FILE ON EDOC'S ✓ YES ______ NO

SITE NAME ______________________________

SITE # ______________________________

COUNTY ____________ TOWN ____________

FOILABLE ✓ YES __________ NO

SC/PSA ________ RI/FS ________

RD ________ RA ________

SM ________ OTHER ________

NAME DESCRIPTION:
Report.HW130004.1993-07-01.OU1 - FS_Report

LBG ENGINEERING SERVICES, INC.

Professional Environmental & Civil Engineers

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WASTE REMEDIATION

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Feasibility Study Report
for Operable Unit 1

July 1993

LBG ENGINEERING SERVICES, INC.
Professional Environmental & Civil Engineers
72 Danbury Road
Wilton, CT 06897

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Feasibility Study Report for Operable Unit 1

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OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Feasibility Study Report for Operable Unit 1

1.0 Introduction

This Feasibility Study (FS) has been completed for Operable Unit 1 (OU 1), onsite groundwater and soil, at the Hooker/Ruco site, located in Hicksville, New York. The Environmental Protection Agency (EPA) Risk Assessment (RA) entitled "Hooker Chemical/Ruco Polymer Site Risk Assessment and Fate and Transport Report" (EPA, 1992) identified the current and future use of groundwater at the site as the only risk to human health or the environment, based on the following compounds of concern (COCs): tetrachloroethylene (PCE), vinyl chloride, arsenic and beryllium. Development of alternatives which will reduce risks to human health associated with site related compounds in groundwater was the primary objective of the FS. Other objectives included consideration of soil guidance values for protection of groundwater and consideration of applicable or relevant and appropriate requirements (ARARs) including the to-be-considered criteria (TBCs). The Draft Remedial Investigation (RI) report (OCC, 1992a), which summarizes the data developed to define the nature and extent of groundwater and soil chemistry, formed the basis of the RA.

Three media have been addressed in the FS: groundwater, deep soils and shallow soils. The three media are part of one operable unit for the Hooker/Ruco site.

1.1 Feasibility Study Methodology

The FS report format as well as the procedures used to complete the FS, as described below, follow the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, 1988a). Remedial alternatives were developed for each medium, the developed remedial alternatives were screened against one another, and the retained remedial alternatives were subjected to detailed analyses.

Upon completion of the detailed analyses, the retained alternatives were presented to enable the selection of the most appropriate alternative.

2.0 Background to the Groundwater Medium

The following sections summarize information about the Hooker/Ruco site that is pertinent to the screening of remedial alternatives for the groundwater. The information was presented in the RI.

2.1 General Site Conditions

The following information about the Hooker/Ruco site summarizes the conditions, setting and land uses of this study area.

2.1.1 Study Area

The Hooker/Ruco site is located in Hicksville, Township of Oyster Bay, Nassau County, New York, approximately 25 miles east of New York City. The Hooker/Ruco site is an active chemical manufacturing facility in a heavily industrialized section of Hicksville. The plant, currently owned and operated by the Ruco Polymer Corporation (Ruco), contains four buildings for the manufacture and storage of chemical products (Plants 1, 2, 3 and the Pilot Plant) and an administration building. The remainder of the 14-acre site contains parking areas, chemical storage tanks, recharge basins (sumps) and small ancillary buildings. The facility currently manufactures polyester, polyols and powder coating resins.

The major industrial facilities in the area is the Grumman Aerospace Corporation (Grumman) Bethpage manufacturing facility and airport and the Naval Weapons Reserve Facility. There are other small industries, commercial operations, residential areas, utilities and transportation corridors in the area. Figure 2.1 is a compilation of several United States Geological Survey (USGS) topographic maps showing the site and its surroundings. Figure 2.2 shows the surrounding land use as of 1984. Figure 2.3 is a plant map showing major features.

2.1.2 Environmental Setting

Commerce Street and adjacent industrial development comprise the 880-foot northern site boundary. Along the site's 1,000-foot eastern side is a large warehouse building owned by Grumman. A small portion of undeveloped Grumman land abuts the site's 250-foot southern property boundary. Two active tracks of the Long Island Railroad parallel the site's 940-foot southwestern property boundary. The site is bounded on the 270-foot western boundary by New South Road. The property is enclosed by a chain-linked fence which completely encompasses the site. Four surface-water sumps are located on the Hooker/Ruco site along the eastern property boundary.

The area surrounding the Hooker/Ruco site is comprised of an industrialized corridor and residential complexes. Residential dwellings comprise approximately 22 percent of the area and are located southwest of the site. Approximately 65 percent of the area land use is industrial or commercial.

2.1.3 Site History

The Hicksville Plant site was developed by Rubber Corporation of America, a small privately-held company. Operations at the site began in 1945 and included natural rubber latex storage, concentrating and compounding. Five years later, the plant began producing small volumes of plasticizers. These activities were expanded and modified through the years. In 1956, a polyvinyl chloride (PVC) plant was built, and was initially operated under the name Insular Chemical Corporation. The plant continued in operation until 1975. Hooker Chemical Corporation purchased Rubber Corporation of America in 1965, and operated the facility as the Ruco Division. Hooker has undergone several name changes, with the current name being Occidental Chemical Corporation (OCC). The site was sold to Ruco employees in February 1982. Thus OCC or the Rubber Corporation of America owned and operated the site between 1945 and 1982. The site is now operated by a privately held corporation under the name Ruco Chemical Corporation which is not affiliated with OCC. Although the OCC did not lease any portion of the site to third parties, the office building for the plant was a leased building north of the site.

PVC was a key material in the products made at the site until 1975. Prior to 1955, this material was purchased from outside sources. In 1956, a partnership was formed with Ross & Roberts of Stratford, Connecticut to construct and operate a PVC production facility at the Hicksville site. This venture was known as Insular Chemical Corporation. Insular was later dissolved when Rubber Corporation of America purchased its partner's share. Today, no distinction is made between the property which was under the control of Insular and the property which was owned by Rubber Corporation of America. The site encompasses all of this property.

Through the years in which OCC operated the site, various processes were employed including the manufacture of polyesters, polyurethanes and specialty plasticizers for the vinyl industry. As mentioned above, during the period 1956 to 1975, PVC was produced at the site. Other products included vinyl film and sheeting, solution polyurethanes and polyurethane latexes, dry blends and pelletized plastic compounds. A pilot plant produced polyester, plasticizer and polyurethane products and the laboratory was utilized for organic chemical synthesis and technical service.

From 1951 to 1974, process wastewater from ester production was fed to the ester plant recharge basin (Sump 1). After 1975, the waste stream was incinerated onsite. Sump 1 continued to receive discharges from the floor drains in the pilot plant until 1976.

Sump 2 received the overflow from Sump 1, as well as stormwater runoff and, therefore, received the same waste products as Sump 1, but in smaller quantities. Sump 1 has been partially backfilled and contains a series of six concrete settling basins. Sump 3 currently receives the surface-water runoff from a large part of the plant, including most of the manufacturing areas. There are no direct process waste lines to this sump. Sumps 4, 5, and 6 received the wastestreams from Plant 2 processes. Sumps 4 and 5 were the primary recipients of the waste streams, with Sump 6 added in 1962 to handle overflow caused by plugging of Sumps 4 and 5. Sump 6, for a relatively short period of time, received only intermittent discharges. Sumps 5 and 6 have since been completely backfilled. Sump 4 is currently used for the discharge of blowdown from the non-contact cooling water system. A schematic showing the sump locations at the site is presented as figure 2.4.

Several environmental investigations have been conducted at the Hooker/Ruco site since 1978. Originally, efforts were directed towards understanding past manufacturing processes, waste generation and waste disposal. A site background report was prepared in July 1981. This report presented the site in the context of its surroundings and examined waste disposal, regional geology and hydrogeology and regional water withdrawals and water quality.

At that time, the New York State Department of Environmental Conservation (DEC) was the lead government agency. A work plan for conducting a soils and groundwater investigation was submitted to the DEC in April 1983. By June 21, 1983, the plan had been approved and the investigation commenced. The investigation consisted of the drilling and installation of six well clusters at locations downgradient of suspected areas of waste disposal, and the drilling and sampling of two deep test borings in formerly operating sumps. The results of this study were presented in a report entitled "Report of Groundwater & Soils Investigation at the Former Ruco Division Plant Site, Hicksville, New York", dated August 1984.

In July 1987, EPA sent OCC a request for information on the Hooker/Ruco site. A response to the EPA request for information was submitted in September 1988. OCC entered into an Administrative Order on Consent with EPA in September 1988. Subsequently, a Field Operations Plan, based on an EPA Work Plan, was submitted for EPA review in October 1988.

Between September 1989 and March 1990, a RI was conducted at the Hooker/Ruco site. The investigation included a soil-vapor study, an electromagnetic terrain conductivity survey, recharge basin (sump) water and sediment sampling, shallow and deep soil sampling and groundwater sampling. A total of 134 soil samples were collected from 50 borings for analysis of target compound list (TCL) parameters and tentatively identified compounds (TICs). Eight deep wells and 14 shallow wells were installed on and offsite to complement the existing 12 onsite wells. Two offsite piezometers were installed to help define the groundwater flow pattern. Thirty-nine new and existing wells were sampled and analyzed for TCL/TIC parameters. The RI forms the basis for this FS.

2.1.4 Water-Supply Sources

Water supply at the site is now derived from city water mains. The nearest upgradient public supply well is located approximately 2,500 feet northwest of the site. The nearest downgradient public supply well is located approximately 6,000 feet southwest of the site.

2.1.5 Chemical Storage and Wastewater Handling Procedures

Ruco continues to occupy the site and currently manufactures polyester, polyols and powder coating resins. OCC is advised that production waste is currently contained and stored onsite to await offsite treatment by private sources. Current chemical storage areas at the Hooker/Ruco site are shown in figure 2.5.

2.2 Remedial Investigation Summary

The RI, completed over the period of September 1989 to March 1990, was conducted to develop an understanding of the site conditions and to define the nature and extent of the groundwater and soil chemistry. The important findings of that investigation are summarized below.

2.2.1 Geology

The two hydrogeologic units identified during the field investigation are the Glacial Formation and the Magothy Formation. The uppermost formation, the Glacial Formation, is composed of glacial outwash deposits ranging in thickness from 36 to 47 feet at the Hooker/Ruco site. There is little soil cover which overlies the very coarse-grained sediments. The formation consists of fine to very coarse sand, fine to medium gravel, cobbles and traces of silt. The sediments are brown to light tan in color. The basal sediments of the Glacial Formation range in thickness from 4 to 8 feet and are composed of very fine to medium sand, silt and, in some instances, clay. These sediments are iron stained and, in some instances, iron concretions are found. This is a transition zone between the Glacial and Magothy Formations. The basal sediments are either basal sediments of the Glacial Formation or disturbed sediments of the Upper Magothy Formation.

The Magothy Formation lies directly below the Glacial Formation and is typically composed of fine to coarse sand, clayey sand, silt and clay. The sands are generally light gray to tan in color, although some orange layers were observed. The clayey sediments are white, tan, gray and black.

The clayey sediments of the Magothy Formation are usually interbedded with very fine to fine sand lenses and, in some places, form non-continuous layers approximately 4 to 10 feet thick. Lignite, a brownish black coal, was observed at Boring Locations L and S at a depth of 70 feet. The clayey sand layers were observed at the northern, southwestern and eastern boundaries of the plantsite. In other areas of the plantsite, two non-continuous clay layers, approximately 5 to 15 feet thick, were observed. The shallow clay layer was observed at 40 to 85 feet in depth at the northeastern and southwestern boundaries of the plantsite, and a deep clay layer was observed at 95 to 130 feet in depth at the southwestern boundary of the plantsite. During the field investigation, a third clay layer was observed at 130 to 142 feet in depth at Boring Location S. The borings were installed adjacent to, but downgradient from, the monitor wells located as shown on figure 2.6.

2.2.2 Hydrogeology

Long Island is underlain by consolidated bedrock, which in turn is overlain by a wedge-shaped mass of unconsolidated sediments. The top of the bedrock, which is approximately 200 feet below land surface in the northern edge of Nassau County, slopes to the southeast at an average slope of 65 ft/mile (feet per mile). The bedrock is poorly permeable to virtually impermeable crystalline metamorphic and igneous rocks. Although some fresh water exists in fractures within the bedrock matrix, the bedrock surface is considered the lower boundary of the regional groundwater aquifers on Long Island, New York.

The materials that overlie the bedrock are glacially-derived Pleistocene deposits and Upper Cretaceous fluvial and deltaic deposits. The Lloyd Aquifer, composed of fine-to-coarse sand and gravel in a clayey matrix, is contained under artesian pressure by the overlying Raritan Clay. Water supply from the Lloyd Aquifer, approximately 200 feet thick in the Hooker/Ruco area, is generally restricted to the north and south shores of Long Island because of the limited recharge potential. Above the Raritan Clay lies the Magothy Aquifer, which constitutes the principal water-supply unit throughout Long Island. It is approximately 500 feet thick at the Hooker/Ruco site. The Magothy Aquifer is chiefly composed of fine-to-medium sands, clayey in part, with some interbedded lenses of coarse sands and gravel. There are also many discontinuous clay layers within the aquifer. Predominantly, the Magothy Aquifer is moderately to very permeable. In the vicinity of the Hooker/Ruco site, all of the water-supply wells are completed in the Magothy Aquifer. The Magothy Aquifer is subject to saltwater intrusion in southwestern Nassau County, and has been impacted throughout the county by septic system and industrial discharges.

For the purpose of the FS, the Magothy Aquifer has been divided into three aquifer units based specifically on discontinuous clay units which exist at the Hooker/Ruco site. The units will be named the upper Magothy with an average thickness of 24 feet, the mid Magothy with an average thickness of 50 feet, and the lower Magothy which is approximately 475 feet thick. The water table is within the upper Magothy.

The Magothy Aquifer is overlain by highly permeable Pleistocene glacial deposits. These deposits, ranging between 35 and 40 feet thick, are located above the water table and form the majority of the unsaturated sediments at the Hooker/Ruco site. In northern and central Nassau County, the glacial deposits constitute a prolific aquifer, though its water quality has been impaired in many areas. The Glacial Aquifer is utilized primarily north of the Hooker/Ruco site, in the mid-island and north shore areas.

All of the fresh groundwater on Long Island is derived directly from infiltration of precipitation. Approximately 1 mgd/mile^2 (million gallons per day per square mile) recharges the underlying groundwater aquifers. In general, infiltrating precipitation moves vertically downward. After the precipitation reaches the water-table sediments, movement is predominantly horizontal and slightly downward from the center of the island toward the surrounding water bodies. Along the south shore of Long Island, migrating groundwater flows horizontally and upward, discharging to the Atlantic Ocean. Along the north shore of Long Island, migrating groundwater flows horizontally and upward, discharging to Long Island Sound.

Water-table contour maps were developed for the area based on water-level measurements. The contours indicate that the water-table elevation drops from a relatively high area in the northeast corner of the Hooker/Ruco site, to the southeast, south and southwest, in a fan shaped manner. The relatively high water elevations (75.61 feet above mean sea level) in the northeast corner of the site correspond to a low permeability clay present directly below the water-table interface in this vicinity. The low permeability sediments retard the downward percolation of recharging precipitation and strongly influence localized groundwater flow.

The groundwater gradient in the northeast corner of the site is 0.0037 ft/ft, or approximately 19 ft/mile. Groundwater gradients southeast, south, and southwest of this vicinity are less steep averaging 0.0019 ft/ft, or about 10 ft/mile. Downgradient of the site, shallow groundwater flow shifts toward the south with a slight easterly component. This change in groundwater flow directions corresponds to the proximity of adjacent southerly pumping centers of the Grumman well field.

Slug tests completed in an earlier investigation indicate hydraulic conductivities for the saturated screen zones in the water-table wells average 390 gpd/ft^2. Testing results collected onsite correspond with published values of hydraulic conductivity values for southern Nassau County which averaged 420 gpd/ft^2. The shallow, horizontal groundwater movement beneath the plantsite, but south of Plant 2, ranges between 0.20 and 0.93 ft/day. Higher horizontal velocities, caused by the underlying lower permeable sediments, were found to exist in the northeast corner of the site. Horizontal groundwater movement in this area ranges between 0.76 and 0.93 ft/day.

Piezometric contours, determined from water-level elevations in the deeper wells, indicate groundwater flow in the deeper screen zones is more uniform, less influenced by local geology and flows toward the south. The horizontal gradient in the deeper zone averages 0.0011 ft/ft, or approximately 6 feet/mile. Specific onsite hydraulic conductivity values for the deeper zone were not determined, however, using an average published hydraulic conductivity of 420 gpd/ft^2 for the Magothy Aquifer in southern Nassau County, the horizontal velocity ranges between 0.16 and 0.43 ft/day.

Water-level measurements of shallow and deep well clusters indicate a downward head. The downward head was most pronounced at Clusters C and S, with an average vertical differential of 0.77 and 1.26 feet, respectively. The large head differences measured in these cluster wells are attributed to the low permeability clays located near the water table which retard vertical recharge. Vertical gradients in the northeast corner of the site (Clusters C and S) average 0.021 ft/ft. Vertical head relationships at the twelve other well clusters showed a substantially shallower downward hydraulic head ranging between 0.03 and 0.20 foot with an average vertical gradient of 0.0028 ft/ft. Water levels obtained in the plant supply Well No. 1 (N3450) also showed a downward head differential of 0.45 foot between the deep monitor wells and the onsite production wells, and a downward gradient of 0.01 ft/ft.

Vertical permeability is difficult to calculate using standard field testing methods. Vertical permeability can be estimated, however, using Darcy's law, accepted recharge values of 1 mgd/mi^2 and the measured vertical head gradients. The vertical permeability of the zone between the shallow and deep wells, not including Clusters C and S, is 12.8 gpd/ft^2 and vertical flow occurs at an average rate of 0.017 ft/day. Therefore, in a large area beneath the plantsite, groundwater moves approximately 15 feet horizontally for each vertical foot of movement. In areas where the water table is directly underlain by clays, Clusters C and S, vertical permeabilities are substantially lower, ranging between 1.4 and 2.1 gpd/ft^2. The decrease in average vertical permeabilities in these well clusters is directly related to the increase in percentage of fine material in the aquifer. Although the vertical flow in this area of the site is 0.018 ft/day, groundwater in the northeast corner of the site moves horizontally 50 feet for each foot of vertical movement.

2.2.3 Surface-Water Conditions

There are no natural surface water bodies on or in the proximity of the study area.

2.2.4 Chemical Compounds and Migration

The RI, combined with previous studies, has resulted in the characterization of the environmental conditions of the Hooker/Ruco site. Sampling of all media, including air, soil vapor, soils, surface water, sediment and groundwater, has resulted in the identification of areas of potential environmental concern. These areas are limited to groundwater, deep soils and shallow soils.

Groundwater leaving the property contains volatile organic compounds (VOCs), metals and TICs which exceed the New York State Drinking-Water standards, discharge to groundwater standards and/or EPA maximum contaminant levels. Previous studies have demonstrated that there are regional groundwater occurrences of chloroethylenes and that sources of these chemicals exist upgradient of the Hooker/Ruco site (USGS, 1992 and OCC, 1992a).

Groundwater containing a vinyl chloride monomer (VCM) has been observed in the southwest portion of the facility. Previous data have shown the presence of PCE, TCE and DCE in monitoring wells and, therefore, it is likely that a significant portion, if not all, of the VCM is from the degradation of these chloroethylenes.

In addition to this plume and 30 ppb (parts per billion) of PCE in Well L-1, the groundwater leaving the Hooker/Ruco site contains TICs. These were detected in all wells between the Clusters H and F, with the exception of Cluster I. Arsenic was detected above the State drinking water standard in samples from Wells J-1, J-2, K-2, F-1, and F-2.

Deep soils on the site which could potentially constitute continuing sources of compounds to the groundwater have been identified beneath Sump 1 and possibly Sump 2. The soil beneath Sump 1 contains PCE, TCE, 1,2 DCE, phenol, di-n-butylphthalate and TICs at levels which exceed New York State soil cleanup objectives to protect groundwater quality.

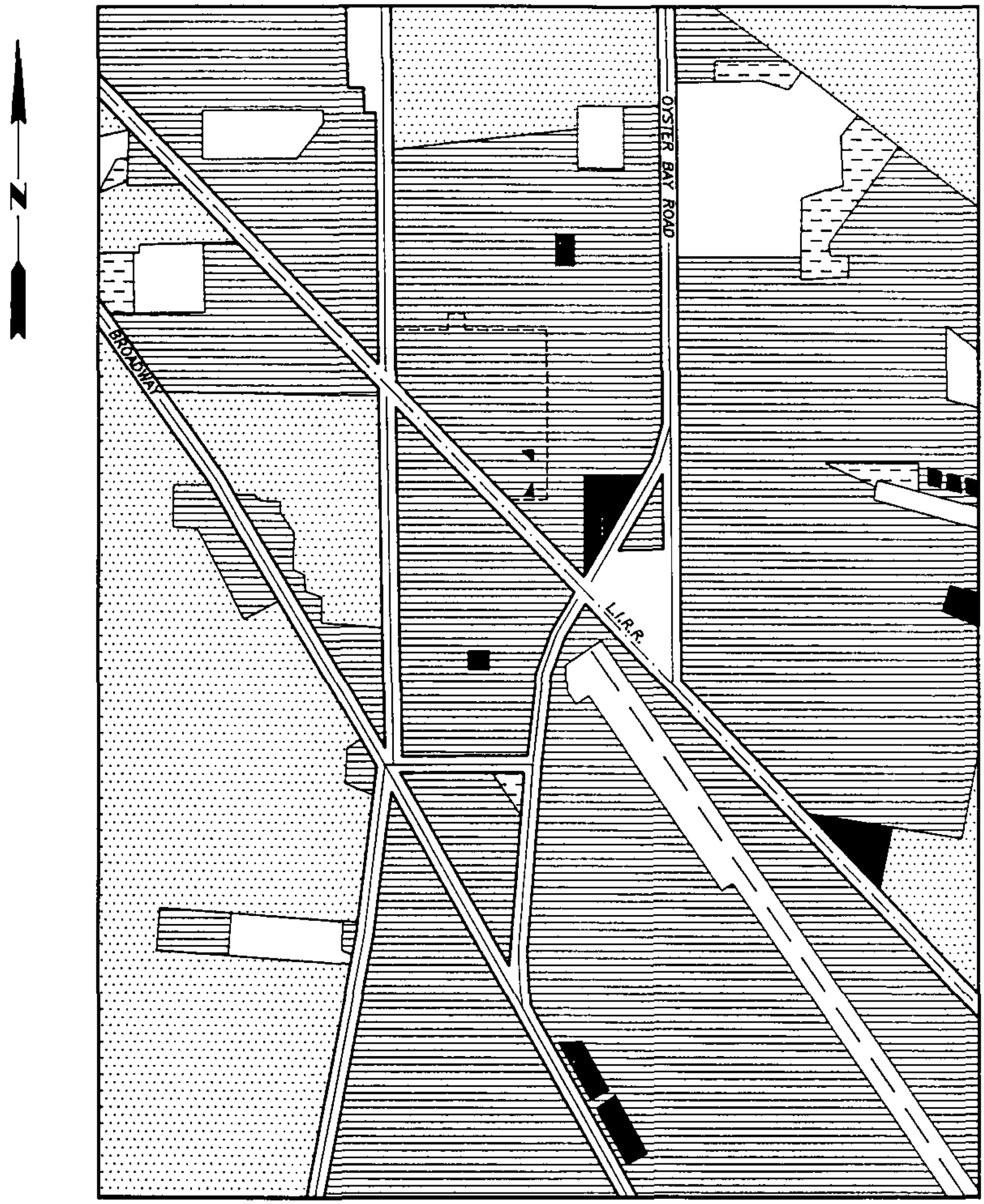
The EPA response comments for the draft FS identified shallow soils in the vicinity of TB-10 in the former drum storage as an area which could potentially constitute continuing sources of compounds to the groundwater. The shallow soil in the drum storage area contains TICs.

SOURCE: USGS TOPOGRAPHIC QUADRANGLES HICKSVILLE, N.Y., FREEPORT, N.Y., HUNTINGTON, N.Y. AND AMITYVILLE, N.Y.

0 2000

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION HOOKER/RUCO SITE HICKSVILLE, NEW YORK		
SITE LOCATION MAP		
DATE	REVISED	PREPARED BY: LBG ENGINEERING SERVICES, INC. Professional Environmental and Civil Engineers 72 Danbury Road Wilton, CT 06897 (203) 762-5502
DATE: **2/25/93**		FIGURE: **2.1**



LEGEND

- NEW INDUSTRIAL/COMMERCIAL
- OLD INDUSTRIAL/COMMERCIAL
- OPEN/AGRICULTURAL
- OLD RESIDENTIAL
- RETENTION LAGOON
- PRESENT RUCO PLANT SITE

0 1000

SCALE IN FEET

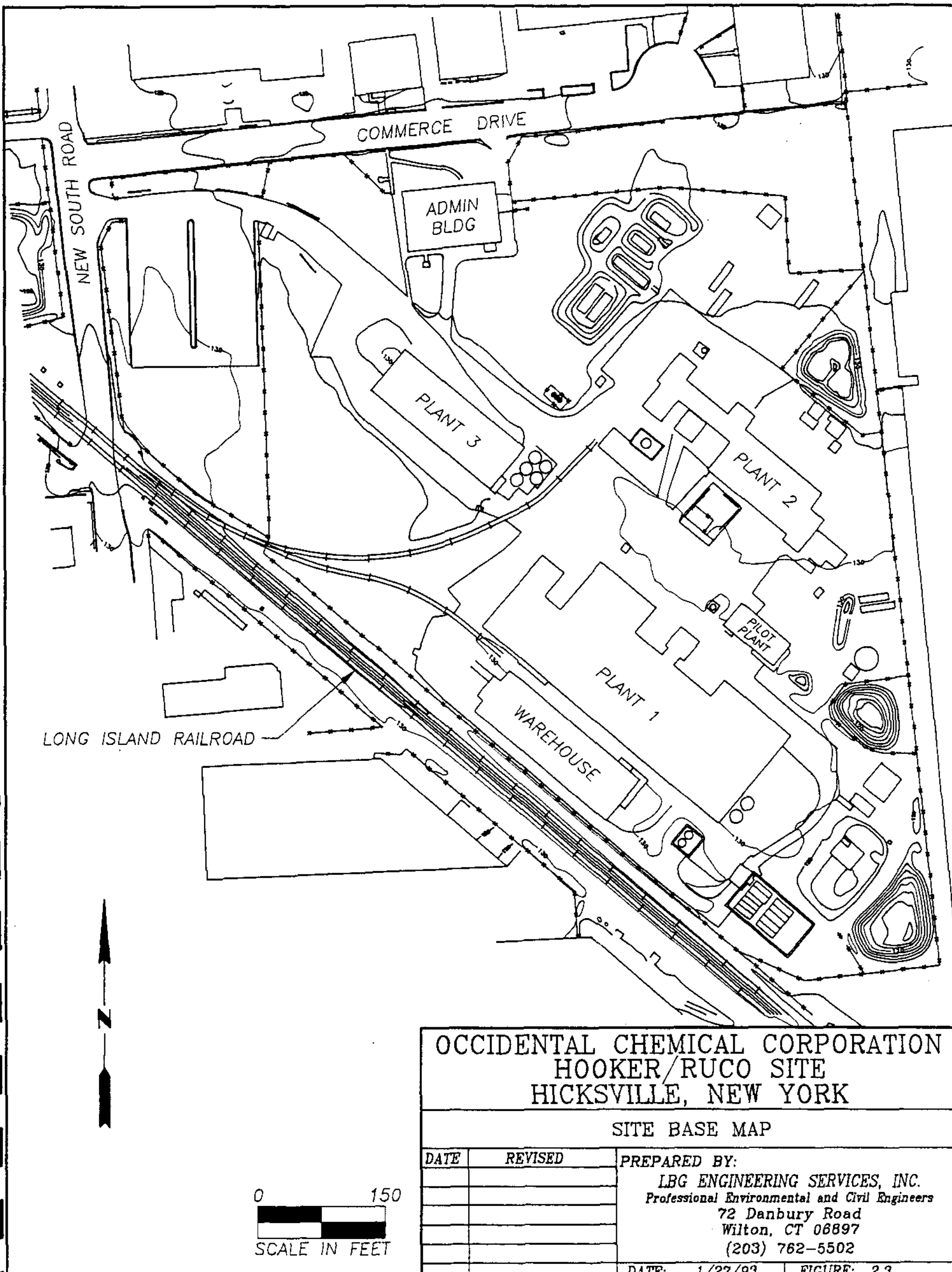
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

LAND USE AS OF 1984

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

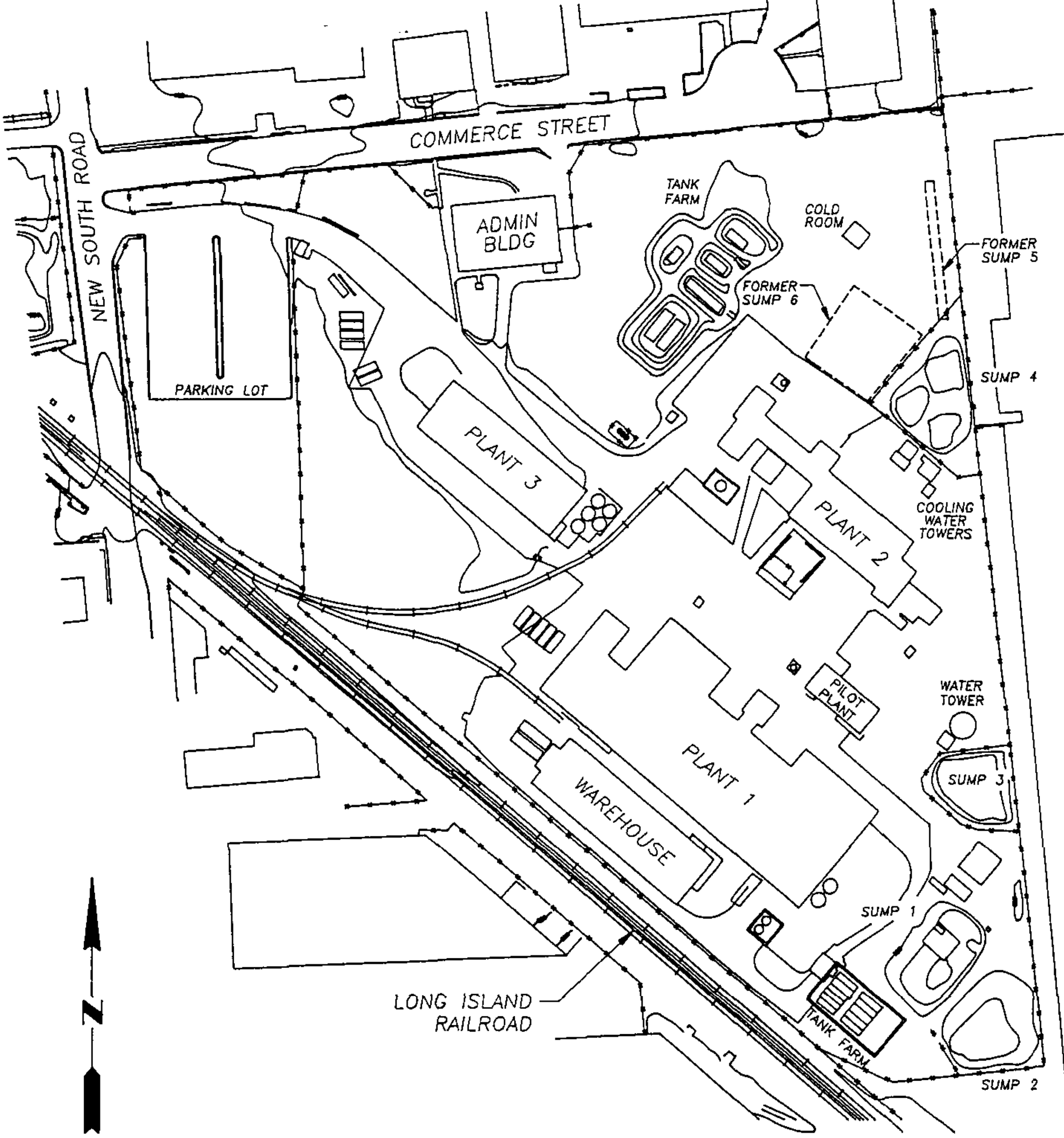
DATE: 4/2/93 FIGURE: 2.2



OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

SITE BASE MAP

DATE	REVISED	PREPARED BY:
		LBG ENGINEERING SERVICES, INC.
		Professional Environmental and Civil Engineers
		72 Danbury Road
		Wilton, CT 06897
		(203) 762-5502
		DATE: 1/27/93 FIGURE: 2.3



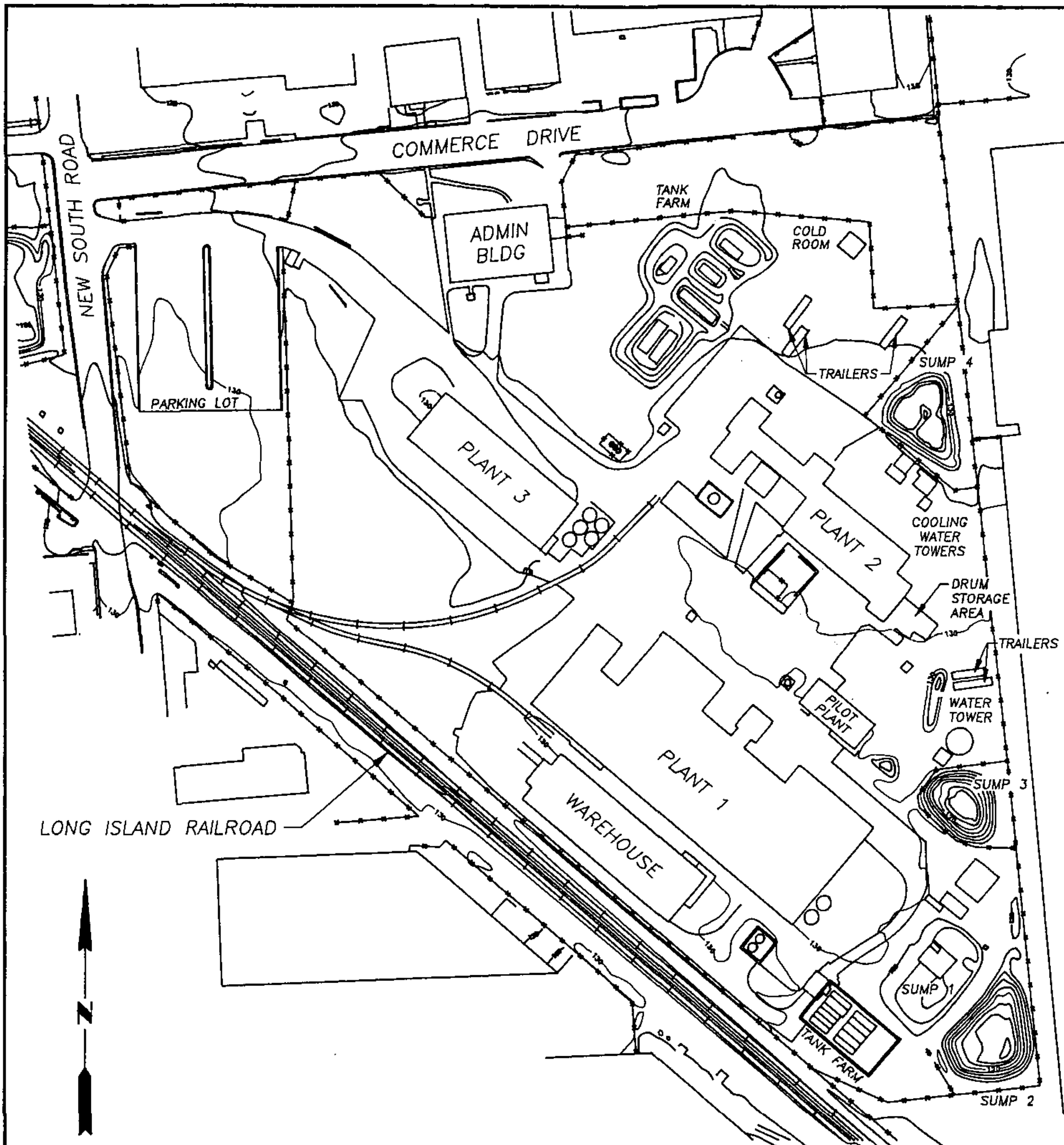
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

SUMP LOCATIONS
AT THE HOOKER/RUCO SITE

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 1/27/93 FIGURE: 2.4



LEGEND

☐ CHEMICAL STORAGE AREAS

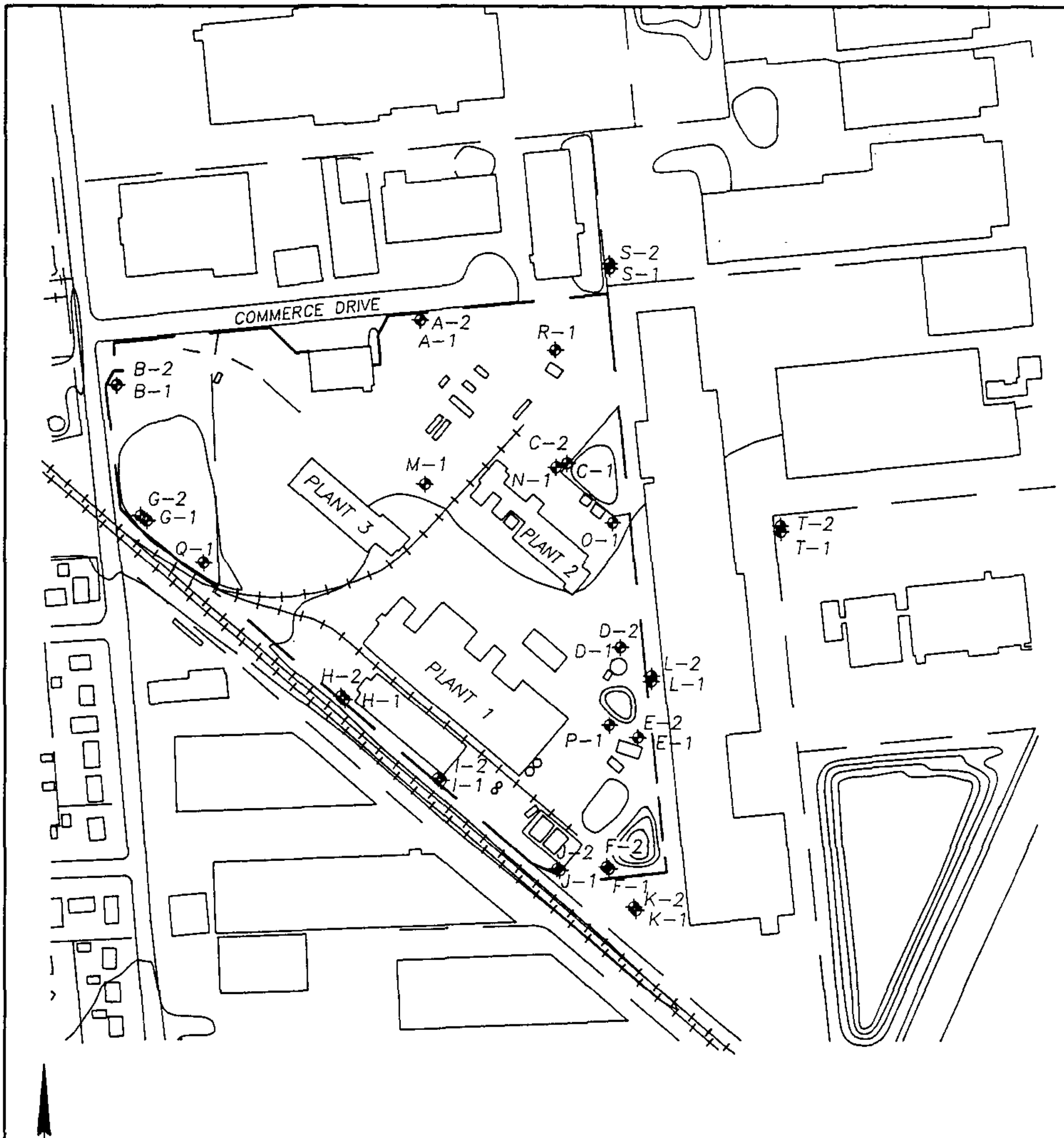
0 150
SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CURRENT CHEMICAL STORAGE AREAS
AT THE HOOKER/RUCO SITE

DATE	REVISED	PREPARED BY:
		LBG ENGINEERING SERVICES, INC.
		Professional Environmental and Civil Engineers
		72 Danbury Road
		Wilton, CT 06897
		(203) 762-5502

DATE: 1/27/93 FIGURE: 2.5



N

LEGEND

T-1 MONITOR WELL LOCATION

0 250

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

MONITOR WELL LOCATION MAP

DATE	REVISED	PREPARED BY: LBG ENGINEERING SERVICES, INC. Professional Environmental and Civil Engineers 72 Danbury Road Wilton, CT 06897 (203) 762-5502
		DATE: 3/15/93 FIGURE: 2.6

3.0 Remedial Action Objectives - Groundwater Medium

The primary remedial action objective for groundwater is the reduction of risks to human health associated with site related compounds. A secondary objective is consideration of ARARs. The effectiveness of the remedial alternatives will be weighed against these objectives.

3.1 Risk Assessment - Groundwater Medium

3.1.1 Compounds of Concern

The RA identified the current and future use of groundwater at the site as the only risk to human health or the environment, based on the following COCs: PCE, vinyl chloride, arsenic and beryllium. This FS will also address compounds not identified as COCs which exceed ARARs.

3.1.2 Exposure Routes and Pathways

The RA identified potential future residential groundwater use at the fenceline as the primary pathway of concern.

3.1.3 Public Health Concerns

The results of the maximum exposure scenario of the RA indicated the potential for future carcinogenic health risks to fenceline resident adults and children from exposure to the groundwater via ingestion, and to adults only via inhalation. Noncarcinogenic risks to future resident adults and children via groundwater ingestion were also identified. Currently, the properties along the fenceline are used exclusively for transportation and industrial purposes, and there are no groundwater wells in the vicinity of the Hooker/Ruco site which are used for potable supply.

3.1.4 Environmental Concerns

The ecological assessment conducted as part of the RA concluded that there are no significant ecological resources in the area of the Hooker/Ruco site, and no evident pathways by which site compounds could migrate and create ecological risk concerns.

3.2 Applicable or Relevant and Appropriate Requirements

3.2.1 ARARs for Groundwater Cleanup Criteria

3.2.1.1 Federal Regulations

The following sources of ARARs have been identified for site groundwater:

40 CFR	Part 141	National Primary Drinking Water Regulations
	Subpart B	Maximum Contaminant Levels
	Section 141.11	Maximum Contaminant Levels for Inorganic Chemicals
	Section 141.12	Maximum Contaminant Levels for Organic Chemicals
	Subpart F	Maximum Contaminant Level Goals
	Section 141.50	Maximum Contaminant Level Goals for Organic Contaminants
	Section 141.51	Maximum Contaminant Level Goals for Inorganic Contaminants
	Subpart G	National Revised Drinking Water Regulations: Maximum Contaminant Levels
	Section 141.61	Maximum Contaminant Levels for Organic Contaminants
40 CFR	Part 143	National Secondary Drinking Water Regulations
	Section 143.3	Secondary Maximum Contaminant Levels

3.2.1.2 New York Regulations

The following sources of ARARs have been identified for site groundwater:

6 NYCRR	Part 701	Classifications-Surface Waters and Ground Waters
	Section 701.15	Class GA Fresh Ground Waters
	Part 702	Derivation and Use of Standards and Guidance Values
	Section 702.1	Basis for Derivation of Water Quality Standards and Guidance Values
	Section 702.2	Standards and Guidance Values for Protection of Human Health and Sources of Potable Water Supplies
	Part 703	Surface Water and Ground Water Quality Standards and Ground Water Effluent Standards
	Section 703.5	Water Quality Standards for Taste, Color and Odor-Producing, Toxic and Other Deleterious Substances
10 NYCRR	Part 5	Drinking Water Supplies
	Subpart 5-1	Public Water Systems
	Section 5-1.51	Maximum Contaminant Levels

Section 5-1.52	Tables; Table 1 - Inorganic Chemicals and Physical Characteristics Maximum Contaminant Level Determination, Table 3 - Organic Chemicals Maximum Contaminant Level Determination

3.2.1.3 Specific ARARs for Groundwater Cleanup Criteria

The specific ARARs for groundwater cleanup criteria are listed in table 3.1.

3.2.2 ARARs for Groundwater Discharge Criteria

3.2.2.1 Federal Regulations

The following sources of ARARs have been identified for site groundwater discharge:

40 CFR	Part 141	National Primary Drinking Water Regulations
	Subpart B	Maximum Contaminant Levels
	Section 141.11	Maximum Contaminant Levels for Inorganic Chemicals
	Section 141.12	Maximum Contaminant Levels for Organic Chemicals
	Subpart F	Maximum Contaminant Level Goals
	Section 141.50	Maximum Contaminant Level Goals for Organic Contaminants
	Section 141.51	Maximum Contaminant Level Goals for Inorganic Contaminants
	Subpart G	National Revised Drinking Water Regulations: Maximum Contaminant Levels
	Section 141.61	Maximum Contaminant Levels for Organic Contaminants
40 CFR	Part 143	National Secondary Drinking Water Regulations
	Section 143.3	Secondary Maximum Contaminant Levels

3.2.2.2 New York Regulations

The following sources of ARARs have been identified for site groundwater discharge:

6 NYCRR	Part 701	Classifications-Surface Waters and Ground Waters
	Section 701.15	Class GA Fresh Ground Waters
	Part 702	Derivation and Use of Standards and Guidance Values

	Section 702.1	Basis for Derivation of Water Quality Standards and Guidance Values
	Section 702.2	Standards and Guidance Values for Protection of Human Health and Sources of Potable Water Supplies
	Section 702.16	Derivation and Implementation of Effluent Limitations
	Part 703	Surface Water and Ground Water Quality Standards and Ground Water Effluent Standards
	Section 703.5	Water Quality Standards for Taste, Color and Odor-Producing, Toxic and Other Deleterious Substances
	Section 703.6	Ground Water Effluent Standards and Limitations for Discharges to Class GA Waters
10 NYCRR	Part 5	Drinking Water Supplies
	Subpart 5-1	Public Water Systems
	Section 5-1.51	Maximum Contaminant Levels
	Section 5-1.52	Tables; Table 1 - Inorganic Chemicals and Physical Characteristics Maximum Contaminant Level Determination, Table 3 - Organic Chemicals Maximum Contaminant Level Determination

3.2.2.3 Specific ARARs for Groundwater Discharge Criteria

The specific ARARs for groundwater discharge criteria are listed in table 3.2.

3.2.3 ARARs for Air Emission Discharge Criteria

3.2.3.1 Federal Regulations

The EPA has established guidance values on the control of air emissions through the Clean Air Act at CERCLA sites for groundwater treatment (EPA, 1989). This guidance indicates that the sources most in need of controls are those with an actual emissions rate in excess of 3 lbs/hr or 15 lbs/day, or a calculated annual rate of 10 tons/year of total VOCs. The calculated annual rate assumes 24-hour operation, 365 days per year.

