which may impact implementation of this alternative. The off-site basins already exist, however, construction may be required to increase the capacity of the basins to accommodate the treated ground water. This alternative will be effective in the long-term. Also, the hydrogeologic impact of a recharge basin may cause a positive hydraulic gradient toward the extraction wells, which could reduce remediation time, if ground water recovery wells were used for collection of the off-site ground water. This alternative affords the highest degree of overall protection of human health and the environment compared to the other off-site ground water alternatives.

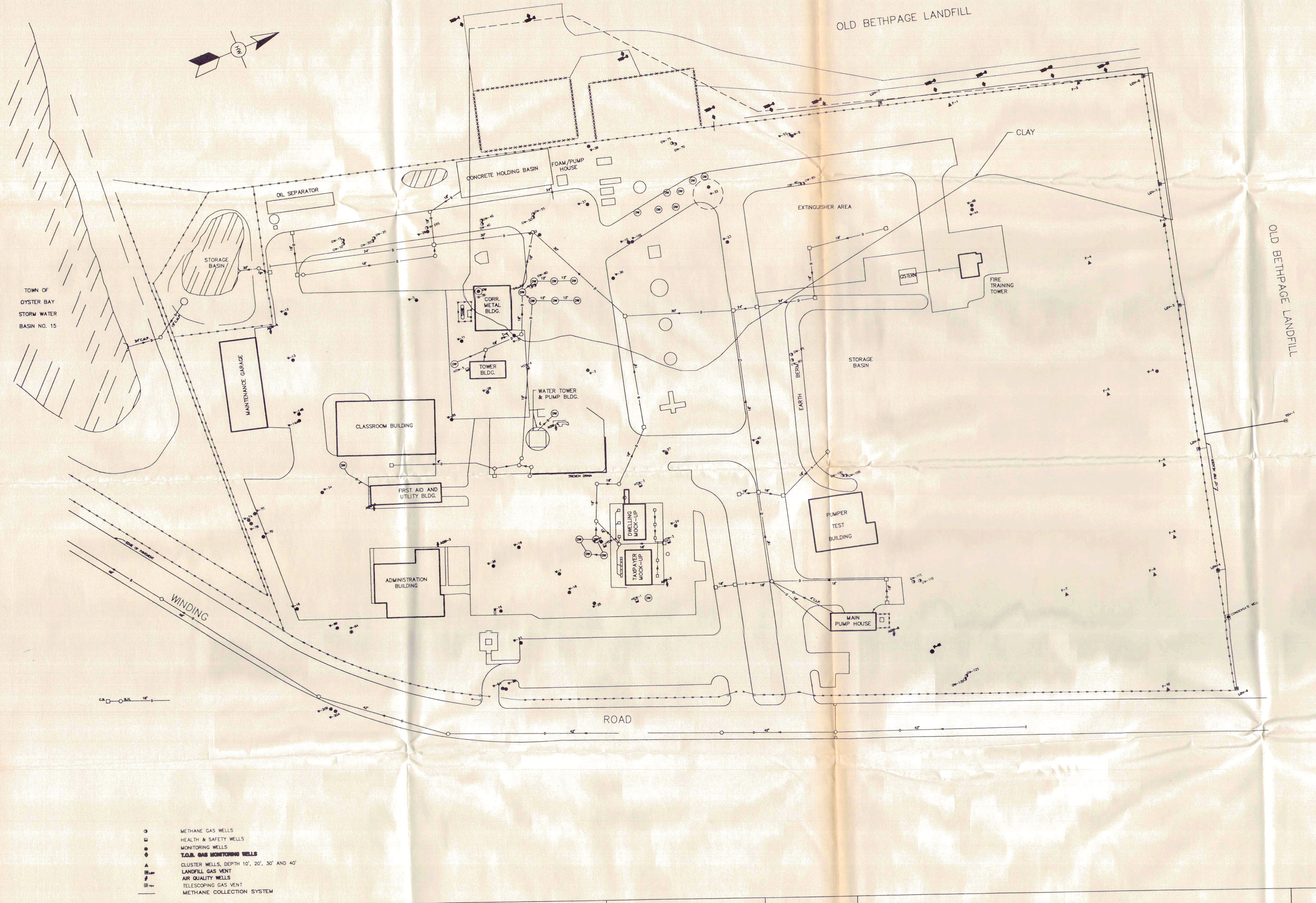


PLATE 1

NO.	REVISION DESCRIPTION	DATE
0	ORIGINAL RELEASE	4-24-91

FILE NAME: \DWG\FIRE-SER-C1-B

CONTRACT NUMBER: S81020

SHEET NO. 1 OF 1

SCALE: 1"=60'

