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NIROP FRIDLEY
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CLOSURE ALTERNATIVES STUDY FOR STORAGE AREA C WITH TRANSMITTAL LETTER

NIROP FRIDLEY MN

10/31/00

UNITED DEFENSE

RMT INC

Engineering and Environmental Management Services

RMT INC.
744 Heartland Trail
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608-831-4444
FAX: 608-831-3334

LETTER OF TRANSMITTAL

DATE: January 2, 1992
JOB NO.: 2313.06
ATTENTION:
RE: NIROP Fridley

To: Jim Shafer
Naval Facilities Engineering Command
U.S. Naval Base, Northern Division
Building 77L
Philadelphia, PA 19112

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

☐ CONTRACT DOCUMENTS ☐ PURCHASE ORDER ☐ WAIVER OF LIEN ☐ LABORATORY ANALYSIS REPORT

☐ CERTIFICATES OF INSURANCE ☐ COPY OF LETTER ☐ PLANS ☒ report

COPIES	DATE	NO.	DESCRIPTION
1	10/91		Closure Alternatives Study for Storage Area C at the NIROP Fridley, MN.

THESE ARE TRANSMITTED as checked below:

☐ FOR APPROVAL ☐ SIGN AND RETURN ☒ FOR YOUR USE

☐ APPROVED AS NOTED ☐ FOR REVIEW AND COMMENT ☒ AS REQUESTED

☐ APPROVED AS SUBMITTED ☐ RETURNED FOR CORRECTIONS ☐ _____

REMARKS

COPY TO 2376.01

SIGNED: Linda E. Hacken

United Defense

31 October 2000
E0084/4.1.3a

Tetra Tech NUS, Inc.
661 Andersen Drive
Pittsburgh, PA 15220

Attn: Mark Sladic

Subject: Closure Report for Former Storage Area C

Enclosed is a copy of the Final Site Closure Report for the former Storage Area C at NIROP. Please contact the undersigned at (763) 572-6906 to address any additional questions.

United Defense, L. P.
Armament Systems Division

Timothy R. Ruda

Timothy R. Ruda
Senior Environmental Control Technician

TRR:/trr

cc: Joel Sanders, SOUTHDIVNAVFACENGCOM

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FAX: 608-831-3334

CLOSURE ALTERNATIVES STUDY FOR STORAGE AREA C AT THE NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA

PREPARED FOR:
FMC CORPORATION
NAVAL SYSTEMS DIVISION

PREPARED BY:
RMT, INC.
MADISON, WISCONSIN

OCTOBER 1991

Steven L. Streblow, P.E., C.H.M.M.
Senior Project Engineer

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Senior Project Engineer

Linda E. Hicken, P.E.
Project Manager

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under laws of the State of Minnesota.

Date 10/14/91 Registration No.20573

Robert J. Vetter, P.E.
Director of Technical Operations

2376.01 0000:RTE:fmc1010

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1. INTRODUCTION

1.1 Background

The Naval Industrial Reserve Ordnance Plant (NIROP) is located in an industrial area in the northern portion of the Minneapolis/St. Paul Metropolitan Area within the city limits of Fridley, Minnesota. Advanced naval weapons systems are designed and manufactured at the NIROP Fridley. The northern portion of the facility is government owned and operated by FMC Corporation, Naval Systems Division, and the remainder of the facility is independently owned by FMC. Figure 1-1 shows the location of the NIROP Fridley.

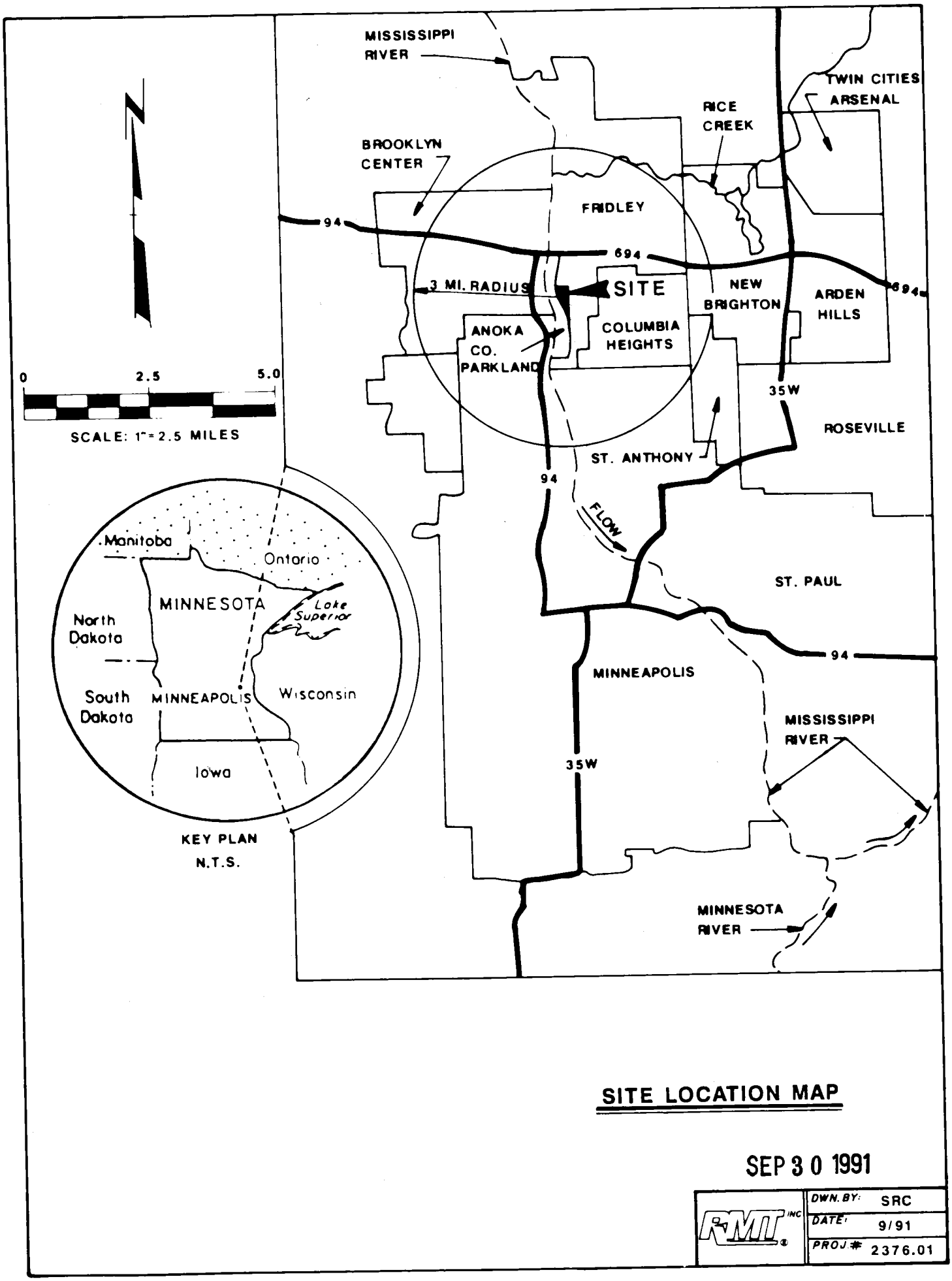
FMC operated a government-owned interim status hazardous waste storage facility known as Storage Area C. Storage Area C is located to the northeast of the main plant building, on government-owned property. Figure 1-2 shows the location of former Storage Area C. The storage area was used to store hazardous wastes that were generated as a result of production processes at the NIROP Fridley.

The foundation for the hazardous waste storage facility was built in 1972 and consisted of an approximate 30-foot-by-30-foot concrete pad. A metal building was constructed over this concrete pad in 1986. The storage area could store a maximum of 114 55-gallon drums. Drainage was directed to a sump in the building floor. When a new hazardous waste storage facility was developed, a closure plan was submitted for Storage Area C by FMC to the Minnesota Pollution Control Agency (MPCA) and the United States Environmental Protection Agency (USEPA), Region V, in accordance with FMC's RCRA Part B hazardous waste storage facility permit.

IT'S A TSD PERMIT!

note permit, an application

The Storage Area C building was dismantled in the fall of 1988, and initial excavation of the concrete pad was conducted in January 1989. During closure activities at Storage Area C, it was discovered that the sump in the building floor was actually a "dry well." The dry well consisted of a section of 48-inch concrete pipe filled with crushed rock to a depth of approximately 11 feet. The bottom of the pipe section was open to the underlying soil.



