FEASIBILITY STUDY REPORT

ARCH CHEMICALS
ROCHESTER PLANT SITE
ROCHESTER, NEW YORK

Submitted to:

Division of Environmental Remediation
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LIST OF ACRONYMS

ABB-ES	ABB Environmental Services
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
CPC	chemical of potential concern
DNAPL	dense non-aqueous phase liquids
ERA	ecological risk assessment
EPC	exposure point concentration
FS	Feasibility Study
ft/d	feet per day
GAC	granular activated carbon
gpm	gallons per minute
GPR	ground-penetrating radar
HI	hazard index
HLA	Harding Lawson Associates
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
µg/L	micrograms per liter

LIST OF ACRONYMS
(Continued)

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
NCP	National Contingency Plan
NUS	NUS Corporation
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbons
PCE	perchloroethylene
PEL	permissible exposure level
POTW	publicly-owned treatment works
PPE	personal protective equipment
RA	Risk Assessment
RAO	Remedial Action Objective
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCG	standards, criteria, and guidelines
SCO	Soil Cleanup Objective

LIST OF ACRONYMS
(Continued)

SDWA	Safe Drinking Water Act
SVOC	semivolatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TBC	to be considered
TCBO	trichlorobutylene oxide
TCE	trichloroethylene
TDA	toluene diamine
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

EXECUTIVE SUMMARY

This report presents the findings of a Feasibility Study (FS) conducted for the Arch Chemicals, Inc. (Arch) manufacturing facility in Rochester, New York (the site). Arch is a new company created when Olin Corporation (Olin) spun off its specialty chemicals business to form an independent company. The former Olin Rochester plant was included in the Olin spin-off, and is now an Arch facility.

This FS was performed to fulfill part of the requirements of the Order on Consent between the New York State Department of Environmental Conservation (NYSDEC) and Olin (Index No. B8-0343-90-08), dated August 23, 1993. This FS report discusses the purpose of the FS, summarizes the baseline risk assessment, and develops and evaluates remedial alternatives to address impacted soil and groundwater.

Site History and Background

Arch's Rochester plant is located at 100 McKee Road, a private industrial road in the southwestern section of Rochester, New York. The plant property is approximately 15.3 acres, and has been an active chemical manufacturing facility since 1948. Areas within the plant boundary are identified as being "on-site", whereas areas outside of the plant boundary are referred to as being "off-site". The off-site area extends southward and westward toward the Dolomite Products quarry, located within the Town of Gates approximately 4,000 feet from the plant.

The site has been the subject of various environmental investigations since the early 1980s, including, but not limited to, a groundwater investigation conducted in 1990 and a two-phased remedial investigation (RI), conducted in 1994-96. Results of these investigations indicated that site-related constituents had been released into the environment and were impacting on-site groundwater and soil.

In an effort to contain shallow groundwater, an overburden groundwater pumping system was installed in 1983 to intercept groundwater and contain constituents on-site. Since 1983, the groundwater pumping system has been expanded to include seven bedrock extraction wells to contain shallow bedrock groundwater on-site. Extracted groundwater is conveyed by pipeline to a treatment system prior to discharge to the Monroe County Pure Waters Publicly Owned Treatment

Works. The extraction system is currently pumping approximately 35 gallons per minute of on-site groundwater.

Risk Assessment Summary

The two-phase RI completed in 1994 and 1996 included a risk assessment (RA) to evaluate potential risks to human health and the environment. The RA identified potential health risks to construction workers exposed to overburden groundwater as exceeding acceptable USEPA values. These risks were mainly attributable to volatile organic compounds (VOCs) (e.g., chloroform, methylene chloride, carbon tetrachloride) and semivolatile organic compounds (SVOCs) (e.g., chloropyridines) detected in the on-site groundwater. The RA also identified potential health risks to construction workers exposed to soil during excavation as exceeding acceptable USEPA values. These risks were mainly attributable to SVOCs detected in the on-site subsurface soil. The RA indicated that ecological receptors that may occur at the site are unlikely to be adversely impacted.

Remedial Action Objectives

Remedial Action Objectives (RAOs) are the specific goals that must be achieved by the remedial actions ultimately selected in this Feasibility Study. The RAOs are risk-based in that they are selected to address specific potential exposure pathways for each of the identified media of concern, as identified in the risk assessment.

RAOs for Soil. The only soils identified as potentially requiring remediation are subsurface soils located within the facility boundary, primarily near monitoring well B-17. The potential exposure pathways of concern include direct contact by plant workers or construction workers, volatilization into facility buildings or excavations, and leaching to groundwater. Because the groundwater pathway will be effectively controlled by satisfying the RAOs for on-site groundwater, the RAOs for impacted soil include limiting dermal contact with, and incidental ingestion of soil by plant personnel and construction workers, and limiting inhalation of volatile organics and particulates from soil by plant personnel and construction workers.

The risk of exposure to impacted soils is further limited by continued enforcement of the plant's excavation policy and other facility health and safety requirements. Facility personnel are already well versed in the safe procedures for handling chemicals since they regularly deal with these same chemicals in the workplace in their concentrated forms.

RAOs for Groundwater. Arch currently operates a groundwater extraction system at the plant site that is intended to create a hydraulic control boundary, effectively preventing further migration of site-related compounds beyond the facility property boundary. RAOs for groundwater are, therefore, established separately for on-site and off-site groundwater.

For on-site groundwater, there is no current or reasonably foreseeable future use of groundwater for potable or other uses. The major potential exposure pathways involve direct contact or inhalation resulting from construction activities below the groundwater table. For protection of human health, the RAOs for on-site groundwater include limiting dermal contact with, incidental ingestion of, and inhalation of volatile organics from on-site groundwater by construction workers. Additionally, to satisfy regulatory program objectives, RAOs include prevention of further off-site migration of impacted groundwater, and restoration of on-site groundwater to regulatory standards or risk-based criteria.

A primary concern for off-site groundwater would be due to its potential use as a potable water supply. However, the natural iron and sulfur content of groundwater in the vicinity of the site already make the water unfit to drink. Also, New York State requires that new housing subdivisions must be served by public water. The Director of Public Works for the Town of Gates reported that there are no known private water supply wells within the town. Therefore, use of groundwater for potable purposes is not considered a reasonable exposure pathway at this site.

Operation of the on-site groundwater extraction system is intended to prevent additional migration of site-related compounds beyond the facility boundary. In addition, the data collected during the RI indicate that the discharge of bedrock groundwater into the southeast corner of the quarry has substantially influenced regional groundwater flow, and that this discharge captures the off-site plume of contaminated groundwater. Combined, these two factors will result in an overall reduction in the concentration of site-related compounds in off-site groundwater, with the ultimate result being that concentrations are reduced to below regulatory standards or risk-based criteria. On this basis, the RAOs for off-site groundwater include: maintaining hydraulic containment at the plant boundary to prevent migration of additional site-related compounds; maintaining the capture of groundwater at the quarry seep to contain the plume of contaminated off-site groundwater; limiting access to groundwater between the plant and the quarry; and ultimately, restoring groundwater to regulatory standards or risk-based criteria.

RAOs for Surface Water. The risk assessment did not identify any unacceptable risk scenarios for exposure to impacted surface water. Contaminant loadings to surface water that are below levels of concern result from the quarry discharge. Because risks are currently at acceptable levels, no RAOs are listed for surface water.

In order to meet all of the RAOs for the site, Arch has developed separate remedial alternatives to address on-site groundwater, off-site groundwater, and on-site soil. The medium-specific actions will work together to form an overall site-wide remediation strategy.

Technology Identification and Screening

Remedial process technologies were identified and screened based on a review of literature sources, contacts with vendors to obtain specific information and performance data, and experience in developing similar feasibility studies under CERCLA. Only remedial process technologies capable of addressing the remedial response objectives were considered. Initial screening evaluated technology types and remedial process technologies based on technical implementability (USEPA, 1988).

After initial screening, technologies were evaluated to reduce the number of potentially applicable remedial process technologies by evaluating factors that may influence process option effectiveness, implementability, and cost.

Development and Screening of Alternatives

Remedial process technologies retained after screening were combined to develop remedial alternatives that provide a range of options to address RAOs. Specific alternatives were developed to address each of the three media at the site. Due to the presence of buildings and other structures above the target soil area, the existing groundwater extraction, treatment, and discharge system, and the existing groundwater seep at the quarry that is effectively capturing off-site groundwater, the number of remedial process technologies retained from the screening and evaluation process was limited. Thus, the number of potential remedial alternatives developed for both groundwater and soil was limited. All alternatives developed for groundwater and soil remediation were retained for detailed analysis.

On-site Groundwater. Four alternatives were developed from the retained remedial process technologies for the remediation of on-site groundwater.

Alternative ONSITE-GW1 - No Action

The No Action Alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls, and assumes that operation of the existing groundwater extraction and treatment system is discontinued. The No Action Alternative does not include any actions to monitor constituent concentrations or prevent exposure to contaminated groundwater.

Alternative GW2 – Institutional Controls and Monitoring

Alternative ONSITE-GW2 utilizes institutional controls to prevent exposure to site-related contaminants, but would not include any active remedial technologies to treat or remove contaminants. Operation of the existing groundwater extraction system would be discontinued.

Institutional controls would include continued adherence to the plant's existing health and safety policies for site excavation activities, and implementation of deed restrictions to restrict future use of on-site groundwater and property. The plant's excavation policy outlines mandatory procedures for conducting invasive activities, including the use of personal protective equipment (PPE). Adherence to this policy mitigates potential exposure to contaminants, and inhalation of vapors from invasive activities in which groundwater may be encountered. The deed restrictions would be instituted only if the property was transferred, sold, or if operations at the plant were discontinued.

Alternative ONSITE-GW3 - Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW3 includes the following components:

- operation of the existing shallow bedrock extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;

- operation of a groundwater treatment system (existing GAC system or system capable of meeting prescribed discharge criteria);
- discharge of treated groundwater to the POTW;
- implementation of institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of on-site groundwater quality and extraction system performance.

This alternative focuses on preventing contaminated on-site groundwater from migrating beyond the plant property boundary in addition to controlling exposure to site-related contaminants. The main feature of the alternative is the operation of the existing perimeter and source-area bedrock extraction wells. Additionally, these wells would be supplemented by an interceptor trench in the southeast portion of the plant to ensure that overburden groundwater is prevented from migrating to the south.

The monitoring program for this alternative would include both groundwater level monitoring of on-site wells and groundwater sampling and analysis. The groundwater level monitoring would be used to evaluate the performance of the extraction system in maintaining hydraulic control at the plant property boundary. Results from groundwater sampling and analysis would be used to monitor trends in constituent concentrations.

This alternative reduces the mobility of contaminated groundwater by preventing off-site migration by establishing and maintaining hydraulic control at the plant property boundary, and removes constituents from groundwater through extraction and treatment.

Alternative ONSITE-GW4 – Dual-phase Extraction (Source Areas), Perimeter Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW4 includes:

- dual-phase extraction at source-area wells to provide contaminant mass reduction;
- operation of the existing perimeter groundwater extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;

- on-site treatment of extracted groundwater;
- discharge of treated groundwater to the POTW;
- institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of the on-site groundwater quality and extraction system performance.

ONSITE-GW4 includes all components of Alternative ONSITE-GW3, but adds dual-phase extraction at the source-area pumping wells (PW10 and PW12) to provide for increased contaminant mass removal. Performance of this alternative would be similar to Alternative ONSITE-GW3, except that the duration of the groundwater extraction operation may be reduced.

On-site Soil. Three alternatives were developed from the retained remedial process technologies for the remediation of the target soil area.

Alternative S1 - No Action

The No Action alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls.

Alternative S2 – Institutional Controls

Alternative S2 includes the following components:

- deed restrictions;
- adherence to Arch's excavation policy; and
- access restrictions through fencing and signs.

This alternative focuses on reducing potential exposure to target soil areas as its main component.

Continued leaching of contaminants from soil to the groundwater is expected to gradually reduce constituent concentrations in the target soil area until, ultimately, SCOs are attained. During this period, site access would be restricted by fencing, and warning signs would be posted indicating that exposure to subsurface soil poses a potential health risk. Implementation of deed restrictions would be included as part of this alternative to further reduce the potential for exposure to site soils. These restrictions would include; registering deed restrictions on the plant property prohibiting land use for residences or other uses that may cause exposure to affected soil, and restricting certain invasive activities (e.g., construction/excavation). Restrictions would be instituted only if the property was transferred, sold, or if operations at the plant were discontinued.

To mitigate current potential exposure to target area soils, Arch regulates invasive activities (e.g., excavation) through a mandatory excavation policy instituted at the plant. Alternative S2 includes adherence to this policy as a means of reducing potential exposure to target area soil. A copy of the excavation policy is included in Appendix D.

This alternative would reduce the volume of affected soil as contaminants leach to groundwater, but would not reduce the mobility of constituents in the unsaturated or saturated zones. Institutional controls would mitigate the potential for exposure of humans to constituents in the soil.

Alternative S3 - Surface Barrier with Institutional Controls

Alternative S3 includes the following components:

- installation of a surface barrier;
- deed restrictions;
- adherence to Arch's excavation policy; and
- access restrictions through fencing and signs.

This alternative focuses on reducing the impact of vadose zone target area soils on site groundwater, and reducing potential exposure to target soil areas as its main components.

Alternative S3 utilizes a surface barrier (e.g., asphalt or concrete paving) in the target soil area to reduce the mobility of contaminants in unsaturated site soils, and relies on natural flushing of groundwater through saturated soils to reduce the concentration of constituents in the saturated zone. Deed restrictions, continued enforcement of Arch's excavation policy, and fencing/signs as described in Alternative S2 would be utilized to mitigate potential exposure of humans to soil constituents.

Surface barriers, such as asphalt or concrete paving, are typically used to minimize infiltration of precipitation and the corresponding leaching of constituents through affected vadose zone soils to groundwater. Installation of surface barriers at target soil areas would allow control of run-on and run-off, and would be installed to accommodate plant operations. The surface barrier would help to prevent future releases of constituents to site soils and groundwater while allowing for continued use of the area for facility operations. Currently, much of the target soil area is either covered by existing structures or asphalt paving. This alternative would require areas within the target soil area that are not currently covered, to be paved using either asphalt or concrete to minimize infiltration.

This alternative would reduce the mobility of constituents in the unsaturated zone, and reduce the potential for exposure of humans to constituents in the soil. However, the mobility of constituents in the saturated zone would not be reduced.

Off-site Groundwater. Two alternatives were developed from the retained remedial process technologies for the remediation of off-site groundwater.

Alternative OFFSITE-GW1 - No Action

The No Action Alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls. The No Action alternative would not include any modifications to the current discharge of groundwater from the quarry seep, nor would it include any remedial process technologies to monitor constituent concentrations, control migration of constituents, or prevent exposure to groundwater.

Alternative OFFSITE-GW2 – Groundwater Extraction at the Quarry Boundary, Treatment if Necessary to Meet Discharge Criteria, Groundwater Use Limitations, and Monitoring

Alternative OFFSITE-GW2 includes the following components:

- extract contaminated groundwater at the quarry boundary;
- treat extracted groundwater if necessary to meet requirements for discharge;

- work with local municipalities to limit future use of groundwater by residential or industrial property owners in the impacted area between the plant and the quarry; and
- monitor off-site groundwater quality to verify progress towards attaining groundwater quality standards.

This alternative assumes that hydraulic control at the plant property boundary as described for the on-site groundwater alternatives is maintained to prevent additional contributions of site-related compounds to off-site groundwater.

The quarry seep has been effectively capturing the off-site plume, preventing further migration and resulting in overall reductions in contaminant mass. Groundwater would be collected just upgradient of the seep using one or more extraction wells to intercept the flow. Extracted groundwater would be treated if necessary to attain discharge criteria, and then discharged either to a nearby public sewer line or directly to the canal.

The monitoring program for this alternative would include routine sampling and analysis of selected off-site wells, similar to the existing groundwater sampling and analysis program conducted by Arch. Results from groundwater sampling and analysis would be used to monitor trends in constituent concentrations.

There are no unacceptable risks from off-site groundwater under current exposure scenarios. The use of institutional controls would assure that potentially unacceptable exposure scenarios would not occur in the future for as long as concentrations of site-related compounds remain above groundwater standards.

This alternative reduces the volume of site-related compounds by capturing impacted groundwater at the quarry boundary.

Detailed and Comparative Analysis of Alternatives

Each of the alternatives developed underwent a detailed analysis using the seven CERCLA evaluation criteria (excluding state and community acceptance, which are typically evaluated during the public comment period). Once the detailed analysis was complete, the alternatives for each medium underwent a comparative analysis to identify advantages and disadvantages of the alternatives relative to one another.

Recommended Remedial Alternatives

The recommended remedial alternatives for the site wide remediation strategy are: Alternative ONSITE-GW3 - Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring; Alternative S2 – Institutional Controls; and Alternative OFFSITE-GW2 - Groundwater Extraction at the Quarry Boundary, Treatment if Necessary to Meet Discharge Criteria, Groundwater Use Limitations, and Monitoring.

Alternative ONSITE-GW3 is recommended for groundwater remediation to establish and maintain hydraulic control of groundwater at the plant boundary through a groundwater extraction system. The extracted groundwater would be treated in a groundwater treatment system to prescribed discharge criteria prior to discharge to the Monroe County Pure Water Authority POTW. During the remediation period adherence to Arch's health and safety policies would mitigate potential exposure risks to contaminated on-site groundwater. These policies outline procedures, including the use of PPE for conducting invasive activities that may encounter contaminated groundwater. Extraction system performance would be evaluated by monitoring groundwater levels and groundwater quality in on-site monitoring wells. Water level measurements would be used to develop piezometric contours and evaluate the extraction system's performance in establishing and maintaining hydraulic control at the property boundary. Groundwater quality would continue to be monitored and evaluated for trends pursuant to the current groundwater monitoring program conducted for the site.

Alternative S2 is recommended to remediate the target soil area. Alternative S2 focuses on reducing potential exposure to the target soil area, and allows continued leaching to reduce constituent mass in the soil. Mobilized constituents would be captured by the recommended on-site groundwater alternative. During the remediation period, adherence to Arch's health and safety policies would mitigate potential exposure risks to the target soil area. Additional protection from potential exposure to target soil area would be provided through the access controls afforded by the fencing and signs around the plant, and controlled access. Long-term protection would be provided under Alternative S2 through the implementation of deed restrictions if the plant were to be sold, transferred or if operations are discontinued.

Alternative OFFSITE-GW2 is recommended for off-site groundwater. This alternative addresses potential future risks through restrictions on groundwater use and exposure, and reduces the contaminant mass by extracting impacted groundwater before it can discharge to the Dolomite Products Quarry. Additional reduction of contaminant mass is expected within the aquifer due to natural attenuation.

Implementing these recommended alternatives would provide an overall site-wide remediation strategy capable of meeting all of the response objectives developed for on-site groundwater, on-site soil, and off-site groundwater.

1.0 INTRODUCTION

This report presents the findings of a Feasibility Study (FS) conducted for the Arch Chemicals, Inc. (Arch) manufacturing facility in Rochester, New York (the site). Arch is a new company created when Olin Corporation (Olin) spun off its specialty chemicals business to form an independent company. The former Olin Rochester plant was included in the Olin spin-off, and is now an Arch facility.

This FS was performed to fulfill part of the requirements of the Order on Consent between the New York State Department of Environmental Conservation (NYSDEC) and Olin (Index No. B8-0343-90-08), dated August 23, 1993. This FS report discusses the purpose of the FS, summarizes the baseline risk assessment, and develops and evaluates remedial alternatives to address impacted soil and groundwater.

The site includes a chemical manufacturing plant located at 100 McKee Road, Rochester, Monroe County, New York. The site has been the subject of various environmental investigations since the early 1980s, including, but not limited to, a groundwater investigation conducted in 1990 and a two-phase remedial investigation (RI), conducted in 1994-96. Through these investigations, chemicals are known to be present in the soil and groundwater at the site.

1.1 PURPOSE AND ORGANIZATION OF REPORT

This FS identifies remedial action objectives (RAOs), general response actions, and remedial treatment technologies for remediation of soil and groundwater at the site impacted by past activities at the plant. These technologies are evaluated on the basis of effectiveness in achieving RAOs, and technical implementability. The technology options are logically combined and considered in the development of remedial action alternatives that are screened with regard to site characteristics, waste characteristics, and technology limitations. A detailed analysis of alternatives and the selection of recommended alternatives are also presented. In the detailed analysis, alternatives are evaluated with regard to:

- overall protection of human health and the environment
- compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

As required by the Order on Consent, this document has been prepared in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), National Contingency Plan (NCP) and Superfund Amendments and Reauthorization Act (SARA). In addition, this document has been prepared considering U.S. Environmental Protection Agency (USEPA) "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (USEPA, 1988) as directed by the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) HWR-89-4025.

This FS report is organized into an executive summary and five sections as follows:

Section 1: Introduction - This section presents a description of the plant and surrounding area and a discussion of the site history, as well as summaries of findings from the RI and risk assessments (RA).

Section 2: Identification and Screening of Technologies - This section presents the RAOs and general response actions for the potentially impacted media. Technology process options capable of meeting the general response actions are then identified and screened.

Section 3: Development and Screening of Remedial Alternatives - In this section, the technology process options are combined to develop remedial alternatives appropriate to source soils and groundwater. The assembled alternatives are then screened based on effectiveness, implementability, and cost.

Section 4: Detailed Analysis of Alternatives - This section individually analyzes the assembled alternatives based on the criteria identified in the USEPA guidance (USEPA 1988). The alternatives are then evaluated in a comparative analysis and recommended alternatives are identified.

Section 5: Literature Cited - This section lists the literature used in the preparation of this document.

1.2 Site Description and History

Site Description. Arch's Rochester plant is located at 100 McKee Road, a private industrial road in the southwestern section of Rochester, New York (Figure 1-1). The plant property is approximately 15.3 acres. Areas identified as being within the plant boundary are identified as being "on-site", whereas areas outside of the plant boundary are referred to as being "off-site". The entire study area is shown in more detail in Figure 1-2.

The plant is at an elevation of approximately 540 feet above mean sea level (msl). The Arch property is relatively flat, with a maximum relief of approximately 12 feet. There are no surface water bodies on-site. Surface drainage from the plant is collected in storm drains and discharged to the Monroe County Pure Waters publicly-owned treatment works (POTW).

The remainder of the study area is also relatively flat, with surface elevation ranging from approximately 535 to 565 feet above msl. The Dolomite Products Company (Dolomite) quarry, located within the Town of Gates approximately 4,000 feet west-southwest of the plant, is a man-made depression. The floor of the quarry has an elevation of approximately 440 feet above msl.

Most of the on-site areas are covered with buildings or paved for roads, parking lots, or for spill prevention. The equipment lay down area, in the northeast portion of the site is unpaved. Small unpaved areas are also located in the southeast portion of the site, and in the vicinity of the offices.