RCRA regulations outlined in 40 CFR Parts 264 and 265, Subpart AA-Air Emission Standards for Process Vents and Subpart BB - Air Emission Standards for Equipment Leaks are potential ARARs. These standards, applicable to wastestreams with organic concentrations of at least 10 ppmw (parts per million by weight), require that the total organic emissions from all effected processes be reduced below 3 lb/hr and 3.1 tons/yr or reduction of total organic emissions by 95 percent weight.

3.2.3.2 New York Guidelines

The New York State DEC Division of Air Resources has issued draft guidelines for the control of toxic ambient air contaminants in New York State. These guidelines are presented in the New York State Air Guide-1. State guidance values pertaining to potential air emissions from groundwater treatment equipment to be used at the Hooker/Ruco site are listed in table 3.3.

3.2.4 ARARs for Transport and Disposal of Hazardous Byproduct Wastes

3.2.4.1 Federal Regulations

The following sources of ARARs have been identified for treatment, transportation and disposal of hazardous byproducts:

40 CFR	Part 261	Identification and Listing of Hazardous Waste
	Part 262	Standards Applicable to Generators of Hazardous Waste
	Part 263	Standards Applicable to Transporters of Hazardous Waste
	Part 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
	Subpart B	General Facility Standards
	Subpart E	Manifest System, Recordkeeping and Reporting
	Subpart N	Landfills
	Subpart O	Incinerators
	Part 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
	Subpart B	General Facility Standards
	Subpart E	Manifest System, Recordkeeping and Reporting
	Subpart N	Landfills
	Subpart O	Incinerators
	Subpart P	Thermal Treatment
	Subpart Q	Chemical, Physical and Biological Treatment
	Part 268	Land Disposal Restrictions
49 CFR	Part 172	Hazardous Material Regulations of the Department of Transportation, Hazardous Materials Tables and

		hazardous Communication Requirements and Emergency Response Information Requirements
	Part 173	Hazardous Material Regulations of the Department of Transportation, Shippers, General Requirements for Shipping and Packaging
	Part 178	Hazardous Material Regulations of the Department of Transportation, Shipping Container Specifications
	Part 179	Hazardous Material Regulations of the Department of Transportation, Specifications for Tank Cars

3.2.4.2 New York Regulations

The following sources of ARARs have been identified for treatment, transportation and disposal of hazardous byproducts:

6 NYCRR	Part 360	Solid Waste Management Facilities
	Part 370	Hazardous Waste Management System - General
	Part 371	Identification and Listing of Hazardous Waste
	Part 372	Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities
	Part 373	Hazardous Waste Management Facilities
	Subpart 373.1	Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements
	Subpart 373.2	Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities
	Subpart 373.3	Interim Status Standards Regulations for Owners and Operators of Hazardous Waste Facilities
	Part 376	Land Disposal Restrictions

3.3 Specific Remedial Action Objectives

The specific remedial action objectives for groundwater are the reduction of risks to human health associated with site related compounds, which are based on the COCs and ARARs for establishing groundwater cleanup criteria and groundwater discharge criteria. These specific remedial objectives meet the general requirements discussed throughout Section 3.

TABLE 3.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Chemical-Specific ARARs for Groundwater Cleanup Criteria[1]

Compound	Federal Standards			State Standards		Minimum ARAR-Based Groundwater Cleanup Criteria
	MCL[2]	*MCLGs*[3]	*SMCLs*[4]	Groundwater Quality Standards[5]	Drinking Water Standards[6]	
Carbon disulfide	NR	NR	NR	NR	50[U]	50
Chlorobenzene	NR	NR	NR	5	5[P]	5
Chloroform	100	NR	NR	7	100	7
Chloromethane	NR	NR	NR	NR	5[P]	5
Dieldrin	NR	NR	NR	ND 2.5	50[U]	ND 2.5
1,2-Dichloroethylene total[2]	70	70	NR	5	5[P]	5
Di-n-butyl-phthalate	NR	NR	NR	NR	50[U]	50
Di-n-octyl-phthalate	NR	NR	NR	NR	50[U]	50
Ethylbenzene	700	700	NR	5	5[P]	5
Heptachlor epoxide	NR	0*	NR	ND 2.2	50[U]	ND 2.2
4-Methyl-2-pentanone	NR	NR	NR	NR	50[U]	50
Naphthalene	NR	NR	NR	NR	50[U]	50
Tetrachloroethylene	5	0*	NR	5	5[P]	5
Trichloroethylene	5	0*	NR	5	5[P]	5
Vinyl chloride	2	0*	NR	2	2	2
Xylenes	10,000	10,000	NR	5	5[P]	5
TICs	NR	NR	NR	NR	50[U]	50
Aluminum	NR	NR	50	NR	NR	NR
Antimony	6	3	NR	NR	NR	6
Arsenic	50	NR	NR	25	50	25
Barium	1,000	2,000	NR	1,000	1,000	1,000
Beryllium	1	0*	NR	NR	NR	1
Cadmium	10	5	NR	10	10	5

TABLE 3.1
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Chemical Specific ARARs for Groundwater Cleanup Criteria[1/]

Compound	Federal Standards			State Standards		Minimum ARAR-Based Groundwater Cleanup Criteria
	MCL[2/]	MCLGs[3/]	SMCLs[4/]	Groundwater Quality Standards[5/]	Drinking Water Standards[6/]	
Calcium	NR	NR	NR	NR	NR	NR
Chromium	50	100	NR	50	50	50
Cobalt	NR	NR	NR	NR	NR	NR
Copper	NR	1,300	1,000	200	1,000	200
Iron	NR	NR	300	300†	300†	300
Lead	15	0*	NR	25	50	15
Magnesium	NR	NR	NR	NR	NR	NR
Manganese	NR	NR	50	300†	300†	300
Nickel	NR	NR	NR	NR	NR	NR
Potassium	NR	NR	NR	NR	NR	NR
Silver	50	NR	NR	50	50	50
Sodium	NR	NR	NR	20,000	NR	20,000
Vanadium	NR	NR	NR	NR	NR	NR
Zinc	NR	NR	5,000	300	5,000	300

1/ Micrograms per liter.
2/ 40 CFR 141.11, 141.12, 141.61.
3/ 40 CFR 141.51.
4/ 40 CFR 143.3.
5/ 6 NYCRR 703.5
6/ 10 NYCRR 5-1.52.
NR Not regulated.
P Principle Organic Compound; each cannot exceed 5 ug/l.
U Unspecified Organic Compound; each cannot exceed 50 ug/l.
ND_x Not detected at or above X.
* The EPA believes that an MCLG of zero is not an appropriate setting for cleanup levels, and the corresponding MCL will be the potentially relevant and appropriate requirement (EPA, 1990).
† The total of iron and manganese cannot exceed 500 ug/l.

TABLE 3.2

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Chemical-Specific ARARs for Groundwater Discharge Criteria[1/]

Compound	Federal Standards			State Standards			ARAR-Based Groundwater Discharge Criteria[8/]
	MCL[2/]	MCLGs[3/]	SMCLs[4/]	Groundwater Quality Standards[5/]	Drinking Water Standards[6/]	Groundwater Effluent Standards Class GA[7/]	
Carbon disulfide	NR	NR	NR	NR	50[U]	NR	50
Chlorobenzene	NR	NR	NR	5	5[P]	NR	5
Chloroform	100	NR	NR	7	100	7	7
Chloromethane	NR	NR	NR	NR	5[P]	NR	5
Dieldrin	NR	NR	NR	ND	50[U]	ND	ND $_{2.5}$
1,2-Dichloroethylene total[2/]	70	70	NR	5	5[P]	NR	5
Di-n-butyl-phthalate	NR	NR	NR	NR	50[U]	770	770
Di-n-octyl-phthalate	NR	NR	NR	NR	50[U]	NR	50
Ethylbenzene	700	700	NR	5	5[P]	NR	5
Heptachlor epoxide	NR	0*	NR	ND	50[U]	ND	ND $_{2.2}$
4-Methyl-2-pentanone	NR	NR	NR	NR	50[U]	NR	50
Naphthalene	NR	NR	NR	NR	50[U]	NR	50
Tetrachloroethylene	5	0*	NR	5	5[P]	NR	5
Trichloroethylene	5	0*	NR	5	5[P]	10	10
Vinyl chloride	2	0*	NR	2	2	5	5

TABLE 3.2
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Chemical Specific ARARs for Groundwater Discharge Criteria[1/]

Compound	Federal Standards			State Standards			ARAR-Based Groundwater Discharge Criteria[8/]
	MCL[2/]	MCLGs[3/]	SMCLs[4/]	Groundwater Quality Standards[5/]	Drinking Water Standards[6/]	Groundwater Effluent Standards Class GA[7/]	
Xylenes	10,000	10,000	NR	5	5[P]	NR	5
TICs	NR	NR	NR	NR	50[U]	NR	50††
Aluminum	NR	NR	50	NR	NR	2,000	2,000
Antimony	6	3	NR	NR	NR	NR	6
Arsenic	50	NR	NR	25	50	50	50
Barium	1,000	2,000	NR	1,000	1,000	2,000	2,000
Beryllium	1	0*	NR	NR	NR	NR	1
Cadmium	10	5	NR	10	10	20	20
Calcium	NR	NR	NR	NR	NR	NR	NR
Chromium	50	100	NR	50	50	100	100
Cobalt	NR	NR	NR	NR	NR	NR	NR
Copper	NR	1,300	1,000	200	1,000	1,000	1,000
Iron	NR	NR	300	300†	300†	600‡	600‡
Lead	50	0*	NR	25	50	50	50
Magnesium	NR	NR	NR	NR	NR	NR	NR

TABLE 3.2
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Chemical Specific ARARs for Groundwater Discharge Criteria[1/]

Compound	Federal Standards			State Standards			ARAR-Based Groundwater Discharge Criteria[8/]
	MCL[2/]	MCLGs[3/]	SMCLs[4/]	Groundwater Quality Standards[5/]	Drinking Water Standards[6/]	Groundwater Effluent Standards Class GA[7/]	
Manganese	NR	NR	50	300†	300†	600‡	600‡
Nickel	NR	NR	NR	NR	NR	2,000	2,000
Potassium	NR	NR	NR	NR	NR	NR	NR
Silver	50	NR	NR	50	50	100	100
Sodium	NR	NR	NR	20,000	NR	NR	20,000
Vanadium	NR	NR	NR	NR	NR	NR	NR
Zinc	NR	NR	5,000	300	5,000	5,000	5,000

1/ Micrograms per liter.
2/ 40 CFR 141.11, 141.12, 141.61.
3/ 40 CFR 141.51.
4/ 40 CFR 143.3.
5/ 6 NYCRR 703.5.
6/ 10 NYCRR 5-1.52.
7/ 6 NYCRR 703.6.
8/ 6 NYCRR 702.16.
NR Not regulated.

P Principle Organic Compound; each cannot exceed 5 ug/l.
U Unspecified Organic Compound; each cannot exceed 50 ug/l.
ND_x Not detected at or above X.
* The EPA believes that an MCLG of zero is not an appropriate setting for cleanup levels, and the corresponding MCL will be the potentially relevant and appropriate requirement (EPA, 1990).
†† Applies to each individual compound.
† The total of iron and manganese cannot exceed 500 ug/l.
‡ Combined concentration of iron and manganese shall not exceed 1,000 ug/l.

TABLE 3.3

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

New York State Draft Guidelines
for Air Emissions[1/]

Compound	Short-Term Guideline Concentration	Annual Guideline Concentration
Chlorobenzene	11,000.0	20.0
Chloroform	980.0	23.0
Chloromethane	22,000.0	770.0
Dieldrin	NR	NR
1,2-Dichloroethylene total	190,000.0	1,900.0
Di-n-butyl-phthalate	NR	NR
Di-n-octyl-phthalate	NR	NR
Ethylbenzene	100,000.0	1,000.0
Heptachlor epoxide	NR	NR
4-Methyl-2-pentanone	NR	NR
Naphthalene	12,000.0	120.0
Tetrachloroethylene	81,000.0	7.5E-02
Trichloroethylene	33,000.0	4.5E-01
Vinyl chloride	1,300.0	2.0E-02
Xylenes	100,000.0	300.0
TICs	NR	NR
Aluminum	NR	NR
Antimony	120.0	1.2
Arsenic	2.0E-01	2.34E-04
Barium	120.0	5.0E-01
Beryllium	5.0E-02	4.0E-04
Cadmium	2.0E-01	5.0E-04

TABLE 3.3
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

New York State Draft Guidelines
for Air Emissions[1/]

Compound	Short-Term Guideline Concentration	Annual Guideline Concentration
Calcium	NR	NR
Chromium	1.0E-01	2.0E-5
Cobalt	12.0	1.2E-01
Copper	240.0	2.4
Iron	NR	NR
Lead	NR	NR
Magnesium	NR	NR
Manganese	240.0	3.0E-01
Nickel	1.5	2.0E-02
Potassium	NR	NR
Silver	NR	NR
Sodium	NR	NR
Vanadium	100.0	2.0E-01
Zinc	NR	NR

1/ Micrograms per cubic meter.
NR Not regulated.

4.0 Development of Remedial Action Alternatives - Groundwater Medium

Alternatives for remedial action were developed by assembling combinations of technologies, into alternatives that address the remedial objectives for groundwater. This process consisted of six steps.

1. General response actions were developed that, either alone or in combination, satisfied the remedial action objectives developed in Section 3 of the FS.

2. Technology types, applicable to each general response action, were identified.

3. Process options for each technology type were identified.

4. The process options were screened on the basis of applicability (preliminary screening); all process options which could aid in achieving the remedial objective were retained.

5. All retained process options, with the exception of the treatment process options, were then screened on the basis of effectiveness, implementability and cost (secondary screening); one or more process options from each general response action were retained based on this screening criteria. The secondary screening of the treatment process options, which will include treatability studies, will be conducted as part of the remedial design.

6. The process options were then assembled into select alternatives which may be capable of achieving the remedial action objectives.

A flow chart of the alternatives development process for groundwater is shown on plate 1. Descriptions of the process options, the preliminary screening and the secondary screening are included in Appendix A.

4.1 General Response Actions

The following are general response actions in common use to address groundwater:

- no action;
- institutional actions;
- containment; and
- extraction, treatment and discharge.

The no action general response action involves taking no physical or administrative actions to meet the remedial action objectives. EPA is requiring that this general response action be considered throughout the FS process as a basis to judge other response actions (EPA, 1988b). Institutional actions will aid in reducing the exposure risks, but do not actively reduce compound concentrations in the groundwater. Containment measures are those which prevent migration of the groundwater. Extraction, treatment and discharge involves recovering groundwater, treating it to discharge levels and discharging it to a receiving body.

4.2 Technology Types

For each general response action, technology types were identified which could be utilized to carry out the general response actions. The institutional actions considered for groundwater were access restrictions and groundwater monitoring. The containment technology considered was vertical barriers. The extraction technology considered was pumping. The treatment technologies considered were solids removal, gas-phase separation, chemical treatment, adsorption, membrane filtration, and biological treatment. The discharge options considered were discharge to a local publicly owned treatment works (POTW), discharge to surface water and discharge to groundwater.

4.3 Process Options

For each technology type, a number of specific process options were identified. These process options, as well as their descriptions, are listed in Appendix A.

4.4 Preliminary Screening

The preliminary screening of remedial technologies for the groundwater was on the basis of technical implementability. The identified process options which were capable of meeting the remedial objectives, in part or in whole, were retained and are described in Appendix A.

4.5 Secondary Screening

The process options retained in the preliminary screening, with the exception of primary treatment process options, then underwent a secondary screening that was based on the general criteria of effectiveness, implementability and cost. The secondary screening of primary treatment process options was based only on implementability and cost. The effectiveness of the primary treatment process options will be determined through treatability studies in the design phase. The secondary screening is also described in Appendix A.

4.5.1 Effectiveness Evaluation

The effectiveness evaluation focused on: 1) the potential effectiveness of the process options in handling the volume of groundwater to be extracted and in meeting the remedial action objectives; 2) the potential impacts to human health and the environment during the construction and implementation phase; and 3) how proven and reliable the processes are with respect to the wastestream and conditions at the Hooker/Ruco site.

4.5.2 Implementability Evaluation

The implementability evaluation encompassed both the technical and administrative feasibility of implementing the process options. Emphasis was placed on the institutional aspects of implementability, such as the ability to obtain necessary permits to implement the remedial action, the availability of treatment, storage and disposal services (including capacity) and the availability of necessary equipment and skilled workers to implement the technology.

4.5.3 Cost Evaluation

The cost evaluation was based on relative capital and operation and maintenance (O&M) costs rather than detailed estimates. The cost analysis also utilized engineering judgement, and each process was evaluated as to whether the costs were very high,

high, moderate, low or very low relative to other process options in the same technology type.

4.6 Assembly of Alternatives

To assemble alternatives, one or more process options from each applicable technology type were chosen to represent the various technology types required for the groundwater medium. The chemistry of groundwater to be treated is complex, therefore, treatability studies will be needed. At the EPA's request however, treatability studies will be deferred until the design stage. Therefore, in the absence of treatability studies, the groundwater treatment process options only list possibly applicable treatment scenarios. The treatability studies and actual treatment selection will be determined during the remedial design.

The remedial alternatives for the Hooker/Ruco site were assembled as follows:

- No action.
- Deed notations, well permitting and periodic groundwater monitoring.
- Deed notations, well permitting, periodic groundwater monitoring, pump from recovery wells, treat utilizing applicable treatment technologies and discharge to settling basins.
- Deed notations, well permitting, periodic groundwater monitoring, pump from recovery wells, treat utilizing applicable treatment technologies and discharge to leaching galleries.

5.0 Assessment of Treatment Process Options - Groundwater Medium

Two of the four remedial alternatives listed in Section 4.5 involve treatment process options which will be determined in the remedial design. Treatability studies will be performed for GAC and chemical oxidation in order to determine which process is more effective and/or economical. Additionally, because of the TICs, the ability of these process options to meet ARARs cannot be determined based solely on knowledge of these treatment technologies and engineering practices. For the purpose of the FS, these potentially effective treatment process options were assessed in order to arrive at a realistic cost for treating the projected wastestream at the Hooker/Ruco site. These costs will then be used for comparison purposes only in the remedial alternatives evaluation.

In order to assess the treatment options, the groundwater extraction flow rate was calculated. A groundwater model was utilized to develop conceptual groundwater pumping strategies. For this evaluation, the flow rate was derived from three recovery wells, operating at a total of 100 gpm (gallons per minute) (75 gpm derived by using the model then multiplied by a 1.33 factor of safety). The recovery well locations and capture zones are shown on figure 5.1. The development and justification of the pumping rates and well locations are included in Appendix B. Actual pumping rates and well locations will be determined by field testing during the remedial design phase and system start-up.

5.1 Treatment Process Options

The complexity of the wastestream at the Hooker/Ruco site is anticipated to require pretreatment for metals and primary treatment for the remaining wastestream compounds. For the purpose of this FS, the metals treatment was assumed to consist of a series of chemical precipitation, flocculation, sedimentation/clarification and filtration. Two primary treatment process options, chemical oxidation (utilizing ultraviolet (UV) light) and granular activated carbon (GAC) adsorption, have been identified along with the pretreatment process options as having the greatest potential to effectively treat the wastestream. Packed tower aeration would be used as an effluent polish with chemical oxidation.

The quality of the groundwater to be treated was projected based on the RI sampling results. For the proposed recovery wells, the maximum compound concentration from the monitor wells within each recovery well capture zone was assigned to that recovery well. The assigned concentrations and rates were then combined using standard mass balance/mixing equations to project the quality of the combined flow to arrive at the design water quality used in the screening of treatment options. The projected design water quality is summarized in table 5.1.

Prior to the design of treatment equipment, effluent discharge criteria must be defined. For the purpose of this FS, the effluent quality criteria were based on groundwater discharge ARARs as determined in Section 3.2.2.

The assessment of the treatment options considered only the treatment equipment, and not the entire system, because the costs of extraction and discharge were independent of the treatment option considered. All costs are included in the evaluation of remedial alternatives. The cost for common items, which include, but are not limited to, metals pretreatment, effluent polish, piping at the treatment system and a treatment shed are included in the cost evaluation of the treatment option considered.

5.2 Costing Procedure or Method

The cost calculated for the treatment process options include the following:

- direct and indirect capital cost; and
- direct and indirect annual O&M costs.

The capital cost calculations are based on the quantity of the required treatment component units (items) multiplied by the material, labor and equipment costs per unit. The item costs are summed to provide a subtotal of the capital cost. This subtotal is then marked up to account for contractor's overhead and profit, administrative, contingency and engineering costs. The marked-up cost is the "total capital cost" of the process option.

The O&M cost calculations are based on the quantity of required items per year multiplied by the material, labor and equipment costs per unit. The item costs are summed to provide a subtotal of annual cost. This subtotal is then marked up to account for contractor's overhead and profit and administrative costs. The marked-up cost is the "total annual O&M cost" of the process option.

5.3 Pre- and Post Treatment Process Options

5.3.1 Metals Pre-Treatment

The metals treatment process was assumed to consist of chemical precipitation, flocculation, sedimentation/clarification and filtration. For chemical precipitation to occur, the pH of an aqueous wastestream is adjusted to the point of a metal's minimum solubility. At this point the dissolved metal ions form a solid which precipitates out of solution, usually as a hydroxide molecule. Flocculation involves mixing the wastewater with a flocculating chemical. Flocculants adhere to suspended solids so the resultant particles are too large to remain in suspension and settle out. The wastewater then enters a clarifier for the sedimentation/clarification process, where heavy solids settle by gravity and collect at the bottom of the vessel resulting in liquid/solid separation. The final metals pre-treatment process is filtration. Suspended solids are removed from the wastewater by passing it through a porous medium.

5.3.1.1 Description

A chemical solution is injected into the recovered groundwater prior to entering a metals precipitation reactor. The metals will be precipitated in the reactor using metal hydroxide precipitation technology. The solids-laden water will flow by gravity to the flocculator/clarifier unit. The treated water will enter the rapid mix chamber of the flocculator/clarifier where anionic polymer will be injected. The polymer will then react with the metals solids to form a large particle size in a slowly mixed flocculation chamber. The flocculated solids will enter the main body of the clarifier where they will settle to the bottom by gravity. The clean, clarified water will then be decanted and discharge to the primary treatment unit. If necessary, settled solids will be transferred to a sludge thickening tank and sludge dewatering unit. A schematic diagram illustrating the groundwater treatment train is shown on figure 5.2.

5.3.2 Packed Tower Aeration

Packed tower aeration consists of a contacting system that provides for mass transfer of VOCs from a dilute aqueous waste stream into an air (vapor) stream. Mass transfer takes place in a tower filled with a packing material with a large surface area. The packing is designed to allow for counterflow passage of water, flowing down by gravity, and of air flowing up through the packing under pressure supplied by a blower. The treated water is discharged and the volatilized air is released to the atmosphere or a vapor treatment unit, depending on the volatile mass concentration.

The ease with which a given volatile compound can be stripped from the water phase is largely reflected by it's Henry's Law Constant. Henry's Law states that the partial pressure of a chemical compound in the air (evaporated from water) is directly proportional to its equilibrium concentration in water. A higher Henry's Law constant indicates a higher affinity of the organic compound for the vapor phase. Henry's Law Constants are highly temperature dependent and influenced by vapor pressure, aqueous solubility and molecular weight. The VOCs detected at the site have large Henry's Constant (i.e., 1,080 atmospheres for PCE) at the anticipated operating temperatures and, therefore, can be easily stripped.

5.3.2.1 Description

Groundwater pumped from the recovery wells will undergo pre-treatment for metals and primary treatment utilizing chemical oxidation. GAC as a primary treatment process will not require the implementation of packed tower aeration for an effluent polish. Groundwater will be piped from the chemical oxidation unit to the top of the packed tower and will be distributed over the top of the packing material in the tower. The treated water will discharge from the bottom of the tower into a sump, from which it will be pumped to the point of discharge.

Vapor emissions are estimated to be 0.004 lb/hr, which is below the ARARs for air emission discharge criteria outlined in Section 3.2.3. Therefore, it is assumed that vapor emission controls will not be required.

5.4 Cost Analysis of Treatment Process Options

5.4.1 Chemical Oxidation

UV light is used as a catalyst for the chemical oxidation of organic compounds in the wastestream by its combined effect upon the organic compound and its reaction with hydrogen peroxide. Many organic compounds absorb UV light and undergo a change in their chemical structure or may become more reactive with chemical oxidants. UV light wavelengths of at less than 400 nm (nanometers) reacts with hydrogen peroxide molecules to form hydroxyl radicals. These chemical oxidants then react with the organic compounds in the water. The reaction products of hydrocarbon oxidation, if carried to completion, are carbon dioxide and water. Due to its very high solubility, the carbon dioxide produced remains dissolved in the water. There are no emissions or large quantities of solid residue or sludge created by this process.

5.4.1.1 Description

The groundwater pumped from the recovery wells will undergo pretreatment and then will be filtered to remove any residual particles prior to the chemical oxidation process. Upon completion of the chemical oxidation process, the wastestream will undergo an effluent polish using packed tower aeration. The treated water will be pumped to the point of discharge. Standard flow controls (valves, meters, etc.) and process controls (pressure sensors, water level sensors, etc.) are included. O&M was assumed to include the power costs of the treatment equipment, system maintenance and repairs, sludge disposal (metals treatment) and monthly influent and effluent sampling of the treatment system. A schematic diagram illustrating the groundwater treatment train is shown on figure 5.2.

5.4.1.2 Cost

The capital cost for chemical oxidation, as described above, is estimated at \$959,000. The annual O&M cost is estimated at \$471,000. The cost calculations are outlined in tables 5.2 and 5.3.

5.4.2 Granular Activated Carbon Adsorption

Adsorption is the process of collecting constituents in aqueous solution (solutes) on a suitable interface. When a solution is contacted with the interface, molecules of the solutes transfer from the fluid phase to the solid phase until the concentration of the solute in aqueous solution is in equilibrium with the solute adsorbed on the interface (Sundstrum and Klei, 1979). GAC adsorption involves treatment of the wastestream by contacting it with GAC in fixed-bed columns. The water is distributed over the top of the columns and withdrawn at the bottom. Provisions for backwash and surface wash are typically included.

5.4.2.1 Description

The wastestream will be pretreated and filtered to remove any residual particles prior to GAC treatment. The treated water will be pumped to the point of discharge. Standard flow controls (valves, meters, etc.) and process controls (pressure sensors, water-level sensors, etc.) are included. O&M was assumed to include the cost for replacement of spent carbon, power costs of the treatment equipment, system maintenance and repairs, sludge disposal (metals treatment) and monthly influent and effluent sampling of the treatment system. A schematic diagram illustrating the groundwater treatment train is shown on figure 5.2.

5.4.2.2 Cost

The capital cost for GAC adsorption, as described above, is estimated at $3,065,000. The high capital cost is attributed to the large quantity of carbon that is anticipated to be required to treat the less soluble TIC compounds in the wastestream. The annual O&M cost is estimated at $449,000. The cost calculations are outlined in tables 5.4 and 5.5.

5.5 Cost for Alternatives Evaluation Purposes

In order to compare Remedial Alternatives in Chapter 6, a treatment cost must be assumed. For the purpose of the FS, the maximum capital and O&M costs associated with groundwater treatment were used.

TABLE 5.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Projected Design Concentrations of Treatment Process Influent[1/]

Compound	RW-1 Effluent[2/]	RW-2 Effluent[3/]	RW-3 Effluent[4/]	Treatment Process Influent
Carbon disulfide	ND	ND	1	0.3
Chlorobenzene	ND	ND	6	2
Chloroform	ND	2	ND	0.7
1,2-Dichloroethylene total	4	22	54	27
Di-n-butyl-phthalate	ND	ND	45	15
Di-n-octyl-phthalate	ND	ND	2	0.7
Ethylbenzene	ND	ND	8	3
4-Methyl-2-pentanone	ND	ND	320	110
Naphthalene	ND	ND	2	0.7
Tetrachloroethylene	5	64	98	56
Trichloroethylene	9	14	18	14
Vinyl chloride	ND	94	83	59
Xylenes	ND	ND	15	5
TICs	NS	NS	240,000	80,000
Aluminum	690	230	410	440
Antimony	ND	6	57	21
Arsenic	ND	10	68	26
Barium	96	140	92	109
Beryllium	36	1	ND	12
Cadmium	ND	130	4	47
Calcium	21,000	38,000	33,000	31,000
Chromium	27	420	160	250
Cobalt	4	49	17	23
Copper	16	10	5	10

TABLE 5.1
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Projected Design Concentrations of Treatment Process Influent[1/]

Compound	RW-1 Effluent[2/]	RW-2 Effluent[3/]	RW-3 Effluent[4/]	Treatment Process Influent
Iron	460	8,400	84,000	31,000
Lead	4	41	3	16
Magnesium	3,300	4,600	3	2,600
Manganese	140	680	970	600
Nickel	150	22	23	65
Potassium	4,500	2,400	9,600	5,500
Silver	6	4	1	4
Sodium	54,000	26,000	25,000	35,000
Vanadium	5	4	ND	3
Zinc	42	8	52	34

1/ Micrograms per liter.
2/ Based on water quality data from Monitor Wells A-1, A-2, H-1, H-2 and M-1.
3/ Based on water quality data from Monitor Wells C-1, C-2, I-1, I-2, N-1 and O-1.
4/ Based on water quality data from Monitor Wells D-1, D-2, E-1, E-2, F-1, F-2, J-1, J-2 and P-1.
ND Not detected in individual monitor wells.
NS Individual monitor wells were not sampled.

TABLE 5.2

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Chemical Oxidation

Item	Qty	Unit	Unit Cost				Total Cost				Total Direct Cost
			Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	
Chemical Oxidation											
– UV Oxidation System	1	Each	0.00	250,000.00	9,000.00	4,000.00	0	250,000	9,000	4,000	263,000
Metals Treatment											
– Metals Treatment System	1	Each	0.00	178,500.00	13,000.00	4,000.00	0	178,500	13,000	4,000	195,500
Flow Equalization	1	Each	0.00	4,000.00	1,000.00	500.00	0	4,000	1,000	500	5,500
Filtration	1	Each	0.00	5,000.00	1,500.00	375.00	0	5,000	1,500	375	6,875
Effluent Air Stripping Polishing	1	Each	0.00	16,000.00	3,000.00	2,000.00	0	16,000	3,000	2,000	21,000
Piping at Treatment System											
– Pipe, 3" PVC	150	LF	0.00	2.93	7.45	0.00	0	440	1,118	0	1,557
– Pipe Fittings	1	LS	0.00	5,000.00	2,000.00	1,000.00	0	5,000	2,000	1,000	8,000
– Flow Meters	1	LS	0.00	6,000.00	2,000.00	500.00	0	6,000	2,000	500	8,500
Other Treatment System Items											
– Controls & Electrical	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000
– Transfer Pumps	4	Each	0.00	900.00	400.00	100.00	0	3,600	1,600	400	5,600
– Treatment Shed	1	LS	0.00	70,000.00	0.00	0.00	0	70,000	0	0	70,000
System Startup and Debugging											
– Equipment Testing/Sampling	1	LS	0.00	0.00	10,000.00	0.00	0	0	10,000	0	10,000
– Laboratory Analysis	1	LS	11,000.00	0.00	0.00	0.00	11,000	0	0	0	11,000
Subtotal							31,000	538,540	44,218	12,775	626,532
Contractor's Overhead & Profit at 10% of Equipment Cost										1,278	1,278
Contractor's Overhead & Profit at 10% of Material Cost								53,854			53,854
Total Direct Cost							31,000	592,393	44,218	14,053	681,663
Engineering Cost at 10% of Total Direct Cost											68,166
Project Administration Cost at 15% of Direct Labor Cost									6,633		6,633
Project Administration Cost at 5% of Direct Material Cost								29,620			29,620
Project Administration Cost at 10% of Direct Unitemized Cost							3,100				3,100
Project Administration Cost at 15% of Engineering Cost											10,225
Total Field Cost							34,100	622,013	50,850	14,053	799,407
Contingency at 20% of Total Field Cost											159,881
Total Capital Cost											$959,000

OCCCOST/OCCCOST/CAPUV.WK3

TABLE 5.3

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Chemical Oxidation

			Unit Cost				Annual Cost				Total Annual
Item	Qty	Unit/Yr	Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	Cost
Chemical Oxidation Maintenance											
- System Power	930,000	kWh	0.09	0.00	0.00	0.00	83,700	0	0	0	83,700
- Replacement Parts	1	LS	0.00	20,000.00	5,000.00	0.00	0	20,000	5,000	0	25,000
- Peroxide Solution	19,000	LB	0.00	0.65	0.10	0.05	0	12,350	1,900	950	15,200
Metals Treatment System											
- System Power	41,160	kWh	0.09	0.00	0.00	0.00	3,704	0	0	0	3,704
- Treatment Chemicals	1	Each	0.00	5,600.00	2,500.00	1,500.00	0	5,600	2,500	1,500	9,600
- Replacement Parts	1	LS	0.00	14,280.00	3,570.00	0.00	0	14,280	3,570	0	17,850
- Sludge Disposal	1825	CF	0.00	0.00	50.00	20.00	0	0	91,250	36,500	127,750
Effluent Polishing System											
- Polishing System Power	19,350	kWh	0.09	0.00	0.00	0.00	1,742	0	0	0	1,742
- Replacement Parts	1	LS	0.00	1,280.00	320.00	0.00	0	1,280	320	0	1,600
Other System Maintenance											
- Weekly Maintenance	52	Each	0.00	100.00	1,000.00	50.00	0	5,200	52,000	2,600	59,800
- Periodic Repairs	5	Each	0.00	1,000.00	1,000.00	100.00	0	5,000	5,000	500	10,500
Influent/Effluent Sampling											
- Sampling (Monthly)	12	Each	0.00	100.00	600.00	0.00	0	1,200	7,200	0	8,400
- Laboratory Analysis	48	Each	1,000.00	0.00	0.00	0.00	48,000	0	0	0	48,000
- Reporting	4	Each	0.00	0.00	1,000.00	0.00	0	0	4,000	0	4,000
Subtotal							137,146	64,910	172,740	42,050	416,846
Contractor's Overhead & Profit at 10% of Equipment Cost										4,205	4,205
Contractor's Overhead & Profit at 10% of Material Cost								6,491			6,491
Total Direct Cost							137,146	71,401	172,740	46,255	427,542
Project Administration Cost at 15% of Direct Labor Cost									25,911		25,911
Project Administration Cost at 5% of Direct Material Cost								3,570			3,570
Project Administration Cost at 10% of Direct Unitemized Cost							13,715				13,715
Total Field Cost							150,860	74,971	198,651	46,255	470,736
Total Annual O&M Cost											$471,000

OCCCOST/OCCCOST/OMUV.WK3

TABLE 5.4

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for GAC Adsorption

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
GAC Adsorption											
– GAC Adsorber System	9	Each	0.00	175,000.00	6,000.00	3,000.00	0	1,575,000	54,000	27,000	1,656,000
Metals Treatment											
– Metals Treatment System	1	Each	0.00	178,500.00	13,000.00	4,000.00	0	178,500	13,000	4,000	195,500
Flow Equalization	1	Each	0.00	4,000.00	1,000.00	500.00	0	4,000	1,000	500	5,500
Filtration	1	Each	0.00	5,000.00	1,500.00	375.00	0	5,000	1,500	375	6,875
Piping at Treatment System											
– Pipe, 3" PVC	150	LF	0.00	2.93	7.45	0.00	0	440	1,118	0	1,557
– Pipe Fittings	1	LS	0.00	5,000.00	2,000.00	1,000.00	0	5,000	2,000	1,000	8,000
– Flow Meters	1	LS	0.00	6,000.00	2,000.00	500.00	0	6,000	2,000	500	8,500
Other Treatment System Items											
– Controls & Electrical	1	LS	20,000.00	0.00	0.00	0.00	20,000	0	0	0	20,000
– Transfer Pumps	3	Each	0.00	900.00	400.00	100.00	0	2,700	1,200	300	4,200
– Treatment Shed	1	LS	0.00	70,000.00	0.00	0.00	0	70,000	0	0	70,000
System Startup and Debugging											
– Equipment Testing/Sampling	1	LS	0.00	0.00	10,000.00	0.00	0	0	10,000	0	10,000
– Laboratory Analysis	1	LS	11,000.00	0.00	0.00	0.00	11,000	0	0	0	11,000
Subtotal							31,000	1,848,640	85,818	33,675	1,997,132
Contractor's Overhead & Profit at 10% of Equipment Cost										3,368	3,368
Contractor's Overhead & Profit at 10% of Material Cost								184,664			184,664
Total Direct Cost							31,000	2,031,303	85,818	37,043	2,185,163
Engineering Cost at 10% of Total Direct Cost											218,516
Project Administration Cost at 15% of Direct Labor Cost									12,873		12,873
Project Administration Cost at 5% of Direct Material Cost								101,565			101,565
Project Administration Cost at 10% of Direct Unitemized Cost							3,100				3,100
Project Administration Cost at 15% of Engineering Cost											32,777
Total Field Cost							34,100	2,132,869	98,690	37,043	2,553,995
Contingency at 20% of Total Field Cost											510,799
Total Capital Cost											$3,065,000

OCCCOST/OCCCOST/CAPGAC.WK3

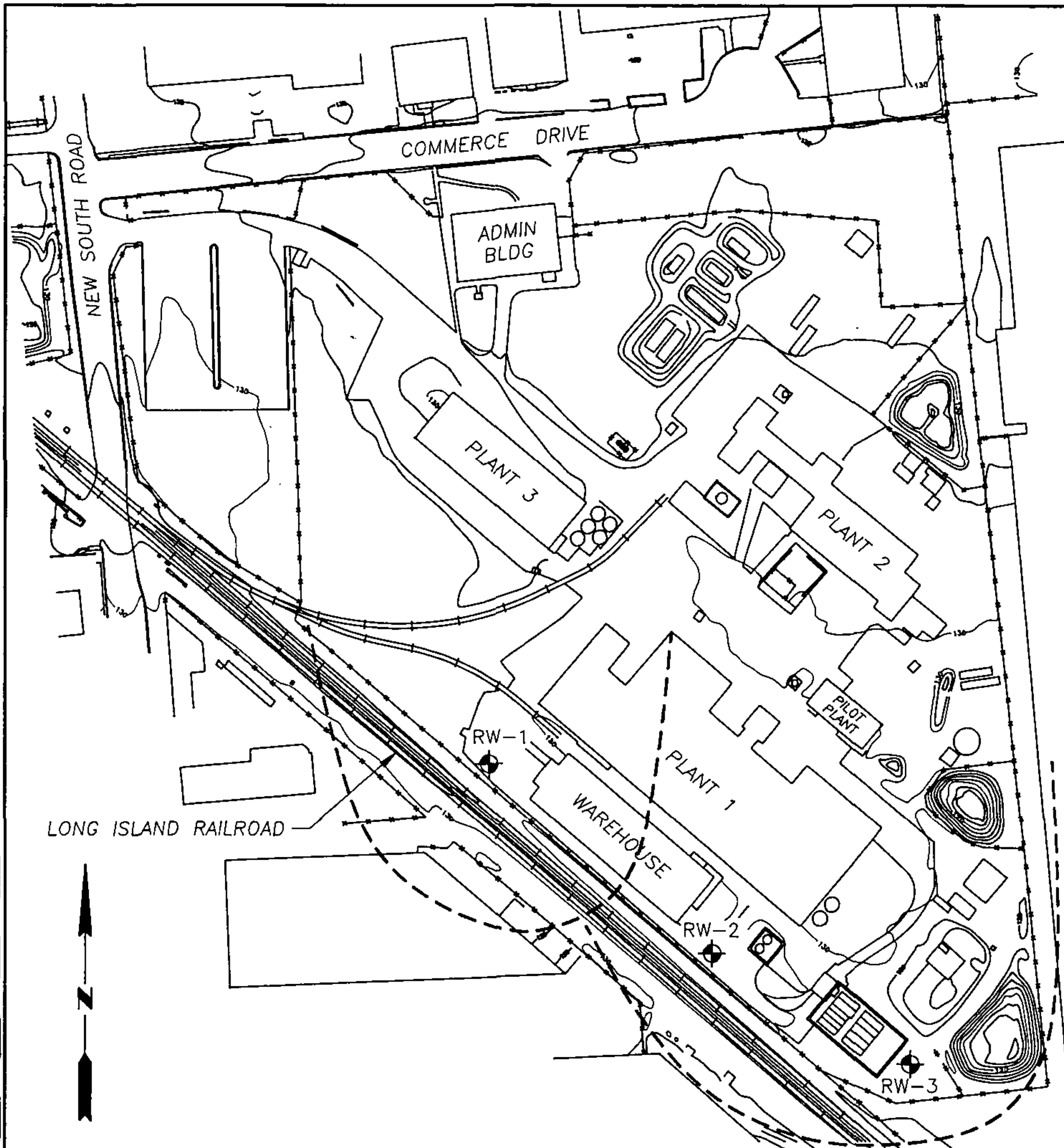
TABLE 5.5

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for GAC Adsorption

Item	Qty	Unit/Yr	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Annual Cost: Unitem.	Annual Cost: Material	Annual Cost: Labor	Annual Cost: Equip.	Total Annual Cost
GAC Adsorber Maintenance											
– Replacement Carbon	33,200	LB	0.00	1.00	0.12	0.10	0	33,200	3,984	3,320	40,504
– Regeneration	298,800	LB	0.00	0.00	0.12	0.10	0	0	35,856	29,880	65,736
Metals Treatment System											
– System Power	41,160	kWh	0.09	0.00	0.00	0.00	3,704	0	0	0	3,704
– Treatment Chemicals	1	Each	0.00	5,600.00	2,500.00	1,500.00	0	5,600	2,500	1,500	9,600
– Replacement Parts	1	LS	0.00	14,280.00	3,570.00	0.00	0	14,280	3,570	0	17,850
– Sludge Disposal	1825	CF	0.00	0.00	50.00	20.00	0	0	91,250	36,500	127,750
Other System Maintenance											
– Weekly Maintenance	52	Each	0.00	100.00	1,000.00	50.00	0	5,200	52,000	2,600	59,800
– Periodic Repairs	5	Each	0.00	1,000.00	1,000.00	100.00	0	5,000	5,000	500	10,500
Influent/Effluent Sampling											
– Sampling (Monthly)	12	Each	0.00	100.00	600.00	0.00	0	1,200	7,200	0	8,400
– Laboratory Analysis	48	Each	1,000.00	0.00	0.00	0.00	48,000	0	0	0	48,000
– Reporting	4	Each	0.00	0.00	1,000.00	0.00	0	0	4,000	0	4,000
Subtotal							51,704	64,480	205,360	74,300	395,844
Contractor's Overhead & Profit at 10% of Equipment Cost										7,430	7,430
Contractor's Overhead & Profit at 10% of Material Cost								6,448			6,448
Total Direct Cost							51,704	70,928	205,360	81,730	409,722
Project Administration Cost at 15% of Direct Labor Cost									30,804		30,804
Project Administration Cost at 5% of Direct Material Cost								3,546			3,546
Project Administration Cost at 10% of Direct Unitemized Cost							5,170				5,170
Total Field Cost							56,875	74,474	236,164	81,730	449,243
Total Annual O&M Cost											$449,000

OCCCOST\OCCCOST\O&MGAC.WK3



LEGEND

RW-1 RECOVERY WELL

CAPTURE ZONE

0 150

SCALE IN FEET

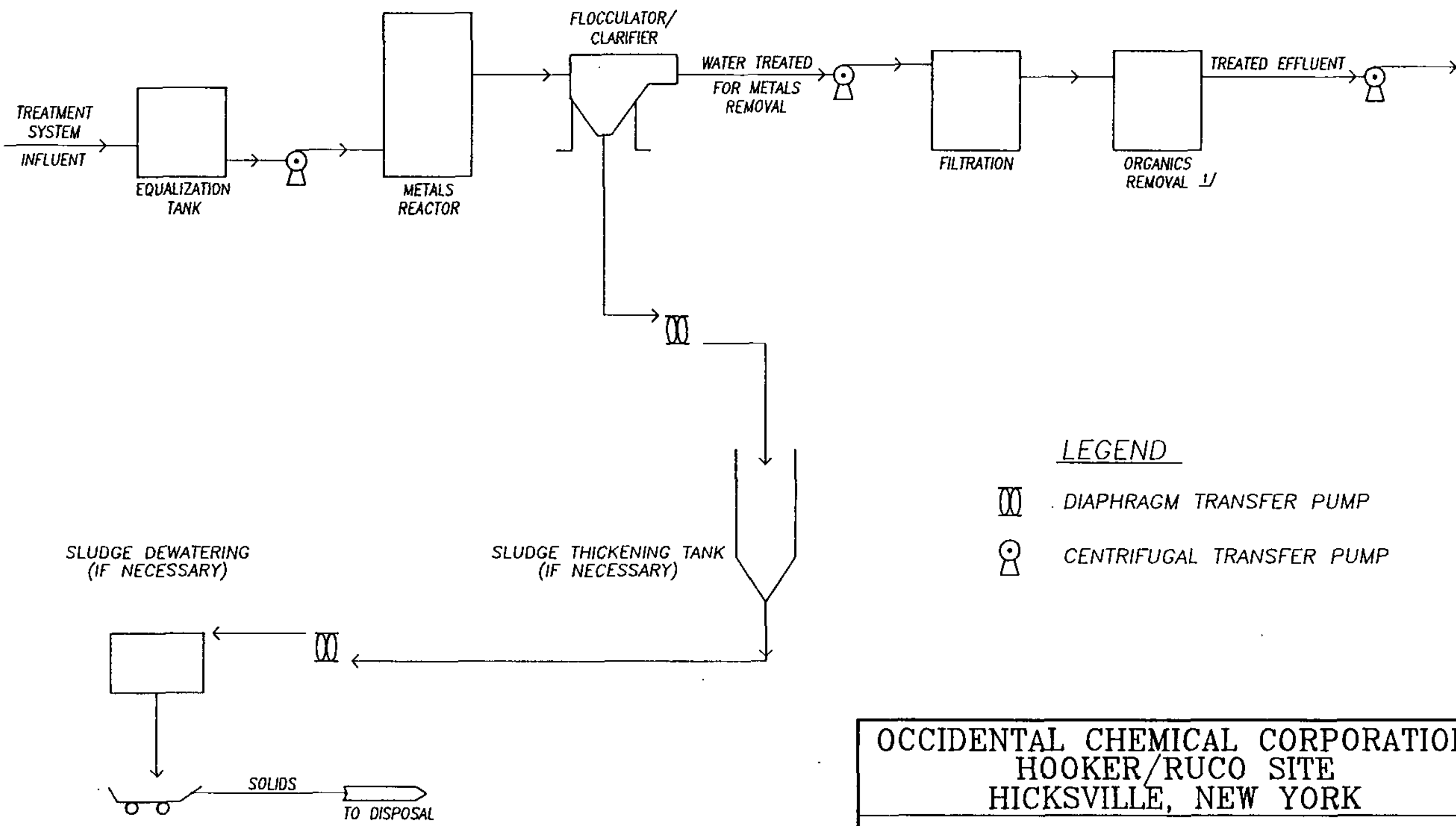
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

RECOVERY WELL LOCATIONS AND CAPTURE ZONES

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 3/9/93 FIGURE: 5.1



1/ (CHEMICAL OXIDATION WITH AIR STRIPPING POLISHING OR GAC)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

GROUNDWATER TREATMENT SYSTEM PROCESS DIAGRAM

DATE	REVISED

PREPARED BY:

LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 7/1/93 | FIGURE: 5.2

6.0 Remedial Alternatives Evaluation - Groundwater Medium

The five alternatives listed in Section 4.5 were subjected to a detailed evaluation to enable the alternatives to be compared against one another. Sufficient data were developed regarding these alternatives so that each could be adequately evaluated and compared. The EPA (EPA, 1988a) guidance document lists nine criteria which address the CERCLA remediation requirements that are important for selecting among remedial alternatives. The evaluation criteria, which fall under the more general criteria of effectiveness, implementability and cost, are the following:

- **Overall protection of human health and the environment** describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

- **Compliance with ARARs** describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered".

