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Environmental Protection
Agency

Office of
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Remedial Response

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September 1993

EPA

Superfund Record of Decision:

New Brighton/Arden Hills, MN

50272-101

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15. Supplementary Notes

PB94-964114

16. Abstract (Limit: 200 words)

The 25-square-mile New Brighton/Arden Hills site consists of the 4 square-mile Twin Cities Army Ammunition Plant (TCAAP) and portions of seven nearby communities: New Brighton, Arden Hills, St. Anthony, Shoreview, Mounds View, Columbia Heights, and Minneapolis, located in Ramsey and Hennepin Counties, Minnesota. Land use in the area is mixed residential, commercial, and industrial, with onsite wetlands and woodlands surrounding the Rice Creek watershed. The site consists of gently rolling, postglacial terrain with several hills and surface water bodies, including lakes and streams, but no extreme relief. The people who reside in the vicinity of the site use the aquifers which fall within the North Plume: the Prarie du Chien/Jordan Sandstone aquifer, the Hillside and Arsenal Sand aquifers, and the Lacustrine Deposits, as their drinking water supply. These aquifers supply water to TCAAP and the municipalities of New Brighton, St. Anthony, Fridley, Mounds View, and Shoreview. The TCAAP facility is an inactive small arms ammunition manufacturing plant. From 1941 to 1981, the site was used for the manufacture, storage, and testing of small arms ammunition and related equipment. Waste materials such as VOCs, heavy metals, corrosive materials, and explosives were disposed of at 14 source areas at TCAAP. In 1981, the State began ground water sampling and analysis which indicated that municipal and private drinking

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - New Brighton/Arden Hills, MN
Second Remedial Action
Contaminated Media: gw, soil, sediment, surface water
Key Contaminants: VOCs (TCE), metals

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

water wells and wells at TCAAP were contaminated with VOCs. As a result, beginning in 1981, the City of New Brighton abandoned several municipal wells and either placed them on standby or deepened several others: the Village of St. Anthony decommissioned one well and connected a portion of the village with nearby Roseville water supplies for an indefinite, but temporary period; a number of New Brighton/Arden Hills residents previously drawing ground water from contaminated private wells were provided with municipal water through the construction of a water main extension; and residents of a nearby trailer park drawing contaminated water were provided with new wells to supply potable water. Furthermore, additional Interim Remedial Actions were implemented as part of the Department of Defense's Installation Restoration Program, which included the removal of contaminated sludge and soil from Building 502 between 1984 and 1986; the construction of in-situ soil vapor extraction (SVE) systems for remediation of contaminated soil at Sites D and G on TCAAP in 1986; the cleaning of all sewer lines at TCAAP in 1986; the installation of a ground water pump-and-treat system at Sites A, I, and K in 1988; and the construction of permanent granular activated carbon treatment systems for the City of New Brighton in 1990 and the Village of St. Anthony in 1991. In 1987, an interim action ROD was written to implement a boundary ground water recovery system consisting of 12 wells to prevent migration of contaminated ground water past the southwest boundary of TCAAP. If 1992 ROD addressed the containment of the South Plume by extracting ground water from its leading edge, as OU3. The thermal treatment of approximately 1,400 yd^3 of PCB-contaminated soil at Site D in 1989. This ROD addresses the North Plume of offsite contaminated ground water. Future RODs will address onsite soil, ground water, sediment, and surface water, as OU2. The primary contaminants of concern affecting the ground water are VOCs, including TCE; and metals.

The selected remedial action for this site includes providing an alternative water supply to residents with private wells under State drinking water advisories within the impacted zone; implementing a ground water extraction scheme for plume containment; treating the extracted ground water onsite by oxidation and filtration to remove iron and manganese, followed by pumping the treated water to a permanent onsite GAC system; discharging all treated water offsite to the New Brighton municipal distribution system; monitoring ground water; and implementing institutional controls, including ground water use restrictions. The estimated present worth cost for this remedial action is $10,310,000, which includes an estimated annual O&M cost of $704,700 for 30 years.

PERFORMANCE STANDARDS OR GOALS:

Chemical-specific ground water cleanup goals are based on SDWA MCLs or health-based State levels, and include 1,1-DCA 70 ug/l; 1,1-DCE 6 ug/l; cis-1,2-DCE 70 ug/l; 1,1,1-TCA 200 ug/l; 1,1,2-TCA 3 ug/l; and TCE 5 ug/l.

RECORD OF DECISION

GROUNDWATER REMEDIATION
OPERABLE UNIT 1
AT NEW BRIGHTON/ARDEN HILLS
SUPERFUND SITE

SEPTEMBER 1993

In accordance with Army Regulation 200-2, this document is intended to comply with the National Environmental Policy Act (NEPA) of 1969.

I. DECLARATION FOR THE RECORD OF DECISION

A. Site Name and Location

New Brighton/Arden Hills (NB/AH) Superfund Site, also known as Twin Cities Army Ammunition Plant (TCAAP), Ramsey County, Minnesota.

B. Statement of Basis and Purpose

This decision document presents the selected remedial action for addressing groundwater contamination at operable unit 1 (OU-1) of the New Brighton/Arden Hills Superfund Site in Ramsey County, Minnesota, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Minnesota Environmental Response and Liability Act (MERLA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The remedial action was selected by the United States Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (MPCA), together with the United States Army (Army) pursuant to the Federal Facilities Agreement (FFA) among the three parties.

This decision document explains the factual and legal basis for selecting the remedy for this site. The information supporting this remedial action decision is contained in the Administrative Record for this site.

C. Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

D. Description of the Selected Remedy

The NB/AH site has been divided into three operable units. The first operable unit, OU-1, addressed by the remedy selected in this ROD, consists of the North Plume of off-TCAAP contaminated groundwater. The second operable unit, OU-2, consists of the on-TCAAP soils, groundwater, sediments, and surface waters. A remedy for OU-2 is expected to be proposed in mid-1994. The third operable unit, OU-3, consists of the South Plume of off-TCAAP contaminated groundwater. A ROD has already been issued for OU-3, for which the selected remedy is to contain the South Plume by extracting groundwater from its leading edge, thus preventing further contaminant migration into areas that have not been impacted.

For OU-1, the major components of the selected remedy include the following:

- Providing an alternative water supply to residents with private wells within the North Plume

- Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a Special Well Construction Area

- Extracting groundwater at the containment boundary in the North Plume near County Road E

- Pumping the extracted groundwater to the Permanent Granular Activated Carbon Water Treatment Facility (PGAC) in New Brighton for removal of volatile organic compounds (VOCs) by a pressurized GAC system

- Discharging all of the treated water to the New Brighton municipal distribution system

- Monitoring the groundwater to verify the effectiveness of the remedy

E. Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Valdas V. Adamkus (signature) — Sept. 30, 1993

Valdas V. Adamkus
Regional Administrator
U.S. Environmental Protection Agency
Region V

Date

______________________ ______________

Charles W. Williams
Commissioner
Minnesota Pollution Control Agency

Date

______________________ ______________

Lewis D. Walker
Deputy Assistant Secretary of Army for
Environment, Safety, and Occupational Health

Date

- Providing an alternative water supply to residents with private wells within the North Plume

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______________________________ ______________
Valdas V. Adamkus Date
Regional Administrator
U.S. Environmental Protection Agency
Region V

______________________________ ______________
Charles W. Williams Date
Commissioner
Minnesota Pollution Control Agency

Lewis D. Walker 9/29/93
______________________________ ______________
Lewis D. Walker Date
Deputy Assistant Secretary of Army for
Environment, Safety, and Occupational Health

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_______________________________ Date
Valdas V. Adamkus
Regional Administrator
U.S. Environmental Protection Agency
Region V

for [signature] September 27, 1993
Charles W. Williams Date
Commissioner
Minnesota Pollution Control Agency

_______________________________ Date
Lewis D. Walker
Deputy Assistant Secretary of Army for
Environment, Safety, and Occupational Health

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To Tom Barounis	From Dagmar R
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II. DECISION SUMMARY

A. Site Name, Location, and Description

The NB/AH site consists of a 25-square-mile area located in Ramsey County and Hennepin County, Minnesota just north of the Minneapolis-St. Paul metropolitan area. This includes the 4-square-mile TCAAP facility and portions of seven nearby communities: New Brighton, Arden Hills, St. Anthony, Shoreview, Mounds View, Columbia Heights, and Minneapolis (Figure 1). Land use in this generally suburban area is mixed residential, commercial, and industrial. As presently defined, the site covers much of the U.S. Geological Survey's New Brighton, Minnesota 7.5-minute quadrangle.

The site consists of gently rolling, postglacial terrain with several hills and surface water bodies, including lakes and streams, but no extreme relief. The site is located within the Rice Creek watershed. Rice Creek and its surrounding marshes and woodlands provide cover for a variety of vegetation and wildlife. Much of the lowland area adjacent to Rice Creek has lush and vigorous vegetation creating a wildlife habitat well suited to small animals.

The TCAAP facility is an inactive small arms ammunition manufacturing plant. It is currently operated by Federal Cartridge Company (FCC) and used by two manufacturing lessees, Alliant Techsystems (previously a branch of Honeywell, Inc.) and 3M Corporation. Approximately 1,000 people are currently employed at TCAAP.

B. Site History and Enforcement Activities

TCAAP has been used to manufacture, store, and test small arms ammunition and related materials since 1941. Information from past studies indicates that between 1941 and 1981, waste materials such as VOCs, heavy metals, corrosive materials, and explosives were disposed of at 14 source areas within TCAAP. In 1981, the MPCA and the Minnesota Department of Health (MDH) began groundwater sampling and analysis. Samples were collected from wells in the TCAAP area. The analytical results from these samples indicated that municipal and private drinking water wells and wells at TCAAP were contaminated by VOCs. As a result, the following actions were taken:

- The City of New Brighton abandoned several municipal wells and either placed on standby or deepened several others.
- The Village of St. Anthony decommissioned one well and connected a portion of the village with Roseville water supplies for an indefinite but temporary period.
- A number of New Brighton/Arden Hills residents drawing contaminated groundwater from private wells were provided with municipal water through the construction of a water main extension.
- Residents of the Arden Manor Trailer Park drawing contaminated groundwater from private wells were provided with new wells to supply potable water. The wells were provided by Arden Manor Trailer Park, which was later reimbursed by the Army.

The NB/AH site was proposed for inclusion on the National Priorities List (NPL) in July 1982 and finalized in September 1983, with a Hazard Ranking System (HRS) score of 59 and a ranking of 43 on the NPL. In 1981, the Army began a Phase I investigation at TCAAP which involved a significant quantity of monitoring wells and sampling efforts designed to identify the overall contribution of TCAAP to the groundwater contamination. In 1983, EPA's Field Investigation Team completed a documentation record and site assessment for the site. The assessment documented high concentrations of VOCs in groundwater at the site. Releases of these compounds from the site to surface water and direct human contact with the compounds were also documented. The elevated HRS score and correspondingly high NPL ranking reflect the following site conditions: 1) the relatively large number of individuals exposed to contaminated groundwater through their potable water supplies, and 2) the potentially carcinogenic nature of the compounds.

The NB/AH site, as currently defined, consists primarily of portions of several regional aquifers that are contaminated to differing degrees with VOCs. Concentrations for several of these compounds exceed current health-based criteria. The affected aquifers supply water to TCAAP and the municipalities of New Brighton, St. Anthony, Fridley, Mounds View, and Shoreview. On TCAAP itself, contamination of soils, sediments, and surface waters is also of concern.

PROBLEM DEFINITION

Groundwater contamination emanating from TCAAP, identified as the primary source of groundwater contamination within the area of the NB/AH site, has posed a potential health hazard. This hazard potentially results from direct human contact (dermal contact, inhalation, or ingestion) of groundwater contaminated with industrial solvents including trichloroethene (TCE), dichloroethene (DCE), trichloroethane (TCA), and dichloroethane (DCA). Studies concerning VOCs in groundwater within the study area have been undertaken primarily by the Army, Alliant Techsystems, MPCA, EPA, and private entities. These studies have largely involved the installation and sampling of monitoring wells and water quality surveys of production, municipal, and residential wells. The objectives and results of the studies are summarized as follows.

PREVIOUS STUDIES

Army reports of investigations and studies at TCAAP in 1983 and 1984 identified major and minor disposal areas on the facility that were sources of release or threatened release of hazardous substances (mainly VOCs). In their review of these reports, EPA and MPCA noted that additional information was needed to address the extent and magnitude of contaminated groundwater, to fill data gaps relative to off-site contamination, and to complete an assessment of the disposal areas identified on TCAAP.

In 1984 and 1985, the Army submitted investigative reports addressing VOC contamination at Alliant-TCAAP buildings 103 and 502 (Sites I and K). The reports indicated that the buildings' operations were a source of VOC-contaminated groundwater migrating towards Rice Creek from Building 103, and also to the west or southwest from the Building 502 area. As a result of these findings, Alliant announced a three-phase off-TCAAP investigation on July 28, 1984, to supplement work being conducted by MPCA to identify off-TCAAP sources of release.