SITE LOCATION MAP

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	PROJ.#	2376.01

FIGURE 1-1

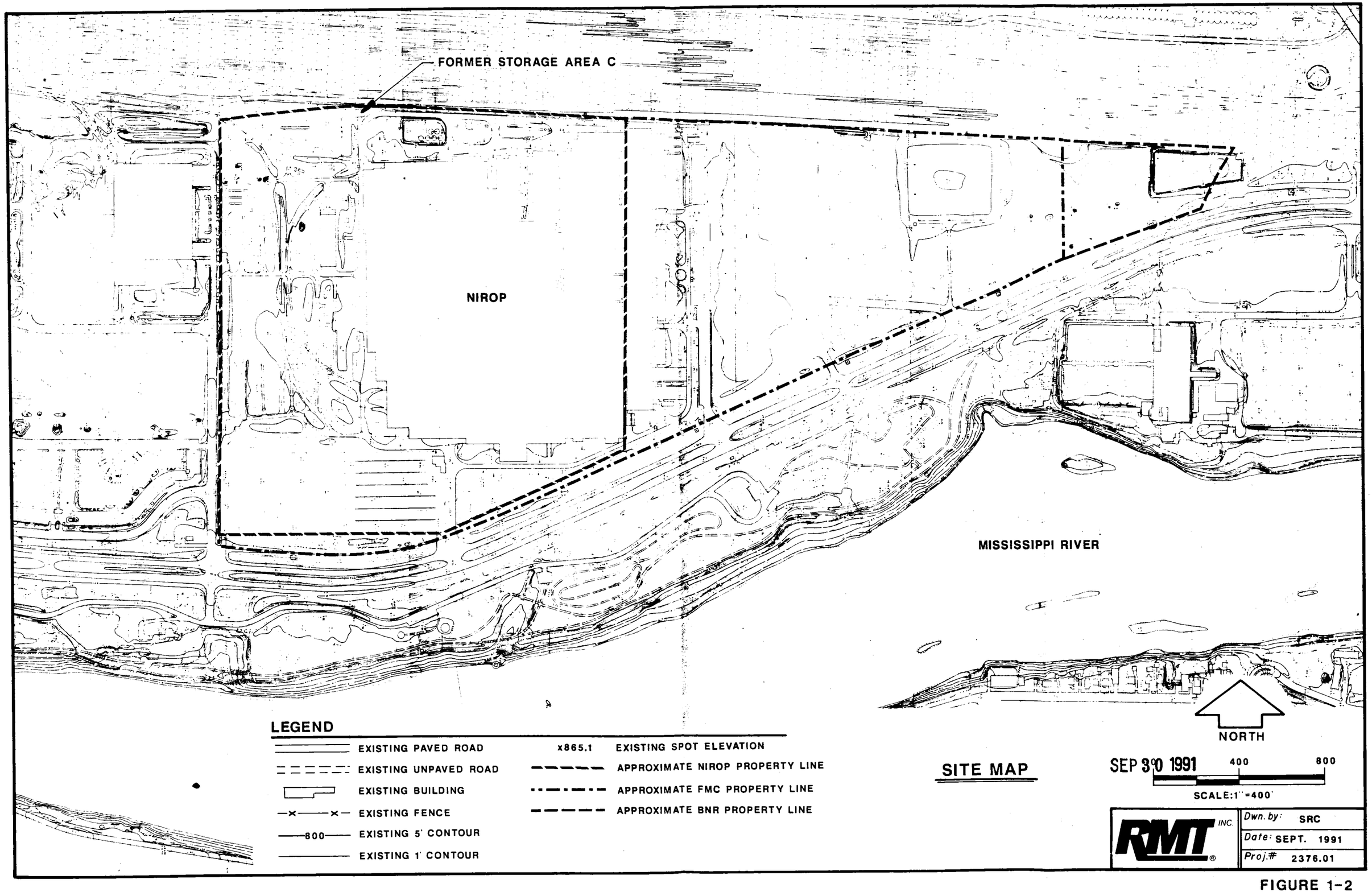
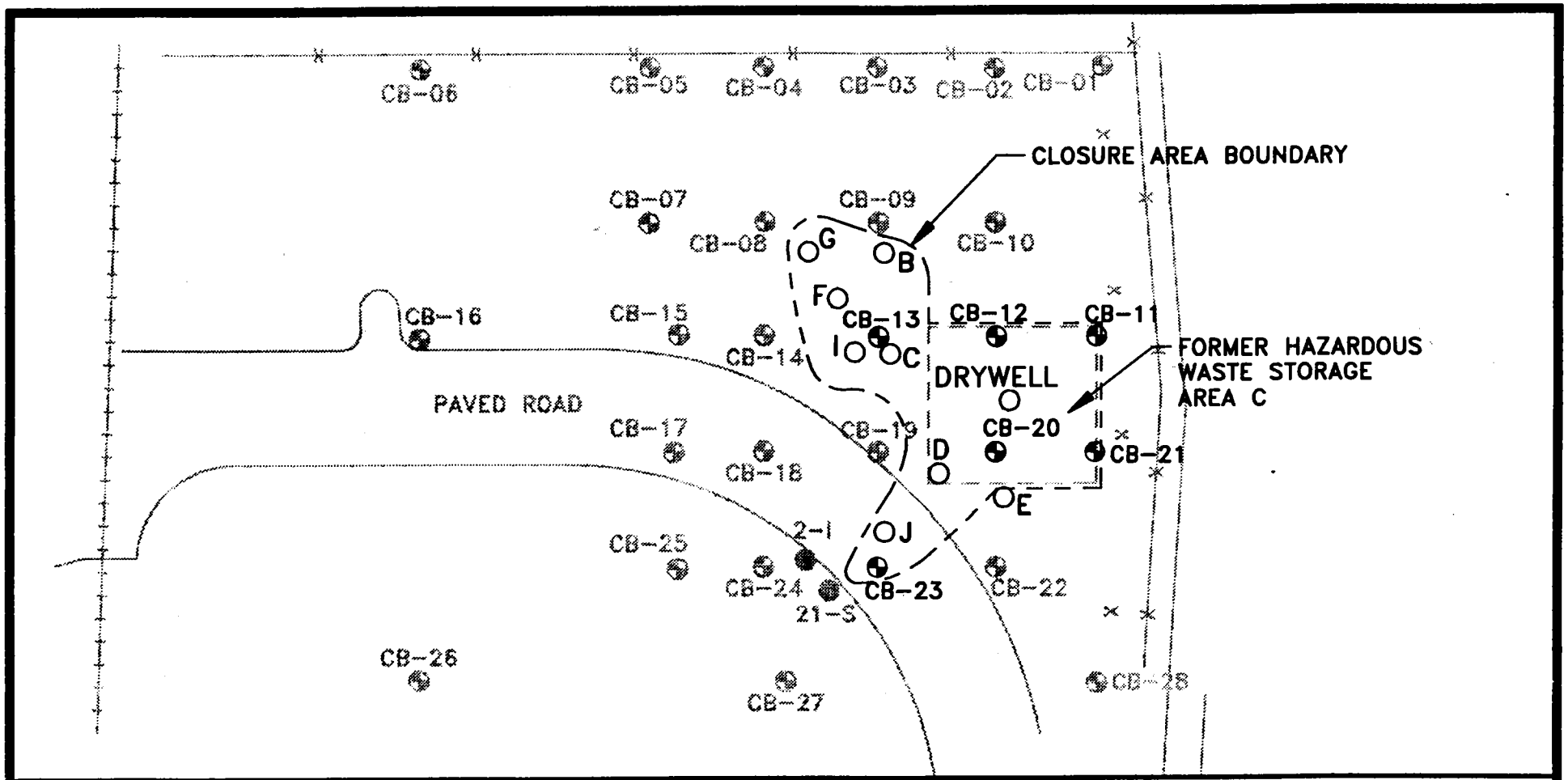

FORMER STORAGE AREA C
NIROP
MISSISSIPPI RIVER
NORTH
LEGEND
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING BUILDING
EXISTING FENCE
800
EXISTING 5' CONTOUR
EXISTING 1' CONTOUR
x865.1
EXISTING SPOT ELEVATION
APPROXIMATE NIROP PROPERTY LINE
APPROXIMATE FMC PROPERTY LINE
APPROXIMATE BNR PROPERTY LINE
SITE MAP
SEP 30 1991
400
800
SCALE:1"=400'
RMT INC.
Dwn. by: SRC
Date: SEPT. 1991
Proj.# 2376.01

FIGURE 1-2



LEGEND

- PAVED ROAD
- RAILROAD
- FENCELINE
- CLOSURE AREA BOUNDARY
- EXCAVATED STORAGE AREA
- CB-01 BORING LOCATION AND NUMBER
- A BORING COMPLETED FOR CLOSURE REPORT BY TCT FOR CECOS
- 3-1 GROUND WATER MONITORING WELL

NOTE

1. BASE MAP SOURCE: DEPARTMENT OF THE NAVY, DRAWING #2000522, PREPARED BY FMC CORPORATION, MINNEAPOLIS, MN, SEPTEMBER 1972.

SCALE: 1" = 40'

CLOSURE AREA

RMT INC.

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DATE:	OCTOBER 1991
PROJ.#	2376.01
FILE #	23760101

FIGURE 1-3

outside of Area C, as well as remediation of ground water at the NIROP Fridley (including Area C), will be addressed under the requirements of CERCLA.

Based on the above discussion, the extent of the Closure Alternatives Study area includes all soils within the closure area identified on Figure 1-3 down to the current water table.

Based on the above information and subsequent calculations, the closure area
to a depth of what? Show diminision in 3-D
includes approximately 4,750 cubic yards of potentially contaminated soil. The maximum observed TCE and PCE concentrations within the closure area were 6,300 µg/kg and 500 µg/kg, respectively. Soils within the closure area are subject to the closure performance standard presented in Subsection 3.1.

2. RECOMMENDATION OF CLOSURE ALTERNATIVE

Based on the results of the closure alternatives study detailed in this report, RMT recommends that FMC implement the closure alternative that utilizes *in-situ* active soil vapor extraction.

A soil vapor extraction system would be installed which consists of up to three 4-inch PVC vapor extraction wells, installed to a depth of approximately 20 feet below ground surface. The wells would be located within the closure area. A vacuum blower would be connected to the vapor extraction wells via a below-grade header pipe. Periodic monitoring of the off-gas would be performed to determine system effectiveness.

Are ni there soil cleanup standards calculated on risk?

At the point that further VOC removal is impractical via this technique, RMT believes that closure activity at the unit should be terminated. At that time, a comparison can be made to risk-based soil concentrations to demonstrate that the unit does not constitute a continuing threat to human health or the environment.

3. TECHNOLOGY SCREENING AND DEVELOPMENT OF ALTERNATIVES

3.1 Discussion of Closure Objectives and Closure Performance Standard

RCRA regulations mandate that closure of hazardous waste management units accomplish the following objectives:

specify CFR # =>

- Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground water, or surface water, or to the atmosphere.

- Minimize the need for further maintenance.

At the NIROP Fridley, historical impacts to ground water are being addressed under CERCLA. Therefore, these closure objectives are applicable only to soils within the RCRA closure area. Traditionally, at RCRA units where soil contamination is present, these closure objectives have been met in one of three ways. These include the following:

- Closure by removal of all hazardous wastes and removal of hazardous constituents to "background" levels (known as a "clean closure").

- Closure with hazardous waste and/or hazardous constituents left in place by construction of a secure cover system and providing a long-term maintenance and monitoring (known as "closure as a landfill").

- Closure by removal of hazardous waste and/or hazardous constituents down to a concentration which represents an acceptable risk level (known as a "risk-based closure").

