FINAL PHASE II
REMEDIAL INVESTIGATION REPORT

OLIN CHEMICALS
ROCHESTER PLANT SITE
ROCHESTER, NEW YORK

VOLUME I

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Submitted to:

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4.0 BASELINE RISK ASSESSMENT

This section presents the results of the human health and ecological risk assessments conducted as part of the Phase II RI. These assessments supplement the risk assessment conducted as part of the Phase I investigation and focus on the off-site groundwater and surface water. Together with the results of the Phase I risk assessment, these assessments provide a complete picture of the potential risks associated with environmental media in the vicinity of the Olin Plant site that may have been affected by past releases from the plant. A comprehensive summary of the human health risk assessments performed in support of the Phase I and Phase II RIs is presented in the Feasibility Study.

4.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

A human health risk assessment has been conducted to evaluate potential health risks to individuals under current or foreseeable future site conditions associated with the Olin Study Area, particularly focused on the environmental data collected in the Phase II investigation.

For the human health risk assessment, the study area was subdivided into location-specific areas for evaluation. The study area is considered to be all of the areas and media investigated as part of this Phase II RI. Within this general study area there are the on-site areas and the off-site area. The on-site area is considered to be the area within the property boundaries of the Olin Plant. The on-site area is further subdivided into areas associated with the active chemical plant facility (the facility), and areas that do not involve the plant and are open, usually grassy areas on plant property (non-facility). Risks for potential exposures to the on-site area were evaluated in the Phase I RI.

The purpose of this assessment is to evaluate potential health risks from exposure to off-site media, which may not be under Olin management. Media sampled at off-site locations included groundwater, groundwater seeps, and surface water. No surface or subsurface soil samples were collected off-site because no source area associated with the Olin Plant was identified off-site, and because surface soil is not expected to migrate off-site. Media sampled at on-site locations in Phase II were surface soil (0-2 inches bgs), subsurface soil (0-10 feet bgs), and groundwater (overburden and bedrock). These data were collected to supplement data gaps identified in the Phase I RI, and were not evaluated in this risk assessment; on-site exposures, therefore, are not further evaluated. The Olin Plant is expected to remain an active chemical plant under Olin management and exposures to on-site chemicals would involve work place conditions under Occupational Safety and Health Administration regulations.

The risk assessment is consistent with relevant guidance and standards developed by USEPA (USEPA, 1989d,f; 1991a,c; 1992d,e,f) and NYSDEC (NYSDEC, 1994a), reflects comments and guidance received from USEPA Region II, and incorporates 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 assessment for the study area consists of the following components:

- Identification of Chemicals of Potential Concern (Subsection 4.1.1)
- Exposure Assessment (Subsection 4.1.2)
- Toxicity Assessment (Subsection 4.1.3)
- Risk Characterization (Subsection 4.1.4)
- Uncertainty Evaluation (Subsection 4.1.5)
- Summary and Conclusions (Subsection 4.1.6)

In summary, the risk assessment evaluated exposures to recreational visitors and industrial workers who might contact chemicals of potential concern in surface water, groundwater, or groundwater seeps. The amount of chemical that those receptors might be exposed to was estimated and combined with relevant toxicity information to calculate estimates of cancer and non-cancer risk. The only exposure that was associated with cancer risk estimates above an excess lifetime cancer risk of 1×10^{-6} or non-cancer risk estimates above a hazard index of 1 was for future industrial workers using off-site groundwater as industrial process water.

4.1.1 Identification of Chemicals of Potential Concern

The first step in the risk assessment was to collect, summarize, and analyze the study area data to identify those chemicals present in environmental media and related to the Olin Plant site. Study-area-related chemicals that were selected for quantitative evaluation were termed Chemicals of Potential Concern (CPCs) and defined as those chemicals that are present as a result of past activities at the Olin Plant site. The procedures used to summarize available data and to screen data for the selection of CPCs are discussed below.

4.1.1.1 Data Summary Procedures. In selecting CPCs, the analytical data for surface water, groundwater seeps and groundwater samples collected during the field investigation were first grouped and summarized. Tables 4-1 through 4-3 present a summary of data used to perform this risk assessment. Sampling and analysis procedures are described in Subsections 2.1 and 2.2. Off-site laboratory results are used for the evaluation of these media. The following steps, which are in accordance with USEPA (1989d) guidance, were used to summarize the analytical data for this risk assessment:

- Data were summarized by environmental medium (i.e., groundwater, surface water, and seep water). All chemicals detected in at least one sample in each medium were listed. All groundwater data collected for a given location in Phase II were averaged to generate a single concentration representative of that location.

- Frequency of detection was calculated as the number of samples in which the chemical was detected, divided by the total number of samples collected. Duplicate samples were considered as one data point for determining frequency of detection.

- The maximum detected concentration of each chemical was reported. For this determination, duplicate samples were considered individually to ensure that any reported maximum concentration was an actual measured number, and not the average of two samples.

- The arithmetic mean of duplicate samples was calculated and this averaged value was used to represent the concentration for that location for the purpose of calculating the arithmetic mean.

- The arithmetic mean was calculated for each chemical using the detected concentration(s), or using one-half the sample quantitation limit (SQL) for the non-detect sample(s). If the reporting limit for a non-detect sample was two or more times higher than the maximum detected concentration in that medium, the sample was not included in the calculation of the mean for that chemical. Duplicate samples for a given sampling point were also treated in this manner if a chemical was detected in only one sample of a duplicate pair.

- Tentatively identified compounds (TICs), which are chemicals identified during a library search of mass spectra, were not included in the analyte list for a specified analysis but show up as additional peaks in the laboratory analysis.

> Because of uncertainties regarding the identity and concentration of TICs, these data were not used to make quantitative assessments of risk. However, these TICs and their potential impact on total risk estimates is discussed in the uncertainty section of the risk assessment (subsection 4.1.5).

Summary sampling data for the study area are presented by medium in Tables 4-1 through 4-3. Summary data were then used in the data screening procedures to select CPCs.

4.1.1.2 Data Screening Procedures. The selection of CPCs following procedures based on USEPA (1989b) guidance is described below. The results are indicated in Tables 4-1 through 4-3.

- Sampling data were compared to blank (laboratory, field, and trip) concentration data as described in Section 2. For purposes of the risk assessment, if all concentrations of a chemical within a sample grouping were considered to be due to blank contamination, then those analytes may be eliminated from consideration as CPCs. However, no chemicals met this criterion and, therefore, no chemicals were eliminated due to blank contamination.

- Because there are no site-specific background concentrations available for naturally-occurring chemicals, the summary data were not screened to eliminate these chemicals. It should be noted that some organic chemicals may be present due to general urban/industrial anthropogenic activities (e.g., pesticides, PAHs) and not specifically related to activities at the Olin Plant. Ambient conditions, which include both naturally-occurring compounds and anthropogenic compounds, are evaluated qualitatively.

- If the number of organic compounds detected was twenty or more, a concentration/toxicity screening procedure (USEPA, 1989d) was used to limit the number of chemicals in a particular medium to those most likely to contribute the majority of risk. A concentration/toxicity screen was performed for groundwater, and it is included in Appendix D.1 as Table D.1-1.

The toxicity screening was performed by scoring each chemical in a medium according to its concentration and toxicity to obtain a risk factor (R_{ij}). Separate scores were calculated for each medium being evaluated using the following formula:

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$$R_{ij}=(C_{ij})(T_{ij})$$

where:

R_{ij} = risk factor for chemical i in medium j;

C_{ij} = concentration of chemical i in medium j; and

T_{ij} = toxicity value for chemical i in medium j (i.e., either the cancer slope factor or 1/risk reference dose [RfD]).

The concentration used in the above equation was the maximum detected concentration for each compound (USEPA, 1989b). In some cases, both the oral and inhalation toxicity factors were available. Normally, in these cases, the most conservative toxicity value (i.e., one yielding the larger risk factor) is used unless an inhalation exposure scenario is unlikely (e.g., sediment).

Chemical risk factors were summed to obtain the total risk factor for all CPCs in a medium. Separate risk factors were calculated for carcinogenic and noncarcinogenic effects. The ratio of the individual risk factor for each chemical to the total risk factor approximates the relative risk for each chemical in a medium. Chemicals with very low ratios (i.e., less than 0.01) were eliminated as CPCs unless they belonged to a class of compounds in which one or more of the compounds exceed the risk ratio of 0.01 (e.g., pyridines). Degradation products of a compound which exceed the risk ratio were retained in the risk assessment.

CPCs retained in the selection process are presented in Tables 4-1 through 4-3 for the various media and are briefly discussed below.

Groundwater. Overburden and bedrock groundwater samples were combined into a single data set. CPCs selected in off-site groundwater samples included VOCs (e.g., 1,2-DCE, PCE, TCE and vinyl chloride), SVOCs (e.g., chloropyridines), and inorganic analytes (Table 4-1).

Surface Water. Because the Phase II surface water sampling was specifically designed to further investigate potential migration of chloropyridines and other site-related chemicals in groundwater, all analytes detected in surface water during the Phase II activities were retained as CPCs. The chloropyridines were also selected as CPCs because they are directly related to the Olin plant site. Olin is the only manufacturer of chlorinated pyridines in the United States. In the Erie Barge Canal, 2-chloropyridine and 2,6-

dichloropyridine were identified as CPCs as shown on Table 4-2. In the quarry seep samples, 2-chloropyridine, 3-chloropyridine, 2,6-dichloropyridine and p-fluoroaniline were identified as CPCs as shown on Table 4-3.