- **Long-term effectiveness and permanence** evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met.

- **Reduction of toxicity, mobility or volume** addresses the statutory preference for selecting remedial actions that employ technologies that permanently and significantly reduce toxicity, mobility or volume of the COCs.

- **Short-term effectiveness** examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until response objectives have been met.

- **Implementability** evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services.

- **Cost** evaluation addresses the direct and indirect capital costs as well as the annual O&M costs. A present-worth analysis is used to evaluate expenditures that occur over 10-year and 30-year time periods by discounting all future costs to a common base year. A discount rate of 5 percent before taxes and after inflation, as suggested by EPA, was used for the present-worth analysis (EPA, 1988a).

- **State Acceptance** reflects the state's (or support agency's) apparent preferences among, or concerns about, alternatives.

- **Community Acceptance** reflects the community's apparent preferences among, or concerns about, alternatives.

The detailed analysis of each remedial alternative includes the following:

- a description of the remedial alternative with respect to the volumes or areas of contaminated media to be addressed, the technologies to be used, and any performance requirements associated with those technologies;

- an assessment and a summary profile of each alternative against the evaluation criteria listed above; and

- a comparative analysis among the alternatives to assess the relative performance of each alternative with respect to the evaluation criteria.

General descriptions of the assembled alternatives have already been completed in the alternative development and screening processes. These general descriptions are further defined to the extent that the evaluation criteria could be applied. The additional information developed consists of preliminary design calculations, preliminary site layouts, and a discussion of limitations, assumptions and uncertainties concerning each alternative. Once the alternatives were described in sufficient detail, each was evaluated against the nine evaluation criteria.

6.1 Remedial Alternative 1 - No Action

The no action alternative assumes no additional actions will be taken beyond the current activities at the site. Public water supply will continue to be used in the affected area. However, there are no restrictions which would prevent future use of the groundwater. The no action alternative has been retained in order to establish a datum from which to evaluate other retained remedial alternatives.

6.1.1 Overall Protection of Human Health and the Environment

The no action alternative is not protective of human health. There are no controls for water use and well construction restrictions are not in place to prevent future groundwater use in the vicinity of the Hooker/Ruco site. The RA concluded that there are no risks to the environment.

6.1.2 Compliance with ARARs

Based on information developed during the RI process, it was determined that the current groundwater flow leaving the Hooker/Ruco site is being captured by production wells operated by Grumman. Therefore, although it can be demonstrated that the impacted groundwater is currently under the influence of an offsite containment scenario, site specific groundwater ARARs are not being met onsite as a result of this situation.

6.1.3 Long-term Effectiveness and Permanence

The possibility of future Grumman well shutdown would discontinue groundwater capture. Therefore, the permanence of the groundwater capture cannot be assured and site specific ARARs will not have been met.

6.1.4 Reduction of Toxicity, Mobility or Volume

The no action alternative does not actively reduce toxicity, mobility or volume of the compounds. The compounds in the groundwater will gradually disperse and be removed through dilution and degradation.

6.1.5 Short-term Effectiveness

The no action alternative is not effective in reducing the short-term risks. Other than a Nassau County Department of Health ordinance prohibiting private supply wells in areas served by public supply, there are no existing water-use controls and well construction restrictions to prevent the use of the groundwater.

6.1.6 Implementability

The no action alternative is easily implementable and requires no modifications to the site.

6.1.7 Cost

Because no action is taken, costs will not be incurred and capital, O&M and present worth costs are all zero.

6.1.8 State (Support Agency) Acceptance

The no action alternative may be acceptable to support agencies because there are no current risks to human health or the environment from the groundwater.

6.1.9 Community Acceptance

Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.

6.2 Remedial Alternative 2 - Deed Notations with Monitoring

Alternative 2 involves obtaining deed notations to limit the land use activities at the Hooker/Ruco site, well permitting to restrict groundwater use to eliminate exposure and periodic groundwater monitoring to track the movement and compound concentrations of the groundwater. The deed notations and well permitting restrictions would be filed by Ruco, a potentially responsible party and the site owner. Annual sampling of 21 onsite monitoring wells will provide data from which to assess the extent and mobility of the COCs. Samples will be collected annually and analyzed to determine the compounds present and their concentrations. Annual status reports will be filed with the appropriate regulatory agencies. Because the monitor wells are already present, the capital cost consists of the legal fees for obtaining the deed notations and well permitting. O&M costs consist of annual monitoring costs.

6.2.1 Overall Protection of Human Health and the Environment

Alternative 2 is protective of human health in that deed notations, well permitting and monitoring are included to mitigate potential future exposure and to track the status of the compounds detected in the groundwater. The deed notations would be focused on preventing the drilling of wells on the Ruco property or requiring treatment of the water if wells are drilled. Well permitting would ensure controls for water use and well construction restrictions. This would be implemented by denying permits required under Environmental Conservation Law Article 15 Title 15, applications for water supply wells, and 6NYCRR, Part 602 regulations for Long Island non-public supply high capacity wells. Water supply wells would also be restricted onsite by deed notations. A Nassau County Department of Health ordinance forbids the use of private supply wells where a public water supply is available. Deed notations and land-use (i.e., water-use) restrictions ensure the appropriate development of the land. Monitoring the groundwater would provide information as to the change in concentration of the compounds detected and rate of movement. Potential future risks to human health are mitigated through the use of this alternative by prohibiting the use of the groundwater. The RA concluded that there are no risks to the environment.

6.2.2 Compliance with ARARs

Compliance with site-specific ARARs is not achieved through the use of this alternative.

6.2.3 Long-term Effectiveness and Permanence

Alternative 2 is not an effective and permanent solution in maintaining protection of human health because site specific ARARs will not have been met.

6.2.4 Reduction of Toxicity, Mobility or Volume

Alternative 2 does not actively reduce toxicity, mobility or volume of the compounds. The compounds in the groundwater will gradually disperse and be removed through dilution and degradation.

6.2.5 Short-term Effectiveness

Alternative 2 is protective of human health and the environment in the short-term because groundwater would not be used for potable purposes in the vicinity of the Hooker/Ruco site through the use of deed notations and well permitting.

6.2.6 Implementability

Alternative 2 is easily implementable. Controls for water use and well construction restrictions would be obtained in the form of permit and approval processes of the DEC and other agencies. Deed notations and well permitting restrictions would be obtained with the cooperation of Ruco. Monitoring the status of the areal extent of impacted groundwater by collection and analysis of groundwater samples is a standard technology that is easily implementable.

6.2.7 Cost

The capital cost for Alternative 2 is $39,000, and the annual O&M cost is $37,000. The 10-year and 30-year present worth costs are $325,000 and $608,000, respectively. The cost calculations are outlined in tables 6.1 through 6.4

6.2.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 2 is anticipated because there are no current risks to human health or the environment from the groundwater. However, the use of institutional controls does not satisfy the statutory preference for treatment that reduces toxicity, mobility or volume as a principal element.

6.2.9 Community Acceptance

Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.

6.3 Remedial Alternative 3 - Groundwater Extraction and Treatment with Discharge to an Onsite Settling Basin

Groundwater will be pumped from three recovery wells at a total flow rate of 100 gpm and piped to a treatment system utilizing applicable technologies. The effluent will be discharged to Sump 3, an onsite settling basin. The layout for this alternative is shown on figure 6.1.

The three recovery wells will be drilled to a depth of about 125 ft bg (feet below grade). The wells will be 8 inches in diameter and screened from about 40 ft bg to the bottom. The wells will be developed until the discharge is clear and nearly free of sediment. A 3-hp (horsepower) submersible pump will be installed in each well, and the necessary pipes and fittings will be used to make the connection with the below-grade pipes leading to the treatment shed. At the treatment shed, the piping from the recovery wells will be routed to a manifold pipe leading to the treatment system. Each well will be completed below grade with access via a manhole. Below-grade electric power will run from the nearest source to each recovery well.

Deed restrictions and monitoring would be applied as described in Section 6.2. The required O&M will include electric power, servicing of pumps and motors, periodic well development, treatment system operation, and annual monitoring.

6.3.1 Overall Protection of Human Health and the Environment

Alternative 3 is protective of human health by actively remediating the groundwater. The effectiveness of the proposed recovery wells was evaluated using the computer model described in Appendix B. The model shows that the recovery wells will prevent offsite movement of the impacted groundwater, as shown on figure 5.1. The computer model also verified that Sump 3 is capable of accepting the proposed effluent rate. The RA concluded that there are no risks to the environment.

6.3.2 Compliance with ARARs

Alternative 3 complies with cleanup ARARs and discharge ARARs for the identified compounds. Compliance with discharge ARARs for TICs will be determined during remedial design through treatability studies.

6.3.3 Long-term Effectiveness and Permanence

Groundwater extraction is an effective and permanent solution for removing impacted groundwater from the site.

6.3.4 Reduction of Toxicity, Mobility or Volume

The treatment is anticipated to reduce the toxicity, mobility and volume of the waste, permanently, through extraction and treatment of impacted groundwater. The COCs will be removed from the groundwater and no risks from groundwater exposure will remain at the site after the remedial objectives have been met.

6.3.5 Short-term Effectiveness

Short-term effectiveness will be achieved through water-use controls and well construction restrictions. Deed notations and monitoring will also contribute to prevent potential future exposure during the remedial period by prohibiting use of the onsite groundwater.

6.3.6 Implementability

Installing three recovery wells is technically feasible. Installation of the treatment system will not interfere with development or continued use of the land, assuming that the treatment equipment is located out of the way of current or planned land uses.

Operation of the recovery wells will not have an adverse impact on the aquifer. As shown on figure 5.1, the capture areas are small, therefore, the groundwater levels are not lowered over large areas.

Alternative 3 is technically feasible in that the necessary equipment, services, and materials are readily available for constructing the system. Trained and experienced personnel are either available for conducting operational and monitoring tasks or can be readily trained. The existing facility SPDES permit will not be required to be modified to include the treatment system discharge to Sump 3 because the remedial action will be conducted entirely onsite (EPA, 1989a). The groundwater treatment would comply with the substantive requirements of the ARARs for groundwater discharge criteria discussed in Section 3.2.2.

Controls for water use and well construction restrictions would be obtained in the form of permit and approval processes of the DEC and other agencies. Deed notations would be obtained with the cooperation of Ruco. Monitoring the status of the areal extent of impacted groundwater by collection and analysis of groundwater samples is a standard technology that is easily implementable.

6.3.7 Cost

The estimated total capital cost for Alternative 3 is \$4,748,000, and the estimated annual O&M cost is \$549,000, utilizing the treatment system costs as determined in Section 5.4. The estimated 10-year and 30-year present worth costs are \$8,986,000 and \$13,185,000, respectively. These costs are outlined in tables 6.5 through 6.8.

6.3.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 3 is anticipated because there are no current risks to human health or the environment from the groundwater, groundwater recovery will prevent offsite migration of the impacted groundwater, and groundwater treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.

6.3.9 Community Acceptance

Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.

6.4 Remedial Alternative 4 - Groundwater Extraction and Treatment with Discharge to Leaching Galleries

The extraction and treatment of groundwater in Alternative 4 is the same as described for Alternative 3 in Section 6.3. The only difference between Alternatives 3 and 4 is the point of discharge. Discharge for Alternative 4 is to leaching galleries. The proposed leaching gallery area will be approximately 75 by 75 ft, and will be completed to a depth of 5 ft bg. The layout of this alternative is shown on figure 6.2.

6.4.1 Overall Protection of Human Health and the Environment

Alternative 4 is protective of human health by actively remediating the groundwater. The effectiveness of the proposed recovery wells is the same as Alternative 3 and is discussed in Section 6.3.1. The computer model verified that the soils at the Hooker/Ruco site are capable of accepting the proposed effluent rate. The RA concluded that there are no risks to the environment.

6.4.2 Compliance with ARARs

Alternative 4 complies with cleanup ARARs and discharge ARARs for the identified compounds. Compliance with discharge ARARs for TICs will be determined during remedial design through treatability studies.

6.4.3 Long-term Effectiveness and Permanence

Groundwater extraction is an effective and permanent solution for removing impacted groundwater from the site.

6.4.4 Reduction of Toxicity, Mobility or Volume

The treatment is anticipated to reduce the toxicity, mobility and volume of the waste, permanently, through extraction and treatment of impacted groundwater. The COCs will be removed from the groundwater and no risks from groundwater exposure will remain at the site after the remedial objectives have been met.

6.4.5 Short-term Effectiveness

Short-term effectiveness will be achieved through water-use controls and well construction restrictions. Deed notations and monitoring will also contribute to prevent potential future exposure during the remedial period by prohibiting use of the onsite groundwater.

6.4.6 Implementability

Alternative 4 is technically feasible. The implementation of the extraction and treatment processes is the same as described in Section 6.3.6 for Alternative 3. Additional piping and trenching will be required for discharge to leaching galleries, which will have to be constructed. However, implementation is not difficult.

6.4.7 Cost

The estimated total capital cost for Alternative 4 is $4,867,000, and the estimated annual O&M cost is $549,000, utilizing the treatment system costs as determined in Section 5.4. The 10-year and 30-year present worth costs are $9,105,000 and $13,304,000, respectively. These costs are outlined in tables 6.9 through 6.12.

6.4.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 4 is anticipated because there are no current risks to human health or the environment from the groundwater, groundwater recovery will prevent offsite migration of the impacted groundwater, and groundwater treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.

6.4.9 Community Acceptance

Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.

6.5 Analysis of Alternatives

A comparative analysis of the remedial alternatives for groundwater is presented in this section to evaluate the relative performance of each alternative with regard to each of the nine evaluation criteria. By identifying the advantages and disadvantages of each alternative relative to one another, key tradeoffs can be determined.

This comparison of alternatives also includes the CERCLA criteria and the weightings to be given them as specified in the NCP (40 CFR Part 300.420 (f)). In the NCP, the CERCLA criteria are divided into three groups: threshold, primary balancing and modifying criteria.

Overall protection of human health and the environment and compliance with ARARs are the threshold requirements that each alternative must meet in order to be eligible for selection. The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility or volume; short-term effectiveness; implementability; and cost. State and community acceptance are the modifying criteria that shall be considered in remedy selection.

A summary of the detailed evaluation for Alternatives 1 through 4 is presented in table 6.13. Based on the evaluation, Alternatives 3 and 4 meet the evaluation criteria for the Hooker/Ruco site.

TABLE 6.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 2

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Institutional Actions											
– Deed/Title Search	1	LS	1,500.00	0.00	0.00	0.00	1,500	0	0	0	1,500
– Legal Fees including Land Use Restrictions	1	LS	25,000.00	0.00	0.00	0.00	25,000	0	0	0	25,000
Subtotal							26,500	0	0	0	26,500
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							26,500	0	0	0	26,500
Engineering Cost at 10% of Total Direct Cost											2,650
Project Administration Cost at 15% of Direct Labor Cost									0		0
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							2,650				2,650
Project Administration Cost at 15% of Engineering Cost											398
Total Field Cost							29,150	0	0	0	32,198
Contingency at 20% of Total Field Cost											6,440
Total Capital Cost											$39,000

OCCCOST/OCCCOST/CAP2REV.WK3

TABLE 6.2

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 2

Item	Qty	Unit/Yr	Unit Cost: Unitem.	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Annual Cost: Unitem.	Annual Cost: Material	Annual Cost: Labor	Annual Cost: Equip.	Total Annual Cost
Periodic Ground-Water Monitoring											
- Sampling	1	LS	0.00	300.00	5,000.00	200.00	0	300	5,000	200	5,500
- Laboratory Analysis	24	Each	1,000.00	0.00	0.00	0.00	24,000	0	0	0	24,000
- Reporting	75	Hour	0.00	0.00	50.00	0.00	0	0	3,750	0	3,750
Subtotal							24,000	300	8,750	200	33,250
Contractor's Overhead & Profit at 10% of Equipment Cost										20	20
Contractor's Overhead & Profit at 10% of Material Cost								30			30
Total Direct Cost							24,000	330	8,750	220	33,300
Project Administration Cost at 15% of Direct Labor Cost									1,313		1,313
Project Administration Cost at 5% of Direct Material Cost								17			17
Project Administration Cost at 10% of Direct Unitemized Cost							2,400				2,400
Total Field Cost							26,400	347	10,063	220	37,029
Total Annual O&M Cost											$37,000

OCCOST/OCCOST/OM2REV.WK3

TABLE 6.3

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 2

Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7	8	9
Capital Cost	38,638	0	0	0	0	0	0	0	0	0
O&M Costs	0	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Total Annual Cost	38,638	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	38,638	35,266	33,586	31,987	30,464	29,013	27,632	26,316	25,063	23,869

	10
Capital Cost	0
O&M Costs	37,029
Total Annual Cost	37,029
Discount Factor	0.61391
Present Worth	22,733

Total Present Worth ($'s)	$325,000

OCCCOST\OCCCOST\10PW2REV.WK3

TABLE 6.4

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	38,638	0	0	0	0	0	0	0	0	0
O&M Costs	0	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Total Annual Cost	38,638	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	38,638	35,266	33,586	31,987	30,464	29,013	27,632	26,316	25,063	23,869

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Total Annual Cost	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	22,733	21,650	20,619	19,637	18,702	17,812	16,963	16,156	15,386	14,654

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Total Annual Cost	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029	37,029
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	13,956	13,291	12,658	12,056	11,482	10,935	10,414	9,918	9,446	8,996

	30
Capital Cost	0
O&M Costs	37,029
Total Annual Cost	37,029
Discount Factor	0.23138
Present Worth	8,568

Total Present Worth ($'s)	$608,000

OCCCOST\OCCCOST\30PW2REV.WK3

TABLE 6.5

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Institutional Actions											
– Deed/Title Search	1	LS	1,500.00	0.00	0.00	0.00	1,500	0	0	0	1,500
– Legal Fees including Land Use Restrictions	1	LS	25,000.00	0.00	0.00	0.00	25,000	0	0	0	25,000
Treatment System											
Capital Cost:	1	Each	3,064,794	0.00	0.00	0.00	3,064,794	0	0	0	3,064,794
Mobilization/Demobilization	1	Each	0.00	0.00	7,000.00	9,000.00	0	0	7,000	9,000	16,000
Recovery Well Installation											
– Drilling	1	LS	60,000.00	0.00	0.00	0.00	60,000	0	0	0	60,000
– Supervision	1	LS	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000
– Submersible Pump, 4 ", 3 hp	3	Each	0.00	800.00	250.00	0.00	0	2,400	750	0	3,150
– Pump Controls	3	Each	0.00	500.00	200.00	100.00	0	1,500	600	300	2,400
– Misc. Fittings	1	Each	0.00	1,000.00	2,000.00	0.00	0	1,000	2,000	0	3,000
– Magnetic Starter	3	Each	0.00	120.00	30.00	0.00	0	360	90	0	450
Piping System											
– Riser Pipe, 2" Galvanized	450	LF	0.00	5.10	6.15	0.00	0	2,295	2,768	0	5,063
– Pipe, 2", Sch 40 PVC	540	LF	0.00	1.92	6.70	0.00	0	1,037	3,618	0	4,655
– Pipe, 3", Sch 40, PVC	360	LF	0.00	2.93	7.48	0.00	0	1,055	2,693	0	3,748
Earthwork											
– Trench Excavation	205	CY	0.00	0.00	2.28	1.34	0	0	467	275	742
– Trench Backfill (Sand)	80	CY	0.00	14.70	6.16	15.80	0	1,176	493	1,264	2,933
– Trench Backfill & Compaction (native)	120	CY	0.00	0.00	4.52	1.25	0	0	542	150	692
Asphalt Surface											
– Binder Course (3" Thick)	175	SY	0.00	3.95	0.36	0.33	0	691	63	58	812
– Wearing Course (3" Thick)	175	SY	0.00	4.33	0.40	0.37	0	758	70	65	893
– *Subbase (12" Thick)*	*175*	*SY*	*0.00*	*4.00*	*0.40*	*1.00*	*0*	*700*	*70*	*175*	*945*
Electrical Service											
– Conduit, 6", Sch 40, PVC	540	LF	0.00	6.85	10.10	0.00	0	3,699	5,454	0	9,153
– Wiring, #6	540	LF	0.00	26.00	33.00	0.00	0	14,040	17,820	0	31,860
Subtotal							3,166,294	30,711	44,498	11,286	3,252,789
Contractor's Overhead & Profit at 10% of Equipment Cost										1,129	1,129
Contractor's Overhead & Profit at 10% of Material Cost								3,071			3,071
Total Direct Cost							3,166,294	33,782	44,498	12,415	3,256,988
Engineering Cost at 10% of Total Direct Cost											325,699
Project Administration Cost at 15% of Direct Labor Cost									6,675		6,675
Project Administration Cost at 5% of Direct Material Cost								1,689			1,689
Project Administration Cost at 10% of Direct Unitemized Cost							316,629				316,629
Project Administration Cost at 15% of Engineering Cost											48,855
Total Field Cost							3,482,923	35,471	51,173	12,415	3,956,535
Contingency at 20% of Total Field Cost											791,307
Total Capital Cost											$4,748,000

OCCCOST/OCCCOST/CAP3REV.WK3

TABLE 6.6

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 3

Item	Qty	Unit/yr	Unit Cost Unitem.	Unit Cost Mater.	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Periodic Ground-Water Monitoring											
- *Sampling*	1	LS		300.00	5,000.00	200.00		300	5,000	200	5,500
- Laboratory Analysis	24	Each	1,000.00	0.00	0.00	0.00	24,000	0	0	0	24,000
- Reporting	75	Hour		0.00	50.00	0.00		0	3,750	0	3,750
Treatment System											
O&M Cost:	1	LS	449,243.00	0.00	0.00	0.00	449,243	0	0	0	449,243
Power Requirements											
- Submersible Pump (3 @ 3 hp)	58,792	kWh	0.09	0.00	0.00	0.00	5,291	0	0	0	5,291
Servicing of Pumps and Motors	100	Hour		6.25	40.00	0.00		625	4,000	0	4,625
Periodic Well Development	3	LS	2,000.00	0.00	0.00	0.00	6,000	0	0	0	6,000
Total Direct Cost							484,534	925	12,750	200	498,409
Project Administration Cost at 15% of Direct Labor Cost									1,913		1,913
Project Administration Cost at 5% of Direct Material Cost								46			46
Project Administration Cost at 10% of Direct Unitemized Cost							48,453				48,453
Total Field Cost							532,988	971	14,663	200	548,821
Total Annual O&M Cost											$549,000

OCCCOST/OCCCOST/OM3REV.WK3

TABLE 6.7

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 3

Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7	8	9
Capital Cost	4,747,842	0	0	0	0	0	0	0	0	0
O&M Costs	0	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	4,747,842	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	4,747,842	522,686	497,797	474,092	451,516	430,016	409,539	390,037	371,464	353,775

	10
Capital Cost	0
O&M Costs	548,821
Total Annual Cost	548,821
Discount Factor	0.61391
Present Worth	336,928

Total Present Worth ($'s)	$6,986,000

OCCCOST\OCCCOST\10PW3REV.WK3

TABLE 6.8

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 3

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	4,747,842	0	0	0	0	0	0	0	0	0
O&M Costs	0	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	4,747,842	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	4,747,842	522,686	497,797	474,092	451,516	430,016	409,539	390,037	371,464	353,775

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	336,928	320,884	305,604	291,051	277,192	263,992	251,421	239,449	228,046	217,187

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	206,845	196,995	187,614	178,680	170,172	162,068	154,351	147,001	140,001	133,334

	30
Capital Cost	0
O&M Costs	548,821
Total Annual Cost	548,821
Discount Factor	0.23138
Present Worth	126,985

Total Present Worth ($'s) $13,185,000

OCCCOST\OCCCOST\30PW3REV.WK3

TABLE 6.9

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 4

Item	Qty	Unit	Unit Cost				Total Cost				Total Direct Cost
			Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	
Institutional Actions											
- Deed/Title Search	1	LS	1,500.00	0.00	0.00	0.00	1,500	0	0	0	1,500
- Legal Fees including Land Use Restrictions	1	LS	25,000.00	0.00	0.00	0.00	25,000	0	0	0	25,000
Treatment System											
Capital Cost:	1	Each	3,064,794	0.00	0.00	0.00	3,064,794	0	0	0	3,064,794
Mobilization/Demobilization	1	Each	0.00	0.00	7,000.00	9,000.00	0	0	7,000	9,000	16,000
Recovery Well Installation											
- Drilling	1	LS	60,000.00	0.00	0.00	0.00	60,000	0	0	0	60,000
- Supervision	1	LS	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000
- Submersible Pump, 4 ", 3 hp	3	Each	0.00	800.00	250.00	0.00	0	2,400	750	0	3,150
- Pump Controls	3	Each	0.00	500.00	200.00	100.00	0	1,500	600	300	2,400
- Misc. Fittings	1	Each	0.00	1,000.00	2,000.00	0.00	0	1,000	2,000	0	3,000
- Magnetic Starter	3	Each	0.00	120.00	30.00	0.00	0	360	90	0	450
Piping System											
- Riser Pipe, 2" Galvanized	450	LF	0.00	5.10	6.15	0.00	0	2,295	2,768	0	5,063
- Pipe, 2", Sch 40, PVC	2655	LF	0.00	1.92	6.70	0.00	0	5,098	17,789	0	22,886
- Pipe, 3", Sch 40, PVC	80	LF	0.00	2.93	7.48	0.00	0	234	598	0	833
Leaching Gallery Pipe											
- Pipe, 3", Sch 40, PVC	225	LF	0.00	2.93	7.48	0.00	0	659	1,683	0	2,342
Earthwork											
- Trench Excavation	320	CY	0.00	0.00	2.28	1.34	0	0	730	429	1,158
- Trench Backfill (Sand)	160	CY	0.00	14.70	6.16	15.80	0	2,352	986	2,528	5,866
- Trench Backfill & Compaction (native)	180	CY	0.00	0.00	4.52	1.25	0	0	814	225	1,039
- Leaching Gallery Excavation	1045	CY	0.00	0.00	1.64	4.40	0	0	1,714	4,598	6,312
Asphalt Surface											
- Binder Course (3" Thick)	225	SY	0.00	3.95	0.36	0.33	0	889	81	74	1,044
- Wearing Course (3" Thick)	225	SY	0.00	4.33	0.40	0.37	0	974	90	83	1,148
- Subbase (12" Thick)	225	SY	0.00	4.00	0.40	1.00	0	900	90	225	1,215
Electrical Service											
- Conduit, 6", Sch 40, PVC	1200	LF	0.00	6.85	10.10	0.00	0	8,220	12,120	0	20,340
- Wiring, #6	1200	LF	0.00	26.00	33.00	0.00	0	31,200	39,600	0	70,800
Subtotal							3,166,294	58,081	89,501	17,462	3,331,339
Contractor's Overhead & Profit at 10% of Equipment Cost										1,746	1,746
Contractor's Overhead & Profit at 10% of Material Cost								5,808			5,808
Total Direct Cost							3,166,294	63,889	89,501	19,209	3,338,893
Engineering Cost at 10% of Total Direct Cost											333,889
Project Administration Cost at 15% of Direct Labor Cost									13,425		13,425
Project Administration Cost at 5% of Direct Material Cost								3,194			3,194
Project Administration Cost at 10% of Direct Unitemized Cost							316,629				316,629
Project Administration Cost at 15% of Engineering Cost											50,083
Total Field Cost							3,482,923	67,084	102,926	19,209	4,056,115
Contingency at 20% of Total Field Cost											811,223
Total Capital Cost											$4,867,000

OCCCOST/OCCCOST/CAP4REV.WK3

TABLE 6.10

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 4

Item	Qty	Unit/yr	Unit Cost Unitem.	Unit Cost Mater.	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Periodic Ground-Water Monitoring											
- Sampling	1	LS	0.00	300.00	5,000.00	200.00	0	300	5,000	200	5,500
- Laboratory Analysis	24	Each	1,000.00	0.00	0.00	0.00	24,000	0	0	0	24,000
- Reporting	75	Hour	0.00	0.00	50.00	0.00	0	0	3,750	0	3,750
Treatment System											
O&M Cost:	1	LS	449,243.00	0.00	0.00	0.00	449,243	0	0	0	449,243
Power Requirements											
- Submersible Pump (3 @ 3 hp)	58,792	kWh	0.09	0.00	0.00	0.00	5,291	0	0	0	5,291
Servicing of Pumps and Motors	100	*Hour*		6.25	40.00	0.00		625	4,000	0	4,625
Periodic Well Development	3	LS	2,000.00	0.00	0.00	0.00	6,000	0	0	0	6,000
Total Direct Cost							484,534	925	12,750	200	498,409
Project Administration Cost at 15% of Direct Labor Cost									1,913		1,913
Project Administration Cost at 5% of Direct Material Cost								46			46
Project Administration Cost at 10% of Direct Unitemized Cost							48,453				48,453
Total Field Cost							532,988	971	14,663	200	548,821
Total Annual O&M Cost											$549,000

OCCCOST/OCCCOST/OM4REV.WK3

TABLE 6.11

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 4

Discount Rate = 0.05

Cost Component	0	1	2	3	4	5	6	7	8	9
	Cost/Year Cost Occurs ($'s)									
Capital Cost	4,867,338	0	0	0	0	0	0	0	0	0
O&M Costs	*0*	*548,821*	*548,821*	*548,821*	*548,821*	*548,821*	*548,821*	*548,821*	*548,821*	*548,821*
Total Annual Cost	4,867,338	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	4,867,338	522,686	497,797	474,092	451,516	430,016	409,539	390,037	371,464	353,775

	10
Capital Cost	0
O&M Costs	548,821
Total Annual Cost	548,821
Discount Factor	0.61391
Present Worth	336,928

Total Present Worth ($'s)	$9,106,000

OCCCOST\OCCCOST\10PW4REV.WK3

TABLE 6.12

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 4

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	4,867,338	0	0	0	0	0	0	0	0	0
O&M Costs	0	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	4,867,338	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	4,867,338	522,686	497,797	474,092	451,516	430,016	409,539	390,037	371,464	353,775

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	336,928	320,884	305,604	291,051	277,192	263,992	251,421	239,449	228,046	217,187

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Total Annual Cost	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821	548,821
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	206,845	196,995	187,614	178,680	170,172	162,068	154,351	147,001	140,001	133,334

	30
Capital Cost	0
O&M Costs	548,821
Total Annual Cost	548,821
Discount Factor	0.23138
Present Worth	126,985

Total Present Worth ($'s)	$13,304,000

OCCCOST\OCCCOST\30PW4REV.WK3

TABLE 6.13

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Groundwater Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring	Alternative 3 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Settling Basin	Alternative 4 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Leaching Galleries
THRESHOLD CRITERIA				
- Overall Protection of Human Health and the Environment	Not protective of human health. The RA concluded that there are no risks to the environment.	Protective of human health. The RA concluded that there are no risks to the environment.	Protective of human health. The RA concluded that there are no risks to the environment.	Protective of human health. The RA concluded that there are no risks to the environment.
- Compliance with ARARs	Does not comply with ARARs.	Does not comply with ARARs.	Complies with cleanup ARARs and discharge ARARs for the identified compounds. Compliance with discharge ARARs for TICs to be determined in the remedial design.	Complies with cleanup ARARs and discharge ARARs for the identified compounds. Compliance with discharge ARARs for TICs to be determined in the remedial design.

TABLE 6.13
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Groundwater Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring	Alternative 3 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Settling Basin	Alternative 4 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Leaching Galleries
PRIMARY BALANCING CRITERIA				
- Long-term Effectiveness and Permanence	Not an effective or permanent solution.	Not an effective or permanent solution.	Groundwater extraction is an effective and permanent solution for removing impacted groundwater from the site.	Groundwater extraction is an effective and permanent solution for removing impacted groundwater from the site.
- Reduction of Toxicity, Mobility or Volume	Does not actively reduce toxicity, mobility or volume of compounds. The compounds in the groundwater will gradually disperse and be removed through dilution and degradation.	Does not actively reduce toxicity, mobility or volume of compounds. The compounds in the groundwater will gradually disperse and be removed through dilution and degradation.	Accelerated reduction in toxicity, mobility and volume is expected through actively pumping and treating the groundwater.	Accelerated reduction in toxicity, mobility and volume is expected through actively pumping and treating the groundwater.
- Short-Term Effectiveness	Not effective in reducing the short-term risks because there are no existing water-use controls and well construction restrictions to prevent use of groundwater.	No present or short-term risks because groundwater in the vicinity of the Hooker/Ruco site is not used for potable purposes. Groundwater use at the site would be prohibited through deed notations and well permitting.	No present or short-term risks because groundwater in the vicinity of the Hooker/Ruco site is not used for potable purposes. Groundwater use at the site would be prohibited through deed notations and well permitting.	No present or short-term risks because groundwater in the vicinity of the Hooker/Ruco site is not used for potable purposes. Groundwater use at the site would be prohibited through deed notations and well permitting.

TABLE 6.13
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Groundwater Medium

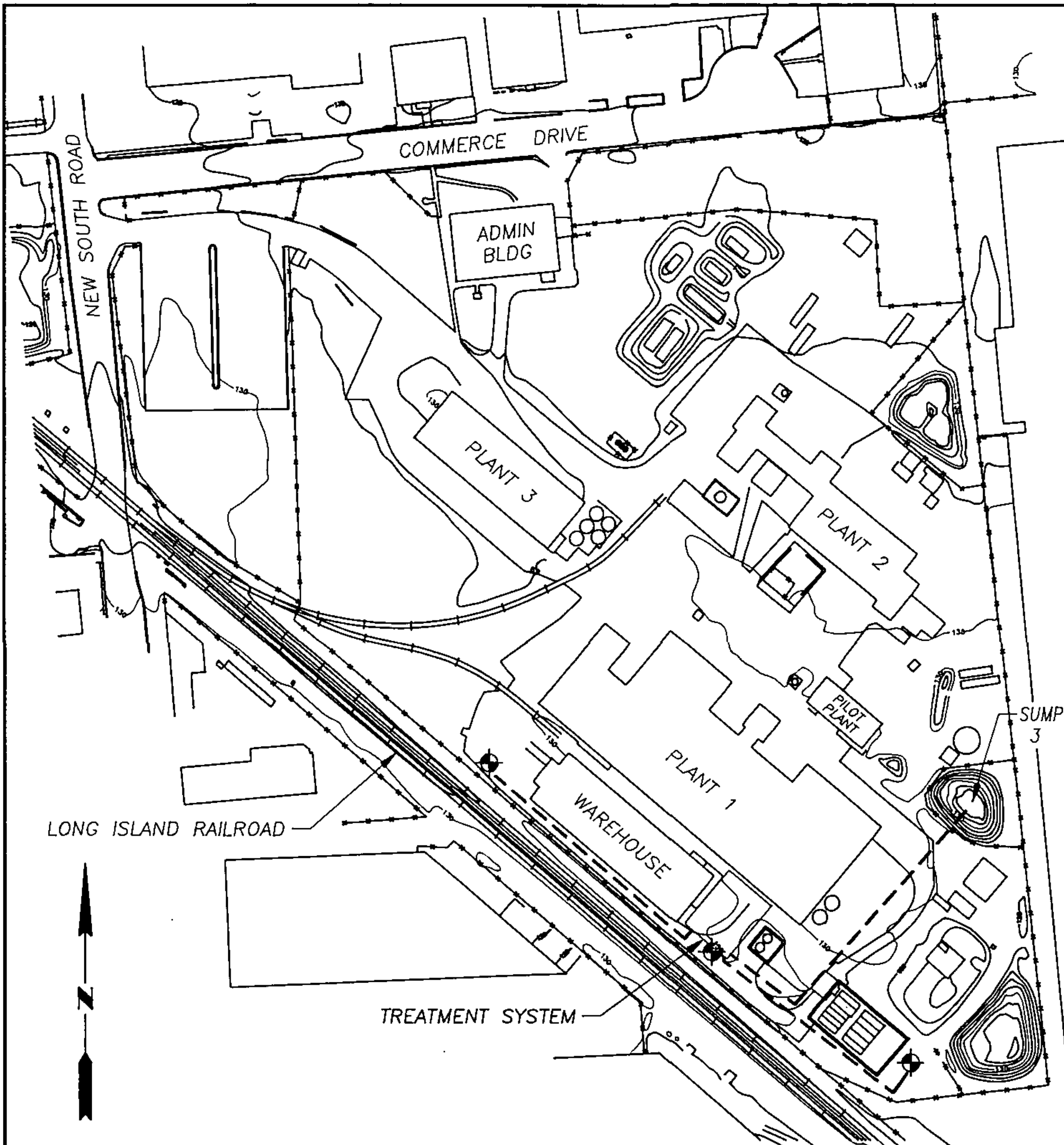
Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	- No Action	- Deed Notations - Well Permitting - Periodic Groundwater Monitoring	- Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Settling Basin	- Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Leaching Galleries
- Implementability	Technically feasible, but generally not administratively feasible. Materials and services are not required.	Technically and administratively feasible. Materials and services are readily available.	Technically and administratively feasible. Materials and services are readily available.	Technically and administratively feasible. Materials and services are readily available.
- Cost				
- Capital Costs	$0	$ 39,000	$ 4,748,000	$ 4,867,000
- Annual O&M Costs	$0	$ 37,000	$ 549,000	$ 549,000
- 10-Year Present Worth	$0	$ 325,000	$ 8,986,000	$ 9,105,000
- 30-Year Present Worth	$0	$ 608,000	$13,185,000	$13,304,000

TABLE 6.13
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Groundwater Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring	Alternative 3 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Settling Basin	Alternative 4 - Deed Notations - Well Permitting - Periodic Groundwater Monitoring - Three Recovery Wells - Groundwater Treatment - Discharge to Leaching Galleries
MODIFYING CRITERIA				
- State Acceptance	The no action alternative may be acceptable to support agencies because there are no current risks to human health or the environment from the groundwater.	Support agency acceptance of Alternative 2 is anticipated because there are no current risks to human health or the environment from the groundwater. However, the use of institutional controls does not satisfy the statutory preference for treatment that reduces toxicity, mobility or volume as a principal element.	Support agency acceptance of Alternative 3 is anticipated because there are no current risks to human health or the environment from the groundwater, groundwater recovery will prevent offsite migration of the impacted groundwater, and groundwater treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.	Support agency acceptance of Alternative 4 is anticipated because there are no current risks to human health or the environment from the groundwater, groundwater recovery will prevent offsite migration of the impacted groundwater, and groundwater treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.
- Community Acceptance	Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no current health or environmental risks and the public is not directly affected.



LEGEND

RECOVERY WELL

TREATMENT SYSTEM PIPING

0 150

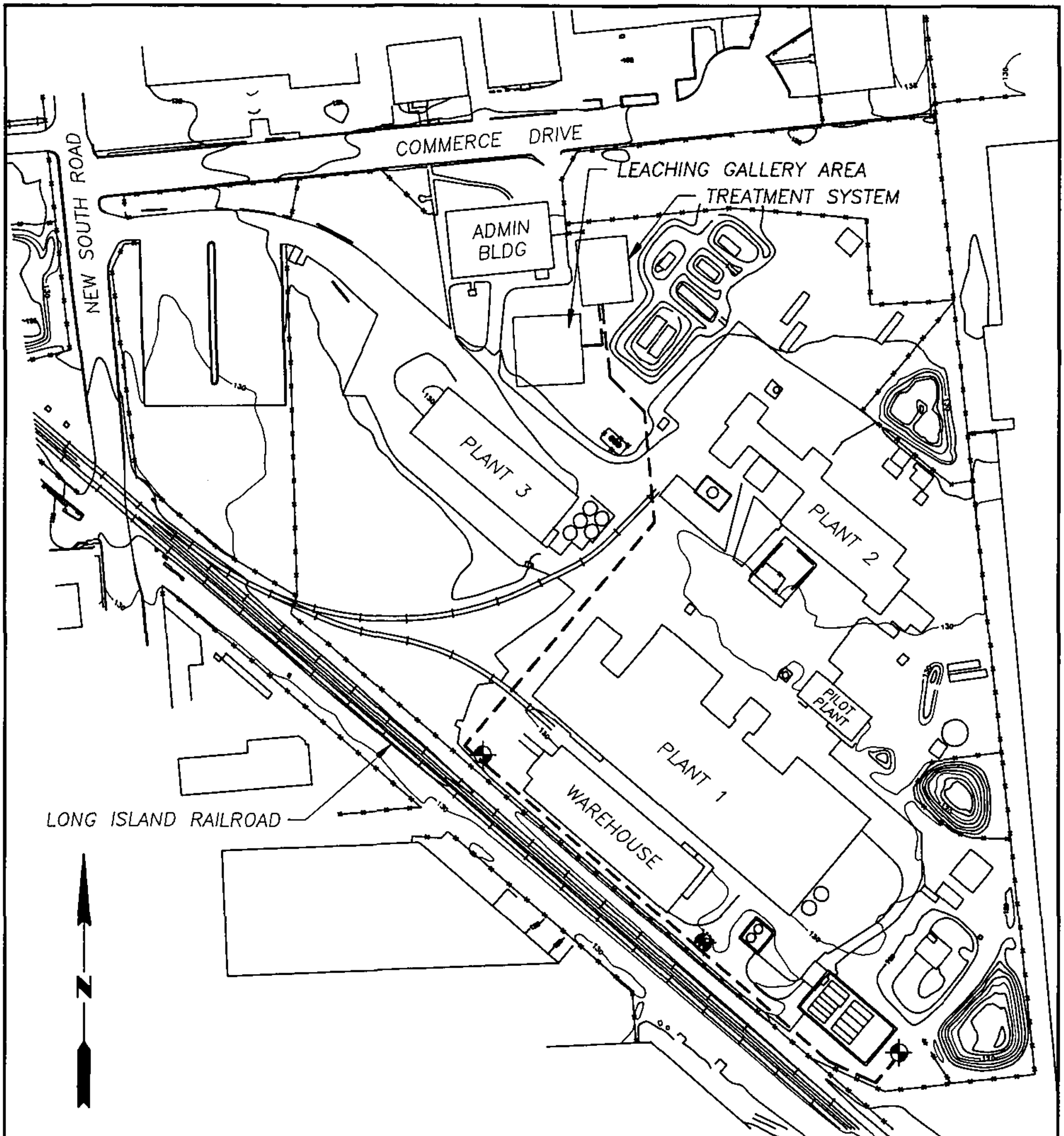
SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION HOOKER/RUCO SITE HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 3

DATE	REVISED	PREPARED BY:
		LBG ENGINEERING SERVICES, INC.
		Professional Environmental and Civil Engineers
		72 Danbury Road
		Wilton, CT 06897
		(203) 762-5502

DATE: 6/28/93 FIGURE: 6.1



LEGEND

RECOVERY WELL

TREATMENT SYSTEM PIPING

0 150

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 4

DATE	REVISED

PREPARED BY:

LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 3/9/93 | FIGURE: 6.2

7.0 Background to Soil Medium

The EPA and DEC have identified the deep soil beneath Sump 1 and Sump 2 and shallow soil in the vicinity of TB-10 in the former drum storage area as possibly requiring remedial measures to prevent mobilization of site related chemistry to the groundwater. The following sections summarize information about the Hooker/Ruco site that is pertinent to the screening of remedial alternatives for the soil. The information was developed during the RI/FS process.

7.1 Site Conditions Specific to Soil Medium

The general site conditions discussed in Section 2.1 for groundwater also apply to the potential soil remediation areas. The site conditions discussed herein pertain specifically to the potential soil remediation areas.

The soil areas identified for possible remediation include the deep soils beneath Sump 1 and possibly Sump 2, as well as the shallow soils near TB-10 in the former drum storage area. The vertical extent of deep soil to be addressed is approximately 15 to 55 ft bg. The volume of the deep soil to be addressed is 20,000 yd^3 beneath Sump 1 and 30,340 yd^3 beneath Sumps 1 and 2. The vertical extent of shallow soil to be addressed is approximately 0 to 10 ft bg, for a total of 445 yd^3. For the purpose of the FS, the identified areas are outlined on figure 7.1. The actual areal extent of the soil to be addressed for Sump 2 and the former drum storage area will be determined through remedial design sampling.

7.2 Remedial Investigation Summary Specific to Soil Medium

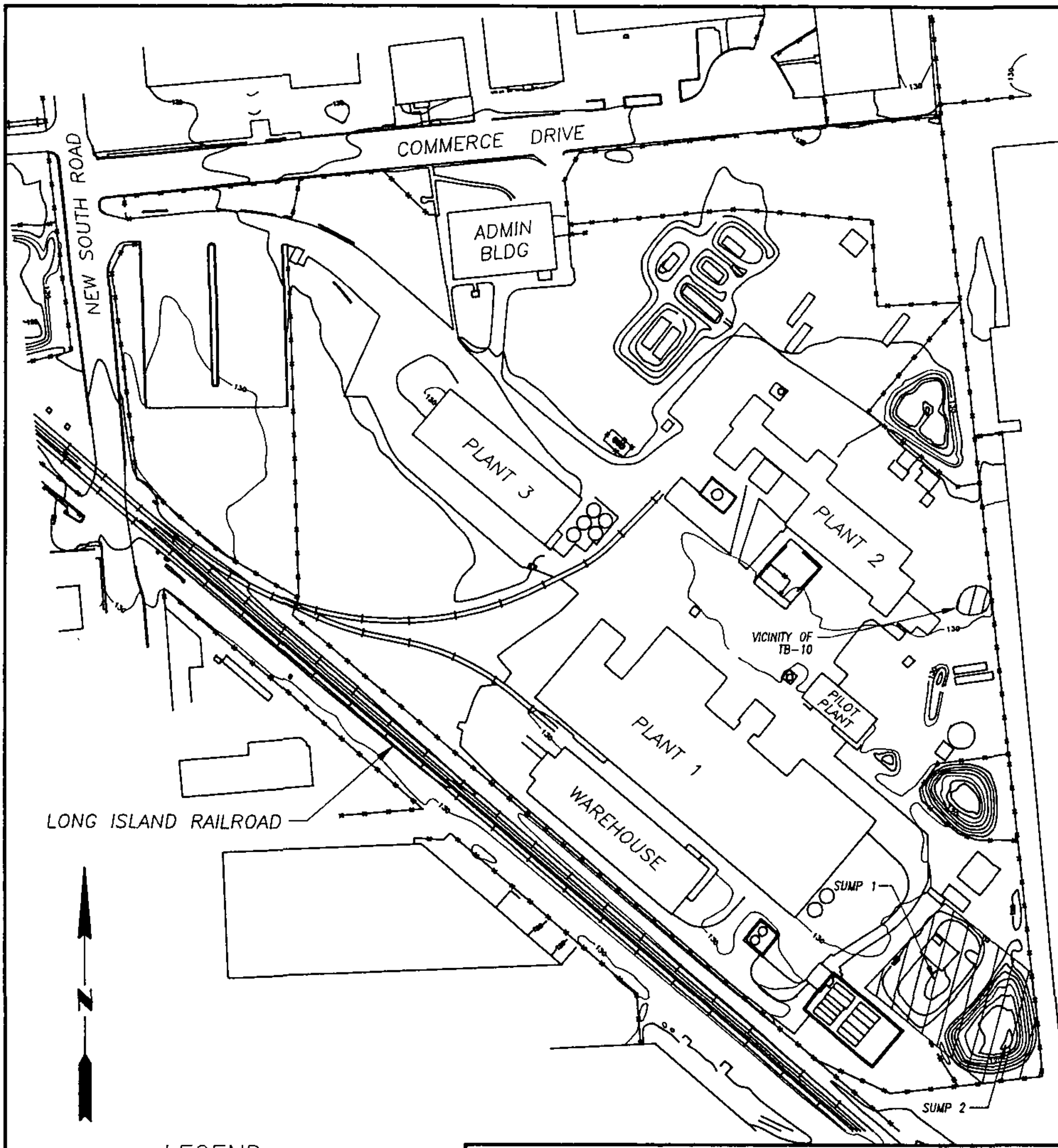
As part of the soils investigation, soil samples were collected during the RI and submitted for laboratory analysis of all TCL/target analyte list (TAL) parameters, 4,4 Methylene (bis) 2-chloroaniline (MOCA) and TIC's. Compounds were identified in the deep soils beneath Sump 1 and possibly Sump 2 and in the shallow soils near TB-10 in the former drum storage area at concentrations which could potentially constitute continuing sources to the groundwater.