The nearest major surface water features are the Erie Barge Canal, located approximately 0.3 miles west of the plant and within the study area, the Genesee River approximately 3 miles south of the plant, and Lake Ontario approximately 7 miles north of the plant.

Manufacturing operations have consisted of organic and inorganic chemical production. The primary products are specialty organic chemicals, many of which are produced in small quantities. Due to the nature of the manufacturing operations at Rochester, a large number of organic raw materials, intermediates, and products have been handled at the plant.

Site History. The original plant has seen commercial activity since 1948. During that year, Genesee Research, a fully-owned subsidiary of the Puritan Company, established a manufacturing facility for automotive specialty products (e.g., brake fluids, polishes, anti-freeze, and specialty organic chemicals) (Olin, 1990). In 1954, Mathieson Chemical Corporation, a predecessor of Olin, acquired Puritan. Mathieson continued the brake fluid and anti-freeze operations for a time, but in 1962 began producing specialty organic chemicals, including Zinc Omadine™. In 1963, the production of chloropyridine was begun.

After 1954, additional property was purchased to the north and south of the original plant property (Figure 1-3). Prior to Olin's acquisition of the northern parcel in 1963, the Asphaltic Concrete Company operated a facility on the parcel and, over a number of years, had disposed of asphalt and concrete debris on the parcel. After acquiring the property, Olin sued Asphaltic to remove the debris; however, the anticipated cost of litigation eventually resulted in Olin removing the debris. After removal of the debris, the surface of the parcel was uneven and lower in elevation than the adjacent areas of the plant. The northern parcel was filled and graded to approximately the same grade as the main plant site. The southern parcel was purchased as undeveloped flat ground and remained in that condition until 1995, when construction of additional warehouse space was initiated.

Adjacent Properties. Several areas along McKee Road have been used as landfill or dump sites over the years. NYSDEC has previously listed two areas west of McKee Road on its Registry of Inactive Sites (the Registry). These sites are registry numbers 8-28-018a, between Firth Rixson (formerly Monroe Forging) and Aid to Hospitals, and 8-28-018b, an area north of Firth Rixson which is currently occupied by Griffith Oil Co. Site no. 8-28-018a has since been delisted from the Registry by NYSDEC. A third site, registry number 8-28-018c (the former location of Asphaltic Concrete Company), is now the northern part of the plant (see Figure 1-3). With the exception of the lab sample disposal area and the BR-5 area, which are both located near the boundary of the northern parcel and the original plant property, Olin never used any of these areas for solid or hazardous waste disposal. The Phase I RI (ABB-ES, 1995) investigated these two areas and characterized the environmental conditions.

The northern part of McKee Road was also the site of a waste incinerator operated by Miljo Liquid Waste Processing Corporation. The waste facility at times stored up to 1,000 drums of oil, gasoline, solvents, and sodium cyanide. The facility was closed in April 1974 by the Monroe County Air Resources

Department for incinerating certain chemicals without a permit. Its term of operation is unknown.

1.2.1 Previous Investigations

The following subsections summarize previous investigations conducted at the site.

1.2.1.1 Historic Waste Management Operations. Some historic waste management operations at the plant have utilized on-site land disposal. The following discussion of the disposal areas is based on available knowledge and interviews with plant personnel at Rochester (Olin, 1990). Areas identified as disposal or potential source areas are presented in Figure 1-4.

Nitrating Acid Neutralization Pond (Referred to as the Well BR-5 Area)

The pond was clay-lined, approximately 30 by 100 by 4 feet deep, and located beneath a portion of the current Tank Farm, and used from 1966 until 1971 to neutralize nitrating acid (from the manufacture of benzotrifluoride) using limestone. An ammonium hydroxide spent scrubber solution was also discharged to the pond. The pond discharged into a low area, thought to be immediately north of the area of the current well BR-5. Accumulated water in the low area evaporated or percolated into soils.

Lab Sample Disposal Area

Quality control samples from the on-site laboratory were disposed of in an area north of the laboratory from the 1950s until 1970. The quantity buried was small due to the small volumes associated with sampling. When the present boiler house was being constructed in 1983, sample bottles were uncovered. The observed sample bottles and surrounding soil were excavated and properly disposed of off-site in a commercial landfill (Olin, 1990).

Also in the vicinity of the lab sample pit was a one-time disposal of a batch of off-specification trichlorobutylene oxide (TCBO), believed to be about 1,000 gallons. This disposal was reported to have occurred in late 1968. Soils that may have become impacted were also removed during the boiler construction (Olin, 1990).

Tank Farm Area

The Tank Farm Area is an active chemical storage area in the central eastern portion of the plant with no documented leaks or spills. However, land covering the eastern-most section of the Tank Farm Area has been used for this purpose since 1948, and was not originally bermed to contain leaks or spills that may have occurred. Currently, the Tank Farm Area is lined, bermed, and sloped to contain possible leaks or spills.

Sodamide Area

Discussions with employees raised the possibility that from one to three drums of sodamide (sodium amide) had been buried in the southeastern corner of the property, near the present firewater tank, in the early 1960s. One letter from the Olin files refers to a burial of elemental sodium in this same area. These are believed to be the same episode and that the correct reference is to sodamide (Olin, 1990).

Toluene diamine (TDA) Area

During 1969, ortho- and meta-toluene diamine (TDA) were processed by the plant in a one-time, short campaign. Soils beneath the rail car unloading area were potentially impacted by drippage during unloading. The soils were spread south of the railroad tracks and covered with clean backfill (Olin, 1990).

Former Building Washdown and Well B-17 Area

Building washdown water in excess of floor drain capacity is reported to have been discharged to the formerly unpaved ground off the southeast end of the Main Plant Building (Olin, 1990). This area currently is the location of a paved loading dock, and also contains structures, including piping and containment vessels, that have been built in the area.

1.2.1.2 1982 Report. During 1981 and 1982, Olin conducted a geohydrological study of the plant site. The purposes of the study were to evaluate the direction of groundwater movement; determine the type and quantity of potential Olin-generated constituents in groundwater; and to address significant problems indicated by the study results.

Available regional geological information was augmented by site-specific geological data to complete the hydrogeological description and analysis of the site. The presence of any nearby pumping wells, their depth, pumping rate, and seasonal pumping schedule, were reviewed to see if they influenced localized groundwater movement. A network of 22 monitoring wells was installed on the plant property. Seventeen wells were located at the plant perimeter to detect any potential off-site chemical movement and to measure the water table gradient. Five wells were installed in the plant operating area to define the area of any contamination and to aid in measuring the water levels.

Water table elevations were measured monthly, and in-situ permeability tests were performed at selected wells to measure the aquifer hydraulic conductivity. Groundwater samples were taken from all wells in January 1982 and April 1982. The findings and conclusions of the 1982 report are summarized below. Some of these findings have been modified since that report was issued, based on more recent and complete information developed in later studies.

The main constituents found in the groundwater were chloropyridines and dichloropyridines. Lesser concentrations of fluoraniline, tetrachloroethene, trichloroethene, methylene chloride, carbon tetrachloride, chloroform and toluene were also detected.

A pumping system to intercept overburden groundwater and contain contaminants at the plant boundary was recommended, and eventually installed. The recommended system used ten existing overburden wells to accomplish the objective. The intercepted groundwater is conveyed by pipeline to an on-site treatment system prior to discharge to the Monroe County Pure Waters POTW collection system.

1.2.1.3 1984 USEPA Site Inspection. In June 1984, NUS Corporation (NUS) conducted a site inspection on behalf of USEPA. Using Olin's 1982 report (described above) as a basis, NUS collected four groundwater, one runoff, and three soil samples for analysis (Olin, 1990). NUS concluded:

- Groundwater discharges to the Barge Canal.
- Groundwater in the vicinity is unusable as drinking water (because of natural background constituents).
- No potential for worker exposure.

- Deep production well west (sic – this represents the Ness well, which is to the south) of site is impacted by chemicals from the plant site.
- No potential exists for air exposure (HNu & organic vapor analyzer [OVA] readings nil).

1.2.1.4 1987/1989 Groundwater Investigation. In May 1987, Olin entered into a Consent Agreement with NYSDEC to continue the investigation at the plant to evaluate the nature of the bedrock and the distribution of groundwater contamination. The field work for this phased program commenced in July 1987, and ended in 1989.

The primary focus of the 1987-1989 groundwater investigation was bedrock groundwater. However, soil sampling to detect potentially entrapped chemical sources, and overburden piezometer installations to monitor interceptor system performance, were also included in the program. In addition, a baseline risk assessment was performed by Sirrine Environmental Consultants (Olin, 1990).

Eight shallow and two deep bedrock monitoring wells were installed at the plant and sampled to characterize the bedrock groundwater. Compounds present in the shallow bedrock aquifer were similar to those detected in the overburden, and were found to have migrated to the south and west from the main production area, where the highest concentrations were detected. Based on these results, two shallow bedrock wells were converted to pumping wells to prevent further migration. Extremely low yields from the two deep bedrock wells suggested that vertical migration of constituents was prevented by the competent rock underlying the upper fractured bedrock.

Ten soil borings were drilled in an open area adjacent to the plant's loading dock to assess the potential presence of residual sources of constituents to groundwater. Soil samples from the borings were screened using an organic vapor analyzer (OVA), and the boring with the highest OVA readings was converted to an overburden monitoring well (B-17).

Five overburden piezometers were installed just outside the plant property to the west and south to assess the performance of the overburden groundwater interceptor system. Two additional overburden monitoring wells were also installed west of the plant, adjacent to the canal. These wells found unsaturated conditions in the overburden.

The risk assessment identified no adverse impacts to either human or ecological receptors from site-derived contaminants.

1.2.1.5 1994 Phase I Remedial Investigation. The Phase I RI was designed and conducted with the intention of meeting the objectives of the RI/FS process. The Phase I RI (ABB-ES 1995) assessed environmental contamination in the following media at the site: soil gas, surface soil, subsurface soil, overburden groundwater, and bedrock groundwater. Most of the investigations were conducted on the plant; however, several wells and piezometers were installed on adjacent properties in the larger Site Study Area. Components of the Phase I program included:

- surface geophysical surveys
- direct-push soil gas, soil and groundwater sampling
- surface soil sampling
- monitoring well and piezometer installations
- borehole geophysics
- packer sampling and testing
- groundwater sampling
- hydraulic conductivity testing
- groundwater and separate phase liquid level measurements
- surveying
- sample analyses

The results of the Phase I RI are summarized in Section 1.3.

1.2.1.6 1995 Phase II Remedial Investigation. Between August and December of 1995, Phase II RI activities were conducted to fulfill part of the requirements of the Consent Agreement between the NYSDEC and Olin. While the bulk of the Phase II activities were directed at characterizing off-site groundwater and surface water, some additional investigative activities pertaining to on-site soil and groundwater were also conducted. On-site activities included additional soil and groundwater sampling at the Lab Sample Disposal Area, and evaluation of the on-site groundwater extraction system. The results of the Phase II RI are summarized in Section 1.3.

1.2.1.7 Supplemental Phase II Investigations. Subsequent to completion of the Phase II RI, three bedrock well pairs and three additional deep bedrock wells were installed to the south and west of the plant. The purpose of these wells was to determine the pathway of the chloropyridine contamination on its way to the Dolomite quarry and to determine whether any part of the plume was bypassing the Dolomite quarry. As part of this phase, existing wells were sampled at the Cumberland Farms Petroleum Terminal, Pfaudler Co. property, and Morey property. In addition, monitoring continued at the Erie Barge Canal and the quarry, and bedrock wells were sampled at the Chevron facility west of the plant.

1.2.1.8 Systematic Monitoring. Since its installation in July 1983, the groundwater extraction system has been monitored under two programs. First, plant preventative maintenance personnel check the recovery wells weekly. Second, water elevation readings are taken in the pumping wells and their associated piezometers. These data are submitted to a hydrogeologist for review.

From 1989 to 1994, selected bedrock and overburden monitoring wells, located on-site and off-site, have been sampled quarterly and analyzed for volatile organic compounds (VOCs), pyridine, and selected chloropyridines. Starting in 1994, selected bedrock and overburden wells were sampled on a semiannual basis under the same analytical protocols. The monitoring program was revised again in 1999, to include 21 wells that are being sampled semi-annually, and an additional 28 wells that are sampled once per year. Results of these analyses have been maintained in a computer database and reported to the NYSDEC.

1.3 SITE PHYSICAL CHARACTERISTICS AND NATURE AND DISTRIBUTION OF CONSTITUENTS

The following is a brief description of the physical characteristics and the nature/distribution of chemical constituents at the site. This information is based on the results first presented in the Phase I RI Report, dated August 1995, and the additional investigations reported in the Draft Phase II RI Report, dated May, 1996.

Site-related chemicals were detected in some on-site samples of soil gas, surface soil, and subsurface soil, and in both on-site and off-site groundwater. The distribution of these constituents is believed to be the result of leaching of chemicals from materials at the plant by infiltrating precipitation, or former percolation of materials through the unsaturated overburden to the groundwater.

1.3.1 Site Physical Characteristics

The following subsections summarize the geology and hydrogeology of the site.

1.3.1.1 Area Geology. Surficial geology is characterized by Late Pleistocene glacially deposited sands and silty sands. In general, sediments in the upper part of the overburden are more poorly graded than the lower portion. Upper overburden sediments show signs of stratification. The sand and silty sands are covered locally by fill interpreted to be recompacted glacial sediments. Collectively, the undisturbed sediment and fill are referred to as overburden in this report. Overburden thickness in the McKee Road Area ranges from approximately 10 to 20 feet.

Bedrock underlying the overburden has been identified as Lockport Dolomite. Within the study area, the formation is characterized by light gray color, medium bedding, and fine-grained texture with interbedded shale lenses and stringers. The bedrock surface is interpreted to have little to moderate relief, with elevation ranging from approximately 520 to 530 feet above MSL. Local bedrock highs exist on-site in the Tank Farm Area and at the southeast corner of the plant. Apparent bedrock lows are present off Arch's southern boundary and at the extreme northwest corner of the plant.

Based on examination of rock cores, an upper fractured, or less-competent, bedrock zone ranges in thickness from 11 to 40 feet (27 to 54 feet bgs). Fractures within the upper zone appear to be primarily near-horizontal. Below the upper zone, the bedrock becomes less fractured and weathering decreases.

1.3.1.2 Hydrogeology. Groundwater flow occurs primarily in the saturated portions of the overburden and the uppermost 11 to 40 feet of bedrock. No barrier to flow between the overburden and the upper bedrock has been identified. A deeper water-bearing zone was identified within the more competent bedrock, occurring 60 to 80 feet bgs.

The groundwater table in the overburden is generally less than 10 feet bgs throughout the plant. Overburden groundwater flow appears to be controlled to some degree by the underlying bedrock surface topography, the nature and distribution of water-bearing fractures, and flow direction in bedrock.

Piezometric contours indicate that overburden groundwater flows primarily west and south from the plant toward the Erie Barge Canal and Buffalo Road. A southeastward flow component is also present in the southeast corner of the plant.

The overburden piezometric contours indicate localized areas of successful on-site groundwater capture by the groundwater extraction system, but are constructed from data too widely spaced in most areas to completely confirm capture. Groundwater capture is evident along the southern boundary of the plant, where there appears to be a groundwater divide (flow converges from the boundary area toward pumping wells in the southwestern part of the plant). In addition, the overburden becomes unsaturated west of the plant, between the plant and the Erie Barge Canal. West of the Erie Barge Canal the overburden is unsaturated.

Overburden piezometric contours from the most recent groundwater monitoring report (Figure 1-5) suggest a southerly horizontal component of flow in the southeast corner of the plant. However, when compared to the piezometric contours of the shallow bedrock groundwater (Figure 1-6), the data also indicate a strong downward vertical gradient beneath the plant, suggesting a downward flow path for overburden groundwater when viewed in three dimensions.

Beneath most of the area, the shallow bedrock underlies, and is in hydraulic communication with, the saturated overburden. At the south end of the plant, the southerly component present in the overburden groundwater system is less apparent in the shallow bedrock. In the area west and southwest of the plant, the overburden is unsaturated and the water table resides in the shallow bedrock.

Bedrock groundwater flow directly beneath the plant appears to be governed by the bedrock pumping wells. Groundwater capture is evident in southern areas of the plant and at BR-5 near the eastern boundary. Hydraulic containment is discussed further in Section 1.3.7.

Hydraulic conductivity estimates calculated from the Phase I RI range from 1.9×10^{-5} to 7.7×10^{-3} centimeters per second (cm/sec) in the overburden. In the shallow bedrock, estimates range from 4.0×10^{-5} to 11.7×10^{-3} cm/sec and in the deeper competent bedrock approximately 10^{-6} cm/sec. In the deep water bearing zone, hydraulic conductivity was estimated to be 2.4×10^{-4} cm/sec.

1.3.2 Geophysical Results

Ground-penetrating radar (GPR) surveys conducted in 1993 at the Sodamide Area and the Decommissioned Equipment Lay-Down Area detected no anomalies to indicate the presence of buried waste materials which could be continuing sources of chemicals. Buried objects, interpreted to be pipes, were detected in both areas, and chaotic signals typical of heterogeneous materials were detected in the Decommissioned Equipment Lay-Down Area. No signals indicative of buried drums were detected in either area.

1.3.3 Soil Gas

Selected VOCs were detected in the soil gas on-site. The primary constituents were carbon tetrachloride (38% of samples), chloroform (31% of samples), and perchloroethylene (PCE), (29% of samples). The highest concentrations of VOCs in soil gas were found in the Well B-17 Area and the Lab Sample Area (maximums of 74 and 13 micrograms per liter [µg/L in air], respectively, for the sum of nine VOC compounds). The specific analytes examined and ranges of detection of these compounds are presented in Table 1-1.

1.3.4 Surface Soil

Soil sampling is discussed in detail in Section 2.2.2.2, which includes a figure showing surface soil sampling locations (Figure 2-6). Briefly, sampling found all on-site surface soil samples contained several polycyclic aromatic hydrocarbons (PAHs) and one or more chloropyridine isomers. Chloroform was the only VOC detected in the surface soil samples. The locations of the maximum concentration of chloroform and many of the semivolatile organic compounds (SVOCs) were in the Well B-17 Area. However, the maximum concentration of bis(2-ethylhexyl)phthalate was located on the southwest property boundary (60 milligrams per kilogram [mg/kg] at sample location SS-107). Only one sample from the Lab Sample Disposal Area and one from the Tank Farm Area contained inorganics above respective background concentrations as indicated in the literature. During the Phase II investigation, two surface soil samples were collected from the Lab Sample Area to further characterize the distribution of mercury detected in the surface soil at location SS-103. Sampling results detected mercury at concentrations comparatively lower than the concentration detected at location SS-103.

The Phase II RI also compared inorganic concentrations measured in all surface and subsurface soil samples to background values from the NYSDEC TAGM

HWR-94-4046 (NYSDEC, 1994) and USEPA Region III risk-based concentrations for industrial soil (USEPA 1994). Magnesium, mercury, and zinc were detected at levels above NYSDEC TAGM background levels at a majority of the sample locations. Arsenic, cadmium, calcium, chromium, copper, iron, lead, and nickel were detected above NYSDEC TAGM background levels at one or more locations. No inorganics were detected above USEPA Region III risk-based concentrations.

1.3.5 Subsurface Soil

The highest concentrations of VOCs, chloropyridines, and other SVOCs were detected in the paved alcove located immediately east of the main plant building. One direct-push sample, adjacent to Well B-17 at 18 ft bgs, showed carbon tetrachloride and 4-chloropyridine at 4200 mg/kg and 1100 mg/kg, respectively. Depth to groundwater in this area is less than 10 ft bgs. Based on observations at nearby monitoring well B-17, these contaminants are present in the saturated zone near the soil/bedrock interface. Analytical results from shallow depth samples collected in the alcove area indicates that the chloropyridines in the unsaturated zone are not confined to the alcove but are distributed along the outer edge of the chlorinator area.

1.3.6 Groundwater

SVOCs, VOCs, and inorganic analytes were detected in overburden and bedrock groundwater beneath the site. Chloropyridines were the most frequently detected organic chemicals in both overburden and bedrock groundwater. The distribution of chloropyridines is believed to represent the greatest extent of site-derived constituents in the groundwater. Two primary lobes of chloropyridines in groundwater are present; one extending west and northwest of the plant, and the other extending south. Total chloropyridine concentrations were lower in deep bedrock wells than in adjacent shallow bedrock wells.

Concentrations of inorganics in groundwater were higher in the overburden than in the bedrock, perhaps due to suspended solids concentrations in unfiltered overburden samples. Maximum inorganic concentrations were detected in wells showing high site-related organic constituent concentrations primarily along the western and southern plant property boundaries. Most inorganics detected in the groundwater are believed to be naturally occurring elements. The co-location of site-related organic constituents with high concentrations of inorganics may be related to constituents, from past releases, facilitating the release of naturally occurring minerals from the soil (e.g., by changing the pH or oxidation-reduction conditions in the groundwater, which can affect the solubility of inorganic compounds such as metals).

1.3.6.1 Overburden Groundwater. Sampling of overburden wells has consistently shown the maximum VOC and SVOC concentrations to be near the main plant building, at monitoring well B-17. In June 1999, the total concentration of chloropyridines at that well was 82 milligrams per liter (mg/L), and total VOCs were measured at 65 mg/L (Arch, 1999).

1.3.6.2 Bedrock Groundwater. June 1999 results show maximum VOC and SVOC concentrations in bedrock groundwater located south of the Well B-17 Area at BR-3 (152 mg/L of total chloropyridines and 343 mg/L total VOCs) (see Figures 1-7, 1-8, and 1-9). Chloropyridines are also found in lower concentrations in bedrock groundwater between the plant and the quarry, but VOCs diminish rapidly to near non-detectable levels in off-site wells.

1.3.7 Groundwater Extraction System Evaluation

The pumping tests and associated well evaluations performed during the Phase II RI indicated that shallow bedrock wells BR-6A and BR-7A were capable of producing higher flow rates than expected. However, most of the existing overburden extraction wells were able to produce only very low yields, despite substantial efforts to improve yields through well rehabilitation. This led to an evaluation of an alternative approach that might prove more effective at capturing overburden groundwater, specifically by pumping from the underlying shallow bedrock aquifer.

A numerical model of groundwater flow in the overburden and shallow bedrock aquifers beneath the site, was constructed using the MODFLOW finite difference model developed by the United States Geological Survey (McDonald and Harbaugh, 1988). The model results are included in Appendix A.

Based on the results of the modeling evaluation, Arch installed an additional shallow bedrock groundwater extraction well in 1995 adjacent to Well BR-102 (Well BR-9). The extraction well network was further expanded in 1999, with the addition of three pumping wells. Two of the recently-added wells (PW10 and PW12) are located in groundwater "hot spot" areas to increase the contaminant mass removal rate of the extraction system. The third well (PW11) was installed near monitoring well BR-8 along the western plant property boundary to enhance hydraulic control in that location.