In the spring of 1985, EPA initiated an investigation of the force mains outside TCAAP because a number of documented breaks had occurred in the line in the study area and because VOCs and other hazardous wastes and metals had been detected in the sewer sediments on TCAAP.

Also in 1985, MPCA released the Phase I Final Report, New Brighton/Arden Hills, Minnesota Multi-Point Source Remedial Investigation. The report identified four potential source areas of VOC release in the study area that had possibly contaminated the groundwater. The source areas included two areas at TCAAP and two areas adjacent to TCAAP. A second phase of the off-TCAAP RI, Phase IA, was initiated in July 1986 and completed in February, 1991. The purpose of the Phase IA RI was to further define the nature and extent of groundwater contamination in off-TCAAP areas.

In 1988, the Army initiated an on-TCAAP RI designed to characterize the nature and extent of contamination within the facility boundary, addressing soils, sediments, surface waters, and groundwater. The on-TCAAP RI was completed in April, 1991.

Additionally, in 1991, EPA completed the Human Health Risk Assessment and the Army completed the Environmental Risk Assessment. The completion of these four documents led to the development of feasibility studies for final remedial actions at the NB/AH site.

INTERIM REMEDIAL ACTIONS

Most of the interim remedial actions (IRAs) taken at TCAAP have been implemented under the Army Installation Restoration Program (IRP). These actions have been coordinated with federal and state regulatory agencies prior to implementation. Alliant Techsystems entered into an agreement with the Army in 1985 to investigate and pursue the cleanup of sites at TCAAP associated with Alliant operations. Industrial operations at TCAAP have generated most of the contamination currently migrating from the site. The IRAs being conducted by the Army and Alliant have concentrated on contaminant source control, with a focus on individual site cleanups and groundwater (aquifer) remediation. Actions that have already been taken can be divided into the categories of : a) alternative water supplies, b) unilateral actions by the Army, c) actions with EPA and state concurrence, and d) other actions initiated by EPA, MPCA, and/or Army.

a) Alternative Water Supplies

In addition to the previously mentioned alternative water supplies that were provided shortly after the discovery of contamination at the site, the following systems have been completed:

- A temporary, followed by a permanent, granular activated carbon (GAC) treatment system constructed for the City of New Brighton by the Army as part of a litigation settlement agreement. The permanent system, completed in June 1990, presently treats water from New Brighton Wells 3, 4, 5, and 6 and has a capacity of 3800 gallons per minute (gpm).

- A temporary, followed by a permanent, GAC treatment system constructed for the Village of St. Anthony by EPA and MPCA. The permanent system is a remedial action pursuant to a ROD signed in September 1986. The system, completed in April 1991, treats water from St. Anthony Wells 3, 4, and 5 and has a capacity of 2400 gpm.

b) Unilateral Actions by the Army

Unilateral removal actions have been taken by the U.S. Army using its own delegated removal authorities under CERCLA section 104. These actions have included:

- In-situ soil vapor extraction (ISV) systems for the remediation of contaminated soils at Sites D and G on TCAAP. The ISV systems were implemented in 1986 and, since then, have removed over 115 tons of VOCs from site soils.

- A groundwater pump-and-treat system at Site A, where the surficial aquifer is contaminated with VOCs. The system, installed by the Army in 1988, utilizes liquid-phase GAC to treat extracted groundwater, which is then surface-discharged.

- Groundwater pump-and-treat systems installed in 1988 at Sites I and K, Alliant operations buildings. Groundwater underneath the buildings is contaminated with VOCs with the likely source identified as leaks from floor drains and sewer lines. The extracted groundwater is treated by air stripping. The treated groundwater from Site K is discharged to a sewer under a National Pollutant Discharge Elimination System (NPDES) permit issued by the state. The treated groundwater from Site I is discharged to the TCAAP Groundwater Recovery System (TGRS). The TGRS is more fully described in the next section.

c) Actions with EPA and State Concurrence

- In 1987, the Army implemented the Boundary Groundwater Recovery System (BGRS), for which the EPA signed a ROD in September 1987. This system initially consisted of a series of six groundwater extraction wells located along the southwest boundary of TCAAP and designed to prevent any further migration of contaminated groundwater off of TCAAP. After a period of performance monitoring, the system was expanded in 1989 to twelve wells. Eight of the BGRS wells draw water from the Hillside Sand aquifer with the other four drawing from the Prairie du Chien aquifer.

- The BGRS operates at an extraction rate of approximately 2100 gpm. Extracted water is pumped to an air stripping facility for the removal of VOCs. From there the treated water is pumped to the Arsenal Sand and Gravel Pit in the north-central portion of TCAAP, where it is discharged and allowed to infiltrate back into the ground. Over five billion gallons of water have been treated and 45 tons of VOCs have been removed by this system.

- In addition to the implementation of the BGRS, the Army subsequently installed five source control (SC) wells downgradient of Sites D, G, and I. The BGRS and SC wells together comprise the TCAAP Groundwater Recovery System (TGRS). The TGRS is designed to provide regional groundwater remediation at TCAAP and prevent additional contamination from migrating beyond the facility boundaries.

d) Other Actions Initiated by EPA, MPCA and/or Army

- Site J, the sanitary sewer system at TCAAP, has been investigated in several studies. In 1983, integrity testing was conducted on part of the upper plant sewer and on the 18-inch and 24-inch force mains. During 1984, approximately 50 percent of the sanitary sewer system (over 42,000 linear feet) was inspected, cleaned, and tested. By July 1986, cleaning of all sewer lines was completed.

- Between 1984 and 1986, Alliant Techsystems removed contaminated sludge from the sewers leading away from Building 502, containerized the sludge in drums and stored it in a building called the Retrievable Monitored Containment Structure (RMCS). In addition, in 1985, Alliant excavated PCB-contaminated soils around Building 502 and placed them in the RMCS.

- About 1400 cubic yards of PCB-contaminated soil at Site D were thermally treated in 1989. EPA prepared the ROD and the risk assessment report for this action.

- The Army completed a two-phase water management study to evaluate feasible alternatives for the disposal of treated groundwater anticipated from future remedial measures.

CERCLA ENFORCEMENT ACTIVITIES

Pursuant to Section 120 of the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Army entered into a Federal Facilities Agreement (FFA) with EPA and the State of Minnesota. The TCAAP FFA, which became effective on December 31, 1987, was the first to be negotiated between EPA and any federal agency since the enactment of SARA. The general purposes of the FFA are to:

1) Ensure that the environmental impacts associated with past and present activities at TCAAP are thoroughly investigated and that appropriate remedial actions are taken to protect the public health, welfare, and the environment.

2) Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with CERCLA/SARA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Superfund guidance and policy, the Resource Conservation and Recovery Act (RCRA), and RCRA guidance and policy.

3) Ensure cooperation, information exchange, and participation of the parties in such actions.

The specific purposes of the agreement are to:

1) Identify interim remedial action alternatives appropriate for preventing further migration of contaminated groundwater prior to the implementation of final remedial actions for the site.

2) Establish requirements for conducting the on-TCAAP RI to determine fully the nature and extent of the threat to the public health, welfare, or the environment caused by the release and threatened release of hazardous substances, pollutants, or contaminants at TCAAP.

3) Establish requirements for conducting an FS for the site to identify, evaluate, and select alternatives for the appropriate remedial action(s) to prevent, mitigate, or abate the release or threatened release of hazardous substances, pollutants, or contaminants at the site in accordance with CERCLA and SARA.

4) Identify the nature, objective, and schedule of response actions to be taken at the site. Response actions at the site shall attain a degree of cleanup of hazardous substances, pollutants, or contaminants mandated by CERCLA and SARA.

5) Implement the selected interim and final remedial action(s).

6) Assure compliance with federal and state hazardous waste laws and regulations for matters covered by the agreement.

C. Highlights of Community Participation

The community near TCAAP has been involved in site activities since the environmental problems related to the TCAAP facility were identified. Numerous fact sheets have been sent and public meetings have been held to keep the community apprised of the various remedial activities at the site.

For the remedy selection for OU-1, the public participation requirements of CERCLA Sections 113 (k) (a) (B) (i-v) and 117 were met through the issuance of a fact sheet and Proposed Plan, notification of the availability of the Proposed Plan by newspaper, and the holding of a Public meeting on August 19, 1993. The public comment period for the Proposed Plan began on August 6, 1993, and ended on September 7, 1993.

D. Scope and Role of Operable Units Within the Overall Cleanup Strategy

The NB/AH site has been divided into three operable units. The first operable unit, OU-1, addressed by the remedy selected in this ROD, consists of the North Plume of off-TCAAP contaminated groundwater. The second operable unit, OU-2, consists of the on-TCAAP soils, groundwater, sediments, and surface waters. The third operable unit, OU-3, consists of the South Plume of off-TCAAP contaminated groundwater. A conceptual illustration of the three operable units is presented in Figure 2.

The main role of OU-1 is the containment of the North Plume of off-TCAAP contaminated groundwater, while the role of OU-3 is the containment of the South Plume. Implementation of the remedies for OU-1 and OU-3 will provide overall protection of human health and the environment. By extracting contaminated groundwater to hydraulically contain the most contaminated portions of the North Plume and fully contain the South Plume, remedial actions at OU-1 and OU-3 will also provide removal of contaminant mass from the system. However, hazardous substances will remain in the groundwater above health-based levels for a long period of time. To mitigate this situation, a more aggressive strategy for removing contaminant mass will be integrated into the objectives of OU-2. Mass removal will be more effective in OU-2 because the source areas of contamination are located within this operable unit.

E. Summary of Site Characteristics

Within the NB/AH study area, groundwater is found in both bedrock and glacial deposit aquifers. On top of the irregular bedrock surface, a series of unconsolidated glacial sediments has been deposited. Several of these units are water-bearing and have been affected by the spread of contaminants from TCAAP.

The Prairie du Chien/Jordan Sandstone aquifer is the principal aquifer in the Twin Cities Basin. This aquifer is referred to as Unit 4. Permeability in the Prairie du Chien/Jordan Sandstone aquifer is controlled by the extent of fractures and joints in the Prairie du Chien unit and the porosity of the Jordan Sandstone unit. Groundwater flow through this aquifer is generally in a west-southwest to south-southwest direction off-TCAAP toward the Mississippi River. Recharge to the Prairie du Chien/Jordan Sandstone aquifer occurs by infiltration through the overlying glacial units.

The Hillside Sand and the Arsenal Sand are referred to as Unit 3. Within the New Brighton quadrangle, the Hillside/Arsenal Sand outcrops in four areas: the Arsenal Kame within TCAAP; the southwestern corner of the quadrangle within Minneapolis; two small areas in Columbia Heights in the vicinity of Silver Lake; and along the southern edge of Snail Lake. Except for the exposure in Minneapolis, the Hillside/Arsenal Sand directly overlies the Prairie du Chien/Jordan Sandstone aquifer; the other three surface exposures provide direct recharge to both units. The groundwater in Unit 3 flows predominantly southwest.

The Twin Cities Till overlies the Hillside Sand in much of the area and is referred to as Unit 2. The Twin Cities Till acts as an aquitard, i.e., a confining layer that prevents direct hydraulic communication between the overlying Lacustrine Deposits and the Hillside Sand below.

The Lacustrine Deposits, referred to as Unit 1, are predominantly fine to medium sands with interbedded silt layers and occasional minor peat and clay layers. These units form the shallow surface aquifer between and to the north of the Hilltop and Arden Hills moraines. Private wells installed in Unit 1 exist to the north of TCAAP. Groundwater in this unit is perched and discontinuous. Any groundwater flow is localized and toward the closest small lake.

Groundwater in aquifer Units 1, 3, and 4 has been contaminated by chemicals coming from one or more of the 14 source areas identified on the TCAAP facility. Outside TCAAP, VOCs within the North Plume migrate horizontally and downward vertically in response to corresponding hydraulic gradients. The North Plume migrates in a southwesterly direction in both the Hillside Sand and Prairie du Chien aquifers. The North and South Plumes diverge immediately off TCAAP with the South Plume moving in a more southerly direction.

F. Summary of Site Risks

A human health risk assessment for TCAAP was performed by EPA in 1991. The risk assessment evaluated the potential risks associated with the source areas at the site as well as the contaminated groundwater both on-TCAAP and off-TCAAP. It also evaluated the ways by which people could be exposed to contaminants. These potential exposure pathways are ingestion, inhalation during showering, and absorption through the skin (dermal contact) during showering or bathing with contaminated groundwater.

The public water supplies in New Brighton, St. Anthony, and the TCAAP area treat their potable water using granular activated carbon to remove organic contaminants. However, a small number of residents may rely on private drinking wells located within the North Plume. These residents are the potential receptors at risk from the contaminated groundwater.