DWG. NO. FTC-100-G1

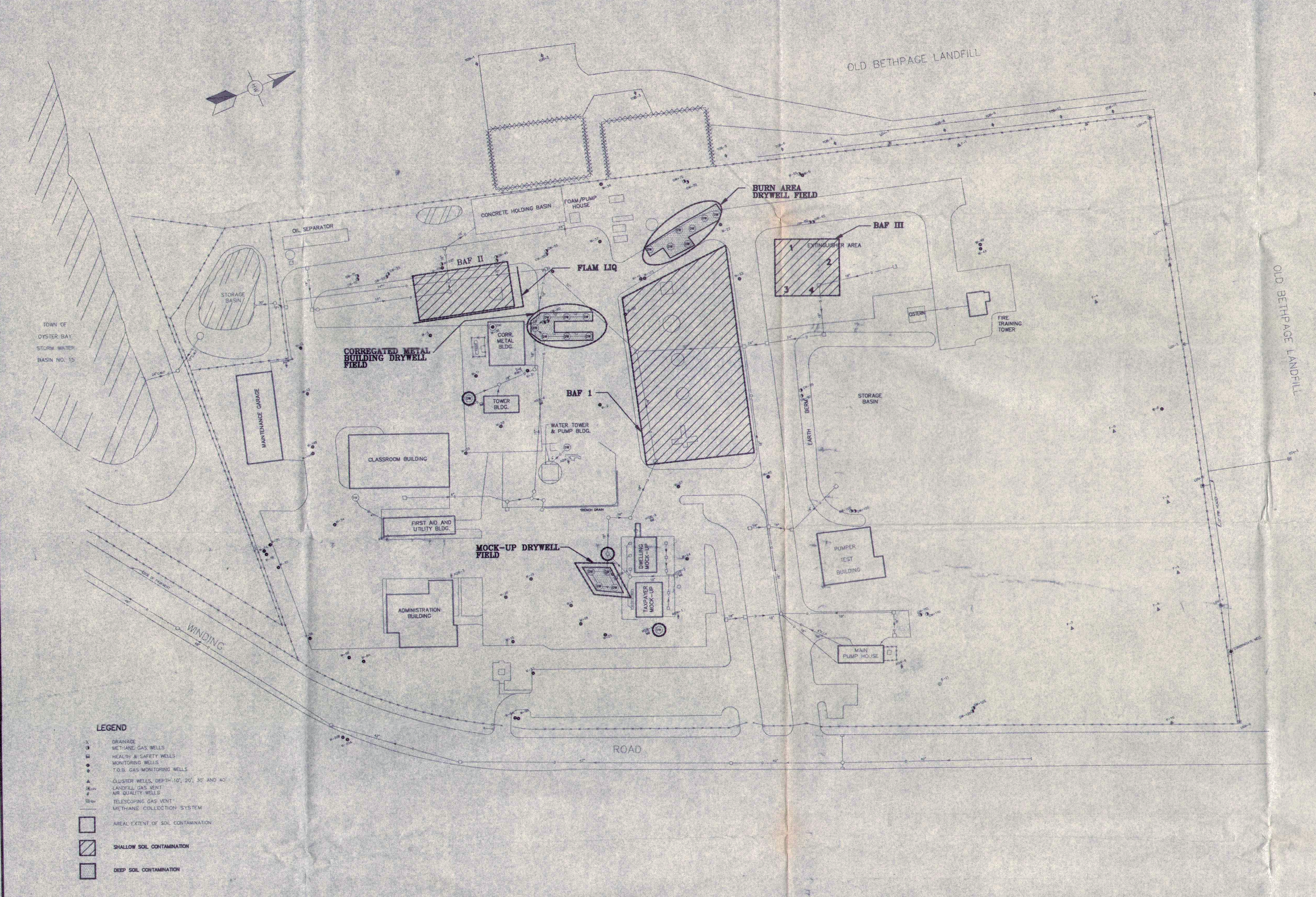
DRAWN BY: J. ZIMMET — DATE 02/01/91

DESIGNED BY: K. ARNOLD — DATE 03/01/91

CHECKED BY: MIKE FLAHERTY — DATE 03/10/91

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
SANITATION & WATER SUPPLY
HAZARDOUS WASTE SERVICES UNIT

SITE PLAN
FIREMEN'S TRAINING CENTER
OLD BETHPAGE, N.Y.