At Storage Area C, all original hazardous wastes have been removed. Concern over potential post-closure effects arises from comparatively low concentrations of hazardous constituents (TCE and PCE) in residual soils. In light of the three available approaches, the following conditions are relevant to the consideration of a closure option:

- Cleanup criteria under CERCLA regulations consider potential risk to human health and the environment. Currently, one-in-a-million increased cancer risk is considered acceptable and is typically used to evaluate remedial alternatives under CERCLA. Because contamination directly outside the closure area is being addressed under the CERCLA program's risk-based criteria, utilization of risk-based closure performance standards for the subject closure area is

appropriate, and is consistent with the overall environmental efforts at the NIROP Fridley and the intent of the Federal Facility Agreement (FFA).

- Risk-based calculations of the maximum allowable concentrations of TCE and PCE in drinking water can be made using oral slope factor values found in the USEPA Health Effects Assessment Summary Table (USEPA, January 1991, NTIS PB91-921199). For purposes of comparison to maximum observed concentrations in soils at the NIROP Fridley, these "maximum allowable" concentrations in drinking water can be converted to maximum allowable concentrations in soil by multiplying by a factor of 20 to account for the liquid-to-solid ratios typically used in water or acid leaching tests designed to assess the leaching potential of solid wastes.

  Multiplying drinking water concentrations by a factor of 20 is a conservative approach, and does not account for natural soil attenuation mechanisms, such as filtration, adsorption, biodegradation, volatilization, and ion exchange, which may reduce the actual amount of a constituent that may migrate from soils to ground water. In addition, the factor of 20 does not account for the effects of the dilution capacity of ground water, which may further reduce the concentrations of constituents leached from the soils.

  Carrying out the above calculations for the closure area yields risk-based maximum allowable concentrations in soil of 70 µg/kg for TCE and 14 µg/kg for PCE. These calculations are shown in Appendix A.

- Federal drinking water standards have been promulgated for TCE and PCE (40 CFR Part 141.61). Federal drinking water standards consist of Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs). MCLGs are nonenforceable health goals which are set at the maximum level in drinking water at which no known or anticipated adverse effects on the health of persons would occur and which allow an adequate margin of safety. MCLs are enforceable standards which are set close to MCLGs, but are also based on treatment feasibility, treatment costs, and analytical detection limits. The MCL for both TCE and PCE is 5 µg/kg.

  Again, for purposes of comparison to maximum observed concentrations in soils at the NIROP Fridley, the MCL of 5.0 µg/kg can be converted to a maximum allowable concentration in soil by multiplying by a factor of 20. This yields a maximum allowable soil concentration of 100 µg/kg.

- The USEPA has proposed setting risk-based "action levels" for use at RCRA corrective action sites. According to the proposal, if concentrations of constituents greater than the action levels are found at a site, this would trigger a Corrective Measures Study. The USEPA's cleanup goal for corrective action is:

  is this sub-parts?

  > "...to the extent practicable, to eliminate significant releases from solid waste management units that pose threats to human health and the environment, and to clean up contaminated media to a level consistent with reasonably expected, as well as current, uses."
  > (July 27, 1990, Federal Register, Vol. 55, No. 145, p. 30804)

  SWMU's

The USEPA's proposed action levels for TCE and PCE in soil are 60 mg/kg and 10 mg/kg, respectively (July 27, 1990, Federal Register, Vol. 55, No. 145, p. 30867).

A comparison of the maximum observed concentrations of TCE and PCE in the closure area with the risk-based concentrations obtained from the USEPA Health Effects Summary Table, the federal drinking water standards, and the proposed RCRA Corrective Action Levels is shown in Table 3-1. As shown in Table 3-1, the maximum concentrations of TCE and PCE observed in the closure area fall between, and at the lower end of, the range of maximum allowable concentrations derived from the two sources cited.

As a result, the existing conditions may already provide a degree of protectiveness which is consistent with the RCRA closure objectives stated above. Thus, any additional closure activities should be directed toward reducing concentrations of TCE and PCE in soil.

3.2 Screening of Closure Technologies

The objective of this section is to identify specific technologies which may be appropriate to meet the closure objectives identified in Subsection 3.1. After a general discussion, these technologies are screened to eliminate those that are inappropriate for inclusion in specific integrated closure alternatives.

Technologies are grouped into four categories: containment, removal, treatment, and disposal. These categories correspond to specific individual potential actions, and can be linked to provide comprehensive closure alternatives.

An identification of remedial technologies is provided in Subsections 3.3.1 through 3.3.4, and is based on the following:

- A review of recent technical literature.
- A review of recent USEPA guidance documents.
- A review of USEPA S.I.T.E. program results.
- Discussions with commercial vendors of specific technologies.

TABLE 3-1

COMPARISON OF SOIL CONCENTRATIONS

	Maximum Observed Conc. in Closure Area	Calculated Concentration Based on the USEPA Health Effects Summary Table[1]	Calculated Concentration Based on the Federal Drinking Water Standards[1]	Proposed RCRA Corrective Action "Action Level" (Federal Register, July 27, 1990)
TCE	6,300 µg/kg	70 µg/kg	100 µg/kg	60,000 µg/kg
PCE	500 µg/kg	14 µg/kg	100 µg/kg	10,000 µg/kg

Note:

[1] Drinking water concentrations derived from this source are multiplied by 20 to approximate soil concentrations.

- Reported field observations of specific technology applications, both through the S.I.T.E. program and through private cleanups.
- RMT's experience on similar projects involving waste, soil, sediment, or ground water remediation.

The universe of remedial technologies includes those that have been widely applied as standard construction techniques, as well as those that have been recently developed for very specific remedial situations. In cases where a technology is common and well understood (such as containment and removal actions), comparatively less discussion is provided to avoid "re-inventing the wheel." Where a technology is innovative or used in an "alternative" application (such as waste treatment and disposal), more discussion is provided.

3.2.1 Containment Technologies

Containment can be used in conjunction with other remedial actions or as a sole means of site stabilization. For this project, applicable containment technologies consist primarily of various cover systems.

The purpose of a cover system, in general, is threefold: 1) to eliminate surface transport of constituents through erosion processes; 2) to eliminate the potential for direct contact with waste material; and 3) to minimize the introduction of precipitation and thereby the leaching of constituents from subsurface waste materials. Capping is frequently employed as a final method of site stabilization for a variety of waste materials, particularly when removal is impractical because of risks from increased human exposure, or the type of constituent present, or cost. Capping does not eliminate the risk associated with a waste, but rather reduces the risk of exposure to it.

A cover could be applied over the closure area, resulting in a capped area of approximately 5,600 square feet.

A discussion of common technology options is presented below.

Concrete Pavement. This option involves grading the site to provide contouring for effective surface water runoff, and placement of a granular base course followed by placement of a concrete slab. The slab would provide a durable surface which would permit selective future surface use of the site for material storage or parking. Concrete slabs have excellent weathering characteristics and excellent water repellency (i.e., low permeability).

Asphalt Pavement. This option involves surface contouring for effective water runoff and placement of a granular base course and an asphaltic surface course. This surface is specifically designed to reduce infiltration and is similar to highway paving asphalt except that the percentages of mineral filler and asphalt cement are increased, providing a low-permeability surface.

***In-situ* Soil Admixtures**. This option involves surface grading followed by addition and mixing into the soil of either a liquid asphalt to create soil asphalt, or cement and water to create soil cement. The mixing depth in either case is generally 6 to 12 inches, resulting in physical soil properties (i.e., strength, water repellency) greater than the natural soil.

Sprayed-On Covers. This technology involves grading the area for effective surface water runoff, compacting and rolling of the area to obtain a smooth surface, and application of a sprayed-on surface membrane. The membrane material generally used is an asphalt or a rubber and/or plastic latex. The finished membrane generally has a thickness of approximately 1/4 inch.

Soil Covers. This technology involves base preparation consisting of regrading and recompacting followed by placement and compaction of clay to achieve a hydraulic conductivity of less than 1×10^{-7} cm/sec. A typical clay thickness is 2 feet, which is then covered by topsoil for revegetation. The clay layer provides a low-permeability barrier that minimizes infiltration of surface waters. Revegetation helps to reduce surface erosion and minimize ground water recharge by evapotranspiration of infiltrated precipitation. Where direct contact is the primary concern, cover soils alone can be utilized.

Synthetic Membranes. This technology involves regrading the site, followed by placement of a synthetic liner between two sand blankets. A layer of fill material to be revegetated is then placed on top of this. The bottom sand blanket provides a cushion for the synthetic membrane, which is usually a flexible polymeric material. The sand blanket above the membrane provides a drainage layer for infiltrated surface water. The fill material protects the membrane from surficial activities, while the revegetation provides erosion control.

Composite Covers. This technology involves placement of a clay layer of less than 1×10^{-7} cm/sec hydraulic conductivity. A synthetic membrane is then placed on top of the clay with an overlying sand drainage layer. Fill material to be revegetated is then placed on top of the sand blanket. This technology provides two low-permeability liners to minimize infiltration, as well as sand blankets to cushion the synthetic membrane and serve as a drainage layer.

3.2.2 Removal Technologies

This technology involves the excavation of materials from an identified area followed by disposal or treatment of those materials. The purpose of the excavation is to physically remove the source of the waste constituents to prevent future migration or contact. Excavation work would be performed using conventional equipment, such as a backhoe. In general, the technology is viable and effective in minimizing future migration of waste constituents in ground water, assuming that all significant sources of these constituents are located. For the closure area, shoring would be required to allow excavation to the required depths, while minimizing the amount of materials excavated outside the RCRA unit.

3.2.3 Treatment Technologies

The field of waste and soil treatment is a changing one. New technologies are being introduced at various stages of development, and existing technologies are being applied in alternate ways. Unlike the more conventional technologies for containment and removal, treatment technologies (or process options) are frequently patented and proprietary, and available only through a limited number of vendors. In some cases, technologies exist at a "full-scale" stage of development, but have yet to be permitted for specific applications. In all cases, a treatment technology is specific to a particular chemical compound or class of compounds.

Information about treatment technologies is presented below.