4.1.2 Exposure Assessment

Potential exposures associated with the study area and evaluated in the Phase II risk assessment are off-site exposure scenarios. Persons involved in recreational activities might contact surface water at the Erie Barge Canal, and workers at the Dolomite Products Quarry might contact surface water that has originated from groundwater seeps. Workers at future facilities which may use groundwater for industrial process water may be exposed to the groundwater or chemicals released from groundwater. On-site exposures are considered under Olin management and were previously addressed in the Phase I investigation. Because no source areas from the Olin Plant are identified for off-site soil, no surface soil samples were taken off-site and no soil exposure scenarios are evaluated.

CPCs associated with the Olin Plant may have migrated from Olin property by groundwater transport. The off-site exposures to groundwater were also assessed because of differences in CPCs (on-site versus off-site) and off-site exposures are not necessarily under direct Olin management.

For groundwater, seep water, and surface water off-site, potential exposure pathways were identified. An exposure pathway (i.e., the sequence of events leading to contact with a chemical) generally consists of four elements:

(1) A source and mechanism of chemical release to the environment;

(2) A retention or transport medium for the released chemical;

(3) A point of potential human contact with the contaminated medium (i.e., the exposure point); and

(4) A route of exposure (e.g., ingestion, dermal contact) for a potential receptor.

When all four of these elements are present, an exposure pathway is considered "complete." In some cases, element (2) is not necessary if exposure to the medium to which the chemical was released occurs. In the risk assessment, only complete or potentially complete exposure pathways are evaluated. The exposure assessment is performed to identify complete pathways at the study area. It draws on information regarding the source, fate and transport of chemicals, and information on human populations potentially exposed to chemicals in environmental media.

In evaluating potential human exposure pathways, 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.

The Olin Plant Site is located on the east side of the Erie Barge Canal, and the area in the immediate vicinity of the site is heavily industrialized. The Dolomite Products Quarry is located on the west side of the Erie Barge Canal. There are residences on the north and south sides of the quarry, and the ditch leading from the quarry to the Barge Canal passes along the edge of a residential development. Figure 4-1 identifies the locations of these features.

The basic future site and surrounding land use conditions at the study area were assumed to be similar to current conditions. Future residential use of the Olin site and Dolomite Products Quarry is not considered plausible, and therefore, future residential exposure was not evaluated. However, recreational exposures to surface water in the Erie Barge Canal, worker exposure to groundwater seeps at the Dolomite Products Quarry, and industrial exposures to off-site groundwater used as industrial process water, may potentially occur. Possible exposure pathways encompassing both current and future conditions are summarized in Figure 4-2 and Table 4-4, and are discussed below.

4.1.2.1 Potential Exposures Under Current Site Use. Appropriate exposure scenarios for the facility reflect the industrial/commercial use of the property. Residential exposures are not appropriate. However, due to the location of residences with respect to the Erie Barge Canal and the Dolomite Products Quarry (Figure 4-1), recreational activities are possible in the canal and the quarry, and industrial activities occur at the quarry. Groundwater is not used for residential or industrial purposes under current land use. Exposure to groundwater, however, could occur at the quarry seeps.

Surface Water. The presence of a rope swing overhanging the Erie Barge Canal in the vicinity of the study area suggests that children may swim in the canal. Discharge of the quarry pond water to the canal through the quarry outfall pipe, and the detection of chloropyridines in canal surface water indicate that exposure pathways may be complete. Older children (ages 7-17) and adults who swim or boat in the canal may be exposed to canal surface water CPCs through ingestion and dermal contact with the surface water.

People have reportedly been observed fishing at the Erie Barge Canal within 200 meters of the quarry outfall. Fish may bioconcentrate chemicals in the surface water, and people who consume the fish that they catch may then be exposed to those chemicals. An evaluation of exposure to site-related compounds via ingestion of fish from the Erie Barge Canal has been performed as a component of a separate report titled Phase II Remedial Investigation, Supplemental Human Health Risk Evaluation, Erie Barge Canal, November 1996 (ABB-ES, 1996a). This report is included as Appendix D-3 of the Phase II RI Report. A comprehensive summary of the human health risk assessments performed in support of the Phase I and Phase II RIs, including risks associated with fish ingestion, is presented in the Feasibility Study.

Workers in the Dolomite Products Quarry might infrequently come into contact with groundwater seeps via dermal contact. Chloropyridines have been detected in the quarry seeps, indicating that exposure pathways may be complete. The groundwater seeps are evaluated as surface water on the rock walls of the quarry. The area where the seeps are located is remote from the areas of activity at the quarry.

4.1.2.2 Potential Exposures Under Future Site Use. In addition to potential exposures discussed under current conditions, other exposures may occur through future-industrial activities.

Surface Water. Future exposures to surface water in the Erie Barge Canal and the Dolomite Products Quarry groundwater seeps would be similar to those described for the current land use scenario. Should the quarry become inactive, it is possible that recreational users or trespassers could contact groundwater seeps in the quarry. Were this to occur, however, it is unlikely that exposures would exceed those assumed for present-day quarry workers. Because the quarry pond is not an aesthetically inviting place to swim, it is very unlikely that children or adults would swim in the quarry pond.

Groundwater. Exposures to groundwater may also occur through future use of off-site groundwater as industrial process water. Dermal contact with the water and inhalation of VOCs released from the water during its use in an operating facility may occur.

4.1.2.3 Development of Exposure Point Concentrations. To quantitatively estimate the magnitude of exposures, and thus the risks that may be experienced by an individual, the concentration of the CPC in the contact medium must be known or estimated. This concentration is referred to as an exposure point concentration (EPC). To estimate exposures, the EPC is combined with assumptions on the rate and magnitude of chemical contact. EPCs for each pathway were determined using data collected during the RI and are described below.

Quantitative exposure estimates are derived by combining EPCs with information describing the extent, frequency, and duration of exposure for each receptor of concern. An overview of the approaches used to quantify exposures is given below, followed by specific details for potential exposure pathways. The approaches described in the following paragraphs to quantify exposures are consistent with guidance provided by USEPA (1989d, 1991a, 1992e,f).

Based on USEPA risk assessment guidance (USEPA, 1989d, 1991a), exposures 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 (see subsection 4.1.3), the RME is intended to place a conservative upper-bound on the potential risks. Consequently, the risk estimate is unlikely to be underestimated but it may very well be overestimated. The likelihood that this RME scenario may actually occur is small, due to the combination of conservative assumptions incorporated into the scenario. The RME estimate for a given pathway is derived by combining the selected EPC (based on the maximum detected concentration) of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA, 1989d). Many of the exposure parameter values used in this assessment have been defined by USEPA (1989b, 1989g, 1991a) for the RME case.

In order to provide a range of risk estimates to be used for risk management decisions, EPCs were also calculated using the average concentration. This provides a more likely EPC than that calculated using only the maximum detected concentration and maximum exposure values. EPCs for groundwater, Barge Canal surface water, and quarry groundwater seeps are the maximum and arithmetic mean concentrations presented in Tables 4-1 through 4-3.

EPCs for the study area are medium- and location-specific. For surface water, the average CPC concentrations represent the arithmetic mean concentrations of CPCs detected in Barge Canal surface water during sampling events performed in April, June, and September 1996, and April and June, 1997, subsequent to other Phase II sampling activities. These data are the most recent data collected, and reflect the temporal average of concentrations during months when swimming in the Barge Canal may occur. Because sampling data suggest that surface water concentrations measured during 1996 and 1997 sampling events are higher than concentrations measured during 1994 and 1995 sampling events, the temporal average of the most recent data are an appropriate representation of the average exposure scenario EPC. The maximum Barge Canal surface water concentrations are represented by the maximum detected concentrations of CPCs in the quarry outfall water. The EPC based on these data is appropriate for conservatively modeling exposures to swimmers who may swim directly beneath the quarry outfall, a scenario which represents the RME for recreational swimmers.

Groundwater was divided into on-site and off-site areas. Groundwater samples taken at the Olin property are considered on-site, while those taken beyond the property line are considered off-site. Seep groundwater, evaluated as surface water for exposure purposes, was collected from four seeps on the face of the quarry wall during the September, 1995 sampling event. No site-related compounds were detected in sample QS-1 and, therefore, data for this sample were excluded from the EPC calculation. Concentrations in sample QS-4 were highest and, therefore, this seep was resampled in October 1995, and March, June, September, and December, 1996. Data for these sampling events were included in the average and RME EPC calculations.

The general equation for calculating chemical intake is as follows:

$$Intake = \frac{(C \times CR \times RAF \times EF \times ED)}{BW \times AT \times CF}$$

where:

Intake = daily intake averaged over the exposure period
C = concentration of the chemical in the exposure medium
CR = contact rate for the medium of concern
RAF = relative absorption factor
EF = exposure frequency
ED = exposure duration
BW = body weight of the hypothetically exposed individual
AT = averaging time (for carcinogens, AT = 70 years; for noncarcinogens, AT = ED)
CF = units conversion factor (365 days/yr)

Specific equations for each exposure scenario are provided in Appendix D.1 on Table D.1-2. Standard parameters from USEPA guidance were used to the extent that is appropriate in the intake equations. Table D.1-2 delineates the parameters used in each scenario and lists a source for each.