NOTES:

- BADW ------- DENOTES AREA OF SOIL CONTAMINATION FROM BURN AREA DRY WELL FIELD.
- BAF1 ------- DENOTES AREA OF SOIL CONTAMINATION FROM BURN AREA 1 FIELD
- BAF2 ------- DENOTES AREA OF SOIL CONTAMINATION FROM BURN AREA 2 FIELD
- CMBDW ------ DENOTES AREA OF SOIL CONTAMINATION FROM CORRIGATED METAL BUILDING DRY WELL FIELD
- MUFDW ------ DENOTES AREA OF SOIL CONTAMINATION FROM MOCK UP DRY WELL FIELD
- FLAM LIQ ----- DENOTES AREA OF SOIL CONTAMINATION FROM FLAMMABLE LIQUIDS AREA.
- EXTINGUISHER -- DENOTES AREA OF SOIL CONTAMINATION FROM EXTINGUISHER AREA.

PLATE 2

NO.	REVISION DESCRIPTION	DATE
0	ORIGINAL RELEASE	4-24-91

CONTRACT NUMBER: S81020
SHEET NO. 1 OF 1
SCALE: 1"=60'
DWG. NO. FTC-100-G1
DRAWN BY: J. ZIMMET
DATE 02/01/91
DESIGNED BY: K. ARNOLD
DATE 03/01/91
CHECKED BY: MIKE FLAHERTY
DATE 03/10/91

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
SANITATION & WATER SUPPLY
HAZARDOUS WASTE SERVICES UNIT

EXTENT OF SOIL CONTAMINATION
FIREMEN'S TRAINING CENTER
OLD BETHPAGE, N.Y.

NOTES:
1. BASE MAP PREPARED BY COUNTY OF NASSAU, DEPARTMENT OF PUBLIC WORKS, AUGUST 20, 1987.
2. WELLS N-7438 AND UM-2 ARE LOCATED APPROXIMATELY 2700 FT SOUTHWEST AND 2700 FT SOUTH, RESPECTIVELY OF WHERE THEY ARE SHOWN ON MAP