7.2.1 Geology and Hydrogeology

The soil in the identified area consists of medium to coarse sand and fine to coarse gravel. The water table at the site fluctuates between 55 and 60 ft bg.

7.2.2 Chemical Compounds and Migration

The RI identified that the deep soil beneath Sump 1 contains PCE, TCE, 1,2-DCE, phenol, di-n-butylphthalate and TICs at levels which exceed New York State soil cleanup objectives to protect groundwater quality. TICs were detected in the shallow soils in the former drum storage area. However, there currently are no soil cleanup standards for the TICs.



OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

AREAL EXTENT OF SOILS TO BE ADDRESSED

DATE	REVISED	PREPARED BY:
		LBG ENGINEERING SERVICES, INC. Professional Environmental and Civil Engineers 72 Danbury Road Wilton, CT 06897 (203) 762-5502
		DATE: 6/28/93 FIGURE: 7.1

8.0 Remedial Action Objective - Soil Medium

The overall remedial action objective for the soil medium is the protection of groundwater quality. The effectiveness of the remedial alternatives will be weighed against this objective.

8.1 Risk Assessment - Soil Medium

The RA did not identify risks to human health or the environment associated with onsite soil. However, the deep soil beneath Sump 1 and possibly Sump 2 and the shallow soil in the former drum storage area near TB-10 have been identified by the EPA and DEC as areas which may require remedial measures for protection of groundwater quality. The presence of site related compounds in Sump 2 and the extent of TICs in the former drum storage area will be determined through the additional sampling of soils during the remedial design phase, which may or may not indicate the need for remedial action.

8.2 Applicable or Relevant and Appropriate Requirements

A review of federal and state regulations and guidance values showed that there are no ARARs for soil cleanup.

8.2.1 TBC Soil Cleanup Criteria to Protect Groundwater Quality

At the request of EPA, the DEC Technical and Administrative Guidance Memorandum (TAGM) values for determination of soil cleanup objectives and cleanup levels, as well as site background levels, were used as TBC criteria for soil cleanup to protect groundwater quality. TAGM values are not promulgated regulations and do not, therefore, have the force and effect of law in New York. As TBCs under the NCP they are not enforceable standards, but may be considered with other considerations in determining whether overall objectives have been met.

8.2.1.1 Specific TBC Soil Cleanup Criteria to Protect Groundwater Quality

The DEC TAGM values for determination of soil cleanup objectives and cleanup levels and site background levels are listed on table 8.1. There are no TBC soil cleanup criteria for TICs.

8.2.2 Action Specific ARARs for the Soil Medium

In order to implement the remedial alternatives at the Hooker/Ruco site, the Resource Conservation and Recovery Act (RCRA) disposal requirements will be met.

8.2.2.1 Land Disposal Restrictions

EPA regulations on Land Disposal Restrictions (LDRs) (40 CFR Part 268) may be applicable regulations for affected soil at the site. If the soils were determined to exhibit characteristics of hazardous waste, the land disposal restrictions would be applicable.

Any soils excavated or otherwise removed during the remedial process will require testing for waste classification parameters. Waste classification analysis would include analysis of the material for ignitability, reactivity, corrosivity and toxicity by the Toxicity Characteristic Leaching Procedure (TCLP) presented in 40 CFR Part 261, Appendix II. Based upon testing results, the waste would be either defined as non-hazardous or characteristically hazardous in accordance with 40 CFR Part 261.

A restricted waste, identified in 40 CFR Part 268.41, may only be land disposed if an extract of the waste or treatment residual does not exceed the values presented in 40 CFR Part 268.41. Hazardous waste that does not meet the RCRA requirements for land disposal would be treated to standards specified in 40 CFR Part 268.45 prior to land disposal.

8.2.2.2 RCRA Underground Storage Tank Regulations

The five waste-water treatment tanks (Ruco Tank Nos. 75 through 79) located in Sump 1 meet the regulatory definition of underground storage tanks (40 CFR Part 280). As such, the design, construction, installation, operation and closure of the tanks are regulated by RCRA. 40 CFR Part 280 - Technical Standards and Corrective Action

Requirements for Owners and Operators of Underground Storage Tanks (USTs) is, therefore, an ARAR.

Ruco, the current owners and operators of the waste-water tanks, have notified the Nassau County Department of Health (NCDOH) and the EPA of their intent to permanently close the tanks. Subpart G - Out of Service UST Systems and Closure defines the steps required to properly close the regulated tanks. 40 CFR Part 280.71 - Permanent Closure, Part 280.72 - Assessing the Site at Closure and Part 280.74 - Closure Records are applicable requirements.

In accordance with 40 CFR Part 280.71, OCC is advised that Ruco will provide at least 30 days notice to the Federal, State and Nassau County agencies of their intent to permanently close the tanks. To permanently close the tanks, Ruco will:

a) empty and clean all accumulated liquid and sludge from the tanks;

b) remove all associated piping; and

c) remove the tanks from the ground or fill the tanks with an inert solid material.

The EPA has determined that the waste-water tanks will have to be removed from the ground in order to execute the remediation of soils in Sump 1. Disposal of the liquid/sludge waste, piping and tank debris will be based upon waste characteristics and all applicable land disposal restriction regulations.

In accordance with 40 CFR Part 280.72, Ruco will be required to complete a site assessment during the tank closure activities. Information from the Final RI report, which investigated Sump 1, will be used to complete the site assessment. Deep soils (greater than 15 feet below grade) in Sump 1, which are directly below the wastewater tanks, and plantsite groundwater quality are being addressed in the Final FS report. Additional field sampling for soil and groundwater cleanup (40 CFR Part 280.65) and corrective action plans (40 CFR Part 280.66) will not be completed. However, any remedial alternative developed to address deep soils within Sump 1 will satisfy the substantive requirements of the RCRA UST corrective action plan.

Ruco advises that it will retain all closure records in accordance with 40 CFR Part 280.34. OCC is further advised that the results of the closure assessment will be maintained by Ruco for a minimum of 3 years.

TABLE 8.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Specific TBC Soil Cleanup Criteria to Protect Groundwater Quality[1/]

Compound	Solubility S (mg/l)	Partition Coefficient K_{OC} (ml/g)	Groundwater Standards Criteria C_W (ug/l)	Allowable Soil Conc.[2/] C_S (ppm)	Soil Cleanup Objectives to Protect Ground-Water Quality[3/] (ppm)	Recommended Soil Cleanup Objective (ppm)	Background[4/5/6/] (ppm)	TBC Soil Cleanup Criteria to Protect Groundwater Quality (ppm)
Organics								
1,2-Dichloroethene (trans)	6,300	59	5	0.003	0.3	0.3	NA	0.3
Di-n-butylphthalate	400	162	50	0.081	8.1	8.1	NA	8.1
Phenol	82,000	27	1	0.0003	0.03	0.03 or MDL	NA	0.03 or MDL
Tetrachloroethene	150	277	5	0.014	1.4	1.4	NA	1.4
Trichloroethene	1,100	126	5	0.007	0.7	0.7	NA	0.7
Inorganics								
Cadmium					NA	1 or SB	0.01 - 2	2
Zinc					NA	20 or SB	<1.7 - 110	110

1/ NYSDEC TAGM 4046, "Determination of Soil Cleanup Objectives and Cleanup Levels," 1992.
2/ Allowable soil concentration $C_S = f * C_W * K_{OC}$ (f=0.01).
3/ Soil Cleanup Objective = C_S * 100 (correction factor).
4/ McGovern, E., "Background Concentrations of 20 Elements in Soil with Special Regard for New York State".
5/ Geraghty & Miller, Inc. "Data Report, Phase I Remedial Investigation, Grumman Aerospace Corporation, Bethpage, New York (1992)"; Inorganic Soil Concentrations from GMS-1S, GMS-1I, GMS-2I and GMS-3I.
6/ Inorganic soil concentrations from baseline borings Pilot Hole G, Pilot Hole S and Well Q-1 installed during the 1989 RI.
NA Not applicable.
MDL Method Detection Limit.
SB Site background.

9.0 Development of Remedial Action Alternatives - Deep Soil Medium

Alternatives for remedial action were developed by assembling combinations of technologies into alternatives that address the remedial objective for the soil medium. The six-step process described in Section 4.0 for the groundwater was also used for this medium. A flow chart of the alternatives development process for the deep soil medium is shown on plate 2. Descriptions of the process options, the preliminary screening and the secondary screening are included in Appendix C.

9.1 General Response Actions

The following general response actions were considered for the soil medium:

- no action;
- institutional actions;
- onsite soil remediation;
- in-situ soil remediation; and
- offsite soil disposal.

The no action general response action, as described in Section 4.1, must be considered throughout the FS process. Institutional actions aid in reducing exposure risks but do not actively reduce compound concentrations. Onsite soil remediation involves excavating and treating the soil, and backfilling the treated soil onsite. In-situ remediation involves treating the soil in place so that no excavation or disposal of soil is required. Offsite disposal involves excavating the soil for disposal at an acceptable facility.

9.2 Technology Types

As described in Section 4.2, technology types were identified for each general response action. The institutional actions considered for the deep soil include access restrictions and monitoring. The onsite remediation technologies consisted of biological treatment, soil stabilization/solidification and chemical extraction. The in-situ remediation technologies considered were bioremediation, containment/encapsulation, gas-phase separation, soil flushing and stabilization/solidification. The offsite disposal technology considered was a landfill.

9.3 Process Options

For each technology type, a number of specific process options were identified. These process options, as well as their descriptions, are listed in Appendix C.

9.4 Preliminary Screening

During the preliminary screening, the remedial technologies for the deep soil were screened on the basis of technical implementability. The identified process options which were capable of meeting the remedial objective, in part or in whole, were retained and are described in Appendix C.

9.5 Secondary Screening

The process options retained in the preliminary screening then underwent a secondary screening based on the general criteria of effectiveness, implementability and cost as described in Sections 4.5.1 through 4.5.3. The secondary screening is described in Appendix C.

9.6 Assembly of Alternatives

The remedial alternatives for the deep soil medium retained after the secondary screening are as follows:

- No action;
- Capping;
- Capping and soil vapor extraction; and
- In-situ soil flushing.

10.0 Remedial Alternatives Evaluation - Deep Soil Medium

The alternatives for the deep soil medium were subjected to a detailed evaluation to determine how the alternatives meet the evaluation criteria and to enable the alternatives to be compared with one another. The evaluation process has been described in Section 6.0.

10.1 Remedial Alternative 1 - No Action

The no action alternative requires no changes to be made to the existing conditions at the site. This alternative serves as a baseline situation to compare the other alternatives.

10.1.1 Overall Protection of Human Health and the Environment

There have been no health or environmental risks associated with direct exposure/contact with the deep soil.

10.1.2 Compliance with ARARs

There are no ARARs for soil cleanup.

10.1.3 Long-term Effectiveness and Permanence

Precipitation would continue to infiltrate the unsaturated soil acting as a natural flushing mechanism and reducing soil compound concentrations. Compounds would be transferred from the soil medium to the groundwater where they would be captured and treated by the groundwater recovery and treatment system. Long-term compound concentrations could be compared to the TBC criteria.

10.1.4 Reduction of Toxicity, Mobility or Volume

The natural flushing that will occur with the no action alternative will reduce the toxicity and volume of impacted soil. Compound mobility is controlled with the use of groundwater recovery.

10.1.5 Short-term Effectiveness

There are no implementation risks involved with the no action alternative.

10.1.6 Implementability

The no action alternative is easily implementable and requires no modifications to the site.

10.1.7 Cost

There are no capital or O&M costs associated with this alternative.

10.1.8 State (Support Agency) Acceptance

The no action alternative may be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the deep soil.

10.1.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

10.2 Remedial Alternative 2 - Capping

Alternative 2 involves installing a cap over the potential deep soil remediation areas in accordance with RCRA performance specifications. The cap will occupy an area of approximately 13,500 ft^2 for Sump 1, as shown on figure 10.1. If remediation is required for Sump 2, the cap will occupy a total area of approximately 20,500 ft^2, as shown on figure 10.2. A cross-section of the cap is shown on figure 10.3.

The cap will consist of the following layers above the underlying soil: a geosynthetic clay liner (comprised of geotextile outer layers with an inner layer of low permeability sodium bentonite) with a permeability of 10^{-9} cm/s, a 60-mil high-density polyethylene (HDPE) geomembrane liner, 6 inches of gravel acting as a drainage layer, a 20-mil filter fabric, 12 inches of gravel subbase and 6 inches of asphalt. All fill material will be placed and compacted in 6-inch lifts. The asphalt surface of the cap will be sloped to direct surface-water runoff northerly. Catch basins will be installed as needed, with piping to be tied into the existing site drainage which discharges to Sump 3. The O&M requirements will consist of semiannual site inspections of the cap and cap repair.

10.2.1 Overall Protection of Human Health and the Environment

The RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil.

10.2.2 Compliance with ARARs

There are no ARARs for soil cleanup.

10.2.3 Long-term Effectiveness and Permanence

A cap designed under RCRA performance specifications is capable of protecting the groundwater quality from vertical migration of compounds detected in the deep soil. There is an inherent weakness in the capping of deep soils because of the fluctuating level of the water table and the potential for lateral infiltration of precipitation. The water table fluctuates about 5 feet per year, potentially effecting about 12 percent of the deep soils. Lateral migration of infiltrating precipitation is unlikely because of the very coarse and permeable nature of the unsaturated Upper Glacial deposits. However, capping will be largely protective of groundwater quality. There will be no significant reductions in compound concentrations when compared to the TBC criteria.

10.2.4 Reduction of Toxicity, Mobility or Volume

Capping does not reduce the concentration of compounds in the soil, but does reduce their mobility.

10.2.5 Short-term Effectiveness

Contact or exposure with the deep soil will not occur during implementation of Alternative 2. In addition, the RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil. Therefore, there are no implementation risks involved with this alternative.

10.2.6 Implementability

A cap requires moderate design effort, approximately two months of field operations and moderate effort in reporting and documentation. Considerable attention must be paid to the proper compaction of the fill materials and installation of the geocomposite clay liner and the geomembrane liner. Periodic inspection will be required to insure the integrity of the cap over time.

10.2.7 Cost

Assuming the deep soils of Sump 2 contain no compounds above levels that are protective of groundwater quality, the capital cost for Alternative 2 is $213,000, and the annual O&M cost is $5,000. The 10-year and 30-year present worth costs are $251,000 and $289,000, respectively. The cost calculations are outlined on tables 10.1 through 10.4.

Assuming the deep soils of Sump 2 contain compounds above levels that are protective of groundwater quality, the capital cost for Alternative 2 is $345,000, and the annual O&M cost is $7,000. The 10-year and 30-year present worth costs are $396,000 and $446,000, respectively. The cost calculations are outlined on tables 10.5 through 10.8.

10.2.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 2 is anticipated because there are no risks to human health or the environment from direct contact/exposure with the deep soil and capping will meet the remedial action objective of protection of groundwater quality.

10.2.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

10.3 Remedial Alternative 3 - Capping and Soil Vapor Extraction

Alternative 3 is the same as described for capping in Alternative 2 with the addition of soil vapor extraction (SVE). Soil vapor could be extracted from two extraction wells in the Sump 1 area and treated prior to discharge to the atmosphere. If remediation is required for Sump 2, the total number of soil vapor extraction wells will be 5. Air inlet wells will be installed at the cap perimeter to enhance vapor removal. The layouts for these alternatives are shown on figure 10.4 for Sump 1 and figure 10.5 for Sumps 1 and 2.

The SVE and air inlet wells will be drilled to a depth of about 50 ft bg. The wells will be 4 inches in diameter and will be screened from about 20 ft bg to the bottom. The SVE piping will be installed beneath the geosynthetic clay liner of the cap. The SVE wells will be joined together by a common header pipe located at the treatment shed, which will be connected to a vapor-water separator (demister) where moisture will be removed from the air stream. The demister will be connected to the suction side of a positive displacement blower, which provides a negative vapor pressure gradient to the subsurface soil. For the purpose of this FS, it was assumed that discharge from the blower will undergo treatment using vapor-phase carbon prior to being vented to the atmosphere. Below-grade power will be run from the nearest source to the treatment system. The cap will act as a seal which will prevent air from entering near the extraction wells (where the pressure gradient is greatest) and will enable a radial horizontal flow. A radial flow forces air to be drawn over a greater distance, thereby contacting a greater volume of soil. Actual system parameters will be determined in the remedial design.

The required O&M, in addition to the O&M required for the cap, will include electric power, replacement of spent carbon, system maintenance and repairs and monthly influent and effluent sampling of the treatment system.

10.3.1 Overall Protection of Human Health and the Environment

The RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil.

10.3.2 Compliance with ARARs

There are no ARARs for soil cleanup.

10.3.3 Long-term Effectiveness and Permanence

A cap designed under RCRA performance specifications is capable of protecting the groundwater quality from vertical migration of compounds detected in the deep soil. Soil vapor extraction will aid in soil compound reduction. The effectiveness of SVE is highly dependent upon the compound volatility (Henry's constant greater than 0.001 atm-m^3/mol (atmosphere cubic meter per mole)). Based on Henry's constants for the specific compounds, SVE will be effective for PCE, TCE and 1,2-DCE but will not be effective for phenol, di-n-butyl phthalate and TICs. Reduction in compound concentrations would be compared to the TBC criteria.

10.3.4 Reduction of Toxicity, Mobility or Volume

Capping does not reduce the concentration of compounds in the soil, but does reduce their mobility. SVE will reduce the concentration of VOCs in the unsaturated sediments and the soils near the water table and the capillary fringe.

10.3.5 Short-term Effectiveness

Minimal contact or exposure with the deep soil may occur during drilling of the SVE and air inlet wells. However, the RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil. Therefore, there are no implementation risks involved with Alternative 3.

10.3.6 Implementability

SVE is a proven technology for soil impacted by VOCs. Equipment is readily available and the process is easily implemented. An air discharge permit will not be required for operation of the SVE system because the remedial action will be conducted entirely onsite (EPA, 1989a). However, the SVE system must comply with the substantive requirements of the ARARs for air emission discharge criteria discussed in Section 3.2.3.

10.3.7 Cost

Assuming the deep soils of Sump 2 contain no compounds above levels that are protective of groundwater quality, the capital cost for Alternative 3 is $332,000, and the annual O&M cost is $48,000. The 10-year and 30-year present worth costs are $703,000 and $1,070,000, respectively. The cost calculations are outlined on tables 10.9 through 10.12.

Assuming the deep soils of Sump 2 contain compounds above levels that are protective of groundwater quality, the capital cost for Alternative 3 is $515,000, and the annual O&M cost is $56,000. The 10-year and 30-year present worth costs are $948,000 and $1,378,000, respectively. The cost calculations are outlined on tables 10.13 through 10.16.

10.3.8 State (Support Agency) Acceptance

Alternative 3 should be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the deep soil, capping will meet the remedial action objective of protection of groundwater quality and SVE satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.

10.3.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

10.4 Remedial Alternative 4 - In-situ Soil Flushing

Remedial Alternative 4 is only considered in conjunction with groundwater extraction and treatment. Treated effluent from the groundwater recovery and treatment system will be used to implement in-situ soil flushing. The treated groundwater will be discharged to either Sump 3 or leaching galleries, with a portion of the treated groundwater being diverted to Sump 1, and possibly Sump 2. The diverted water will be distributed over the sump areas through piping networks. The layouts for these alternatives are shown on figure 10.6 for Sump 1 and figure 10.7 for Sumps 1 and 2.

The groundwater model used to evaluate pumping strategies was also used to evaluate flushing scenarios for Sumps 1 and 2. Based on the model results, each sump is capable of receiving 5 gpm without causing an adverse effect on the capture zone of the recovery wells. The development and justification of the discharge rates are included in Appendix B. The required O&M consists of water distribution pipe and sump maintenance and repair.

10.4.1 Overall Protection of Human Health and the Environment

The RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil.

10.4.2 Compliance with ARARs

There are no ARARs for soil cleanup.

10.4.3 Long-term Effectiveness and Permanence

The groundwater treatment system discharge will infiltrate the unsaturated soil acting as a flushing mechanism and reducing soil compound concentrations. The compounds would be transferred from the soil medium to the groundwater. However, because Alternative 4 will be used in conjunction with the groundwater recovery and treatment system, the compounds would be contained and treated. Therefore, Alternative 4 would be effective in the long term when used with the groundwater and recovery and treatment system. Reduction in compound concentrations would be compared to the TBC criteria.

10.4.4 Reduction of Toxicity, Mobility or Volume

The induced flushing that will occur with Alternative 4 will reduce the toxicity and volume of impacted soil. Compound mobility is controlled with the use of groundwater recovery.

10.4.5 Short-term Effectiveness

Contact or exposure with the deep soil will not occur during implementation of Alternative 4. In addition, the RA concluded that there are no risks to human health or the environment from direct contact/exposure with the deep soil. Therefore, there are no implementation risks involved with this alternative.

10.4.6 Implementability

In-situ soil flushing is easily implementable using the groundwater treatment system discharge. The required materials are readily available, and this alternative is technically and administratively feasible.

10.4.7 Cost

Assuming the deep soils of Sump 2 contain no compounds above levels that are protective of groundwater quality, the capital cost for Alternative 4 is $16,000, and the annual O&M cost is $1,000. The 10-year and 30-year present worth costs are $26,000 and $37,000, respectively. The cost calculations are outlined on tables 10.17 through 10.20.

Assuming the deep soils of Sump 2 contain compounds above levels that are protective of groundwater quality,the capital cost for Alternative 4 is $25,000, and the annual O&M cost is $3,000. The 10-year and 30-year present worth costs are $45,000 and $65,000, respectively. The cost calculations are outlined on tables 10.21 through 10.24.

10.4.8 State (Support Agency) Acceptance

Alternative 4 will be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the deep soil and in-situ flushing combined with groundwater recovery and treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.

10.4.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

10.5 Analysis of Alternatives

A comparative analysis of the alternatives was conducted to evaluate the relative performance of each alternative with regard to each of the evaluation criteria. By identifying the advantages and disadvantages of each alternative relative to one another, key tradeoffs can be determined. This analysis procedure was described in Section 6.5.

A summary of the detailed evaluation for Alternatives 1 through 4 is presented in table 10.25. Based on the evaluation, Alternative 3 meets the evaluation criteria for the Hooker/Ruco site. Alternatives 1 and 4 meet the evaluation criteria when used in conjunction with groundwater recovery and treatment.

TABLE 10.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 2 - Sump 1

Item	Qty	Unit	Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	Direct Cost
Site Preparation											
~ Sump Fill											
& Compaction (Sand)	400	CY	0.00	14.70	6.16	15.80	0	5,880	2,464	6,320	14,664
~ Sump Fill Grading	1500	SY	0.00	0.00	0.17	0.28	0	0	255	420	675
~ Compaction	24	Hour	0.00	0.00	40.20	18.42	0	0	965	442	1,407
~ Mobilization/Demobilization	1	LS	0.00	0.00	3,200.00	5,130.00	0	0	3,200	5,130	8,330
Cap Construction											
~ Geosynthetic Clay Liner	13500	SF	0.00	0.58	0.12	0.24	0	7,830	1,620	3,240	12,690
~ Drainage Layer	325	CY	0.00	11.82	2.71	7.20	0	3,842	881	2,340	7,062
~ Filter Fabric	13500	SF	0.00	0.38	0.31	0.18	0	5,130	4,185	2,430	11,745
~ Geomembrane, 60 mil HDPE	13500	SF	0.00	0.36	0.48	0.42	0	4,860	6,480	5,670	17,010
Pavement											
~ Binder Course, 3" Thick	1500	SY	0.00	4.74	0.43	0.46	0	7,110	645	690	8,445
~ Wearing Course, 3" Thick	1500	SY	0.00	5.2	0.48	0.44	0	7,800	720	660	9,180
~ Subbase, 12" Thick	1500	SY	0.00	3.84	0.24	0.54	0	5,760	360	810	6,930
Drainage Controls	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000
Construction/Safety Supervision	8	Week	750.00	125.00	2,800.00	500.00	6,000	1,000	22,400	4,000	33,400
Subtotal							16,000	49,212	44,175	32,152	141,538
Contractor's Overhead & Profit at 10% of Equipment Cost										3,215	3,215
Contractor's Overhead & Profit at 10% of Material Cost								4,921			4,921
Total Direct Cost							16,000	54,133	44,175	35,367	149,674
Engineering Cost at 10% of Total Direct Cost											14,967
Project Administration Cost at 15% of Direct Labor Cost									6,626		6,626
Project Administration Cost at 5% of Direct Material Cost								2,707			2,707
Project Administration Cost at 10% of Direct Unitemized Cost							1,600				1,600
Project Administration Cost at 15% of Engineering Cost											2,245
Total Field Cost							17,600	56,839	50,801	35,367	177,820
Contingency at 20% of Total Field Cost											35,564
Total Capital Cost											$213,000

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TABLE 10.2

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 2 - Sump 1

Item	Qty	Unit/Yr	Unit Cost: Unitem.	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Annual Cost: Unitem.	Annual Cost: Material	Annual Cost: Labor	Annual Cost: Equip.	Total Annual Cost
Monitoring											
– Inspection	8	Hour	0.00	0.00	50.00	0.00	0	0	400	0	400
– Reporting	20	Hour	0.00	0.00	50.00	0.00	0	0	1,000	0	1,000
– Cap Repair	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000
Subtotal							3,000	0	1,400	0	4,400
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							3,000	0	1,400	0	4,400
Project Administration Cost at 15% of Direct Labor Cost									210		210
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							300				300
Total Field Cost							3,300	0	1,610	0	4,910
Total Annual O&M Cost											$5,000

OCCOST/OCCOST/OMCAP1.WK3

TABLE 10.3

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 2 - Sump 1

Discount Rate = 0.05

	Cost/Year Cost Occurs ($'s)									
Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	213,384	0	0	0	0	0	0	0	0	0
O&M Costs	0	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Total Annual Cost	213,384	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	213,384	4,676	4,454	4,241	4,039	3,847	3,664	3,489	3,323	3,165

	10
Capital Cost	0
O&M Costs	4,910
Total Annual Cost	4,910
Discount Factor	0.61391
Present Worth	3,014

Total Present Worth ($'s)	$251,000

OCCCOST\OCCCOST\10PWCAP1.WK3

TABLE 10.4

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 2 - Sump 1

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	213,384	0	0	0	0	0	0	0	0	0
O&M Costs	0	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Total Annual Cost	213,384	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	213,384	4,676	4,454	4,241	4,039	3,847	3,664	3,489	3,323	3,165

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Total Annual Cost	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	3,014	2,871	2,734	2,604	2,480	2,362	2,249	2,142	2,040	1,943

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Total Annual Cost	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910	4,910
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	1,851	1,762	1,678	1,599	1,522	1,450	1,381	1,315	1,253	1,193

	30
Capital Cost	0
O&M Costs	4,910
Total Annual Cost	4,910
Discount Factor	0.23138
Present Worth	1,136

Total Present Worth ($'s)	$289,000

OCCCOST\OCCCOST\30PWCAP1.WK3

TABLE 10.5

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 2 - Sumps 1 and 2

Item	Qty	Unit	Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	Direct Cost
Site Preparation											
~ Sump Fill											
& Compaction (Sand)	1700	CY	0.00	14.70	6.16	15.80	0	24,990	10,472	26,860	62,322
~ Sump Fill Grading	2276	SY	0.00	0.00	0.17	0.28	0	0	387	637	1,024
~ Compaction	48	Hour	0.00	0.00	40.20	18.42	0	0	1,930	884	2,814
~ Mobilization/Demobilization	1	LS	0.00	0.00	3,200.00	5,130.00	0	0	3,200	5,130	8,330
Cap Construction											
~ Geosynthetic Clay Liner	20480	SF	0.00	0.58	0.12	0.24	0	11,878	2,458	4,915	19,251
~ Drainage Layer	493	CY	0.00	11.82	2.71	7.20	0	5,827	1,336	3,550	10,713
~ Filter Fabric	20480	SF	0.00	0.38	0.31	0.18	0	7,782	6,349	3,686	17,818
~ Geomembrane, 60 mil HDPE	20480	SF	0.00	0.36	0.48	0.42	0	7,373	9,830	8,602	25,805
Pavement											
~ Binder Course, 3" Thick	2276	SY	0.00	4.74	0.43	0.46	0	10,788	979	1,047	12,814
~ Wearing Course, 3" Thick	2276	SY	0.00	5.2	0.48	0.44	0	11,835	1,092	1,001	13,929
~ Subbase, 12" Thick	2276	SY	0.00	3.84	0.24	0.54	0	8,740	546	1,229	10,515
Drainage Controls	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000
Construction/Safety Supervision	8	Week	750.00	125.00	2,800.00	500.00	6,000	1,000	22,400	4,000	33,400
Subtotal							16,000	90,214	60,979	61,542	228,735
Contractor's Overhead & Profit at 10% of Equipment Cost										6,154	6,154
Contractor's Overhead & Profit at 10% of Material Cost								9,021			9,021
Total Direct Cost							16,000	99,236	60,979	67,696	243,910
Engineering Cost at 10% of Total Direct Cost											24,391
Project Administration Cost at 15% of Direct Labor Cost									9,147		9,147
Project Administration Cost at 5% of Direct Material Cost								4,962			4,962
Project Administration Cost at 10% of Direct Unitemized Cost							1,600				1,600
Project Administration Cost at 15% of Engineering Cost											3,659
Total Field Cost							17,600	104,197	70,126	67,696	287,668
Contingency at 20% of Total Field Cost											57,534
Total Capital Cost											$345,000

OCCCOST\OCCCOST\CAP1&2.WK3

TABLE 10.6

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 2 - Sumps 1 and 2

Item	Qty	Unit/Yr	Unit Cost Unitem.	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Monitoring											
- Inspection	8	Hour	0.00	0.00	50.00	0.00	0	0	400	0	400
- Reporting	20	Hour	0.00	0.00	50.00	0.00	0	0	1,000	0	1,000
- Cap Repair	1	LS	4,500.00	0.00	0.00	0.00	4,500	0	0	0	4,500
Subtotal							4,500	0	1,400	0	5,900
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							4,500	0	1,400	0	5,900
Project Administration Cost at 15% of Direct Labor Cost									210		210
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							450				450
Total Field Cost							4,950	0	1,610	0	6,560
Total Annual O&M Cost											$7,000

OCCOST/OCCOST/OMCAP1&2.WK3

TABLE 10.7

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 2 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	345,202	0	0	0	0	0	0	0	0	0
O&M Costs	0	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Total Annual Cost	345,202	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	345,202	6,248	5,950	5,667	5,397	5,140	4,895	4,662	4,440	4,229

	10
Capital Cost	0
O&M Costs	6,560
Total Annual Cost	6,560
Discount Factor	0.61391
Present Worth	4,027

Total Present Worth ($'s)	$396,000

OCCCOST\OCCCOST\10PWC1&2.WK3

TABLE 10.8

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 2 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	345,202	0	0	0	0	0	0	0	0	0
O&M Costs	0	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Total Annual Cost	345,202	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	345,202	6,248	5,950	5,667	5,397	5,140	4,895	4,662	4,440	4,229

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Total Annual Cost	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	4,027	3,835	3,653	3,479	3,313	3,155	3,005	2,862	2,726	2,596

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Total Annual Cost	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560	6,560
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	2,472	2,355	2,243	2,136	2,034	1,937	1,845	1,757	1,673	1,594

	30
Capital Cost	0
O&M Costs	6,560
Total Annual Cost	6,560
Discount Factor	0.23138
Present Worth	1,518

Total Present Worth ($'s)	$446,000

OCCCOST\OCCCOST\30PWC1&2.WK3

TABLE 10.9

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3 - Sump 1

Item	Qty	Unit	Unit Cost				Total Cost				Total Direct Cost
			Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	
Site Preparation											
– Sump Fill											
& Compaction (Sand)	400	CY	0.00	14.70	6.16	15.80	0	5,880	2,464	6,320	14,664
– Sump Fill Grading	1500	SY	0.00	0.00	0.17	0.28	0	0	255	420	675
– Compaction	24	Hour	0.00	0.00	40.20	18.42	0	0	965	442	1,407
– Mobilization/Demobilization	1	LS	0.00	0.00	3,200.00	5,130.00	0	0	3,200	5,130	8,330
Cap Construction											
– Geosynthetic Clay Liner	13500	SF	0.00	0.58	0.12	0.24	0	7,830	1,620	3,240	12,690
– Drainage Layer	250	CY	0.00	11.82	2.71	7.20	0	2,955	678	1,800	5,433
– Filter Fabric	13500	SF	0.00	0.38	0.31	0.18	0	5,130	4,185	2,430	11,745
– Geomembrane, 60 mil HDPE	13500	SF	0.00	0.36	0.48	0.42	0	4,860	6,480	5,670	17,010
Pavement											
– Binder Course, 3" Thick	1500	SY	0.00	4.74	0.43	0.46	0	7,110	645	690	8,445
– Wearing Course, 3" Thick	1500	SY	0.00	5.2	0.48	0.44	0	7,800	720	660	9,180
– *Subbase, 12" Thick*	1500	SY	*0.00*	3.84	*0.24*	*0.54*	*0*	*5,760*	360	*810*	*6,930*
Drainage Controls	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000
Construction/Safety Supervision	8	Week	750.00	125.00	2,800.00	500.00	6,000	1,000	22,400	4,000	33,400
SVE/Air Inlet Well Installation											
– Drilling	1	LS	9,000.00	0.00	0.00	0.00	9,000	0	0	0	9,000
– Drilling Supervision	6	DY	0.00	0.00	700.00	100.00	0	0	4,200	600	4,800
SVE System Piping											
– SVE Well Riser											
Pipe, 4", Sch. 40, PVC	240	LF	0.00	3.73	8.20	0.00	0	895	1,968	0	2,863
– *Well screen*, 4", Sch.40, PVC	60	LF	0.00	3.90	8.20	0.00	0	234	492	0	726
– Pipe, 4", Sch.40, PVC	180	LF	0.00	3.73	8.20	0.00	0	671	1,476	0	2,147
– Misc. Fittings	1	Each	0.00	1000.00	2000.00	0.00	0	1,000	2,000	0	3,000
SVE Trench											
– Trench Excavation	14	CY	0.00	0.00	2.28	1.34	0	0	32	19	51
– Trench Backfill (Sand)	14	CY	0.00	14.70	6.16	15.80	0	206	86	221	513
Electrical Trench											
– Trench Excavation	39	CY	0.00	0.00	2.28	1.34	0	0	89	52	141
– Trench Backfill											
& Compaction (Sand)	20	CY	0.00	14.70	6.16	15.80	0	294	123	316	733
– Trench Backfill											
& Compaction (native)	23	CY	0.00	0.00	4.52	1.25	0	0	104	29	133
Electrical Service											
– Conduit, 6", Sch 40, PVC	150	LF	0.00	6.85	10.10	0.00	0	1,028	1,515	0	2,543
– *Wiring, #6*	*150*	*LF*	*0.00*	*26.00*	*33.00*	*0.00*	*0*	3,900	4,950	*0*	*8,850*
SVE Equipment											
– Vapor Extraction Unit 10HP, 200SCFM, 6"Hg motor starter and electrical wiring, inlet filter, gauges, valves, demister,cabinet and skid	1	Each	0.00	0.00	0.00	14,500.00	0	0	0	14,500	14,500
– Vapor Phase Carbon	2	Each	0.00	8,000.00	3,000.00	1,000.00	0	16,000	6,000	2,000	24,000
– *Treatment Shed*	225	SF	*30.70*	*0.00*	*0.00*	*0.00*	*6,908*	*0*	*0*	*0*	*6,908*
Subtotal							31,908	72,553	67,007	49,349	220,816

TABLE 10.9
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3 - Sump 1

Contractor's Overhead & Profit at 10% of Equipment Cost				4,935	4,935
Contractor's Overhead & Profit at 10% of Material Cost		7,255			7,255
Total Direct Cost	31,908	79,808	67,007	54,284	233,006
Engineering Cost at 10% of Total Direct Cost					23,301
Project Administration Cost at 15% of Direct Labor Cost			10,051		10,051
Project Administration Cost at 5% of Direct Material Cost		3,990			3,990
Project Administration Cost at 10% of Direct Unitemized Cost	3,191				3,191
Project Administration Cost at 15% of Engineering Cost					3,495
Total Field Cost	35,098	83,799	77,058	54,284	277,034
Contingency at 20% of Total Field Cost					55,407
Total Capital Cost					$332,000

OCCCOST/OCCCOST/CAPSVE1.WK3

TABLE 10.10

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 3 - Sump 1

Item	Qty	Unit/Yr	Unit Cost Unitem.	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Cap O&M											
Monitoring											
~ Inspection	8	Hour	0.00	0.00	50.00	0.00	0	0	400	0	400
~ Reporting	20	Hour	0.00	0.00	50.00	0.00	0	0	1,000	0	1,000
~ Cap Repair	1	LS	3,000.00	0.00	0.00	0.00	3,000	0	0	0	3,000
SVE O&M											
Power Requirements											
~ Blower (10 HP)	65,324	kWh	0.09	0.00	0.00	0.00	5,879	0	0	0	5,879
~ Replacement Carbon	400	LB	0.00	1.20	0.33	0.63	0	480	132	252	864
~ Regeneration	3,600	LB	0.00	0.65	0.33	0.63	0	2,340	1,188	2,268	5,796
Monitoring											
~ Air Analyses	48	Each	300.00	0.00	0.00	0.00	14,400	0	0	0	14,400
~ Sampling	1	LS	0.00	300.00	1,500.00	500.00	0	300	1,500	500	2,300
~ System Inspection	120	Hour	0.00	10.00	50.00	0.00	0	1,200	6,000	0	7,200
~ Reporting	40	Hour	0.00	0.00	50.00	0.00	0	0	2,000	0	2,000
Subtotal							23,279	4,320	12,220	3,020	42,839
Contractor's Overhead & Profit at 10% of Equipment Cost										302	302
Contractor's Overhead & Profit at 10% of Material Cost								432			432
Total Direct Cost							23,279	4,752	12,220	3,322	43,573
Project Administration Cost at 15% of Direct Labor Cost									1,833		1,833
Project Administration Cost at 5% of Direct Material Cost								238			238
Project Administration Cost at 10% of Direct Unitemized Cost							2,328				2,328
Total Field Cost							25,607	4,990	14,053	3,322	47,972
Total Annual O&M Cost											$48,000

OCCOST/OCCOST/OMCSVE1.WK3

TABLE 10.11

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 3 - Sump 1

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	332,441	0	0	0	0	0	0	0	0	0
O&M Costs	0	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Total Annual Cost	332,441	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	332,441	45,688	43,512	41,440	39,467	37,587	35,797	34,093	32,469	30,923

	10
Capital Cost	*0*
O&M Costs	47,972
Total Annual Cost	47,972
Discount Factor	0.61391
Present Worth	29,451

Total Present Worth ($'s)	$703,000

OCCCOST\OCCCOST\10PWCSVE1.WK3

TABLE 10.12

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 3 - Sump 1

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	332,441	0	0	0	0	0	0	0	0	0
O&M Costs	0	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Total Annual Cost	332,441	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	332,441	45,688	43,512	41,440	39,467	37,587	35,797	34,093	32,469	30,923

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Total Annual Cost	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	29,451	28,048	26,713	25,441	24,229	23,075	21,977	20,930	19,933	18,984

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Total Annual Cost	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972	47,972
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	18,080	17,219	16,399	15,618	14,875	14,166	13,492	12,849	12,237	11,655

	30
Capital Cost	0
O&M Costs	47,972
Total Annual Cost	47,972
Discount Factor	0.23138
Present Worth	11,100

Total Present Worth ($'s)	$1,070,000

OCCCOST\OCCCOST\30PWCSVE1.WK3

TABLE 10.13

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3 - Sumps 1 and 2

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Site Preparation											
- Sump Fill											
& Compaction (Sand)	*1700*	*CY*	*0.00*	*14.70*	*6.16*	*15.80*	*0*	*24,990*	*10,472*	*26,860*	*62,322*
- Sump Fill Grading	2276	SY	0.00	0.00	0.17	0.28	0	0	387	637	1,024
- Compaction	48	Hour	0.00	0.00	40.20	18.42	0	0	1,930	884	2,814
- Mobilization/Demobilization	1	LS	0.00	0.00	3,200.00	5,130.00	0	0	3,200	5,130	8,330
Cap Construction											
- Geosynthetic Clay Liner	20480	SF	0.00	0.58	0.12	0.24	0	11,878	2,458	4,915	19,251
- Drainage Layer	493	CY	0.00	11.82	2.71	7.20	0	5,827	1,336	3,550	10,713
- Filter Fabric	*20480*	*SF*	*0.00*	*0.38*	*0.31*	*0.18*	*0*	*7,782*	*6,349*	*3,686*	*17,818*
- Geomembrane, 60 mil HDPE	20480	SF	0.00	0.36	0.48	0.42	0	7,373	9,830	8,602	25,805
Pavement											
- Binder Course, 3" Thick	2276	SY	0.00	4.74	0.43	0.46	0	10,788	979	1,047	12,814
- Wearing Course, 3" Thick	2276	SY	0.00	5.2	0.48	0.44	0	11,835	1,092	1,001	13,929
- Subbase, 12" Thick	2276	SY	0.00	3.84	0.24	0.54	0	8,740	546	1,229	10,515
Drainage Controls	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000
Construction/Safety Supervision	*8*	*Week*	*750.00*	*125.00*	*2,800.00*	*500.00*	*6,000*	*1,000*	*22,400*	*4,000*	*33,400*
SVE/Air Inlet Well Installation											
- Drilling	1	LS	15,000.00	0.00	0.00	0.00	15,000	0	0	0	15,000
- Drilling Supervision	10	DY	0.00	0.00	700.00	100.00	0	0	7,000	1,000	8,000
SVE System Piping											
- SVE Well Riser											
Pipe, 4", Sch. 40, PVC	400	LF	0.00	3.73	8.20	0.00	0	1,492	3,280	0	4,772
- Well screen, 4", Sch.40, PVC	100	LF	0.00	3.90	8.20	0.00	0	390	820	0	1,210
- Pipe, 4", Sch.40, PVC	545	LF	0.00	3.73	8.20	0.00	0	2,033	4,469	0	6,502
- Misc. Fittings	1	Each	0.00	2000.00	3000.00	0.00	0	2,000	3,000	0	5,000
SVE Trench											
- Trench Excavation	20	CY	0.00	0.00	2.28	1.34	0	0	46	27	72
- Trench Backfill (Sand)	20	CY	0.00	14.70	6.16	15.80	0	294	123	316	733
Electrical Trench											
- Trench Excavation	39	CY	0.00	0.00	2.28	1.34	0	0	89	52	141
- Trench Backfill											
& Compaction (Sand)	20	CY	0.00	14.70	6.16	15.80	0	294	123	316	733
- Trench Backfill											
& Compaction (native)	23	CY	0.00	0.00	4.52	1.25	0	0	104	29	133
Electrical Service											
- Conduit, 6", Sch 40, PVC	150	LF	0.00	6.85	10.10	0.00	0	1,028	1,515	0	2,543
- Wiring, #6	150	LF	0.00	26.00	33.00	0.00	0	3,900	4,950	0	8,850
SVE Equipment											
- Vapor Extraction Unit 10HP, 200SCFM, 6"Hg motor starter and electrical wiring, inlet filter, gauges, valves, demister,cabinet and skid	2	Each	0.00	0.00	0.00	14,500.00	0	0	0	29,000	29,000
- Vapor Phase Carbon	2	Each	0.00	8,000.00	3,000.00	1,000.00	0	16,000	6,000	2,000	24,000
- Treatment Shed	225	SF	30.70	0.00	0.00	0.00	6,908	0	0	0	6,908
Subtotal							37,908	117,644	92,496	94,281	342,331

TABLE 10.13
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3 - Sumps 1 and 2

Contractor's Overhead & Profit at 10% of Equipment Cost				9,428	9,428
Contractor's Overhead & Profit at 10% of Material Cost		11,764			11,764
Total Direct Cost	37,908	129,409	92,498	103,710	363,524
Engineering Cost at 10% of Total Direct Cost					36,352
Project Administration Cost at 15% of Direct Labor Cost			13,875		13,875
Project Administration Cost at 5% of Direct Material Cost		6,470			6,470
Project Administration Cost at 10% of Direct Unitemized Cost	3,791				3,791
Project Administration Cost at 15% of Engineering Cost					5,453
Total Field Cost	41,698	135,879	106,372	103,710	429,465
Contingency at 20% of Total Field Cost					85,893
Total Capital Cost					$515,000

OCCCOST/OCCCOST/CAPSVE12.WK3

TABLE 10.14

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 3 - Sumps 1 and 2

Item	Qty	Unit/Yr	Unit Cost Unitem.	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Cap O&M											
Monitoring											
– Inspection	8	Hour	0.00	0.00	50.00	0.00	0	0	400	0	400
– Reporting	20	Hour	0.00	0.00	50.00	0.00	0	0	1,000	0	1,000
– Cap Repair	1	LS	4,500.00	0.00	0.00	0.00	4,500	0	0	0	4,500
SVE O&M											
Power Requirements											
– Blowers (10 HP)	130,648	kWh	0.09	0.00	0.00	0.00	11,758	0	0	0	11,758
– Replacement Carbon	400	LB	0.00	1.20	0.33	0.63	0	480	132	252	864
– Regeneration	3,600	LB	0.00	0.65	0.33	0.63	0	2,340	1,188	2,268	5,796
Monitoring											
– Air Analyses	48	Each	300.00	0.00	0.00	0.00	14,400	0	0	0	14,400
– Sampling	1	LS	0.00	300.00	1,500.00	500.00	0	300	1,500	500	2,300
– System Inspection	120	Hour	0.00	10.00	50.00	0.00	0	1,200	6,000	0	7,200
– Reporting	40	Hour	0.00	0.00	50.00	0.00	0	0	2,000	0	2,000
Subtotal							30,658	4,320	12,220	3,020	50,218
Contractor's Overhead & Profit at 10% of Equipment Cost										302	302
Contractor's Overhead & Profit at 10% of Material Cost								432			432
Total Direct Cost							30,658	4,752	12,220	3,322	50,952
Project Administration Cost at 15% of Direct Labor Cost									1,833		1,833
Project Administration Cost at 5% of Direct Material Cost								238			238
Project Administration Cost at 10% of Direct Unitemized Cost							3,066				3,066
Total Field Cost							33,724	4,990	14,053	3,322	56,089
Total Annual O&M Cost											$56,000