The contact rate reflects the amount of contaminated medium contacted per unit of time or event. The contact rate for dermal exposure to CPCs in water is estimated by combining information on exposed skin surface area, the dermal permeability of the CPC, and the exposure time. Dermal permeability of CPCs in water was evaluated using an approach identified in "Dermal Exposure Assessment: Principles and Application" (USEPA, 1992e). For inorganics, a steady-state approach was used, wherein the permeability coefficient for the inorganic is multiplied by the exposure time, assuming that the contact rate depends only on the amount of chemical crossing the skin barrier. For organic CPCs, a nonsteady-state approach was used which accounts for the total amount of chemical crossing the exposed (outside) skin surface rather than the amount which has traversed the skin and entered the blood during the exposure period (i.e., under a steady-state condition). Therefore, the nonsteady-state approach more accurately reflects normal exposure conditions (under which steady-state often may not occur) and accounts for the dose that may enter the circulatory system after the exposure event due to the storage of chemicals in skin lipids (USEPA, 1992e). In this approach, the permeability coefficient is modified by various factors to account for partitioning properties of the chemical, thickness of the skin, and diffusivity of the chemical within the skin layer. The equations to adjust the permeability coefficient vary according to whether the actual exposure time is more or less than the time it takes for the chemical to reach steady-state. The equations and factors used for each identified CPC in groundwater and surface water are listed in Table D.1-3.

Calculation of theoretical indoor air concentrations - industrial process water scenario. Since there is no means of measuring indoor air concentrations for a potential facility which might use groundwater as industrial process water, a theoretical calculation was conducted to estimate conservatively the concentration in a facility's air in the event that volatile organic compounds were to be released from groundwater which might be used as industrial process water in a manner that is open to the air.

The industrial process water scenario assumes a theoretical building 34.1 meters (approximately 112 feet) long, 34.1 meters (approximately 112 feet) wide, and 3 meters (approximately 10 feet) high. It is assumed that the air exchange rate in the industrial facility is 1 building volume per hour. Residential dwellings in this area of the U.S. typically have air exchange rates between 0.25 and 0.82 building volumes per hour (Murray et al., 1995) with a mean over the four seasons of the year of 0.40 building volumes per hour. Industrial buildings typically have greater air exchange rates than residential dwellings.

It is assumed that a very large volume of groundwater is used as industrial process water in the theoretical facility. One million liters per day (264,200 gallons per day), used at a constant rate throughout the day, is the assumed groundwater usage. It is further assumed that all of the groundwater used in the facility contains all of the compounds which have been detected in the Phase II investigation. The inhalation evaluation was conducted in two ways, using both average and maximum reported groundwater concentrations. In evaluating potential inhalation exposures, it is assumed that the volatile compounds in the groundwater are released from the water to the building interior immediately and are immediately dispersed upon use of the water.

The total mass of each volatile compound released to the building interior per day can be calculated as the concentration of the compound in groundwater multiplied by the volume of groundwater used in the facility per day. Further, the concentration of the compound in the building interior air can be calculated as the total mass released divided by the volume of air passing through the building per day. That volume of air is simply the volume of the building multiplied by the air exchange rate (building volumes per hour) multiplied by 24 hours. Table D.2-3 presents these calculations and the estimated building interior air concentrations based on both the average and maximum reported groundwater concentrations.

4.1.3 Toxicity Assessment

The objective of the dose-response assessment is to define the relationship between the dose of a substance and the likelihood that a toxic effect, either carcinogenic or noncarcinogenic, will result from exposure to that substance. Dose-response values were identified and used to estimate the likelihood of adverse effects as a function of human exposure to an agent. Dose-response summaries are presented in Appendix D.1 on Tables D.1-4 through D.1-6.

There are two types of dose-response values: cancer slope factors (CSFs) and reference doses (RfDs). The derivation of each value for a particular compound depends on the toxicity of that compound and whether it displays carcinogenic or noncarcinogenic effects. USEPA has derived CSFs and RfDs to evaluate carcinogenic and noncarcinogenic (systemic) risks, respectively. The definition of CSFs and RfDs, as stated in USEPA guidance are:

- Cancer Slope Factor - a plausible upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular concentration of a potential carcinogen (USEPA Class A or B carcinogens) (USEPA, 1989d).

- Chronic Reference Dose - an estimate of a daily exposure concentration for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective from long-term exposure to a compound (e.g., as a Superfund program guideline, seven years to lifetime) (USEPA, 1989d).
- Subchronic Reference Dose - an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a portion of a lifetime (e.g., as a Superfund program guideline, two weeks to seven years) (USEPA, 1989d).

In addition, because the toxicity and/or carcinogenicity of a compound can depend on the route of exposure (e.g., oral or inhalation), unique dose-response values (e.g., CSFs and RfDs) have been developed for the oral and inhalation exposure routes.

The primary source for identifying dose-response values is the Integrated Risk Information System (IRIS) (USEPA, 1996). If no information is found in IRIS, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995) are used. If appropriate dose-response values are not available from either of these two sources, other USEPA sources are consulted (e.g., the USEPA National Center for Environmental Assessment [NCEA]). If no data exist to support the derivation of a toxicity value for a given substance, a surrogate assignment may be made or the compound is discussed qualitatively in the uncertainty section.

The methodology used to develop dermal toxicity values is obtained from Risk Assessment Guidance for Superfund, Appendix A (USEPA, 1989d). In general, the oral toxicity value is adjusted from administered dose to absorbed dose, if necessary. The absorption efficiency of a particular compound is used to calculate the RfD based on absorbed dose. For example: if the RfD based on administered dose was 20 mg/kg/day, and the absorption efficiency in the study, which is the basis of the RfD, was 10 percent, then: 20 mg/kg/day x 0.10 = 2 mg/kg/day. Therefore, the adjusted RfD is 2 mg/kg/day. The adjusted RfD is compared to the amount estimated to be absorbed from dermal exposure. This adjusted value is the dermal reference dose (RfD_{derm}). Similarly, the dermal cancer slope factor (SFD) is adjusted from the oral CSF. For example: if the CSF based on administered dose was 1.6 $(mg/kg/day)^{-1}$, and the absorption efficiency in the study, which is the basis of the CSF, is 20 percent, then: 1.6 $(mg/kg/day)^{-1}/0.20 = 8$ $(mg/kg/day)^{-1}$. The adjusted CSF is compared to the amount estimated to be absorbed from dermal exposure. This adjusted value is the SFD.

The oral (or in some cases inhalation) absorption efficiency for individual compounds is obtained from IRIS, HEAST or Agency for Toxic Substances and Disease Registry (ATSDR) toxicity profiles. If the absorption efficiency is not available from these sources, the efficiency is assumed to be similar to structurally similar compounds.

No dose-response health effects criteria were available for some of the CPCs. Therefore, risks associated with these chemicals could not be quantitatively evaluated although they may be retained as CPCs as indicated in the appropriate tables. Chemicals not quantitatively evaluated include lead, nutrients in groundwater, and a number of TICs. Because of the relatively high concentrations of chloropyridines detected, these compounds were quantitatively evaluated using chlorobenzene and/or 1,4-dichlorobenzene as a surrogate compound, although this adds to the uncertainty of the risk evaluation. The following discussion presents the rationale for selection of these compounds as surrogates with respect to potential toxicity of chloropyridines.

4.1.3.1 Surrogate Dose-Response Values. Because there are no published USEPA RfDs or CSFs for the chloropyridine compounds detected at the site, alternative sources of toxicological information were accessed to either develop compound-specific dose-response values or to estimate the toxicity of these compounds based on the toxicity of structurally similar compounds which have published dose-response values. The following paragraphs provide documentation and rationale for the selection of surrogate dose-response values. The toxicological literature was searched to identify appropriate toxicity data. Unfortunately, data suitable for derivation of dose-response values were very limited for chloropyridine compounds; only acute toxicity data (e.g., LD_{50} data) and mutagenicity studies were located. However, data presented in a number of mutagenicity studies provided sufficient information to identify suitable surrogate compounds for chloropyridine compounds, as described below.

Available evidence suggests that some chloropyridine compounds are mutagenic, whereas others are not; the mutagenic potential appears to be related to the position of the chlorine atom(s) relative to the nitrogen atom. In Salmonella reversion assays, 3-chloropyridine and 4-chloropyridine are not mutagenic (Claxton, 1987; Dearfield, 1986, 1993). No information for these compounds in other test systems is available. In contrast, 2-chloropyridine is mutagenic in both the Salmonella reversion assay and mouse lymphoma cells, but only in the presence of metabolic activation. Di-substituted pyridines with one halogen atom in the ortho-position (such as 2,6-dichloropyridine) are also mutagenic in Salmonella in the presence of metabolic activation (Claxton, 1987; Dearfield, 1986, 1993; Chlopkiewicz, 1993). These findings suggest that chloropyridines are more potent mutagens when the chlorine atom is in the ortho position relative to the nitrogen atom. In addition, since mutagenicity appears to occur only in the presence of metabolic activation, a metabolite or reactive chemical intermediate produced during chloropyridine biotransformation is likely responsible for the observed mutagenic effects. This possibility is supported by the observation that reactive species such as peroxides and hydroxide radicals, which are often products of ring-hydroxylation metabolism and are known to react with cellular macromolecules such as DNA, were produced during 2-chloropyridine biotransformation (Chlopkiewicz, 1993).