Figure 1-10 shows the current configuration of the shallow bedrock extraction well network. Aquifer responses to operation of the upgraded system are being monitored to evaluate performance of the extraction system.

Appendix B includes a set of time-series plots of contaminant concentrations in several key wells around the Arch Plant. Most plots show significant reductions in contaminant levels since the extraction system has been operational. With the addition of new pumping well PW11, it is expected that monitoring well BR-106 will also begin to show a downward trend in future monitoring of contaminant levels.

1.4 Chemical Fate and Transport

The fate and transport analysis of the Phase I RI (ABB-ES, 1995) concentrated on site-related VOCs, chloropyridines, and other SVOCs, and inorganics migrating from on-site sources to overburden and bedrock groundwater. Based on the physical-chemical properties of site-related constituents presented in the RI, dissolved-phase transport in groundwater is considered the most important migration pathway. Other less significant pathways investigated include migration of VOCs from the subsurface into neighboring buildings, and surface water transport of constituents potentially discharged via groundwater to the Erie Barge Canal.

The physical-chemical properties of VOCs, chloropyridines, and other SVOCs (primarily PAHs and phthalates) were also evaluated to assess the importance of biodegradation, adsorption, volatilization, and dissolution as fate processes (ABB-ES, 1995). Dissolution and degradation of VOCs from past releases to groundwater are believed to be the most significant fate processes for VOCs at the site. Dissolution occurs for all VOCs, and the rate depends upon residence time of groundwater in impacted soil. Anaerobic degradation is believed to be the most important fate process for PCE and trichloroethylene (TCE); however, other halogenated VOCs may also biodegrade over time. Adsorption to soil was identified as the most important fate process controlling the distribution of PAHs and pesticides. At the time the Phase I RI was issued, little data were available on the physical-chemical properties of chloropyridines; however, biodegradation, photo-oxidation and volatilization were identified as the most important fate processes for these compounds (ABB-ES, 1995). In the time since the RI was completed, Arch has developed additional physical-chemical data on chloropyridines. This information is included in Appendix C.

Liquids that are immiscible or only partially soluble in water are referred to as non-aqueous phase liquids. If their densities are greater than water they are dense non-aqueous phase liquids (DNAPL), and if their densities are less than water they are light non-aqueous phase liquids. Chloropyridines and several of the chlorinated VOCs identified as contaminants of concern at the site are DNAPLs. If DNAPLs enter the saturated zone, they will migrate in a direction dependent on the specific gravity of the liquid phase, groundwater flow, entry pressures, and the surface topography of any confining layers. Over time, and depending on the characteristics of the bedrock fractures, some fraction of DNAPL will diffuse into the pores of the rock matrix where it will become relatively immobile, but will continue to be a source of groundwater contamination when contacted by groundwater. Groundwater data from the Phase I RI and prior sampling events show the concentrations of several VOCs exceeding one percent of solubility limits (ABB-ES, 1995), a nominal indicator of the potential presence of DNAPL. A separate phase liquid has been observed in the past in two bedrock wells (BR-3 and BR-5) (Olin, 1990). However, no separate phase liquid was observed during either the Phase I or Phase II RIs.

Assessment of fate processes for inorganics was qualitative. Mobility of inorganics in soil-groundwater systems is affected by soil-, water- and chemical-specific properties including compound solubility, pH, soil cation exchange capacity, and oxidation-reduction potential. Groundwater in the vicinity of the plant is naturally high in sulfur, and would be expected to be naturally high in calcium and magnesium because of the presence of carbonate bedrock. These natural constituents in the local groundwater prevent its use for drinking and most other purposes without some type of treatment or conditioning.

A conceptual model was developed which considers that chemicals are leached from soil at the plant by infiltrating precipitation, and migrate through the unsaturated overburden to the groundwater. Once in the groundwater, constituents migrate in the dissolved phase in the saturated overburden and bedrock. Oxidation/reduction processes, dissolution, degradation, volatilization, and adsorption processes act to reduce concentrations of chemicals in the groundwater during migration.

1.5 Human Health Risk Assessment Summary

This section presents a summary of the human health risk assessments performed in support of the Phase I and Phase II RIs for the Arch Plant in Rochester, NY. The risk assessments were conducted to evaluate health risks associated with potential exposures to constituents related to the plant in environmental media under the current landuse, continuing land-use, and potential future land use conditions.

The risk assessments were performed using methods consistent with relevant guidance and standards developed by USEPA (USEPA, 1989d,f, 1991a,c, 1992d,e,f) and NYSDEC (NYSDEC, 1994a); they reflect comments and guidance received from USEPA Region II, NYSDEC, and NYSDOH, and incorporate data from the scientific literature used in conjunction with professional judgment. NYSDEC, in general, follows USEPA guidance for risk assessment and does not have specific promulgated guidances for risk assessment methodology.

The risk assessments consisted of the following components:

- Identification of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Evaluation
- Summary and Conclusions

This section provides only a summary of the purposes, procedures, and results for each of these components. Complete documentation of the risk assessment methods and results is provided in the Phase I and Phase II RI risk assessments.

1.5.1 Chemicals and Media of Potential Concern

Study area-related chemicals that were selected for quantitative evaluation in the risk assessment were termed Chemicals of Potential Concern (CPCs), and are defined as those chemicals that are present in environmental media and related to the plant as a result of past manufacturing activities. In selecting CPCs, the analytical data for each environmental medium were first grouped and summarized into descriptor statistics, including frequency of detection, range of detected concentrations, and arithmetic mean concentrations. Screening procedures were then used to reduce the list of detected chemicals to those that are related to the plant, such as pyridine, fluoroaniline, and chloropyridine compounds, or those that are most likely to contribute the majority of risk.

The purpose of the Phase I RI was primarily to investigate environmental media at or very near to the plant (e.g., on-site soils and groundwater), whereas the purpose of the Phase II RI was primarily to investigate environmental media outside the fenced area, where site-related constituents have migrated via groundwater transport (e.g., Erie Barge Canal surface water, Dolomite Products Quarry groundwater seeps). The environmental media investigated in the Phase I and II RIs and evaluated in the Phase I and Phase II RI risk assessments are summarized below:

Medium	Report	Summarized In:
• Soil gas (on-site and off-site)	Phase I	Table 1-1
• Surface Soil - Facility, On-Site (0-2 inches bgs)	Phase I	Table 1-2
• Surface Soil - Non-Facility, On-Site (0-2 inches bgs)	Phase I	Table 1-2
• On-Site Soil (0-10 feet bgs)	Phase I	Table 1-2
• Overburden Groundwater - On-Site	Phase I	Table 1-3
• Overburden Groundwater - Off-Site	Phase I	Table 1-3
• Bedrock Groundwater - On-Site	Phase I	Table 1-4
• Bedrock Groundwater - Off-Site	Phase I	Table 1-4
• Overburden and Bedrock Groundwater - Phase II Off-Site Sampling Points	Phase II	Table 1-5
• Erie Barge Canal Surface Water	Phase II	Table 1-6
• Quarry Outfall Water	Phase II	Table 1-6
• Dolomite Products Quarry Groundwater Seeps	Phase II	Table 1-7

For each of these media, data were summarized and CPCs were selected. The CPCs for each of these media are presented in Tables 1-1 through 1-7. As described in the Phase I RI risk assessment, the distinction between on-site and off-site media was determined by the location of samples with respect to the plant property boundary. No soil data were collected off-site because no source areas associated with the plant were identified off-site, and because surface soil is not expected to migrate off-site. For the purposes of exposure assessment, surface soil data were grouped into on-site facility and on-site non-facility areas. On-site facility areas are the areas that are within the active industrial use portions of the plant, and on-site non-facility areas are the areas that are within the property boundary of the plant but are not located within active use areas. Overburden and bedrock groundwater were evaluated as separate media in the Phase I risk assessment, but as the same medium in the Phase II risk assessment. The off-site soil gas and overburden groundwater data presented in Tables 1-1 and 1-3 include data for the adjacent property to the south, 58 McKee Road, (formerly Kodak property).

1.5.2 Exposure Assessment

The exposure assessment combined information concerning where CPCs were present in environmental media (e.g., off-site overburden groundwater, Erie Barge Canal), with information concerning current and potential future land uses at the plant and surrounding area. This was done in order to identify the groups of people who might be exposed to CPCs (i.e., human receptors), where they might be exposed, and how they might be exposed. This information was used to identify exposure pathways (i.e., the sequence of events leading to contact with a chemical) for each receptor evaluated. Exposure pathway information was then combined with estimates of the amount of CPC in each contact medium (the exposure point concentration), and assumptions regarding the rate and magnitude of CPC contact, to generate quantitative estimates of CPC exposure.

Table 1-8 presents a summary of the receptors and exposure pathways evaluated in the Phase I and Phase II RI risk assessments. As indicated in Table 1-8, exposures under both current and potential future site and surrounding land use conditions were evaluated. Current land use conditions were evaluated to take into account actual or possible exposures. Future site land use conditions were considered to address exposures which may occur as a result of any future activities or land use changes.

1.5.2.1 Current Exposure Scenario. The exposure scenarios summarized in Table 1-8 reflect the industrial/commercial use of the study area. The Arch Plant is located on the east side of the Erie Barge Canal, and the area in the immediate vicinity of the plant is heavily industrialized. The only exposures that may occur on the facility property under current land use are to **on-site facility commercial/industrial workers** and **on-site non-facility commercial/ industrial workers** who may contact surface soil. The Erie Barge Canal trends northwest-southeast through the Arch Study Area. Under current land use conditions, recreational exposures to surface water in the Erie Barge Canal may occur for **older child and adult recreational boater/swimmers** and **adult recreational anglers**. The Dolomite Products Quarry is located on the west side of the Erie Barge Canal. Exposure to groundwater seeps may occur for **quarry workers at the Dolomite Products Quarry**. In addition to these exposures, there are residences on the north and south sides of the quarry, and the ditch leading from the quarry to the Erie Barge Canal passes along the edge of a residential development. Although this exposure was not formally evaluated, recreational exposures to surface water in the Erie Barge Canal would be a conservative estimate of risk from exposures to water in the ditch.

1.5.2.2 Potential Future Exposure Scenario. The basic future site and surrounding land use conditions at the study area were assumed to be similar to current conditions. **On-site construction workers** were assumed to be exposed to soil (0-10 feet bgs) and overburden groundwater in the event that future construction or excavation activities take place at the plant. Construction workers were evaluated for 1-month and 6-month exposures. In addition, **off-site construction workers** were assumed to have exposures to overburden groundwater in the event that future construction or excavation activities take place in the vicinity of the site. Future residential use of the plant site and Dolomite Quarry is not considered plausible, and therefore, future residential exposures were not evaluated in the Phase I and Phase II risk assessments. However, full-time, long-term exposures to groundwater used as industrial process water were assumed to occur for **off-site commercial/industrial workers**.

Potential exposures to bedrock groundwater were not quantitatively evaluated in the risk assessments. The bedrock groundwater is not currently used for residential or industrial purposes, and is not expected to be used in the future because of the high concentrations of salts, naturally-occurring sulfide, and dissolved gases which make the water non-potable. Public water is available, and its use is required for new developments of more than five houses. The risk assessments provided a comparison of bedrock groundwater CPCs to MCLs and New York State groundwater standards for informational purposes.

1.5.2.3 Method of Exposure Estimation. Based on USEPA risk assessment guidance (USEPA, 1989d, 1991a), exposure estimates for each exposure pathway were quantified by estimating the reasonable maximum exposure (RME) associated with a pathway of concern. The term RME is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA, 1989d). Used in combination with conservative dose-response values that are protective for sensitive subpopulations, the RME is intended to place a conservative upper-bound on the potential risks. Consequently, the risk is unlikely to be underestimated but it may very well be overestimated.

In the risk assessments for the on-site and off-site areas, exposures and risks were estimated for both RME and average exposure conditions. The RME was calculated by using the maximum detected concentration of chemical in a given exposure medium as the exposure point concentration (EPC), and conservative estimates of contact rate, exposure frequency, and exposure duration. Average exposures were calculated by using the arithmetic mean CPC concentration as the EPC, and the same exposure rate, frequency, and duration estimates that were used in the RME calculations. The exposure rate, frequency, and duration values for each receptor were developed using USEPA risk assessment guidance, and are documented in the Phase I and Phase II RI risk assessments. The EPCs for each exposure medium evaluated in the risk assessments are the maximum and arithmetic mean concentrations presented in Tables 1-1 through 1-7. The EPCs for volatile CPCs that may migrate from groundwater to excavations or indoor industrial facility air were estimated using the groundwater EPCs and conservative modeling approaches that were likely to overestimate the potential air concentrations.

1.5.3 Toxicity Assessment

The purpose of the toxicity assessments was to define the relationship between the dose of a substance and the likelihood that a toxic effect, either carcinogenic or noncarcinogenic, would result from exposure to that substance. For risk assessment purposes this relationship was quantified by dose-response values, which estimate the likelihood of adverse effects as a function of human exposure to an agent. Consistent with USEPA risk assessment guidance, dose-response values were identified primarily from the USEPA Integrated Risk Information System, and secondarily from the USEPA Health Effects Assessment Summary Tables (HEAST). If appropriate dose-response values were not available from either of these two sources, other USEPA sources were consulted (e.g., the USEPA National Center for Environmental Assessment [NCEA]). Dose-response values used in the on-site (Phase I) and off-site (Phase II) RI risk assessments were current as of the date of report publication.

No dose-response values have been published for chlorinated pyridine compounds. Because chlorinated pyridine compounds were identified as CPCs due to their association with the plant, surrogate dose-response values were developed in the off-site risk assessment. These dose-response values, which were based on values for chlorobenzene compounds, were accepted for use by NYSDOH, along with the compounds themselves, and were used to quantify risks in the off-site RI risk assessment. These surrogate values were not used in the on-site (Phase I RI) risk assessment. However, based on a review of the on-site RI risk assessment, quantification of risks for chlorinated benzene compounds using the surrogate dose-response values does not affect the conclusions of the on-site RI risk assessment. The on-site RI risk assessment cancer risk estimates would be unaffected by use of the surrogate dose-response values, and non-cancer risk estimates would remain unchanged, or in some cases be reduced slightly, by use of the surrogate dose-response values.

1.5.4 Human Health Risk Characterization

In the risk characterization, the exposure and toxicity information were integrated to develop both quantitative and qualitative evaluations of risk. Risk estimates were calculated in the Phase I and Phase II RI risk assessments for both carcinogenic and non-carcinogenic effects. Documentation of the risk calculation methods is provided in the Phase I and Phase II RI documents.

Cancer risk estimates were expressed as individual upper bound excess lifetime cancer risks. The cancer risk estimate is an estimate of the probability of contracting cancer as a result of exposure to the potential carcinogen over a 70-year lifetime under the specified exposure conditions. A risk level of $1x10^{-6}$, for example, represents an upper bound probability of one in one million that an individual will contract cancer. In comparison, the national incidence of cancer in the general population from all causes is 1 in 2 for men and 1 in 3 for women. The upper bound cancer risk estimates provide estimates of the upper limits of risk, and the risk estimates produced are likely to be greater than the 99th percentile of risks faced by actual receptors (USEPA 1992f). The relative significance of risk estimates were evaluated by comparison to a target risk range of $1x10^{-4}$ to $1x10^{-6}$ established by USEPA (USEPA, 1989b), and to the lower value of this range, which the NYSDOH considers to be a boundary between cancer risks that are negligible and those that require further evaluation.

Noncancer risks were expressed as hazard indexes (HIs). HIs represent the likelihood of adverse effects occurring as a result of exposure to a chemical. An HI of 1 or less indicates that the associated exposure is not likely to result in any adverse health effects, whereas HIs greater than one indicate that adverse health effects may occur. HIs were evaluated by comparison to the USEPA threshold HI of 1.

Cancer and non-cancer risk estimates were calculated for ingestion, dermal contact, and particulate and vapor inhalation exposures to the exposure media evaluated in the risk assessments. Risks for potential inhalation exposures to VOCs that may migrate from soil gas or groundwater were evaluated by calculating quantitative risk estimates or comparing EPCs to workplace air standards (Permissible Exposure Levels or PELs) issued by the American Conference of Governmental and Industrial Hygienists. Risks to future construction workers who may inhale VOCs that migrate from overburden groundwater were evaluated by calculating quantitative cancer and non-cancer risk estimates. Possible vapor inhalation exposures to workers in future facilities using groundwater as industrial process water were evaluated by comparing estimated indoor air chemical concentrations to workplace indoor air standards. This approach was also used to evaluate on-site facility and non-facility workers and construction workers who may potentially be exposed to CPCs in soil gas.

Table 1-9 presents a summary of cancer and non-cancer risk estimates for the [current and future current and continuing, and potential future] land use exposure scenarios evaluated in the Phase I and Phase II RI risk assessments. The risk estimates presented in this table represent the total risks to each receptor from all media to which the receptor may potentially be exposed. Table 1-10 provides a summary of the risk estimates for each receptor, categorized by exposure medium. The risk estimates summarized in this table depict the risks posed by each exposure medium and exposure pathway. This information is useful for identifying exposure media and pathways that contribute significant risks, and can be used to focus risk management decision-making.

1.5.4.1 Total Receptor Risks. Table 1-9 provides a summary of total receptor risk estimates (i.e., risks for multi-media exposures) for the current and future land use exposure scenarios evaluated in the on-site and off-site RI risk assessments.

Current and Continuing Land Use Cancer risk estimates for current land use, based on RME and average exposures, are within the USEPA acceptable excess lifetime cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. The non-cancer risk estimates for current land use, based on RME and average exposures, are less than a hazard index value of 1 for all receptors evaluated. Risks for the exposure scenarios presented in Section 1.5.2 and summarized in Table 1-8 are discussed below:

On-site facility commercial/industrial worker and **on-site non-facility commercial/industrial worker:** RME and average cancer risks for exposure to on-site surface soils are within USEPA acceptable ranges, although cancer risks are above an excess lifetime cancer risk of $1x10^{-6}$, a level considered negligible by NYSDEC.

Only one soil gas sample had a CPC detected above the air standard. Carbon tetrachloride was detected at 38 µg/L in sample SG-120, located about 100 feet east-northeast of the well B-17 area in the plant. This concentration is only slightly in excess of the standard of 31 µg/L. Because no other CPC exceeded the criteria and because of the conservative nature of the evaluation, no substantial health risks were identified for exposures to soil gas.

Plant workers are subject to Occupational Safety and Health Administration (OSHA) workplace standards and receive training and personal protective equipment (PPE) so they can work safely in the hazardous environment. Therefore, it is unlikely that workers would be subjected to any unacceptable health risks.

Older child and adult recreational boater/swimmer: RME and average cancer risks for recreational boater/swimmers are less than an excess lifetime cancer risk of $1x10^{-6}$. RME and average exposure non-cancer risk estimates are less than a hazard index value of 1 for recreational boater/swimmers.

Recreational angler: RME and average cancer risks for recreational anglers are less than an excess lifetime cancer risk of $1x10^{-6}$. RME and average exposure non-cancer risk estimates are less than a hazard index value of 1 for recreational anglers.

Quarry worker: RME and average cancer risks for quarry workers are less than an excess lifetime cancer risk of $1x10^{-6}$. RME and average exposure non-cancer risk estimates are less than a hazard index value of 1 for quarry workers.

Because of the current land use conditions at and in the vicinity of the plant, risk estimates to the receptors evaluated for current land use conditions hold true for future land use conditions. Table 1-9 provides a summary of total receptor risk estimates (i.e., risks for multi-media exposures) for the current and future land use exposure scenarios evaluated in the on-site and off-site RI risk assessments.

Potential Future Land Use Risks for the exposure scenarios presented in Section 1.5.2 and summarized in Table 1-9 are discussed below.

On-site construction worker: RME and average cancer risk estimates for one-month and six-month exposures to soil and overburden groundwater exceed NYSDEC's level of negligible risk of $1x10^{-6}$, as well as the USEPA acceptable excess lifetime cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. RME and average non-cancer risks exceed an HI of 1.

Only one soil gas sample had a CPC detected above the air standard. Carbon tetrachloride was detected at 38 µg/L in sample SG-120, located about 100 feet east-northeast of the well B-17 area in the plant. This concentration is only slightly above the standard of 31 µg/L. Because no other CPC exceeded the criteria and because of the conservative nature of the evaluation, no substantial health risks were identified for exposures to soil gas.

Plant workers are subject to OSHA workplace standards and receive training and PPE so they can work safely in the hazardous environment. Therefore, it is unlikely that workers would be subjected to any unacceptable health risks.

Off-site construction worker: RME and average cancer risk estimates for six-month exposure and RME for one-month exposure to overburden groundwater exceed NYSDEC's level of negligible risk of $1x10^{-6}$, but within the USEPA acceptable excess lifetime cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. Average cancer risk for one-month exposure to overburden groundwater is less than NYSDEC's level of negligible risk of $1x10^{-6}$, as well as the USEPA acceptable excess lifetime cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. RME and average non-cancer risks for one-month and six-month exposures exceed an HI of 1.

Off-site commercial/industrial worker: Cancer risk estimates for exposure to groundwater used as industrial process water exceed the USEPA acceptable cancer risk range of 1×10^{-6} to 1×10^{-4} under RME conditions, but are within this range for exposures under average conditions. Cancer risk estimates for RME and average conditions exceed 1×10^{-6} . Non-cancer risks for these exposure scenarios are above a hazard index of 1. Estimated air concentrations of chemicals that may volatilize from the groundwater used as industrial process water to indoor air do not exceed permissible occupational exposure limits, indicating that inhalation exposures to volatile chemicals in groundwater are not a concern for workers.

In summary, cancer and non-cancer risks to future on-site excavation workers exceed USEPA acceptable levels. Cancer risks to future off-site excavation workers are within USEPA acceptable ranges, although cancer risks exceed a level of $1x10^{-6}$. Non-cancer risks for these receptors exceed an HI of 1. Cancer risks for a future full-time, long-term industrial worker who is exposed to groundwater used as process water are in excess of $1x10^{-6}$ for average and RME conditions, and in excess of $1x10^{-4}$ for RME conditions. Non-cancer risks for this potential receptor exceed an HI of 1. These risk estimates are valid only under the assumed future use conditions; if excavations are not advanced and groundwater is not used as industrial process water, these risks will not occur. Likewise, if exposures to the media are limited or controlled, risks will be mitigated.

Table 1-9 provides a summary of total receptor risk estimates (i.e., risks for multi-media exposures) for the current and future land use exposure scenarios evaluated in the on-site and off-site RI risk assessments.

1.5.4.2 Exposure Medium Risks. Table 1-10 provides a summary of risk estimates for each exposure medium evaluated in the Phase I and Phase II RI risk assessments.

Surface Soil Surface soil at the plant may be contacted by full-time, long term commercial/industrial workers under the current and anticipated future industrial land use conditions. Cancer risk estimates for RME and average exposure conditions at the facility and non-facility areas exceed an excess lifetime cancer risk of $1x10^{-6}$, but are within the USEPA acceptable cancer risk range. Non-cancer risks for these areas are less than an HI of 1. The Arch Plant has a mandatory policy for on-site excavation (Appendix D) that requires the determination of whether or not hazardous conditions are present, and use of appropriate PPE to limit exposure and mitigate risk.