Biological Treatment. Organic constituents may be amenable to biological treatment under certain conditions, using naturally occurring or enhanced micro-organisms. Under *in-situ* conditions, existing aerobic microbial populations may be enhanced by introducing nutrients and oxygen to the subsurface via an injection system. Water which is leached to the ground water can be recovered, replenished with appropriate nutrients, and then recirculated. By providing otherwise rate-limiting nutrients, naturally occurring degradation is enhanced. Less- or non-toxic byproducts are produced. If anaerobic conditions are present in the closure area, anaerobic reductive dehalogenation may be naturally occurring.

The most common process options include rotary kilns, liquid-injection systems, multiple hearths, and fluidized beds. Innovative process options include infrared units, plasma furnaces, and plasma arcs. Selection of a particular option is based on feed material characteristics, commercial availability, and economics.

Fixed-base commercial facilities exist around the country for the treatment of RCRA hazardous wastes, PCB wastes, and other solids or liquid wastes containing organic constituents. For large volumes of material which cannot be economically transported to a fixed-base facility, transportable units are available for on-site remedial actions. Transportable units require ancillary equipment for treatment of air and wastewater sidestreams, and may be subject to state and federal permitting.

Thermal Extraction. Thermal extraction is a technology used to remove organics from a waste stream under comparatively low temperature conditions (400° to 800° F). During the extraction process, organics are transferred from the solid matrix to a gaseous matrix. Depending on the process option, the off-gas may be passed through an afterburner for destruction of organic constituents, or may be condensed for organics recovery. Treated soil may be backfilled or otherwise treated/disposed. This technology is offered commercially in the form of transportable units. Fixed-base facilities have not been developed to date since the attractiveness of this technology is for cost-effective on-site applications. Transportable units can provide complete processing capabilities, with the exception of condensate which may require off-site management. Depending on the regulatory classification of the feed material and local requirements, state or federal permits may be necessary.

Solidification/Chemical Fixation. A variety of proprietary and non-proprietary equipment and additives are available to solidify/chemically fixate soils or solids. The net result of the technology is to reduce the leachability of waste constituents by physical encapsulation, chemical reaction, or a combination of both. The technology can be applied on a batch or continuous basis or by using *in-situ* techniques. When waste is excavated and processed, the treated material may be backfilled or otherwise disposed.

In terms of leaching potential, solidification without chemical alteration of the waste may not provide long-term effectiveness. In addition, materials containing high levels of organics are typically less amenable to solidification than materials with inorganic constituents, when leaching potential is the standard of measure. At the present time, there is no definitive guidance from USEPA headquarters or the regions concerning the allowable "leachability" of constituents from a solidified material. It is also uncertain as to which leach test protocols should be applied to measure the performance of a solidification technology.

Physical Separation (Preprocessing) This technology involves the separation of dissimilar materials by mechanical means. A common application is the screening of soils containing bulk debris as a processing step prior to soil treatment. A variety of equipment and techniques are readily available.

In an application where soil is being sorted prior to treatment, bulk items would be managed as a separate waste stream. Depending on site and regulatory conditions, this portion of the waste stream may or may not be classified as a hazardous waste. When this material is considered a regulated material, and one which cannot be otherwise treated, direct land disposal may be necessary.

3.2.4 Disposal Technologies

Land disposal of both hazardous and nonhazardous wastes and bulk soil or solids is a proven technology that has been used for many years. However, proposed use of land disposal technology for site remediation must comply with the USEPA's recent "land ban" regulations if RCRA-regulated hazardous wastes will be placed in disposal units.

The options for disposal of excavated solids include the following:

Off-Site Facility. Excavation of material would be performed by a backhoe or other mechanical means. Excavated material would then be transported by licensed hazardous waste haulers to an off-site permitted disposal facility. Imported fill material would be required to backfill the excavated areas. This technology permits full future use of the site. Long-term management of the removed material would become the responsibility of a third party; however, the liability associated with the material remains that of the generator. This option may also be subject to the above-mentioned "land ban."

On-Site Facility. This technology could involve the construction of a disposal facility on-site. A newly constructed landfill would have to meet land disposal design requirements consisting of a base, cap, and sidewalls constructed of low-permeability clay with a second internal synthetic liner. This option may also be subject to the pretreatment requirements of the above-mentioned "land ban." Sufficient land area must be available, and future land use would be restricted.

3.3 Technologies Suitable for Further Consideration

Table 3-2 provides a screening of those technologies that may be appropriate for inclusion in specific closure alternatives. Each technology was screened on the basis of consistency with closure objectives, applicability to site characteristics, effectiveness with respect to the constituents of concern, and technical limitations. This screening is designed to eliminate those technologies that may prove infeasible to implement, that are unlikely to perform satisfactorily or reliably, or that will not achieve the closure objectives within a reasonable time. A determination was made on whether a specific technology is appropriate for application as part of a broader remedial alternative.

As shown in Table 3-2, the following technologies were deemed by the screening process to be appropriate for further development: concrete cover, composite RCRA cover, soil excavation, *in-situ* soil vapor extraction, and off-site disposal.

3.4 Development of Closure Alternatives

The technologies which were deemed in Subsection 3.3 to be appropriate for further development could be combined or used separately to form the following four closure alternatives:

- Soil excavation and off-site treatment and disposal
- A RCRA cover of composite construction
- A concrete cover
- An active *in-situ* soil vapor extraction system

These alternatives are presented in Section 4.

TABLE 3-2

SUMMARY OF TECHNOLOGY SCREENING

Technology	Consistency with Closure Objectives	Compatibility with Closure Area Characteristics	Compatibility with Waste Characteristics	Technology Limitations	Further Evaluation? (Yes/No)
Containment:					
1. Concrete Pavement	• Reduces potential for leachate generation. • Does not reduce toxicity or persistence of contaminants. • Provides protection from direct exposure.	• The small size of the subject area would be amenable to this type of cap. • Allows for future use of area.	• Option is compatible.	• No significant limitations.	Y
2. Asphalt Pavement	• Same as concrete.	• The small size of the subject area would be amenable to this type of a cap.	• Option is compatible	• Semirigid material is more flexible than concrete. • Less durable under industrial usage.	N
3. *In-Situ* Soil Admixtures	• Same as concrete.	• Restricts future site use.	• Option is compatible	• Surface not as durable as concrete and asphalt. • Requires surface sealant to reduce permeability.	N
4. Sprayed-On Caps	• Same as concrete.	• Restricts future site usage.	• Option is compatible	• Not as durable as concrete or asphalt.	N
5. Soil Caps	• Same as concrete.	• Restricts future site usage somewhat.	• Option is compatible	• Not as durable as concrete or asphalt.	N
6. Synthetic Membranes	• Same as concrete.	• Restricts future site usage.	• Option is compatible	• Not as durable as concrete or asphalt.	N
7. Composite Covers (RCRA Cover)	• Same as concrete.	• Option is compatible if concrete wear surface is incorporated.	• Option is compatible	• No major limitations. • Requires most sophisticated design and construction.	Y

Analysis of soil samples collected from a boring at the dry well location indicated the presence of volatile organic compounds (VOCs), primarily trichloroethene (TCE) and tetrachloroethene (PCE). Excavation of over 300 tons of contaminated soil was conducted in January 1989. Analysis of a soil sample collected from the sidewall of the excavation had a TCE concentration of 900 μg/kg. The excavation was backfilled with clean sand from an off-NIROP location in April 1989.

In the fall of 1990, RMT, Inc. (RMT), was retained by the U.S. Army Corps of Engineers for the Nav to conduct four soil borings within the footprint of the former Storage Area C foundation as part of a soil investigation project that included other areas at the plant. Analysis of samples from these borings for 16 volatile organic parameters indicated the presence of only TCE and PCE. The samples were collected at depths ranging from the surface to 25 feet.

The MPCA has requested that FMC propose a closure alternative for Storage Area C. FMC has retained RMT to conduct a Closure Alternatives Study. This report presents the results of that study.

1.2 Purpose and Scope

The purpose of this report is to develop and evaluate closure alternatives for Storage Area C and to recommend a preferred closure approach. The closure alternatives address only soil contamination in the closure area, as defined in Subsection 1.3.

The scope of this closure alternatives study included the following:

- Reviewed existing site information that RMT had obtained through previous environmental investigations at the NIROP Fridley and from available site data and regulatory information supplied to RMT by FMC.
- A September 24, 1991, telephone conference between representatives of RMT, FMC, the USEPA, the MPCA, and the U.S. Navy to discuss the MPCA's expectations for closure.
- Identified closure objectives.
- Screened closure technologies for applicability to the closure area.

- Developed four closure alternatives from the screened technologies, including conceptual diagrams, preliminary sizings and types of construction for structures, and description of required utilities.

- Evaluated the four closure alternatives with respect to technical, environmental, human health, and institutional factors.

- Developed a preliminary opinion of probable cost for each of the four alternatives evaluated.

- Recommended one closure alternative.

1.3 Description of Existing Conditions

Previous geologic and hydrogeologic investigations conducted at the NIROP Fridley indicated that soils in the closure area consist of fill sand and native fine to coarse silty sand and clay till.

Information regarding the constituents of concern and soil and ground water conditions in the area are summarized below:

- Based on February 1991 ground water data collected at the site, the water table is at an elevation approximately 24 feet below grade in the closure area.

- The concrete pad associated with Storage Area C consists of approximately 900 square feet. Approximately 317 tons (approximately 250 cubic yards) of soil have been previously excavated to a depth of approximately 10 feet and disposed off-site.

- A soil sample collected by Soil Testing Services (STS) from the wall of the initial closure excavation in January 1989 exhibited a TCE concentration of 900 µg/kg. In October 1990, four borings were advanced directly into the former building location to a depth of 25 feet. Maximum concentrations of 130 µg/kg PCE and 680 µg/kg TCE were reported in soil samples collected by RMT from these borings. These two compounds were the only VOCs reported above the method detection limits. No BNAs, PCBs, or pesticides were reported above method detection limits in soil samples from these borings. No anomalous trace element concentrations were observed in soil samples from these borings.