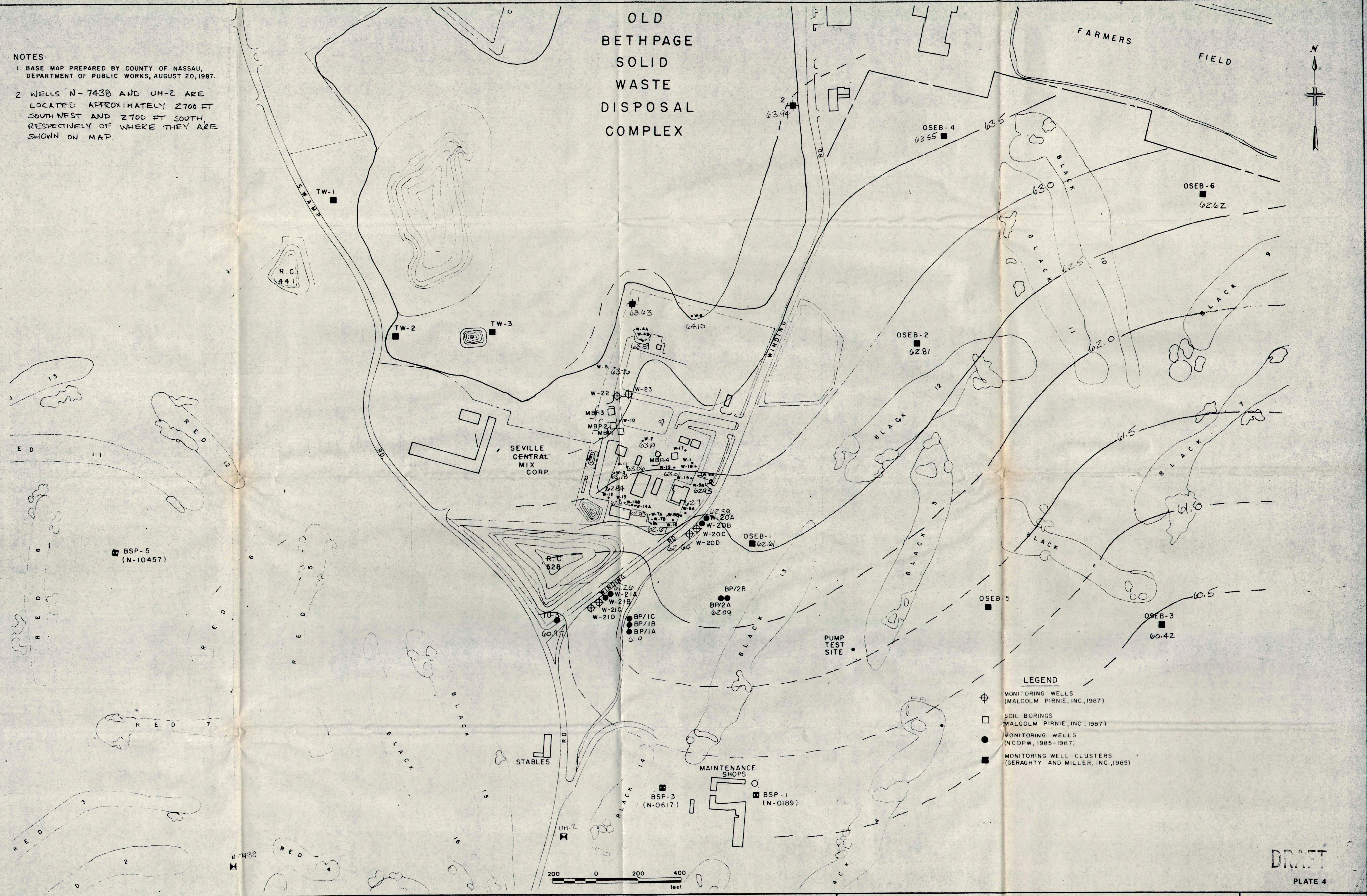


PLATE 4

MALCOLM PIRNIE	REVISIONS	DES / DWN / CKD	NASSAU COUNTY FIREMEN'S TRAINING CENTER OLD BETHPAGE, NEW YORK	CONFIGURATION OF WATER TABLE (FEET ABOVE MEAN SEA LEVEL) OCTOBER 19, 1987	MALCOLM PIRNIE, INC. DATE FEBRUARY 1988 SHEET [redacted] OF [redacted] DWG NO.

NO	BY	DATE	REMARKS

PLATE 6

NO.	REVISION DESCRIPTION	DATE
0	ORIGINAL RELEASE	04/20/91

FILE NAME: \DWG\FTCFSSOL-B1-B		CONTRACT NUMBER; S81020	SHEET NO. 1 OF 1
SCALE: 1"=60'	DWG. NO. FTC-100-G1	DRAWN BY: L.E.T	DATE 04/05/91
DESIGNED BY: K. ARNOLD	DATE 03/01/91	CHECKED BY: MIKE FLAHERTY	DATE 03/10/91

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
SANITATION & WATER SUPPLY
HAZARDOUS WASTE SERVICES UNIT

EXTENT OF SOIL CONTAMINATION
FIREMEN'S TRAINING CENTER
OLD BETHPAGE, N.Y.