Soil Gas Commercial/industrial workers and future excavation workers could be potentially exposed to soil gas. Only one soil gas sample had a CPC detected above the air standard. Carbon tetrachloride was detected in sample SS-120 at 38 µg/L, only slightly above the standard of 31 µg/L. Because no other CPC exceeded the criteria and because of the conservative nature of the evaluation, no substantial health risks were identified for exposures to soil gas.

Surface Water Possible exposures to CPCs in surface water at the Erie Barge Canal could occur to older child and adult swimmers or boaters, and recreational anglers. Cancer risk estimates for RME and average exposures are within the USEPA acceptable cancer risk range. Non-cancer risks for these exposures are less than an HI of 1.

Groundwater Seeps Possible exposures to CPCs in groundwater seeps at the Dolomite Products Quarry could occur to adult quarry workers. Cancer risk estimates for RME and average exposures are within the USEPA acceptable cancer risk range. Non-cancer risks are less than an HI of 1.

On-Site Soil Soil at the plant may be contacted by excavation workers if excavations or construction is performed in the future. Cancer risk estimates for RME and average exposure exceed an excess lifetime cancer risk of $1x10^{-6}$, but are within the USEPA acceptable cancer risk range. Non-cancer risks exceed an HI of 1. The majority of non-cancer risk for this exposure medium is associated with potential inhalation exposures to particulates. The Arch Plant has a mandatory policy for on-site excavation (Appendix D) that requires the determination of whether or not hazardous conditions are present, and use of appropriate PPE to limit exposure and mitigate risk.

On-Site Overburden Groundwater Overburden groundwater at the plant may be contacted by excavation workers if excavations or construction is performed in the future. Cancer risk estimates for RME and average exposure exceed the USEPA acceptable cancer risk range. Non-cancer risks exceed an HI of 1. The majority of non-cancer risk for this exposure medium is associated with potential dermal contact exposures. Risks could be reduced by controlling or eliminating exposure to groundwater. The Arch Plant has a mandatory policy for excavation (Appendix D) that requires the determination of whether or not hazardous conditions are present, and use of appropriate PPE to limit exposure and mitigate risk.

Off-Site Overburden Groundwater Overburden groundwater outside the plant may be contacted by excavation workers if excavations or construction is performed in the future. Cancer risk estimates for RME and average exposure are in excess of an excess lifetime cancer risk of $1x10^{-6}$, but are within the USEPA acceptable cancer risk range. Non-cancer risks exceed an HI of 1. The majority of non-cancer risk for this exposure medium is associated with potential dermal contact exposures. Risks could be reduced by controlling or eliminating exposure to groundwater.

Off-Site Overburden and Bedrock Groundwater - Phase II Sampling Points Groundwater outside the plant at the Phase II sampling points was assumed to be contacted by future full time, long-term industrial workers using the groundwater as industrial process water. Cancer risk estimates for average exposure exceed an excess lifetime cancer risk of $1x10^{-6}$, but are within the USEPA acceptable cancer risk range. Cancer risk estimates for the RME conditions exceed the USEPA acceptable cancer risk range. Non-cancer risks exceed an HI of 1. The risk for this exposure medium is associated with potential dermal contact exposures. Estimated concentrations of VOCs in industrial facility air were less than OSHA air standards. This exposure scenario represents a hypothetical future use of groundwater. If such a groundwater use actually occurred in the future, risks could be reduced by controlling or eliminating dermal exposure to groundwater.

1.6 Summary of Ecological Risk Assessment

Because of its heavily industrialized nature, the site is not anticipated to provide the necessary habitat to support a diverse and well-balanced ecological community. Based on the findings of the Ecological Risk Assessment (ERA), ecological receptors that may occur at the site are unlikely to be adversely impacted as a result of exposures associated with foraging. Maximum detected surface soil concentrations of several inorganic CPCs exceeded the screening toxicological benchmarks for plants and invertebrates; however, the poor ecological habitat quality in the area combined with the conservative nature of the screening benchmark values employed during the ERA, suggest that the potential risks to these groups are overly conservative. Measured surface water analytical data were used to assess the likelihood of adverse impacts to ecological receptor populations that exist in the surface water habitat in the vicinity of the plant. Aquatic toxicity benchmarks were developed for all surface water analytes and were compared to the detected estimated surface water concentrations. Estimated concentrations of the surface water analytes detected in the Erie Barge Canal were lower than all toxicity benchmarks for aquatic receptors. Consequently, no adverse impacts to these receptors would be anticipated. Food chain-related exposures by semi-aquatic receptors were evaluated using bioconcentration factors to estimate fish tissue concentrations. Due to the low-magnitude, low frequency detections of estimated concentrations, and the low uptake potential of the surface water analytes, bioconcentration hazards to semi-aquatic wildlife are considered insignificant. Based on concentrations of chloropyridines detected in Phase II wells adjacent to the Erie Barge Canal, no adverse effects to ecological receptors were identified in the ERA should undiluted groundwater discharge into the canal.

Further details on the ERA can be found in the Phase II RI (ABB-ES, 1996a) and the Phase II RI Addendum (ABB-ES, 1996b).

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The development of remedial alternatives follows a logical series of steps presented in the RI/FS guidance (USEPA, 1988). This section presents the first five steps in the alternative development process. These steps include:

- development of remedial action objectives
- identification of volumes and areas of potentially affected media
- development of general response actions
- identification of remedial technologies
- evaluation and screening of remedial technologies

2.1 INTRODUCTION

Remedial technologies were identified, screened, and assembled into remedial alternatives in the following sections.

2.2 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The general objective of this remedial technology evaluation is to support the selection of a remedy that best meets the following requirements:

- is protective of human health and the environment;
- attains federal ARARs and, when more stringent, New York State Standards, Criteria, and Guidelines (SCGs);
- satisfies the preference for treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous constituents as a principal element (or provides an explanation why this requirement is not met); and
- is cost effective.

2.2.1 Applicable or Relevant and Appropriate Requirements and State Standards, Criteria, and Guidelines

ARARs and SCGs are federal and state public health and environmental requirements used to: (1) evaluate the appropriate extent of cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the selected action.

To properly consider ARARs and SCGs and to clarify the function of these requirements in the RI/FS and remedial response processes, the NCP (40 Code of Federal Regulations [CFR] Part 300) defines two ARAR components: (1) applicable requirements; and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable requirements are those federal and state requirements that would be legally applicable, either directly or as incorporated by a federally authorized state program. Requirements that specifically address and have jurisdiction over a given situation are considered "applicable requirements." An example of an applicable requirement is the use of MCLs for a site where groundwater contamination enters a public water supply. For this site, MCLs are not applicable because the area is served by a public water supply that is drawn from a surface water body and is not affected by local groundwater.

Relevant and appropriate requirements are those federal and state requirements that, while not legally "applicable," can be applied to a site if it is determined that site circumstances are sufficiently similar to those situations that are covered. The NCP states that relevant and appropriate requirements have the same weight and consideration as applicable requirements.

The term "relevant" was included so that a requirement initially screened as nonapplicable because of jurisdictional restrictions would be reconsidered and, if appropriate, be included as an ARAR. For example, MCLs would be relevant and appropriate requirements at a site where groundwater contamination could affect a potential, rather than actual, drinking water source.

Other requirements to be considered (TBCs) are federal and state nonpromulgated advisories or guidelines that are not legally binding and do not have the status of potential ARARs and SCGs. However, if there are no specific ARARs and SCGs for a chemical or site condition, or if existing ARARs and SCGs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to ensure protection of public health and the environment.

Under the description of ARARs in the NCP, state and federal environmental requirements must be considered. These requirements include ARARs that are:

- chemical-specific (i.e., govern the level or extent of site remediation);
- location-specific (i.e., pertain to existing site features); and
- potential action-specific (i.e., pertain to proposed site remedies and govern implementation of the selected site remedy).

2.2.1.1 Chemical-Specific ARARs and SCGs. Chemical-specific ARARs and SCGs are usually health-based or risk-based standards, limiting the concentration of a chemical found in or discharged to the environment. Chemical-specific ARARs and SCGs govern the extent of site remediation by providing either actual clean-up levels, or the basis for calculating such levels. For example, groundwater standards may provide necessary cleanup goals for sites with contaminated groundwater. Chemical-specific ARARs and SCGs for this site may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirements, and to assess the effectiveness of future remedial alternatives. Chemical-specific ARARs and SCGs which may apply to the site are presented in Table 2-1.

Groundwater in the vicinity of the site is not used as a drinking water source due to naturally-occurring constituents; and residents are served by public drinking water. Therefore, drinking water standards, promulgated under the Safe Drinking Water Act (SDWA) (40 CFR 141.11-141.16) and New York State Department of Health (NYSDOH) Public Water Supplies Drinking Water Standards (10 New York Code of Rules and Regulations [NYCRR] Subpart 5-1) are not directly applicable. These standards were, however, used during the RI/FS to compare to the concentration of chemicals detected in the groundwater (Table 2-2). New York State Water Quality Regulations for Groundwater (6 NYCRR Parts 701 - 705) are applicable. Groundwater in the Rochester area is classified as Class GA.

NYSDEC has developed guidance procedures for determining soil cleanup objectives (SCOs) that will, at a minimum, eliminate all significant threats to human health and the environment posed by an inactive hazardous waste site

(NYSDEC TAGM HWR-94-4046). This TAGM includes SCOs for several constituents as well as the method for developing SCOs for additional constituents. This guidance is utilized in subsequent sections to evaluate the concentrations of constituents detected in soils.

2.2.1.2 Location-Specific ARARs and SCGs. Location-specific ARARs and SCGs pertain to natural site features (e.g., wetlands, floodplains, and sensitive ecosystems) and man-made features (e.g., existing landfills, disposal areas, and places of historical or archeological significance). These ARARs and SCGs generally restrict the concentration of hazardous substances, or the conduct of activities based on a site's particular characteristics or location. No site features were identified that are regulated or protected by location-specific ARARs and SCGs.

2.2.1.3 Action-Specific ARARs and SCGs. Action-specific ARARs, unlike location-specific and chemical-specific ARARs, are usually technology-based or activity-based limitations that direct how remedial actions are conducted. Action-specific ARARs provide a basis for assessing the feasibility and effectiveness of each of the remedial alternatives retained for detailed evaluation. Action-specific ARARs are discussed in Section 4 as part of the detailed analysis.

2.2.2 Remedial Goals

In this section, proposed remedial goals are presented for target constituents detected in groundwater and soils. Remedial goals were established to define endpoints of remediation activities. Once remedial goals are met, remediation efforts would be considered complete. In the short-term, not all technologies and subsequently developed alternatives are able to attain remedial goals. Some alternatives will manage existing contamination by containing it within a specific area, while remedial goals will be met over an extended period of time.

2.2.2.1 On-site Groundwater. Remedial goals for on-site groundwater were established based on regulatory criteria and chemical-specific ARARs. These regulatory criteria and chemical-specific ARARs are presented on Table 2-2.

Attainment of regulatory criteria and chemical-specific ARARs are the remedial goals of the on-site groundwater remediation strategy. Short-term goals for groundwater remediation are to mitigate migration of contaminated on-site groundwater beyond the plant boundary. Short-term goals may be attained by establishing hydraulic containment of on-site groundwater to prevent off-site migration of contaminated groundwater.

2.2.2.2 On-site Soil. Remedial goals for on-site soil were established based on regulatory criteria and risk assessment evaluations. Soil analytical results are compared to existing NYSDEC SCOs in the following paragraphs and on Figures 2-1 through 2-5. This comparison is integrated with the results of the baseline risk assessment to develop remedial goals for soil at the site.

Pyridines and Chloropyridines. Due to the unique nature of some constituents present at the site (i.e., chloropyridines), predetermined regulatory target clean-up levels are not available. Therefore, soil clean-up objectives were developed using NYSDEC guidance (NYSDEC TAGM, HWR-94-4046) for the four chloropyridine compounds identified as target constituents. The compounds and SCOs developed are as follows:

Compound	SCO (mg/kg)
2-Chloropyridine	12
3-Chloropyridine	12
4-Chloropyridine	12
2,6-Dichloropyridine	19

The process used in developing these SCOs is presented in Appendix E.

Comparison of Contaminant Levels To SCOs. The NYSDEC TAGM (HWR-94-4046) presents generic cleanup objectives for several compounds at inactive hazardous wastes sites. These objectives, at a minimum, eliminate significant threats to human health and/or the environment posed by the sites. Although the plant is an active and operating facility, the site is listed as an inactive hazardous waste disposal site in New York State. Because of this, a comparison to the established SCOs for inactive hazardous waste sites was conducted to evaluate potential source areas. Constituents that were detected in soil samples from the site, and that had established SCOs, were compared directly to the SCOs. Also, as stated in Section 2.2.2.2, SCOs were calculated for four chloropyridine compounds identified as target constituents at the site. Several other constituents (carbazole, hexachlorobutadiene, and pyridine) detected in soil samples did not have SCOs established in the NYSDEC TAGM. These constituents were not compared to regulatory standards or guidance; however, they were included in the risk evaluation.

Subsurface soil constituents exceeding SCOs at the sample points are shown for each of the potential contaminant source areas on Figures 2-1 through 2-5. Surface soil samples were collected from 15 locations and are shown on Figure 2-6. Constituents exceeding SCOs at these locations are shown on Table 2-3. No surface soil sample VOC constituents exceeded SCOs.

The results of this comparison indicate isolated exceedances of SCOs at five of the six potential source areas. The Well B-17 area exhibited more numerous exceedances of several SCOs, including SCOs developed for chloropyridines.

Polycyclic Aromatic Hydrocarbons. PAHs were detected in several samples of surface soils. Because of the common detection of this class of compounds in urban soils, and because past and current operations at the plant did not include processes which generated these compounds, a review of urban background concentrations was conducted.

The most comprehensive work on this subject in the literature featured the collection of 60 surface soil samples from three cities in New England (Bradley, Magee, and Allen, 1994). All 60 samples were collected from areas not likely to be directly affected by industrial sites (along roadways, in parks and open lots). Data from the site are compared to the data presented in the cited paper (see Table 2-4).

As Table 2-4 shows, of the seventeen surface soils from the site (fifteen locations plus two duplicates), fifteen showed PAH concentrations within the background range developed in the cited paper. The highest concentrations of PAHs were detected at sample location SS-110 near the railroad siding to the south of the Production Area. Soils near railroad tracks often show elevated concentrations of PAHs as a result of creosote on railroad ties, diesel fuel, etc. The variability of soils in a small area is also shown by the fact that one duplicate sample at SS-111 was within the background range while the other was slightly higher. This pattern of PAH concentrations at the site appears to represent background conditions and, therefore, no remedies for PAHs in soils are proposed or evaluated.

2.2.2.3 Off-site Groundwater. Remedial goals for off-site groundwater were established based on regulatory criteria and chemical-specific ARARs. These regulatory criteria and ARARs are also presented in Table 2-2.

2.2.3 Remedial Action Objectives

Remedial Action Objectives (RAOs) are the specific goals that must be achieved by the remedial actions ultimately selected in this Feasibility Study. The RAOs are risk-based in that they are selected to address specific potential exposure pathways for each of the identified media of concern, as identified in the risk assessment.

2.2.3.1 RAOs for Soil. The only soils that have been identified as potentially requiring remediation are subsurface soils located within the facility boundary, primarily near monitoring well B-17 (see Figure 2-7). The potential exposure pathways of concern include direct contact by plant workers or construction workers, volatilization into facility buildings or excavations, and leaching to groundwater. Because the groundwater pathway will be effectively controlled by satisfying the RAOs for on-site groundwater, the RAOs for impacted soil include limiting dermal contact with, and incidental ingestion of soil by plant personnel and construction workers, and limiting inhalation of volatile organics and particulates from soil by plant personnel and construction workers.

The risk of exposure to impacted soils is further limited by continued enforcement of the plant's excavation policy and other mandatory facility health and safety requirements. Facility personnel are already well versed in the safe procedures for handling chemicals since they regularly deal with these same chemicals in the workplace in their concentrated forms.

2.2.3.2 RAOs for Groundwater. Arch currently operates a groundwater extraction system at the plant site that is intended to create a hydraulic control boundary, effectively preventing further migration of site-related compounds beyond the facility property boundary. RAOs for groundwater are, therefore, established separately for on-site and off-site groundwater.

On-Site Groundwater. For on-site groundwater, there is no current or reasonably foreseeable future use of groundwater for potable or other uses. The major potential exposure pathways involve direct contact or inhalation resulting from construction activities below the groundwater table. For protection of human health, the RAOs for on-site groundwater include limiting dermal contact with, incidental ingestion of, and inhalation of volatile organics from on-site groundwater by construction workers. Additionally, to satisfy regulatory program objectives, RAOs include prevention of further off-site migration of impacted groundwater, and restoration of on-site groundwater to regulatory standards or risk-based criteria.

Off-Site Groundwater. A primary concern for off-site groundwater would be due to its potential use as a potable water supply. However, the natural iron and sulfur content of groundwater in the vicinity of the site already make the water unfit to drink. Also, New York State requires that new housing subdivisions must be served by public water. The Director of Public Works for the Town of Gates reported that there are no known private water supply wells within the town. Therefore, use of groundwater for potable purposes is not considered a reasonable exposure pathway at this site.

Operation of the on-site groundwater extraction system is intended to prevent additional migration of site-related compounds beyond the facility boundary. In addition, the data collected during the RI indicate that the discharge of bedrock groundwater into the southeast corner of the quarry has substantially influenced regional groundwater flow, and that this discharge captures the off-site plume of contaminated groundwater. Combined, these two factors will result in an overall reduction in the concentration of site-related compounds in off-site groundwater, with the ultimate result being that concentrations are reduced to below regulatory standards or risk-based criteria. On this basis, the RAOs for off-site groundwater include: maintaining hydraulic containment at the plant boundary to prevent migration of additional site-related compounds; maintaining the capture of groundwater at the quarry seep to contain the plume of contaminated off-site groundwater; limiting access to groundwater between the plant and the quarry; and ultimately, restoring groundwater to regulatory standards or risk-based criteria.

2.2.3.3 RAOs for Surface Water. The risk assessment did not identify any unacceptable risk scenarios for exposure to impacted surface water. Contaminant loadings to surface water that are below levels of concern result from the quarry discharge. Because risks are currently at acceptable levels, no RAOs are listed for surface water.

2.3 General Response Actions

General response actions describe categories of remedial actions that may be employed to satisfy remedial action objectives and provide the basis for identifying specific remedial technologies. These actions will vary with the medium and the type, extent, and location of the chemical constituents. The broad categories of the general response actions are as follows:

- no action
- limited action
- containment/collection
- removal
- treatment
- recycling
- disposal

2.3.1 General Response Actions - On-Site Groundwater

General response actions for on-site groundwater remediation at the site were developed with the intent of utilizing the existing groundwater extraction, treatment, and discharge system as a major component of the overall site remedy. Arch expects that the groundwater containment system will be operated for an extended period of time.

The primary limitation to pumping options is the suspected presence of DNAPL in the fractured bedrock. There is consensus in the groundwater literature that any attempts to recover DNAPL from fractured bedrock are not likely to be successful (Pankow and Cherry, 1996; Parker et al., 1994). DNAPL is difficult to remove from fractured bedrock because of different wetting phases, pore and fracture sizes, and diffusion into the rock matrix. Attempts at enhancing contaminant mobility through the use of flushing agents (solvents, surfactants) have very limited effectiveness in that they primarily act in the larger connected fractures, whereas much of the contaminant mass may be found in small and dead-end fractures, or even diffused into the bedrock matrix. Thermal enhancement, involving in-situ heating by electrical means or through steam injection, are subject to the same limitations as well as being difficult to implement beneath the water table. For these reasons, direct removal of suspected DNAPL would not be feasible at this site.

Substantial mass removal is currently being accomplished at the site through groundwater pumping. Even prior to the recent addition of two source-area pumping wells, the extraction system was recovering site-related contaminants at a calculated rate of approximately 4,000 lb/yr. With the new configuration of extraction wells, mass removal should increase significantly.

Technologies for destroying the contaminants in situ also appear technically infeasible at this site. Destruction technologies result in the decomposition or conversion of site-related contaminants into low-toxicity compounds, and generally fall into one of three categories: thermal, chemical, or biological.

In-situ thermal destruction would require that the subsurface environment be raised to sufficiently high temperatures to decompose the contaminants of concern. The energy to accomplish this is generally introduced into the subsurface via electrodes, or through the use of radio-frequency or microwave energy. Thermal destruction technologies are not practical at this site since the majority of any DNAPL present is expected to be found well below the groundwater table in bedrock, making the thermal approaches technically infeasible.

In-situ chemical destruction technologies are currently receiving increased attention in the field of site remediation, due to their potential effectiveness and relatively low cost when site conditions are favorable. There are two general factors that determine whether these approaches will be effective at a site: (1) whether the site-related contaminants can be chemically converted to non-toxic compounds under ambient subsurface conditions, and (2) whether the necessary chemical reagents can be contacted with the contaminants in-situ.

Regarding the effectiveness of the chemistry in-situ, Arch contracted with a leading vendor of in-situ chemical oxidation technology to conduct treatability tests using samples from the site. These tests showed that the technology, which is based on the use of Fenton's chemistry (using hydrogen peroxide and a ferrous iron catalyst) was relatively ineffective. The principal reasons for the failure of the approach were the resistance to oxidation exhibited by chloropyridines (confirming the conclusions of the expert in chloropyridine chemistry Arch had consulted previously (Boudakian, 1998)), and the high buffering capacity of the natural groundwater in the vicinity of the site, which made it difficult to attain the low pH conditions necessary for the Fenton's reaction to be effective. Additionally, the vendor reported that the technology is known to be ineffective on several of the VOCs present in groundwater at the site, including carbon tetrachloride, chloroform, and methylene chloride.

Other potential oxidants are generally less aggressive than Fenton's chemistry; however, the in-situ oxidation vendor also performed initial jar tests using potassium permanganate, another commonly used oxidant for in-situ treatment applications. The results of those tests indicate that potassium permanganate is also ineffective on the contaminants at the site. The vendor's reports are included in Appendix F.

In regard to implementability, i.e., contacting the site-related contaminants with applied reagents, the potential presence of DNAPL in the fractured bedrock zone again presents a significant obstacle. The Fenton's chemistry vendor reports that the technology is applicable primarily in unconsolidated deposits, and not bedrock. The application of the method is premised upon delivering the products to the contaminant. In many areas of the site, surface access is not possible for well installation. Angled and horizontal drilling technologies may be able to overcome some logistical impediments in overburden; however, the chemicals would still be needed in the non-homogeneous medium of fractured bedrock, with little likelihood of uniform distribution in the subsurface.

Based on the limited effectiveness of the technology as demonstrated in the treatability study, and on the implementability concerns described above, in-situ chemical oxidation has been eliminated from further consideration as a remedial technology at this site.