- Twenty-four additional borings were installed by RMT in October 1990 in the immediate vicinity, but outside the footprint, of the former building location. Maximum observed concentrations of TCE and PCE in samples collected from these borings were 6,300 µg/kg for TCE and 500 µg/kg for PCE. Relatively high concentrations of some trace elements were also detected in some of these samples. Additionally, the vertical and horizontal extent of fill materials (slag, metal, glass, brick, etc.) noted in some of these borings suggests a

backfilled trench may exist to the west of Storage Area C. It is unclear if results of chemical analyses conducted on soil samples collected from these borings are due to activities at the former Storage Area C or activities associated with the trench.

In a September 24, 1991, telephone conference between representatives of RMT, FMC, the USEPA, the MPCA, and the U.S. Navy, the MPCA indicated that the TCE and PCE concentrations identified in soil borings conducted to the west of the former Storage Area C may be a result of RCRA hazardous waste management activities at Storage Area C. In the referenced telephone conference call, the MPCA stated that areas contiguous with Storage Area C in which soil concentrations of TCE exceed 100 μg/kg should be considered part of the RCRA unit, and thus the closure area. While FMC does not necessarily agree that the VOC contamination identified in soil samples from borings to the west of Storage Area C is a result of activities associated with the RCRA unit, FMC has agreed to define the closure area to include those areas contiguous with Storage Area C, where TCE soil concentrations have exceeded 100 μg/kg.

why 100 mg/kg

As shown on Figure 1-3, the proposed closure area includes all of the area within the footprint of the former Storage Area C building, plus an area to the west of the former Storage Area C. This area to the west of the former Storage Area C was delineated by locating previous borings conducted by RMT and Soil Testing Services, and drawing a boundary line around those borings in which soil samples from any depth contained TCE concentrations in excess of 100 μg/kg.

Other environmental investigations concerning contamination from sources other than a RCRA unit are ongoing at the NIROP Fridley. In accordance with the Federal Facility Agreement under CERCLA Section 120 between the USEPA, Region V, the U.S Department of the Navy, and the MPCA, dated March 1991, only the soils associated with Area C will be addressed under the requirements of RCRA. Remediation of soils at the NIROP Fridley site

TABLE 3-2 (CONTINUED)

SUMMARY OF TECHNOLOGY SCREENING

Technology	Consistency with Closure Objectives	Compatibility with Closure Area Characteristics	Compatibility with Waste Characteristics	Technology Limitations	Further Evaluation? (Yes/No)
Removal:					
8. Soil Excavation	• Source removal eliminates the potential for post-closure leaching to ground water. • Treatment and/or secure off-site disposal further reduces risk of exposure on-site.	• Shoring will be needed to excavate to required depth. • Provides no restrictions on future use of closure area.	• Option is compatible.	• Can be accomplished using conventional technology. • Excavated areas will require backfilling.	Y
Treatment:					
9. *In-Situ* Biological Treatment	• Reduces toxicity of soil; breaks contaminants down into naturally occurring elements.	• Minimal disturbance to the site. Allows for future use of area. • Site geology would be conducive to *in-situ* application of this technology.	• TCE and PCE may not be highly degradable under aerobic conditions in the subsoil using typical enhancement techniques.	• Documentation of treatment effectiveness may be difficult. • Requires the introduction of additional constituents (nutrients) into the environment. • Technology not widely applied. • Laboratory and pilot treatability testing would be required. • Requires high degree of operating and maintenance activity and expertise.	N

TABLE 3-2 (CONTINUED)

SUMMARY OF TECHNOLOGY SCREENING

Technology	Consistency with Closure Objectives	Compatibility with Closure Area Characteristics	Compatibility with Waste Characteristics	Technology Limitations	Further Evaluation? (Yes/No)
Treatment (cont.):					
10. Aboveground Biological Treatment	• Reduces toxicity of soil; breaks contaminants down into naturally occurring elements.	• Technology is compatible.	• TCE and PCE may not be highly degradable using typical aerobic techniques.	• Technology not widely applied. • Laboratory and possibly pilot treatability testing would be required. • Requires high degree of operating and maintenance activity and expertise.	N
11. Soil Flushing	• Source removal during controlled recovery and treatment of ground water reduces the potential for post-closure leaching to ground water long-term.	• Site geology would be conducive to application of this technology. • Reduces toxicity of soil with minimal disturbance to the site.	• Liquid phase removal is less efficient on PCE- and TCE-contaminated soils than vapor phase removal.	• May require the introduction of additional constituents (emulsifiers) to the environment which may have cross-media effects. • Emulsifiers are specific to type of contaminant. Would require laboratory treatability testing. • Subsequent recovery and treatment of ground water is required.	N
12. *In-Situ* Soil Vapor Extraction	• Reduces toxicity of soil with minimal disturbance to the site.	• Site soil conditions are conducive to this technology. • Does not significantly restrict future use of area.	• This technology is appropriate for the constituents of concern.	• No significant limitations.	Y

TABLE 3-2 (CONTINUED)

SUMMARY OF TECHNOLOGY SCREENING

Technology	Consistency with Closure Objectives	Compatibility with Closure Area Characteristics	Compatibility with Waste Characteristics	Technology Limitations	Further Evaluation? (Yes/No)
Treatment (cont.):					
13. Thermal Destruction	• Would reduce volume, toxicity, and mobility of source soil.	• Volumes of affected soils remaining at the site do not allow for cost-effective utilization of this technology	• Option is compatible.	• Technology requires high level of operating control. • Equipment is highly sophisticated with significant mobilization requirements.	N
14. Thermal Extraction	• Would reduce volume, toxicity, and mobility of source soil.	• Volumes of affected soils remaining at the site do not allow for cost-effective utilization of this technology	• Option is compatible.	• Technology requires high level of operating control. • Equipment is highly sophisticated with significant mobilization requirements.	N
15. *In-Situ* Solidification/ Chemical Fixation	• Reduces mobility of constituents with minimal disturbance to the site. • Would not reduce toxicity or persistence.	• Site soil conditions are conducive to this technology. However, does not provide benefits commensurate with cost.	• Bulk material (wood, debris, etc.) may limit effectiveness.	• Equipment is highly sophisticated and of limited availability. • Effectiveness has not been widely demonstrated.	N
16. Aboveground Solidification/ Chemical Fixation	• Reduces mobility. • Would not reduce toxicity or persistence.	• Would require regulatory approval to backfill solidified material on-site to be cost-effective. • Does not provide benefits commensurate with cost.	• Bulk material (wood, debris, etc.) may limit effectiveness.	• Equipment is moderately sophisticated.	N

TABLE 3-2 (CONTINUED)

SUMMARY OF TECHNOLOGY SCREENING

Technology	Consistency with Closure Objectives	Compatibility with Closure Area Characteristics	Compatibility with Waste Characteristics	Technology Limitations	Further Evaluation? (Yes/No)
Disposal:					
17. Off-Site Facility	• Removes contaminated material off-site, thereby minimizing potential leaching of contaminants to ground water at the site.	• Moves risk of material to another location, permits full future use of site.	• Pretreatment required if "Land-Ban" levels are exceeded.	• Commonly used technology.	Y
18. On-Site Facility	• Engineered controls can effectively contain and isolate waste.	• Volumes of affected soils remaining at site do not allow for cost-effective utilization of this technology. • Requires extensive land area; future use restricted.	• For closure area, would provide limited additional protectiveness over capping in-place.	• Requires considerable RCRA permitting work.	N

4. EVALUATION OF CLOSURE ALTERNATIVES

4.1 Alternative No. 1: Soil Excavation and Off-Site Treatment and Disposal

This alternative would consist of excavation of approximately 4,750 cubic yards of soil, and transportation of the soil by truck to a licensed hazardous waste disposal facility. The excavation would then be backfilled and graded for its intended future use.

Based on existing analytical data, it is assumed that the Best Demonstrated Available Technology (BDAT) level for the RCRA land disposal restrictions will not be exceeded and that the soil can be landfilled as a hazardous waste without pretreatment.

4.1.1 Technical

The technologies involved with soil removal and treatment are well known and widely used. A large-tracked backhoe would be used to excavate the soils. Sheet piling would be used with bracing on three sides of the excavation to safely maintain the open excavation. This would allow the backhoe to terrace its way down as needed to reach the anticipated required excavation depth of 24 feet, while minimizing the amount of excess materials which would be excavated from outside the closure area.

This alternative will require virtually no long-term maintenance at the site. After soils are removed and the excavation is backfilled with clean, select materials, the closure area will require no additional work. Future use of the area will not be limited.

The constructability of this alternative is high, limited only by the need to utilize shoring of the excavation sidewalls to allow excavation to the required depth. There are no known physical barriers at the site (such as utilities, nearby buildings, etc.) which will impede implementation of this alternative.

This alternative can be implemented quickly—the largest component of the overall time required to implement the alternative will be the time required to obtain disposal approval.

Alternative 1 represents a potential safety hazard during the excavation portion of the alternative implementation. As previously mentioned, shoring will be required. Traffic control on the plant roadway near the closure area will be needed during the time the excavation is open. Also, significant issues related to protection of human health may arise during excavation activities, when potentially harmful concentrations of VOCs could be volatilized during soil removal. A worker exposure monitoring plan will need to be in-place during excavation activities to ensure worker safety.

Because excavation of all soils within the closure area down to the water table is easily documented, this alternative has a low risk of failure. However, mismanagement of excavated soils during transport to, or management at, the disposal site could result in additional human health or environmental exposure concerns.

from what?

4.1.2 Environmental

Implementation of this alternative would effectively eliminate the constituents of concern from the closure area. Thus, this alternative yields high short- and long-term results with respect to the existing facility conditions.

Because implementation of this alternative does not involve introduction of other constituents into the environment, no adverse effects of the closure alternative on soils or ground water would be expected. However, the potential exists for the transfer of some contamination from soils to the air from volatilization of VOCs which is likely to occur during excavation. However, based on available information with respect to the total mass of TCE and PCE in the soils, air contamination is not likely to be significant. The reduction in exposure potential at the NIROP Fridley from implementation of this alternative is offset somewhat by the continuing potential at the point of disposal.

4.1.3 Human Health

Excavation of all contaminated soils within the closure area will effectively mitigate short-term and long-term exposure to residual contamination at the closure area. As mentioned in Subsection 4.1.2, however, some ongoing potential for exposure will exist at the point of disposal.