OCCOST/OCCOST/OMCSVE12.WK3

TABLE 10.15

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 3 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	515,358	0	0	0	0	0	0	0	0	0
O&M Costs	0	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Total Annual Cost	515,358	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	515,358	53,418	50,874	48,452	46,145	43,947	41,854	39,861	37,963	36,155

	10
Capital Cost	0
O&M Costs	56,089
Total Annual Cost	56,089
Discount Factor	0.61391
Present Worth	34,434

Total Present Worth ($'s) $948,000

OCCCOST\OCCCOST\10PWCSV2.WK3

TABLE 10.16

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 3 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	515,358	0	0	0	0	0	0	0	0	0
O&M Costs	0	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Total Annual Cost	515,358	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	515,358	53,418	50,874	48,452	46,145	43,947	41,854	39,861	37,963	36,155

Cost Component	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Total Annual Cost	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	34,434	32,794	31,232	29,745	28,329	26,980	25,695	24,471	23,306	22,196

Cost Component	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Total Annual Cost	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089	56,089
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	21,139	20,133	19,174	18,261	17,391	16,563	15,775	15,023	14,308	13,627

Cost Component	30
Capital Cost	0
O&M Costs	56,089
Total Annual Cost	56,089
Discount Factor	0.23138
Present Worth	12,978

Total Present Worth ($'s) $1,378,000

OCCCOST\OCCCOST\30PWCSV2.WK3

TABLE 10.17

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 4 - Sump 1

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Below-Ground Piping											
- Pipe, 2", Sch 40, PVC	67	LF	0.00	2.93	7.48	0.00	0	196	501	0	697
Water Distribution Piping											
- Pipe, 2", Sch 40, GS	395	LF	0.00	5.10	6.15	0.00	0	2,015	2,429	0	4,444
- Spray Nozzles, GS	20	Ea	0.00	175.00	20.00	0.00	0	3,500	400	0	3,900
Misc. Piping											
- Pipe Supports, Sch. 40, GS	140	LF	0.00	5.10	6.15	0.00	0	714	861	0	1,575
Earthwork											
- Trench Excavation	15	CY	0.00	0.00	2.28	1.34	0	0	34	20	54
- Trench Backfill (Sand)	6	CY	0.00	14.70	6.16	15.80	0	88	37	95	220
- Trench Backfill & Compaction (native)	6	CY	0.00	0.00	4.52	1.25	0	0	27	8	35
Asphalt Surface											
- Binder Course (3" Thick)	3	SY	0.00	3.95	0.36	0.33	0	12	1	1	14
- Wearing Course (3" Thick)	3	SY	0.00	4.33	0.40	0.37	0	13	1	1	15
- Subbase (6" Thick)	3	SY	0.00	4.00	0.40	1.00	0	12	1	3	16
Subtotal							0	6,354	3,792	128	10,273
Contractor's Overhead & Profit at 10% of Equipment Cost										13	13
Contractor's Overhead & Profit at 10% of Material Cost								635			635
Total Direct Cost							0	6,989	3,792	140	10,921
Engineering Cost at 10% of Total Direct Cost											1,092
Project Administration Cost at 15% of Direct Labor Cost									569		569
Project Administration Cost at 5% of Direct Material Cost								349			349
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											164
Total Field Cost							0	7,338	4,361	140	13,095
Contingency at 20% of Total Field Cost											2,619
Total Capital Cost											$16,000

OCCCOST/OCCCOST/FLUSH1.WK3

TABLE 10.18

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 4 - Sump 1

Item	Qty	Unit/yr	Unit Cost Unitem.	Unit Cost Mater.	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
– Misc. water distribution pipe maintenance/repair	1	LS		150.00	250.00	100.00		150	250	100	500
– Misc. sump maintenance/repair	1	LS		150.00	400.00	200.00		150	400	200	750
Total Direct Cost							0	300	650	300	1,250
Project Administration Cost at 15% of Direct Labor Cost									98		98
Project Administration Cost at 5% of Direct Material Cost								15			15
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Total Field Cost							0	315	748	300	1,363
Total Annual O&M Cost											$1,000

OCCCOST/OCCCOST/OMFLUSH1.WK3

TABLE 10.19

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 4 - Sump 1

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	15,714	0	0	0	0	0	0	0	0	0
O&M Costs	0	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Total Annual Cost	15,714	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	15,714	1,298	1,236	1,177	1,121	1,068	1,017	969	923	879

	10
Capital Cost	0
O&M Costs	1,363
Total Annual Cost	1,363
Discount Factor	0.61391
Present Worth	837

Total Present Worth ($'s)	$26,000

OCCCOST\OCCCOST\10PWFL1.WK3

TABLE 10.20

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 4 - Sump 1

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	15,714	0	0	0	0	0	0	0	0	0
O&M Costs	0	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Total Annual Cost	15,714	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	15,714	1,298	1,236	1,177	1,121	1,068	1,017	969	923	879

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Total Annual Cost	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	837	797	759	723	688	656	624	595	566	539

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Total Annual Cost	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363	1,363
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	514	489	466	444	423	402	383	365	348	331

	30
Capital Cost	0
O&M Costs	1,363
Total Annual Cost	1,363
Discount Factor	0.23138
Present Worth	315

Total Present Worth ($'s)	$37,000

OCCCOST\OCCCOST\30PWFL1.WK3

TABLE 10.21

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 4 - Sumps 1 and 2

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Below-Ground Piping											
- Pipe, 2", Sch 40, PVC	67	LF	0.00	2.93	7.48	0.00	0	196	501	0	697
Water Distribution Piping											
- Pipe, 2", Sch 40, GS	635	LF	0.00	5.10	6.15	0.00	0	3,239	3,905	0	7,144
- Spray Nozzles, GS	28	Ea	0.00	175.00	20.00	0.00	0	4,900	560	0	5,460
Misc. Piping											
- Pipe Supports, Sch. 40, GS	250	LF	0.00	5.10	6.15	0.00	0	1,275	1,538	0	2,813
Earthwork											
- Trench Excavation	15	CY	0.00	0.00	2.28	1.34	0	0	34	20	54
- Trench Backfill (Sand)	6	CY	0.00	14.70	6.16	15.80	0	88	37	95	220
- Trench Backfill & Compaction (native)	6	CY	0.00	0.00	4.52	1.25	0	0	27	8	35
Asphalt Surface											
- Binder Course (3" Thick)	3	SY	0.00	3.95	0.36	0.33	0	12	1	1	14
- Wearing Course (3" Thick)	3	SY	0.00	4.33	0.40	0.37	0	13	1	1	15
- Subbase (6" Thick)	3	SY	0.00	4.00	0.40	1.00	0	12	1	3	16
Subtotal							0	9,735	6,606	128	16,468
Contractor's Overhead & Profit at 10% of Equipment Cost										13	13
Contractor's Overhead & Profit at 10% of Material Cost								973			973
Total Direct Cost							0	10,708	6,606	140	17,454
Engineering Cost at 10% of Total Direct Cost											1,745
Project Administration Cost at 15% of Direct Labor Cost									991		991
Project Administration Cost at 5% of Direct Material Cost								535			535
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											262
Total Field Cost							0	11,244	7,597	140	20,988
Contingency at 20% of Total Field Cost											4,198
Total Capital Cost											$25,000

OCCCOST/OCCCOST/FLUSH1&2.WK3

TABLE 10.22

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 4 - Sumps 1 and 2

Item	Qty	Unit/yr	Unit Cost: Unitem.	Unit Cost: Mater.	Unit Cost: Labor	Unit Cost: Equip.	Annual Cost: Unitem.	Annual Cost: Material	Annual Cost: Labor	Annual Cost: Equip.	Total Annual Cost
– Misc. water distribution pipe maintenance/repair	1	LS		300.00	500.00	200.00	0	300	500	200	1,000
– Misc. sump maintenance/repair	1	LS		300.00	800.00	400.00		300	800	400	1,500
Total Direct Cost							0	300	500	200	2,500
Project Administration Cost at 15% of Direct Labor Cost									75		75
Project Administration Cost at 5% of Direct Material Cost								15			15
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Total Field Cost							0	315	575	200	2,590
Total Annual O&M Cost											$3,000

OCCCOST/OCCCOST/OMFL1&2.WK3

TABLE 10.23

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 4 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	25,185	0	0	0	0	0	0	0	0	0
O&M Costs	0	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Total Annual Cost	25,185	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	25,185	2,467	2,349	2,237	2,131	2,029	1,933	1,841	1,753	1,670

	10
Capital Cost	0
O&M Costs	2,590
Total Annual Cost	2,590
Discount Factor	0.61391
Present Worth	1,590

Total Present Worth ($'s)	$45,000

OCCCOST\OCCCOST\10PWFL12.WK3

TABLE 10.24

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 4 - Sumps 1 and 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	25,185	0	0	0	0	0	0	0	0	0
O&M Costs	0	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Total Annual Cost	25,185	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	25,185	2,467	2,349	2,237	2,131	2,029	1,933	1,841	1,753	1,670

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Total Annual Cost	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	1,590	1,514	1,442	1,374	1,308	1,246	1,187	1,130	1,076	1,025

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Total Annual Cost	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590	2,590
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	976	930	885	843	803	765	728	694	661	629

	30
Capital Cost	0
O&M Costs	2,590
Total Annual Cost	2,590
Discount Factor	0.23138
Present Worth	599

Total Present Worth ($'s) $65,000

OCCCOST\OCCCOST\30PWFL12.WK3

TABLE 10.25

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Deep Soil Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Capping - Soil Vapor Extraction	Alternative 4 - In-situ Soil Flushing
THRESHOLD CRITERIA				
- Overall Protection of Human Health and Environment	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the deep soil.	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the deep soil.	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the deep soil.	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the deep soil.
- Compliance with ARARs	There are no ARARs for soil cleanup.	There are no ARARs for soil cleanup.	There are no ARARs for soil cleanup.	There are no ARARs for soil cleanup.
PRIMARY BALANCING CRITERIA				
- Long-term Effectiveness and Permanence	Effective in the long-term through natural flushing when used in conjunction with groundwater recovery and treatment. Long-term compound concentrations could be compared to TBC criteria.	Not effective in the long-term for reducing soil compound concentrations. Effective in the long-term for preventing potential vertical infiltration to the groundwater. No significant reductions in concentrations when compared to TBC criteria.	Effective in the long-term for preventing potential vertical infiltration to the groundwater and limited compound removal from the soil vapor. Reductions in compound concentrations would be compared to TBC criteria.	Effective in the long-term for reducing compound concentrations when used in conjunction with groundwater recovery and treatment. Reductions in concentrations would be compared to TBC criteria.

TABLE 10.259
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Deep Soil Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Capping - Soil Vapor Extraction	Alternative 4 - In-situ Soil Flushing
- Reduction of Toxicity, Mobility or Volume	Natural flushing reduces the toxicity and volume of impacted soils. Groundwater recovery limits mobility.	Does not reduce toxicity or volume of impacted soil, but the cap reduces mobility by preventing vertical infiltration of precipitation that may carry compounds to the groundwater.	Capping reduces mobility by preventing vertical infiltration of precipitation that may carry compounds to the groundwater. SVE reduces toxicity, mobility and volume of impacted soil by extracting compounds from the soil vapor.	Flushing reduces the toxicity and volume of impacted soils. Groundwater recovery limits mobility.
- Short-Term Effectiveness	No implementation risks involved.	No implementation risks involved.	No implementation risks involved.	No implementation risks involved.
- Implementability	Technically and administratively feasible. Materials and services are not required.	Technically and administratively feasible. Materials and services are available.	Technically and administratively feasible. Materials and services are available.	Technically and administratively feasible. Materials and services are readily available.

TABLE 10.259
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Deep Soil Medium

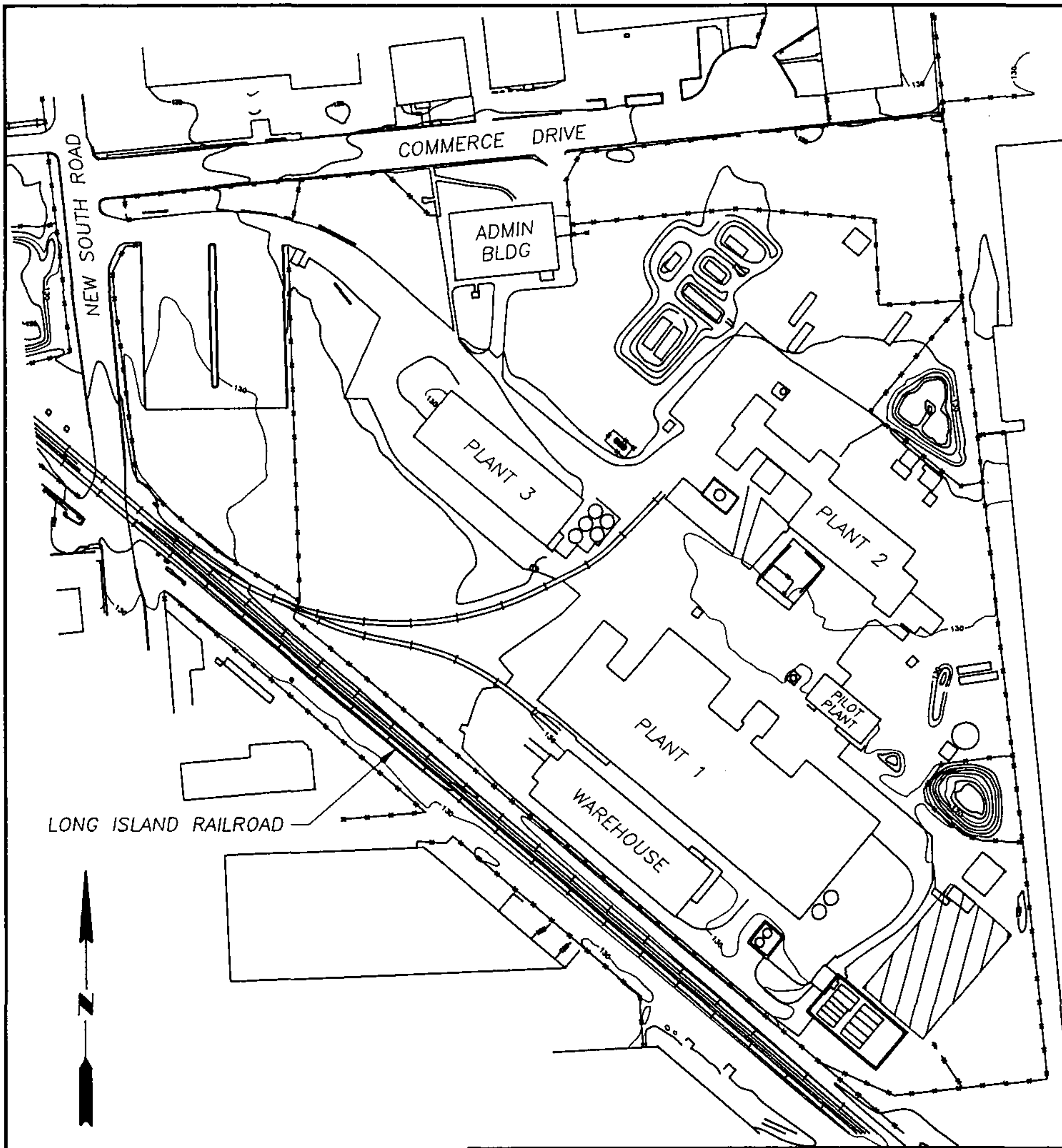
Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Capping - Soil Vapor Extraction	Alternative 4 - In-situ Soil Flushing
- Cost for Sump 1				
- Capital Costs	$0	$213,000	$ 332,000	$16,000
- Annual O&M Costs	$0	$ 5,000	$ 48,000	$ 1,000
- 10-Year Present Worth	$0	$251,000	$ 703,000	$26,000
- 30-Year Present Worth	$0	$289,000	$1,070,000	$37,000
- Cost for Sump 1 and 2				
- Capital Costs	$0	$345,000	$ 515,000	$25,000
- Annual O&M Costs	$0	$ 7,000	$ 56,000	$ 3,000
- 10-Year Present Worth	$0	$396,000	$ 948,000	$45,000
- 30-Year Present Worth	$0	$446,000	$1,378,000	$65,000

TABLE 10.259
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Deep Soil Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Capping - Soil Vapor Extraction	Alternative 4 - In-situ Soil Flushing
MODIFYING CRITERIA				
- State Acceptance	May be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the deep soil.	Support agency acceptance is anticipated because there are no risks to human health or the environment from direct contact/exposure with the deep soil and capping will meet the remedial action objective of protection of groundwater quality.	Support agency acceptance is anticipated because there are no risks to human health or the environment from direct contact/exposure with the deep soil, capping will meet the remedial action objective of protection of groundwater quality and SVE satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.	Support agency acceptance is anticipated because there are no risks to human health or the environment from direct contact/exposure with the deep soil and in-situ flushing combined with groundwater recovery and treatment satisfies the statutory preference for treatment that reduces the toxicity, mobility or volume as a principle element.
- Community Acceptance	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.



LEGEND

AREAL EXTENT OF PROPOSED CAP

0 150

SCALE IN FEET

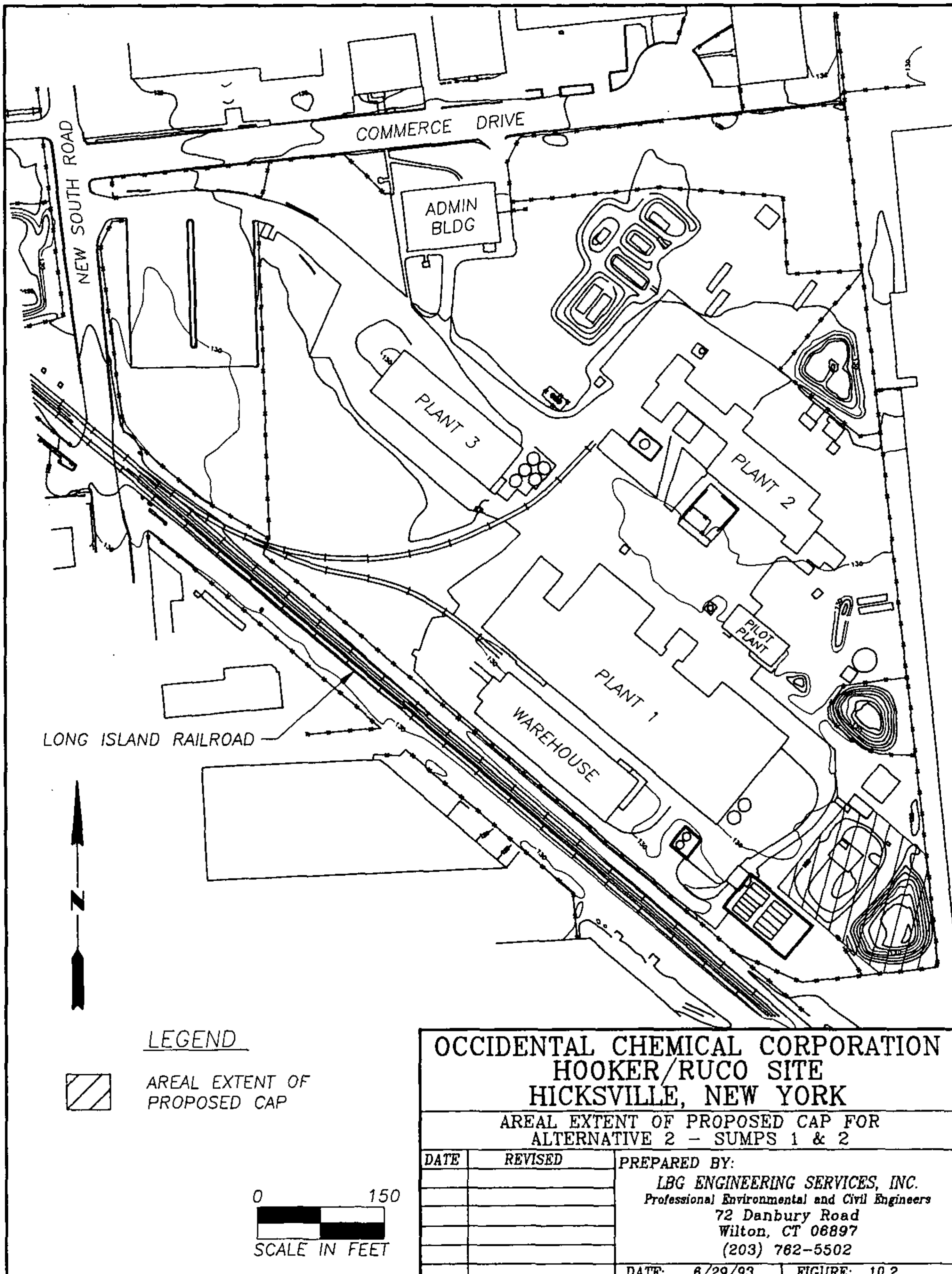
OCCIDENTAL CHEMICAL CORPORATION HOOKER/RUCO SITE HICKSVILLE, NEW YORK

AREAL EXTENT OF PROPOSED CAP FOR ALTERNATIVE 2 – SUMP 1

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/29/93 FIGURE: 10.1



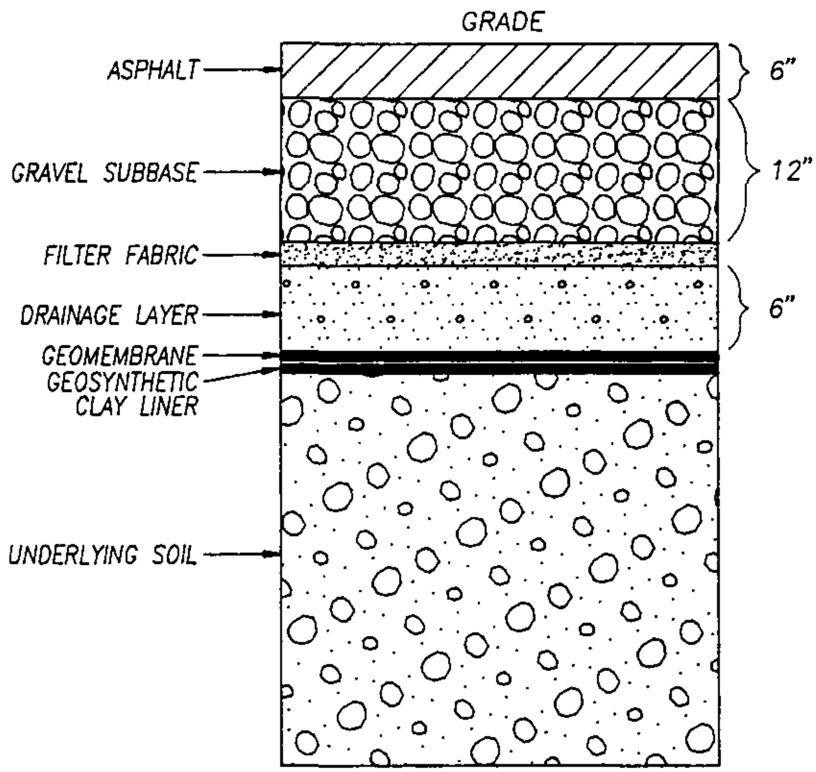
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

AREAL EXTENT OF PROPOSED CAP FOR ALTERNATIVE 2 – SUMPS 1 & 2

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/29/93 | FIGURE: 10.2



NOT TO SCALE

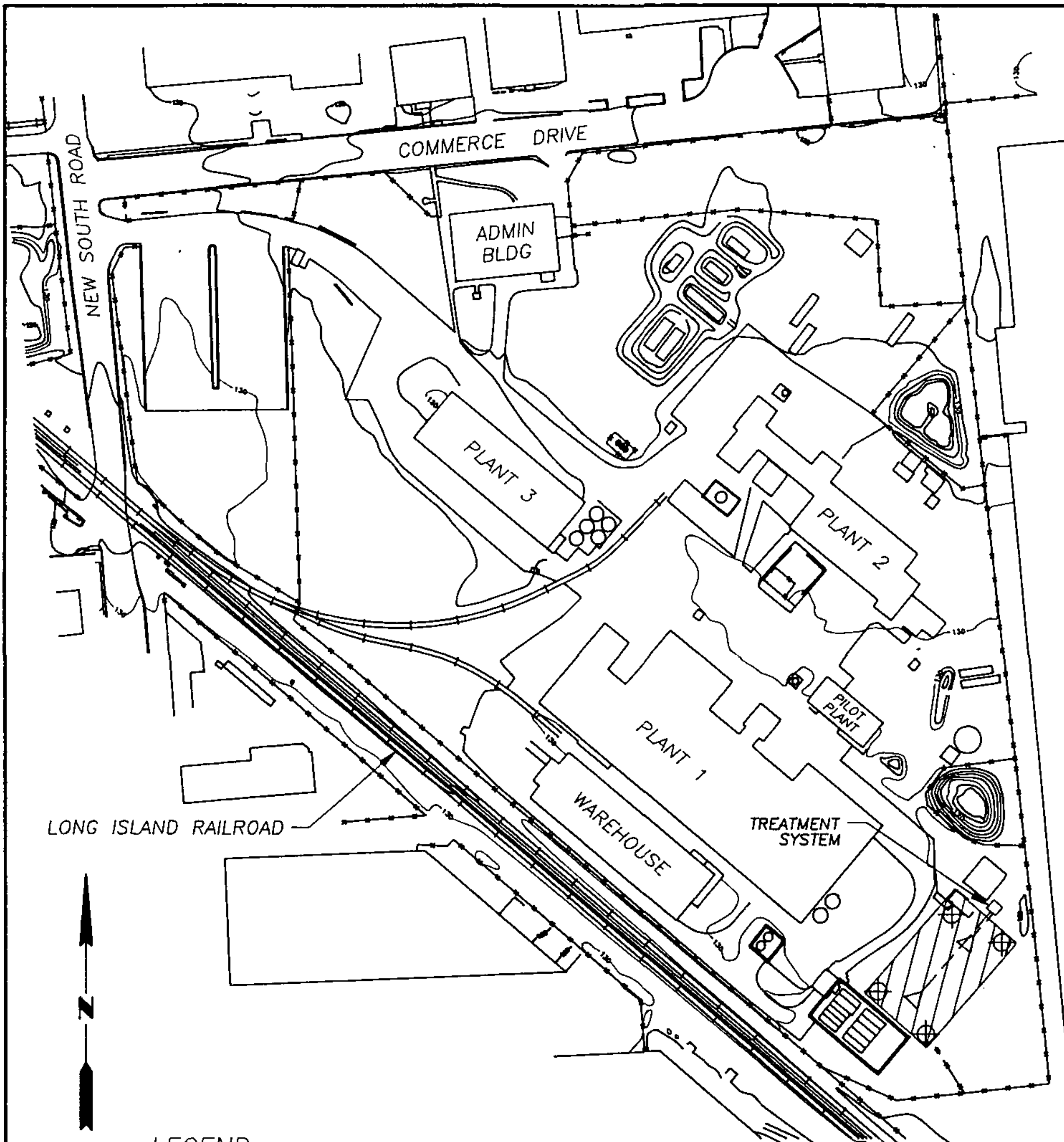
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CROSS-SECTION OF CAP

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/29/93 | FIGURE: 10.3



LEGEND

AREAL EXTENT OF PROPOSED CAP
SOIL VAPOR EXTRACTION WELL
AIR INLET WELL
TREATMENT SYSTEM PIPING

0 150
SCALE IN FEET

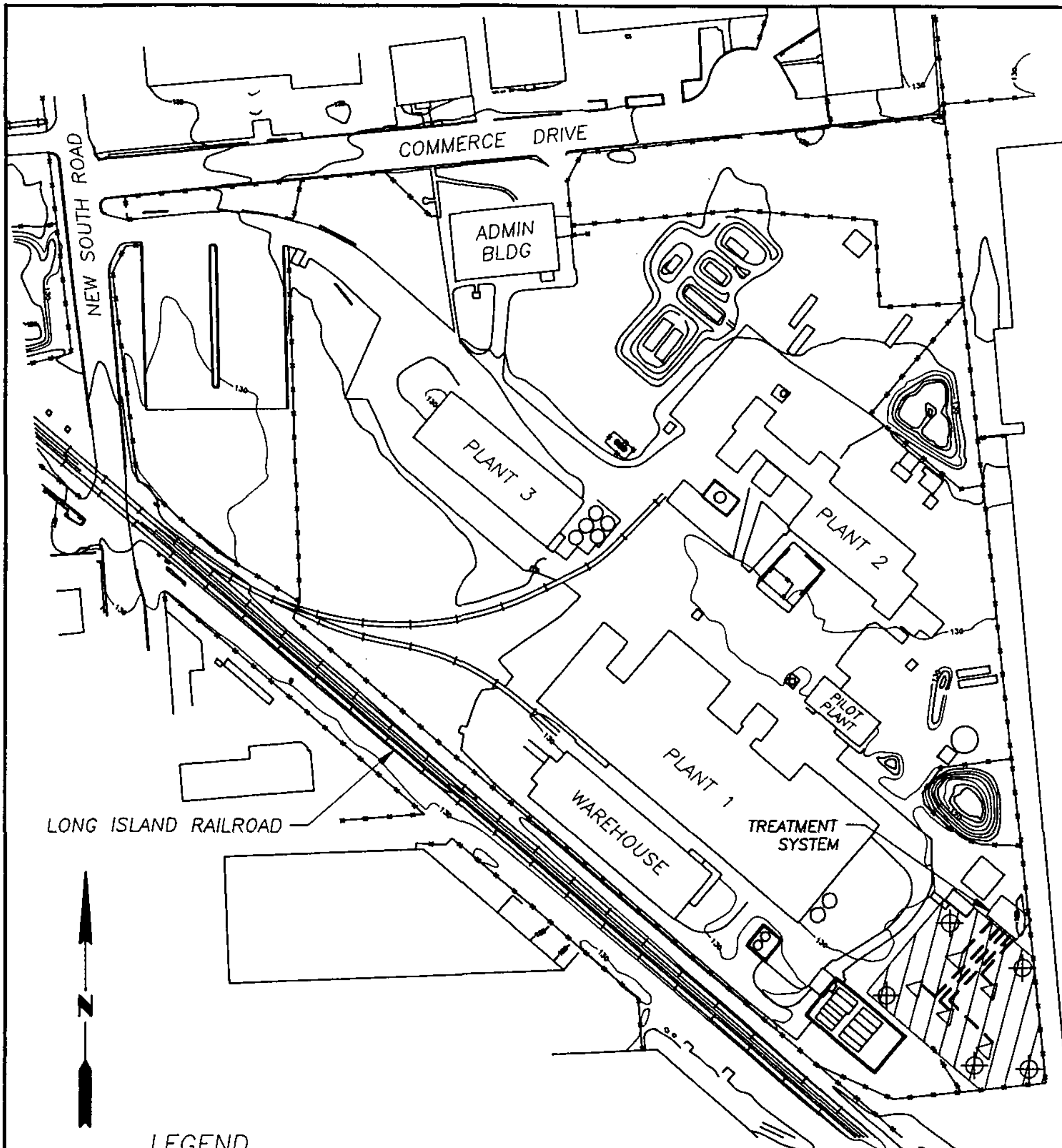
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 3 – SUMP 1

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 7/1/93 FIGURE: 10.4



LEGEND

AREAL EXTENT OF PROPOSED CAP

△ SOIL VAPOR EXTRACTION WELL

⊕ AIR INLET WELL

— — — TREATMENT SYSTEM PIPING

0 150

SCALE IN FEET

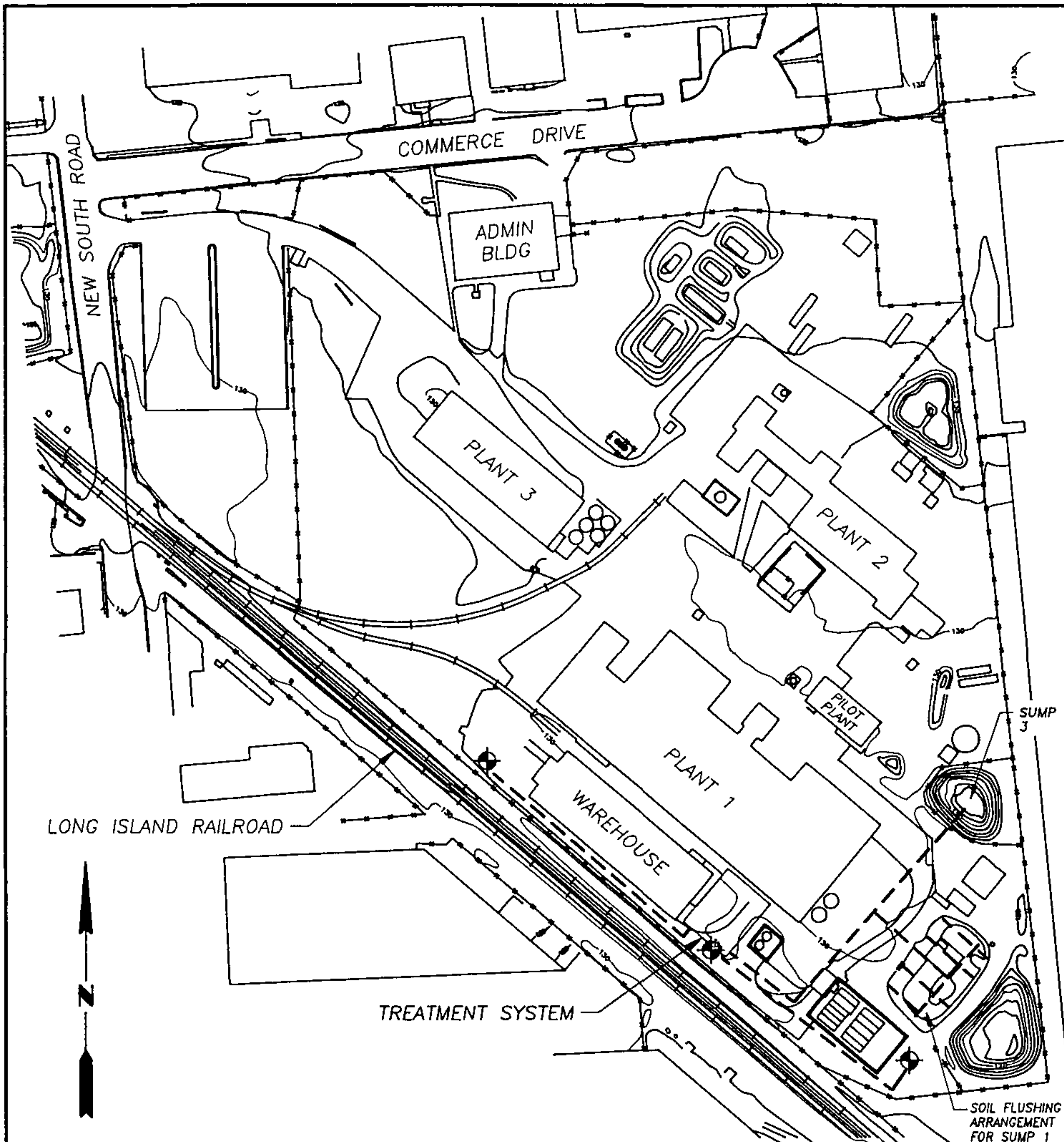
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 3 – SUMPS 1 & 2

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 7/1/93 FIGURE: 10.5



LEGEND

RECOVERY WELL

TREATMENT SYSTEM PIPING

0 150

SCALE IN FEET

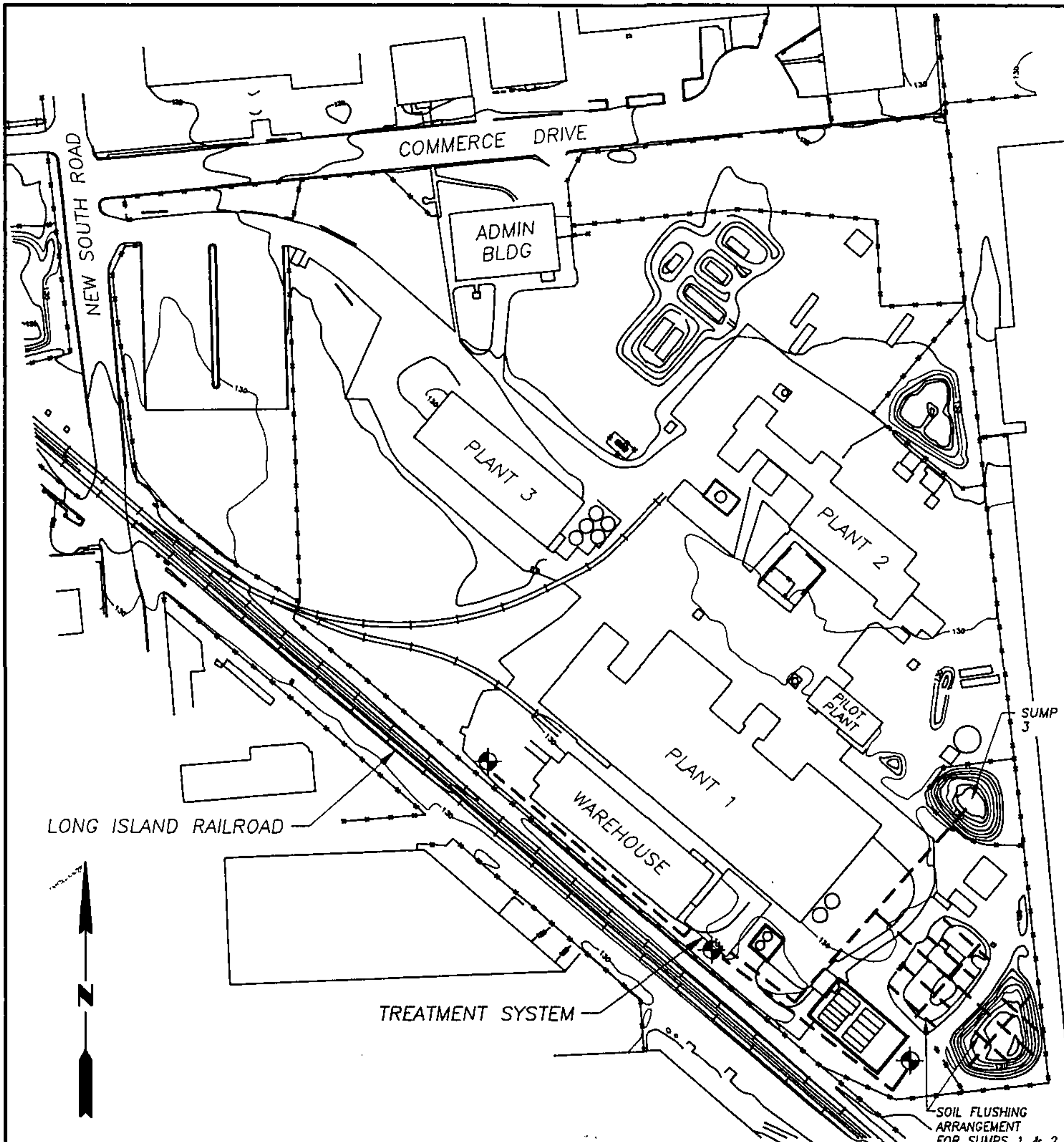
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 4 – SUMP 1

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/29/93 | FIGURE: 10.6



LEGEND

RECOVERY WELL

TREATMENT SYSTEM PIPING

0 150
SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

APPROXIMATE LOCATION OF TREATMENT SYSTEM AND PIPING FOR ALTERNATIVE 4 – SUMPS 1 & 2

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/29/93 | FIGURE: 10.7

11.0 Development of Remedial Action Alternatives - Shallow Soil Medium

Alternatives for remedial action were developed by assembling combinations of technologies into alternatives that address the remedial objective for the shallow soil medium. The six-step process described in Section 4.0 for the groundwater was also used for this medium. A flow chart of the alternatives development process for the shallow soil medium is shown on plate 3. Descriptions of the process options, the preliminary screening and the secondary screening are included in Appendix D.

11.1 General Response Actions

The following general response actions were considered for the shallow soil medium:

- no action;
- institutional actions;
- onsite soil remediation;
- in-situ soil remediation; and
- offsite soil disposal.

The no action general response action, as described in Section 4.1, must be considered throughout the FS process. Institutional actions aid in reducing exposure risks but do not actively reduce compound concentrations. Onsite soil remediation involves recovering and treating the soil, and backfilling the treated soil onsite. In-situ remediation involves treating the soil in place so that no excavation or disposal of soil is required. Offsite disposal involves recovering the soil for disposal at an acceptable facility.

11.2 Technology Types

As described in Section 4.2, technology types were identified for each general response action. The institutional actions considered for the shallow soil include access restrictions and monitoring. The onsite remediation technologies consisted of biological treatment, soil stabilization/solidification and chemical extraction. The in-situ remediation technologies considered were bioremediation, containment/encapsulation, soil flushing, gas-phase separation and stabilization/solidification. The offsite disposal technology considered was a landfill.

11.3 Process Options

For each technology type, a number of specific process options were identified. These process options, as well as their descriptions, are listed in Appendix D.

11.4 Preliminary Screening

During the preliminary screening, the remedial technologies for the shallow soil were screened on the basis of technical implementability. The identified process options which were capable of meeting the remedial objective, in part or in whole, were retained and are described in Appendix D.

11.5 Secondary Screening

The process options retained in the preliminary screening then underwent a secondary screening based on the general criteria of effectiveness, implementability and cost as described in Sections 4.5.1 through 4.5.3. The secondary screening is described in Appendix D.

11.6 Assembly of Alternatives

The remedial alternatives for the shallow soil medium retained after the secondary screening are as follows:

- No action;
- Capping; and
- Offsite disposal at a chemical waste landfill.

12.0 Remedial Alternatives Evaluation - Shallow Soil Medium

The alternatives for the shallow soil medium were subjected to a detailed evaluation to determine how the alternatives meet the evaluation criteria and to enable the alternatives to be compared with one another. The evaluation process has been described in Section 6.0.

12.1 Remedial Alternative 1 - No Action

The no action alternative requires no changes to be made to the existing conditions at the site. This alternative serves as a baseline situation to compare the other alternatives.

12.1.1 Overall Protection of Human Health and the Environment

There have been no health or environmental risks associated with direct exposure/contact with the shallow soil.

12.1.2 Compliance with ARARs

There are no ARARs for soil cleanup.

12.1.3 Long-term Effectiveness and Permanence

Precipitation would continue to infiltrate the unsaturated soil, possibly acting as a natural flushing mechanism and reducing soil compound concentrations. Compounds would be transferred from the soil medium to the groundwater where, assuming the groundwater pump and treat alternative is chosen, they would be captured and treated by the groundwater recovery and treatment system. There are no TBC criteria for TICs to compare long-term concentrations.

12.1.4 Reduction of Toxicity, Mobility or Volume

The natural flushing that will occur with the no action alternative will reduce the toxicity and volume of impacted soil. Compound mobility is controlled with the use of groundwater recovery.

12.1.5 Short-term Effectiveness

There are no implementation risks involved with the no action alternative.

12.1.6 Implementability

The no action alternative is easily implementable and requires no modifications to the site.

12.1.7 Cost

There are no capital or O&M costs associated with this alternative.

12.1.8 State (Support Agency) Acceptance

The no action alternative may be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the shallow soil.

12.1.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

12.2 Remedial Alternative 2 - Capping

Alternative 2 involves installing a cap over the potential shallow soil remediation areas in accordance with RCRA performance specifications. The cap will occupy an area of approximately 5,000 ft^2, as shown on figure 12.1. A cross-section of the cap is shown on figure 10.3.

The cap will consist of the following layers above the underlying soil: a geosynthetic clay liner (comprised of geotextile outer layers with an inner layer of low permeability sodium bentonite) with a permeability of 10^{-9} cm/s, a 60-mil high-density polyethylene (HDPE) geomembrane liner, 6 inches of gravel acting as a drainage layer, a 20-mil filter fabric, 12 inches of gravel subbase and 6 inches of asphalt. All fill material will be placed and compacted in 6-inch lifts. The asphalt surface of the cap will be sloped to direct surface-water runoff southerly. Catch basins will be installed as needed, with piping to be tied into the existing site drainage which discharges to Sump 3. The O&M requirements will consist of semiannual site inspections of the cap.

12.2.1 Overall Protection of Human Health and the Environment

There have been no health or environmental risks associated with direct exposure/contact with the shallow soil.

12.2.2 Compliance with ARARs

There are no ARARs for soil cleanup.

12.2.3 Long-term Effectiveness and Permanence

A cap designed under RCRA performance specifications is capable of protecting the groundwater quality from vertical migration of compounds detected in the shallow soil. Alternative 2 will therefore be effective in the long term. There are no TBC criteria for TICs to compare long-term considerations.

12.2.4 Reduction of Toxicity, Mobility or Volume

Capping does not reduce the toxicity or volume of compounds in the soil, but does reduce their mobility.

12.2.5 Short-term Effectiveness

There are no implementation risks involved with Alternative 2 because the RA concluded that there are no risks to human health or the environment from direct exposure/contact with the shallow soil.

12.2.6 Implementability

A cap requires moderate design effort, approximately one month of field operations and moderate effort in reporting and documentation. Considerable attention must be paid to the proper compaction of the fill materials and installation of the geocomposite clay liner and the geomembrane liner. Periodic inspection will be required to insure the integrity of the cap over time.

12.2.7 Cost

The capital cost for Alternative 2 is $86,000, and the annual O&M cost is $3,000. The 10-year and 30-year present worth costs are $111,000 and $136,000, respectively. The cost calculations are outlined on tables 12.1 through 12.4.

12.2.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 2 is anticipated because there are no risks to human health or the environment from direct contact/exposure with the shallow soil and capping will meet the remedial action objective of protection of groundwater quality.

12.2.9 Community Acceptance

Public acceptance is anticipated because there are no health or environment risks and the public is not directly affected.

12.3 Remedial Alternative 3 - Chemical Waste Landfill

Once disturbed, the soil targeted for remediation may be considered a listed hazardous waste. TCLP analyses will be performed to determine the concentration of compounds that may leach into the ground water and to compare these concentrations with Land Disposal Restrictions. Pending proper Land Disposal Restriction compliance and chemical waste landfill acceptance, the soil may either be directly transported to the landfill or require pretreatment (incineration) or stabilization prior to disposal. TCLP analyses will be required in order to determine whether pretreatment will be required prior to disposal. For FS purposes, the assumption was made that the soil will not need pretreatment prior to disposal.

The soil will be excavated in bulk and hauled by a hazardous waste transportation service. Transportation from the site to a chemical waste landfill has been estimated to be 1,000 miles round trip. Preliminary calculations indicate a volume of approximately

445 yd^3 of soil will be removed. Approximately 580 yd^3 of clean fill will be imported, backfilled and compacted in the excavation.

12.3.1 Overall Protection of Human Health and the Environment

There have been no health or environmental risks associated with direct exposure/contact with the shallow soil. Protection of groundwater quality is achieved through source removal.

12.3.2 Compliance with ARARs

There are no ARARs for soil cleanup.

12.3.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence is achieved onsite through source removal.

12.3.4 Reduction of Toxicity, Mobility or Volume

Reduction of toxicity, mobility and volume is achieved onsite through source removal.

12.3.5 Short-term Effectiveness

There are no implementation risks involved with the excavation or transportation of the shallow soil because no the RA concluded that there are no risks to human health or the environment from direct exposure/contact.

12.3.6 Implementability

Disposal of soil at a chemical waste landfill is readily implementable. Active chemical waste landfills are known to operate in New York and several locations within the United States.

12.3.7 Cost

The capital cost for Alternative 3 is $482,000, and there is no annual O&M cost. The 10-year and 30-year present worth costs are each $482,000. The cost calculations are outlined on tables 12.5 through 12.7.