The following compounds have been identified as the most prevalent chemicals of concern in the groundwater: chloroform; 1,1-dichloroethane; 1,1-dichloroethene; 1,2-dichloroethene; 1,1,1-trichloroethane; trichloroethene; and bis(2-ethylhexyl)phthalate. These contaminants could pose an increased carcinogenic risk to those exposed to the contamination. This risk is over and above the average or "background" level of cancer occurrence in the general population, which is about one in three or 33 percent.

Based on the EPA risk assessment, it was estimated that maximum exposure to the chemicals at the site could result in an increased cancer risk of one in one hundred (10^{-2}) or one percent. This projected increase was based on the assumption that those exposed would use untreated ground-water from private wells installed in the most contaminated part of the North Plume and that this exposure would last for an average lifetime. The projected one percent increase in the risk of cancer is well over the amount EPA and MPCA consider acceptable. Indeed, Federal and State regulations often require action when the increased cancer risk reaches the range of one in ten thousand (10^{-4}) to one in one million (10^{-6}). In addition, the Hazard Index for Carcinogenic Mixtures, as calculated from Minn. Proposed Rule 4717.7700 (see Table 7) exceeds the acceptable value of 1.0, which represents a lifetime risk level of one in one hundred thousand (10^{-5}).

Noncarcinogenic risk, such as the risk of liver damage or reproductive abnormalities, is evaluated through the calculation of a hazard index for each chemical of concern. The hazard index accounts for either the short-term (acute) or long-term (chronic) exposure via ingestion, inhalation, and dermal contact. Noncarcinogenic risk for a given contaminant exists when the hazard index is greater than one (1.0). The hazard index for one of the contaminants of concern (1,1,1-trichloroethane) in the North Plume exceeds 1.0 in two exposure areas. In addition, the Hazard Index for Noncarcinogenic Mixtures, as calculated from Minn. Proposed Rule 4717.7700 (see Table 7), exceeds the acceptable value of 1.0, which represents the health risk limit for noncarcinogenic mixtures.

The exposure areas associated with off-post Units 3 and 4 groundwater contamination are shown in Figures 3 and 4, respectively. The excess lifetime cancer risks and the hazard indices for exposure to off-TCAAP groundwater are summarized in Table 1.

In addition to the EPA-conducted human health risk assessment, the Army conducted an ecological risk assessment at TCAAP. For the most part, the ecological risk assessment addressed on-TCAAP risks to plants and animals, and concluded that no significant risks exist. For off-TCAAP groundwater contamination, it was inferred that the contaminated groundwater in the deep aquifers does not pose any risks to plants and animals.

In summary, actual or threatened releases of hazardous substances from this site, if not addressed by implementing the remedial action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

G. Description of Alternatives

The Feasibility Study for OU-1 was performed in accordance with EPA guidance for Superfund Remedial Investigations and Feasibility Studies. Table 2 presents a tabular summary of the technology screening for OU-1. The potentially feasible remedial technologies retained from the screening are listed in Table 3. These technologies were combined into various remedial alternatives, which were then developed and screened. Three remedial alternatives were retained for detailed analysis:

Alternative 1: No Action

The no-action alternative is a baseline against which other alternatives are compared, as required by the NCP for Superfund sites. Under this alternative, no additional remedial action would be undertaken for the North Plume. Groundwater monitoring would continue under the existing FFA. The PGAC would continue to operate as it is currently operating and the PGRS would operate at a nominal capacity of 1,000 gpm. The no-action alternative provides no additional protection of human health or the environment.

The estimated 30-year present worth cost for continued semiannual groundwater monitoring is approximately $726,000 (Table 4).

Alternative 2: Mass Removal Alternative

This alternative includes providing an alternative water supply to residents with private wells with MDH drinking water advisories within the impacted zone, implementing drilling advisories that would regulate the installation of new private wells within the zone impacted by the contamination as a Special Well Construction Area, installing three new wells in the area of highest concentrations of contamination, pumping the extracted water to the PGAC, installing and operating an iron and manganese removal system upstream of the PGAC carbon units, and discharging a portion of the treated water to the New Brighton municipal distribution system interconnect.

The extraction well placement for this alternative is illustrated in Figure 5. The three new extraction wells (MR-1, MR-2, MR-3) would be screened in the Unit 3 and Unit 4 aquifers and would extract groundwater at a total flowrate of 2,250 gpm. Four existing PGAC wells (NB3, NB4, NB5, and NB6) would continue pumping at a rate of approximately 1,350 gpm, while the PGRS would be operated at 1,000 gpm. The extracted water from the new extraction wells would be pumped to the PGAC, which would bring its total operating flowrate to approximately 3,600 gpm. This is below the plant's maximum operating capacity of 3,800 gpm.

Pumping untreated water to the PGAC would require easements for the pipeline that would run from the new extraction wells to the PGAC. A 24-inch sanitary forcemain runs from TCAAP along 5th Ave., northwest from the TCAAP boundary to Interstate 694. This forcemain is within 0.5 miles of the proposed extraction wells. South of Interstate 694, the forcemain takes a jog and runs east along 7th Street, south along 23rd Avenue, and then south along Silver Lake Road. At this point, the forcemain is within 1,500 feet of the PGAC. A 16-inch pipe would be required to convey 2,250 gpm of untreated water at a flow velocity of about 5 feet per second. The 24-inch sanitary forcemain could serve as a secondary containment, although Minnesota does not require secondary containment at this time. About 3 miles of pipe would be required.

Alternative 2 includes the construction and operation of an oxidation/filtration system to remove the iron and manganese from the groundwater before it is pumped through the carbon adsorption units. A building area of approximately 50 feet by 100 feet is needed for this pretreatment system. Because space within the PGAC building is not available, an additional building for the inorganics treatment system is included in this alternative.

A major issue associated with Alternative 2 is that of managing excess treated water from the PGAC. The New Brighton municipal distribution system can accept a maximum of 2,500 gpm, which is far below the expected total flowrate of 3,600 gpm for this alternative.

Based on the groundwater modeling efforts, Alternative 2 is expected to remove an estimated 83% of the mass of contaminants after 30 years of operation, and an estimated 86% after 100 years. The North Plume will not be fully contained; contaminated groundwater is expected to continue migrating southward.

The estimated 30-year present worth cost for Alternative 2 is $14.2 Million. Table 5 presents a more detailed cost breakdown of this alternative.

Alternative 3: Containment Alternative

This alternative includes providing an alternative water supply to residents with private wells with MDH drinking water advisories within the impacted zone, implementing drilling advisories that would regulate the installation of new private wells within the zone impacted by the contamination as a Special Well Construction Area, implementing a groundwater extraction scheme for plume containment, pumping the extracted water to the PGAC, installing and operating an iron and manganese removal system upstream of the PGAC carbon units, and discharging all of the treated water to the New Brighton municipal distribution system.

The extraction well placement for this alternative is illustrated in Figure 6. The two new extraction wells (NB14 and NB15) would be screened in the Unit 4 aquifer, one near the corner of 7th Street NW and 13th Avenue, and the other in the vicinity of NB5 and NB6. The water from the new wells would be conveyed to the PGAC using the 24-inch sanitary forcemain that runs along 7th Street. Two existing PGAC wells (NB3 and NB4) would continue pumping, while the PGRS would be operated at 1,000 gpm. The extracted water from the new wells would be pumped to the PGAC, which would bring its total operating flowrate to approximately 2,200 gpm.

The construction and operation of the inorganics treatment facility is the same as described for Alternative 2.

Based on the ground-water modeling efforts, Alternative 3 is expected to remove an estimated 68% of the mass of contaminants after 30 years of operation, and an estimated 77% after 100 years. This alternative will contain the North Plume in the vicinity of County Road E and provide for the water to be treated to a TCE concentration of 5 μg/L.

The estimated 30-year present worth cost for Alternative 3 is $10.3 Million. Table 6 presents a more detailed cost breakdown of this alternative.

H. Summary of the Comparative Analysis of Alternatives

This section discusses how the alternatives retained for detailed analysis compare to one another when measured against the EPA's nine evaluation criteria for addressing Superfund sites. Each of the nine criteria are briefly described before the alternatives are evaluated against them.

1) Overall Protection of Human Health and the Environment

The analysis with respect to overall protection of human health and the environment provides a summary evaluation of how the alternative reduces the risk from potential exposure pathways through treatment, engineering, and/or institutional controls. An examination of whether alternatives pose any unacceptable short-term or cross-media impacts is also included in this analysis.

Alternative 1: The no-action alternative is not effective in preventing human exposure to contaminated water that could result in unacceptable risks to human health. Private wells may currently be located within the current or potential future plume boundaries. In some areas, there are no regulations that would prevent private citizens from locating wells within the plume boundaries. The greatest excess lifetime cancer risk estimated for exposure by an off-TCAAP resident to the contaminated groundwater is 1×10^{-2}. This value is above both the EPA range for acceptable risk (i.e., 10^{-4} to 10^{-6}) and the MPCA acceptable risk value of 10^{-5}. The EPA acceptable benchmark for noncarcinogenic risk was also exceeded in two of the exposure areas evaluated.

Alternative 2: This alternative protects human health by removing VOCs from the groundwater and by implementing institutional controls that prevent exposure to contaminated groundwater. Residents with private wells with MDH drinking water advisories located within the impacted zone will be provided with an alternative water supply. In addition, a Special Well Construction Zone will be designated that would regulate installation of wells in the impacted zone. This alternative also includes new facilities to remove iron and manganese thereby meeting all the water quality objectives for potable supply. However, it can be seen in Figure 5 that the plume breaks through between the PGAC and the PGRS; thus, the contaminants will continue to migrate towards the Mississippi River. Therefore, this alternative does not prevent the further spread of contaminated groundwater into portions of the aquifer that are significantly less contaminated and provides less protection of human health for potential well users within and beyond the current plume boundary.

Alternative 3: This alternative protects human health and the environment by containing the plume in the vicinity of County Road E, by removing VOCs from the groundwater and by implementing institutional controls that prevent exposure to contaminated groundwater. Residents with private wells with MDH drinking water advisories located within the impacted zone will be provided with an alternative water supply. In addition, drilling advisories would be implemented in the impacted zone. This alternative also includes new facilities to remove iron and manganese thereby meeting all the water quality objectives for potable supply. Figure 6 shows that this alternative provides a more effective capture zone than Alternative 2. Although the alternative does not contain the plume beyond the vicinity of County Road E, it does contain the most contaminated portions of the North Plume and prevents it from spreading further. For this reason, overall protection of human health and the environment is greater for Alternative 3 than Alternative 2.

2) <u>Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)</u>

The ability of each alternative to meet all of its federal and state requirements that are applicable or relevant and appropriate is noted for each alternative. The major ARARs for OU-1 are chemical-specific and action-specific, and are enumerated in Section J below. Table 7 summarizes the drinking water standards established by the Federal Safe Drinking Water Act (SDWA) and adopted by the State of Minnesota for public water supplies. Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs) are the major federal ARARs for cleanup of groundwater at OU-1. Minnesota Health Risk Limits (HRLs) and Recommended Allowable Limits (RALs) are additional to be considered (TBC) criteria because they are intended to protect groundwater and present and future private well users, respectively. The most stringent standard for each compound represents the chemical-specific cleanup standard for that compound.

Alternative 1: The no-action alternative does not comply with ARARs or TBC guidance values. There are currently 12 contaminants of concern in the groundwater at concentrations above MCLs, RALs, and HRLs which would be left unaddressed in this alternative.

Alternatives 2 and 3: These alternatives provide for treatment of VOCs using the existing PGAC system and also include new facilities to remove iron and manganese thereby meeting all of the water quality objectives for potable supply. Thus, treated groundwater will be in compliance with ARARs. However, it is estimated that contaminants would remain in the aquifer at concentrations approaching but still greater than MCLs, RALs, and HRLs for more than 100 years.

3) <u>Long-Term Effectiveness and Permanence</u>

Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage remaining waste over the long-term.

Alternative 1: The no-action alternative does not provide long-term effectiveness and permanence since the current interim treatment systems do not contain the entire plume and private wells may be located in the plume pathway. TCE and other contaminants are currently allowed to migrate towards the Mississippi River. As the plume migrates, the number of private wells that could be impacted by the advancing plume potentially increases.

Alternative 2: This alternative provides long-term effectiveness by removing contaminant mass, providing an alternative water supply to residents with private wells located within the plume boundary, and enacting drilling advisories that regulate the installation of new private wells within the North Plume as a Special Well Construction Area. However, because this alternative does not effectively contain the North Plume at any boundary, it does not provide a permanent solution to the problem.

Alternative 3: This alternative also provides long-term effectiveness by removing contaminant mass and containing the plume, providing an alternative water supply to residents with private wells located within the plume boundary, and enacting drilling advisories that regulate construction of new wells within the plume boundary. Because this alternative effectively contains the most contaminated portions of the North Plume in the vicinity of County Road E it also provides a more permanent solution to the problem.