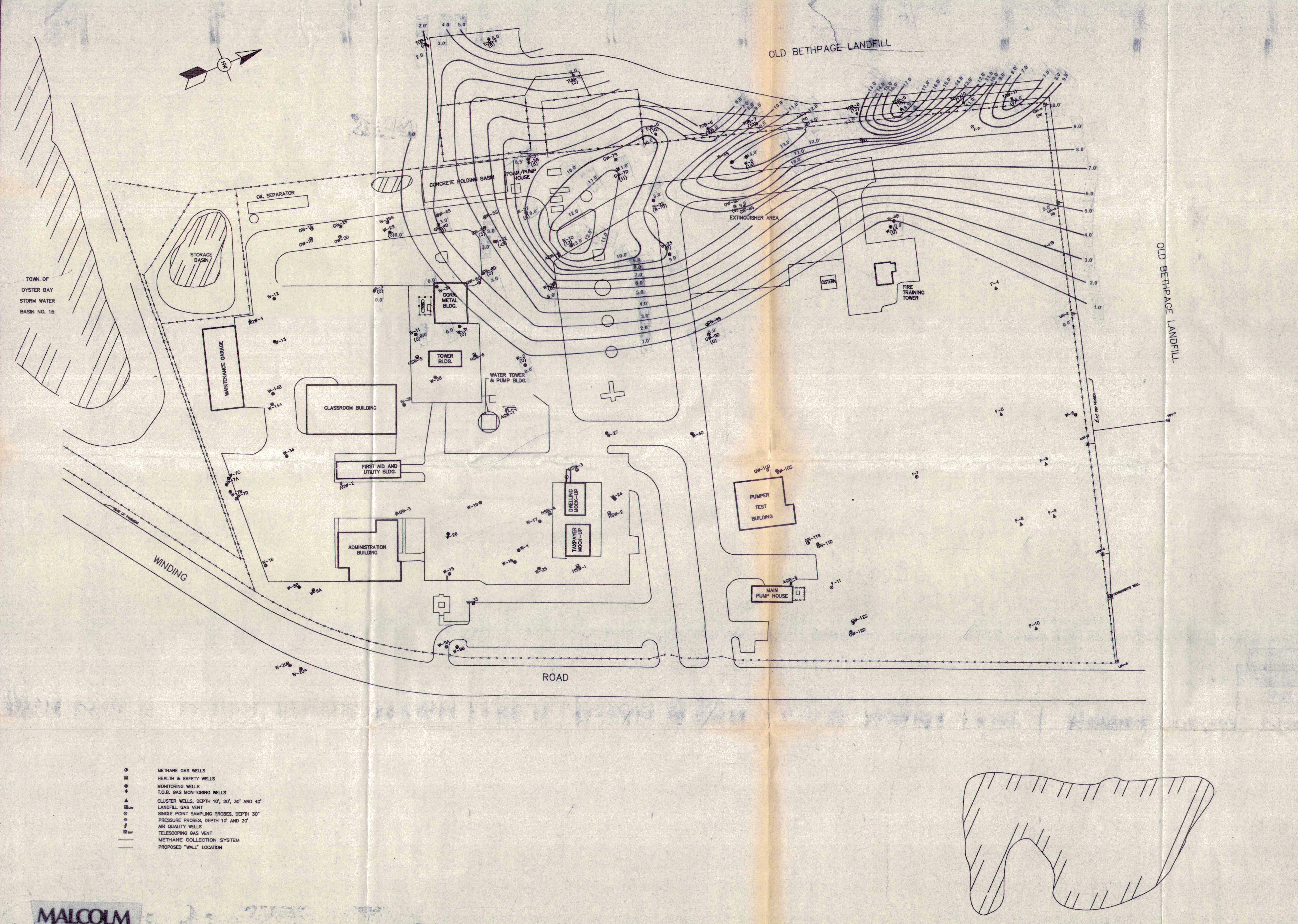


PLATE 4

NASSAU COUNTY FIREMANS TRAINING CENTER

ESTIMATED THICKNESS AND EXTENT OF UPPER CLAY UNIT

DEPTH TO UNIT: 10-15 FEET BELOW GRADE

SCALE 1" = 50'

NO.	REVISION DESCRIPTION	DATE
0	ORIGINAL RELEASE	4/23/90

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
SANITATION & WATER SUPPLY
HAZARDOUS WASTE SERVICES UNIT

FIREMEN'S TRAINING CENTER
SITE PLAN
OLD BETHPAGE, NEW YORK

CONTRACT NUMBER	DWG. NO.	DRAWN BY	SHEET NO.
130042			1 OF 1
DESIGNED BY: K.ARNOLD	DATE 4/23/90	CHECKED BY: M.FLAHERTY	DATE 4/23/90