12.3.8 State (Support Agency) Acceptance

Support agency acceptance of Alternative 3 is anticipated because there are no risks to human health or the environment from direct contact/exposure with the shallow soil and will involve the complete removal of the impacted soil from the site.

12.3.9 Community Acceptance

Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.

12.4 Analysis of Alternatives

A comparative analysis of the alternatives was conducted to evaluate the relative performance of each alternative with regard to each of the evaluation criteria. By identifying the advantages and disadvantages of each alternative relative to one another, key tradeoffs can be determined. This analysis procedure was described in Section 6.5. A summary of the detailed evaluation for Alternatives 1, 2 and 3 is presented in table 12.8.

Based on the above analysis, Alternatives 1, 2 and 3 meet the evaluation criteria for the Hooker/Ruco site.

TABLE 12.1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 2

Item	Qty	Unit	Unit Cost				Total Cost				Total Direct Cost
			Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	
Site Preparation											
– Compaction	24	Hour	0.00	0.00	40.20	18.42	0	0	965	442	1,407
– Mobilization/Demobilization	1	LS	0.00	0.00	3,200.00	5,130.00	0	0	3,200	5,130	8,330
Cap Construction											
– Geosynthetic Clay Liner	3850	SF	0.00	0.58	0.12	0.24	0	2,233	462	924	3,619
– Drainage Layer	93	CY	0.00	11.82	2.71	7.20	0	1,099	252	670	2,021
– Filter Fabric	3850	SF	0.00	0.38	0.31	0.18	0	1,463	1,194	693	3,350
– Geomembrane, 60 mil HDPE	3850	SF	0.00	0.36	0.48	0.42	0	1,386	1,848	1,617	4,851
Pavement											
– Binder Course, 3" Thick	427	SY	0.00	4.74	0.43	0.46	0	2,024	184	196	2,404
– Wearing Course, 3" Thick	427	SY	0.00	5.2	0.48	0.44	0	2,220	205	188	2,613
– Subbase, 12" Thick	427	SY	0.00	3.84	0.24	0.54	0	1,640	102	231	1,973
Drainage Controls	1	LS	10,000.00	0.00	0.00	0.00	10,000	0	0	0	10,000
Construction/Safety Supervision	4	Week	750.00	125.00	2,800.00	500.00	3,000	500	11,200	2,000	16,700
Subtotal							13,000	12,565	19,611	12,091	57,267
Contractor's Overhead & Profit at 10% of Equipment Cost										1,209	0
Contractor's Overhead & Profit at 10% of Material Cost								1,257			1,209
Total Direct Cost							13,000	13,822	19,611	13,300	59,733
Engineering Cost at 10% of Total Direct Cost											5,973
Project Administration Cost at 15% of Direct Labor Cost									2,942		2,942
Project Administration Cost at 5% of Direct Material Cost								691			691
Project Administration Cost at 10% of Direct Unitemized Cost							1,300				1,300
Project Administration Cost at 15% of Engineering Cost											896
Total Field Cost							14,300	14,513	22,553	13,300	71,535
Contingency at 20% of Total Field Cost											14,307
Total Capital Cost											$86,000

OCCCOST/OCCCOST/SHCAP.WK3

TABLE 12.2

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Annual O&M Costs for Alternative 2

Item	Qty	Unit/Yr	Unit Cost Unitem.	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Monitoring											
– Inspection	8	Hour	0.00	0.00	50.00	0.00	0	0	400	0	400
– Reporting	20	Hour	0.00	0.00	50.00	0.00	0	0	1,000	0	1,000
– Cap Repair	1	LS	1,500.00	0.00	0.00	0.00	1,500	0	0	0	1,500
Subtotal							1,500	0	1,400	0	2,900
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							1,500	0	1,400	0	2,900
Project Administration Cost at 15% of Direct Labor Cost									210		210
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							150				150
Total Field Cost							1,650	0	1,610	0	3,260
Total Annual O&M Cost											$3,000

OCCOST/OCCOST/SHOMCAP.WK3

TABLE 12.3

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 2

Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s)									
	0	1	2	3	4	5	6	7	8	9
Capital Cost	85,842	0	0	0	0	0	0	0	0	0
O&M Costs	0	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Total Annual Cost	85,842	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	85,842	3,105	2,957	2,816	2,682	2,554	2,433	2,317	2,206	2,101

	10
Capital Cost	0
O&M Costs	3,260
Total Annual Cost	3,260
Discount Factor	0.61391
Present Worth	2,001

Total Present Worth ($'s)	$111,000

OCCCOST\OCCCOST\10PWSHCP.WK3

TABLE 12.4

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 2

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	85,842	0	0	0	0	0	0	0	0	0
O&M Costs	0	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Total Annual Cost	85,842	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	85,842	3,105	2,957	2,816	2,682	2,554	2,433	2,317	2,206	2,101

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Total Annual Cost	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	2,001	1,906	1,815	1,729	1,647	1,568	1,493	1,422	1,355	1,290

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Total Annual Cost	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260	3,260
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	1,229	1,170	1,114	1,061	1,011	963	917	873	832	792

	30
Capital Cost	0
O&M Costs	3,260
Total Annual Cost	3,260
Discount Factor	0.23138
Present Worth	754

Total Present Worth ($'s)	$136,000

OCCCOST\OCCCOST\30PWSHCP.WK3

TABLE 12.5

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Capital Costs for Alternative 3

Item	Qty	Unit	Unitemized	Material	Labor	Equip.	Unitem.	Material	Labor	Equip.	Direct Cost
Shallow Soils Excavation/Transport											
– Mobilization/Demobilization	1	LS	0.00	0.00	500.00	800.00	0	0	500	800	1,300
– Excavation	444	CY	22.00	0.00	0.00	0.00	9,768	0	0	0	9,768
– Excavation Shoring	1480	SF	0.00	8.70	1.85	2.21	0	12,876	2,738	3,271	18,885
– Soil Transport	746	Ton	200.00	0.00	0.00	0.00	149,200	0	0	0	149,200
– Construction/Safety Supervision	8	Week	750.00	125.00	2,800.00	500.00	6,000	1,000	22,400	4,000	33,400
Shallow Soils Disposal											
– Chemical Waste Landfill	746	Ton	122.00	0.00	0.00	0.00	91,012	0	0	0	91,012
Soils Area Restoration											
– Backfill	577	CY	0.00	16.00	18.00	6.00	0	9,232	10,386	3,462	23,080
– Grass Sodding	427	SY	0.00	1.46	0.94	0.2	0	623	401	85	1,110
Subtotal							255,980	23,731	36,425	11,618	327,755
Contractor's Overhead & Profit at 10% of Equipment Cost										1,162	1,162
Contractor's Overhead & Profit at 10% of Material Cost								2,373			2,373
Total Direct Cost							255,980	26,105	36,425	12,780	331,290
Engineering Cost at 10% of Total Direct Cost											33,129
Project Administration Cost at 15% of Direct Labor Cost									5,464		5,464
Project Administration Cost at 5% of Direct Material Cost								1,305			1,305
Project Administration Cost at 10% of Direct Unitemized Cost							25,598				25,598
Project Administration Cost at 15% of Engineering Cost											4,969
Total Field Cost							281,578	27,410	41,889	12,780	401,755
Contingency at 20% of Total Field Cost											80,351
Total Capital Cost											$482,000

OCCCOST\OCCCOST\CAPSHEXC.WK3

TABLE 12.6

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

10-Year Present Worth Costs for Alternative 3

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	482,106	0	0	0	0	0	0	0	0	0
O&M Costs	0	0	0	0	0	0	0	0	0	0
Total Annual Cost	482,106	0	0	0	0	0	0	0	0	0
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	482,106	0	0	0	0	0	0	0	0	0

	10
Capital Cost	0
O&M Costs	0
Total Annual Cost	0
Discount Factor	0.61391
Present Worth	0

Total Present Worth ($'s)	$482,000

OCCCOST\OCCCOST\10PWSHEX.WK3

TABLE 12.7

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

30-Year Present Worth Costs for Alternative 3

Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	482,106	0	0	0	0	0	0	0	0	0
O&M Costs	0	0	0	0	0	0	0	0	0	0
Total Annual Cost	482,106	0	0	0	0	0	0	0	0	0
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	482,106	0	0	0	0	0	0	0	0	0

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	0	0	0	0	0	0	0	0	0	0
Total Annual Cost	0	0	0	0	0	0	0	0	0	0
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	0	0	0	0	0	0	0	0	0	0

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	0	0	0	0	0	0	0	0	0	0
Total Annual Cost	0	0	0	0	0	0	0	0	0	0
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	0	0	0	0	0	0	0	0	0	0

	30
Capital Cost	0
O&M Costs	0
Total Annual Cost	0
Discount Factor	0.23138
Present Worth	0

Total Present Worth ($'s)	$482,000

OCCCOST\OCCCOST\30PWSHEX.WK3

TABLE 12.8

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Shallow Soil Medium

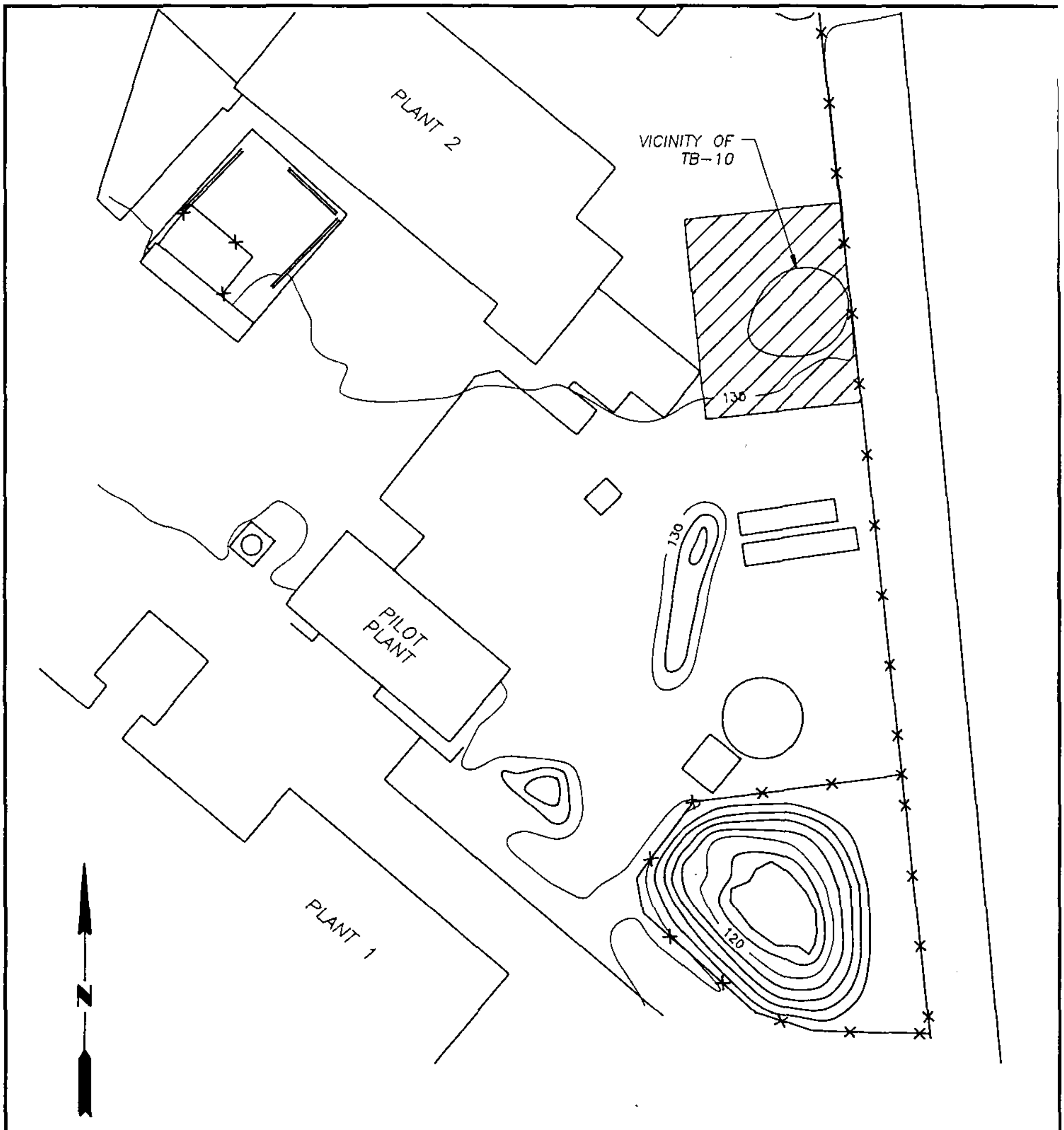
Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Chemical Waste Landfill
THRESHOLD CRITERIA			
- Overall Protection of Human Health and Environment	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the shallow soil.	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the shallow soil.	The RA concluded that there are no risks to human health or the environment from direct exposure/contact with the shallow soil.
- Compliance with ARARs	There are no ARARs for soil cleanup.	There are no ARARs for soil cleanup.	There are no ARARs for soil cleanup.
PRIMARY BALANCING CRITERIA			
- Long-term Effectiveness and Permanence	Effective in the long-term through natural flushing when used in conjunction with groundwater recovery and treatment. There are no TBC criteria for TICs to compare long-term concentrations.	Not effective in the long-term for reducing soil compound concentrations. Effective in the long-term for preventing potential vertical infiltration to the groundwater. There are no TBC criteria for TICs to compare long-term concentrations.	Effective in the long-term through source removal.
- Reduction of Toxicity, Mobility or Volume	Flushing reduces the toxicity and volume of impacted soils. Groundwater recovery limits mobility.	Does not reduce toxicity or volume of impacted soil, but the cap reduces mobility by preventing vertical infiltration of precipitation that may carry compounds to the groundwater.	Reduction of toxicity, mobility and volume is achieved onsite through source removal.
- Short-Term Effectiveness	No implementation risks involved.	No implementation risks involved.	No implementation risks involved.
- Implementability	Technically and administratively feasible. Materials and services are not required.	Technically and administratively feasible. Materials and services are available.	Technically and administratively feasible. Materials and services are readily available.

TABLE 12.8
(continued)

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Alternative Comparison Summary for the Shallow Soil Medium

Evaluation Criteria	Alternative 1 - No Action	Alternative 2 - Capping	Alternative 3 - Chemical Waste Landfill
- Cost - Capital Costs - Annual O&M Costs - 10-Year Present Worth - 30-Year Present Worth	 $0 $0 $0 $0	 $ 86,000 $ 3,000 $111,000 $136,000	 $482,000 $ 0 $482,000 $482,000
MODIFYING CRITERIA			
- State Acceptance	May be acceptable to support agencies because there are no risks to human health or the environment from direct contact/exposure with the shallow soil.	Support agency acceptance is anticipated because there are no risks to human health or the environment from direct contact/exposure with the shallow soil and capping will meet the remedial action objective of protection of groundwater quality.	Support agency acceptance is anticipated because there are no risks to human health or the environment from direct contact/exposure with the shallow soil and will involve the complete removal of the impacted soil from the site.
- Community Acceptance	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.	Public acceptance is anticipated because there are no health or environmental risks and the public is not directly affected.



LEGEND

AREAL EXTENT OF CAP

0 50

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

AREAL EXTENT OF PROPOSED CAP FOR ALTERNATIVE 2

DATE	REVISED

PREPARED BY:

LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 6/28/93 | FIGURE: 12.1

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OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Appendix A
Identification and Screening of Remedial Technologies
for Groundwater

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(continued)

A. Groundwater Medium

This appendix presents the initial screening of technologies and process options using the format provided in EPA's CERCLA Guidance (EPA, 1988). The general response actions, remedial technologies and process options are presented as shown in the legend.

The section numbers are referenced on Plate 1 which illustrates the alternative development process.

A.1 No Action ← General Response Action
A.1.1 None ← Remedial Technology
A.1.1.1 Not Applicable ← Process Option

Legend

A.1 No Action

A.1.1 None

A.1.1.1 Not Applicable

Description: No further action is taken.

Applicability: For CERCLA Feasibility Studies, this process option must be considered regardless of applicability.

Preliminary Screening: Retained; this option must be retained.

Secondary Screening: Retained; this option must be retained.
Effectiveness: Does not achieve remedial action objectives.
Implementability: Generally not acceptable to local, state or federal government.
Cost: None.

A.2 Institutional Actions

A.2.1 Access Restrictions

A.2.1.1 Deed Notations

Description: Deed notations are legally enforceable land-use restrictions that are placed on a site. This process can be used to eliminate exposure to soil or groundwater or both on properties where impacted soil and groundwater exist.

Applicability: This process is applicable in all jurisdictions that have deed restricting authority.

Limitations: This process alone does not reduce compound toxicity, mobility or volume; it only reduces the risk of human exposure. The effectiveness of this process depends on continued enforcement.

Preliminary Screening: Retained; this option is potentially applicable for eliminating human exposure to groundwater.

Secondary Screening: Retained.

> Effectiveness: Effectiveness is dependent on continued future implementation. Deed notations do not reduce compound concentrations or migration.
> Implementability: Implementability is dependent on local requirements and jurisdictional authority.
> Cost: Very low capital, no operation and maintenance (O&M).

A.2.1.2 Well Permitting

Description: Groundwater use is legally restricted by selective issuance of well permits to eliminate groundwater exposure routes.

Applicability: This process is applicable in all jurisdictions that issue well permits.

Limitations: This process alone does not reduce compound toxicity, mobility or volume; it only reduces the risk of human exposure. The effectiveness of this process depends on continued enforcement.

Preliminary Screening: Retained; this option is potentially applicable for eliminating human exposure to groundwater.

Secondary Screening: Retained.

Effectiveness: Effectiveness is dependent on continued future implementation. Well permits do not reduce compound concentrations or migration.

Implementability: Implementability is dependent on local requirements and jurisdictional authority.

Cost: Very low capital, no O&M.

A.2.1.3 Physical Restrictions

Description: Land use is physically restricted by erecting barriers to eliminate groundwater exposure routes.

Applicability: This process is applicable to all sites where site conditions and legal circumstances will permit the construction of physical barriers.

Limitations: This process alone does not reduce compound toxicity, mobility or volume; it only reduces the risk of human exposure. The effectiveness of this process depends on continued upkeep of the barriers.

Preliminary Screening: Rejected; groundwater at the Hooker/Ruco site is approximately 55 feet below grade. Therefore, physical restrictions are not required to limit access.

A.2.2 Groundwater Monitoring

A.2.2.1 Periodic Groundwater Monitoring

Description: Groundwater samples are collected and analyzed on a routine basis.

Applicability: This process is applicable to all sites with impacted groundwater.

Preliminary Screening: Retained; this option is potentially applicable for monitoring the groundwater quality.

Secondary Screening: Retained.

Effectiveness: This process is useful for documenting conditions, but does not reduce risk by itself.

Implementability: Easy to implement.

Cost: Very low capital, low to moderate O&M.

A.2.2.2 Continuous Groundwater Monitoring

Description: This process involves automated screening of groundwater on a continuous basis using remote sampling and analysis techniques.

Applicability: This process is applicable to all sites with impacted groundwater.

Preliminary Screening: Rejected; this process is not feasible due to the nature and extent of required monitoring.

A.3 Containment

A.3.1 Vertical Barrier

A.3.1.1 Containment

Description: Vertical slurry-cutoff walls, grout curtains or vibrating beam walls are erected to divert groundwater flow. The barriers are constructed by excavating a narrow trench using an engineered fluid for wall stabilization and backfilling with soil-bentonite, cement-bentonite or composite slurries or by advancing vibrating beams.

Applicability: This process is useful for containing floating compounds, such as fuel oil, within a bermed area. This process is also useful for containing dissolved compounds when used in conjunction with a horizontal barrier or when there is an impermeable base to key into.

Preliminary Screening: Rejected; there is no natural impermeable base to key into at the Hooker/Ruco site. Therefore, this process could only be used effectively in combination with a horizontal barrier and capping, which would result in an extremely high cost. Other technologies offer greater technical and economic feasibility.

A.4 *Extraction*

A.4.1 Pumping

A.4.1.1 Recovery Wells

Description: Wells are used to recover impacted groundwater. Wells that may be used include, but are not limited to, existing wells, new wells and well points.

Applicability: This process is useful for recovering impacted groundwater for treatment or discharge or both.

Preliminary Screening: Retained; this option is applicable for the recovery of impacted groundwater.

Secondary Screening: Retained.

> Effectiveness: Effective in recovering impacted groundwater resulting in ultimate compound reduction.
> Implementability: Easily implemented by conventional construction techniques; local approvals or permits may by needed.
> Cost: Moderate capital, low O&M.

A.4.1.2 Collector Trench

Description: A collector trench is used to recover impacted groundwater.

Applicability: This process is useful for recovering impacted groundwater for treatment or disposal or both.

Preliminary Screening: Rejected; the depth to groundwater at the Hooker/Ruco site renders this option technically infeasible.

A.5 Treatment

A.5.1 Solids Removal

A.5.1.1 Filtration

Description: Suspended solids are removed from a liquid by passing the liquid through a porous medium.

Applicability: Wastewaters containing suspended solids can be treated with this process.

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Benefits: Various media are available; some are capable of removing particles less than 1 micron in diameter.

Limitations: Compounds may build up (fouling) which will decrease the hydraulic capacity of the filter.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of removing precipitated metals in the wastewater.

Secondary Screening: Retained; potentially applicable for metals treatment.
Effectiveness: Effective in removing precipitated metals.
Implementability: Easily implementable using readily available technology.
Cost: Low capital, low O&M.

A.5.1.2 Evaporation

Description: Evaporation is the physical separation of a liquid from dissolved and suspended solids. This process involves the application of energy to evaporate the liquid.

Applicability: This process can be used to treat any mixture of liquids and nonvolatile solids provided the liquid is volatile enough to evaporate under reasonable heating or vacuum conditions (both the liquid and solid should be stable under those conditions).

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Preliminary Screening: Rejected; evaporation is effective at treating wastewater containing solids at low flow rates. The process is not designed to treat dilute solutions at high flow rates typical of the groundwater that would be recovered at the Hooker/Ruco site.

A.5.1.3 Sedimentation/Clarification

Description: Wastewater is introduced to a containment vessel (clarifier) where heavy solids settle by gravity and collect at the bottom of the vessel resulting in liquid/solid separation.

Applicability: Wastewater containing solids with a specific gravity greater than water can be treated with this process.

Benefits: Flocculation and clarification can be combined with the aid of chemical coagulants. Parallel coalescing plates can be used to aid in settling, and thereby, reduce the time required by conventional clarifiers.

Limitations: This process is not suitable for wastes containing emulsified water.

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of removing precipitated metals in the wastewater.

Secondary Screening: Retained; potentially applicable for metals treatment.
- Effectiveness: Effective in removing precipitated metals when used in conjunction with flocculation and chemical precipitation.
- Implementability: Easily implementable using readily available technology.
- Cost: Moderate to high capital, low O&M.

A.5.1.4 Centrifugation

Description: Components of a fluid mixture are separated, based on their relative density, by rapidly rotating the fluid mixture within a rigid vessel.

Applicability: This process can be used for dewatering sludges, separating oils from water, clarification of viscous gums and resins.

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Limitations: Centrifuges often cannot be used for clarification since they may fail to remove less dense solids and those which are small enough to remain in suspension.

Preliminary Screening: Rejected; centrifugation is effective at dewatering sludges. The process is not designed to treat dilute solutions at high flow rates typical of the groundwater that would be recovered at the Hooker/Ruco site.

A.5.1.5 Flocculation

Description: The wastewater is mixed with a flocculating chemical. Flocculants adhere to suspended solids so the resultant particles are too large to remain in suspension and settle out. This process is used in conjunction with sedimentation/clarification (see Section A.5.1.3).

Applicability: Wastewater containing suspended solids (primarily inorganics) can be treated with this process.

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Limitations: The time required for complete flocculation is dependent upon the flow rate, the composition and pH of the wastestream. This process is not recommended for high viscosity wastestreams.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of removing precipitated metals in the wastewater.

Secondary Screening: Retained; potentially applicable for metals treatment.
- Effectiveness: Effective in removing precipitated metals when used in conjunction with sedimentation/clarification and chemical precipitation.
- Implementability: Easily implementable using readily available technology.
- Cost: Moderate capital, moderate O&M.

A.5.1.6 Dissolved Air Flotation

Description: Wastewater is treated in a dissolved air flotation chamber. Dissolved air is precipitated out of solution to form micro bubbles which adhere onto small particles causing them to float. A skimmer then removes the floating waste.

Applicability: Wastewater containing solids with densities close to water can be treated with this process.

Residual Products: Sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of removing precipitated metals in the wastewater.

Secondary Screening: Rejected; effectiveness.

Effectiveness: Effective in removing precipitated metals, however it is generally less effective than other retained technologies.

Implementability: Easily implementable using readily available technology.

Cost: Moderate capital, low O&M.

A.5.2 Gas-Phase Separation

As a general rule, compounds having Henry's Law Constants greater than 10^{-3} atm m^3/mol (atmosphere-cubic meter per mole) are "easy to strip". Those with Henry's Law Constants between 10^{-3} and 10^{-4} atm m^3/mol are "difficult to strip", and below 10^{-4} atm m^3/mol are "non-strippable".

A.5.2.1 Spray Aeration

Description: Wastewater is pumped through spray nozzles that break the liquid stream into fine droplets. The volatile compounds in the wastewater volatilize into the vapor phase via mass transfer processes. The wastewater can be injected into the open air or into a tower to provide contact between the atmospheric air and the water.

Applicability: Wastewater containing compounds with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.2).

Residual Products: This process produces air emissions. Based on mass transfer calulations, treatment of the off gases are not required.

Limitations: This process is generally less efficient than packed tower or tray aeration.

Preliminary Screening: Rejected; this process will not treat the tentatively identified compounds (TICs) and metals, and other gas-phase separation processes offer greater efficiency for the removal of volatile organic compounds (VOCs).

A.5.2.2 Mechanical Aeration

Description: The volatile compounds in the wastewater volatilize into the vapor phase via mass transfer processes. Air is introduced to the wastewater by mechanical means. Aerators utilize water falling through a rotor for aspiration and rotation. An air flow damper is provided for control of air input and evaporation. The contents of a tank are circulated providing continuous contact between the atmospheric air and the water.

Applicability: Wastewater containing compounds with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.2).

Residual Products: This process produces air emissions. Based on mass transfer calulations, treatment of the off gases are not required.

Benefits: A model is available that is self-cleaning and can handle up to 15 mgd (millions gallons per day).

Limitations: This process is generally less efficient than packed tower or tray aeration.

Preliminary Screening: Rejected; this process will not treat the TICs and metals, and other gas-phase separation processes offer greater efficiency for the removal of VOCs.

A.5.2.3 Packed Tower Aeration

Description: Volatile compounds in the wastewater volatilize into the air phase via mass transfer processes. Mass transfer takes place in an aeration unit filled with a packing material with a large surface area. The water flows down through the packed bed, exposing a large surface area for mass transfer into the air which enters at the bottom of the tower. Packing material can be randomly dumped or stacked in the aeration unit.

Applicability: Wastewater containing compounds with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.2).

Residual Products: This process produces air emissions. Based on mass transfer calulations, treatment of the off gases are not required.

Benefits: This process is available with air emission control devices. Removal efficiencies in excess of 99.9 percent are possible.

Limitations: Mineral oxidation may result in the accumulation of precipitates in the packing. To prevent this, the packing must be cleaned and changed periodically. The stripping efficiency will vary with changes in the ambient temperature as well as the presence of suspended solids in the wastestream.

Preliminary Screening: Retained; although this process will not treat the TICs and metals, it may be applicable as a secondary treatment for VOCs.

Secondary Screening: Retained; potentially applicable for effluent polish.
Effectiveness: Very effective in removing VOCs in the wastestream.
Implementability: Commercially available and readily implementable.
Cost: Low capital, low to moderate O&M.

A.5.2.4 Tray Aeration

Description: Volatile compounds in the wastewater are volatilized into the air phase via mass transfer processes. Mass transfer takes place in an aeration unit filled with regularly spaced trays or plates allowing for staged contact between the liquid and vapor phases. The vapor passes through openings in each tray and contacts the liquid flowing across the tray. A quantity of liquid is retained on each tray by a weir. To reach the next stage, the liquid flows over the weir through a downcomer which provides sufficient volume and enough residence time for the liquid to be freed of entrained vapor before entering the next tray.

Applicability: Wastewater containing compounds with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.2).

Residual Products: This process produces air emissions. Based on mass transfer calulations, treatment of the off gases are not required.

Preliminary Screening: Retained; although this process will not treat the TICs and metals, it may be applicable as a secondary treatment for VOCs.

Secondary Screening: Rejected, cost. Other gas-phase separation processes offer equal efficiency and lower cost.
Effectiveness: Very effective in removing VOCs in the wastestream.
Implementability: Commercially available and readily implementable.
Cost: Moderate capital, low to moderate O&M.

A.5.2.5 Diffused Aeration

Description: Volatile compounds in the wastewater are volatilized into the air phase via mass transfer processes. Air is injected into the wastewater using a sparging device or porous diffusers which produce a multitude of fine bubbles. As the bubbles rise, mass transfer occurs across the water-air interface until the bubbles either leave the water column or becomes saturated with the compound.

Applicability: Wastewater containing compounds with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.2).

Residual Products: This process produces air emissions. Based on mass transfer calulations, treatment of the off gases are not required.

Limitations: This process is generally less efficient than packed tower or tray aeration.

Preliminary Screening: Rejected; this process will not treat the TICs and metals, and other gas-phase separation processes offer greater efficiency for the removal of VOCs.

A.5.2.6 Steam Stripping

Description: Steam is used to evaporate volatile organics from wastewater. This process operates like an airstripper, only steam is used instead of air.

Applicability: Wastewater containing compounds less volatile and more soluble than those for which airstripping is applicable (see Section A.5.2) can be treated with this process. This process is most effective for low continuous flows or batch treatment of concentrated volatile organic aqueous mixtures.

Benefits: *Products of treatment are high quality water and a very small volume of nearly* 100 percent liquid organic compounds.

Residual Products: This process produces air emissions and steam condensate. Based on mass transfer calulations, treatment of the off gases are not required. Depending on the characteristics of the steam condensate, it may be classified as a hazardous waste.

Preliminary Screening: Rejected; this process will not treat the TICs and metals, and other gas-phase separation processes offer much greater technical and economic feasibility for the removal of VOCs.

A.5.2.7 Distillation

Description: Wastewater is evaporated and condensed to separate out volatile organics.

Applicability: Wastewater containing concentrated miscible organic solvents and low flow rates are most effectively treated by this process.

Residual Products: Sludge and recovered compounds are produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Limitations: Distillation for recovery can be limited by the presence of either volatile or thermally reactive suspended solids.

Preliminary Screening: Rejected; this process is designed to separate concentrated solutions at low flow rates. The process is not designed to treat dilute solutions at high flow rates typical of the groundwater that would be recovered at the Hooker/Ruco site.

A.5.3 Chemical Treatment

A.5.3.1 Chemical Precipitation

Description: The pH of an aqueous wastestream is adjusted to the point of a metal's minimum solubility. At this point the dissolved metal ions form a solid which precipitates out of solution, usually as a hydroxide molecule.

Applicability: Wastewater containing dissolved metals can be treated with this process.

Limitations: Pretreatment is sometimes required to remove substances that interfere with the precipitation process. Cyanide and ammonia form complexes with many metals that limit the removal achieved by precipitation.

Residual Products: Metal hydroxide sludge is produced which will require disposal. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of decreasing the metal concentrations in the wastewater.

Secondary Screening: Retained; potentially applicable for metals treatment.
- Effectiveness: Effective for treating wastewater containing dissolved metals when used in conjunction with sedimentation/clarification and flocculation.
- Implementability: Easily implementable, and automated systems are available.
- Cost: Moderate capital, moderate O&M.

A.5.3.2 Chemical Oxidation

Description: Oxidants, such as chlorine, ozone, hydrogen peroxide and potassium permanganate are introduced to a wastewater to oxidize compounds to terminal end products or to intermediate products that are more readily biodegradable or more readily removed by adsorption. This process may be enhanced by ultra violet (UV) light.

Applicability: Wastewater with low concentrations of organic compounds, dissolved iron and manganese, phenols and odorous compounds can be treated with this process.

Benefits: If carried to completion, the reaction products of hydrocarbon oxidation are carbon dioxide and water. No vapor emissions or solid residue remain.

Limitations: The effectiveness is pH and catalyst dependent, and also depends on the type and concentration of organic compounds, the light transmittance of the wastewater, the UV and hydrogen peroxide dosage and the mixing efficiency.

Residual Products: No hazardous residual products are produced.

Preliminary Screening: Retained; this option is potentially applicable for treating the wastestream at the Hooker/Ruco site.

Secondary Screening: Retained; potentially applicable for primary treatment.
Effectiveness: Effectiveness to be determined by treatability studies.
Implementability: Easily implementable, and automated systems are available.
Cost: High capital, moderate O&M.

A.5.3.3 Wet Air Oxidation

Description: Wet air oxidation destroys organics in wastewater by breaking down complex molecular structures into simpler components. Organics are oxidized in water in the absence of flames at pressures of 500 to 3,000 psig (pound per square inch gauge) and at elevated temperatures of 20 to 500^{0}C. Oxygen becomes very soluble when added at this point and consequently acts as an oxidizing agent in the wastestream.

Applicability: High-strength industrial wastewater with carbon oxygen demand (COD) values greater than 10,000 mg/l (milligrams per liter), organic wastewater too dilute to incinerate economically and too toxic to biologically treat can be treated with this process.

Residual Products: No hazardous residual products are produced.

Preliminary Screening: Rejected; constituents of the wastestream at the Hooker/Ruco site do not exhibit characteristics that meet this technology's applicability. The highest COD value reported for the onsite groundwater was 41 mg/l which is far below the concentration required for this process.

A.5.3.4 Hydroxyl Radical Treatment

Description: Municipal sewage or industrial effluents that contain from as low as 0.1 percent to as high as 10 percent salt are passed through reactor electrodes to liberate nascent chlorine, ozone and their respective hydroxyl/free radicals. These agents destroy, neutralize and oxidize all oxidizable organics. This process also sterilizes the wastewater and removes color and odors, rendering the effluent safe for disposal purposes.

Applicability: Wastewater containing oxidizable organics (PCBs, dioxin, carbon tetrachloride, toluene, etc.) can be treated with this process.

Residual Products: No hazardous residual products are produced.

Benefits: Rock salt can be added to increase the salt concentration. No other chemicals are required. Treatment systems can be designed for flow rates of up to 4,000 gpm (gallons per minute).

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of decreasing the organic concentrations in the wastewater.

Secondary Screening: Rejected; similar technologies are more cost effective.
Effectiveness: Effective for treating wastewater containing salt.
Implementability: Easy to install; daily cleaning is required.
Cost: High capital, high O&M.

A.5.4 Adsorption

Wastewater is brought in contact with an adsorbent by a variety of means. Compounds in the wastewater adhere to the surface of the adsorbent medium, and the wastewater is discharged.

A.5.4.1 GAC Adsorption

Description: Wastewater is passed through a bed of activated carbon. Organics in the wastewater adsorb onto the carbon, and the treated water is discharged.

Applicability: Wastewater containing organic chemicals with low solubility, certain metals, total organic carbon and ammonia can be treated with this process.

Residual Products: Spent carbon is produced which will require disposal. Depending on the characteristics of the carbon, RCRA disposal requirements may apply.

Benefits: This process offers both adsorption and filtration. Segregated carbon regeneration is available.

Limitations: To control carbon expenditure, rule of thumb guidelines indicate that concentrations of organic solutes, suspended solids, dissolved inorganics and oil and grease should be less than 10,000, 50, 10 and 10 ppm, respectively. When daily carbon usage approaches 1,000 pounds per day, onsite carbon regeneration may become cost effective.

Preliminary Screening: Retained; this technology is potentially applicable for treating the wastestream at the Hooker/Ruco site.

Secondary Screening: Retained; potentially applicable for primary treatment.
Effectiveness: Effectiveness to be determined by treatability studies.
Implementability: Easily implementable; disposal or regeneration of spent carbon is required.
Cost: High capital, moderate to high O&M.

A.5.4.2 Ion Exchange

Description: Wastewater is passed through a bed of ion exchange resin. Non-hazardous ions on the resin are exchanged for hazardous ions in the wastewater, and the treated water is discharged.

Applicability: Wastewater containing toxic metals can be treated with this process.

Residual Products: Spent resin and spent regenerants (acid, caustic or brine) are produced which will require disposal or regeneration. Depending on the characteristics of the spent materials, RCRA disposal requirements may apply.

Limitations: The efficiency of this process is affected by selective competition, pH and suspended solids. Concentrated (25,000 mg/l compounds) wastestreams can usually be separated more cost effectively by other means. High solids concentrations (greater than about 50 mg/l) may cause resin blinding.

Preliminary Screening: Retained; although this technology in itself will not meet the treatment objectives, this technology is potentially applicable as a means of decreasing the metal concentrations in the wastewater.

Secondary Screening: Rejected; effectiveness.
Effectiveness: Effective for treating groundwater containing metal cations, however it is generally less effective than other retained technologies.
Implementability: Pretreatment necessary to avoid membrane fouling.
Cost: High capital, moderate to high O&M.

A.5.5 Membrane Filtration

A.5.5.1 Membrane Filtration

Description: Wastewater flows across a membrane surface. Water and low molecular weight solutes pass through the membrane and are removed as permeate. Emulsified oils and suspended solids are rejected by the membrane and are removed as concentrate.

Applicability: Wastewater containing emulsified oils and suspended solids can be treated by this process.

Residual Products: A concentrated solution is produced which will require disposal. Depending on the characteristics of the solution, RCRA disposal requirements may apply.

Benefits: Cross flow prevents filter cake build up, and high filtration rates can be maintained continuously.

Preliminary Screening: Rejected; the groundwater at the Hooker/Ruco site does not contain emulsified oils.

A.5.5.2 Reverse Osmosis

Description: A pressurized semi-permeable membrane attracts compounds from a dilute wastestream to a more concentrated solution (opposite of normal osmosis).

Applicability: Wastewater containing dissolved organics and dissolved salts can be treated with this process.

Residual Products: A concentrated solution is produced which will require disposal. Depending on the characteristics of the solution, RCRA disposal requirements may apply.

Limitations: For an efficient reverse osmosis process, the chemical and physical properties of the semi-permeable membrane must be compatible with the wastestream's chemical and physical characteristics. Some membranes may be dissolved by certain wastes. Suspended solids and certain organics will clog the membrane material, and low-solubility salts may precipitate onto the membrane surface. A very high quality feed is required to operate a reverse osmosis unit efficiently. The pH of the feed should be adjusted to a range of 4.0 to 7.5 to inhibit scale formation.

Preliminary Screening: Rejected; the process is not designed to treat dilute solutions at high flow rates typical of the groundwater that would be recovered at the Hooker/Ruco site.

A.5.6 Biological Treatment

A.5.6.1 Anaerobic Digestion

Description: Wastewater is passed through a contact chamber and then passed through a degasifier and a clarifier. The solids from the clarifier are recycled to the contact chamber, and the treated water is discharged. The hydraulic retention time varies with variations in this process.

Applicability: Organic wastes with both high and low nutrient concentrations can be treated by this process. It is particularly useful for the stabilization of concentrated sludges produced during wastewater treatment.

Residual Products: Methane, carbon dioxide and sludge are produced by this process. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Benefits: Nutrient requirements are lower than aerobic treatment systems.

Limitations: Slow growth rate of methanogenic bacteria requires a retention time of 15 to 60 days. Operational problems result from imbalances of microbial populations. The system requires close supervision, and cannot be shut down for extended periods of time (two weeks or longer).

Preliminary Screening: Rejected; the process is not designed to treat dilute solutions typical of the groundwater that would be recovered at the Hooker/Ruco site. Additionally, a full time operator would be required to operate this process, resulting in a high operating cost.

A.5.6.2 Aerobic Digestion

Description: Wastewater and sludge are passed through an aeration chamber, but do not mix. The effluent is passed to a clarifier where the sludge is collected and recycled to the aeration chamber and the liquid is discharged.

Applicability: Organic wastes with high nutrient concentrations can be treated by this process.

Residual Products: Carbon dioxide, water and sludge are produced. Depending on the characteristics of the sludge, RCRA disposal requirements may apply.

Limitations: All microorganisms require adequate levels of inorganic and organic nutrients, water, oxygen, carbon dioxide, and sufficient biological space for survival and growth. Aerobic degradation is usually carried out in processes in which all or many of the requisite environmental conditions can be controlled. To continue to produce and function properly, an organism must have a source of energy and carbon for the synthesis of new cellular material: carbon dioxide and/or organic matter.

Preliminary Screening: Rejected; the process is not designed to treat dilute solutions typical of the groundwater that would be recovered at the Hooker/Ruco site. Additionally, a full time operator would be required to operate this process, resulting in a high operating cost.

A.6 Discharge

A.6.1 Discharge to Treatment Works

A.6.1.1 Discharge to Cedar Creek POTW

Description: The treated effluent is discharged to publicly owned treatment works.

Preliminary Screening: Retained; this option is potentially applicable for offsite discharge of the treated water at the Hooker/Ruco site.

Secondary Screening: Rejected; implementability.
Effectiveness: Very effective as a discharge option.
Implementability: Cedar Creek POTW will not accept discharge from a groundwater remediation project.
Cost: Low capital, moderate O&M.

A.6.2 Discharge to Surface Water

A.6.2.1 Discharge to Surface Water

Description: The treated effluent is discharged to surface water.

Limitations: A SPDES permit must be obtained for discharge.

Preliminary Screening: Rejected; there are no available surface-water bodies.

A.6.3 Discharge to Groundwater

A.6.3.1 Discharge to Injection Wells

Description: The treated effluent is discharged to injection wells to recharge the aquifer.

Preliminary Screening: Retained; this option is potentially applicable for onsite discharge of the treated wastewater at the Hooker/Ruco site.

Secondary Screening: Rejected, implementability and cost.
Effectiveness: Effective in high permeability soils.
Implementability: May be difficult to implement because of the sole-source aquifer status of Long Island.
Cost: Moderate to high capital, high O&M.

A.6.3.2 Discharge to Settling Basin

Description: The treated effluent is discharged to a settling basin to recharge the aquifer.

Preliminary Screening: Retained; this option is potentially applicable for onsite discharge of the treated wastewater at the Hooker/Ruco site.

Secondary Screening: Retained.
Effectiveness: Effective in high permeability soils.
Implementability: There are existing settling basins onsite which may be utilized.
Cost: Low capital, low O&M.

A.6.3.3 Discharge to Leaching Galleries

Description: The treated effluent is discharged to leaching galleries to recharge the aquifer.

Preliminary Screening: Retained; this option is potentially applicable for onsite discharge of the treated wastewater at the Hooker/Ruco site.

Secondary Screening: Retained.
Effectiveness: Effective in high permeability soils.
Implementability: Requires moderate land area.
Cost: Moderate capital, low O&M.

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HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Appendix B
Groundwater Flow Model Report

GROUNDWATER FLOW MODEL OF THE HOOKER/RUCO SITE HICKSVILLE, NEW YORK

Prepared For

Occidental Chemical Corporation

July 1993

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water and Environmental Services
72 Danbury Road
Wilton, CT 06897

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(continued)
(at end of report)

GROUNDWATER FLOW MODEL OF THE HOOKER/RUCO SITE HICKSVILLE, NEW YORK

INTRODUCTION

Purpose and Scope

A groundwater flow model has been developed to assist in the specifications of potential pump-and-treat systems at the Hooker/Ruco site in Hicksville, New York. This report describes the development and use of the groundwater flow model.

GROUNDWATER FLOW MODEL

The physical system, described in the Feasibility Study (FS) section on Hydrogeology, Section 2.2.2, is the basis for the groundwater flow model. A model that simulates actual aquifer behavior provides a powerful tool to test the understanding and concepts of the flow system. Although simplified from the physical system, a model should be consistent with all known hydrogeologic observations.

Model Construction

The United States Geological Survey's finite-difference digital model (MODFLOW) developed by McDonald and Harbaugh (1988) was used in this study. The finite-difference computer model requires that the study area be divided into discrete sub-areas (blocks), and that a finite-difference approximation of the continuous differential equation be solved for each block for specified boundary conditions and aquifer hydraulic properties. A rectangular grid defines the discretization and arrangement of the blocks in the model. In the center of each block is a node. The model grid dimensions are 2,500 feet by 2,500 feet and include the study area. The grid is discretized into a matrix of 33 rows by 59 columns (figure 1). There are 1,947 active nodes for each layer; 5,841 nodes total.

The model consists of three aquifer layers: the Upper Magothy aquifer, the Mid Magothy aquifer and the Lower Magothy aquifer. The aquifer layers are separated by discontinuous clay layers within the study area. Thicknesses of these clay units range from 0 to 20 feet. The lower vertical boundary in the model is at the Raritan Clay. The water table lies within the Upper Magothy which is overlain by unsaturated, unconsolidated sediments.

Assumptions

A three-layer aquifer model was constructed to represent the flow system in and around the Hooker/Ruco site. The relation between the geologic units of the natural system, hydrogeologic units of the conceptual model and equivalent units in the groundwater flow model is shown in figure 2.

The following assumptions were made to simulate the groundwater system:

1. The bottom of the model is assumed to be a no-flow boundary, because the clay unit below the Magothy Aquifer, the Raritan Clay, is assumed to have little, if any, vertical leakage down into the Lloyd Formation.

2. By definition, the hydraulic characteristics of the geologic units are homogeneous within a block of the finite-difference grid.

3. Flow within each layer is horizontal; flow (leakage) between the layers is vertical.

4. The axes of the model grid are oriented in the north-south and east-west directions with the north-south axes aligned parallel to the groundwater flow.

5. The groundwater system is at steady state.

The grid blocks are variably-sized to accommodate more detail in the Hooker/Ruco site, and to separate monitoring wells into individual grid blocks to aid in a more precise calibration. The dimensions of the smallest grid blocks, located in the center of the grid within the plant site, are 25 feet by 25 feet and the largest grid blocks, at the boundaries, are 100 feet by 100 feet. The smallest grid blocks were used in areas where it was necessary to provide greater detail for potential future analysis.

Boundary Conditions

The model is three dimensional, so it is necessary to define both the vertical and horizontal boundaries. Vertically, the upper boundary is the water table, in the Upper Magothy aquifer, and the lower boundary is the top of the Raritan Clay.

The boundaries between layers 1 and 2 and layers 2 and 3 are, geologically, discontinuous clay units throughout the area. Within the plant site, two known areas of thick clay are in the southwest and northeast areas of the site (figures 3 and 4). These clays exist at varying thicknesses between layers 1 and 2 and layers 2 and 3. The boundaries where the clay lenses are not present, where the aquifers directly overlie other aquifers, are modeled as having high leakage. The quantitative value used for these high leakage values is approximated based on vertical conductivities of the two aquifers.

The clay unit that does continually exist, the Raritan Clay, is considered to be of low leakage to no leakage to aquifers below and, therefore, serves as a no-flow boundary and the base of the model.

Horizontally, the northern boundary of the modeled area is simulated as a constant-head boundary in layer 1, and as an active flow boundary in layers 2 and 3. The groundwater flow direction is north to south, therefore, the east and west boundaries are simulated as no-flow in each of the three layers. The southern boundary in layer 1 is simulated as a constant-head boundary, and layers 2 and 3 as head-dependent flux boundaries allowing the water entering the groundwater system to leave the system.

Calibration

The process of adjusting the input to produce the best match between simulated and observed water levels is known as calibration.