In-situ biological destruction technologies make use of microbial populations to metabolize or co-metabolize the undesired organic constituents present in the subsurface. The process can occur under existing conditions from native microbial populations, in which case it is termed intrinsic bioremediation. Alternatively, microbes and/or nutrients can be introduced into the subsurface to initiate, sustain, or enhance biodegradation. For this approach to be effective, conditions must be favorable (electron donors, electron acceptors, redox) for the particular microbes, and the organic constituents must be amenable to biological degradation processes.

Of the contaminants detected at the site, chlorinated VOCs are known to biodegrade under anaerobic conditions. Based on site groundwater data collected in March 1997, there is evidence to suggest on-going (intrinsic) biological degradation of chlorinated VOCs in the on-site wells. In off-site locations, conditions in the deeper bedrock wells appear favorable for anaerobic degradation of chlorinated VOCs, whereas shallow bedrock and overburden wells show limited potential for anaerobic degradation. The low concentrations of chlorinated VOCs in the quarry seep is another piece of evidence suggesting ongoing attenuation of the off-site VOC plume.

Few data are available on the degradability of chloropyridines; however, the presence of significant quantities of chloropyridines at the quarry suggests that these compounds are not readily degrading under local conditions. Treatability tests could determine whether biological degradation has any potential to be effective on chloropyridines; however, effective and implementable delivery of microbes and/or nutrients would remain as an issue. Modification of the subsurface environment (i.e., in fractured bedrock) to enhance biodegradation would face the same physical limitations as in-situ chemical oxidation. The subsurface is extremely heterogeneous, and the distribution of contaminants likely also is heterogeneous. Delivery of materials to the subsurface would occur neither uniformly nor necessarily proportional to the presence of contamination.

Overall, biological degradation by itself does not appear to be a candidate technology for remediation of this site. Although some of the site-related contaminants (i.e., chlorinated VOCs) appear to be undergoing sufficient biodegradation to limit the extent of their off-site migration, there is no evidence that biological treatment can be used to significantly reduce chloropyridine concentrations in the subsurface at the site. Intrinsic bioremediation will, therefore, be considered as a remedial technology only in conjunction with other technologies as part of a comprehensive sitewide remediation alternative.

Immobilization technologies are intended to reduce or eliminate groundwater impacts by reducing the solubility of the site-related contaminants, or by isolating them from the groundwater environment. Solubility reduction can be accomplished through chemical reactions with the contaminants that change their form (convert them to a solid) or reduce their solubility. Isolation technologies include modifying the matrix in which the contaminants are found (for example, soil stabilization), or by diverting groundwater flow around the area of contamination.

Because of their chemical stability, chloropyridines cannot easily be polymerized or converted into a less soluble form (Boudakian, 1998). Also, because these chemicals are present in the fractured bedrock, soil stabilization approaches are not applicable. Therefore, immobilization technologies potentially appropriate for the site are limited to isolation techniques.

Isolation approaches generally consist of groundwater cutoff barriers, (slurry walls, grout curtains), diversion trenches, and impermeable surface barriers. Groundwater barriers are generally limited to overburden applications, and would not be applicable to the fractured bedrock aquifer at this site. Diversion trenches are also most commonly used in overburden aquifers. Blasted bedrock trenches are not considered feasible for this site due to the extensive active facility operations throughout the area and the distance into the rock that the trench would have to be advanced (nearly sixty feet below the top of rock) to intercept the significant deep fracture in the bedrock. Installation of a surface barrier will be evaluated as an element of a site remediation alternative for on-site soils. The site is currently nearly completely covered by pavement, buildings and other structures, which results in minimal surface infiltration. Therefore, evaluation of a surface barrier would be applicable only to the few minor areas of the site that remain uncovered.

Because of site conditions and process limitations, extraction and treatment is the only applicable groundwater technology available for this site.

The current extraction system includes shallow bedrock extraction wells that were installed to extract groundwater and prevent further migration of constituents off of the plant. Groundwater monitoring results indicate that the extraction system has effectively cut off migration of contaminants in shallow bedrock in the southerly and southwesterly direction, as evidenced by substantial decreases in chloropyridine concentrations in monitoring wells BR104 and BR105. However, monitoring well BR106, located beyond the Arch property boundary to the west of the main plant building, has not shown a significant downward trend. This observation, coupled with groundwater modeling results that suggested a weakness in capture in this area, has led Arch to enhance the extraction system by installing an additional perimeter bedrock well along the western plant boundary. Modeling of the new configuration of extraction wells indicates that adequate hydraulic containment of shallow bedrock groundwater has now been established.

The original overburden extraction wells have not performed adequately. This appears to be due primarily to low hydraulic conductivities and relatively small saturated thicknesses in the overburden, although poor well efficiencies may also result from the use of wells designed as monitoring wells, not as pumping wells. In addition, iron and/or bacterial fouling may contribute to the poor performance, although extensive efforts at well rehabilitation in 1995 failed to increase well yields.

Although the performance of the overburden extraction wells has been poor, modeling suggests that the shallow bedrock extraction wells will influence overburden groundwater and result in overall capture in both the overburden and the shallow bedrock. Recent piezometric plots from both zones generally support this interpretation (see Figures 1-5 and 1-6). A significant downward vertical gradient is evident in the data, suggesting the flow path for overburden groundwater is generally downward into the shallow fractured bedrock zone.

The portion of the plant site where the potential for off-site migration of impacted overburden groundwater appears greatest is in the southeast corner of the plant, where the horizontal component of flow is generally to the south. Because there is no bedrock extraction well in that area, it is possible that overburden groundwater migrates beyond the property boundary before flowing downward into the shallow bedrock. However, groundwater monitoring data from well E-1 indicate a substantial reduction in contaminant concentration in this area since 1994, suggesting that off-site migration of site-related contaminants is being mitigated by remedial measures already implemented at the site. Additional groundwater samples were collected in November 1999 from fourteen overburden monitoring wells along the southern and southeastern boundary of the plant. Review of the data from these samples indicates substantial overall reductions in contaminant concentrations in this area when compared to 1994 results. Results are summarized in Table 2-5.

Arch has also recently added two mass removal pumping wells in the identified source areas to accelerate contaminant removal. Groundwater modeling results also indicate that these new mass removal wells further enhance the containment of on-site groundwater, providing a higher degree of confidence in the adequacy of the hydraulic containment system.

Extracted groundwater is combined with plant process water and passed through a treatment system to reduce constituents to discharge criteria prescribed in the plant's discharge permit. Arch regularly monitors extraction system flow rates, treatment system influent and effluent concentrations, and groundwater levels in the area of the extraction wells.

In conjunction with the groundwater extraction system, Arch will maintain and operate a treatment system to meet prescribed POTW discharge criteria. The treatment system currently in use at the plant is a granular activated carbon (GAC) system consisting of dual carbon bed units, each containing 20,000 pounds of activated carbon. The GAC system is operating and achieving the prescribed discharge criteria. Arch desires to maintain flexibility in the components of the treatment system utilized to attain discharge criteria to accommodate operational and process changes within the plant. Any modifications made to the treatment system to improve removal efficiency, or to accommodate operational and process changes, will attain prescribed discharge criteria. For the purpose of this feasibility study, the treatment system utilized to treat extracted groundwater will be referred to as the existing GAC system, or an equivalent system capable of meeting prescribed discharge criteria.

The general response actions and associated remedial technology type for on-site groundwater at the plant are as follows:

General Response Action	Technology Type
No Action	None
Limited Action	Institutional Controls
	Monitoring
	Access Restrictions
Removal	Source-area Extraction Wells
Hydraulic Containment/Collection	Perimeter Extraction Wells
	Overburden Interceptor Trench
Treatment	Groundwater Treatment System
	Intrinsic Bioremediation
Disposal	Discharge to Municipal Sewer

2.3.2 General Response Actions - On-site Soil

As discussed in Section 2.2.3.1, RAOs for on-site soils consist of limiting direct contact with impacted soil and inhalation of site-related contaminants by plant personnel and construction workers. Because of the limited accessibility of impacted soils at the site, response actions involving extensive excavation are technically impractical and will not be considered. Limited excavation of specific areas of high soil concentrations might be feasible, but no specific hot spots were identified in the RI. In general, response actions for on-site soil will be limited to controlling direct contact by site workers, although the possible use of in-situ treatment technologies will receive further evaluation. The associated technology types applicable to soil remediation at the site are as follows:

General Response Action	Technology Type
No Action	None
Limited Action	Institutional Controls Access Restrictions
Containment	Surface Barrier
Treatment (in-situ)	Vapor Extraction Natural Attenuation

2.3.3 General Response Actions - Off-site Groundwater

General response actions for off-site groundwater remediation are limited based on the findings that there are few current or likely future exposure pathways that result in unacceptable risk, and that the existing groundwater seep at the Dolomite Products Quarry is the terminus of the migrating plume. The general response actions and the associated technology types applicable to off-site groundwater include the following:

General Response Action	Technology Type
No Action	None
Limited Action	Institutional Controls
	Monitoring
	Access Restrictions
Hydraulic Containment/Collection	Extraction System
Treatment (ex-situ)	Physical/Chemical Treatment
Disposal	Discharge to Canal

2.4 Evaluation of Remedial Technology Types and Process Technologies

Once media-specific general response actions were developed, potential remedial process technologies were selected for screening and evaluation. Remedial process technologies refers to a specific process within a technology type. The purpose of screening and evaluation was to select the remedial process technologies that would be assembled into remedial alternatives. This section describes the following:

- Identification of remedial process technologies.
- Screening of remedial process technologies.
- Evaluation of remedial process technologies based on effectiveness, implementability, and cost.
- Selection of remedial process technologies for further evaluation.

2.4.1 Identification and Screening of Remedial Process Technologies

Remedial process technologies were identified and screened based on a review of literature sources, contacts with vendors to obtain specific information and performance data, and experience in developing similar feasibility studies under CERCLA. Only remedial process technologies capable of addressing the remedial response objectives were considered. Initial screening evaluated technology types and remedial process technologies based on technical implementability (USEPA, 1988).

2.4.1.1 On-Site Groundwater Remediation. Remedial process technologies identified for on-site groundwater remediation were limited due to the existing groundwater extraction and treatment system currently operating. Table 2-6 presents the identification and initial screening of remedial process technologies.

2.4.1.2 On-Site Soil Remediation. Table 2-7 presents the identification and initial screening of remedial process technologies for soil at the site. Technology types and remedial process technologies were screened using information available from the RI site characterization including contaminant types, contaminant concentrations, and site characteristics.

2.4.1.3 Off-Site Groundwater Remediation. Remedial process technologies identified for off-site groundwater remediation were limited because of the minimal exposure pathways and the effectiveness of the existing quarry seep in capturing the contaminated groundwater plume. Table 2-8 presents the identification and initial screening of remedial process technologies for off-site groundwater.

2.4.2 Evaluation of Remedial Process Technologies Based Upon Effectiveness, Implementability, and Cost

The technology evaluation process reduces the number of potentially applicable remedial process technologies by evaluating factors that may influence process option effectiveness and implementability. Additionally, the relative costs of the technologies are evaluated, although technologies are not eliminated at this stage on the basis of cost.

The evaluation process assesses each technology for its probable effectiveness and implementability with regard to site-specific conditions, site constituents, and affected environmental media. The effectiveness evaluation focuses on: (1) whether the technology is capable of handling the estimated areas or volumes of media and meeting the constituent reduction goals identified in the remedial action objectives; (2) the effectiveness of the technology in protecting human health during the construction and implementation phase; and (3) how proven and reliable the technology is with respect to the constituents and conditions at the site. Implementability encompasses both the technical and institutional feasibility of implementing a technology. The cost evaluation includes a qualitative (e.g., low, moderate, high) estimation of the relative capital, and operation and maintenance (O&M) costs associated with remedial process technologies.

2.4.2.1 On-Site Groundwater Remediation. Table 2-9 presents the remedial process technology evaluation for on-site groundwater. Technologies judged ineffective or not implementable were eliminated from further consideration in this evaluation. Table 2-10 summarizes the on-site groundwater remedial process technologies retained for further consideration.

2.4.2.2 On-Site Soil Remediation. Table 2-11 presents the remedial process technology evaluation for on-site soil. Technologies judged ineffective or not implementable were eliminated from further consideration in this evaluation. Table 2-12 summarizes the soil remedial process technologies retained for further consideration.

2.4.2.3 Off-Site Groundwater Remediation. Table 2-13 presents the remedial process technology evaluation for off-site groundwater. Technologies judged ineffective or not implementable were eliminated from further consideration in this evaluation. Table 2-14 summarizes the off-site groundwater remedial process technologies retained for further consideration.

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

Remedial process technologies retained following the technology screening and evaluation in Section 2, represent an inventory of options considered potentially suitable for the site. The process technologies retained for further analysis are technologies that manage the migration of, treat, or limit exposure to contaminated groundwater, and remediate the target soil area or mitigate exposure risks to these soils. In this section, remedial process technologies retained in Section 2.4.2.1 through 2.4.2.3 are combined to develop remedial alternatives that provide a range of options to address RAOs. Specific alternatives are developed to address each medium at the site.

Consistent with Section 300.430 (e)(3) of the NCP, remedial alternatives were developed for each medium. To the extent practical, the alternatives ranged from eliminating the need for long-term management by removing or destroying contaminants to the maximum extent feasible, to alternatives including little or no treatment that provide protection of human health and the environment by controlling exposure to contaminants. No-action alternatives were developed to provide a baseline comparison with other alternatives (USEPA, 1988).

After alternatives are formulated, an initial screening is performed to narrow the list of potential alternatives retained for detailed analysis, and to ensure that the most promising alternatives are being considered. Due to the presence of buildings and other structures above the target soil area, the existing groundwater extraction, treatment, and discharge system, and the existing groundwater seep at the quarry that is effectively capturing off-site groundwater, the number of remedial process technologies retained from the screening and evaluation process was limited; and thus, the number of potential remedial alternatives developed was limited. Because of this limitation, alternatives will not undergo an initial screening process. Instead, all alternatives will be retained for detailed analysis in Section 4.0.

3.1 ON-SITE GROUNDWATER REMEDIATION ALTERNATIVES

Four alternatives were developed from the retained remedial process technologies for the remediation of on-site groundwater. Alternatives developed for on-site groundwater are labeled with the prefix ONSITE-GW. The following subsections describe the alternatives developed.

3.1.1 Alternative ONSITE-GW1 - No Action

The No Action Alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls. The No Action alternative would require that operation of the existing groundwater extraction system be discontinued. The existing GAC system or a treatment system capable of meeting prescribed discharge criteria would be operated to treat process water only. The No Action Alternative does not include any remedial process technologies to monitor constituent concentrations, control migration of constituents, or prevent exposure to contaminated groundwater.

3.1.2 Alternative ONSITE-GW2 - Institutional Controls and Monitoring

Alternative ONSITE-GW2 utilizes institutional controls to prevent exposure to site-related contaminants, but would not include any active remedial technologies to treat or remove contaminants. Operation of the existing groundwater extraction system would be discontinued.

Institutional controls would include continued adherence to the plant's existing health and safety policies for site excavation activities, and implementation of deed restrictions to restrict future use of on-site groundwater. The plant's excavation policy outlines procedures for conducting invasive activities, including the use of personal protective equipment (PPE). Adherence to this policy mitigates potential exposure to contaminants, and inhalation of vapors from invasive activities in which groundwater may be encountered. The deed restrictions would be instituted only if the property was transferred, sold, or if operations at the plant were discontinued.

Natural attenuation processes (i.e., adsorption, dispersion, dilution, and degradation) would result in decreases in contaminant concentrations over time. Monitoring of groundwater quality, using existing monitoring wells, would be conducted to observe trends in contaminant concentrations and provide data to eventually support modification or discontinuance of institutional controls.

3.1.3 Alternative ONSITE-GW3 - Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW3 includes the following components:

- operation of the existing shallow bedrock extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;
- operation of a groundwater treatment system (existing GAC system or system capable of meeting prescribed discharge criteria);
- discharge of treated groundwater to the POTW;
- implementation of institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of on-site groundwater quality and extraction system performance.

This alternative focuses on preventing contaminated on-site groundwater from migrating beyond the plant property boundary in addition to controlling exposure to site-related contaminants. The main feature of the alternative is the operation of the existing perimeter and source-area bedrock extraction wells. Additionally, these wells would be supplemented by an interceptor trench in the southeast portion of the plant to ensure that overburden groundwater is prevented from migrating to the south.

The monitoring program for this alternative would include both groundwater level monitoring of on-site wells and groundwater sampling and analysis. The groundwater level monitoring would be used to evaluate the performance of the extraction system in maintaining hydraulic control at the plant property boundary. Results from groundwater sampling and analysis would be used to monitor trends in constituent concentrations.

This alternative reduces the mobility of contaminated groundwater by preventing off-site migration by establishing and maintaining hydraulic control at the plant property boundary, and removes constituents from groundwater through extraction and treatment.

3.1.4 Alternative ONSITE-GW4 – Dual-phase Extraction (Source Areas), Perimeter Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW4 includes:

- dual-phase extraction at source-area wells to provide contaminant mass reduction;
- operation of the existing perimeter groundwater extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;
- on-site treatment of extracted groundwater;
- discharge of treated groundwater to the POTW;
- institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of the on-site groundwater quality and extraction system performance.

ONSITE-GW4 includes all components of Alternative ONSITE-GW3, but adds dual-phase extraction at the source-area pumping wells (PW10 and PW12) to provide for increased contaminant mass removal. Performance of this alternative would be similar to Alternative ONSITE-GW3, except that the duration of the groundwater extraction operation may be reduced.

3.2 ON-SITE SOIL REMEDIATION ALTERNATIVES

Off-site soil was not identified as a medium of concern; therefore, alternatives were developed for on-site soil only. Three alternatives were developed from the retained remedial process technologies for the remediation of the target soil area (see Figure 2-7). Alternatives developed for on-site soil are labeled with the prefix S for soil remediation options.

3.2.1 Alternative S1 - No Action

The No Action alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls. The No Action alternative does not include any remedial process technologies to monitor constituent concentrations, control migration of constituents, or prevent exposure to affected soil.

3.2.2 Alternative S2 – Institutional Controls

Alternative S2 includes the following components:

- deed restrictions;
- adherence to Arch's excavation policy; and
- access restrictions through fencing and signs.

This alternative focuses on reducing potential exposure to target soil areas as its main component.

Continued leaching of contaminants from soil to the groundwater is expected to gradually reduce constituent concentrations in the target soil area until, ultimately, SCOs are attained. During this period, site access would be restricted by fencing, and warning signs would be posted indicating that exposure to subsurface soil poses a potential health risk. Implementation of deed restrictions would be included as part of this alternative to further reduce the potential for exposure to site soils. These restrictions would include; registering deed restrictions on the plant property prohibiting land use for residences or other uses that may cause exposure to affected soil, and restricting invasive activities (e.g., construction/excavation). Restrictions would be instituted only if the property was transferred, sold, or if operations at the plant were discontinued.

To mitigate current potential exposure to target area soils, Arch regulates invasive activities (e.g., excavation) through an excavation policy instituted at the plant. Alternative S2 includes adherence to this policy as a means of reducing potential exposure to target area soil. A copy of the excavation policy is included in Appendix D.

This alternative would reduce the volume of affected soil as contaminants leach to groundwater, but would not reduce the mobility of constituents in the unsaturated or saturated zones. Institutional controls would mitigate the potential for exposure of humans to constituents in the soil.

3.2.3 Alternative S3 - Surface Barrier with Institutional Controls

Alternative S3 includes the following components:

- installation of a surface barrier;
- deed restrictions;
- adherence to Arch's excavation policy; and
- access restrictions through fencing and signs.

This alternative focuses on reducing the impact of vadose zone target area soils on site groundwater, and reducing potential exposure to target soil areas as its main components.

Alternative S3 utilizes a surface barrier (e.g., asphalt or concrete paving) in the target soil area to reduce the mobility of contaminants in unsaturated site soils, and relies on natural flushing of groundwater through saturated soils to reduce the concentration of constituents in the saturated zone (see Figure 2-7). Deed restrictions, enforcement of Arch's excavation policy, and fencing/signs as described in Alternative S2 would be utilized to mitigate potential exposure of humans to soil constituents.

Surface barriers, such as asphalt or concrete paving, are typically used to minimize infiltration of precipitation and the corresponding leaching of constituents through affected vadose zone soils to groundwater. Installation of surface barriers at target soil areas would allow control of run-on and run-off, and would be installed to accommodate plant operations. The surface barrier would help to prevent future releases of constituents to site soils and groundwater while allowing for continued use of the area for facility operations. Currently, much of the target soil area is either covered by existing structures or asphalt paving. This alternative would require areas within the target soil area that are not currently covered, to be paved using either asphalt or concrete to minimize infiltration (see Figure 2-7).

This alternative would reduce the mobility of constituents in the unsaturated zone, and reduce the potential for exposure of humans to constituents in the soil. However, the mobility of constituents in the saturated zone would not be reduced.

3.3 Off-Site Groundwater Remediation Alternatives

Two alternatives were developed from the retained remedial process technologies for the remediation of off-site groundwater. Alternatives developed for off-site groundwater are labeled with the prefix OFFSITE-GW. The following subsections describe the alternatives.

3.3.1 Alternative OFFSITE-GW1 - No Action

The No Action Alternative was developed as a baseline for comparison with other remedial action alternatives. This alternative does not implement any remedial process technologies or controls. The No Action alternative would not include any modifications to the current discharge of groundwater from the quarry seep, nor would it include any remedial process technologies to monitor constituent concentrations, control migration of constituents, or prevent exposure to groundwater.

3.3.2 Alternative OFFSITE-GW2 – Groundwater Extraction at the Quarry Boundary, Treatment if Necessary to Meet Discharge Criteria, Groundwater Use Limitations, and Monitoring

Alternative OFFSITE-GW2 includes the following components:

- extract contaminated groundwater at the quarry boundary;
- treat extracted groundwater if necessary to meet requirements for discharge;
- work with local municipalities to limit future use of groundwater by residential or industrial property owners in the impacted area between the plant and the quarry; and
- monitor off-site groundwater quality to verify progress towards attaining groundwater quality standards.

This alternative assumes that hydraulic control at the plant property boundary as described for the on-site groundwater alternatives is maintained to prevent additional contributions of site-related compounds to off-site groundwater.

The quarry seep has been effectively capturing the off-site plume, preventing further migration and resulting in overall reductions in contaminant mass. Groundwater would be collected just upgradient of the seep using one or more extraction wells to intercept the flow. Extracted groundwater would be treated if necessary to attain discharge criteria, and then discharged either to a nearby public sewer line or directly to the canal.

The monitoring program for this alternative would include routine sampling and analysis of selected off-site wells, similar to the existing groundwater sampling and analysis program conducted by Arch. Results from groundwater sampling and analysis would be used to monitor trends in constituent concentrations.