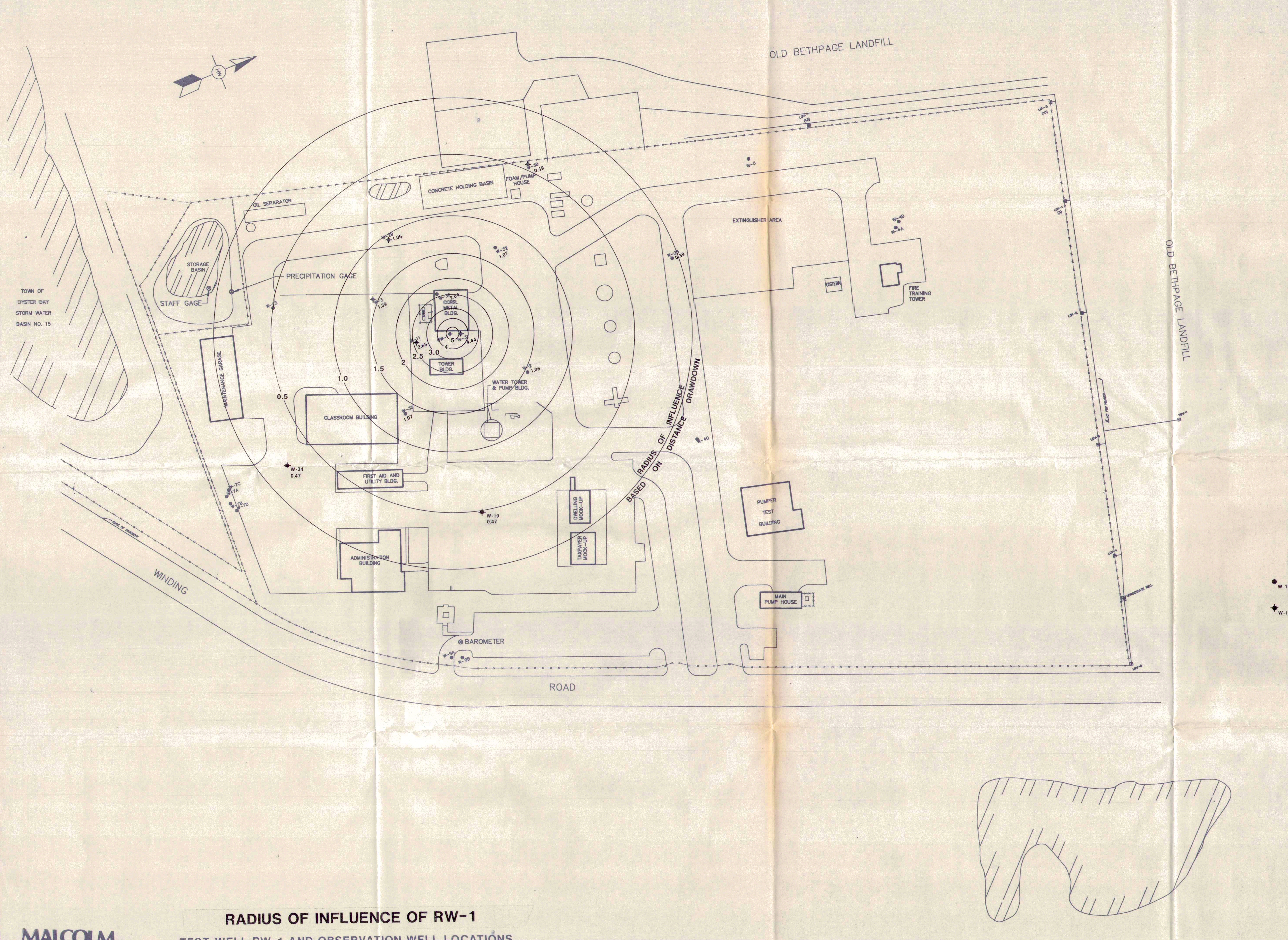


PLATE 5

KEY

● W-12 ALL WELLS WITHIN 0.5' BETWEEN OBSERVED DRAWDOWN AND PREDICTED DRAWDOWN USING DISTANCE DRAWDOWN PLOT

✦ W-19 OBSERVATION WELLS WITH ≈ EXACT MATCH TO PREDICTED DRAWDOWN USING DISTANCE DRAWDOWN PLOT

SCALE: 1" = 50'

NO.	REVISION DESCRIPTION	DATE
0	ORIGINAL RELEASE	4/23/90

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
SANITATION & WATER SUPPLY
HAZARDOUS WASTE SERVICES UNIT

FIREMEN'S TRAINING CENTER
SITE PLAN
OLD BETHPAGE, NEW YORK

CONTRACT NUMBER	DWG. NO.	DRAWN BY	SHEET NO.
130042			1 OF 1
DESIGNED BY:	DATE	CHECKED BY:	DATE
K.ARNOLD	4/23/90	M.FLAHERTY	4/23/90

RADIUS OF INFLUENCE OF RW-1

TEST WELL RW-1 AND OBSERVATION WELL LOCATIONS

USED FOR JANUARY 1991 PUMPING TEST

MALCOLM PIRNIE