The computer model constructed for this particular study was simulated using steady-state conditions. It was calibrated by minimizing the difference between simulated and observed water levels. The simulated water levels were compared with 36 water levels taken from wells measured on December 22, 1989, the most complete and representative collection of data available. Water levels were used for comparison in 16 wells for layer 1, 7 wells for layer 2, and 13 wells for layer 3.

The model was calibrated by adjusting global multipliers of conductivity of the Upper Magothy (layer 1), and transmissivities in the Mid and Lower Magothy (layers 2 and 3). The leakage through the different aquifer layers was modified by uniformly adjusting the vertical conductance as the transmissivity was adjusted. Final hydraulic conductivities used in the model are listed in table 1. Recharge was not adjusted during calibration because 23 inches per year is a realistic value for recharge in the study area. Calibrated values for hydraulic properties were within the range of those determined by the aquifer tests, slug tests and specific capacity tests as reported in previous regional and site-specific investigations on Long Island.

Several methods are used in finding the "best" estimated model. One method is an error analysis of simulated and observed water levels at nodes representing control points. The root mean square error (RMSE) is used to judge how closely the model simulation matched the natural system, which was defined by the measured water levels. The best RMSE in the Upper Magothy aquifer was about 0.37; in the Mid Magothy aquifer about 0.39; and in the Lower Magothy aquifer about 0.45. Over 85 percent of the simulated water levels were within 0.5 foot of the observed water levels. The simulated heads were consistently higher than the observed heads throughout the study area.

Model-simulated water levels for each layer are considered to be a good representation of the overall flow system. Figures 5 and 6 show the Upper and Mid Magothy simulated as model layers 1 and 2, respectively.

Sensitivity Analysis

The sensitivity of the model to changes in various model-input parameters was evaluated by sensitivity analysis. The relative sensitivity of the model to these changes indicated the degree of importance of individual parameters to the simulation of groundwater flow, and can provide an indication of the uniqueness of the model calibration. For example, if similar model results are obtained when a model-input parameter is varied over a large range of values from the calibrated value, then the model is insensitive to that parameter and the model solution can be considered as non-unique. Additionally, if the model is insensitive to a parameter, then obtaining additional field information to refine knowledge of that parameter would do little to improve model results.

Each parameter was adjusted uniformly over the entire model area, and the RMSE was calculated and compared to the calibrated RMSE values. The parameters were evaluated independently of one another.

The subsequent effects of these variations on calculated water levels in the three aquifers were evaluated by RMSE comparison of observed and simulated water levels for December 1989 conditions. The most significant results of the sensitivity analysis were graphed and are shown in figure 7 for the three aquifers.

Hydraulic conductivity for each of the aquifers was adjusted individually for each of the three layers: Upper Magothy, Mid Magothy and Lower Magothy aquifers, while the other two layers were held constant. The model is most sensitive to increases in hydraulic conductivities for layers 1 and 3, and decreases in layer 3. The model is sensitive to decreases in hydraulic conductivity in layer 1 and insensitive to any change in hydraulic conductivity of layer 2 (figure 7).

The model is sensitive to decreases in vertical conductivity (vertical leakage) between layers 1 and 2, and sensitive to increases in vertical conductivity between layers 1 and 2 and decreases in vertical conductivity between layers 2 and 3. The model is insensitive to increases in vertical conductivity between layers 2 and 3 (figure 7).

These results indicate that the most sensitive parameter is the hydraulic conductivity of layer 3 followed by increases in hydraulic conductivity of layer 1 and decreases in vertical conductivity between layers 1 and 2. The results also show that the values used in the calibrated model are reasonable approximations of actual conditions within the aquifer.

CAPTURE ZONE ANALYSIS

The calibrated model was used to analyze pump-and-treat strategies and delineate capture zones. It was determined that the zone of capture should include the H cluster wells, located in the south-central area of the site, the F cluster in the southeast portion of the site, and the E cluster in the east-central area of the site. For purposes of this report, the area which encompasses the cluster wells is known as the site area. Because groundwater flow in the area is generally north to south-southwest, wells along the south and southwest boundaries of the site would capture groundwater flow leaving the site. Well locations were selected on the basis of the proposed capture zone area and accessible areas at the plant site. The wells would pump groundwater from the Upper and Mid Magothy aquifers where the compounds of concern were detected. The water would then be treated and brought back into the groundwater system at the surface by a recharge basin/leaching field located in the northern area of the site or through Sump 3. The location of the basin/field was selected so that the recharge would not alter the groundwater flow pattern close to the pumping wells. The basin/field was modeled as a 125 foot by 150 foot area of recharge equivalent to the amount of water taken out of the system by the wells. The location of the basin/field remained unchanged throughout the model simulations. In addition, Sumps 1, 2, 3 and 4 were also simulated as recharge areas to observe any influence on the groundwater flow in the zone of capture. Recharge variations on two or more of the sumps were tried in an effort to provide a soil flushing option in Sumps 1 and 2. After many model runs, six main strategies were studied.

<u>Strategy 1</u>

One well was placed in the southern boundary of the site pumping 50, 100, 150 and 200 gpm (gallons per minute). Figures 8 and 9 are based on a well pumping at the optimum rate of 100 gpm. The zone of capture is limited, and one well does not cover the western boundary of the site area. Increasing the pumping rate did not extend the area of capture. The basin/field approach was used and can be seen in the figures 8 and 9.

<u>Strategy 2</u>

Two wells were placed in the south-southwest boundary of the site, pumping at combined rates of 50 and 100 gpm (figures 10 and 11) and using the basin/field approach for recharging the aquifer with the water pumped from the wells. Figures 10 and 11 are based on two wells pumping at a combined rate of 100 gpm. The zone of capture, similar to Strategy 1, did not fully contain the site area. The zone of capture also included a lot of area south of the site area and outside the site area. This would not cover the optimum area discussed earlier.

<u>Strategy 3</u>

Three wells were placed along the south-southwest edge of the site. Pumping rates varied within each well between the Upper and Mid Magothy for combined rates of 75, 100 and 150 gpm. Using three wells, at lower individual pumping rates of 25 gpm, and the basin/field recharge area extended the capture zone to include the site area of interest without capturing groundwater outside the site area (figures 12 and 13). In addition, using three wells and Sump 3 as the recharge area did not disrupt the groundwater in the area of capture, so that the water could be brought back into the system through Sump 3 (figures 14 and 15).

Strategy 4

The placement and pumping rates of the three wells in Strategy 3 did not change. A simulation using Sump 4 as a recharge area created a mound of water because of a clay unit, which exists underneath the sump, which prevents the water from recharging back into the aquifer (figures 16 and 17).

Strategy 5

The wells from in Strategy 3 were used at the optimum combined pumping rate of 75 gpm with recharge to Sump 1 located in the southeast edge of the site. Recharging to this area at 75 gpm created a potentiometric high and an area of capture which did not fully cover the site area as preferred (figures 18 and 19). Recharge was then distributed evenly over Sumps 1 and 2 (figures 20 and 21). However, this option did not produce a large enough capture zone to cover the site area.

Strategy 6

Three wells used in Strategy 3 simulated with recharge to Sumps 1 and 2 using a combined recharge rate of 10 gpm and Sump 3 at a recharge rate of 65 gpm (figures 22 and 23). This scenario provides another option which will capture the site area under concern and at the same time allow for soil flushing in Sumps 1 and 2.

Of the strategies discussed, Strategy 3 is the optimum pump-and-treat scenario with well locations shown in figure 24. Strategy 6 is an alternative if soil flushing is necessary in Sumps 1 and 2. However, most of the water is recharged into the system through Sump 3, similar to Strategy 3. In general, more than three wells did not increase the area of capture within the site area any more than the three wells.

SUMMARY OF SIMULATIONS

A digital computer model was constructed and used as a tool to aid in determining optimum pump-and-treat locations within the Hooker/Ruco site. The model-simulated heads were compared with December 1989 water levels and the final calibration shows that most of the simulated heads are within 0.5 foot higher than those observed. The calibrated model was then used to assess pump-and-treat strategies at the Hooker/Ruco site. Six pump-and-treat strategies are presented in this report. The optimum pump-and-treat scenarios are described in Strategy 3 and 6 of the Capture Zone Analysis section of this report. Three wells were pumped using a total pumping rate of approximately 75 gpm (25 gpm per well). Pumping at the locations indicated, at low rates both in the Upper Magothy and Mid Magothy, produces a zone of capture over the entire site area so that any groundwater flowing on or within the site will be captured, treated and brought back into the system through either a recharge basin/leaching field along the northern boundary of the site, through Sump 3 or through Sump 3 and Sumps 1 and 2. Discharging water into the basin/field or Sump 3 creates a dilution effect of recharging clean water with water that has yet to be treated. The placement, within the model, of the basin/field is far enough away from the pumping wells to allow the natural dilution of the water to occur. Recharge to Sumps 1 and 2 allows for soil flushing which may be necessary.

The model was used as a tool to provide optimum well locations to aid in the development of a pump-and-treat facility.

kaf
July 15, 1993
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REFERENCE

McDonald, M. G. and A. W. Harbaugh, 1988, "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model", U.S. Geological Survey Techniques & Water Resources Investigations, Book 6, Chapter A1, 586p.

TABLE

TABLE 1

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Hydrologic Parameters Used in the Hooker/Ruco Model

Aquifer Layer	Aquifer thickness (in feet)	Hydraulic conductivity (gpd/ft^2)[1/]
Upper Magothy	24	103
Mid Magothy	50	403
Lower Magothy	475	1,225

1/ Gallons per day per square foot.

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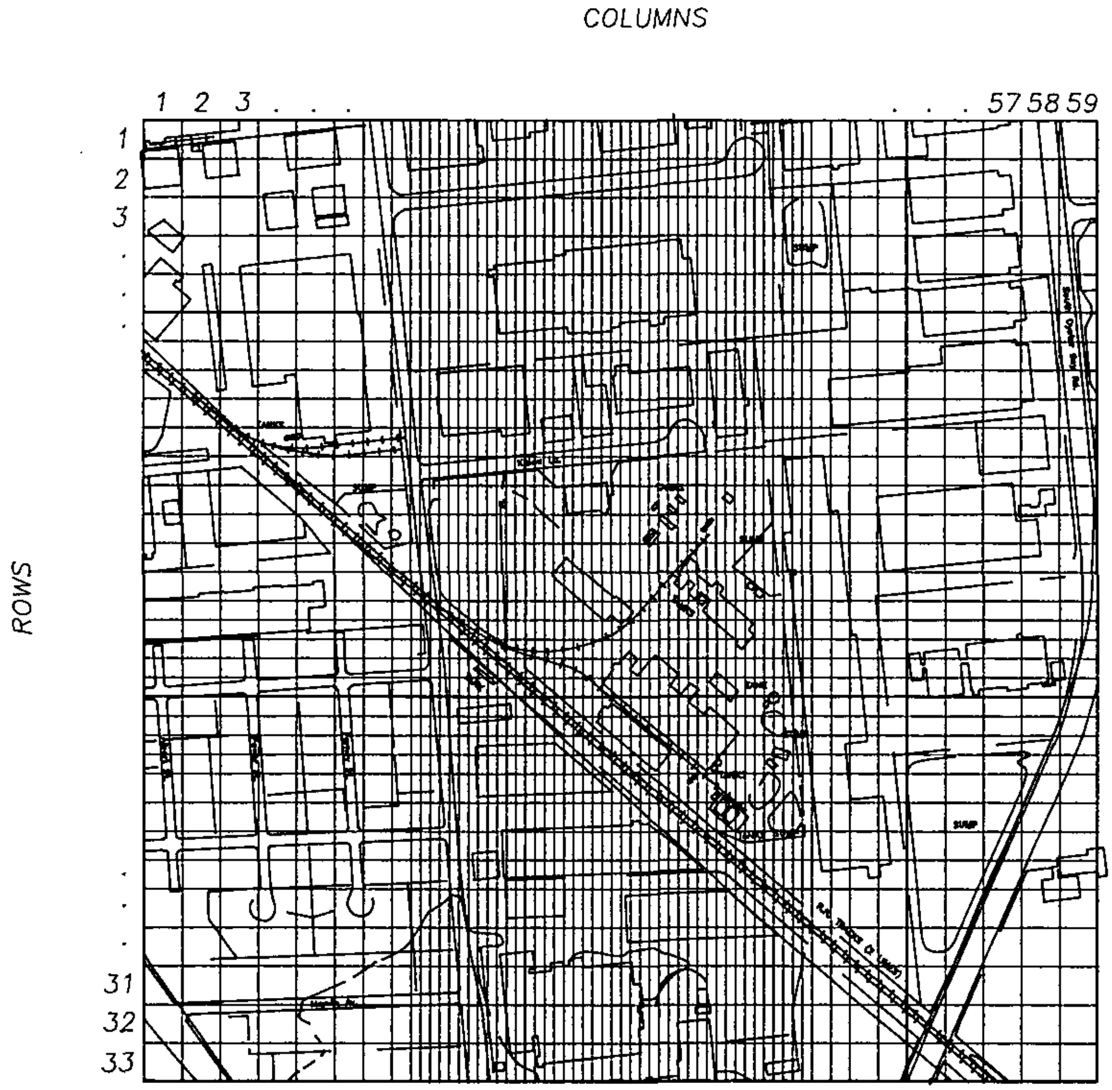
FIGURES



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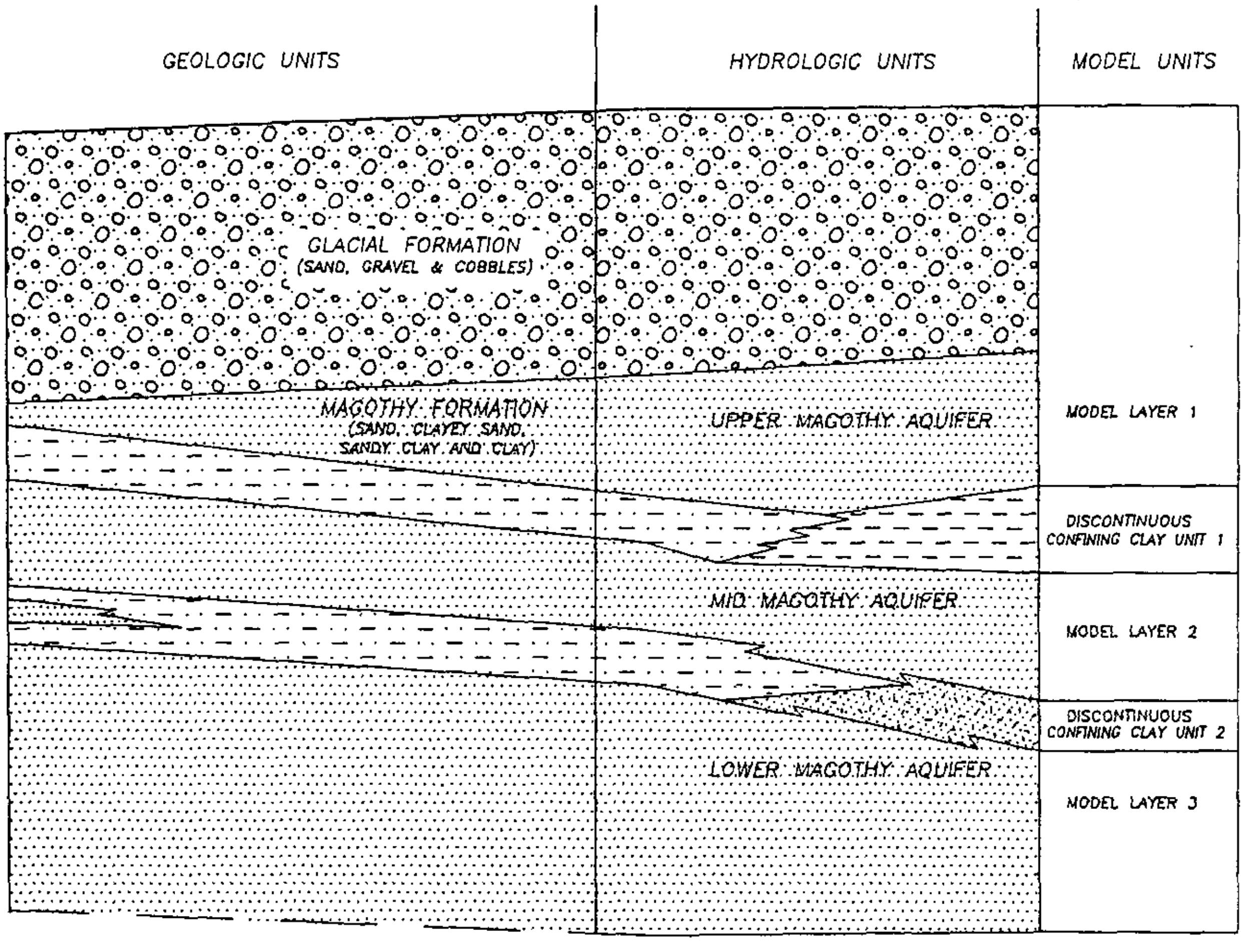
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

MODEL GRID USED AT HOOKER/RUCO SITE

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 1



LEGEND

- SAND, GRAVEL AND COBBLES
- SAND, CLAYEY SAND, SANDY CLAY AND CLAY
- CLAY
- CLAYEY SAND
- SILT

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HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

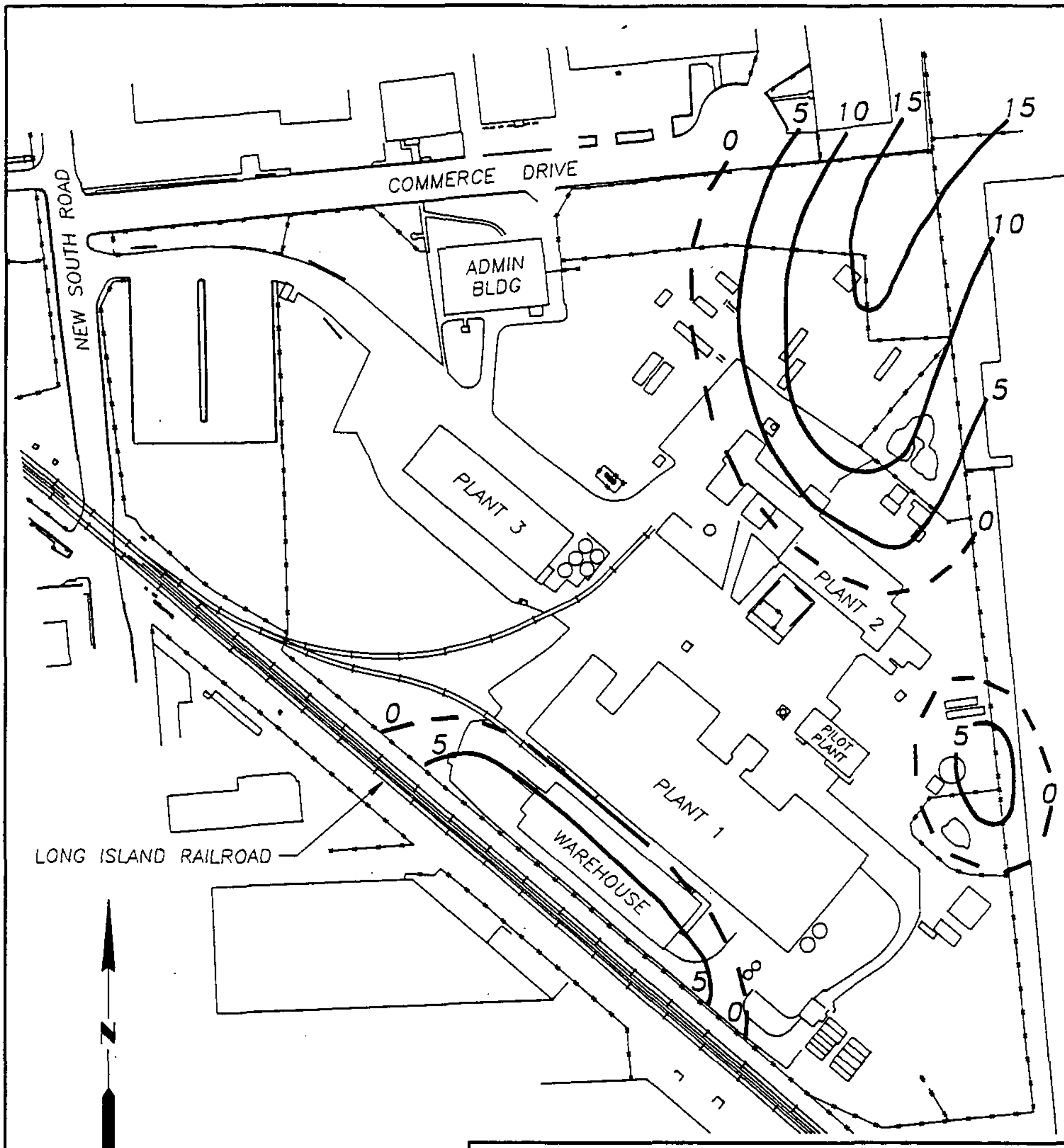
RELATION BETWEEN GEOLOGIC UNITS, HYDROLOGIC UNITS AND EQUIVALENT UNITS IN THE GROUNDWATER FLOW MODEL

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water and Environmental Services
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 3/11/93 FIGURE: 2



LEGEND

— DENOTES APPROXIMATE THICKNESS AND NUMBER OF THE SHALLOW CLAY UNIT

0 150
SCALE IN FEET

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HICKSVILLE, NEW YORK

DISCONTINUOUS CLAY BETWEEN LAYERS 1 & 2

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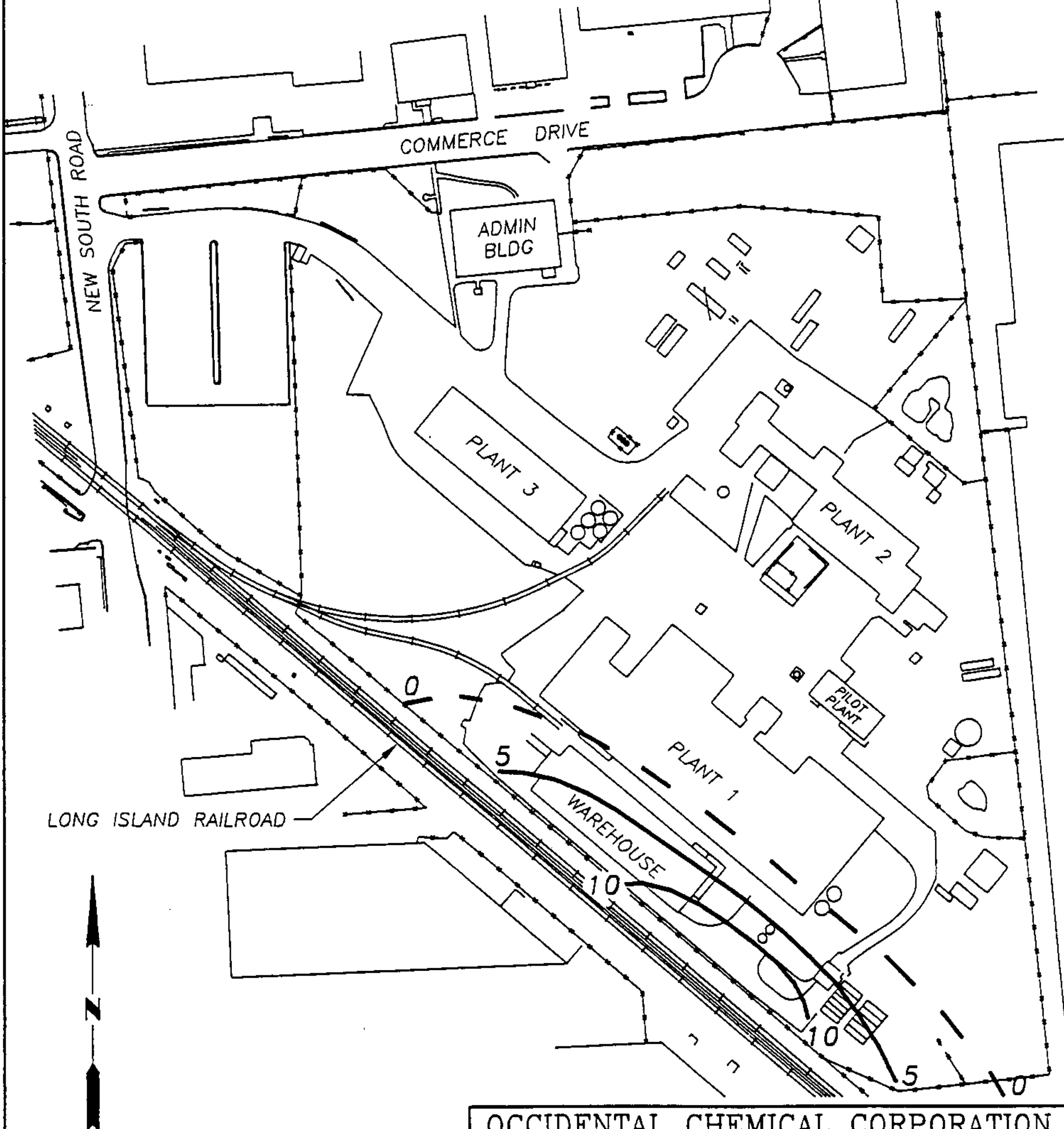
PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/18/93 | FIGURE: 3



LEGEND

DENOTES APPROXIMATE THICKNESS OF DEEP CLAY UNIT

0 150
SCALE IN FEET

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DISCONTINUOUS CLAY BETWEEN LAYERS 2 & 3

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PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/18/93 FIGURE: 4

LEGEND

OBSERVED POTENTIOMETRIC SURFACE

SIMULATED POTENTIOMETRIC SURFACE

0 500

SCALE IN FEET

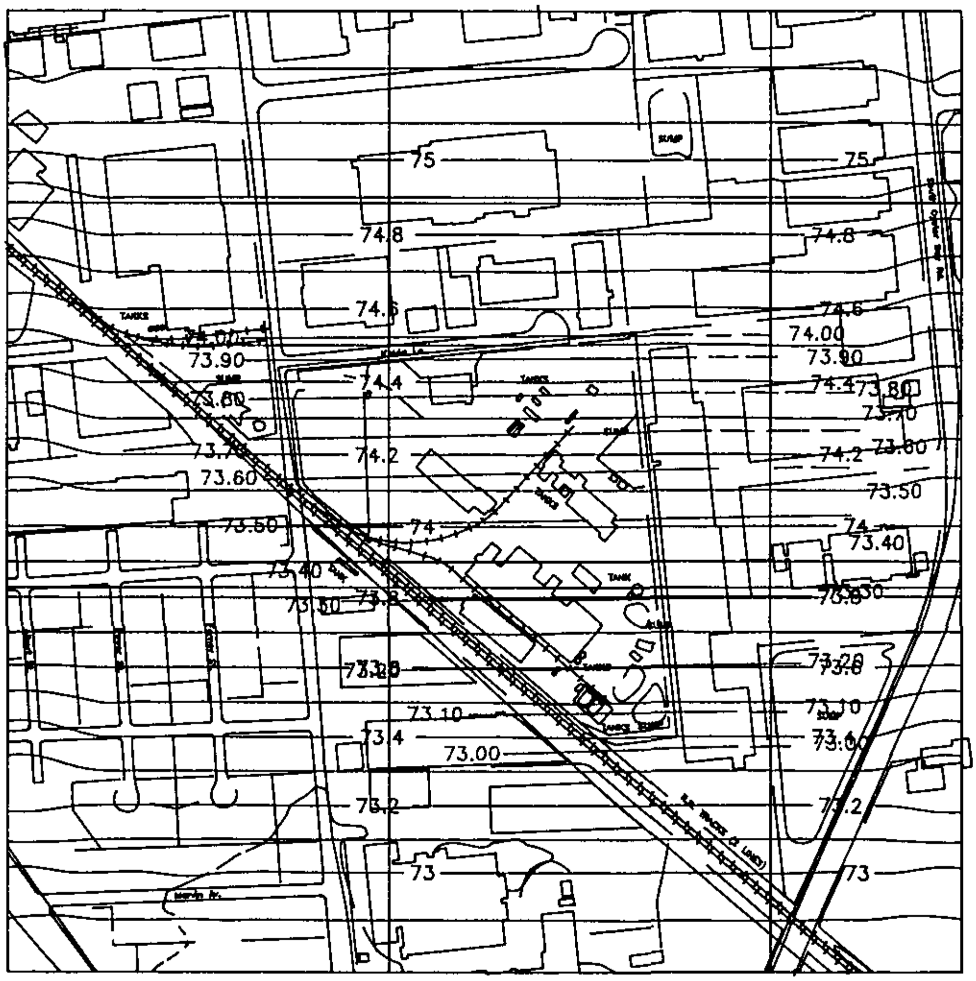
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

POTENTIOMETRIC SURFACE OF THE UPPER MAGOTHY AQUIFER
DECEMBER 1989

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 5



LEGEND

OBSERVED POTENTIOMETRIC SURFACE

SIMULATED POTENTIOMETRIC SURFACE

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

POTENTIOMETRIC SURFACE OF THE MID MAGOTHY AQUIFER
DECEMBER 1989

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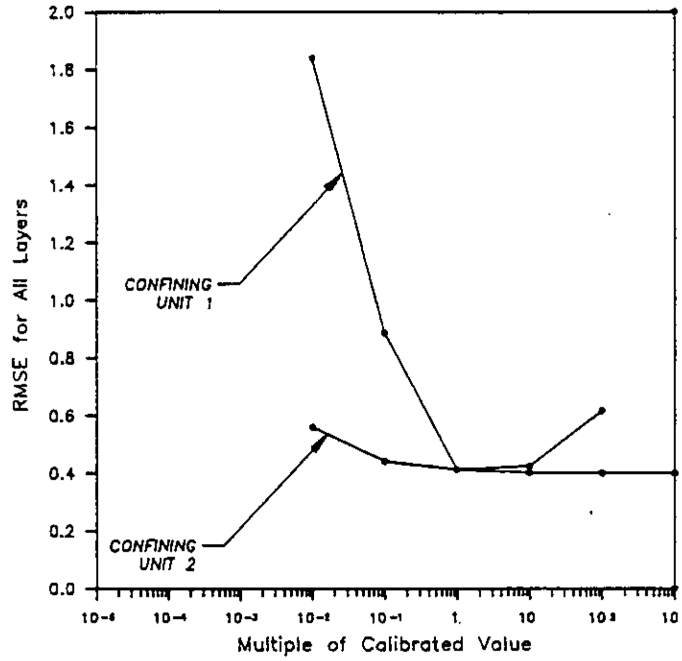
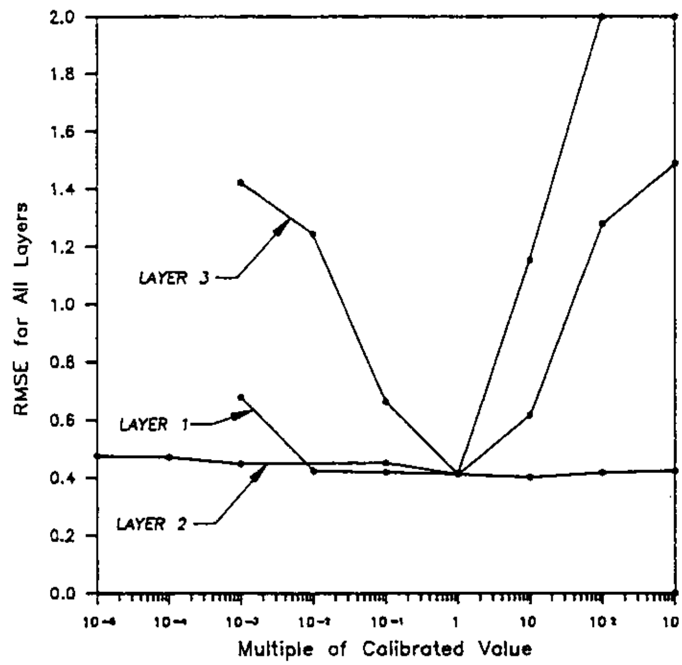
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 6

Vertical Conductivity Comparison of Confining Units 1 & 2



Transmissivity Comparison of Layers 1, 2 & 3



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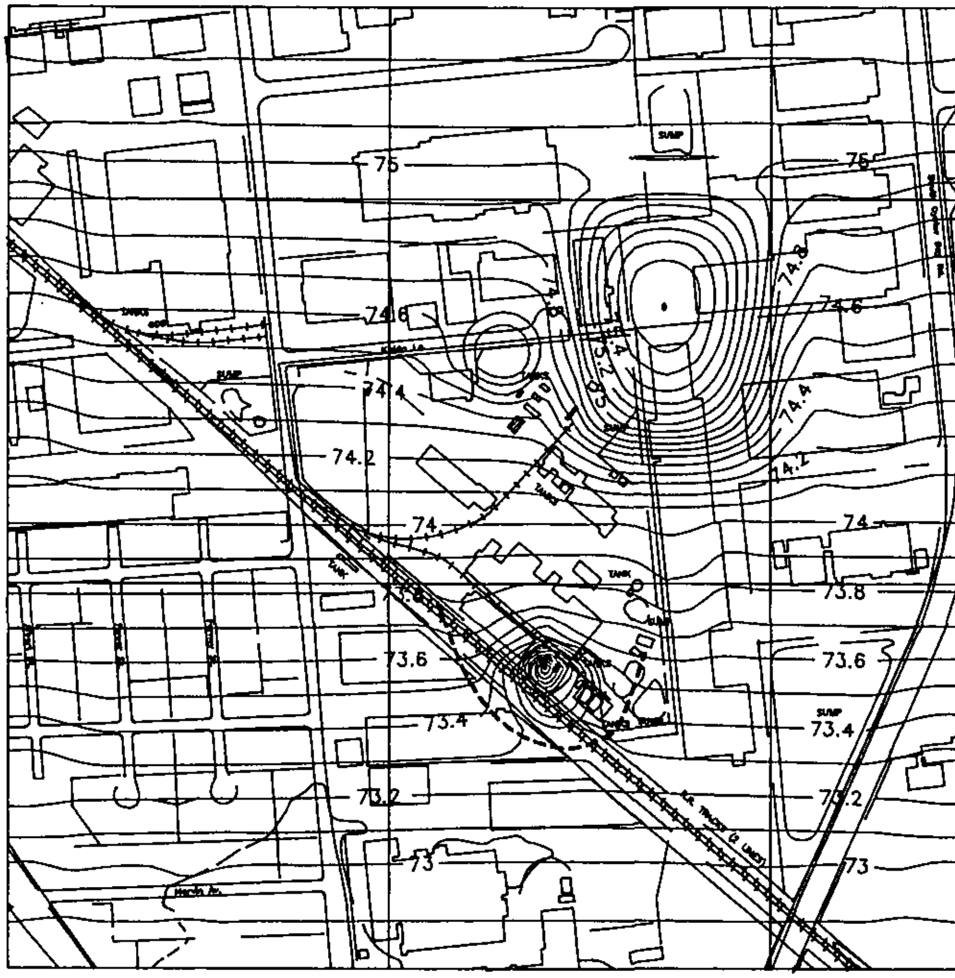
HICKSVILLE, NEW YORK

SENSITIVITY ANALYSIS

DATE	REVISED	PREPARED BY:
		LEGGETTE, BRASHEARS & GRAHAM, INC.
		Professional Ground-Water and Environmental Services
		72 Danbury Road
		Wilton, CT 06897
		(203) 762-1207
		DATE: 3/11/93 FIGURE: 7



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING ONE WELL

0 500

SCALE IN FEET

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HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING ONE WELL PUMPING AT 100 GPM, LAYER 1

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 | FIGURE: 8

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING ONE WELL

0 500

SCALE IN FEET

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CAPTURE ZONE ANALYSIS USING ONE WELL PUMPING AT 100 GPM, LAYER 2

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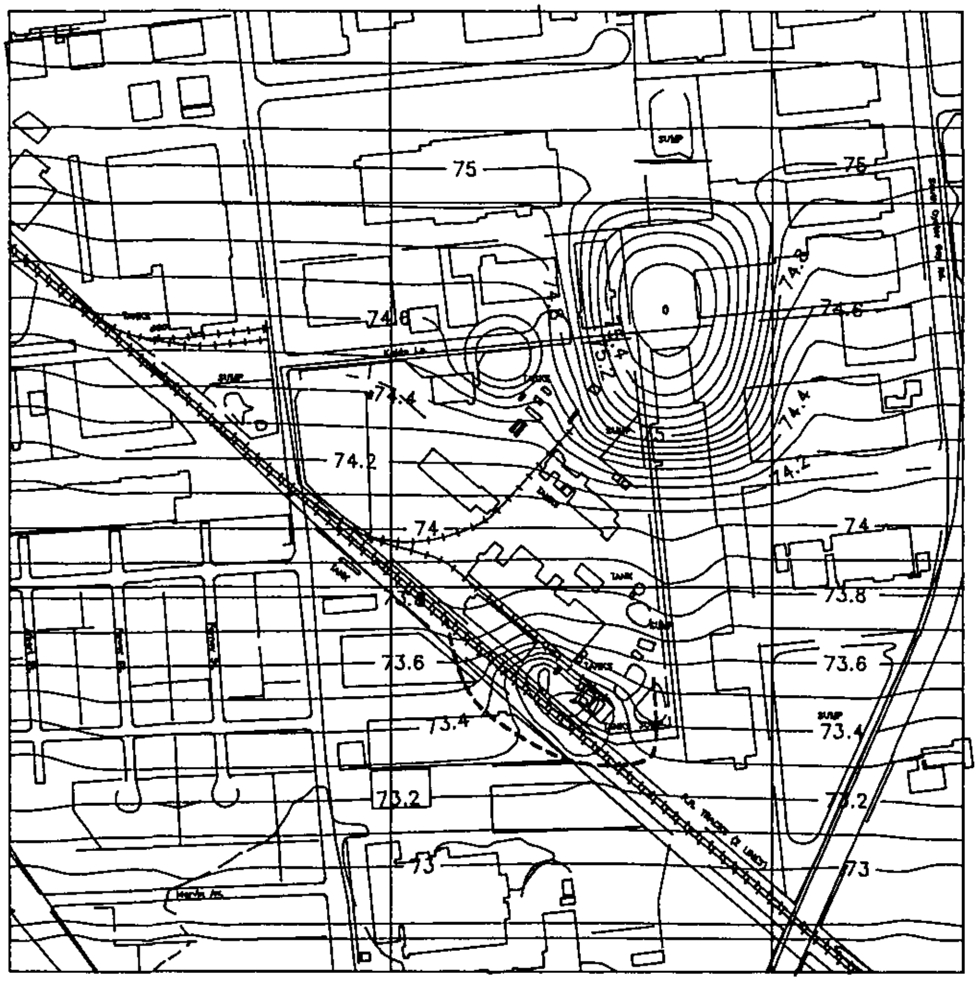
PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 9



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING TWO WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
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CAPTURE ZONE ANALYSIS USING TWO WELLS WITH COMBINED PUMPING AT 100 GPM, LAYER 1

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PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 10

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING TWO WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING TWO WELLS WITH COMBINED PUMPING AT 100 GPM, LAYER 2

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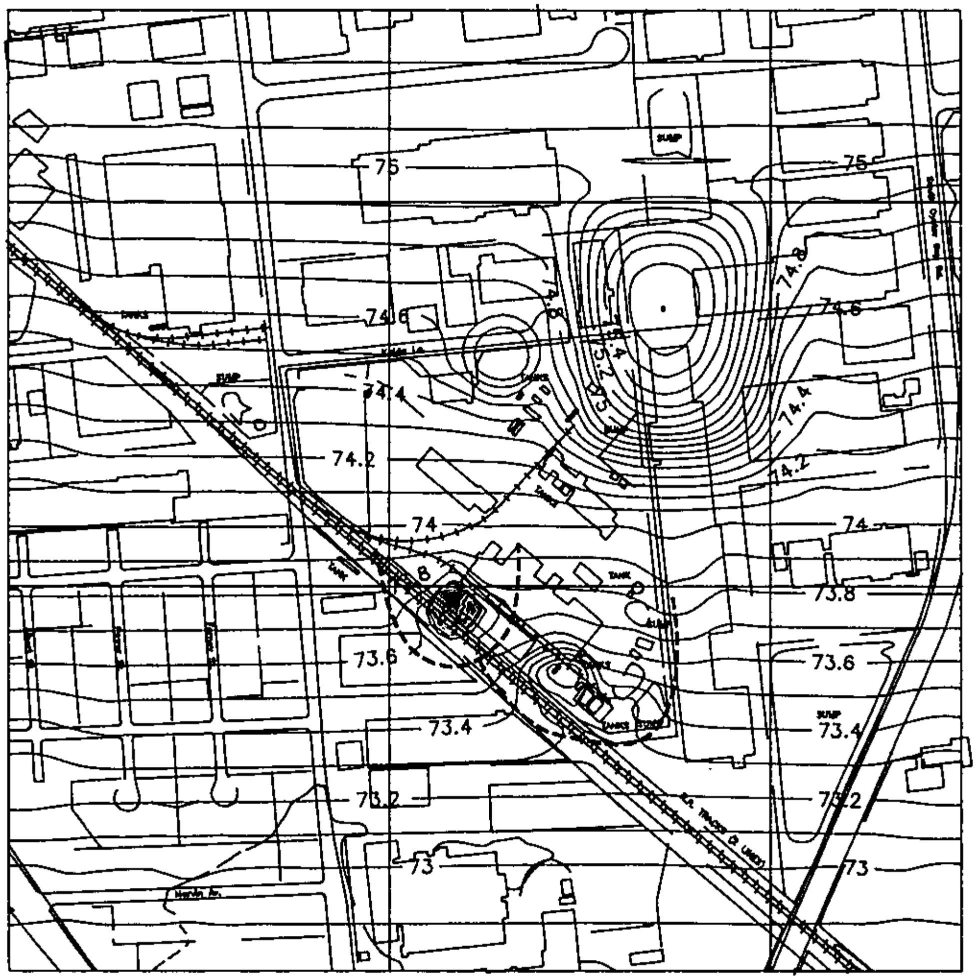
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 11



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS WITH COMBINED PUMPING AT 75 GPM, LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 12

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

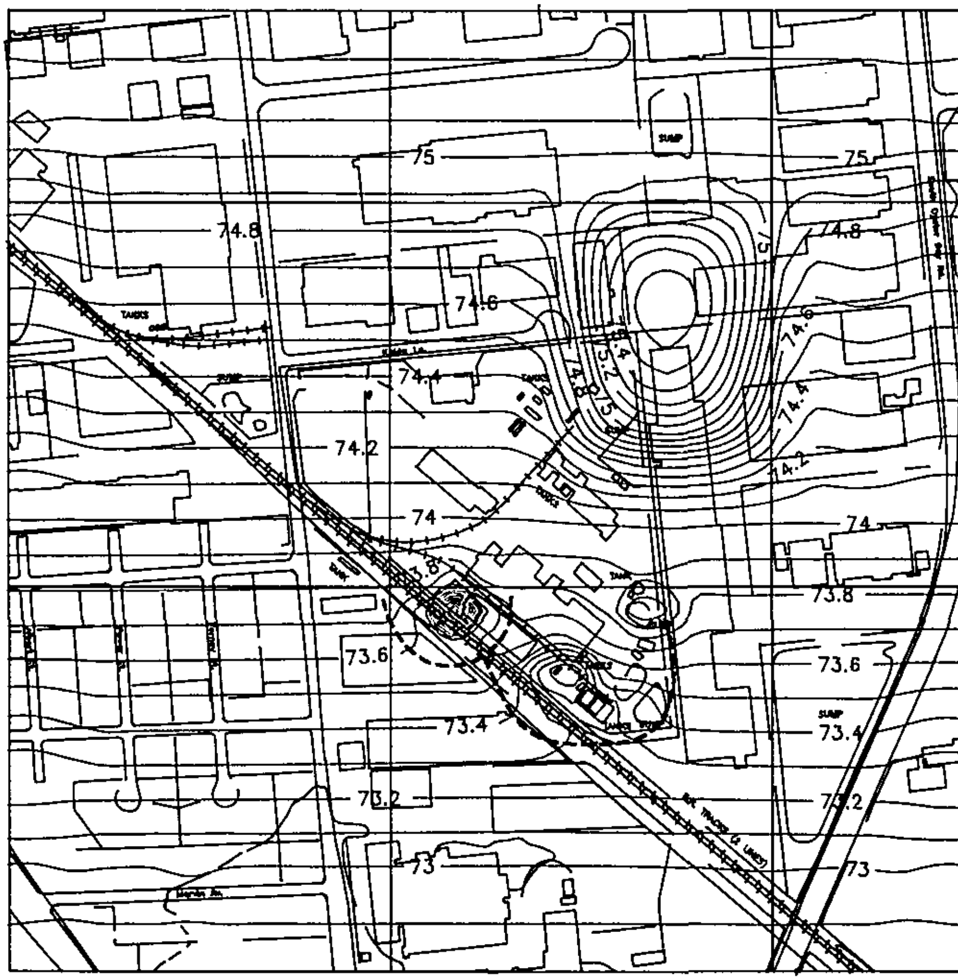
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS WITH COMBINED PUMPING AT 75 GPM, LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/11/93 FIGURE: 13



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS AND SUMP 3 RECHARGE AREA WITH COMBINED PUMPING AT 75 GPM, LAYER 1

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 2/26/93 FIGURE: 14

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500
SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS AND SUMP 3 RECHARGE AREA WITH COMBINED PUMPING AT 75 GPM, LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 3/10/93 FIGURE: 15

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMP 4 RECHARGE AREA, LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 | FIGURE: 16

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMP 4 RECHARGE AREA, LAYER 2

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 17

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMPS 1 AND 2 RECHARGE AREAS, LAYER 1

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 18

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

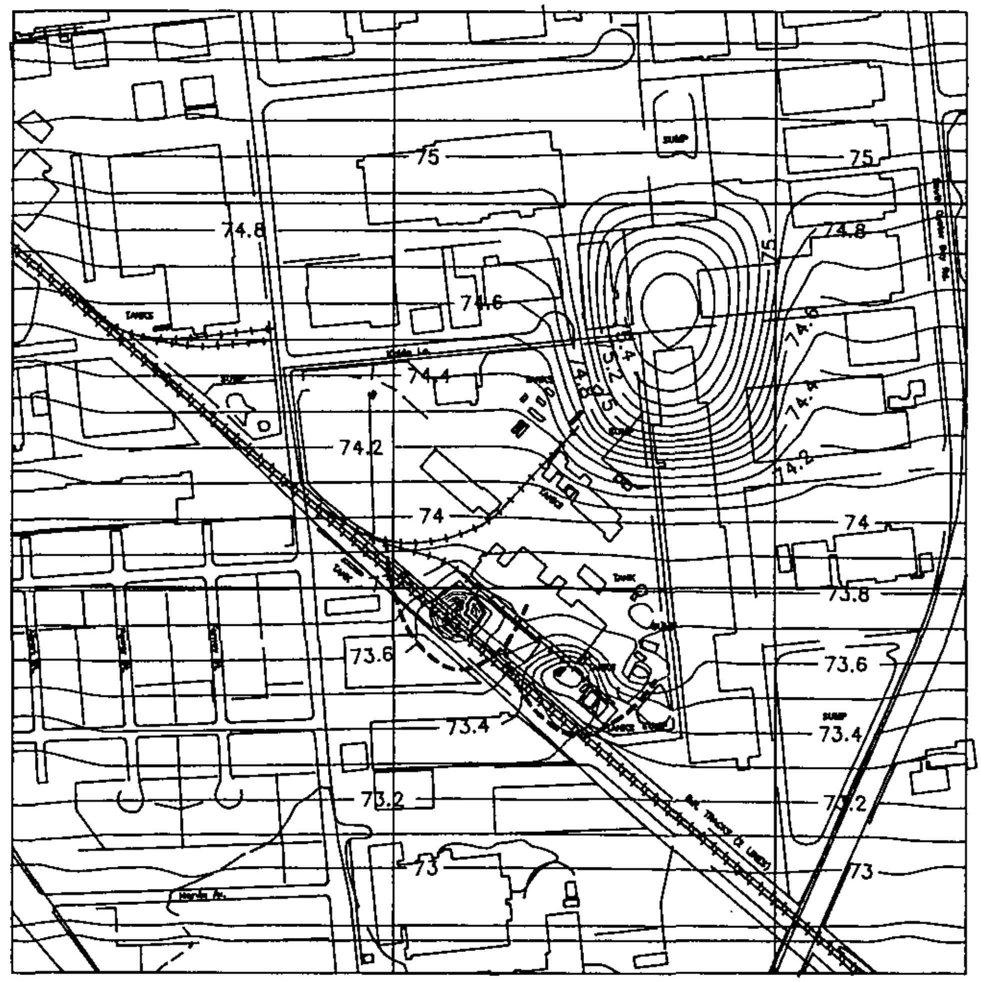
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMPS 1 AND 2 RECHARGE AREAS, LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 19