Although information concerning the biotransformation of other chloropyridine compounds is not available, it is likely that they are biotransformed through a similar pathway. Likewise, the potential carcinogenicity of chloropyridines is unknown, since no bioassay data are available. However, the mutagenic activity demonstrated in the in vitro test systems suggests that chloropyridines are potential carcinogens.

Given the toxicity data presented above, an appropriate surrogate for 2-CPL and 2,6-CPL should be a chemical with a structure that consists of a single aromatic ring, preferably substituted, that is potentially carcinogenic and yields mutagenic intermediates or by-products during metabolism. A chemical with a similar structure, but possessing less carcinogenic or mutagenic potential, should be a suitable surrogate for 3-CPL and 4-chloropyridine (4-CPL). Based on chemical structure, pyridine and chlorobenzenes are possible choices as surrogate chemicals for chloropyridines.

Both pyridine and chlorobenzenes possess chemical attributes similar to chloropyridines. Pyridine contains the nitrogen atom present in chloropyridines, whereas chlorobenzenes contain the chlorine substituents present in chloropyridines. However, the commonality of chlorine substituents on chlorobenzenes and chloropyridines suggest that pharmacokinetics and metabolism may be more similar between these chemicals than between pyridine and chloropyridines. A comparison of available toxicological data for 1,4-dichlorobenzene, chlorobenzene, and pyridine support this hypothesis.

Available data indicate that 1,4-dichlorobenzene may be mutagenic in mammalian cell cultures when tested in the presence of metabolic activation. The results of a cancer bioassay indicate that 1,4-dichlorobenzene is carcinogenic to mice and rats. The metabolic pathway for 1,4-dichlorobenzene is not well characterized, but may involve ring-hydroxylation with subsequent formation of epoxide intermediates and generation of peroxides (ATSDR, 1990a). This evidence suggests 1,4-dichlorobenzene acts as a tumor promoter, rather than a direct-acting carcinogen. Based on this evidence, USEPA has classified 1,4-dichlorobenzene as a Group C "possible human carcinogen".

Chlorobenzene was not mutagenic in mammalian cell cultures or bacterial cultures when tested in the presence or absence of metabolic activation. Although chlorobenzene produced neoplastic nodules in male rats in a cancer bioassay, it did not produce neoplastic lesions in female rats or in either sex of mice. The metabolism of chlorobenzene involves ring-hydroxylation with subsequent formation of epoxide intermediates and peroxides (ATSDR, 1989). Together, this evidence suggests that chlorobenzene is, at best, a weak carcinogen. Nonetheless, USEPA has ranked chlorobenzene as a Group C "possible human carcinogen".

Pyridine was not mutagenic in mammalian or bacterial cell cultures in the presence or absence of metabolic activation, nor was it considered carcinogenic in a cancer bioassay. Most pyridine biotransformation pathways involve metabolism of the nitrogen atom, and not ring-hydroxylation. Therefore, reactive chemical intermediates are not produced (ATSDR, 1990b).

Based on these toxicological considerations, chloropyridines and chlorobenzenes may yield similar mutagenic and potentially carcinogenic chemical intermediates and metabolites during biotransformation. In contrast, the biotransformation of pyridine does not appear to produce mutagenic or potentially carcinogenic products. Based on this information, chlorobenzenes are the preferred surrogates for chloropyridines.

The assigning of surrogates for the various chloropyridine compounds is based on a comparison of the relative potential carcinogenic potency among chloropyridine compounds to the relative carcinogenic potency among chlorobenzene compounds. Based on the limited data available, ortho-substituted chloropyridines appear to be more potent mutagens than other chloropyridine compounds (i.e., non-ortho-substituted), just as 1,4-dichlorobenzene appears to be a more potent mutagen than chlorobenzene. Although no cancer bioassay data are available for chloropyridines, the available mutagenicity data suggest that 2-CPL and 2,6-CPL may be potential carcinogens.

The lack of mutagenic activity of 3-CPL and 4-CPL does not discount them as potential carcinogens, but suggests that potential carcinogenic potency is lower. Likewise, the positive carcinogenicity data for 1,4-dichlorobenzene and the ambiguity of the carcinogenicity data for chlorobenzene suggest that 1,4-dichlorobenzene is a more potent carcinogen than chlorobenzene. Given these data, the more potent chloropyridine compounds, 2-CPL and 2,6-CPL, are assigned the more potent chlorobenzene compound, 1,4-dichlorobenzene as a surrogate. Therefore, the oral CSF for 1,4-dichlorobenzene of

0.024 $(mg/kg/day)^{-1}$ has been assigned to those two compounds. The chloropyridine compounds of lesser potency, 3-CPL and 4-CPL, are assigned chlorobenzene as a surrogate, which appears to be a less potent carcinogen than 1,4-dichlorobenzene. Therefore since a CSF has not been developed for chlorobenzene, the oral RfD of 0.02 mg/kg/day for chlorobenzene has been assigned to those compounds. This assumes that noncancer effects are more significant for chlorobenzene, due to its low potential carcinogenic potency.

4.1.4 Risk Characterization

In this final step of the risk assessment process, the exposure and toxicity information are integrated to develop both quantitative and qualitative evaluations of risk. To quantitatively assess risks associated with CPCs in an environmental medium, the average daily intakes calculated in the Exposure Assessment were combined with the health effects criteria presented in the Toxicity Assessment. The methodology used to quantitatively assess risks is described in detail below.

Methodology. USEPA (1989d, 1992f) has developed guidance for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals. The USEPA uses separate methodologies for estimating the risks from chemicals causing cancer and from chemicals causing adverse noncarcinogenic effects.

For exposures to a chemical exhibiting carcinogenic effects, an individual upper bound excess lifetime cancer risk was calculated by multiplying the estimated daily intake by the relevant CSF. The resulting 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. 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). To assess the upper bound individual excess lifetime cancer risks associated with simultaneous exposure to all carcinogenic chemicals of concern, the risks derived from the individual chemicals were summed within each exposure pathway. This approach is consistent with the USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA 1989d), but is not realistic if maximum concentrations occurring in different locations were used as exposure point concentrations. The relative significance of risk estimates were evaluated by comparison to a target risk level of 10^{-4} to 10^{-6} established by USEPA (USEPA, 1989b), and to the lower value of this range, which the NYSDOH considers to be a bound between cancer risks that are negligible and those that require further evaluation.

Unlike carcinogenic effects, noncarcinogenic effects are not expressed as incidence probabilities. Rather, potential noncarcinogenic impacts were calculated by means of a hazard quotient (HQ)/hazard index (HI) technique as recommended by USEPA (1989d). To assess impacts associated with noncarcinogenic exposures, the ratio of the daily intake to the reference dose was calculated for each noncarcinogenic chemical to derive an HQ. In general, HQs that are less than one indicate that the associated exposure is not likely to result in any adverse health effects, whereas HQs greater than one indicate that adverse health effects may occur. The effects from simultaneous exposures to all CPCs were computed by summing the individual HQs within each exposure pathway. This sum, known as the HI, serves the same function for exposures to a mixture as the HQ does for exposures to an individual compound. HIs greater than one indicate the potential for the occurrence of adverse health effects. A conclusion should not be categorically drawn, however, that all HIs greater than one are "unacceptable," because of the multiple conservative assumptions built into the exposure estimates and toxicity characterization. For these same reasons, the HIs less than one are generally regarded as being "safe." If an HI calculated in this assessment was greater than one, the CPCs were subdivided into categories based on target organ/critical effect affected by exposure (e.g., liver, skin, etc.) in accordance with USEPA guidance (USEPA, 1989d). HIs were then reexamined for these categories to better identify the potential for noncarcinogenic effects to occur.

Inhalation exposures for workers in operating facilities have been evaluated by comparing estimated indoor air chemical concentrations to workplace indoor air standards (Permissible Exposure Levels or PELs) issued by the American Conference of Governmental and Industrial Hygienists (ACGIH).

Results. Potential human health risks associated with the various environmental media investigated at the Olin Study Area were characterized using USEPA guidance. The media evaluated were groundwater (and associated inhalation exposures), surface water, and groundwater seeps. Cancer risks were characterized by comparison to the USEPA acceptable risk level of 1×10^{-4} to 1×10^{-6}. Noncancer risks were evaluated by comparison to the USEPA HI of 1.0. An HI of 1.0 or less indicates that no adverse health risks are expected from exposures at the study area. NYSDEC has established guidance risk levels for residential exposures, but not industrial exposures (NYSDEC, 1994a). The NYSDOH considers excess lifetime cancer risks below 1×10^{-6} to be negligible, and those above that level to require further evaluation.

The risk characterization tables for the individual media and exposure scenarios are presented in Appendix D-2 spreadsheets. Quantitative potential health risks are summarized by medium in Table 4-5, and by receptor in Table 4-6.