There are no unacceptable risks from off-site groundwater under current exposure scenarios. The use of institutional controls would assure that potentially unacceptable exposure scenarios would not occur in the future for as long as concentrations of site-related compounds remain above groundwater standards.

This alternative reduces the volume of site-related compounds by capturing impacted groundwater at the quarry boundary.

3.4 Summary of Remedial Alternatives For Detailed Analysis

Remedial alternatives to be evaluated in detail in Section 4.0 are summarized on Figures 3-1, 3-2, and 3-3.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

The purpose of the detailed analysis is to evaluate the remedial alternatives and provide a basis for selection of the final site remedial action. The detailed analysis builds on the evaluations conducted during alternative development. The results of the detailed analysis support the final selection of a site remedial action and provide the foundation for the Record of Decision (ROD).

4.1 INTRODUCTION

The detailed analysis of alternatives was performed using the following nine evaluation criteria as prescribed in the CERCLA RI/FS guidance document (USEPA, 1988):

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reduction of toxicity, mobility, and volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

The final two criteria, state acceptance and community acceptance, are typically considered during the public review period of the Proposed Plan. The remaining seven criteria are described in the following paragraphs.

Overall Protection of Human Health and the Environment. This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The environmental risk assessment indicated that ecological receptors in the study area are unlikely to be adversely impacted from site related constituents; therefore, this evaluation criterion will focus on evaluation of human health risks.

Compliance with ARARs. This evaluation criterion is used to determine whether alternatives meet the established regulatory standards, criteria, and guidelines. Chemical-specific ARARs identified in Section 2.2.1.1 were reviewed with respect to each alternative to evaluate compliance. No location-specific ARARs were identified as applicable, or relevant and appropriate to the site in Section 2.2.1.2, therefore no discussion of location-specific ARARs is presented in the detailed analysis. The detailed analysis identifies and evaluates action-specific ARARs and discusses compliance for each remedial alternative.

Long-Term Effectiveness and Permanence. This criterion focuses on the evaluation of residual risks after completion of the remedial action, and the ability of engineering controls, institutional controls, and monitoring activities to manage constituents remaining at the site.

Reduction of Mobility, Toxicity, and Volume. This evaluation criterion addresses the statutory preference for selecting remedial actions that result in a permanent and significant reduction in toxicity, mobility, or volume of hazardous substances. Specific factors considered include: the amount of hazardous materials destroyed or treated; the expected reduction in toxicity, mobility, or volume; the degree to which the treatment is irreversible; and the type and quantity of treatment residuals remaining on-site.

Short-Term Effectiveness. This evaluation criterion addresses the effects of the alternative during the construction and implementation phase of the remedial action. Protection of workers and the community, environmental impacts, and length of time required to achieve response objectives are considered.

Implementability. This evaluation criterion addresses the technical and administrative feasibility of the remedial alternative. Specific elements considered in the evaluation include: the ability to construct, operate and maintain the implemented technology; reliability of the technology; ability to monitor effectiveness; ease of undertaking additional remedial actions once the remedial alternative is implemented; ability to obtain approval from other agencies (i.e., permitting); and availability of services and materials.

Cost. A cost estimate is provided for each alternative. Cost estimates developed during the FS typically are expected to provide an accuracy of +50 percent to -30 percent (USEPA, 1988). The estimates include capital, indirect, and O&M costs associated with each alternative to estimate a present net worth. Consistent with USEPA guidance, a discount rate of 7-percent was assumed (USEPA, 1988). Capital costs include costs associated with equipment, labor, and materials. Indirect costs include those costs associated with engineering services, permitting and legal services, and construction services. Annual O&M costs include operation labor, maintenance materials and labor, and operation costs (e.g. power, treatment chemicals) for continued O&M. A contingency is included in each estimate to account for uncertainties and unforeseen conditions during implementation.

Estimates are based on several sources of information including contractor and vendor estimates, conventional cost estimating guides, and previous experience. The estimates have been prepared for use in evaluation of alternatives from information available at the time of the estimate. Actual costs would depend upon labor and material costs, site conditions during implementation, schedule, market conditions, project scope, and other variable factors.

4.2 INDIVIDUAL ANALYSIS OF ON-SITE GROUNDWATER REMEDIATION ALTERNATIVES

The following subsections evaluate the four remedial alternatives developed for remediation of on-site groundwater at the plant. The evaluation utilizes the seven criteria presented in Section 4.1.

4.2.1 Alternative ONSITE-GW1 - No Action

Alternative ONSITE-GW1 is the no-action alternative for on-site groundwater. This alternative does not implement any remedial activities to address contaminated on-site groundwater. This alternative was developed as a baseline for comparison with other remedial action alternatives, to comply with the NCP protocol for evaluation. Under this alternative, use of the existing groundwater extraction, treatment, and discharge system would be discontinued, and plant policies and procedures regulating invasive activities would not be implemented.

4.2.1.1 Overall Protection of Human Health and the Environment. The risk assessment identified construction workers involved in excavation activities as potential human receptors through contact with, and inhalation of, vapors from on-site groundwater. This alternative would not provide any protection to these potential receptors. No adverse impacts to ecological receptors were identified in the risk assessment.

4.2.1.2 Compliance With ARARs. Because groundwater at the plant is not utilized for a drinking water source, MCLs are not applicable, but are relevant and appropriate. On-site groundwater currently exceeds MCLs for several constituents (see Table 1-3). The no-action alternative does not actively reduce constituent concentrations to below MCLs.

4.2.1.3 Long-Term Effectiveness and Permanence. The no-action alternative would not meet remedial response objectives and would not reduce risks associated with on-site groundwater. The no-action alternative would not provide long-term effectiveness.

Impact on Site-Wide Remediation. The no-action alternative would have an adverse effect on potential remedial measures for off-site groundwater, in that off-site migration of site-related contaminants would resume.

4.2.1.4 Reduction of Toxicity, Mobility, and Volume. Because no containment, extraction, or treatment processes would be employed under this alternative for contaminated on-site groundwater, no reduction of toxicity, mobility, or volume would be achieved.

4.2.1.5 Short-Term Effectiveness. This alternative does not include any remedial actions and could be implemented immediately. Because there are no remedial actions, short-term risks to workers, the community, and the environment would not result from implementation.

4.2.1.6 Implementability. With no active remedial actions, implementability is not an issue.

4.2.1.7 Cost. Since there are no remedial actions included as part of this alternative, no costs would be incurred.

4.2.2 Alternative ONSITE-GW2 - Institutional Controls and Monitoring

Alternative ONSITE-GW2 includes the following components:

- continued adherence to the plant's health and safety policies for site excavation activities;
- deed restrictions; and
- groundwater monitoring.

The plant currently has a set of health and safety policies that would apply to any excavation or other invasive activities occurring within the facility. These policies describe procedures to be followed and PPE to be used during excavation activities to protect worker health and safety.

Deed restrictions would be used in the event that the plant was transferred or sold, or if operations at the Plant were discontinued. These restrictions would limit the future use of the property to activities and uses that would not result in unacceptable groundwater exposure risks. The form and content of these restrictions would be developed by Arch in consultation with state and federal regulators, and would require approvals from the City of Rochester, Monroe County, and NYSDEC.

Groundwater monitoring would continue under the existing monitoring program at the facility. Concentrations of site-related contaminants would be expected to diminish over time due to natural attenuation processes (adsorption, dispersion, dilution, and degradation). Groundwater monitoring data would be used to track the reduction of contaminants, and would ultimately be used to support modification or discontinuance of institutional controls. Monitoring reports would be provided to NYSDEC on a regular schedule, to be agreed upon by Arch and NYSDEC.

4.2.2.1 Overall Protection of Human Health and the Environment. The risk assessment identified construction workers as potential receptors through contact with, and inhalation of vapors from on-site groundwater. Protection would be provided to these potential receptors inside of the plant through enforcement of Arch's health and safety procedures and the facility excavation policy. The excavation policy is included in Appendix D. Enforcement of these policies would mitigate potential exposure risks while the plant remains an active facility. In the event that the Plant is transferred or sold, or becomes inactive, restrictions on future activities of the site, accomplished through deed restrictions (or other enforceable mechanism acceptable to state and local regulators), would prevent unacceptable exposures to groundwater contaminants.

4.2.2.2 Compliance With ARARs. Because groundwater at the plant is not utilized for a drinking water source, MCLs are not applicable, but are relevant and appropriate. Groundwater would continue to exceed MCLs until natural attenuation processes reduce concentrations to below regulatory thresholds.

Groundwater quality would be monitored under the ongoing groundwater monitoring program established for the site.

4.2.2.3 Long-Term Effectiveness and Permanence. Residual risks would remain within the plant boundary from exposure to and inhalation of vapors from contaminated groundwater. These on-site risks would be mitigated through continued adherence to the plant's health and safety policies. Future impacts to off-site groundwater would continue until concentrations of site-related contaminants drop below regulatory thresholds due to natural attenuation.

Impact On Site-Wide Remediation Strategy. Risks associated with potential exposure to contaminated groundwater are mitigated through enforcement of Arch's health and safety policies. This alternative, used in combination with a soil alternative capable of mitigating risks associated with exposure to contaminated on-site soils, would provide a comprehensive response to potential on-site human health risks. Other response objectives would likely require a lengthy period of time before they are attained through natural attenuation.

This alternative would have an adverse effect on potential remedial measures for off-site groundwater, in that off-site migration of site-related contaminants would resume.

4.2.2.4 Reduction of Toxicity, Mobility, and Volume. Alternative ONSITE-GW2 does not include any active remedial technologies to reduce the toxicity, mobility, or volume of site-related contaminants. Reductions will occur, however, due to natural attenuation. Strong evidence of ongoing degradation of chlorinated VOCs was observed in on-site monitoring wells (Olin, 1997). The effect of natural attenuation processes on chloropyridines is not as well understood. Several additional years of monitoring may be needed to determine the ultimate fate of these compounds in groundwater.

4.2.2.5 Short-Term Effectiveness. Because no active remedial actions are included in this alternative, no short-term risks to workers, the community, or the environment would be encountered.

4.2.2.6 Implementability. The elements of Alternative ONSITE-GW2 are easily implemented. Arch's health and safety policies are already being enforced, and groundwater monitoring is already underway.

4.2.2.7 Cost. The cost estimate for this alternative is provided on Table 4-1. There are no capital costs associated with Alternative ONSITE-GW2. Indirect costs include the development of future use restrictions for the site, although these would not become necessary unless the facility is sold or ceases operation. Operation and maintenance costs include groundwater monitoring and data reporting.

4.2.3 Alternative ONSITE-GW3 - Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW3 includes the following components:

- operation of the existing shallow bedrock extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;
- operation of a groundwater treatment system (existing granular activated carbon (GAC) system or other system capable of meeting prescribed discharge criteria);
- discharge of treated groundwater to the POTW;
- implementation of institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of on-site groundwater quality and extraction system performance.

As discussed in Section 2.3.1, Arch is already operating an on-site groundwater extraction, treatment, and discharge system. The system currently includes seven bedrock extraction wells (pumping at a total of approximately 35 gpm) to extract contaminated water and prevent further migration of site-related contaminants beyond the plant boundary. The extraction system was recently expanded to include an additional perimeter containment well along the western plant boundary and two source-area wells for increased contaminant mass removal. In addition, Arch would install an overburden groundwater recovery system in the southeast corner of the plant property to ensure that impacted groundwater does not migrate beyond the property boundary in that area. Conceptually, this overburden groundwater recovery system would consist of a 300-foot long trench along the curved property boundary from approximately well B-11 to well B-9 (see Figure 4-1). The trench would be excavated to the top of bedrock, to intercept the entire thickness of saturated overburden. Due to the low hydraulic conductivity of the overburden soils, it is estimated that the long-term yield of this trench would be approximately 1.5 gpm. Based on the anticipated contaminant concentrations in the overburden groundwater in this area, total contaminant mass removal will be minimal; therefore, the main purpose of this component of the extraction system would be to ensure hydraulic capture of overburden groundwater in the southeast corner of the plant.

The current on-site treatment system utilizes GAC to treat extracted groundwater along with plant process water prior to POTW discharge. As stated in Section 2.3.1, Arch intends to operate a treatment system to treat on-site groundwater to prescribed POTW discharge criteria. However, Arch desires to maintain flexibility in the treatment system it uses to attain discharge criteria to accommodate operational and process changes within the plant and treatment technology advances. In the event that the existing treatment system requires modification, or plant process water should require a greater capacity than the existing system, or if treatment efficiency decreases, Arch may replace the existing system with another treatment system. This system could be designed to treat either the combined groundwater/process water stream or two separate systems could be installed to treat streams independently. Any modification or changes in the treatment system would still meet POTW discharge criteria.

Monitoring of on-site groundwater levels would be conducted to supplement the ongoing groundwater sampling and analysis program. Monitoring of groundwater levels would be used to evaluate the extraction system's performance in preventing further migration of impacted groundwater beyond the plant property boundary. Groundwater sampling and analysis results would be used to evaluate on-site groundwater quality. Data from the monitoring program would continue to be reported to NYSDEC on an on-going basis. Adherence to Arch's health and safety policies is included in this alternative to prevent exposure to contaminated on-site groundwater. The policies outline procedures for conducting invasive activities within the plant, including procedures for use of PPE to prevent exposure to contaminated media on-site. Also, as described for Alternative ONSITE-GW2, restrictions on future use of the site would be implemented if the facility is transferred or sold, or if the facility becomes inactive.

4.2.3.1 Overall Protection of Human Health and the Environment. This alternative would establish and maintain hydraulic control of groundwater at the plant boundary to prevent further impacts to off-site groundwater. Protection for potential receptors inside the plant boundary would be provided through enforcement of Arch's health and safety policies.

4.2.3.2 Compliance With ARARs. This alternative would establish hydraulic control at the plant boundary to mitigate off-site transport of contaminated groundwater. Groundwater would continue to exceed regulatory criteria until mass removal of site-related contaminants reduces concentrations through groundwater partitioning and extraction. Groundwater quality would be monitored under the ongoing groundwater monitoring program established for the site.

4.2.3.3 Long-Term Effectiveness and Permanence. With a groundwater extraction, treatment, and discharge system in place and operating to meet prescribed POTW discharge criteria, contaminated on-site groundwater would be managed within the plant property boundary. Residual risks would remain within the plant boundary from potential direct contact with, and inhalation of vapors from contaminated groundwater. These on-site risks would be mitigated through continued adherence to the plant's health and safety policies. Future impacts to off-site groundwater would be controlled by establishing and maintaining hydraulic control at the plant boundary.

The current treatment system utilizes GAC to treat extracted groundwater along with plant process water prior to POTW discharge. Under this alternative, Arch would maintain and operate the existing GAC system, or an equivalent system capable of meeting prescribed discharge POTW criteria. The duration of operation of the extraction and treatment system is unknown. The system's performance would be evaluated using groundwater data collected under the ongoing groundwater monitoring program. As part of the reporting of monitoring data, Arch would make periodic recommendations to NYSDEC as to continuing, modifying, or discontinuing operation of the on-site groundwater extraction and treatment system. Based on the geologic and hydrogeologic conditions at the site it is anticipated that the on-site groundwater extraction, treatment, and discharge system may be in operation for the duration of the 30-year study period used in feasibility study evaluations. This feasibility study will assume an operating period of 30-years for the system.

The effectiveness of the extraction system in maintaining hydraulic control of on-site groundwater would be monitored by recording groundwater levels in monitoring wells in the vicinity of the plant. Water level measurements would be used to generate piezometric contours to determine the effectiveness of the extraction system. Groundwater quality would continue to be monitored under the monitoring program being conducted at the site, and would be used to evaluate constituent reduction. Arch would continue to report the results from the environmental monitoring program to NYSDEC on an ongoing basis. The monitoring results would include analytical results from groundwater sampling to evaluate constituent reduction, and piezometric plots of the groundwater elevation to evaluate the effectiveness of the groundwater extraction system in achieving on-site groundwater containment.

As stated in the previous paragraphs, due to site conditions, it is anticipated that the on-site groundwater extraction, treatment, and discharge system would be in operation for an extended period prior to achieving remedial goals. Operation of the system provides permanent treatment of constituents in groundwater.

Impact On Site-Wide Remediation Strategy. Alternative ONSITE-GW3 utilizes a groundwater extraction system to limit the mobility of contaminated on-site groundwater and establish and maintain hydraulic control of impacted groundwater at the plant boundary. Risks associated with potential exposure to contaminated groundwater would be mitigated through enforcement of Arch's health and safety policies. This alternative, used in combination with a soil alternative capable of mitigating risks associated with exposure to contaminated on-site soils, would be capable of achieving the response objectives for all on-site media of concern at the plant.

4.2.3.4 Reduction of Toxicity, Mobility, and Volume. This alternative would provide a reduction in the mobility of constituents in groundwater by controlling off-site migration, and would reduce the volume of site-related constituents by extracting and treating impacted groundwater.

Under this alternative, Arch would maintain and operate the existing GAC system or an equivalent system capable of meeting prescribed POTW discharge criteria. The extraction, treatment, and discharge system would be operated until on-site groundwater attained remedial goals for the constituents detected. The duration of the operating period is anticipated to be greater than the 30-year evaluation period of this feasibility study.

The existing GAC system removes constituents from the water stream and concentrates them on the activated carbon. Once the carbon becomes saturated with adsorbed constituents, the carbon is replaced with fresh activated carbon. The spent carbon is sent off-site to a regeneration facility. During the regeneration process, the spent carbon is heated to high temperatures to destroy the adsorbed contaminants and reactivate the carbon. For any equivalent treatment system employed at the plant, residuals from treatment of contaminated groundwater would be managed and disposed of in accordance with applicable regulations.

4.2.3.5 Short-Term Effectiveness. Because most components of this alternative are already in place, short-term risks to workers, the community, or the environment would be minimal. Proper health and safety precautions would be taken during construction of the groundwater collection trench to protect site workers, and trench spoils would be sampled and properly managed to prevent potential risks to human health and the environment.

4.2.3.6 Implementability. Installation of a groundwater recovery trench along the southeast plant property boundary presents no significant construction difficulties. Other components of the alternative are already in place. Arch currently has a discharge agreement with the Monroe County Pure Water Authority to discharge from the plant to the Monroe County Pure Water Authority POTW. Should process and operational changes dictate that the treatment system be modified or the treatment process be changed, these changes could be easily installed without impacting the existing agreements.

4.2.3.7 Cost. The cost estimate for this alternative is provided on Table 4-2. The capital cost estimate for this alternative only includes costs associated with installation of additional components needed to supplement the existing groundwater extraction and treatment system. Costs associated with developing future use restrictions for the site are included as indirect costs, although these would not become necessary unless the facility is sold or ceases operation.

Operation and maintenance costs include the cost of operating the groundwater extraction and treatment system, as well as costs associated with groundwater monitoring and data reporting.

4.2.4 Alternative ONSITE-GW4 – Dual-phase Extraction (Source Areas), Perimeter Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring

Alternative ONSITE-GW4 includes:

- dual-phase extraction at source-area wells to provide contaminant mass reduction;
- operation of the existing perimeter groundwater extraction wells;
- installation and operation of an overburden groundwater interceptor trench in the southeast corner of the plant property;
- on-site treatment of extracted groundwater;
- discharge of treated groundwater to the POTW;
- institutional controls as described in Alternative ONSITE-GW2; and
- monitoring of the on-site groundwater quality and extraction system performance.

ONSITE-GW4 includes all components of Alternative ONSITE-GW3, but adds dual-phase extraction at the source-area pumping wells (PW10 and PW12) to provide for increased contaminant mass removal. Dual-phase extraction (DPE) technologies remove both contaminated groundwater and soil vapors from the same extraction well. The two methods of extraction may complement each other, resulting in a higher rate of contaminant mass removal than either technology would yield alone. The effectiveness of DPE depends on several factors, including:

- volatility of the contaminants of concern;
- hydrogeologic conditions in the subsurface; and
- distribution of contaminants in the subsurface.

In general, DPE is considered to be most effective on VOCs (compounds with vapor pressures exceeding 1mm Hg), and in low to moderate hydraulic conductivity soils. In low hydraulic conductivity settings (i.e., in wells that achieve groundwater pumping rates of less than 5 gallons per minute), a high vacuum approach is typically used, which results in both removal of soil gas and, in many cases, increased flow of contaminated groundwater and non-aqueous phase liquids to the well.

With DPE, groundwater extraction within the well creates a cone of depression that allows for vapor movement through the formerly saturated or partially-saturated soils, including the capillary fringe where concentrations of lighter VOCs typically are highest. In addition, VOCs with low water solubility and high affinity for soil carbon may be more effectively removed by exposure to soil venting and volatilization than by desorption and recovery in a groundwater extraction system.

DPE can also enhance the removal of dissolved groundwater contamination and NAPL by creating a pneumatic gradient in the well in addition to the hydraulic gradient. This phenomenon tends to be more pronounced in low hydraulic conductivity soils, where higher vacuums can be attained and deeper cones of depression are formed.

Conditions at this site are not ideal for the application of DPE for two reasons. First, a substantial portion of the contaminants of concern consists of chloropyridines, which are semivolatile compounds with vapor pressures lower than 1 mm Hg. These compounds are not expected to be appreciably removed with the vapor phase of the DPE process; however, it is possible that the pneumatic gradients in a DPE well could enhance the mass removal rate of chloropyridines in the groundwater extraction component of the technology. Second, a substantial portion of the contaminant mass is present within the shallow fractured bedrock beneath the site. It is estimated that roughly 40 percent of the total VOC contaminant mass resides within the shallow bedrock groundwater. Groundwater pumping at the site would not be expected to dewater the upper bedrock to any significant degree. Even if bedrock were dewatered, vapor movement would be predominantly through larger, connected fractures, whereas much of the contaminant mass is likely to be located within dead-end fractures or even permeated into the rock matrix. Therefore, it is anticipated that the groundwater pumping associated with DPE will result in the bulk of the mass removal from the well.

Despite the discouraging site conditions, there are portions of the site where elevated quantities of VOCs are found within the overburden groundwater (most notably, in the area near monitoring well B17). This is where it is possible that DPE may provide significantly enhanced mass removal rates over groundwater extraction alone.

In November 1999, a pilot test was conducted at the site to determine whether DPE had the potential to be an effective remedial technology at this site. The test was performed on the newly-installed pumping well PW10, located near monitoring well B17 at the rear of the main plant building. The goal of the test was to determine whether the use of DPE would result in significantly higher overall mass removal rates from well PW10 than groundwater pumping would alone. The results of the test indicated that over 99.8 percent of the contaminant mass removal resulted from the groundwater pumping (at a total estimated rate of 2,100 pounds of contaminants per year), as compared to the vapor phase which accounted for mass removal at an estimated 4 pounds per year. These findings indicate that DPE would provide no significant benefit over groundwater extraction alone. The results of the pilot test are included in Appendix G.

4.2.4.1 Overall Protection of Human Health and the Environment. This alternative would provide essentially the same overall protection of human health and the environment as Alternative ONSITE-GW3.