4) <u>Reduction of Toxicity, Mobility, and Volume Through Treatment</u>

The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies included in the remedial alternative.

Alternative 1: The treatment systems currently in place (i.e., TGRS, PGAC, St. Anthony Municipal Water Supply) are moderately effective in reducing the volume of contaminants in the groundwater. However, these systems do not contain the plume (i.e., there is little reduction in mobility).

Alternative 2: The mass removal alternative is designed to maximize the removal of contaminant mass in the shortest amount of time. Based on computer modeling performed for this FS, the mass removal alternative is predicted to remove about 83 percent of the mass of contaminants in the groundwater within 30 years (Figure 7). Within 100 years, about 86 percent of the contaminant mass is predicted to be removed. This alternative is more effective than Alternative 3 in reducing contaminant toxicity and volume, since it removes more contaminant mass in less time. However, it is less effective in reducing mobility because it does not contain the plume at any boundary.

Alternative 3: The containment alternative also provides removal of contaminant mass. As shown in Figure 7, this alternative is predicted to remove about 68 percent of the mass of contaminants in the groundwater within 30 years, and about 77 percent within 100 years. Furthermore, because this alternative effectively contains the plume in the vicinity of County Road E, it provides greater reduction in mobility than Alternative 2.

5) <u>Short-Term Effectiveness</u>

The assessment against this criterion examines the effectiveness of the alternative in protecting human health and the environment during the construction and implementation of a remedy until the response objectives have been met.

Since the only activity included as part of the No Action alternative (Alternative 1) is the continuation of groundwater monitoring, it provides the greatest short-term effectiveness. Alternative 2 is the least effective in the short-term because it includes more extensive construction activities than Alternatives 1 or 3 (more wells, longer lengths of pipeline and a new treatment facility). Alternative 3 provides a level of short-term effectiveness intermediate between Alternatives 1 and 2.

6) Implementability

The analysis of implementability evaluates the technical and administrative feasibility of the alternative and the availability of the goods and services needed to implement it.

Alternative 1: There is nothing new to implement with the no-action alternative.

Alternative 2: This alternative will be difficult to implement for the following reasons. Alternative 2 would require three additional wells capable of extracting 750 gpm each, generating approximately 2150 gpm (3.1 mgd) over a period of 50 to 100 years. The wells would have to be located in a largely residential area, and easements may be very restrictive. In addition, this alternative would extract more water than the New Brighton distribution system can accommodate. Finally, because the City of New Brighton has concerns regarding the water quality of any water coming from the Unit 3 aquifer, it will not accept this water into its distribution system (i.e., the PGAC). Therefore, if Alternative 2 were implemented, 3.1 mgd would have to be treated and disposed, for which no water management option has yet been identified.

Another problem with this alternative involves its potential ineffectiveness for vertical containment of the contamination. Existing municipal wells would be pumping continuously at a minimum rate of 1335 gpm, making the total volume of water to be generated by this alternative approximately 3500 gpm (5.0 mgd). Preferably, most of this water should be extracted from the upper portion of the Unit 4 aquifer (i.e., the Prairie du Chien) to minimize the potential of drawing contamination into the less-contaminated lower portion (i.e., the Jordan). However, the Prairie du Chien aquifer may not be able to sustain the pumping rates estimated for this extraction scenario. This means that the pumping rates of some of the Jordan wells will have to be increased, thereby increasing the potential of drawing contamination into the Jordan aquifer, where it may spread further.

Alternative 3: The containment alternative involves installing two new extraction wells, constructing a pipeline from the wells to the PGAC, constructing and operating an iron and manganese removal system, and managing the excess water generated. The new wells for this alternative would be installed near existing municipal wells, making their management easier. The construction of a pipeline will also be readily implementable, since a 24-inch sanitary forcemain currently located near the extraction wells and the PGAC can be used to convey the water. Some easements for pipe runs that connect the extraction well to the main pipeline are required; these are not expected to be difficult to obtain.

The current New Brighton water distribution system can handle a flowrate of 2,500 gpm from the PGAC. This alternative produces about 2,200 gpm of treated water from the PGAC. No additional water management options are required with this alternative. Most of this water will be extracted from the Prairie du Chien aquifer, thereby minimizing further contamination of the Jordan aquifer.

7) Cost

The cost estimates for the three alternatives are preliminary and approximate. The evaluation against this criterion compares the capital costs and operating and maintenance (O&M) costs of each alternative on a present-worth basis. The present-worth costs have been determined for 30 years at a 10 percent discount rate.

Alternative 1: There are no new costs associated with the no-action alternative. The U.S. Army will continue to pay for O&M costs for the PGAC, which have been estimated at $450,000 per year. Moreover, the Army will continue to pay the city of St. Anthony approximately $200,000 per year for the GAC used in its water treatment facility (for the first 10 years of operation). The annual costs of continued groundwater monitoring have been estimated at approximately $70,000. The estimated 30-year present worth cost for continued semiannual groundwater monitoring is approximately $726,000 (Table 4).

Alternative 2: The costs associated with this alternative include additional O&M costs for the PGAC system, construction costs for the extraction wells and the pipeline, and construction and O&M costs for the inorganics treatment facility. The total capital expenditure has been estimated at approximately $4.6 million dollars and the annual O&M costs have been estimated at approximately $900,000. The annual O&M costs include costs for both organics and inorganics treatment. The estimated 30-year present worth cost for Alternative 2 is $14.2 Million (Table 5).

Alternative 3: The costs associated with this alternative include additional O&M costs for the PGAC system, construction costs for the extraction wells and the pipeline, and construction and O&M costs for the inorganics treatment facility. The total capital expenditure has been estimated at approximately $3 million and the annual operating cost is expected to be approximately $700,000. The annual O&M costs for this alternative include costs for both VOC removal and inorganics treatment. The estimated 30-year present worth cost for Alternative 3 is $10.3 Million (Table 6).

8 & 9) State and Community Acceptance

These criteria reflect the state's and community's preferences among or concerns about each alternative.

Alternative 1: The state and the community have expressed the need for additional remedial action beyond the current interim actions in place.

Alternative 2: This alternative may not be acceptable to the community (as represented by officials of New Brighton) because they will not accept water from sources north of Interstate 694 into their distribution system. Furthermore, they are concerned about the water management problem involved with this alternative.

Alternative 3: State acceptance of this alternative is indicated by state concurrence on this ROD. The community as represented by officials of the cities of New Brighton and Fridley has strongly endorsed this alternative. Based upon comments received during the public comment period, the community accepts Alternative 3 as the selected remedy.

I. The Selected Remedy

The selected remedy for OU-1 is Alternative 3, the containment alternative. This alternative includes providing an alternative water supply to residents with private wells with MDH drinking water advisories within the impacted zone, implementing drilling advisories that would regulate the installation of new private wells within the zone impacted by the contamination as a Special Well Construction Area, implementing a groundwater extraction scheme for plume containment, pumping the extracted water to the PGAC, installing and operating an iron and manganese removal system upstream of the PGAC carbon units, and discharging all of the treated water to the New Brighton municipal distribution system.

CLEANUP STANDARDS

Following are the specific contaminant cleanup standards to be attained in the aquifer before the remedy can be considered complete:

Contaminant	Cleanup Standard µg/L	Basis
1,1-Dichloroethane	70	RAL
1,1-Dichloroethene	6	HRL*
cis-1,2-Dichloroethene	70	MCL, RAL
1,1,1-Trichloroethane	200	MCL
1,1,2-Trichloroethane	3	MCLG (proposed), HRL*
Trichloroethene	5	MCL
Other TBCs		
Hazard Index for Carcinogenic Mixture (see Table 7)	≤1.0	HRL*
Hazard Index for Noncarcinogenic Mixture (see Table 7)	≤1.0	HRL*

* *Proposed Minn. Rules, Parts 4717.7100 to 4717.7800*

The point of compliance will be along the containment boundary created by the combined pumping of the existing New Brighton wells NB3 and NB4 and new extraction wells NB14 and NB15, which groundwater modeling shows to be in the vicinity of County Road E. The area of attainment is considered to be the areal and vertical extent of the North Plume. Groundwater monitoring will be required until restoration of the aquifer is achieved.

Alternative 3 will achieve substantial risk reduction by effectively containing the contaminant plume in the vicinity of County Road E, while at the same time putting the treated water to its most beneficial use. In addition, the North Plume will be extracted until groundwater cleanup standards are achieved. The cleanup standards are based upon the ARARs identified for the remedy and upon the HRLs as proposed groundwater cleanup standards and the Minnesota RALS for private potable water supplies. Extracted groundwater will be treated to meet MCLs and non-zero MCLGs established by the SDWA. The most carcinogenic and pervasive compound, trichloroethene, will be reduced to 5µg/l or below, which corresponds to a 1.7×10^{-6}

cancer risk. The State of Minnesota RAL will be the cleanup goal for 1,1-dichloroethane because no Federal MCL/MCLG exists for this compound. For cis-1,2-dichloroethene the Minnesota MCL, the SDWA MCL, and the RAL are the same, 70 μg/L. The State of Minnesota HRL will be the cleanup goal for 1,1,-dichloroethene because it is more stringent than the Federal MCL/MCLG. The regulation of water well drilling by the State of Minnesota is the institutional control to be used to regulate drilling of private wells in the North Plume before cleanup standards are achieved.

Alternative 3 provides the best balance among the three alternatives evaluated against the nine evaluation criteria. Based on the available information, EPA and MPCA believe that the selected remedy is protective of human health and the environment, satisfies the remedial objective of plume containment, is cost-effective, and utilizes permanent solutions to the maximum extent practicable.

J. Statutory Determinations

This section discusses how the selected remedy for OU-1 meets the five statutory requirements established by CERCLA.

Protection of Human Health and the Environment

The selected remedy will provide overall protection of human health and the environment through extraction and treatment of contaminated groundwater. The extraction of the groundwater will contain the most contaminated portions of the North Plume and prevent it from spreading further. The extracted water will be treated to meet drinking water standards and discharged to a public water supply. Institutional controls on the drilling of private wells will help to regulate the installation of new exposure points within the contaminated areas at the site. No unacceptable short-term risks or cross-media impacts will be caused by implementation of the remedy.

Compliance with ARARs

The selected remedy will comply with ARARs over time. The extracted groundwater will meet the chemical-specific ARARs by undergoing treatment at the PGAC, while the action-specific ARARs will be met during the construction, operation, and monitoring phases of the remedy. The following is a list of ARARs and "to be considered" guidelines for the remedy:

Chemical-Specific

- Safe Drinking Water Act, 40 CFR Part 141, Maximum Contaminant Levels and Non-Zero Maximum Contaminant Levels - Finalized and Proposed for cis-1,2-dichloroethene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and trichloroethene - Applicable for Discharge to Public Water Supply and Relevant and Appropriate for Groundwater Restoration

- Minnesota Recommended Allowable Limits, MDH Release No. 3 (Jan. 1991), for 1,1-dichloroethane and cis-1,2-dichloroethene - To Be Considered for Protection of Private Water Supplies

- Minnesota Health Risk Limits, in Proposed Minnesota Rules Parts 4717.7100 to 4717.7800 for 1,1-dichloroethene and 1,1,2-trichloroethane - To Be Considered for Groundwater Restoration; Determination of Hazard Indices for Carcinogenic and Noncarcinogenic Mixtures - To Be Considered for Groundwater Restoration

<u>Action-Specific</u>

- Resource Conservation and Recovery Act (RCRA), 40 CFR Part 268 Subpart D - Regulates the disposal of spent carbon - Applicable

- RCRA, 40 CFR Part 264 Subpart J - Requirements for tanks used for the treatment of waste - Applicable

- Minnesota Rules, Part 7060.0400 - Uses of Underground Waters - Relevant and Appropriate

- Minnesota Rules Chapter 4720, Public Water Supplies - Regulates community and non-community public water supplies - Applicable

- Minnesota Rules Chapter 4725, Water Well Code - Establishes well construction standards and specifies requirements for designating Special Well Construction Areas - Applicable

<u>Cost-Effectiveness</u>

The selected remedy provides an effective remedy proportionate to its cost. The degree of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume of contaminants, and ease of implementability afforded by this remedy give it a reasonable value for its cost.

<u>Utilization of Permanent Solutions and Resource Recovery Technologies to the Maximum Extent Practicable</u>

The selected remedy meets the statutory requirement to utilize permanent solutions and resource recovery technologies to the maximum extent practicable.