Surface Water. Surface water is quantitatively evaluated in the risk assessment because of the potential for exposures to the surface water in the Erie Barge Canal during recreational use, and groundwater seeps in the Dolomite Products Quarry during industrial use. Risks are calculated for exposures to an older child (ages 7 through 17) and adult who are assumed to swim in the Barge Canal. As discussed previously, the series of groundwater seeps on the face of the quarry walls is evaluated as a "surface water" exposure to a quarry worker. The evaluation of risks to an angler is presented in Appendix D-3.

As shown on Table 4-5, cancer risks for potential exposure to these media are below an excess lifetime cancer risk of 1×10^{-6} for both the average and RME scenarios. Likewise, non-cancer risks are below a hazard index of one for both scenarios. Risk calculations are presented in Tables D.2-4 through D.2-9. Evaluation of risks to site-related chemicals from potential ingestion of fish taken from the Erie Barge Canal are also below a cancer risk of 1×10^{-6} and a hazard index of 1 (Appendix D-3).

Groundwater. Groundwater associated with the study area was characterized as a single data set because the presumed potential future use of the groundwater is industrial process water, which might be withdrawn from any depth within the aquifer. Groundwater is quantitatively evaluated in the risk assessment because of the potential for exposures to workers in industrial facilities that might use groundwater as industrial process water in the future. There are no uses of groundwater under current land use. As shown in Table 4-5, cancer risk for exposure to offsite groundwater (mean concentrations) is 7×10^{-5}, which is within the USEPA acceptable carcinogenic risk range of 1×10^{-6} to 1×10^{-4}. The Cancer risk for the RME to off-site groundwater is 9×10^{-4}, which exceeds the upper end of the USEPA acceptable carcinogenic risk range. Noncancer risks exceed the generally accepted levels for maximum reported concentrations (hazard index of 29) and for mean concentrations (hazard index of 4). Risk calculations are presented in Tables D.2-1 and D.2-2.

The predominant contributors to carcinogenic risk (mean concentrations) are vinyl chloride (48.6% of the risk), 2-CLP (31.6% of the risk) and 2,6-DCLP (12:6% of the risk). The major contributors to noncancer risk are iron (79% of the risk), benzene (13.3% of the risk), and zinc (4.5% of the risk), for the dermal contact exposure scenario. It appears that the high levels of iron and zinc observed in the groundwater may be associated with turbidity in the groundwater samples, and, therefore, the concentrations and risks may not be representative of the exposure scenario which was evaluated. In addition, iron and zinc do not appear necessarily to be site-related. As a consequence, the results do not indicate significant potential health risks associated with dermal exposure to inorganics in off-site groundwater in an industrial process water scenario.

An inhalation-based exposure scenario for the use of groundwater as industrial process water was evaluated using a very conservative screening assessment for potential releases of VOCs from groundwater into the air within an operating industrial facility. As shown in Table D.2-3, it has been assumed that the maximum reported concentrations of VOCs in groundwater are released into the air from uncontained processing equipment. Concentrations in air for a theoretical facility were compared to permissible exposure limits (PELs) published by ACGIH; none of the estimated concentrations of volatiles exceeded any PELs (Table D.2-3). Therefore, estimated concentrations meet workplace air standards.

Summary. Table 4-6 provides a summary of risk estimates for current recreational and potential future recreational and industrial land use conditions. As indicated in Table 4-6, cancer risks for a recreational child and adult swimmer exposed to Erie Barge Canal surface water and Quarry Outfall water are below an excess lifetime cancer risk of 1 x 10^{-6}, and non-cancer risks for these exposures are below a hazard index of 1. In addition, risks for ingestion of site-related chemicals in fish taken from the Erie Barge Canal are below these levels (Appendix D-3). The risks for recreational uses of the Erie Barge Canal and industrial uses of the Dolomite Products Quarry are at a level which USEPA and NYSDOH consider to be negligible.

Cancer risk estimates for a future industrial worker exposed to groundwater used as industrial process water exceed the USEPA acceptable cancer risk range of 1 x 10^{-6} to 1 x 10^{-4} under RME conditions, but are within this range for exposures to average groundwater concentrations. 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. Because cancer risks for potential future industrial use direct-contact exposures to groundwater exceed an excess lifetime cancer risk of 1 x 10^{-6}, and non-cancer risks exceed a hazard index of 1, the need for establishing specific remedial goals will be evaluated in the Feasibility Study.

The results of the risk assessment for the Phase II RI are consistent with previous risk assessments. Sirrine Environmental (Olin, 1990) conducted an assessment of potential human health risks associated with surface water in the Erie Barge Canal. The assessment was part of an investigation of the groundwater at the Olin Plant site. The risk assessment modeled the transport of site-related CPCs to the Erie Barge Canal. Exposure to the

CPCs was assumed to occur through swimming in the canal and consumption of fish caught from the canal. The CPCs identified were benzene, dibromochloromethane, bromoform, carbon tetrachloride, chlorobenzene, 1,2-DCE, 1,3-dichlorobenzene, TCE, PCE, chloroform, p-fluoroaniline, methylene chloride, pyridine, monochloropyridines, 2,6-CPL, and vinyl chloride. The risk characterization identified a noncancer HI of only $7x10^{-4}$, well below the USEPA guidance level of 1.0. The calculated cancer risk, $4.5x10^{-8}$, was also below the USEPA target risk range of $1x10^{-4}$ to $1x10^{-6}$.

A summary of the risk assessments performed in support of the Phase I and Phase II RIs for the Olin Chemicals Facility is provided in the Feasibility Study.

4.1.5 Evaluation of Uncertainty

The interpretation of risk estimates is subject to a number of uncertainties as a result of multiple assumptions inherent in risk assessment. All quantitative estimates of risk are based on numerous assumptions, most intended to be protective of human health (i.e., conservative). As such, risk estimates are not truly probabilistic estimates of risk, but rather conditional estimates given a series of assumptions, usually conservative, about exposure and toxicity.

In general, sources of uncertainty are categorized into general uncertainties inherent in most risk assessments (e.g., toxicity assessment methods), and site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions). Major sources of uncertainty and their potential effects (e.g., to over- or underestimate risks) are presented in Table 4-7. Site-specific uncertainties that lend to over- or under-estimation of risks, and therefore have the greatest bearing on interpretation of the risks estimated in this risk assessment, are discussed below.

Tentatively Identified Compounds Tentatively identified compounds (TICs), which are chemicals identified during a library search of mass spectra, were not included in the analyte list for a specified analysis but show up as additional peaks in the laboratory analysis. Because of uncertainties regarding the identity and concentration of TICs, these data were not used to make quantitative assessments of risk. A review of the TIC data (available for groundwater only) indicates that several petroleum hydrocarbon compounds were detected in groundwater at estimated concentrations ranging from 1 ug/L to 260 ug/L. The majority of compounds were classified as substituted benzene derivatives, alkylbenzene derivatives, hexane, or pentane. No dose-response data are available for these compounds, and both the estimated identity and concentrations of these compounds are uncertain. However, substituted benzenes and alkyl benzenes are anticipated to have the same general pharmacokinetic and toxicological properties as specific compounds in this chemical group for which considerable information is available (e.g., ethylbenzene, xylenes). Ethylbenzene, toluene, and xylenes, which were detected at concentrations of up to 2,300 ug/L, were eliminated as groundwater CPCs in this risk assessment following the toxicity screening procedure. Therefore, it is unlikely that the petroleum hydrocarbon TICs that were identified in groundwater at considerably lower concentrations would pose a risk of concern. Excluding these compounds from the risk assessment has not resulted in a substantial underestimation of risk.

Surrogate Dose-Response Values Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values. Sources of uncertainty for calculating toxicity factors include extrapolation from short-term to long-term exposures, amount of data (e.g., number of studies) supporting the toxicity factors, consistency of different studies for the same chemical, and responses of various species to equivalent doses.

The assignment of surrogate toxicity factors for the chloropyridine compounds is a source of uncertainty. By assigning the cancer slope factors for 1,4-dichlorobenzene to 2-CPL and 2,6-CPL, a conservative approach has been taken in evaluating risks for those compounds. Likewise, the assignment of the RfD for chlorobenzene to 3-chloropyridine and 4-CPL is believed to represent a conservative approach to the evaluation of non-carcinogenic health risks. The risks associated with exposure to p-fluoroaniline were evaluated using the RfD for 4-chloroaniline. In the absence of a published RfD for p-fluoroaniline, this is considered a conservative approach to the evaluation of risks.

Dose response values are not available for calcium, magnesium, potassium, and sodium. Therefore, risks for exposure to these inorganics could not be quantified. However, these four inorganics are essential nutrients that are required for maintenance of normal physiological functions. The Food and Drug Administration has established Recommended Dietary Allowances (RDAs) of these nutrients (NRC, 1989). Intakes below or above the RDA may result in toxicity, however, humans can tolerate intakes several times greater than the RDA before adverse effects develop (NRC, 1989). The intakes of essential nutrients calculated in this risk assessment are below RDAs indicating that, even with additional exposure to these substances in environmental media, adverse effects would not be expected.