4.2.4.2 Compliance With ARARs. The ability of Alternative ONSITE-GW4 to comply with ARARs is similar to that of Alternative ONSITE-GW3. It had been hoped that regulatory objectives (i.e., attaining NYS groundwater standards) would be attained in a somewhat shorter timeframe due to higher contaminant mass removal rates, but the results of the pilot test suggest that the use of DPE would not appreciably shorten overall remediation timeframes.

4.2.4.3 Long-Term Effectiveness and Permanence. The long-term effectiveness and permanence of this alternative would be similar to Alternative ONSITE-GW3, as presented in Section 4.2.3.3. Based on the results of the pilot test, the use of DPE in the former source areas would not be expected to significantly improve contaminant mass removal rates over groundwater pumping alone.

Impact On Site Wide Remediation Strategy. This evaluation of Alternative ONSITE-GW4 is also similar to the evaluation of Alternative ONSITE-GW3, as presented in Section 4.2.3.3.

4.2.4.4 Reduction of Toxicity, Mobility, and Volume. The ability of Alternative ONSITE-GW4 to reduce the mobility, toxicity, and volume of contaminants is similar to that of Alternative ONSITE-GW3. See the discussion in Section 4.2.3.4.

4.2.4.5 Short-Term Effectiveness. Alternative ONSITE-GW4 would require the installation of a vacuum system and associated piping in the Main Plant Building area. Short-term exposure risks to construction workers would be mitigated through proper use of PPE. If the extraction system is constructed inside the building itself, measures may be required to protect the health and safety of facility workers.

4.2.4.6 Implementability. Installation of a vacuum system is technically feasible. Air permitting issues would have to be addressed; however, due to the very small amount of VOC mass that would be removed in the vapor phase, these issues should be minor.

4.2.4.7 Cost. Costs associated with Alternative ONSITE-GW4 would be similar to Alternative ONSITE-GW3, with the addition of capital, operating, and maintenance costs for the construction of the vacuum system and associated piping. It is assumed that the total flow of extracted groundwater from the overall extraction system would be the same as from the current system, and that the current treatment system would provide adequate treatment. Vapor phase treatment costs are considered negligible due to the small quantity of VOCs expected in the vapor phase. The cost estimate for this alternative is provided on Table 4-3.

4.3 INDIVIDUAL ANALYSIS OF SOIL REMEDIATION ALTERNATIVES

The following subsections evaluate the three remedial alternatives developed for the remediation of contaminated soil in the target soil area (see Figure 2-7). The evaluation utilizes the seven evaluation criteria presented in Section 4.1.

4.3.1 Alternative S1 - No Action

Alternative S1 is the no-action alternative for target area soils. This alternative does not implement any remedial activities to address contaminated soil in the target soil area. This alternative was developed as a baseline for comparison with other remedial action alternatives, to comply with the NCP protocol for evaluation. The no-action alternative assumes that no natural mechanisms will impact constituents in soil, and that plant policies and procedures regulating invasive activities will not be enforced.

4.3.1.1 Overall Protection of Human Health and the Environment. The risk assessment identified potential health risks to construction workers exposed to subsurface soil in the target soil area through dermal contact with, and ingestion of, contaminated soil. This alternative would not provide any protection to these potential receptors. No adverse impacts to ecological receptors were identified in the risk assessment.

4.3.1.2 Compliance With ARARs. Soil in the target soil area exceeds NYSDEC SCOs for several constituents and presents potential exposure risks to construction workers. The no-action alternative does not address exceedances of NYSDEC SCOs or potential exposure risks, and would not comply with chemical-specific ARARs.

Since no remedial actions would be conducted under this alternative, there are no action-specific ARARs. No location-specific ARARs were identified in Section 2.2.1.2.

4.3.1.3 Long-Term Effectiveness and Permanence. The no-action alternative would not meet remedial response objectives or reduce risks associated with soil in the target soil area. The no-action alternative would not provide any long-term effectiveness.

Impact On Site Wide Remediation Strategy. The no action alternative for soil in the target soil area would not address any potential exposure risks identified in the risk assessment or reduce the impact of constituents in soil to on-site groundwater. This alternative would need to be combined with an active groundwater remediation alternative to prevent off-site migration of contamination via groundwater partitioning and transport.

4.3.1.4 Reduction of Toxicity, Mobility, and Volume. Because no remedial activities would be employed under this alternative for soil in the target soil area, no reduction of toxicity, mobility, or volume would be achieved.

4.3.1.5 Short-Term Effectiveness. This alternative does not include any remedial actions; therefore, short-term risks to workers, the community, and the environment would not result from implementation.

4.3.1.6 Implementability. This alternative requires no remedial activities and would be easily implemented.

4.3.1.7 Cost. Because there are no remedial actions included as part of this alternative, no costs would be incurred.

4.3.2 Alternative S2 - Minimal Action

Alternative S2 includes the following components:

- deed restrictions;
- continued adherence to the plant's health and safety policies for site excavation activities; and
- access restrictions through fencing and signs

Continued leaching of contaminants from soil to the groundwater is expected to gradually reduce constituent concentrations in the target soil area. Site access would be restricted by fencing, and warning signs would be posted indicating that exposure to subsurface soil poses a potential health risk. Implementation of deed restrictions would be included as part of this alternative to further reduce the potential for exposure to site soils. These restrictions would include; registering deed restrictions on the plant property prohibiting land use for residences or other uses that may cause exposure to affected soil, and restricting invasive activities (e.g., construction/excavation). Restrictions would be instituted only if the property was transferred, sold, or if operations at the plant were discontinued.

To mitigate current potential exposure to target area soils, Arch regulates invasive activities (e.g., excavation) through health and safety policies instituted at the plant. Alternative S2 includes adherence to these policies as a means of reducing potential exposure to target area soil.

4.3.2.1 Overall Protection of Human Health and the Environment. The risk assessment identified potential health risks to construction workers exposed to subsurface soil in the target soil area through dermal contact and ingestion. This alternative would provide protection to these potential receptors by mitigating potential exposure routes through site access controls, and by continued adherence to the plant's health and safety policies.

Deed restrictions would be implemented if the property were to be sold, transferred or if operations at the plant were discontinued. These restrictions would be incorporated into the deed restricting future installation of subsurface structures to prevent possible exposure to contaminated subsurface soil in the target soil area.

4.3.2.2 Compliance With ARARs. Soil in the target soil area would continue to exceed NYSDEC SCOs for several constituents for an extended time. Natural attenuation mechanisms such as leaching and biodegradation would be expected to reduce constituent concentrations in the target soil area, and may ultimately reduce constituent concentrations to below NYSDEC SCOs.

Because no active treatment is included in this alternative, no action-specific ARARs would apply. No location-specific ARARs were identified in Section 2.2.1.2.

4.3.2.3 Long-Term Effectiveness and Permanence. This alternative would rely on site access controls to mitigate potential exposure to contaminated soil. As an active manufacturing facility, site access controls and health and safety procedures are routinely and effectively enforced.

As described in Section 1.2, the plant is located in an industrialized area of Rochester, NY. Due to the location of the property and its industrial surroundings, use of the plant property for other than an industrial purpose is neither practical nor likely in the near future. Restrictions on future use of the property would be incorporated into the deed if the property were to be sold or transferred.

Impact On Site Wide Remediation Strategy. Alternative S2 addresses the risks associated with the target area soil identified in the risk assessment, and relies on natural attenuation to reduce constituent concentrations in the target soil area. Because the alternative relies in part upon constituent partitioning to groundwater, an on-site groundwater containment and/or treatment system would be an integral part of the site wide remediation strategy to complement this soil remediation alternative. This alternative combined with an on-site groundwater containment and/or treatment alternative would be capable of achieving the response objectives for both media of concern at the plant.

4.3.2.4 Reduction of Toxicity, Mobility, and Volume. This alternative does not include active measures to reduce the toxicity, mobility, or volume of soil contaminants. Ultimately, contaminant mass in the soil would be reduced through natural attenuation processes.

4.3.2.5 Short-Term Effectiveness. Since this alternative does not include any active remedial measures, short-term risks to workers, the community, and the environment would not result from implementation.

4.3.2.6 Implementability. Access restrictions are already in place at the plant. The property is surrounded by fencing to limit access, and all site personnel and visitors are required to sign in prior to entering the site and must sign out upon leaving. Additionally, the plant currently enforces health and safety policies outlining procedures for conducting invasive activities.

4.3.2.7 Cost. The cost estimate for this alternative is provided on Table 4-4. Capital, operating and maintenance costs associated with this alternative are negligible. Costs associated with establishing and incorporating deed restrictions are included as indirect costs.

4.3.3 Alternative S3 - Surface Barrier with Institutional Controls

Alternative S3 includes the following components:

- installation of a surface barrier;
- deed restrictions;
- continued adherence to the plant's health and safety policies for site excavation activities; and
- access restrictions through fencing and signs.

This alternative focuses on reducing the impact of vadose zone target area soils on site groundwater, and reducing potential exposure to target soil areas as its main components.

Alternative S3 utilizes a surface barrier (e.g., asphalt or concrete paving) in the target soil area to reduce the mobility of contaminants in unsaturated site soils, and relies on natural flushing of groundwater through saturated soils to reduce the concentration of constituents in the saturated zone. Deed restrictions, enforcement of Arch's health and safety policies, and fencing/signs as described in Alternative S2 would be utilized to mitigate potential exposure of humans to soil constituents.

Surface barriers, such as asphalt or concrete paving, are typically used to minimize infiltration of precipitation and the corresponding leaching of constituents through affected vadose zone soils to groundwater. Installation of surface barriers at target soil areas would allow control of run-on and run-off, and would be installed to accommodate plant operations. The surface barrier would help to prevent future releases of constituents to site soils and groundwater while allowing for continued use of the area for facility operations. Approximately 70-percent of the target soil area is currently paved or covered with existing structures. The surface barrier would be installed to complete coverage of the target soil area. Approximately 26,000 square feet would require covering (Figure 4-2).

Although this alternative would eliminate infiltration of precipitation, and in turn, eliminate one mechanism of natural attenuation (flushing of vadose zone soils by infiltration), some components of natural attenuation are likely to occur. For example, constituents in saturated soils in the target soil area would continue to be partitioned from soil to groundwater. While these components may reduce constituent concentrations in target area soil, it is not anticipated that SCOs would be attained in all site soils within a reasonable timeframe.

Similar to Alternative S2, site risks would be further limited by controlling and limiting potential exposure routes through site access controls (fencing/signs) and deed restrictions. Adherence to Arch's health and safety policies would also reduce the potential for exposure to contaminated soil.

4.3.3.1 Overall Protection of Human Health and the Environment. The risk assessment identified potential health risks to construction workers exposed to subsurface soil in the target soil area through dermal contact and ingestion. This alternative would provide long-term protection to potential receptors by mitigating potential exposure routes through the use of institutional controls. These restrictions would be the same as discussed for Alternative S2 in Section 4.3.2.1.

4.3.3.2 Compliance With ARARs. Soil in the target soil area exceeds NYSDEC SCOs for several constituents and presents potential exposure risks to construction workers. Under this alternative, some decrease in constituent concentrations may occur in the short-term, but the rate of constituent mass reduction is expected to decrease with the installation of the surface barrier. The surface barrier would eliminate infiltration and, in turn, minimize partitioning of constituents from unsaturated soil to groundwater. It is not anticipated that this alternative would reduce constituent concentrations in all portions of the target soil area to attain NYSDEC SCOs.

4.3.3.3 Long-Term Effectiveness and Permanence. This alternative would allow soil posing potential exposure risks to remain on-site, and relies on long-term management of residual risks as its main focus. Implementation of deed restrictions and site access control would contribute to the long-term management of impacted soil.

4.3.3.4 Reduction of Toxicity, Mobility, and Volume. This alternative does not significantly reduce the toxicity, or volume of contaminated soil in the target soil area. A surface barrier would reduce the mobility of constituents in the vadose zone soil by reducing infiltration and subsequent groundwater partitioning.

Impact On Site Wide Remediation Strategy. Alternative S3 addresses the risks associated with target area soil identified in the risk assessment by mitigating potential exposure to contaminated soil. The alternative relies on a surface barrier to mitigate impact of contaminated vadose zone soil on site groundwater. This alternative manages residual risks associated with target area soils remaining on site, and limits potential exposure to soil in the target soil area.

Because this alternative does not address saturated soil in the target soil area, a groundwater containment and/or treatment system would be an integral part of the site-wide remediation strategy to complement this soil remediation alternative. This alternative, combined with an on-site groundwater containment and/or treatment alternative, would be capable of achieving all the response objectives developed for the on-site area with the exception of attaining SCOs for the target soil area.

4.3.3.5 Short-Term Effectiveness. Remedial activities included in this alternative include placement of a surface barrier over the target soil area. Short-term impacts to workers would be minimized by using safe work practices and proper personnel protection while placing the surface barrier. Because access to the plant is restricted, no short-term impacts to the community are expected. It is anticipated that the surface barrier could be installed quickly.

4.3.3.6 Implementability. Installation of the surface barrier is easily implementable at the plant and is a proven method of reducing infiltration through the unsaturated soil zone. Installation activities would need to be completed during periods of seasonal weather conditions. Minimal site preparation (e.g., placement of gravel subbase) would be required prior to installation of the surface barrier.

Implementation of deed restrictions and access restrictions are discussed under Alternative S2 in Section 4.3.2.5

4.3.3.7 Cost. The cost estimate for this alternative is provided on Table 4-5. Capital costs are included for site preparation and installation of the surface barrier. Costs associated with establishing and incorporating deed restrictions are included as indirect costs in the cost estimate.

Operation and maintenance costs for this alternative include maintenance of the surface barrier.

4.4 Individual Analysis of Off-site Groundwater Remediation Alternatives

The following subsections evaluate the two remedial alternatives developed for remediation of off-site groundwater. The evaluation utilizes the seven criteria presented in Section 4.1.

4.4.1 Alternative OFFSITE-GW1 - No Action

Alternative OFFSITE-GW1 is the no-action alternative for off-site groundwater. This alternative does not implement any remedial activities to address contaminated off-site groundwater, and current off-site monitoring of groundwater and surface water would cease. This alternative was developed as a baseline for comparison with other remedial action alternatives, to comply with the NCP protocol for evaluation.

4.4.1.1 Overall Protection of Human Health and the Environment. The risk assessment identified no unacceptable risks from current exposure scenarios. Therefore, the no-action alternative is protective of human health and the environment under current conditions. This alternative would not prevent unacceptable exposure scenarios from occurring in the future, so it does not provide protection for potential future use scenarios identified in the risk assessment as posing an unacceptable risk.

4.4.1.2 Compliance With ARARs. Some site-related chemicals are present in off-site groundwater at concentrations exceeding New York State groundwater criteria. The no-action alternative does not include any active steps to reduce concentrations in groundwater. If, however, the on-site groundwater extraction system continues to operate, concentrations will diminish over time.

4.4.1.3 Long-Term Effectiveness and Permanence. The no-action alternative would not achieve remedial action objectives for off-site groundwater, because the potential for future unacceptable exposures to contaminated groundwater would continue for an indefinite period of time.

4.4.1.4 Reduction of Toxicity, Mobility, and Volume. The no-action alternative would not reduce the toxicity or mobility of site-related chemicals in off-site groundwater.

4.4.1.5 Short-Term Effectiveness. This alternative does not include any remedial actions and could be implemented immediately. Because there are no remedial actions, short-term risks to workers, the community, and the environment would not result from implementation.

4.4.1.6 Implementability. With no active remedial actions, implementability is not an issue.

4.4.1.7 Cost. Since there are no remedial actions included as part of this alternative, no costs would be incurred.

4.4.2 Alternative OFFSITE-GW2 – Groundwater Extraction at the Quarry Boundary, Treatment if Necessary to Meet Discharge Criteria, Groundwater Use Limitations, and Monitoring

Alternative OFFSITE-GW2 includes the following components:

- extract contaminated groundwater at the quarry boundary;
- treat extracted groundwater if necessary to meet requirements for discharge;

- work with local municipalities to limit future use of groundwater by residential or industrial property owners in the impacted area between the plant and the quarry; and
- monitor off-site groundwater quality to verify progress towards attaining groundwater quality standards.

This alternative assumes that hydraulic control at the plant property boundary as described for the on-site groundwater alternatives is maintained to prevent additional contributions of site-related compounds to off-site groundwater.

The quarry seep has been effectively capturing the off-site plume, preventing further migration and resulting in overall reductions in contaminant mass. Groundwater would be collected just upgradient of the seep using an extraction well to intercept the flow.

Based on observations of groundwater discharging from the eastern quarry wall and analytical results for samples collected from this discharge, a relatively thin zone within the bedrock is transmitting most of the groundwater containing chloropyridines near the quarry. This zone is interpreted to be roughly horizontal and to reside at an elevation between 487 and 490 feet msl. Groundwater discharging from this zone is evident across most of the eastern wall of the quarry, and sampling has indicated that high chloropyridine concentrations are limited to a relatively narrow (less than 100 feet long) section near the southerly end of the wall. No significant discharge of groundwater is evident along the eastern portion of the south quarry wall.

A single groundwater recovery well, located approximately 200 feet upgradient from the quarry, appears capable of intercepting the groundwater containing chloropyridines that is currently discharging to the quarry. Figure 4-3 shows the proposed location for the recovery well, which is interpreted to be directly upgradient from the quarry seep sampling location (QS-4) where the highest discharging chloropyridine concentrations have been detected. Although the convergence of groundwater flow near the quarry suggests that the chloropyridine plume is likely narrower near the quarry wall, locating the well 200 feet upgradient of the quarry would provide a larger available water level drawdown for the well, which would increase the well's area of potential influence.

Although no measurements of hydraulic conductivity for the targeted zone of rock are available from wells near the quarry, measurements from wells located near the Arch plant indicate a range of values for this zone of between 8.5 and 20 feet per day (ft/d). Based on the relatively high rate of flow from the eastern quarry wall, the upper end of this range is assumed to be most representative of near-quarry conditions. Using a hydraulic conductivity of 20 ft/d and an assumed thickness of 10 feet for the target zone, the Theis (1935) model for transient flow to a well predicts that a pumping rate of 5 gpm would be sustainable from a single well. At this pumping rate, and assuming a hydraulic gradient of 0.0044 (based on June 1999 well water levels), a single well would capture the entire chloropyridine plume adjacent to the quarry.

Extracted groundwater would be treated if necessary to attain discharge criteria, and then discharged. The need for treatment would be determined based on the discharge requirements established by the State of New York. Based on the September 1999 quarry seep data, the concentration of total chloropyridines in the extracted groundwater would be expected to be 1,000 ug/L or less. Although this concentration may be able to be directly discharged without treatment, this FS will assume that a small activated carbon treatment system would be used to treat the groundwater prior to discharge.

There are no unacceptable risks from off-site groundwater under current exposure scenarios. Groundwater is not used as drinking water in the vicinity of the site due to high natural iron and sulfur content and the availability of public water. Establishment of institutional controls would assure that potentially unacceptable exposure scenarios would not occur in the future for as long as concentrations of site-related compounds remain above groundwater criteria.

There are currently several industrial/commercial properties in the affected area downgradient of the plant. None are currently known to be using groundwater for any purpose. Restrictions or institutional controls would limit unacceptable uses or exposures to groundwater unless testing confirms that site-related chemicals are not present at concentrations of concern.

This alternative also includes a continuation of Arch's groundwater monitoring program for off-site wells. Data from the monitoring program would continue to be reported to NYSDEC on an on-going basis. For the purposes of this detailed analysis, the duration of the groundwater monitoring program is assumed to be 30 years.

4.4.2.1 Overall Protection of Human Health and the Environment. Alternative OFFSITE-GW2 addresses all potentially unacceptable exposure scenarios identified in the risk assessment for off-site groundwater.

4.4.2.2 Compliance With ARARs. This alternative would allow concentrations of site-related chemicals that currently exceed New York State criteria in off-site groundwater to diminish over time as contaminated groundwater is captured at the quarry. Groundwater quality would be monitored under the ongoing groundwater monitoring program.

4.4.2.3 Long-Term Effectiveness and Permanence. As long as the on-site groundwater extraction system is effective in preventing further site-related chemicals from migrating to off-site areas, Alternative OFFSITE-GW2 would reduce the potential risks from exposure to off-site groundwater. Until concentrations are reduced to below New York State criteria, this alternative would rely on the restriction of unacceptable uses of groundwater to maintain protectiveness.

Progress toward attaining New York State groundwater criteria would be evaluated using groundwater data collected under the ongoing groundwater monitoring program. As part of the reporting of monitoring data, Arch would make periodic recommendations to NYSDEC as to continuing, modifying, or discontinuing operation of the groundwater extraction system.

4.4.2.4 Reduction of Toxicity, Mobility, and Volume. This alternative would reduce the volume of site-related contaminants by capturing impacted off-site groundwater. Additional reduction of contaminant toxicity, mobility, and volume is likely to result from natural attenuation processes within the aquifer.

4.4.2.5 Short-Term Effectiveness. Installation of the groundwater extraction system poses minimal potential short-term exposure risks to construction workers that can be easily controlled through the use of PPE and proper work practices. No other short-term impacts are expected from implementation of this alternative.

4.4.2.6 Implementability. Installation of the extraction system is technically feasible. Easements may be required from multiple landowners for the extraction well and discharge line. A discharge agreement would be required with either NYSDEC or the Monroe County Pure Water Authority. Institutional controls would require mutual coordination and approval by the City of Rochester, Town of Gates, Monroe County, NYSDEC, and Arch, and may also involve negotiations with downgradient property owners. The groundwater monitoring program is already in place and poses no significant implementation issues.

4.4.2.7 Cost. The cost estimate for this alternative is provided on Table 4-6. The capital cost estimate for this alternative includes costs associated with installation of the groundwater extraction and discharge system. Capital costs also include indirect costs (e.g., technical and legal assistance) associated with establishing restrictions on future use of groundwater.

Operation and maintenance costs include expenses associated with operating the extraction system (including assumed treatment costs), and the cost of groundwater monitoring and reporting.

4.5 Comparative Analysis Of Alternatives

The comparative analysis compares the alternatives for each medium with respect to the seven evaluation criteria. The purpose of the comparative analysis is to identify the advantages and disadvantages of the alternatives relative to one another and to aid in the eventual selection of remedial alternatives for on-site groundwater, on-site soil, and off-site groundwater. Subsection 4.5.1 presents the approach of the comparative analysis based on the NCP and Subsections 4.5.2 and 4.5.3 presents the comparison of the alternatives for each medium.

Arch's recommended alternatives are proposed in Section 4.6. Following approval of this FS by NYSDEC, the final preferred alternative for each medium will be identified in a Proposed Plan.

4.5.1 Approach to the Comparative Analysis

Specific CERCLA requirements are considered when comparing alternatives for selection of a preferred site remedy. To the extent practicable, the selected alternative should:

- be protective of human health and the environment

- comply with ARARs (or provide grounds for invoking a waiver)
- use permanent solutions and alternative treatment technologies
- satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element; if this preference is not satisfied, the Proposed Plan and ROD must explain why
- be cost-effective.