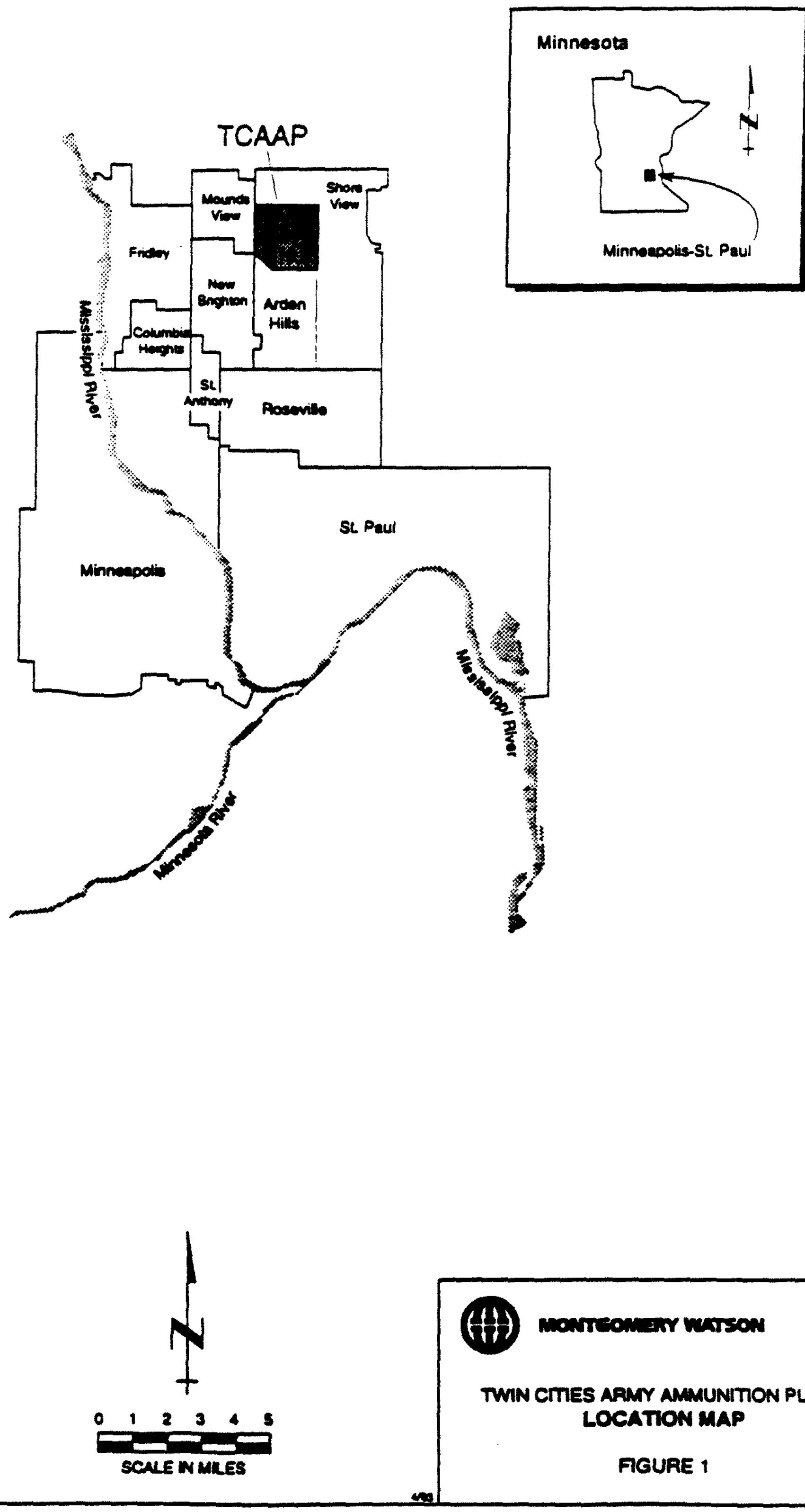
The selected remedy, Alternative 3, provides the best balance among the three alternatives with respect to the primary balancing criteria. Alternative 3 provides a greater degree of long-term effectiveness and permanence than Alternatives 1 or 2. Both Alternatives 2 and 3 provide a reduction in toxicity and volume of contaminants. In addition, Alternative 3 provides the greatest reduction in mobility among the three alternatives, and is less costly and easier to implement than Alternative 2.

Of the five primary balancing criteria, long-term effectiveness and permanence, implementability and cost were the most decisive factors in the selection decision. By using the treated groundwater in the municipal water supply system of New Brighton, the local contaminated groundwater resource is recovered and the groundwater resource is conserved. Finally, the State of Minnesota and the community support the selected remedy.

Preference for Treatment as a Principal Element

The selected remedy removes and treats VOCs in the groundwater using GAC. Therefore, it satisfies the statutory preference for remedies that employ treatment as a principal element.