4.1.4 Institutional

Removal of all affected soils from the closure area and replacement with select, clean fill is in keeping with RCRA's clean-closure performance standard of cleanup to "background" conditions. Excavated soils must meet the BDAT-based standards for treatment of hazardous wastes, according to the land disposal restrictions. These treatment standards are currently 0.091 mg/L for TCE and 0.05 mg/L for PCE for listed hazardous wastes, based on concentrations in a TCLP extract. Although treatment standards for PCE and TCE soil concentrations have not been established to date, multiplying the TCLP extract–based treatment standards by a factor of 20 to approximate the maximum allowable soil concentration which would still meet the treatment standards yields concentrations of 1.8 mg/kg for TCE and 1.0 mg/kg for PCE. Because these levels are above the concentrations which would likely be observed in representative samples of excavated soils in the closure area, the BDAT requirements will not likely be an issue.

However, disposal of contaminated soils in a landfill is identified as the least-favored remedial alternative in USEPA guidance.

4.1.5 Preliminary Cost Estimate

Typical capital costs for this alternative are presented in Table 4-1. This cost estimate is subject to the following assumptions and limitations:

TABLE 4-1

TYPICAL CAPITAL COSTS
ALTERNATIVE 1: SOIL EXCAVATION AND OFF-SITE DISPOSAL

Item	Units	Unit Cost	Quantity	Extension
DIRECT CAPITAL COSTS:				
1.0 Mobilization				$10,000
2.0 Site Work				
2.1 Install sheetpiling	sf	$15.00	12,000	$180,000
2.2 Excavate "clean" soil	cy	$5.00	250	$1,250
2.3 Excavate and load contaminated soil	cy	$5.00	4,750	$23,750
2.4 Backfill "clean" stockpile	cy	$2.00	250	$500
2.5 Backfill from off-site borrow	cy	$8.00	4,750	$38,000
3.0 Purchased Equipment				$0
4.0 Off-Site Disposal				
4.1 Haul to landfill	cy	$180.00	4,750	$855,000
4.2 Tipping fee at RCRA landfill	cy	$180.00	4,750	$855,000
SUBTOTAL - Direct Capital Costs				**$1,963,500**
INDIRECT CAPITAL COSTS:				
5.0 Engineering				
5.1 Workplanning	ls	$15,000	1	$15,000
5.2 Design	ls	$40,000	1	$40,000
5.3 Field	week	$6,000	5	$30,000
6.0 Contingency (on direct costs)				
6.1 Scope contingency		25%		$500,000
6.2 Bid contingency		10%		$200,000
SUBTOTAL - Indirect Capital Costs				**$785,000**
			TOTAL CAPITAL COSTS:	**$2,750,000**

- The ultimate cost for this alternative is highly dependent on the volume of soil determined to exceed the MPCA closure limit of 100 μg/kg. The present calculation is based on limited definition of the extent of contamination.
- It is assumed that the soil can be landfilled directly at the USPCI facility in Waynoka, Oklahoma, one of FMC's pre-approved RCRA disposal locations.
- A typical cost for sheetpiling is included, but this cost may increase, depending on the specific shoring technique used.
- Confirmation sampling of the excavation is not included.

As shown in Table 4-1, the estimated capital cost of Alternative No. 1 is approximately $2,750,000. Because a detailed design has not been prepared, these costs are approximate, and should only be used as a general indicator of eventual project costs. Since this alternative would constitute a "clean closure," no post-closure costs are included.

4.2 Alternative No. 2: RCRA Composite Cover

This alternative would consist of constructing a composite cover, including a 2-foot-thick layer of clay, a 40-mil-thick flexible membrane liner (FML), a 2-foot-thick layer of granular fill, an 8-ounce polypropylene geotextile, a 6-inch crushed stone base course, and a 6-inch layer of concrete sealed with a sprayed-on elastic membrane film, over the closure area. The fill layers would result in the clay soils being at or below the local frostline, assumed to be 42 inches. The cover would extend 5 feet past the perimeter of the RCRA unit in each direction. Based on the present definition of soils exceeding 100 μg/kg, the size of the cover would be at least 5,600 square feet. A typical detail of a RCRA composite cover is shown on Figure 4-1.

4.2.1 Technical

The technologies associated with RCRA cover construction are well known and widely used. The effectiveness of this particular containment system would be fairly high. The relatively permeable soils at and around the closure area will result in nearly vertical paths of

This alternative represents a relatively low safety risk with respect to the safety of nearby communities, FMC personnel, and the environment, as well as those workers involved in construction of the cover.

4.2.2 Environmental

This alternative does not address removal of contamination or reduction in the volume or toxicity of the contaminants. However, the cover system is designed to eliminate conditions which may allow migration of these contaminants to other media and, thus, to other receptors.

The short-term benefit of this alternative will be to immediately reduce the transport of contaminants through the environment from infiltration. Long-term benefits consist of reduced potential for off-site migration via ground water from the closure area.

4.2.3 Human Health

By eliminating the contamination transport mechanism, this alternative further reduces the short- and long-term potential for human exposure via downgradient contact with ground water. This alternative also reduces the potential for direct contact with subsoils since future access to the closure area will be restricted.

4.2.4 Institutional

This type of closure alternative is typically used in conjunction with long-term monitoring of a site. Ground water issues at the NIROP Fridley (including Storage Area C) will be dealt with under CERCLA. Although this may be a point of potential confusion when dealing with regulatory agencies and the community, ongoing protectiveness can still be provided.

Because this alternative does not address removal or reduction of the toxicity of the affected soils, capping alone may be viewed as a less desirable alternative by the MPCA.

4.2.5 Preliminary Cost Estimate

Typical capital costs for this alternative are contained in Table 4-2. This cost estimate is subject to the following assumptions and limitations:

- The areal extent of coverage is presently at least 5,600 square feet. This may increase if additional soils at greater than 100 μg/kg are identified.
- It is assumed that the cover will be constructed above present grade and can be contoured with surrounding terrain to provide positive drainage. Only minimal additional filling is assumed, and no excavation (and subsequent management) of contaminated soil is included.
- The cover design is based on RMT's experience on similar RCRA closures, and is assumed to be approvable under Minnesota rules.
- It is assumed that post-closure ground water monitoring will be provided as part of the CERCLA activities. Costs are not included herein.

As shown in Table 4-2, the estimated total capital cost of Alternative No. 2 is $245,000. Because a detailed design has not been prepared, these costs are approximate, and should only be used as a general indicator of eventual project costs.

The MPCA also requires an annual post-closure fee of $27,330 and a reapplication fee of $13,670 every 5 years. The present value of these annual costs (i = 10%, n = 30 years) is $283,000.

4.3 Alternative No. 3: Concrete Cover

This alternative would consist of constructing a single-material cap of 6 inches of reinforced concrete over the closure area. Like the cover in Alternative No. 2, this cover would extend 5 feet past the perimeter of the RCRA unit in each direction, resulting in a cover of at least 5,600 square feet. The concrete would be underlain by 6 inches of crushed stone base course, and would be sealed with a sprayed-on elastic membrane to enhance the impermeability of the material, and to bridge small cracks which may develop in the concrete.

TABLE 4-2

TYPICAL CAPITAL COSTS
ALTERNATIVE 2: RCRA COMPOSITE COVER

Item	Units	Unit Cost	Quantity	Extension
DIRECT CAPITAL COSTS:				
1.0 Mobilization				$5,000
2.0 Site Work				
2.1 Construct cover	ls	$75,000	1	$75,000
2.2 Miscellaneous final grading, drainage improvements, etc.	ls	$15,000	1	$15,000
3.0 Purchased Equipment				$0
4.0 Off-Site Disposal				$0
SUBTOTAL - Direct Capital Costs				**$95,000**
INDIRECT CAPITAL COSTS:				
5.0 Engineering				
5.1 Workplanning/Post-Closure Permit application	ls	$25,000	1	$25,000
5.2 Design	ls	$50,000	1	$50,000
5.3 Field	week	$6,000	2	$12,000
6.0 Permitting				
6.1 MPCA Post-Closure Permit fee	ls	$28,000	1	$28,000
7.0 Contingency (on direct costs)				
7.1 Scope contingency		25%		$25,000
7.2 Bid contingency		10%		$10,000
SUBTOTAL - Indirect Capital Costs				**$150,000**
			TOTAL CAPITAL COSTS:	**$245,000**

4.3.1 Technical

The technology associated with concrete cover construction is simple and straightforward, and widely used. No physical barriers are known to exist which would impede construction.

The effectiveness of this particular containment system would be fairly high. While the design of the cover will not meet some institutional requirements (i.e., RCRA cover construction criteria), the cover will be effective in reducing a large portion of the infiltration currently moving through affected soils at the closure area. This will significantly reduce the mass of contaminants which may migrate to other media.

As mentioned in Subsection 4.2.1, the relatively permeable soils at and around the closure area will result in nearly vertical paths of infiltration, reducing the amount of water originating outside the RCRA unit which will contact the affected soils once the cover is in place. The 5-foot extension of the cover in each direction from the unit boundary will also aid in reducing movement of surface water from outside the capped area through the affected soils.

This alternative will require low long-term maintenance; however, periodic inspections for cracks or structural deterioration in the cap will be required. As with Alternative No. 2, the cover's concrete surface will allow future use of the site for parking and/or storage, but use of the area for other purposes (such as building construction, below-ground utility installation, etc.) will be somewhat restricted. The useful life of this alternative can be extended indefinitely with routine maintenance and repairs.

This technology has been used very frequently under analogous conditions. Because affected soils are no longer present at the ground surface, the unlikely failure of the cover would not result in an immediate impact to human receptors. Such a failure of the cover would represent conditions no worse than those which existed prior to implementation of the technology. Thus, the risk and the effects of failure of this alternative are low.

The time required for implementation of this technology is quite short. The cover could be designed and constructed within 1-2 months of approval from the MPCA. The beneficial results from utilization of this alternative are achieved as soon as the cover is in place.