This in particular is the case for iron, which is also an essential nutrient but for which a provisional dose-response value has been published by the National Center for Environmental Assessment (NCEA). The NCEA provisional RfD for iron is not based on a threshold dose for toxicity, but is instead based on the average intake of iron required as an essential nutrient. As a result, hazard quotients that would be calculated for potential exposures to iron do not represent increased likelihood of adverse health effects. Use of the iron RfD for calculating human health risks for iron exposures only reflects the ratio of iron intake received from environmental media to the dose required for normal physiological functions. It does not reflect the ratio of iron intake received from environmental media to the threshold dose for iron toxicity. A hazard quotient of 1 for iron, for example, indicates that the dose of iron theoretically received from environmental media is equal to the daily dose required as an essential nutrient, and not a dose which is associated with toxicity. Moreover, a hazard quotient of 1 calculated using the NCEA provisional iron RfD would fall below the RDA for a child and within the NOAEL dose range for both children and adults. The hazard quotients for iron for potential future industrial worker dermal exposures to groundwater, therefore, are not considered representative of substantial risks.

Volatile Migration to Building Air Olin has researched groundwater use in the site area and believes that there is little likelihood that there is any resident using groundwater for landscaping or other purposes. If such a case were to be present however, the potential exposure could be thought to be similar to the pathway discussed in Section 4.1.2.2 - dermal exposure to quarry workers. This pathway was examined in the risk assessment and was not associated with any unacceptable risks.

One potential exposure pathway, migration of VOCs from groundwater to indoor air via basement seepage, was not quantitatively evaluated in the Phase II RI risk assessment. However, the risk assessment incorporated a very conservative evaluation of VOC migration from groundwater used as process water to indoor air. This evaluation, which assumed that a hypothetical facility uses a large amount of groundwater (i.e., 1 million liters per day) and that the entire mass of all VOCs detected in groundwater was released from the process water to indoor air, concluded that no indoor air concentrations would exceed workplace air standards. Seepage of groundwater to buildings (e.g., into basements) would not result in indoor air concentrations as high as those estimated for the process water scenario, and groundwater VOCs migrating to indoor air via soil gas would not result in indoor air concentrations as high as those estimated in the process water scenario.

In order for indoor air concentrations of any compound detected in groundwater to exceed workplace air standards, it would be necessary to assume that either: 1) the contribution of VOCs to indoor air from groundwater migration via soil gas was equal to the contribution from process water, and that both fate and transport processes occurred simultaneously (to result in indoor air concentrations twice those estimated for the process water scenario), or 2) the building air exchange rate was reduced from one building volume air exchange per hour, to 0.4 building volume air exchanges per hour (representing the mean annual building air exchange rate for residential dwellings). These assumptions are not realistic for a well-vented commercial/industrial building. Even using these unrealistic assumptions and maximum groundwater concentrations, only benzene and p-fluoroaniline would theoretically occur in indoor air at concentrations up to 7 mg/m^3 and 9.5 mg/m^3, respectively, values slightly above the workplace air standards of 3 mg/ m^3 and 8 mg/ m^3, respectively.

The low likelihood that groundwater VOCs would occur in indoor air at concentrations of concern is further supported by soil gas data collected during the Phase I investigation. Of the soil gas measurements recorded at 87 locations in the vicinity of the Olin Plant, only one compound (trichloroethene) was detected at a single location at a concentration above the OSHA workplace air standard.

<u>Swimmer Exposure Assumptions</u> To help describe the uncertainty associated with the chemical-physical data and the exposure assumptions used in the swimmer exposure scenario, risks were developed for minimum, average, and maximum exposure assumptions. Risk-based concentrations (RBCs) were then developed from these risk estimates. This evaluation is described in detail in Appendix D-3. The RBCs can be compared to surface water concentrations in the Barge Canal or Quarry outfall to gauge the risks to humans potentially exposed to those media (via recreational swimming). As described in Appendix D-3, only the <u>maximum</u> concentrations of 2,6-dichloropyridine and 2-chloropyridine, which are represented by the data for the quarry outfall water, exceed RBCs. The RBCs exceeded are those based on maximum exposure conditions for the $1x10^{-6}$ cancer risk level; RBCs based on average exposure conditions or non-cancer effects are not exceeded. Again, comparison of quarry outfall water concentrations to RBCs that are based on the most stringent exposure conditions represents an extremely conservative evaluation of potential risks.

4.1.6 Human Health Risk Assessment Summary and Conclusions

Health risks associated with potential exposures to media off-site at the Olin Plant were evaluated for groundwater (including associated inhalation exposures) and surface water, including groundwater seeps. CPCs were selected on a medium- and location-specific basis. Generally, the CPCs identified were VOCs (particularly chlorinated compounds), SVOCs (primarily chloropyridines), and inorganics. The exposure scenarios quantitatively evaluated include industrial/commercial worker and recreational exposures. Potential health risks are characterized using USEPA-acceptable risk levels. The potential health risks are summarized below.

- No significant human health risks were identified for potential exposures to surface water in the Erie Barge Canal or to groundwater seeps in the Dolomite Products Quarry under current or potential future land use conditions; cancer risks did not exceed an excess lifetime cancer risk of 1×10^{-6}, and non-cancer risks did not exceed a hazard index of 1.

- Evaluation of potential future worker exposure to off-site groundwater used as industrial process water identified cancer risks above 1×10^{-6} but below 1×10^{-4} (i.e., within the USEPA acceptable cancer risk range) for mean groundwater concentrations. For maximum concentrations, however, carcinogenic risks were calculated to be 9×10^{-4}, above the upper end of the USEPA acceptable cancer risk range. Calculated non-cancer risks were elevated, but the majority of that risk appears to be attributable to iron and zinc associated with turbidity in groundwater samples. In addition, the iron and zinc concentrations detected in off-site wells were higher than any detections on-site. Therefore, risks are unlikely to be related to Olin operations. Because risks for potential future exposures to off-site groundwater used as industrial process water exceeded an excess lifetime cancer risk of 1×10^{-6} and a non-cancer hazard index of 1, the need for establishing specific remedial goals will be evaluated in the Feasibility Study.

- Modelling a hypothetical future release of VOCs from groundwater used as process water to industrial facility air did not result in any exceedances of workplace air standards.

- Groundwater concentrations exceeded MCLs and New York Standards for several CPCs. No domestic use of the groundwater is anticipated. For aesthetic reasons, groundwater in the vicinity of the Olin Study Area is not used as a drinking water source. Naturally-occurring sulfide and explosive gases preclude use of bedrock groundwater for drinking water.

4.2 HABITAT-BASED ECOLOGICAL ASSESSMENT

This subsection presents the results of a supplemental ecological risk assessment (ERA) for the Olin Study Area conducted as part of the Phase II RI. This assessment was performed in accordance with NYSDEC (1989, 1991) guidance, which provides an approach for the "characterization of the fish and wildlife values and threats at hazardous waste sites being considered for remediation".

This assessment supplements, rather than replaces, the Phase I ERA (ABB-ES, 1994), and focuses on an evaluation of additional site data collected to fill information gaps identified during the Phase I RI. Surface water data that were collected following the completion of the Phase I RI were used to characterize potential risks to aquatic receptors and semi-aquatic wildlife that may occur in the Erie Barge Canal. A computer search of a USEPA aquatic toxicity database (AQUIRE) was conducted and regression models employed to more fully characterize the potential toxicity of the primary groundwater chemicals of concern to ecological receptors. In addition, NYSDEC historically has collected stream and river aquatic macroinvertebrate data as a component to long-term water quality assessment studies. Macroinvertebrate data collected in the 1970's and early 1980's from several locations within the Erie Barge Canal in the general vicinity of the Olin Plant site were also evaluated in order to characterize the nature of the macroinvertebrate communities in this aquatic habitat. Finally, the Phase I ERA conclusions regarding ecological risks associated with surface soil exposure within the Olin Plant site were re-evaluated using regional background data for inorganic analytes. The background data, described in Section 2.1, are from a NYSDEC (1994) document on determination of soil cleanup objectives.

The ERA for the study area includes the following elements:

- Data Evaluation (Subsection 4.2.1)
- Identification of Potential Ecological Receptors (Subsection 4.2.2)
- Ecological Exposure Pathways (Subsection 4.2.3)
- Ecological Effects Assessment (Subsection 4.2.4)
- Ecological Risk Characterization (Subsection 4.2.5)
- Ecological Risk Assessment Uncertainties (Subsection 4.2.6)
- Ecological Risk Assessment Summary and Conclusions (Subsection 4.2.7)

4.2.1 Data Evaluation

The analytical data considered in this ERA include surface water samples collected from the Erie Barge Canal, off-facility groundwater, and two additional surface soil samples collected at the Olin Plant site. Phase II analytical data were collected to address certain data gaps that were identified during the Phase I RI. As a result, no CPC screening was conducted in this ERA.

Surface Water Samples. Surface water samples have been collected quarterly since September 194 at three sampling locations (SW-1, SW-2, and SW-3) within the Erie Barge Canal in the vicinity of the Olin Plant site (Figure 2.5a). Beginning in 1996, additional locations have been added to the surface water sampling program in order to better define the presence of site-related constituents in the canal. Additional sampling locations include SW-7, SW-8, SW-9, SW-11, and SW-12, which are located progressively upstream from SW-1, and SW-4, SW-5, and SW-6, which are located between SW-3 and the confluence with the Genessee River (Figure 2.5a). A surface water sample was also collected at SW-10, located in the canal south of the Genessee River, in December 1996. The potential effected of discharge from the dolomite quarry, located southwest of the Olin Plant, has been evaluated by collecting quarterly samples from the outfall (Quarry Outfall) since June 1996. Surface water samples have also been collected from the Erie Barge Canal at distances of 100 and 200 feet above and below the Quarry Outfall (QO-2N1, -2N2, -2S1, and -2S2) (Figure 2.5a). All surface water samples have been analyzed for pyridine, 2-CPL, 3-CPL, 4-CPL, 2,6-CPL, and p-fluoroaniline and analytical results are presented in Appendix B.