APPENDIX A
LIST OF FIGURES

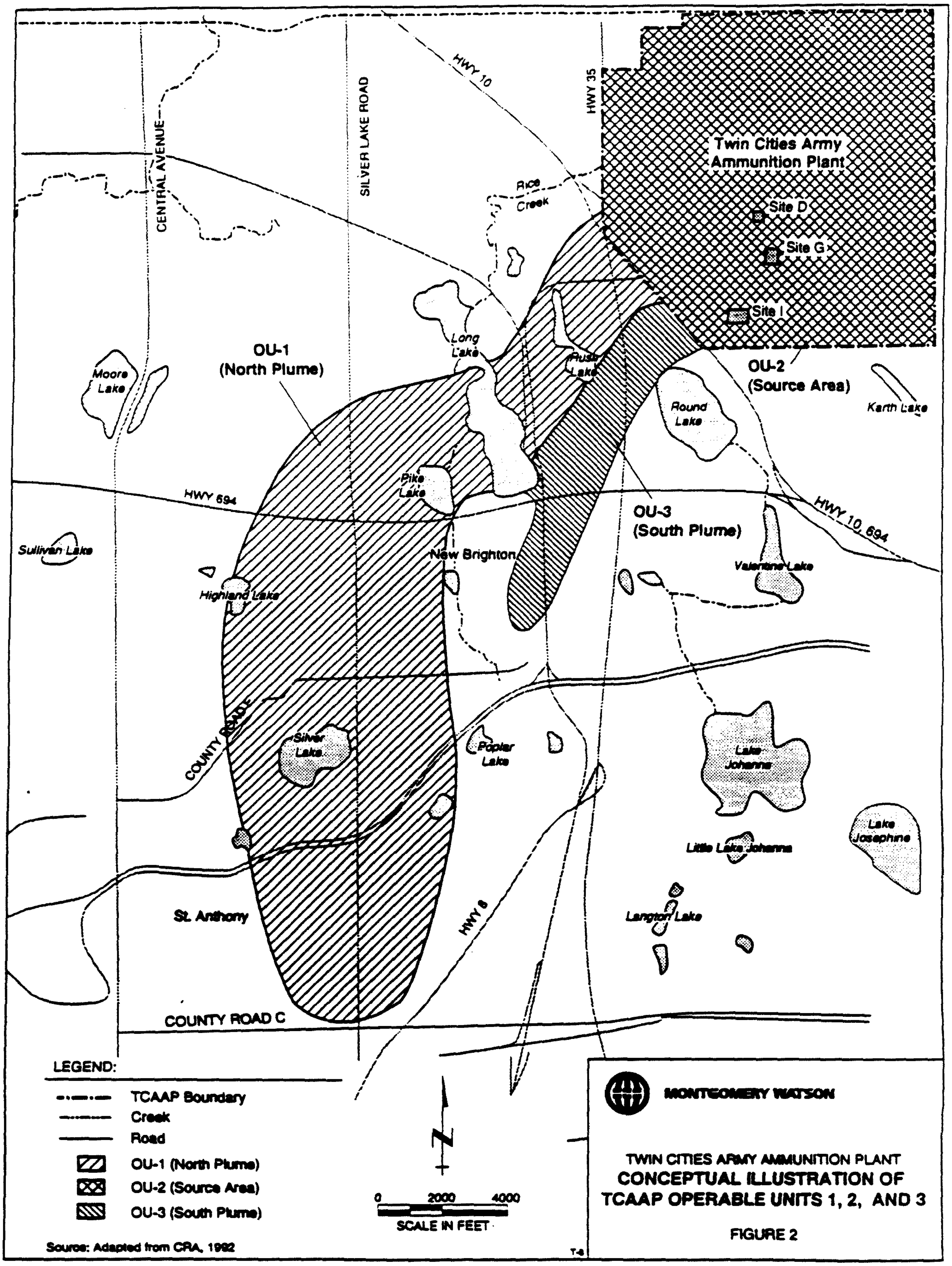


Source: Modified from ANL, 1988

MONTGOMERY WATSON

TWIN CITIES ARMY AMMUNITION PLANT
LOCATION MAP

FIGURE 1

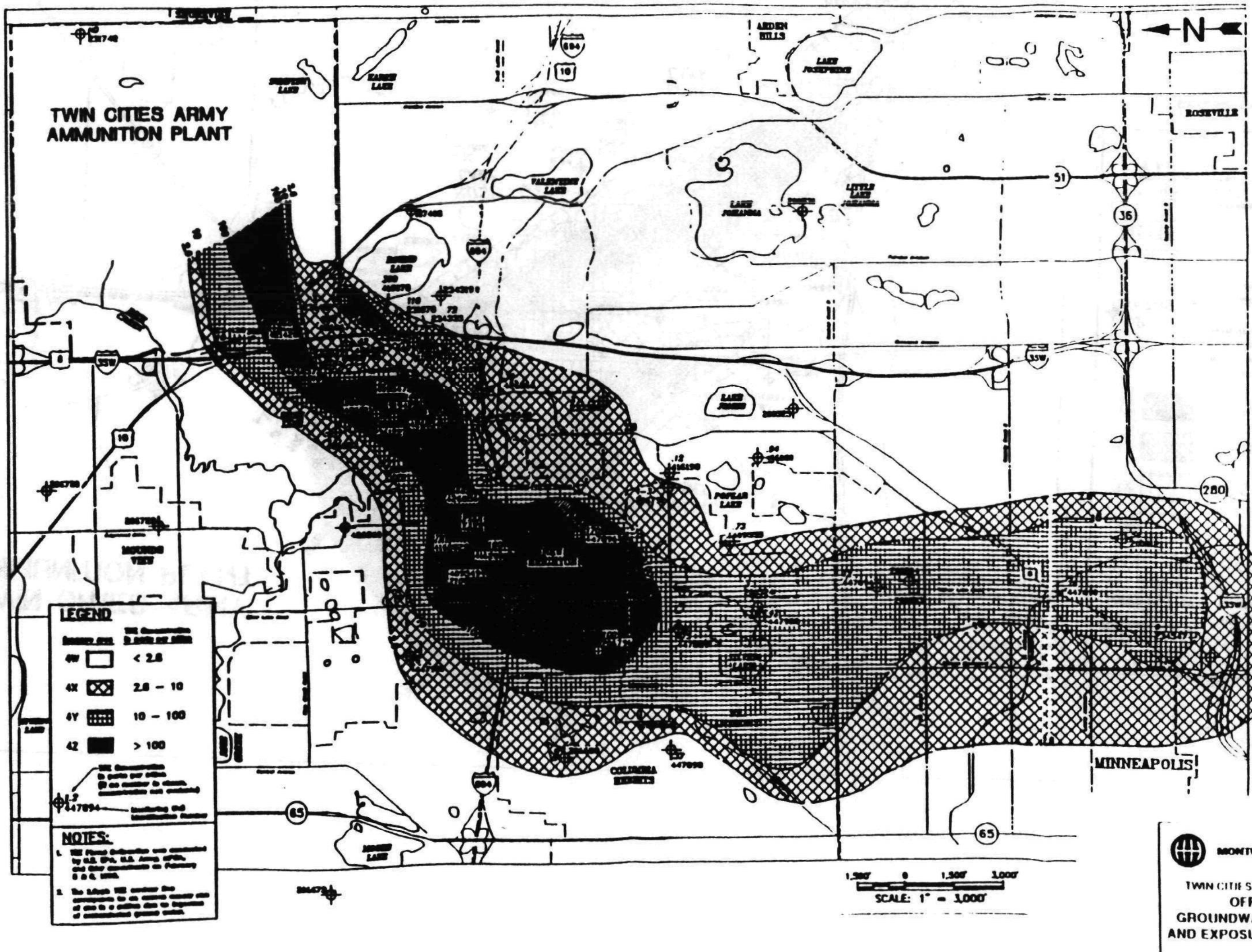


MONTGOMERY WATSON

TWIN CITIES ARMY AMMUNITION PLANT

CONCEPTUAL ILLUSTRATION OF TCAAP OPERABLE UNITS 1, 2, AND 3

FIGURE 2

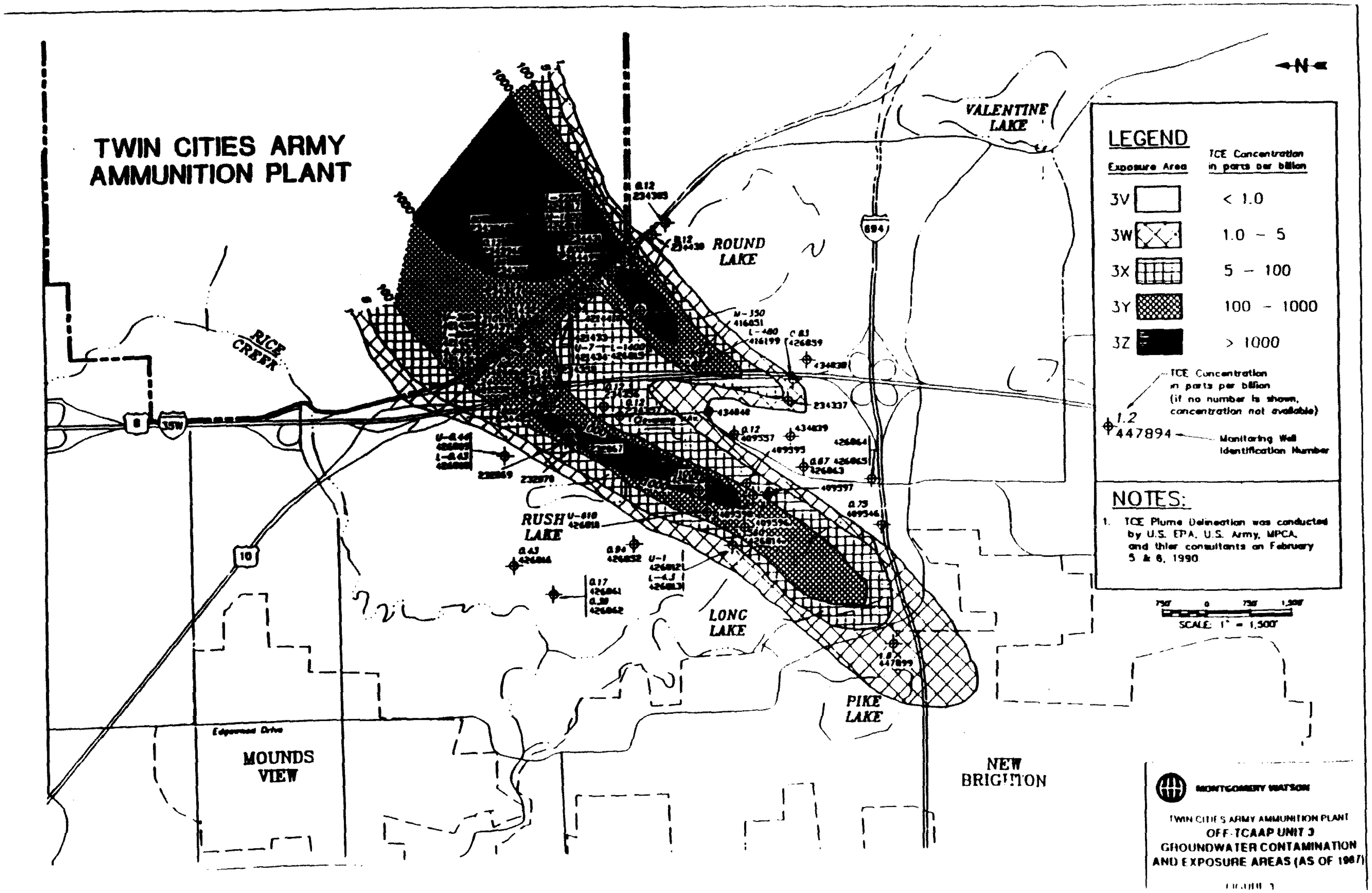


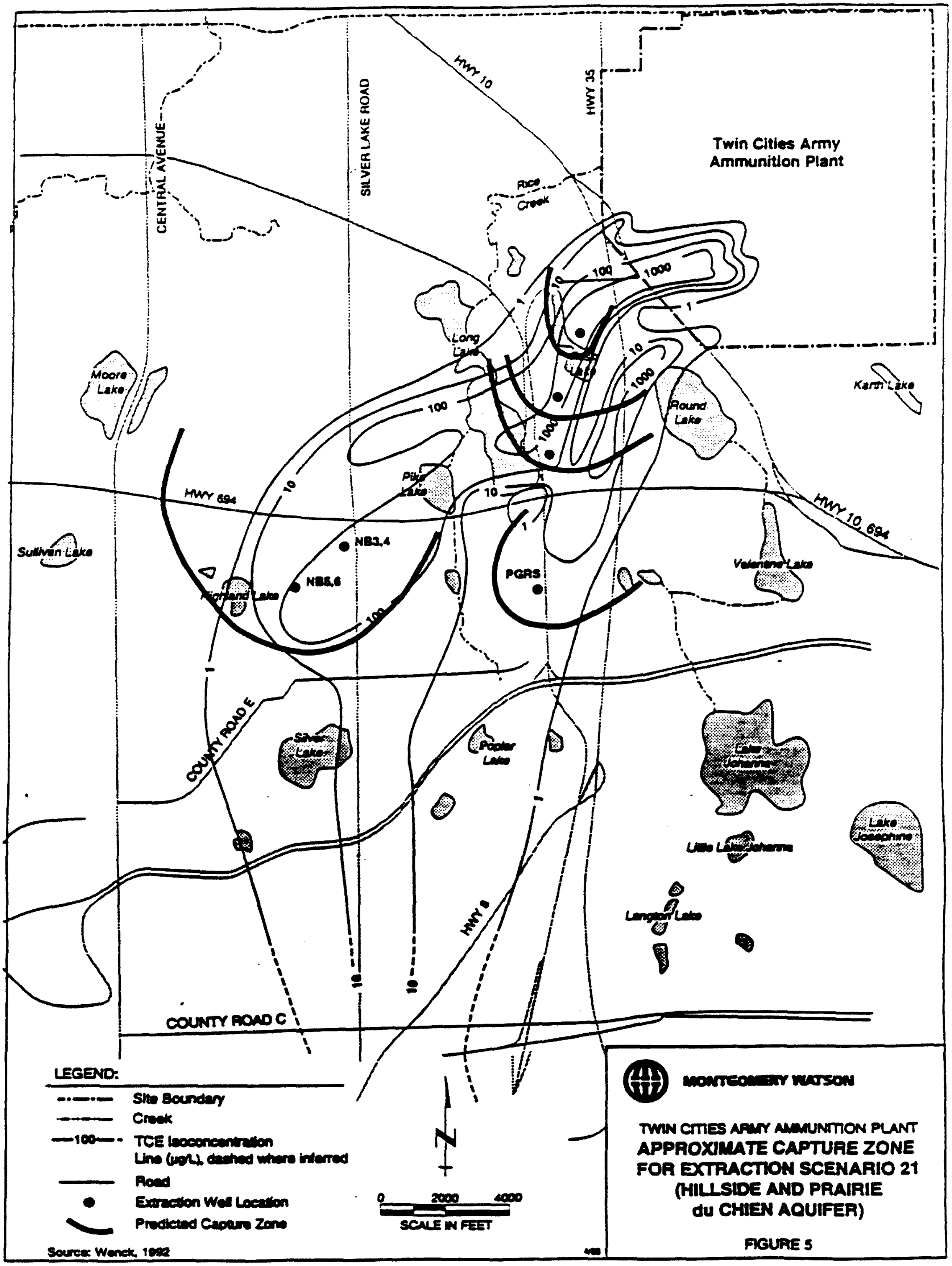
MONTGOMERY WATSON

TWIN CITIES ARMY AMMUNITION PLANT
OFF-TCAAP UNIT 4
GROUNDWATER CONTAMINATION AND EXPOSURE AREAS (AS OF 1987)

FIGURE 4

SOURCE USEPA, 1991

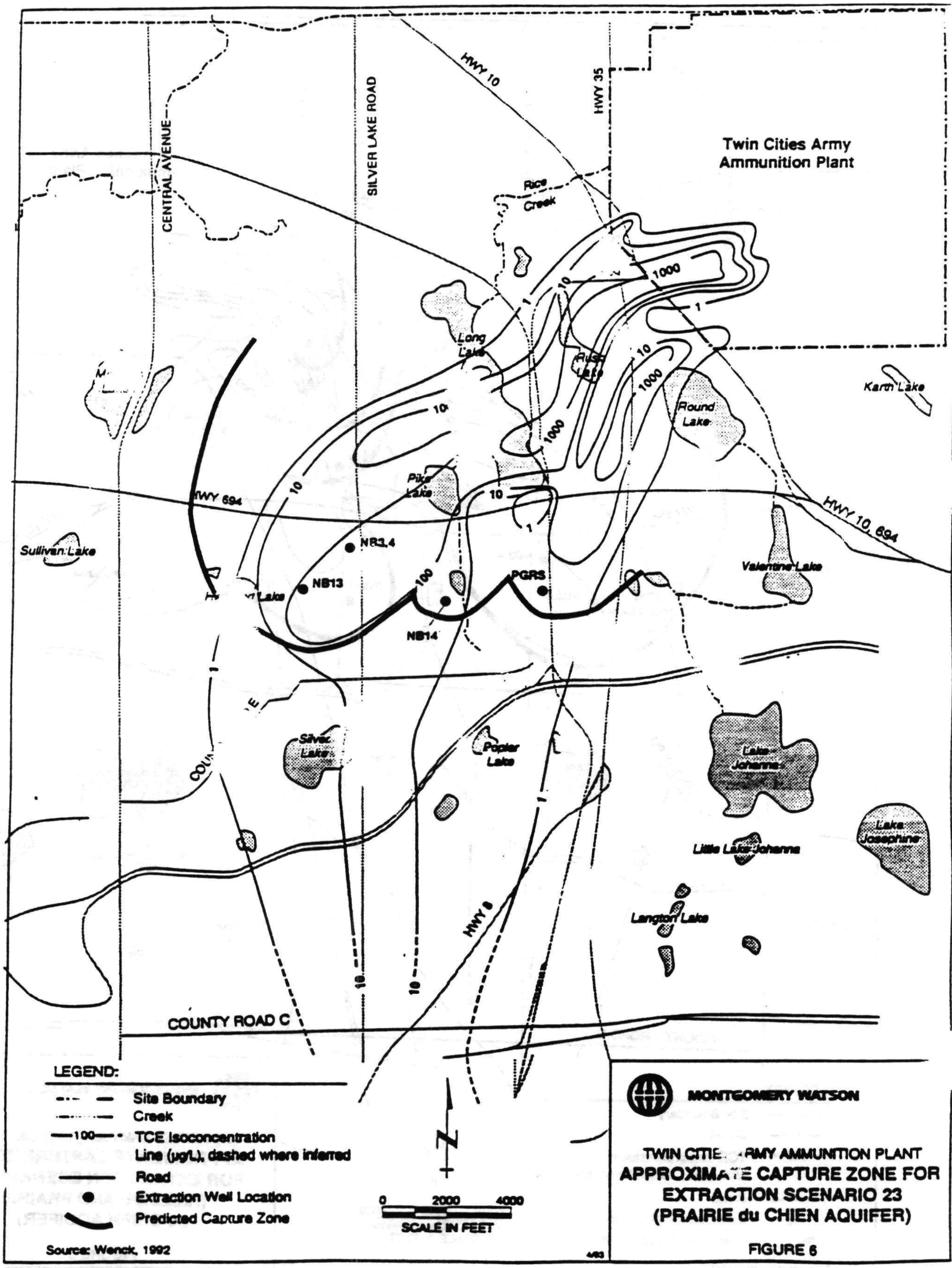

TWIN CITIES ARMY AMMUNITION PLANT
ROUND LAKE
VALENTINE LAKE
RICE CREEK
RUSH LAKE
LONG LAKE
PIKE LAKE
MOUNDS VIEW
NEW BRIGHTON
Edgewood Drive
LEGEND
Exposure Area
TCE Concentration in parts per billion
3V < 1.0
3W 1.0 - 5
3X 5 - 100
3Y 100 - 1000
3Z > 1000
TCE Concentration in parts per billion (if no number is shown, concentration not available)
1.2
447894
Monitoring Well Identification Number
NOTES:
1. TCE Plume Delineation was conducted by U.S. EPA, U.S. Army, MPCA, and their consultants on February 5 & 6, 1990.
SCALE: 1" = 1,500'
MONTGOMERY WATSON
TWIN CITIES ARMY AMMUNITION PLANT
OFF-TCAAP UNIT 3
GROUNDWATER CONTAMINATION
AND EXPOSURE AREAS (AS OF 1987)



TWIN CITIES ARMY AMMUNITION PLANT

APPROXIMATE CAPTURE ZONE FOR EXTRACTION SCENARIO 21 (HILLSIDE AND PRAIRIE du CHIEN AQUIFER)