This alternative represents a relatively low safety risk with respect to the safety of nearby communities, FMC personnel, and the environment, as well as those workers involved in construction of the cover.

4.3.2 Environmental

This alternative does not address removal of contamination or reduction in the volume or toxicity of the contaminants. However, the cover is designed to eliminate conditions which may allow migration of these contaminants to other media, and thus to other receptors. The short-term benefit of this alternative will be to immediately reduce the transport of contaminants through the environment from infiltration. Long-term benefits consist of reduced potential for migration of contaminants via ground water.

4.3.3 Human Health

By eliminating the contamination transport mechanism, this alternative further reduces the short- and long-term potential for human exposure via downgradient contact with ground water. The alternative also reduces the potential for direct contact with subsoils since future access to the location will be restricted.

4.3.4 Institutional

This type of closure alternative is typically used in conjunction with long-term monitoring of a site. Ground water issues at the NIROP Fridley (including Storage Area C) will be dealt with under CERCLA. Although this may be a point of potential confusion when

dealing with regulatory agencies and the community, ongoing protectiveness can still be provided.

Finally, because this alternative does not address removal or reduction of the toxicity of the affected soils, capping alone may be viewed as a less desirable alternative by the MPCA.

4.3.5 Preliminary Cost Estimate

Typical capital costs for this alternative are presented in Table 4-3. This cost estimate is subject to the following assumptions and limitations:

- The areal extent of coverage is presently at least 5,600 square feet. This may increase if additional soils at greater than 100 μg/kg are identified.
- It is assumed that post-closure ground water monitoring will be provided as part of the CERCLA activities. Costs are not included herein.

As shown in Table 4-3, the estimated total capital cost of Alternative No. 3 is $143,000. Because a detailed design has not been prepared, these costs are approximate, and should only be used as a general indicator of eventual project costs.

The MPCA also requires an annual post-closure fee of $27,330 and a reapplication fee of $13,670 every 5 years. The present value of these annual costs (i = 10%, n = 30 years) is $283,000.

4.4 Alternative No. 4: Active Soil Vapor Extraction (SVE) System

This alternative consists of installing an active soil vapor extraction system to treat the contaminated soils. This system would consist of up to three 4-inch-diameter PVC wells, installed to a depth of 20 feet, located within the closure area. Two vacuum monitoring probes would be installed outside the closure area to allow measurement of the system's radius of influence.

TABLE 4-3

TYPICAL CAPITAL COSTS
ALTERNATIVE 3: CONCRETE COVER

Item	Units	Unit Cost	Quantity	Extension
DIRECT CAPITAL COSTS:				
1.0 Mobilization				$2,000
2.0 Site Work				
2.1 Place 6 inches base course	cy	$12.00	100	$1,200
2.2 Place 6 inches concrete	sf	$4.00	5,600	$22,400
2.3 Construct curbing	lf	$6.00	400	$2,400
2.4 Place synthetic cover	sf	$4.00	5,600	$22,400
2.5 Miscellaneous final grading	ls	$1,000.00	1	$1,000
3.0 Purchased Equipment				$0
4.0 Off-Site Disposal				$0
SUBTOTAL - Direct Capital Costs				**$51,400**
INDIRECT CAPITAL COSTS:				
5.0 Engineering				
5.1 Workplanning/Post-Closure	ls	$20,000	1	$20,000
Permit application			1	
5.2 Design	ls	$20,000	1	$20,000
5.3 Field	week	$6,000		$6,000
6.0 Permits				
6.1 MPCA Post-Closure Permit fee	ls	$28,000	1	$28,000
7.0 Contingency (on direct costs)				
7.1 Scope contingency		25%		$13,000
7.2 Bid contingency		10%		$5,000
SUBTOTAL - Indirect Capital Costs				**$92,000**
			TOTAL CAPITAL COSTS:	**$143,000**

A small enclosure constructed within the closure area would house a vacuum blower and associated controls and instrumentation. Electrical power would be routed from an existing plant source. The blower would be connected to the vapor extraction wells via a below-grade header pipe. A typical detail of an SVE system is shown on Figure 4-2.

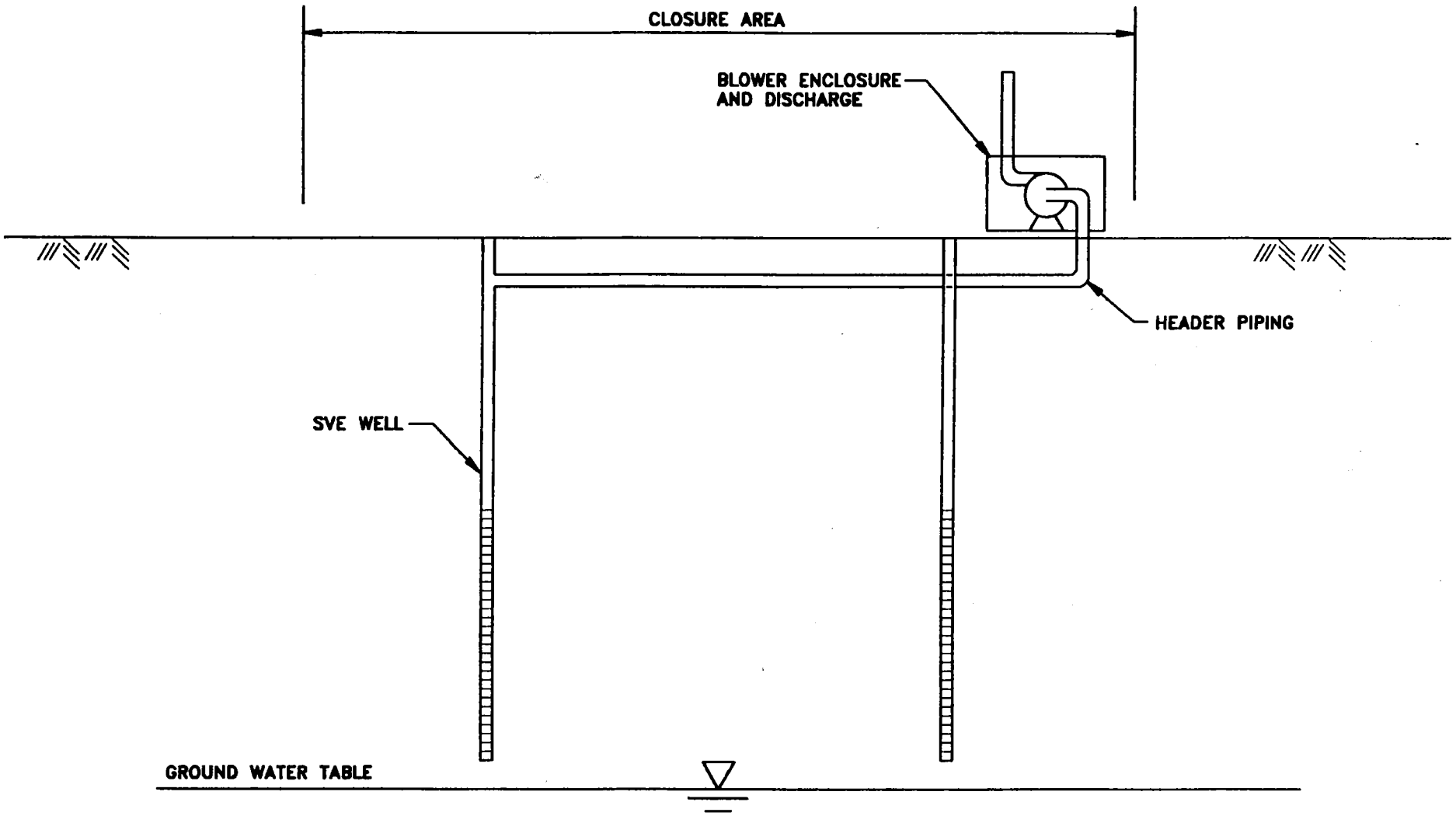
The concentration of VOCs in the off-gas from such a system cannot be predicted with available site information. Typical concentrations range from 10^{-7} to 10^{-5} lb/ft^3 of air. Using the higher value and an assumed airflow rate of 200 cfm, the mass discharge would be 0.002 lb/min (15,133 μg/sec). This is below the MPCA limits above which off-gas controls are required (for TCE and PCE, 22,600 and 65,200 μg/sec, respectively). Therefore, it is assumed at this point that the off-gas could be directly vented to the atmosphere without the use of controls.

4.4.1 Technical

Vapor extraction technology is becoming more widely used and accepted and has been used effectively in the past under analogous conditions; however, the technology still represents a relatively new alternative to remediation of VOC contamination.

This alternative will remove the mobile fraction of VOC contamination in the soils. The removal effectiveness of the vapor extraction system can be determined over time by the analysis of off-gas samples and the collection of soil samples within the RCRA unit to evaluate residual VOC concentrations after treatment.

This alternative will require moderate long-term maintenance. Periodic inspections of the vapor extraction system will be required. Operation of the SVE system may continue for up to several years until VOC concentrations in the off-gas reach an asymptotically low level. At this point, a demonstration would be made to the MPCA that the practical extent of VOC removal had been achieved. There will be minimal (if any) future use restrictions of the closure area.



ALTERNATIVE 4 – CONCEPTUAL CROSS SECTION OF A SVE SYSTEM

RMT INC.

DWN. BY:	SRC
DATE:	OCTOBER 1991
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FILE #	23760103

FIGURE 4–2

Failure of the vapor extraction system would not result in a condition which exceeds the current conditions at the RCRA unit. Failure of the vapor extraction system would not impact short-term exposure issues, and would represent only a delay in the long-term soil toxicity reduction program. In the worst case, a system failure would represent conditions at the site which would be no worse than those which existed prior to implementation of the alternative. Restoration of the system would be straightforward. Thus, the overall risk and effect of failure of the alternative is quite small.

The sandy nature of the subject soils is conducive to vapor extraction. It is expected that a radius of influence of at least 50 feet can be achieved. If pilot testing indicates that the lateral influence of the system is limited by infiltration of atmospheric air, an impermeable cover could be added (such as by paving the area) to improve system effectiveness.