A subset of the available data was used to develop surface water exposure concentrations for aquatic biota in the Erie Barge Canal for the ERA. Surface water data collected prior to 1996 were excluded as these are historical and not representative of current conditions (the maximum concentrations of all detected analytes are included in the 1996/1997 samples). None of the target analytes were detected in the surface water sample collected at SW-10, located in the Erie Barge Canal south of the confluence with the Genessee River, and this location was excluded from the data summaries. The analytical results for the Quarry Outfall (QO-2) were also not evaluated because these samples were collected directly from the outfall pipe and are not representative of exposure conditions within the canal.

Surface water sampling locations were segregated into two sets in order to distinguish the potential contribution of the Quarry Outfall on Erie Barge Canal water quality. Sampling locations upstream of the Quarry Outfall include SW-1, SW-2, SW-3, SW-7, SW-8, SW-9, SW-11, and SW-12. Sampling locations in the vicinity, and downstream, of the quarry outfall include QO-2N1, QO-2N2, QO-2S1, QO-2S2, SW-4, SW-5, and SW-6. Tables 4-8 and 4-9 present summaries of the 1996-1997 analytical results for the sampling locations upstream of and adjacent to/downstream of the Quarry Outfall, respectively. Three of the target analytes, pyridine, p-fluoroaniline, and 4-CPL have never been detected in Erie Barge Canal surface water samples (including pre-1996 data) and are not listed in the summary tables. The tables present detection frequencies, arithmetic average and maximum detected concentrations of 2,6-

CPL, 2-CPL, and 3-CPL. The arithmetic average was calculated using one-half of the reporting limit for non-detect results.

Groundwater Samples. Although no direct ecological exposure to groundwater is likely, future exposures may occur in the scenario of discharge to the Erie Barge Canal. Consequently, groundwater data for the six surface water analytes were evaluated in this ERA. Groundwater data collected from monitoring wells located adjacent to the Erie Barge Canal were compared to canal surface water data to evaluate the relationship between these two media. In addition, concentrations of the six surface water analytes in the overall off-facility groundwater data set were also evaluated to determine whether exposure conditions would likely change in the future.

Surface Soil Samples. With the exception of two locations in the immediate vicinity of the SS-103, no surface soil data were collected as part of Phase II sampling activities. Table 4-10 provides a summary of the surface soil data that were evaluated in the Phase I ERA and regional background inorganic concentration ranges (NYSDEC, 1994). The background data were presented previously in Section 2.2. Six surface soil sampling locations (i.e., SS-102, SS-105, SS-109, SS-112, SS-113, and SS-115) were selected to represent ecological exposures at the Olin Plant site in the Phase I ERA (ABB-ES, 1995a). These locations were generally located along the eastern perimeter of the facility in areas that were not covered by coarse gravel and compacted and where ecological exposures could reasonably be expected. Maximum concentrations of chromium, mercury, nickel, and zinc exceed background concentration ranges, and only the average zinc concentration exceeds the maximum concentration associated with background conditions.

During the Phase I RI, mercury was detected at a concentration of 214 mg/kg in this surface soil sample SS-103 (see Figure 2-4). Mercury was also detected in seven other surface soil samples collected within the Olin Plant site during this same sampling program, at concentrations that ranged from 0.16 to 2.2 mg/kg. The mercury concentration at SS-103 does not appear to be consistent with the other analytical results, and therefore, two additional surface soil samples were collected in the vicinity of this location as part of the Phase II RI field activities. The Phase II RI surface soil analytical results (these samples were only analyzed for mercury) are presented in Appendix B-1. The detected mercury concentrations at locations SS-116 and SS-117 are 0.15 and 7.2 mg/kg, respectively. These results further suggest that the Phase I analytical result at SS-103 is atypical.

4.2.2 Identification of Potential Ecological Receptors

The general types of ecological receptors that are expected to occur in the Erie Barge Canal in the vicinity of the Olin Plant site have been described in the Phase I ERA. Additional information on the invertebrate fauna characteristic of this section of the canal was received after the submission of the Phase I RI report. Although these data are primarily of historical interest (the barge canal immediately upstream of the Genessee River was sampled in 1975 and 1981) and are not necessarily representative of current conditions, they provide an indication of types of organisms that would be expected to occur in this aquatic habitat. Between the years 1972 and 1992, NYSDEC's Stream Biomonitoring Unit collected macroinvertebrate community data from New York State streams and rivers. A sampling location in the Erie Barge Canal located in the vicinity of the Olin Plant site was sampled in 1975 and 1981. During this time period, NYSDEC biologists reported a general improvement in water quality as measured by macroinvertebrate community structure and function (NYSDEC, 1993). In 1975, high organic inputs were noted in the Erie Barge Canal upstream of the Olin Plant site. This organic enrichment, which was also observed in the sampling location within the study area, was correlated with large standing crops of pollution-tolerant organisms. By 1981, standing crops had declined in this area and macroinvertebrate abundances were relatively consistent throughout the sampled portion of the canal. In addition, relatively pollution-sensitive organisms such as the mayfly (*Stenonema femoratum*) and caddisfly (*Cheumatopsyche* sp.) were collected throughout the entire reach sampled (NYSDEC, 1993). The water quality at the sampling location near the Olin Plant site was classified as "non-impacted" in 1981. Although the invertebrate community at this sampling location was still dominated by oligochaete worms (*Nais* sp.) and pollution-tolerant chironomid midge larvae (e.g., *Dicrotendipes* sp.), standing crop decreased and species diversity dramatically increased over the 6 year interval. The researchers suggested that these changes may have been due to improvements in several point source inputs to the Erie Barge Canal upstream of the Olin Plant site (NYSDEC, 1993).

In addition to aquatic receptors (i.e., fish, amphibians, invertebrates, and plants), semi-aquatic wildlife, such as piscivorous birds and mammals could be exposed as a result of feeding on contaminated prey items from the Erie Barge Canal. Although the heavy residential and industrial land use of the area surrounding the potentially affected portion of the Erie Barge Canal probably does not offer suitable habitat for the more reclusive large predatory species, it is likely that piscivores such as raccoons (*Procyon lotor*) and belted kingfisher (*Ceryle alcyon*) would utilize this foraging area.

4.2.3 Ecological Exposure Assessment

The purpose of the ecological exposure assessment is to evaluate the potential for ecological receptor exposures to chemical constituents in the study area.

4.2.3.1 Aquatic Biota. Tables 4-8 and 4-9 present summaries of the 1996-1997 analytical results for the sampling locations upstream of and adjacent to/downstream of the Quarry

Outfall, respectively. Of the three detected target analytes, 2-CPL has been detected most frequently, and at highest concentrations; this analyte was detected in 23 of 36 samples collected upstream of the Quarry Outfall (Figure 4-8). 2-Chloropyridine is also the only analyte detected at sampling locations in the vicinity, and downstream, of the outfall (Table 4-9), with estimated values ranging from 0.2 µg/L to 4 µg/L. With the exception of analytical results collected in March and April 1996, detected 2-CPL concentrations have been less than 10 µg/L. Analytical results for surface water samples collected at SW-1, SW-2, and SW-3 in March and April 1996, and at SW-7 and SW-8 in April 1996, range from 25.5 µg/L to 45 µg/L (Appendix B). 2,6-Chloropyridine was detected at a maximum (estimated) concentration of 5 µg/L at SW-3 in April 1996 and 3-CPL was detected at a maximum (estimated) concentration of 3 µg/L at SW-2 in March 1996.

4.2.3.2 Semi-Aquatic Wildlife. Table 4-11 presents the estimated exposure body dose estimates for two representative piscivorous wildlife receptors, belted kingfisher and raccoon. For both species, fish tissue concentrations were conservatively estimated by applying a bioconcentration factor (BCF) to the maximum surface water concentration detected throughout the sampling program. Ingestion body dose estimates were then derived by multiplying the estimated fish tissue concentration by the daily ingestion rate and dividing by the receptor body weight. It was assumed that the representative receptors consume only barge canal fish and that the fish have bioaccumulated these three surface water analytes as predicted from a long-term exposure to the maximum concentrations detected in surface water.

4.2.4 Ecological Effects Assessment

The purpose of the ecological effects assessment is to describe the toxic or adverse ecological effects associated with the six surface water analytes and evaluate the relationship between these measured concentrations to which an organism is exposed and the potential adverse effects due to such exposures. The primary aspect of the effects assessment is the identification of threshold or reference toxicity values (RTVs) for each of the chemicals of concern. Information provided in the effects assessment is used in conjunction with exposure information to evaluate ecological risks to aquatic receptors and wildlife in the ecological risk characterization.