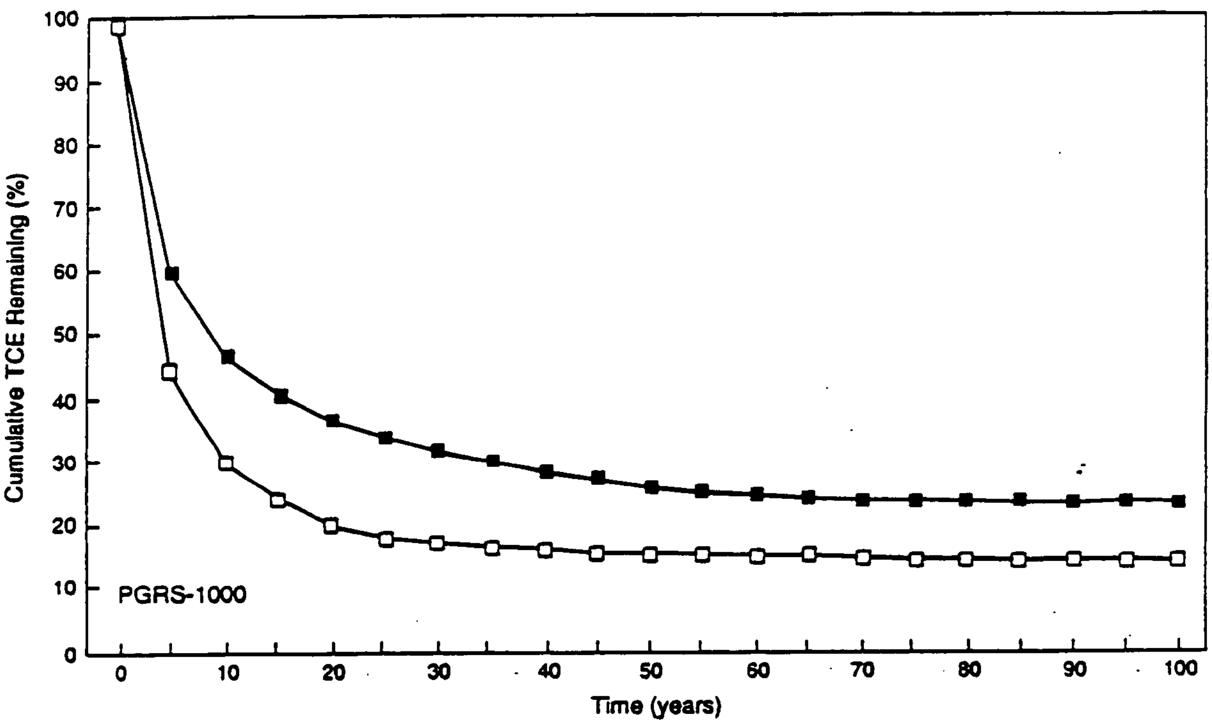
FIGURE 5



TWIN CITIES ARMY AMMUNITION PLANT

APPROXIMATE CAPTURE ZONE FOR EXTRACTION SCENARIO 23 (PRAIRIE du CHIEN AQUIFER)

FIGURE 6



LEGEND

■ SC23 (Alternative 3)

□ SC21 (Alternative 2)

MONTGOMERY WATSON

TWIN CITIES ARMY AMMUNITION PLANT

TCE REMAINING - ALTERNATIVES COMPARISON

FIGURE 7

Source: ETA, 1992

4/93

APPENDIX B
LIST OF TABLES

TABLE 1

SUMMARY OF RISKS FOR EXPOSURE TO OFF-TCAAP GROUND WATER
PROBABLE AND REASONABLE MAXIMUM EXPOSURES
CURRENT AND PROBABLE FUTURE & RME FUTURE LAND USE CONDITIONS
(Page 1 of 4)

Exposure Area/Unit	Pathway	Exposure	Upperbound Excess Cancer Risks: Resident	Acute Hazard Indices: Child[a]	Acute Hazard Indices: Adult	Chronic Hazard Indices: Child[a]	Chronic Hazard Indices: Adult
1S Unit 1	Ingestion	Probable[b]	4E-08	3.7E-03	1.3E-03	3.7E-03	1.3E-03
		RME[c]	2E-07	7.0E-03	3.4E-03	7.0E-03	3.4E-03
	Inhalation	Probable	2E-07	--	--	--	--
		RME	2E-06	--	--	--	--
	Dermal Contact	Probable	6E-08	3.1E-03	1.6E-03	4.0E-03	2.1E-03
		RME	3E-07	1.0E-02	5.1E-03	1.2E-02	6.2E-03
TOTAL		Probable	3E-07	ND	ND	ND	ND
		RME	3E-06	ND	ND	ND	ND
3V Unit 3	Ingestion	Probable	4E-06	3.3E-01	1.1E-01	3.3E-01	1.2E-01
		RME	2E-05	6.6E-01	2.6E-01	5.3E-01	2.6E-01
	Inhalation	Probable	2E-06	NA	NA	1.0E-04	1.6E-05
		RME	2E-05	NA	NA	7.6E-04	1.2E-04
	Dermal Contact	Probable	4E-06	1.8E-02	8.6E-03	1.3E-02	5.8E-03
		RME	5E-05	3.3E-02	1.7E-02	4.4E-02	2.3E-02
TOTAL		Probable	1E-05	ND	ND	ND	ND
		RME	9E-05	ND	ND	ND	ND
3W Unit 3	Ingestion	Probable	4E-06	2.0E-03	7.1E-04	5.5E-03	2.0E-03
		RME	2E-05	5.6E-03	2.7E-03	1.5E-02	7.5E-03
	Inhalation	Probable	2E-06	NA	NA	9.2E-04	1.4E-04
		RME	2E-05	NA	NA	6.1E-03	9.3E-04
	Dermal Contact	Probable	6E-06	2.5E-03	1.3E-03	7.0E-03	3.6E-03
		RME	6E-05	1.1E-02	5.7E-03	3.2E-02	1.6E-02
TOTAL		Probable	1E-05	ND	ND	ND	ND
		RME	1E-04	ND	ND	ND	ND

SOURCE: USEPA, 1991

TABLE 1

SUMMARY OF RISKS FOR EXPOSURE TO OFF-TCAAP GROUND WATER
PROBABLE AND REASONABLE MAXIMUM EXPOSURES
CURRENT AND PROBABLE FUTURE & RME FUTURE LAND USE CONDITIONS

Exposure Area/Unit	Pathway	Exposure	Upperbound Excess Cancer Risks: Resident	Acute Hazard Indices: Child[a]	Acute Hazard Indices: Adult	Chronic Hazard Indices: Child[a]	Chronic Hazard Indices: Adult
3X Unit 3	Ingestion	Probable	2E-06	1.6E-02	5.6E-03	8.3E-02	3.0E-02
		RME	1E-04	4.6E-02	2.3E-02	2.6E-01	1.3E-01
	Inhalation	Probable	1E-06	NA	NA	4.8E-04	7.3E-05
		RME	1E-04	NA	NA	2.6E-03	3.8E-04
	Dermal Contact	Probable	3E-06	1.8E-02	9.5E-03	9.4E-02	4.8E-02
		RME	2E-04	8.6E-02	4.5E-02	4.6E-01	2.8E-01
TOTAL		Probable	6E-06	ND	ND	ND	ND
		RME	4E-04	ND	ND	ND	ND
3Y Unit 3	Ingestion	Probable	4E-04	3.3E-01	7.4E-02	1.2E+00[d]	3.8E-01
		RME	2E-03	8.6E-01	4.2E-01	3.0E+00[d]	1.6E+00[d]
	Inhalation	Probable	6E-06	NA	NA	3.2E-02	6.0E-03
		RME	2E-03	NA	NA	1.2E-01	1.9E-02
	Dermal Contact	Probable	8E-04	4.6E-01	2.6E-01	1.3E+00[d]	6.6E-01
		RME	4E-03	1.3E+00[d]	6.6E-01	6.3E+00[d]	2.7E+00[d]
TOTAL		Probable	1E-03	ND	ND	ND	ND
		RME	8E-03	ND	ND	ND	ND
3Z Unit 3	Ingestion	Probable	6E-04	6.8E-01	2.4E-01	1.1E+00[d]	4.9E-01
		RME	2E-03	1.0E+00[d]	4.7E-01	1.6E+00[d]	8.4E-01
	Inhalation	Probable	5E-04	NA	NA	2.4E-02	3.7E-03
		RME	4E-03	NA	NA	1.3E-01	1.9E-02
	Dermal Contact	Probable	9E-04	4.3E-01	2.1E-01	9.1E-01	4.6E-01
		RME	6E-03	1.2E+00[d]	6.1E-01	2.6E+00[d]	1.3E+00[d]
TOTAL		Probable	2E-03	NA	ND	ND	ND
		RME	1E-02	NA	ND	ND	ND

TABLE 1

SUMMARY OF RISKS FOR EXPOSURE TO OFF-TCAAP GROUND WATER
PROBABLE AND REASONABLE MAXIMUM EXPOSURES
CURRENT AND PROBABLE FUTURE & RME FUTURE LAND USE CONDITIONS

Exposure Area/Unit	Pathway	Exposure	Upperbound Excess Cancer Risks	Acute Hazard Indices		Chronic Hazard Indices	
			Resident	Child[a]	Adult	Child[a]	Adult
4W Unit 4	Ingestion	Probable	2E-05	8.8E-01	3.2E-01	8.3E-01	3.0E-01
		RME	1E-04	8.6E-01	4.2E-01	9.0E-01	4.4E-01
	Inhalation	Probable	1E-05	NA	NA	1.0E-03	1.6E-04
		RME	1E-04	NA	NA	7.6E-03	1.1E-03
	Dermal Contact	Probable	1E-05	1.6E-02	8.3E-03	3.0E-02	1.6E-02
		RME	2E-04	6.1E-02	3.2E-02	1.1E-01	8.7E-02
TOTAL		Probable	4E-05	ND	ND	ND	ND
		RME	4E-04	ND	ND	ND	ND
4X Unit 4	Ingestion	Probable	8E-06	6.0E+00[d]	2.2E+00[d]	6.7E+00[d]	2.4+00[d]
		RME	2E-04	6.2E+00[d]	2.9E+00[d]	7.4E+00[d]	3.6E+00[d]
	Inhalation	Probable	1E-06	NA	NA	1.1E-03	1.7E-04
		RME	1E-05	NA	NA	8.4E-03	1.2E-03
	Dermal Contact	Probable	3E-06	1.6E-01	1.0E-01	2.4E-01	1.3E-01
		RME	2E-06	3.4E-01	1.8E-01	4.4E-01	2.3E-01
TOTAL		Probable	8E-06	ND	ND	ND	ND
		RME	2E-04	ND	ND	ND	ND
4Y Unit 4	Ingestion	Probable	2E-05	1.5E-02	5.4E-03	2.6E-02	9.5E-03
		RME	4E-05	2.1E-02	1.0E-02	3.7E-02	1.8E-02
	Inhalation	Probable	1E-05	NA	NA	1.8E-03	2.8E-04
		RME	7E-05	NA	NA	8.2E-03	1.2E-03
	Dermal Contact	Probable	3E-05	1.8E-02	9.2E-03	4.4E-02	2.3E-02
		RME	1E-04	3.6E-02	1.9E-02	6.6E-02	3.0E-02
TOTAL		Probable	6E-05	ND	ND	ND	ND
		RME	2E-04	ND	ND	ND	ND

TABLE 1

SUMMARY OF RISKS FOR EXPOSURE TO OFF-TCAAP GROUND WATER
PROBABLE AND REASONABLE MAXIMUM EXPOSURES
CURRENT AND PROBABLE FUTURE & RME FUTURE LAND USE CONDITIONS
(Page 4 of 4)

Exposure Area/Unit	Pathway	Exposure	Upperbound Excess Cancer Risks	Acute Hazard Indices		Chronic Hazard Indices	
			[illegible]	Child[a]	Adult	Child[a]	Adult
Unit 4	Ingestion	Probable	3E-04	1.1E+00[b]	4.0E-01	1.3[illegible]	4.7E-01
		RME	1E-03	1.4E+00[b]	6.6E-01	1.9E[illegible]	8.6E-01
	Inhalation	Probable	2E-04	NA	NA	1.9E-02	3.0E-03
		RME	1E-03	NA	[illegible]	1.0[illegible]	1.6E-02
	Dermal Contact	Probable	2E-04	2.4E-01	1.2[illegible]	6[illegible]	2.6E-01
		RME	3E-03	8.4E-01	4.3E-01	1.2E+00[b]	8.1E-01
TOTAL		Probable	7E-04	ND	ND	ND	ND
		RME	5E-03	ND	ND	ND	ND

TAB.