Because limited excavation of soils will be required to install the soil vapor extraction system, issues relating to protection of human health may arise during system construction. These exposures would be dealt with using a worker exposure monitoring plan.

The period of time required to construct and implement Alternative No. 4 is relatively short. However, the time required to reach the vapor extraction system's maximum treatment effectiveness can range up to several years.

4.4.2 Environmental

Alternative No. 4 addresses active removal of contaminants from the soil, and thus the reduction of migration of these contaminants to other media. Long-term benefits of Alternative No. 4 include removal of the mobile fraction of the contaminants from the soil.

A potential adverse effect of this alternative consists of the potential for extracting VOC contaminants from the soil and introducing them to the air. Thus, an evaluation of off-gas control requirements would be completed, according to state air permitting guidelines.

4.4.3 Human Health

This alternative would be effective at mitigating long-term potential exposures to residual contamination and protection of human health during and after implementation. Reduction of toxicity of the affected soils, and thus reduction of human health exposure issues, is achieved by the active vapor extraction system. Concentrations of any constituents of concern which may remain after the useful life of this alternative would be the less mobile VOC fractions.

4.4.4 Institutional

This alternative addresses the RCRA closure objective of minimizing post-closure releases and migration of hazardous constituents by source reduction. It is also consistent with risk-based closure approaches by further reducing what may already be acceptable soil concentrations.

The active approach of this alternative to mitigating long-term exposures is expected to be viewed as positive by regulatory agencies and the community.

4.4.5 Preliminary Cost Estimate

Typical capital costs for this alternative are presented in Table 4-4. This cost estimate is subject to the following assumptions and limitations:

- It is assumed that the existing plastic liner delineating the extent of the original closure excavation will not adversely affect airflow through the subsoil, and that three extraction wells can provide adequate lateral coverage.
- It is assumed that post-closure ground water monitoring, if required, would be provided as part of the CERCLA activities. Costs are not included herein.
- Although the preliminary calculations described earlier indicate that off-gas controls may not be required, an allowance of $2,000 for a small activated carbon filter is included in the estimate. The estimate also includes a pilot test (which would be performed after SVE well installation but before equipment procurement) to make a more definitive determination of actual off-gas composition and the need for an impervious surface barrier.

TABLE 4-4

TYPICAL CAPITAL COSTS
ALTERNATIVE 4: SVE SYSTEM

Item	Units	Unit Cost	Quantity	Extension
DIRECT CAPITAL COSTS:				
1.0 Mobilization				$2,000
2.0 Site Work				
2.1 Install SVE extraction wells (3)	lf	$50.00	60	$3,000
2.2 Install SVE monitoring probes (2)	lf	$50.00	40	$2,000
2.3 Construct header piping, blower enclosure, discharge stack	ls	$5,000.00	1	$5,000
2.4 Electrical service	ls	$5,000.00	1	$5,000
3.0 Purchased Equipment				
3.1 Blower and associated instrumentation	ls	$7,000.00	1	$7,000
3.2 Protective cover for SVE wells	ea	$100.00	5	$500
4.0 Off-Site Disposal				$0
SUBTOTAL - Direct Capital Costs				**$24,500**
INDIRECT CAPITAL COSTS:				
5.0 Engineering				
5.1 Workplanning	ls	$10,000	1	$10,000
5.2 Pilot test	ls	$8,000	1	$8,000
5.3 Design	ls	$20,000	1	$20,000
5.4 Field and start-up testing	week	$6,000	2	$12,000
6.0 Contingency (on direct costs)				
6.1 Scope contingency		25%		$6,000
6.2 Bid contingency		10%		$2,500
SUBTOTAL - Indirect Capital Costs				**$58,500**
			TOTAL CAPITAL COSTS:	**$83,000**

As shown in Table 4-4, the estimated total capital cost of Alternative No. 4 is $83,000. Because a detailed design has not been prepared, these costs are approximate, and should only be used as a general indicator of eventual project costs.

It is assumed that this closure alternative would constitute a hybrid between closure by removal and a risk-based closure. Since it would not entail closure as a landfill, it is assumed that post-closure permitting would not be necessary. Therefore, the present worth cost of annual fees (as in Alternatives 2 and 3) is not included.

Operating costs would include the cost of power for the blower (often less than $200/month) and periodic replacement of carbon. (Although it may not be required at all for off-gas control, an allowance of $1,000 per year is included.) Costs for sampling and analysis of the off-gas typically are $2,000-$3,000 per event, and if performed quarterly, the total annual costs would be approximately $15,000. If the system is active for 5 years, the present worth (i = 10%) of the annual costs would be approximately $57,000.

4.5 Summary

Based on the information presented in the preceding subsections on the four alternatives, RMT believes that Alternative Nos. 2 (RCRA composite cover), 3 (concrete cover), and 4 (active *in-situ* soil vapor extraction) provide cost-effective options for meeting the closure objectives presented in Subsection 3.2. As such, RMT concluded that these three alternatives should be subjected to a comparative analysis, the results of which are contained in Section 5.

RMT concluded that Alternative No. 1 (soil excavation and off-site treatment and disposal) should not be considered further. Therefore, Alternative No. 1 was not included in the comparative analysis contained in Section 5. The major reasons for eliminating Alternative No. 1 include the potential for transferring liabilities to an off-site location, and the exceptionally high cost to implement this alternative.

5. COMPARATIVE ANALYSIS OF CLOSURE ALTERNATIVES

RMT conducted a comparative analysis of three closure alternatives based on the results of the evaluation presented in the preceding section. The comparative analysis of the closure alternatives was based on the following criteria: performance, reliability, implementability, safety, cost, protection of human health, and environmental considerations.

Based on the results of this comparative analysis, RMT recommends that closure Alternative No. 4 (soil vapor extraction) be implemented at the subject area. RMT believes that Alternative No. 4 will provide a degree of effectiveness sufficient to meet the closure performance standard at a reasonable cost.

A discussion of the comparative analysis which resulted in the selection of Alternative No. 4 is presented below.

5.1 Technical

Each of the three alternatives will be effective at performing their intended functions. Alternative No. 4 represents greater "usefulness" than do Alternatives No. 2 and No. 3 because it provides for removal of constituents of concern, compared to the containment offered by the other two alternatives.

While Alternative No. 4 will require more maintenance than Alternatives No. 2 and No. 3, the incremental increase in required maintenance is felt to be more than offset by the additional benefits in soil toxicity reduction derived from the use of the "active" system (SVE) used in Alternative No. 4 versus the "passive" systems (containment only) used by the other two alternatives.

Alternative No. 4 may have an additional off-gas control and permitting issue not present in either of the other two alternatives. Again, however, the additional benefits derived from this alternative versus the others offset the incremental increase in regulatory requirements.

The three alternatives are very similar in their capability to limit, in the short term, the safety threat to nearby residents, FMC personnel, and workers implementing the alternative. In the long term, however, Alternative No. 4 achieves a more significant reduction in the risk of exposure.

5.2 Human Health

Alternative No. 4 is superior with respect to the actual protection of human health. Of the three alternatives, Alternative No. 4 will provide the least level of human exposure to the constituents of concern over the long term.

Alternative No. 4 will also provide the greatest reduction in concentration of the constituents of concern over time, compared to Alternatives No. 2 and No. 3, which do not provide active soil toxicity reduction.

5.3 Environmental

All three alternatives will take approximately the same period of time to implement. By eliminating infiltration which may allow migration of contaminants to other media, and thus to other receptors, Alternative Nos. 2 and 3 will realize greater short-term benefits immediately after implementation than will Alternative No. 4. However, Alternative No. 4 will provide the greatest improvement to existing conditions in the closure area over the useful life of the alternative.

5.4 Cost

As presented in Section 4, the preliminary estimates of costs for each of the three alternatives are as follows:

	Capital Cost	Present Worth, Annual Costs	Total Project Costs
Alternative No. 2	$245,000	$283,000	$528,000
Alternative No. 3	$105,400	$283,000	$426,000
Alternative No. 4	$83,000	$57,000	$140,000

Because Alternative No. 4 will provide superior results to Alternative Nos. 2 and 3 in meeting the closure objectives, but is estimated to cost substantially less to implement. Alternative No. 4 provides the highest degree of cost effectiveness. RMT does not believe that the benefits derived from implementation of Alternative No. 2 or 3 are commensurate with the costs.

As a result, RMT recommends that FMC implement Alternative No. 4 to address the closure objectives in the closure area.

APPENDIX A

MAXIMUM ALLOWABLE TCE AND PCE CONCENTRATIONS IN SOIL BASED ON RISK-BASED CRITERIA

COMPUTATION SHEET

RMT INC.
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334

SHEET ____ OF ____

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
FMC - NIROP FRIDLEY	SLS	9-30-91			2376.01

Calculation of risk-specific concentrations in drinking water from the oral slope factor values in Table B of the USEPA Office of Environmental Criteria and Assessment - Health Effects Assessment Summary Tables (USEPA, January 1991, NTIS PB91-921199):

$$\text{mg/l in water} = \frac{1 \times 10^{-6} \times 70\ \text{Kg}}{\text{slope factor in } (\text{mg/kg/day})^{-1} \times 2\ \text{l/day}}$$

For Trichloroethene:

Oral slope factor $= 1.1 \times 10^{-2}$

$$\text{mg/l in water} = \frac{1 \times 10^{-6} \times 70\ \text{Kg}}{1 \times 10^{-2}\ (\text{mg/Kg/day})^{-1} \times 2\ \text{l/day}}$$

$= 0.0035$ mg/l ✓

$= 3.5$ ug/l ✓

For Tetrachloroethene:

Oral slope factor $= 5.1 \times 10^{-2}$

$$\text{mg/l in water} = \frac{1 \times 10^{-6} \times 70\ \text{Kg}}{5.1 \times 10^{-2} \times 2\ \text{l/day}}$$

$= 0.0007$ mg/l ✓

$= 0.7$ ug/l ✓

To convert these concentrations in water to soil concentrations, multiply by a dilution/transport factor (assumed) of 20:

Trichloroethane — 3.5 ug/l × 20 = 70 ug/kg ✓
Tetrachloroethane — 0.7 ug/l × 20 = 14 ug/kg ✓