The NCP outlines the approach for performing the comparative analysis of site alternatives. The remedy proposed in the Proposed Plan must reflect the scope and purpose of the actions being undertaken, how these actions relate to other remedial actions, and the long-term response at the site. Identification of the preferred alternative and final remedy selection are based on an evaluation of the major tradeoffs among the alternatives in terms of the evaluation criteria. USEPA categorizes the evaluation criteria into three groups: threshold, balancing, and modifying. Each criteria group is discussed in the following subsections.

4.5.1.1 Threshold Criteria. USEPA has designated (1) overall protection of human health and the environment, and (2) compliance with ARARs as the two threshold criteria. An alternative must meet both criteria to be eligible for selection as the preferred site remedy.

4.5.1.2 Primary Balancing Criteria. The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost. These balancing criteria provide a preliminary assessment of the extent to which permanent solutions and treatment can be used practicably and in a cost-effective manner.

The alternative that is protective of human health and the environment, is ARAR-compliant, and affords the best balance among these criteria is identified as the preferred alternative in the Proposed Plan. The balancing emphasizes long-term effectiveness and reduction of toxicity, mobility, or volume.

4.5.1.3 Modifying Criteria. State and community acceptance are factored into a final balancing that determines the preferred remedy and the extent of permanent solutions and treatment practicable for the site. As stated in Section 4.1, these two criteria will be incorporated into the FS process during the public review period of the proposed plan.

4.5.2 Comparative Analysis of On-Site Groundwater Alternatives

Four alternatives were developed for remediation of on-site groundwater. Alternative ONSITE-GW1 - No Action, was developed as a baseline for comparison with other remedial action alternatives and does not meet the remedial action objectives identified in Section 2.2.3, or the threshold criteria used in this evaluation.

Alternative ONSITE-GW2 uses institutional controls to prevent exposure to contaminated on-site groundwater by construction workers, the only unacceptable exposure risk identified by the risk assessment. This alternative would rely on natural attenuation processes to reduce contaminant concentrations in groundwater to below NYS groundwater criteria. This alternative would meet the remedial action objectives identified in Section 2.2.3, and would satisfy the threshold evaluation criteria.

Alternatives ONSITE-GW3 and ONSITE-GW4 both include the same institutional controls as ONSITE-GW2, and also utilize a groundwater extraction system to establish and maintain hydraulic control of groundwater at the plant boundary. Groundwater would be treated to prescribed discharge criteria prior to discharge to a POTW. Alternative ONSITE-GW4 adds dual-phase extraction on source-area wells with the intention of accelerating mass removal from the subsurface. Both of these alternatives meet the remedial action objectives identified in Section 2.2.3 and meet the threshold criteria used in this evaluation.

A summary of the comparative analysis for the on-site groundwater alternatives is presented on Table 4-7and in the following subsections.

4.5.2.1 Overall Protection of Human Health and the Environment. Alternative ONSITE-GW1 does not provide any protection to human health since no remedial action would be conducted, and does not meet this threshold criterion. Alternatives ONSITE-GW2, ONSITE-GW3, and ONSITE-GW4 are protective of human health and satisfy this threshold criterion. These three alternatives provide protection to human health through the use of institutional controls to prevent exposure to contaminated groundwater.

4.5.2.2 Compliance With ARARs. Alternative ONSITE-GW1 would not comply with ARARs and does not meet this threshold requirement. Under alternative ONSITE-GW2, on-site groundwater would remain above NYS groundwater criteria until natural attenuation processes reduce contaminant concentrations below prescribed levels. This alternative would not prevent further off-site migration of site-related contaminants. Alternatives ONSITE-GW3 and ONSITE-GW4 would utilize hydraulic control of groundwater to mitigate off-site transport of site-related contaminants. Under alternatives ONSITE-GW3 and ONSITE-GW4, on-site groundwater would continue to exceed NYS groundwater criteria until mass reduction of constituents in groundwater and soils reduces concentrations through groundwater partitioning and extraction. Due to the active pumping of contaminated groundwater under these two alternatives, they would be expected to attain groundwater criteria more quickly than alternative ONSITE-GW2; however, all three alternatives ultimately would attain compliance with chemical-specific ARARs and meet this threshold requirement for on-site groundwater.

4.5.2.3 Long-Term Effectiveness and Permanence. Alternative ONSITE-GW1 does not provide any treatment of contaminated groundwater. Alternative ONSITE-GW2 would rely on natural attenuation for permanent reduction of contaminant mass. Alternatives ONSITE-GW3 and ONSITE-GW4 utilize a groundwater extraction, treatment, and discharge system to permanently treat contaminated on-site groundwater. Additionally, ONSITE-GW4 includes dual-phase extraction on source-area wells, with the goal of accelerating mass removal of site-related contaminants. Pilot test data indicates, however, that the technology would result in a negligible increase in mass removal rates. Alternatives ONSITE-GW2, ONSITE-GW3, and ONSITE-GW4 include institutional controls to mitigate potential exposure to contaminated on-site groundwater during the remediation period.

4.5.2.4 Reduction of Toxicity, Mobility, and Volume. Alternative ONSITE-GW1 does not provide any reduction in toxicity, mobility, or volume of contaminated on-site groundwater. In Alternative ONSITE-GW2, natural attenuation would result in some reduction of contaminant mass from degradation, but this alternative would allow continued off-site migration of site-related contaminants. Alternatives ONSITE-GW3 and ONSITE-GW4 use a groundwater extraction system to reduce the mobility of contaminated groundwater by establishing hydraulic control of groundwater at the plant boundary. Both Alternatives ONSITE-GW3 and ONSITE-GW4 include a groundwater treatment system to reduce the volume of contaminants through irreversible treatment. ONSITE-GW4 would provide a small additional reduction in the volume of site-related contaminants due to vapor-phase extraction and treatment at the source-area wells.

4.5.2.5 Short-Term Effectiveness. Alternatives ONSITE-GW1 and ONSITE-GW2 do not include any active remedial actions, therefore short-term impacts to workers, the community, and the environment are not an issue. Alternative ONSITE-GW3 uses the existing groundwater extraction, treatment, and discharge system to treat contaminated on-site groundwater. No additional remedial activities would be undertaken for this alternative, therefore, short-term impacts to workers, the community, and the environment are not an issue. Alternative ONSITE-GW4 would involve the installation of a vacuum system near the Main Plant Building. Short-term exposure risks to construction workers would be minimal and could be mitigated through proper worker safety procedures.

4.5.2.6 Implementability. Alternative ONSITE-GW1 requires no action, therefore, implementability is not an issue. Alternatives ONSITE-GW2, ONSITE-GW3, and ONSITE-GW4 all include implementation of institutional controls. Most of these controls, related to protecting worker health and safety during on-site excavation activities are already being enforced. Alternative ONSITE-GW3 includes the continued operation of the existing groundwater extraction, treatment, and discharge system. Under alternative ONSITE-GW4, installation of a vacuum system near the Main Plant Building would not involve specialized equipment and/or contractors, and could be easily implemented.

4.5.2.7 Cost. Alternative ONSITE-GW1 does not include any remedial actions, therefore no costs would be incurred.

Estimated costs for Alternative ONSITE-GW2 are:

- Capital Costs - none
- Indirect Costs - $28,000
- Operating Costs - $780,000
- 20% contingency (low uncertainty) - $162,000
- Total Present Worth - $970,000

Estimated costs for Alternative ONSITE-GW3 are:

- Capital Costs - $190,000
- Indirect Costs - $190,000
- Operating Costs - $4,629,000
- 20% contingency (low uncertainty) - $1,002,000
- Total Present Worth - $6,011,000

Estimated costs for Alternative ONSITE-GW4 are:

- Capital Costs - $215,000
- Indirect Costs - $211,000
- Operating Costs - $4,815,000
- 35% contingency (medium uncertainty) - $1,834,000
- Total Present Worth - $11,403,000

4.5.3 Comparative Analysis Soil Alternatives

Three alternatives were developed for remediation of target area soils in the Well B-17 area. Alternative S1 - No Action, was developed as a baseline for comparison with other remedial alternatives and does not meet the remedial objectives identified in Section 2.2.3, or the threshold criteria used in this evaluation.

Alternatives S2 and S3 use site access controls and restrictions to prevent exposure to impacted subsurface soils. These actions would include:

- adherence to Arch's health and safety policies;
- fencing and signs around the plant; and
- implementation of deed restrictions if the property is sold, transferred, or if operations at the plant are discontinued.

Alternative S3 also uses a surface barrier to reduce the impact of target area soils on site groundwater.

Alternative S2 may ultimately reduce constituent concentrations below NYSDEC SCOs as contaminants partition into groundwater due to leaching. Alternative S3 is not expected to reduce constituent concentrations to below NYSDEC SCOs in the foreseeable future due to reduced leaching resulting from the use of a surface barrier.

A summary of the comparative analysis for the soil alternatives is presented on Table 4-8 and in the following subsections.

4.5.3.1 Overall Protection of Human Health and the Environment. Alternative S1 does not provide any protection to human health since no remedial measures would be implemented, and does not meet this threshold criterion. Alternatives S2 and S3 are protective of human health and meet this threshold criterion. Risks to human health from potential exposure to subsurface soils within the target soil area would be controlled through adherence to Arch's health and safety policies. These policies outline procedures for conducting invasive activities, including the use of PPE, to mitigate potential exposure to contaminated soil. Alternatives S2 and S3 provide additional long-term protection through the implementation of deed restrictions. These restrictions would prohibit land use for residences or other uses that may cause exposure to affected site soils, and would restrict invasive activities prior to attainment of the remedial goals.

4.5.3.2 Compliance With ARARs. Alternative S1 would not comply with ARARs and does not meet this threshold criterion. Continued leaching of soil contaminants to groundwater under Alternative S2 would reduce constituent concentration in some soils and may ultimately reduce concentrations to below SCOs and comply with chemical-specific ARARs. Alternative S3 uses a surface barrier to eliminate potential exposure pathways and control leaching to groundwater. This alternative primarily relies on access restrictions to manage soil exceeding SCOs remaining on-site. While some reduction in constituent concentrations may occur under Alternative S3, it is not anticipated that concentrations would be sufficiently reduced to comply with ARARs in a reasonable timeframe, and meet this threshold criterion.

4.5.3.3 Long-Term Effectiveness and Permanence. Alternative S1 does not provide long-term effectiveness, since no actions are taken to control exposures to on-site soils. Alternatives S2 and S3 rely on institutional controls to limit exposures, and the long-term effectiveness of these alternatives would be dependent on the continued enforcement of the controls. As the owner and operator of this facility, Arch is able to ensure that institutional controls remain in effect. In the event that the property is sold, transferred, or if operations at the plant are discontinued, deed restrictions would be implemented to prohibit residential land use or other uses that may cause exposure to affected site soils, and to restrict invasive activities prior to attainment of the remedial goals.

4.5.3.4 Reduction of Toxicity, Mobility, and Volume. Alternative S1 does not provide any reduction in toxicity, mobility, or volume of target area soils. Alternative S2 may ultimately reduce the contaminant mass in soil. Alternative S2 relies on groundwater partitioning as a non-destructive mechanism of natural attenuation and therefore does not reduce the mobility of constituents in target area soils. Alternative S3 uses a surface barrier to reduce the mobility of constituents in vadose zone soil, but does not reduce the mobility of constituents in saturated soil. Alternative S3 does not significantly reduce the toxicity or volume of site-related contaminants in soil.

4.5.3.5 Short-Term Effectiveness. Alternatives S1 and S2 do not include any active remedial actions, therefore short-term impacts to workers, the community, and the environment are not an issue. Alternative S3 requires installation of a surface barrier over the target soil area. Use of safe work practices during site preparation and installation of the surface barrier would minimize any short-term risks to workers. No risks to the community or the environment are anticipated during placement of the surface barrier.

4.5.3.6 Implementability. Alternative S1 requires no action; therefore, implementation is not an issue. Implementing Alternative S2 also requires no active treatment processes. Alternative S3 requires seasonal weather conditions and coordination with plant operations, but involves no particular technical complexities.

4.5.3.7 Cost. Alternative S1 does not include any remedial actions, so no costs would be incurred.

Estimated costs for Alternative S2 are:

- Capital Costs - none
- Indirect Costs - $28,000
- Operating Costs – none
- 20% contingency (low uncertainty) - $6,000
- Total Present Worth - $34,000

Estimated costs for Alternative S3 are:

- Capital Costs - $33,000
- Indirect Costs - $52,000
- Operating Costs - $24,000
- 20% contingency (low uncertainty) - $21,000
- Total Present Worth - $130,000

4.5.4 Comparative Analysis of Off-Site Groundwater Alternatives

Two alternatives were developed for remediation of off-site groundwater. Alternative OFFSITE-GW1 - No Action, was developed as a baseline for comparison with other remedial action alternatives and does not fully meet the remedial action objectives identified in Section 2.2.3, or the threshold criteria used in this evaluation.

Alternative OFFSITE-GW2 ensures that groundwater will continue to be captured at the quarry seep, and employs groundwater use restrictions to prevent unacceptable exposures to contaminated groundwater until concentrations drop to below groundwater criteria. This alternative attains the remedial action objectives identified in Section 2.2.3 and meets the threshold criteria used in this evaluation.

A summary of the comparative analysis for the off-site groundwater alternatives is presented on Table 4-9 and in the following subsections.

4.5.4.1 Overall Protection of Human Health and the Environment. Alternative OFFSITE-GW1 does not provide protection for potential future human exposures since no remedial actions would be conducted, and therefore does not meet this threshold criterion. Alternative OFFSITE-GW2 is fully protective of human health and satisfies this threshold criterion. Alternative OFFSITE-GW2 employs groundwater use restrictions to prevent unacceptable exposures to contaminated off-site groundwater. These restrictions would prohibit the use of groundwater as a source of drinking water and establish limits on downgradient industrial property owners to restrict use and exposure to contaminated groundwater.

4.5.4.2 Compliance With ARARs. Both off-site groundwater alternatives would ultimately be expected to attain compliance with New York State groundwater criteria and meet this threshold requirement. Alternative OFFSITE-GW2 may have slightly more reliability since Arch would be monitoring the concentrations of site-related contaminants in off-site groundwater to track the progress towards attainment of ARARs.

4.5.4.3 Long-Term Effectiveness and Permanence. Alternative OFFSITE-GW1 would rely primarily on the quarry seep to continue to capture contaminated groundwater and reduce contaminant mass in the aquifer, while OFFSITE-GW2 would include an active groundwater extraction system. Additional reductions may occur through natural attenuation. Alternative OFFSITE-GW2 provides additional long-term management of potential future exposure risks through restrictions on the use of groundwater by downgradient residential and industrial property owners.

4.5.4.4 Reduction of Toxicity, Mobility, and Volume. Both off-site groundwater alternatives would reduce the volume of contaminated off-site groundwater, with additional reduction in contaminant mass likely due to natural attenuation. In Alternative OFFSITE-GW2, impacted groundwater would be extracted before it discharges into the quarry. Extracted groundwater would be pre-treated if necessary to meet discharge requirements. Treated water would then be discharged to the canal where natural attenuation processes would control the long-term fate of residual contaminants. In Alternative OFFSITE-GW1, uncontrolled discharge of groundwater to the canal would continue.

4.5.4.5 Short-Term Effectiveness. Alternative OFFSITE-GW1 does not include any remedial actions, so short-term impacts to workers, the community, and the environment are not an issue. For Alternative OFFSITE-GW2, installation of the groundwater extraction well and treatment system or discharge line poses minimal potential short-term exposure risks to construction workers that can be easily controlled through the use of PPE and proper work practices. No other short-term impacts are expected from implementation of this alternative.

4.5.4.6 Implementability. Alternative OFFSITE-GW1 requires no action, and therefore is easily implementable. Alternative OFFSITE-GW2 includes installation of extraction, treatment, and/or discharge systems. These systems are easily designed and readily implementable by conventional means. Alternative OFFSITE-GW2 would also require that Arch establish a discharge agreement with NYSDEC. Limitations on future groundwater use will require coordination with local officials. The groundwater monitoring program is already in place and poses no significant implementation issues.

4.5.4.7 Cost. Alternative OFFSITE-GW1 does not include any remedial actions, therefore no costs would be incurred.

Estimated costs for Alternative OFFSITE-GW2 are:

- Capital Costs - $116,000
- Indirect Costs - $265,000
- Operating Costs - $965,000
- 35% contingency (medium uncertainty) - $471,000
- Total Present Worth - $1,817,000

4.6 Recommended Remedial Alternatives

The recommended remedial alternatives for the site wide remediation strategy are: Alternative ONSITE-GW3 - Groundwater Extraction, Treatment, POTW Discharge, Institutional Controls, and Monitoring; Alternative S2 – Institutional Controls; and Alternative OFFSITE-GW2 - Groundwater Extraction at the Quarry Boundary, Treatment if Necessary to Meet Discharge Criteria, Groundwater Use Limitations, and Monitoring.

Alternative ONSITE-GW3 is recommended for groundwater remediation to establish and maintain hydraulic control of groundwater at the plant boundary through a groundwater extraction system. The extracted groundwater would be treated in a groundwater treatment system to prescribed discharge criteria prior to discharge to the Monroe County Pure Water Authority POTW. During the remediation period adherence to Arch's health and safety policies would mitigate potential exposure risks to contaminated on-site groundwater. These policies outline procedures, including the use of PPE for conducting invasive activities that may encounter contaminated groundwater. Extraction system performance would be evaluated by monitoring groundwater levels and groundwater quality in on-site monitoring wells. Water level measurements would be used to develop piezometric contours and evaluate the extraction system's performance in establishing and maintaining a hydraulic POC boundary. Groundwater quality would continue to be monitored and evaluated for trends pursuant to the current groundwater monitoring program conducted for the site.

Alternative S2 is recommended to remediate target soil area. Alternative S2 focuses on reducing potential exposure to the target soil area, and allows continued leaching to reduce constituent mass in the soil. During the remediation period, adherence to Arch's health and safety policies would mitigate potential exposure risks to the target soil area. Additional protection from potential exposure to target soil area would be provided through the access controls afforded by the fencing and signs around the plant, and controlled access. Long-term protection would be provided under Alternative S2 through the implementation of deed restrictions if the plant were to be sold, transferred or if operations are discontinued.

Alternative OFFSITE-GW2 is recommended for off-site groundwater. This alternative addresses potential future risks through restrictions on groundwater use and exposure, and reduces the contaminant mass by extracting impacted groundwater before it can discharge to the Dolomite Products Quarry. Additional reduction of contaminant mass is expected within the aquifer due to natural attenuation.

Implementing these recommended alternatives would provide an overall site-wide remediation strategy capable of meeting all of the response objectives developed for on-site groundwater, on-site soil, and off-site groundwater at this site.

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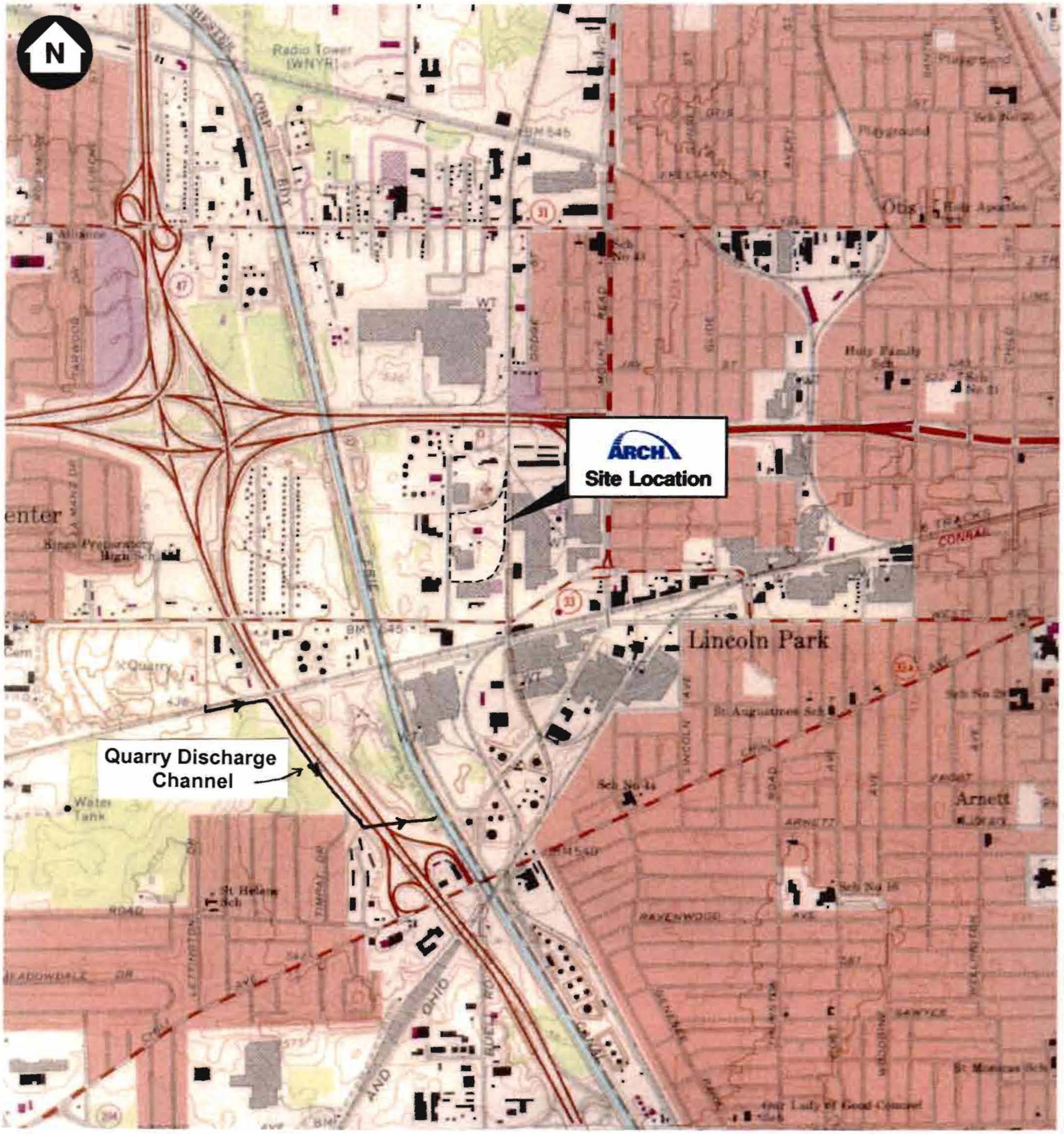

Source: USGS Topographic Quadrangle, 7.5-Minute Series, Rochester West, N.Y. 1971 (Photorevised 1978).

SCALE IN FEET

0 2,000 4,000

FIGURE 1-1
SITE LOCATION MAP
ARCH CHEMICALS, INC.
FEASIBILITY STUDY
ROCHESTER, NEW YORK

Harding Lawson Associates

W9905010(c)