SUMMARY OF TECHNOLOGY AND PROCESS OPTIONS SCREENING

Technology	Treatment Effectiveness	Implementability	Cost	Result of Initial Screening	Comments
INSTITUTIONAL CONTROLS					
Groundwater Monitoring	None	Easy	Moderate	Eliminate	Extensive groundwater monitoring program exists
Alternative Water Supply (a)	**None**	**Moderate**	**Low**	**Consider**	**Includes well abandonment and hook-up to municipal system**
Use Restrictions	None	Difficult	Low	Eliminate	Restrictions are difficult to verify long-term
Drilling Advisories	**None**	**Moderate**	**Low**	**Consider**	**Restrictions are difficult to enforce and verify long-term**
CONTAINMENT					
Gradient Control Wells	**None**	**Moderate**	**Moderate**	**Consider**	**See Table 4-4 for Extraction/Removal Options**
Slurry Wall	None	Difficult	High	Eliminate	Requires impermeable substrate
GROUNDWATER TREATMENT - Organics					
Physical Treatment					
Air Stripping	High	Difficult	Moderate	Eliminate	Community acceptance may be difficult
Activated Carbon Adsorption	**High**	**Easy**	**Moderate**	**Consider**	**Cost-effective; presently being used for PGAC**
Resin Adsorption	Moderate	Easy	High	Eliminate	Less cost-effective than carbon adsorption for removing VOCs
Chemical Treatment					
Ultraviolet (UV) Oxidation	High	Moderate	High	Eliminate	Not cost-effective for dilute waste streams
Biological Treatment					
Methanotrophic Biodegradation (Aerobic)	High	Difficult	Moderate	Eliminate	Not yet demonstrated for full-scale remediation
Reductive Dehalogenation (Anaerobic)	Moderate	Difficult	Moderate	Eliminate	Not yet demonstrated for full-scale remediation
GROUNDWATER TREATMENT - Inorganics					
Physical Treatment					
Coagulation/flocculation	Low	Moderate	Moderate	Eliminate	Particulate removal proces; typically used with precipt. process
Filtration	**Low**	**Moderate**	**Low**	**Consider**	**Often used as polishing step to remove particulates**
Resin Adsorption	High	Moderate	High	Eliminate	Secondary treatment of regenerant required
Reverse Osmosis	High	Moderate	High	Eliminate	Concentrates waste; secondary treatment required
Chemical Treatment					
Oxidation/Reduction	**High**	**Low**	**Moderate**	**Consider**	**Effective for both iron and manganese**
Precipitation	High	Moderate	High	Eliminate	Costly; best suited for high flows and high concentrations
WATER MANAGEMENT OPTIONS					
Municipal Usage	**N/A**	**Moderate**	**Moderate**	**Consider**	**Maximum beneficial use of the resource**
Discharge to Rice Creek	N/A	Difficult	High	Eliminate	Long pipeline required; difficult and costly to implement
On-Post Groundwater Recharge: Gravel Pit	N/A	Difficult	High	Eliminate	Long pipeline required; difficult and costly to implement
On-Post Groundwater Recharge: Wells	N/A	Difficult	High	Eliminate	Long pipeline required; difficult and costly to implement
On-Post Groundwater Recharge: Trench	N/A	Difficult	High	Eliminate	Long pipeline required; difficult and costly to implement
Discharge to Pike Lake/Long Lake	N/A	Difficult	High	Eliminate	Requires additional treatment; ice safety concern

(a) Bold indicates that the technology is considered for further evaluation

TABLE 3

POTENTIALLY FEASIBLE TREATMENT TECHNOLOGIES AND PROCESS OPTIONS

General Response Actions	Technologies/Process Options
Institutional Controls	Alternative Water Supply Drilling Advisories
Removal/Extraction Options	Scenario 21 Scenario 23
Groundwater Treatment	Liquid-phase GAC, Oxidation/Filtration
Water Management Options	Municipal Usage

TABLE 4

COST ESTIMATE FOR ALTERNATIVE 1: NO ACTION ALTERNATIVE

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
ANNUAL OPERATING AND MAINTENANCE COSTS				
Continued Groundwater Monitoring Program (semiannually)				
Sample Collection and Analysis	2	per year		$50,000
Consulting and Reporting services		lump sum		$20,000
	TOTAL ANNUAL COST			$70,000
PRESENT WORTH				
		Interest Rate	10%	
		Years	30	
	TOTAL PRESENT WORTH			$726,000

TABLE 5

COST ESTIMATE FOR ALTERNATIVE 2: MASS REMOVAL ALTERNATIVE

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
CAPITAL COSTS (CC)				
Additional Groundwater Monitoring				
Well Drilling and Installation	10	each	$22,500	$225,000
Preparation of Monitoring Plan		lump sum		$15,000
Extraction Wells	3	each	$80,000	$240,000
Conveyance System to PGAC				
Inspection/cleaning	15,840	each	$4	$63,360
Pipeline Installation	15,840	feet	$20	$316,800
Pump	1	each	$20,000	$20,000
Alternative Water Supply				
Abandon Private Wells	200	each	$1,500	$300,000
Hook-up to Municipal Supply	20,000	linear feet	$15	$300,000
Inorganics Treatment				
Equipment Costs (EC)				
influent surge tank	1	each	$85,000	$85,000
transfer pumps	2	each	$12,000	$24,000
greensand filters	5	each	$80,000	$400,000
KMnO4 storage tank	1	each	$10,000	$10,000
chemical feed pumps	2	each	$3,500	$7,000
		Total Inorganics Treatment EC		$526,000
Installation (30% EC)				$157,800
Mechanical (40% of EC)				$210,400
Electrical (10% of EC)				$52,600
Instrumentation (10% of EC)				$52,600
Building Costs	5,000	square feet	$100	$500,000
Site Preparation	1	lump sum	$70,000	$70,000
		Subtotal Construction Costs (CC)		$3,049,560
Engineering Design (10% of CC)				$304,960
Administration Costs (17% of CC)				$518,430
Contingency (25% of CC)				$762,390
	TOTAL CAPITAL COSTS			$4,635,340
ANNUAL OPERATING AND MAINTENANCE COSTS				
Continued Groundwater Monitoring Program (semiannually)				
Sample Collection and Analysis	2	per year		$46,000
Consulting and Reporting Services		lump sum		$15,000
Additional Groundwater Monitoring Program (semiannually)				
Sample Collection and Analysis	2	per year		$48,000
Consulting and Reporting Services		lump sum		$15,000
Inorganics Treatment (Fe & Mn removal)				
Labor	1	man-year	$100,000	$100,000
Energy	580,000	kw-hr	$0.10	$58,000
Chemicals		lump sum	$98,000	$98,000
Equipment Maintenance		2% of EC		$105,200
Monitoring		lump sum		$2,500
Additional Organics Treatment (PGAC at 3,585 gpm)				
Carbon Changeout	213,300	pounds	$1.50	$319,950
Chemicals		lump sum	$10,100	$10,100
Maintenance		lump sum	$6,800	$6,800
Labor	1	man-year	$100,000	$100,000
	TOTAL ANNUAL COST			$924,550
PRESENT WORTH				
		Interest Rate	10%	
		Years	30	
	TOTAL PRESENT WORTH			$14,200,000

TABLE 6

COST ESTIMATE FOR
ALTERNATIVE 3: CONTAINMENT ALTERNATIVE

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
CAPITAL COSTS (CC)				
Additional Groundwater Monitoring				
Well Drilling and Installation	10	each	$22,500	$225,000
Preparation of Monitoring Plan		lump sum		$15,000
Extraction Well	1	each	$80,000	$80,000
Conveyance System to PGAC				
Inspection/cleaning	5,280	each	$4	$21,120
Pipeline Installation	5,280	feet	$20	$105,600
Pump	1	each	$20,000	$20,000
Alternative Water Supply				
Abandon Private Wells	200	each	$1,500	$300,000
Hook-up to Municipal Supply	20,000	linear feet	$15	$300,000
Inorganics Treatment				
Equipment Costs (EC)				
influent surge tank	1	each	$85,000	$85,000
transfer pumps	2	each	$12,000	$24,000
greensand filters	2	each	$80,000	$160,000
KMnO4 storage tank	1	each	$10,000	$10,000
chemical feed pumps	2	each	$3,500	$7,000
		Total Inorganics Treatment EC		$286,000
Installation (30% EC)				$85,800
Mechanical (40% of EC)				$114,400
Electrical (10% of EC)				$28,600
Instrumentation (10% of EC)				$28,600
Building Costs	3,000	square feet	$100	$300,000
Site Preparation	1	lump sum	$70,000	$70,000
		Subtotal Construction Costs (CC)		$1,980,120
Engineering Design (10% of CC)				$198,010
Administration Costs (17% of CC)				$336,620
Contingency (25% of CC)				$495,030
	TOTAL CAPITAL COSTS			$3,009,780
ANNUAL OPERATING AND MAINTENANCE COSTS				
Continued Groundwater Monitoring Program (semiannually)				
Sample Collection and Analysis	2	per year		$46,000
Consulting and Reporting Services		lump sum		$15,000
Additional Groundwater Monitoring Program (semiannually)				
Sample Collection and Analysis	2	per year		$48,000
Consulting and Reporting Services		lump sum		$15,000
Inorganics Treatment (Fe & Mn removal)				
Labor	1	man-year	$100,000	$100,000
Energy	420,000	kw-hr	$0.10	$42,000
Chemicals		lump sum	$33,000	$33,000
Equipment Maintenance		2% of EC		$57,200
Monitoring		lump sum		$2,500
Additional Organics Treatment (PGAC at 2,250 gpm)				
Carbon Changeout	158,000	pounds	$1.50	$237,000
Chemicals		lump sum	$6,200	$6,200
Maintenance		lump sum	$2,800	$2,800
Labor	1	man-year	$100,000	$100,000
	TOTAL ANNUAL COST			$704,700
PRESENT WORTH				
		Interest Rate	10%	
		Years	30	
	TOTAL PRESENT WORTH			$10,310,000

TABLE 7

DRINKING WATER CRITERIA/GUIDELINES FOR PUBLIC AND PRIVATE WELL SUPPLIES

Compound	Maximum Contaminant Level (MCL) (μg/l)	Recommended Allowable Limit (RAL) (μg/l)	[illegible]th [illegible] Limit [illegible]L) (μg/l)
1,1-Dichloroethane	-	70	-
1,1-Dichloroethene	7	6	6
cis-1,2-Dichloroethene	70*	70	-
1,1,1-Trichloroethane	200	600	-
1,1,2-Trichloroethane	5*	3	3
Trichloroethene	5	30	-
Hazard Index for Carcinogenic Mixtures	-	-	See Note 4
Hazar[illegible]dex for Noncarcinogenic Mixtures	-	-	See Note 5

* Proposed MCL.
\- Does not exist

Notes:

1. Maximum contaminant levels are specified in the Primary Drinking Water Regulations (40 CFR 141).
2. Recommended Allowable Limits are specified in Release No. 3, Minnesota Department of Health, January 1991.
3. Health Risk Limits are proposed values as of April 19, 1993.
4. To determine if the health risk limit for a mixture of carcinogens is exceeded, a hazard index must be calculated using the following procedure (Minnesota State Register, Proposed Rule 4717.7700):

   A. A hazard index shall be determined for substances or chemicals with a toxic endpoint of cancer as specified in Proposed Rule 4717.7650 using the following equation:

$$Hazard\ index = \frac{E_{C_1}}{HRL_{C_1}} + \frac{E_{C_2}}{HRL_{C_2}} + ----- + \frac{E_{C_n}}{HRL_{C_n}}$$

   where: (1) E_{C_n} repre[illegible] the concentr[illegible] of the first, second, ...nth carcinogen detected in groundwater; and
   (2) HRL_{C_n} re[illegible]ts the healt[illegible] limit of the first, second, ...nth carcinogen as specified in Proposed Rule 4717.750[illegible].

   B. A hazard index of one indicates a lifetime risk level of one in 100,000.
   C. A hazard index of one equals the health risk limit.
   D. A haz[illegible] index greater [illegible] one exceeds the health risk limit.

5. To determine if the health risk limit for a mixture of systemic toxicants is exceeded, a hazard index must be calcu[illegible]ing the following procedure (Minnesota State Register, Proposed Rule 4717.7700):

   A. The substances or chemicals detected in the groundwater must be grouped by toxic endpoint as specified in Proposed Rule 4717.7650.
   B. When two or more substances or chemicals have the same toxic endpoint, a hazard index must be determined for each group of substances or chemicals with the same toxic [illegible]point using the following equation:

$$Hazard\ index = \frac{E_{ST_1}}{HRL_{ST_1}} + \frac{E_{ST_2}}{HRL_{ST_2}} + ----- + \frac{E_{ST_n}}{HRL_{ST_n}}$$

   where: (1) E_{ST_n} represents the concentration of the first, second, ... nth systemic toxicant detected in groundwater; and
   (2) HRL_{ST_n} represents the health risk limit of the first, second, ... nth systemic toxicant as specified in Proposed Rule 4717.7500.

   C. A hazard index of one equals the health risk limit.
   D. A hazard index greater than one exceeds the health risk limit.