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMP 1 RECHARGE AREA, LAYER 1

DATE	REVISED

PREPARED BY:

LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 20

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500
SCALE IN FEET

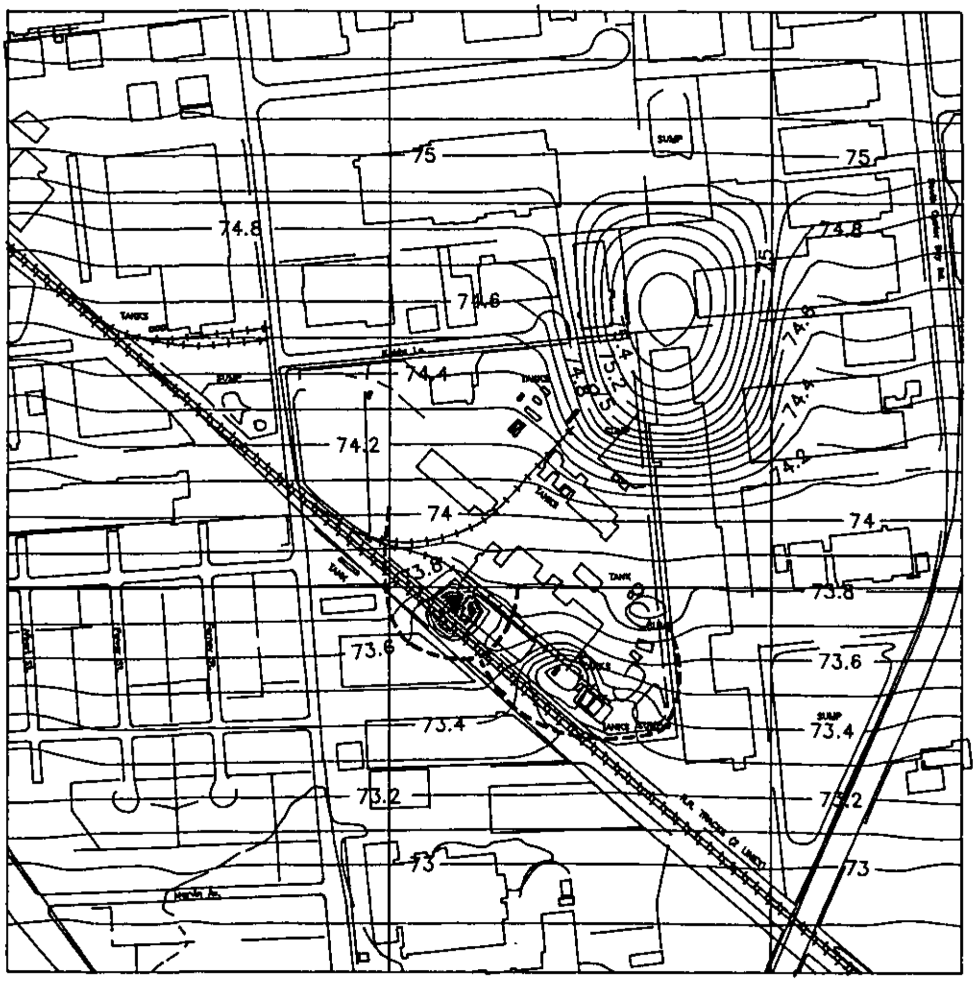
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMP 1 RECHARGE AREA, LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 21



LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 1

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMPS 1, 2 AND 3 RECHARGE AREAS, LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 22

LEGEND

SIMULATED POTENTIOMETRIC SURFACE OF LAYER 2

CAPTURE ZONE USING THREE WELLS

0 500

SCALE IN FEET

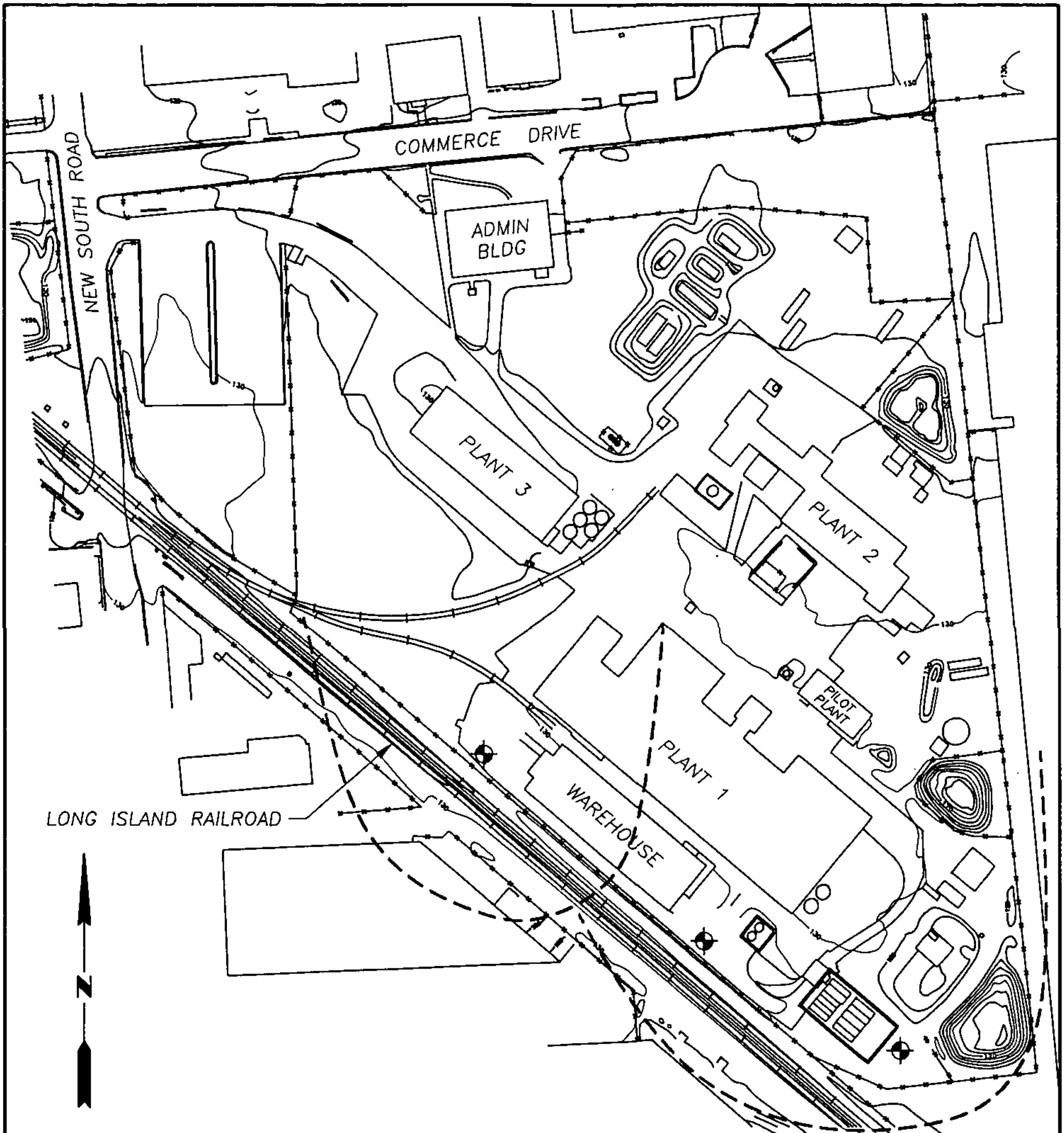
OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

CAPTURE ZONE ANALYSIS USING THREE WELLS PUMPING AT A COMBINED RATE OF 75 GPM AND SUMPS 1, 2 AND 3 RECHARGE AREAS, LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/21/93 FIGURE: 23



LEGEND

RECOVERY WELL

CAPTURE ZONE

0 150

SCALE IN FEET

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

OPTIMAL RECOVERY WELL LOCATIONS AND CAPTURE ZONES USING A COMBINED PUMPING RATE OF 75 GPM

DATE	REVISED	PREPARED BY:
		LEGGETTE, BRASHEARS & GRAHAM, INC.
		Professional Ground-Water and Environmental Services
		72 Danbury Road
		Wilton, CT 06897
		(203) 762-5802
		DATE: 4/5/93 FIGURE: 24

OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Appendix C
Identification and Screening of Remedial Technologies
for Deep Soils

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(continued)

C. Deep Soil Medium

This appendix presents the initial screening of technologies and process options using the format provided in EPA's CERCLA Guidance (EPA, 1988). The general response actions, remedial technologies and process options are presented as shown in the legend.

The section numbers are referenced on Plate 2 which illustrates the alternative development process.

C.1 No Action ← General Response Action
C.1.1 None ← Remedial Technology
C.1.1.1 Not Applicable ← Process Option

Legend

C.1 No Action

C.1.1 None

C.1.1.1 Not Applicable

Description: No action is taken.

Applicability: For CERCLA feasibility studies, this process must be considered regardless of applicability.

Preliminary Screening: Retained; option must be retained.

Secondary Screening: Retained; option must be retained.
Effectiveness: Does not achieve the remedial action objective.
Implementability: Generally not acceptable to local, state or federal governments.
Cost: None.

C.2 Institutional Actions

C.2.1 Access Restrictions

C.2.1.1 Deed Notations

Description: Deed notations are legally enforceable land-use restrictions that are placed on a property. This process can be used to eliminate exposure to soil or groundwater or both on properties where impacted soil and groundwater exist.

Applicability: This process is applicable in all jurisdictions that have deed restricting authority.

Limitations: This process alone does not reduce the toxicity, volume or mobility of chemical compounds. Deed notations can reduce the risk to human health by minimizing or eliminating exposure routes.

Preliminary Screening: Rejected; there are no human health risks associated with the deep soil at the Hooker/Ruco site. Therefore, deed restrictions are not required to limit access.

C.2.1.2 Physical Restrictions

Description: The land use is physically restricted by erecting barriers to eliminate soil exposure routes.

Applicability: This process is applicable to all sites where site conditions and legal circumstances will permit the construction of physical barriers.

Limitations: This process alone does not reduce the toxicity, mobility or volume of chemical compounds; it only reduces the risk of human exposure.

Preliminary Screening: Rejected; there are no human health risks associated with the deep soil at the Hooker/Ruco site. Therefore, physical restrictions are not required to limit access.

C.2.2 Monitoring

C.2.2.1 Periodic Soil Monitoring/Sampling

Description: Soil samples are collected and analyzed on a routine basis.

Applicability: This process is applicable to all sites where soil chemistry is expected to change over time.

Preliminary Screening: Rejected; because of the depth of the deep soils, it is not practicable to collect repeated soil samples.

C.3 Onsite Soil Remediation

C.3.1 Biological Treatment

C.3.1.1 Biological Treatment

Description: Excavated soil is biologically treated using methods such as land farming/composting, liquid-solid contact digestion, white-rot fungus or augmented bioreclamation. Various techniques are used to control the microbial environment of the soil to be treated.

Applicability: This process is applicable for soils containing biodegradable organics.

Benefits: Contaminants are destroyed, not transferred from one media to another.

Preliminary Screening: Rejected; the deep soil to be addressed at the Hooker/Ruco site contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process. Furthermore, this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.2 Soil Stabilization/Solidification

C.3.2.1 Soil Stabilization/Solidification

Description: Excavated soil is stabilized/solidified using methods such as lime based possolan process, portland cement possolan process or asphalt-based (thermoplastic) microencapsulation. The impacted soil is mixed with siliceous material or other matrix and/or combined with a settling agent and placed in molds. The mixture then hardens, resulting in dewatered, stabilized, solidified blocks which are then buried back in the excavation or disposed of elsewhere.

Applicability: Soils containing metals, waste oils, solvents and hazardous wastes that are complex and difficult to treat can be stabilized with this process.

Residual Products: A solidified block of material is produced which will require disposal. Depending on the characteristics of the material, RCRA disposal requirements may apply.

Preliminary Screening: Rejected; this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.3 Chemical Extraction

C.3.3.1 Soil Washing

Description: Soil is sized to less than 1/4 inch by standard crushing and screening equipment and fed as a 30 percent solids slurry to a conditioning tank. In the conditioning tank, alkaline agents and surfactants are added to liberate the compounds from the soil mineral particles. The clean soil is returned to the original excavation site, and the froth is dewatered with the compound-rich froth cake and incinerated, biodegraded or dechlorinated.

Applicability: This process can treat organics and inorganics. Process rates for a full-scale facility can be varied from as low as 5 tpd (tons per day) to as large as 5,000 tpd depending on cleanup rate desired. Typically, for every 100 tons of impacted soil treated onsite, approximately 90 tons of cleaned, washed soil can be replaced onsite with the remaining 10 tons requiring final disposition.

Limitations: This process is not effective for fine soils.

Preliminary Screening: Rejected; this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.3.2 Supercritical Water Oxidation

Description: This oxidation process uses temperatures and pressures of supercritical water (above 374°C and over 218 atmospheres) to convert hazardous organics to carbon dioxide and other less harmful products. The sediments are fed to the oxidizer as a pressurized, heated slurry (20 to 40 percent solids). Pressurized oxygen and a source of organic fuel (required to provide the energy needs of the oxidation process) are also added to the oxidizer. In the oxidizer, chlorine atoms from chlorinated organics are transformed to chloride ions, nitrogen to nitrogen gas, sulfur to sulfates and phosphorous to phosphates. By adding cations (e.g., Na^+, Mg^{++}, Ca^{++}), inorganic salts are formed. The effluent from the oxidizer is then fed to a salt and sediment separator where solids are removed as a slurry.

Applicability: This process can treat soil containing organics including chlorinated organics.

Residual Products: Sludge and off gases are produced.

Preliminary Screening: Rejected; this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.3.3 Solvent Extraction

Description: Liquified gases (propane or carbon dioxide), solvents, surfactants or chelating molecules are used to remove organic constituents from excavated soils, sludges and liquid wastes. The compounds are extracted from the soil into the solvent. The treated soil is separated and the spent solvent is recovered and treated for compound removal.

Applicability: Soils, sludges and liquids containing organics and inorganics can be treated by this process.

Residual Products: Wastewater, spent solvents and concentrated organics are produced which must be recycled or disposed.

Preliminary Screening: Rejected; this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.3.4 Basic Extraction Sludge Treatment Process

Description: The basic extraction sludge treatment process is used to dewater and de-oil impacted sludges and soils. The process uses differences in chemical solubility of triethylamine (TEA) in water at different temperatures to break waste into three constituents: dischargeable water, oil and organics and dry oil-free solids. Heavy metals are isolated by conversion to hydrated oxides which precipitate out and exit the process with the solids fraction. Mobile units are available with capacities of 24 to 90 cubic yards per day.

Applicability: Soil and sludge containing organics can be treated by this process.

Benefits: This process costs less than incineration, releases no air emissions and treats wet and dry wastes. Removal efficiencies of 99 percent or more are possible depending on the number of extraction stages and matrix characteristics.

Residual Products: Wastewater and concentrated organics are produced which require disposal.

Preliminary Screening: Rejected; the deep soil to be treated at the Hooker/Ruco site does not contain oil. Furthermore, this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.3.3.5 Heavy Media Separation

Description: Heavy media separation is a process for separating two solid materials which have significantly different absolute densities. The mixed solids to be separated are placed into a fluid whose specific gravity is chosen or adjusted so that the lighter solids float while the heavier solids sink. Usually, the heavy media separating fluid is a suspension of magnetite in water. Magnetite can be easily recovered magnetically from rinse waters and then reused.

Applicability: Soils containing mixed solids of different densities can be treated using this process.

Limitations: The possibility exists of dissolving the solids. Solids of similar density to those whose separation is desired cannot be effectively treated by this process.

Residual Products: Wastewater is produced which requires disposal.

Preliminary Screening: Rejected; heavy media separation is not well suited for the deep soil at the Hooker/Ruco site because the densities of the primary organics to be addressed are not significantly different. Furthermore, this process requires excavation which is not practicable due to the depth of soil to be treated (40 to 50 ft bg).

C.4 In-Situ Soil Remediation

C.4.1 In-Situ Bioremediation

C.4.1.1 In-Situ Bioremediation

Description: Microorganisms and nutrients are introduced to the soil so that aerobic or anaerobic biodegradation can occur. This process enhances the naturally occurring microbial growth by supplementing the soils with required nutrients and altering the environmental conditions.

Applicability: Soils containing biodegradable organics can be treated with this process.

Benefits: This process can be used as a primary treatment method or in conjunction with other techniques to reduce soil chemical concentrations to acceptable levels.

Limitations: The effectiveness of this process is site specific; it depends on the site microbiology, hydrogeology and chemistry. Remediation time is longer using this process than most other in-situ processes.

Residual Products: No hazardous residual products are produced with this process.

Preliminary Screening: Retained; this process option is potentially applicable for treating the non-halogenated organics in the deep soils.

Secondary Screening: Rejected; effectiveness and implementability.

> Effectiveness: This process option may be capable of reducing the non-halogenated organics, however, treatability studies would be needed to quantify the effectiveness.
> Implementability: Because this process involves introducing chemical nutrients to the ground, it may not be acceptable to local or state governments.
> Cost: Moderate to high capital, moderate O&M.

C.4.2 In-Situ Containment/Encapsulation

C.4.2.1 Slurry-Cutoff Walls

Description: Subsurface chemical migration is contained by installing vertical slurry-cutoff walls. The walls are constructed by excavating a narrow trench under an engineered fluid and backfilling with soil-bentonite, cement-bentonite or composite slurries.

Applicability: This process is applicable where horizontal chemical migration in the unsaturated zone is possible.

Residual Products: Excavated soil may require disposal. Depending on the characteristics of the soil, RCRA disposal requirements may apply.

Preliminary Screening: Rejected; horizontal chemical migration in the unsaturated zone is not occurring in the deep soils at the Hooker/Ruco site.

C.4.2.2 Capping/Lining

Description: This process utilizes multimedia caps, paving materials, or synthetic covers in conjunction with geomembrane liners to isolate impacted soils. The cap prevents infiltration through the soil, and the liner prevents leachate movement out of the soil, thereby reducing the possibility of impacted groundwater. Double liners may be implemented with sampling ports.

Applicability: This process can be used to isolate any unsaturated soil.

Limitations: Capping/lining does not treat the soils; it only prevents the spread of soil compounds.

Residual Products: This process does not produce hazardous residual products.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This option may be effective at reducing the required remediation time of the groundwater recovery and treatment option. This option will not reduce compound concentrations or toxicity. This option is effective in preventing vertical migration of infiltration from precipitation events.
Implementability: Easily implemented using standard construction methods.
Cost: High capital, low O&M.

C.4.3 In-Situ Gas-Phase Separation

C.4.3.1 Soil Vapor Extraction

Description: A vacuum pump or fan is connected to one or more vapor extraction wells. Typically, the extraction wells are installed to penetrate the impacted soil near the zone of highest VOC concentration. When suction is applied to the well(s), subsurface airflow is induced radially toward the extraction well. The extracted air is then treated and released or released directly to the atmosphere.

Applicability: Permeable soils containing volatile organics can be treated with this process.

Limitations: The major factors to be considered in applying this process are compound volatility, site soil porosity and the site specific clean-up level. This process is effective only in the unsaturated zone and for compounds with Henry's Law Constant greater than 0.001.

Residual Products: This process produces air emissions which may require treatment.

Preliminary Screening: Retained; this process is potentially applicable for treating the volatile compounds in the deep soil.

Secondary Screening: Retained.

Effectiveness: This process can reduce volatile organic concentrations in the deep soil.

Implementability: This process is easily implementable using readily available technology.

Cost: Moderate capital, moderate O&M.

C.4.3.2 Steam Stripping

Description: Specially designed auger blades mix the soil in-situ and introduce steam and air from the auger tips to the surrounding soil. The steam and air strip the organic compounds from the mixed soil and transport them in the vapor phase to the ground surface. A shroud covers the treatment area to collect the stripped volatiles. The collected vapor is treated in a condenser where the water and organics are separated and recovered.

Applicability: Soil containing volatile and semi-volatile organics with boiling points of less than 300 to 350°F can be treated using this process.

Benefits: This process is quicker than traditional soil-vapor recovery and can treat organics that are only moderately volatile.

Limitations: With currently available equipment, the remediation depth is limited to approximately 30 feet, and the soil cannot contain obstacles greater than 14 inches in diameter.

Residual Products: This process produces organic vapors which require treatment.

Preliminary Screening: Rejected; the main compounds of concern have boiling points greater than 350°F. In addition, this process is not implementable due to the depth of soil to be treated (40 to 50 ft bg).

C.4.4 In-Situ Soil Flushing

C.4.4.1 In-Situ Soil Flushing

Description: This process is accomplished by passing extractant solvents through the soils using an injection/recirculation process. These solvents may include water, water surfactant mixtures, acids or bases (for organics), chelating agents, oxidizing agents or reducing agents. The use of surfactants can increase the solubility and recovery of slightly soluble organic compounds.

Applicability: Soils containing inorganic and organic compounds can be treated with this process.

Limitations: Soil washing fluids must have good extraction coefficients, low volatility and toxicity, be safe and easy to handle and be recoverable/recyclable. Problems are likely in dry or in organic-rich soils.

Residual Products: Wastewater is produced which must be recovered, treated and disposed.

Preliminary Screening: Retained; this process is potentially applicable only if used in conjunction with groundwater recovery and treatment.

Secondary Screening: Retained.

Effectiveness: There are insufficient compound concentrations in the deep soil for complete remediation by this process. As a result of continuous flushing over an extended period of time, any remaining residual soil compounds would not be likely to leach from the soil in significant concentrations to effect the groundwater quality.

Implementability: Easily implemented from a construction standpoint using some specialized technology. Public and regulatory acceptance using surfactants is questionable because of the sole source aquifer status on Long Island. However, the use of the treated groundwater discharge may be allowable provided discharge ARARs are met.

Cost: Moderate capital, low O&M.

C.4.5 In-Situ Soil Stabilization/Solidification

C.4.5.1 Deep Soil Mixing

Description: A multiple auger with overlapping mixing paddles is used to uniformly mix hazardous soils with treatment chemicals. During auger penetration, 60 to 80 percent of the treatment chemicals are injected; the remainder are injected during auger withdrawal. This process can be used above and below the groundwater table to depths of 150 feet.

Applicability: Soils containing organic and inorganic compounds can be treated with this process.

Benefits: This process can be used above and below the water table, therefore, dewatering is not required. This process is effective for a wide variety of soil conditions.

Preliminary Screening: Rejected; because of the soil chemistry, it is uncertain whether or not this process can adequately treat the deep soils.

C.5 Off-Site Soil Remediation/Disposal

C.5.1 Chemical Waste Landfill

C.5.1.1 Chemical Waste Landfill

Description: Excavated soil is transported to a chemical waste landfill for disposal.

Applicability: Soils containing compounds that are not banned by RCRA for land disposal.

Benefits: Remediation time is very short, and no onsite remediation equipment is required.

Limitations: Potential liabilities are incurred with offsite disposal options.

Residual Products: No onsite hazardous residual products are produced with offsite treatment and disposal options.

Preliminary Screening: Rejected; this process requires excavation which is not *practicable due to the depth of soil to be treated* (40 to 50 ft bg).

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OCCIDENTAL CHEMICAL CORPORATION
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

Appendix D
Identification and Screening of Remedial Technologies
for Shallow Soils

LBG ENGINEERING SERVICES, INC.

TABLE OF CONTENTS

D. Shallow Soil Medium

This appendix presents the initial screening of technologies and process options using the format provided in EPA's CERCLA Guidance (EPA, 1988). The general response actions, remedial technologies and process options are presented as shown in the legend.

The section numbers are referenced on Plate 3 which illustrates the alternative development process.

D.1 No Action ← General Response Action
D.1.1 None ← Remedial Technology
D.1.1.1 Not Applicable ← Process Option

Legend

D.1 *No Action*

D.1.1 None

D.1.1.1 Not Applicable

Description: No action is taken.

Applicability: For CERCLA feasibility studies, this process must be considered regardless of applicability.

Preliminary Screening: Retained; option must be retained.

Secondary Screening: Retained; option must be retained.
Effectiveness: Does not achieve the remedial action objective.
Implementability: Generally not acceptable to local, state or federal governments.
Cost: None.

D.2 Institutional Actions

D.2.1 Access Restrictions

D.2.1.1 Deed Notations

Description: Deed notations are legally enforceable land-use restrictions that are placed on a property. This process can be used to eliminate exposure to soil or groundwater or both on properties where impacted soil and groundwater exist.

Applicability: This process is applicable in all jurisdictions that have deed restricting authority.

Limitations: This process alone does not reduce the toxicity, volume or mobility of chemical compounds. Deed notations can reduce the risk to human health by minimizing or eliminating exposure routes.

Preliminary Screening: Rejected; there are no human health risks associated with the shallow soil at the Hooker/Ruco site.

D.2.1.2 Physical Restrictions

Description: The land use is physically restricted by erecting barriers to eliminate soil exposure routes.

Applicability: This process is applicable to all sites where site conditions and legal circumstances will permit the construction of physical barriers.

Limitations: This process alone does not reduce the toxicity, mobility or volume of chemical compounds; it only reduces the risk of human exposure.

Preliminary Screening: Rejected; there are no human health risks associated with the shallow soil at the Hooker/Ruco site.

D.2.2 Monitoring

D.2.2.1 Periodic Soil Monitoring/Sampling

Description: Soil samples are collected and analyzed on a routine basis.

Applicability: This process is applicable to all sites where soil chemistry is expected to change over time (as a result of in-situ remediation).

Preliminary Screening: Rejected; periodic soil monitoring would be of little value unless used to monitor the effects of in-situ remediation.

D.3 Onsite Soil Remediation

D.3.1 Biological Treatment

D.3.1.1 Biological Treatment

Description: Excavated soil is biologically treated using methods such as land farming/composting, liquid-solid contact digestion, white-rot fungus or augmented bioreclamation. Various techniques are used to control the microbial environment of the soil to be treated.

Applicability: This process is applicable for soils containing biodegradable organics.

Benefits: Compounds are destroyed, not transferred from one media to another.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.
- Effectiveness: This process is not fully effective. Compound reductions typically do not exceed 70 percent.
- Implementability: Easily implementable with readily available equipment if indigenous microbes are used. Less easily implementable if genetically engineered microbes are needed.
- Cost: Moderate capital, low (duration of treatment less than one year) O&M.

D.3.2 Soil Stabilization/Solidification

D.3.2.1 Soil Stabilization/Solidification

Description: Excavated soil is stabilized/solidified using methods such as lime based possolan process, portland cement possolan process or asphalt-based (thermoplastic) microencapsulation. The impacted soil is mixed with siliceous material or other matrix and/or combined with a settling agent and placed in molds. The mixture then hardens, resulting in dewatered, stabilized, solidified blocks which are then buried back in the excavation or disposed of elsewhere.

Applicability: Soils containing metals, waste oils, solvents and hazardous wastes that are complex and difficult to treat can be stabilized with this process.

Residual Products: A solidified block of material is produced requiring disposal.

Preliminary Screening: Rejected; other processes offer greater technical and economic feasibility for addressing the shallow soils at the Hooker/Ruco site.

D.3.3 Chemical Extraction

D.3.3.1 Soil Washing

Description: Soil is sized to less than 1/4 inch by standard crushing and screening equipment and fed as a 30 percent solids slurry to a conditioning tank. In the conditioning tank, alkaline agents and surfactants are added to liberate the compounds from the soil mineral particles. The clean soil is returned to the original excavation site, and the froth is dewatered with the compound-rich froth cake and incinerated, biodegraded or dechlorinated.

Applicability: This process can treat organics and inorganics. Process rates for a full-scale facility can be varied from as low as 5 tpd (tons per day) to as large as 5,000 tpd depending on cleanup rate desired. Typically, for every 100 tons of impacted soil treated onsite, approximately 90 tons of cleaned, washed soil can be replaced onsite with the remaining 10 tons requiring final disposition.

Limitations: This process is not effective for fine soils.

Preliminary Screening: Rejected; other processes offer greater technical and economic feasibility for addressing the shallow soils at the Hooker/Ruco site.

D.3.3.2 Supercritical Water Oxidation

Description: This oxidation process uses temperatures and pressures of supercritical water (above 374°C and over 218 atmospheres) to convert hazardous organics to carbon dioxide and other less harmful products. The sediments are fed to the oxidizer as a pressurized, heated slurry (20 to 40 percent solids). Pressurized oxygen and a source of organic fuel (required to provide the energy needs of the oxidation process) are also added to the oxidizer. In the oxidizer, chlorine atoms from chlorinated organics are transformed to chloride ions, nitrogen to nitrogen gas, sulfur to sulfates and phosphorous to phosphates. By adding cations (e.g., Na^+, Mg^{++}, Ca^{++}), inorganic salts are formed. The effluent from the oxidizer is then fed to a salt and sediment separator where solids are removed as a slurry.

Applicability: This process can treat soil containing organics including chlorinated organics.

Residual Products: Sludge and off gases are produced.

Preliminary Screening: Rejected; other processes offer greater technical and economic feasibility for addressing the shallow soils at the Hooker/Ruco site.

D.3.3.3 Solvent Extraction

Description: Liquified gases (propane or carbon dioxide), solvents, surfactants or chelating molecules are used to remove organic constituents from excavated soils, sludges and liquid wastes. The compounds are extracted from the soil into the solvent. The treated soil is separated and the spent solvent is recovered and treated for compound removal.

Applicability: Soils, sludges and liquids containing organics and inorganics can be treated by this process.

Residual Products: Wastewater, spent solvents and concentrated organics are produced which must be recycled or disposed.

Preliminary Screening: Rejected; other processes offer greater technical and economic feasibility for addressing the shallow soils at the Hooker/Ruco site.

D.3.3.4 Basic Extraction Sludge Treatment Process

Description: The basic extraction sludge treatment process is used to dewater and de-oil impacted sludges and soils. The process uses differences in chemical solubility of triethylamine (TEA) in water at different temperatures to break waste into three constituents: dischargeable water, oil and organics and dry oil-free solids. Heavy metals are isolated by conversion to hydrated oxides which precipitate out and exit the process with the solids fraction. Mobile units are available with capacities of 24 to 90 cubic yards per day.

Applicability: Soil and sludge containing organics can be treated by this process.

Benefits: This process costs less than incineration, releases no air emissions, and treats wet and dry wastes. Removal efficiencies of 99 percent or more are possible depending on the number of extraction stages and matrix characteristics.

Residual Products: Wastewater and concentrated organics are produced which require disposal.

Preliminary Screening: Rejected; the shallow soil to be addressed at the Hooker/Ruco site does not contain oil.

D.3.3.5 Heavy Media Separation

Description: Heavy media separation is a process for separating two solid materials which have significantly different absolute densities. The mixed solids to be separated are placed into a fluid whose specific gravity is chosen or adjusted so that the lighter solids float while the heavier solids sink. Usually, the heavy media separating fluid is a suspension of magnetite in water. Magnetite can be easily recovered magnetically from rinse waters and then reused.

Applicability: Soils containing mixed solids of different densities can be treated using this process.

Limitations: The possibility exists of dissolving the solids. Solids of similar density to those whose separation is desired cannot be effectively treated by this process.

Residual Products: Wastewater is produced which requires disposal.

Preliminary Screening: Rejected; heavy media separation is not well suited for the shallow soil at the Hooker/Ruco site.

D.4 In-Situ Soil Remediation

D.4.1 In-Situ Bioremediation

D.4.1.1 In-Situ Bioremediation

Description: Microorganisms and nutrients are introduced to the soil so that aerobic or anaerobic biodegradation can occur. This process enhances the naturally occurring microbial growth by supplementing the soils with required nutrients and altering the environmental conditions.

Applicability: Soils containing biodegradable organics can be treated with this process.

Benefits: This process can be used as a primary treatment method or in conjunction with other techniques to reduce soil chemical concentrations to acceptable levels.

Limitations: The effectiveness of this process is site specific; it depends on the site microbiology, hydrogeology and chemistry. Remediation time is longer using this process than most other in-situ processes.

Residual Products: No hazardous residual products are produced with this process.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.
> Effectiveness: This process is not fully effective. Compound reductions typically do not exceed 70 percent.
> Implementability: Easily implementable with readily available equipment if indigenous microbes are used. Less easily implementable if genetically engineered microbes are needed.
> Cost: Moderate capital, low (duration of treatment less than one year) O&M.

D.4.2 In-Situ Containment/Encapsulation

D.4.2.1 Slurry-Cutoff Walls

Description: Subsurface chemical migration is contained by installing vertical slurry-cutoff walls. The walls are constructed by excavating a narrow trench under an engineered fluid and backfilling with soil-bentonite, cement-bentonite or composite slurries.

Applicability: This process is applicable where horizontal chemical migration in the unsaturated zone is possible.

Residual Products: Excavated soil may require disposal.

Preliminary Screening: Rejected; horizontal chemical migration in the unsaturated zone is not occurring in the shallow soils at the Hooker/Ruco site.

D.4.2.2 Capping/Lining

Description: This process utilizes multimedia caps, paving materials, or synthetic covers in conjunction with geomembrane liners to isolate impacted soils. The cap prevents infiltration through the soil, and the liner prevents leachate movement out of the soil, thereby reducing the possibility of impacted groundwater. Double liners may be implemented with sampling ports.

Applicability: This process can be used to isolate any unsaturated soil.

Limitations: Capping/lining does not treat the soils; it only prevents the spread of soil compounds.

Residual Products: This process does not produce hazardous residual products.

Preliminary Screening: Retained.

Secondary Screening: Retained.

> Effectiveness: This option may be effective at reducing the required remediation time of the groundwater recovery and treatment option. This option will not reduce compound concentrations or toxicity. This option is effective in preventing vertical migration of infiltration from precipitation events.
> Implementability: Easily implemented using standard construction methods.
> Cost: High capital, low O&M.

D.4.3 In-Situ Soil Flushing

D.4.3.1 In-Situ Soil Flushing

Description: This process is accomplished by passing extractant solvents through the soils using an injection/recirculation process. These solvents may include water, water surfactant mixtures, acids or bases (for organics), chelating agents, oxidizing agents or reducing agents. The use of surfactants can increase the solubility and recovery of slightly soluble organic compounds.

Applicability: Soils containing inorganic and organic compounds can be treated with this process.

Limitations: Soil washing fluids must have good extraction coefficients, low volatility and toxicity, be safe and easy to handle and be recoverable/recyclable. Problems are likely in dry or in organic-rich soils.

Residual Products: Wastewater is produced which must be recovered, treated and disposed.

Preliminary Screening: Rejected; there are insufficient chemical concentrations in the shallow soils for effective treatment by this process.

D.4.4 In-Situ Gas-Phase Separation

D.4.4.1 Soil Vapor Extraction

Description: A vacuum pump or fan is connected to one or more vapor extraction wells. Typically, the extraction wells are installed to penetrate the impacted soil near the zone of highest VOC concentration. When suction is applied to the well(s), subsurface airflow is induced radially toward the extraction well. The extracted air is then treated and released or released directly to the atmosphere.

Applicability: Permeable soils containing volatile organics can be treated with this process.

Limitations: The major factors to be considered in applying this process are compound volatility, site soil porosity and the site-specific clean-up level. This process is effective only in the unsaturated zone and for compounds with Henry's Law Constant greater than 0.001.

Residual Products: This process produces air emissions which may require treatment.

Preliminary Screening: Rejected; this process is not applicable for treating the TICs in the shallow soil.

D.4.4.2 Steam Stripping

Description: Specially designed auger blades mix the soil in-situ and introduce steam and air from the auger tips to the surrounding soil. The steam and air strip the organic compounds from the mixed soil and transport them in the vapor phase to the ground surface. A shroud covers the treatment area to collect the stripped volatiles. The collected vapor is treated in a condenser where the water and organics are separated and recovered.

Applicability: Soil containing volatile and semi-volatile organics with boiling points of less than 300 to 350°F can be treated using this process.

Benefits: This process is quicker than traditional soil-vapor recovery and can treat organics that are only moderately volatile.

Limitations: With currently available equipment, the remediation depth is limited to approximately 30 feet, and the soil cannot contain obstacles greater than 14 inches in diameter.

Residual Products: This process produces organic vapors which require treatment.

Preliminary Screening: Rejected; this process is not applicable for treating the TICs in the shallow soil.

D.4.5 In-Situ Soil Stabilization/Solidification

D.4.5.1 Shallow Soil Mixing

Description: This process uses auger blades to uniformly mix hazardous soils with treatment chemicals to produce a solidified or stabilized end product, while capturing vapors and dust that are produced.

Applicability: Soils containing organic and inorganic compounds can be treated.

Benefits: Soils of variable moisture content, ranging from dry soil to fluid sludge, can be treated by this process.

Limitations: This process can only be used to depths of 40 feet.

Residual Products: Vapors and dust may be produced which require capture and treatment.

Preliminary Screening: Rejected; other processes offer much greater technical and economic feasibility.

D.5 Off-Site Soil Remediation/Disposal

D.5.1 Chemical Waste Landfill

D.5.1.1 Chemical Waste Landfill

Description: Excavated soil is transported to a chemical waste landfill for disposal.

Applicability: Soils containing compounds that are not banned by RCRA for land disposal.

Benefits: Remediation time is very short, and no onsite remediation equipment is required.

Limitations: Potential liabilities are incurred with offsite disposal options.

Residual Products: No onsite hazardous residual products are produced with offsite treatment and disposal options.

Preliminary Screening: Retained.

Secondary Screening: Retained.

> Effectiveness: No onsite hazardous residual products are produced with offsite disposal.
> Implementability: Remediation time is very short, and no onsite treatment equipment is required. Potential liabilities are incurred with offsite disposal options.
> Cost: Moderate capital, no O&M.

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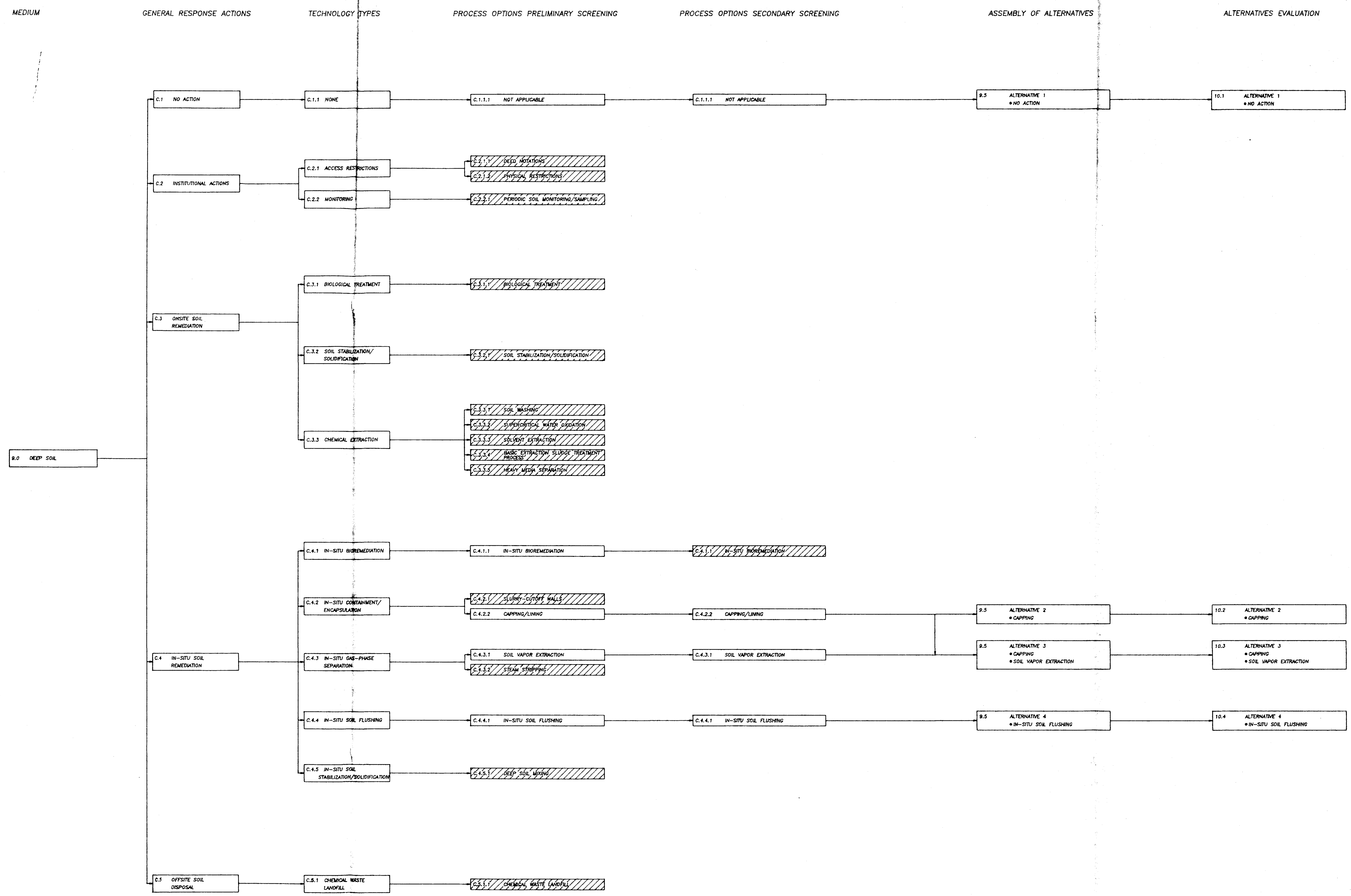

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C.4.2.2 REFERENCE TO SECTION IN F.S.

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		DEEP SOIL – FLOW DIAGRAM OF ALTERNATIVE DEVELOPMENT AND DETAILED EVALUATION PROCESS

DATE	REVISED	PREPARED BY:
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		DATE: 7/10/93 PLATE: 2 OF 3

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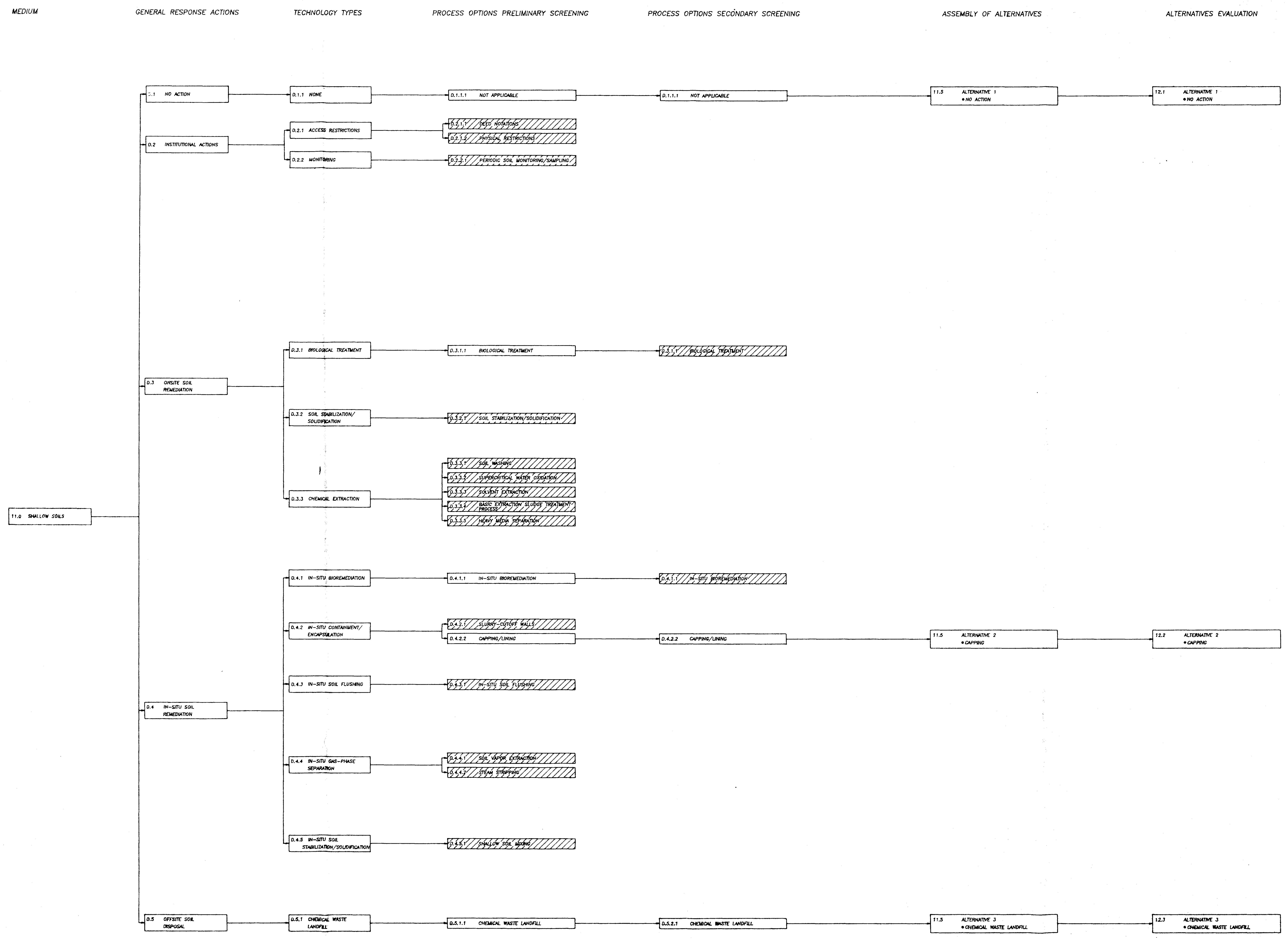
HOOKER/RUCO SITE
HICKSVILLE, NEW YORK

GROUNDWATER – FLOW DIAGRAM OF ALTERNATIVE DEVELOPMENT AND DETAILED EVALUATION PROCESS

DATE	REVISED

PREPARED BY:
LBG ENGINEERING SERVICES, INC.
Professional Environmental and Civil Engineers
72 Danbury Road
Wilton, CT 06897
(203) 762-5502

DATE: 7/10/93
PLATE: 1 OF 3



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D.4.2.2 REFERENCE TO SECTION IN F.S.

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		SHALLOW SOIL – FLOW DIAGRAM OF ALTERNATIVE DEVELOPMENT AND DETAILED EVALUATION PROCESS

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