4.2.4.1 Toxicity to Aquatic Receptors in the Erie Barge Canal. The primary sources of aquatic toxicity information used to develop aquatic RTVs were the USEPA AQUIRE and ecological structure activity relationship (ECOSAR), a computer program which estimates aquatic toxicity of chemicals based on structure activity relationship (SAR) regression models.

AQUIRE database. The AQUIRE database presents information extracted from independently-compiled data files and from published literature that focuses on the toxicity of chemicals to aquatic organisms. A search of the AQUIRE database was conducted for the following six surface water analytes (i.e., pyridine, 2-CPL, 3-CPL, 4-CPL, 2,6-CPL and p-fluoroaniline). One Hundred and Thirty One records were retrieved as a result of the database search, consisting of 123 records for pyridine, one record for each of the monochloropyridines and 2,6-CPL, and four records for p-fluoroaniline.

Each record is assigned a code representing the estimated reliability of the study, as established by the USEPA. Code categories are assigned to indicate whether a specific study meets all established criteria, meets some of the established criteria, does not meet any criteria, or was not reviewed; these categories are designated as "1", "2", "3", and "4", respectively. In addition, studies designated with a reliability code of "5" are from the "Guilford file", which contains acute toxicological data derived from studies which focused on acute toxicity of organic chemicals to fathead minnows. For pyridine, 99 records were assigned reliability codes of either 1 or 2, twenty-two were designated as either a 3 or 4, while the remaining two were assigned a category of "5". All of the chloropyridine records were designated with a reliability code of 2. Finally, for p-fluoroaniline one record was designated with a 1 and the remaining three were designated with 3s. Selected fields from the entire set of retrieved records from the AQUIRE database search are presented in Table 4-12.

Figure 4-2 presents a summary of the acute toxicity data for pyridine obtained from the AQUIRE database. Pyridine was the only study analyte with sufficient data to develop a cumulative effects distribution. This figure presents only those studies which derived an acute LC_{50} (the single dose lethal to 50 percent of the test population). LC_{50} results range from 1,100 µg/L to 9,550,000 µg/L, a range of almost 4 orders of magnitude. Based on the toxicological data included in the AQUIRE database, the most sensitive aquatic organism is the pink salmon (*Oncorhynchus gorbuscha*) with an LC_{50} concentration of 1,100 µg/L. The least sensitive organism included in the database is the clawed toad (*Xenopus laevis*), which had the highest LC_{50} value of 9,550,000 µg/L. However, it is important to note that considerable variation in toxicological response within taxonomic categories is evident in the AQUIRE results. For instance, LC_{50} values for salmonid fish range from 1,100 (pink salmon) to 560,000 µg/L (rainbow trout), which differ by approximately 500 times. LC_{50} values for the clawed toad range from 1,000,000 to 9,550,000 µg/L, or nearly one order of magnitude (Table 4-12). Assuming that the available data are normally distributed and representative of the toxicological response of most aquatic species, less than 1 percent of all LC_{50}s are expected to fall below 115,000 µg/L and 50 percent are expected to be 1,900,000 µg/L or greater (Figure 4-2).

Structure-Activity Relationships (SARs). A computer model ECOSAR, developed by the USEPA (Clements and Nabholz, 1994) was also employed to estimate effect thresholds for the study analytes. As discussed above, with the exception of pyridine, few data were obtained from the AQUIRE database search. The ECOSAR program estimates threshold effect concentrations for different aquatic taxa; separate regression models are available for different types of endpoints (including LC_{50}s, EC_{50}s and chronic values (CVs). Currently, the program contains over 100 SAR regression models for 42 chemical classes. The majority of these regression models were developed using measured aquatic toxicity data and octanol/water partition coefficients (K_{ow}). The majority of which have been developed for acute toxicity to fish (fresh and saltwater), water fleas (daphnids), green algae, however SARs have been also been developed for earthworms and other endpoints such as chronic toxicity and bioconcentration factors.

The inputs required to run the ECOSAR model include chemical name, Chemical Abstract Service (CAS) number, molecular weight, melting point, solubility, physical state, and $\log K_{ow}$. The physio-chemical information that was utilized to estimate effect concentrations for the surface water analytes is provided in Table 4-13. The first step in estimating toxicological thresholds utilizing the ECOSAR program requires selecting a specific chemical class for which SARs have been developed that is appropriate for the chemical in question. The classes chosen for pyridine compounds and p-fluoroanilines were halogenated aromatic hydrocarbons and anilines, respectively. Physio-chemical data are input and the types of organisms, exposure duration, and endpoints of interest are selected from the menu of available regression models. The output generated by the program is a SAR report, which includes all chemical-specific input data and predicted toxicity values for the selected endpoints. The user can also request information about the selected regression models, including the compounds used to develop the SAR, recommendations regarding applications and limitations of the particular model, and the primary literature reference(s). The SAR reports and cover sheets generated for the 6 surface water analytes are presented in Appendix E.

The ECOSAR model results including the LC_{50}, and EC_{50} and CV results are presented in Figures 4-3 and 4-4, respectively. The specific SAR models used in developing these toxicity estimates are presented in Table 4-14. As indicated in Figure 4-3, daphnids appear to be more sensitive to the surface water analytes than are the other modeled taxa. Based on the SAR model estimates, pyridine toxicity appears to be related to increasing chlorination, and p-fluoroaniline appears to be more toxic to aquatic organisms than are pyridines, in general.

Surface water Benchmark Development. The lowest chronic values from the evaluated toxicological data were used to develop RTVs for each of the surface water analytes. These RTVs, which represent a threshold concentration for effects to aquatic organisms, are expressed in µg/L. Although only 2-CPL, 3-CPL, and 2,6-CPL have been detected in barge canal surface water samples, and only at estimated concentrations, RTVs were developed for all 6 analytes in order to evaluate potential risks associated with the future discharge of groundwater.

The AQUIRE database included few chronic toxicity data for the surface water analytes; these data are necessary in order to develop RTVs that are protective of chronic exposures. Where possible, taxon-specific acute to chronic ratios were developed for each pyridine compound based on the estimated ECOSAR results (Appendix E). For those compounds having sufficient acute data to adequately characterize the lethal endpoint in aquatic receptors, the maximum acute/chronic ratio (derived from the ECOSAR model) was then applied to the lowest LC_{50} value to estimate a chronic RTV. For pyridine, the maximum acute/chronic ratio (9.22) was applied to the lowest LC_{50} concentration (1,100 µg/L) reported in the AQUIRE database. This resulted in a surface water RTV of 120 µg/L. In the case of the monochloropyridine compounds and 2,6-CPL, available toxicological data are very limited and the may not be characteristic or protective of organisms for which data do not exist. Consequently, the lowest estimated ECOSAR model results were selected as the RTVs for the chloropyridine compounds. As presented in Appendix C, the selected RTVs are as follow:

2-chloropyridine	14,000 µg/L
3-chloropyridine	12,900 µg/L
4-chloropyridine	15,300 µg/L
2,6-dichloropyridine	4,700 µg/L

For p-fluoroaniline, the acute/chronic ratio value of 219 was applied to the available acute value (16,900 µg/L from a single LC_{50} study for fathead minnow). The estimated chronic value (77.1 µg/L) based on this approach was compared to the lowest chronic value (32 µg/L) estimated using the ECOSAR program and the lower of the two values was selected as the RTV for p-fluoroaniline.

4.2.4.2 Toxicity to Semi-Aquatic Wildlife Receptors in the Erie Barge Canal. Published laboratory-derived toxicological data were evaluated in order to develop ingestion RTVs for the selected representative wildlife receptors, the belted kingfisher (*Ceryle alcyon*) and raccoon (*Procyon lotor*). RTVs were developed for the three detected surface water analytes, 2,6-CPL, 2-CPL, and 3-CPL. Very limited published data are available for these compounds; in fact, a single acute oral LD_{50} was obtained for each. A safety factor of 20 percent was applied to this value to generate an acute lowest observed adverse effects level (LOAEL). From this number a chronic LOAEL was calculated by applying an acute/chronic ratio of 10. The ATSDR (1990b) for pyridine provided additional toxicological information on this group of organic compound. Acute and chronic values presented for pyridine were slightly higher than the derived numbers for the chlorinated pyridines as would be expected. The ATSDR document also provides limited toxicological data for sublethal effects associated with chronic exposure to pyridines. Sublethal effects to mammals associated with chronic pyridine exposure include hepatic effects (e.g., increased liver weight and inflammatory lesions), decreased weight gain, and central nervous system toxicity.

4.2.5 Ecological Risk Characterization

This subsection characterizes the risk to aquatic receptors from exposure to estimated concentrations of surface water analytes detected in the Erie Barge Canal. In addition, the concentrations of the surface water analytes detected in groundwater monitoring wells were evaluated to assess the relative magnitude of future exposures associated with the discharge of contaminated groundwater into the canal. The exposure information combined with the ecological effects information provides the basis for this risk characterization.

4.2.5.1 Risks to Aquatic Receptors in Barge Canal. A groundwater dilution model was employed in the Phase I RI ERA to assess aquatic risks associated with the discharge of contaminated groundwater into the Erie Barge Canal. It was concluded that the estimated surface water concentrations under both high- and low-water conditions were several orders of magnitude lower than screening benchmark values and that no risks to aquatic organisms were indicated. The results of the Phase II surface water sampling program confirm these conclusions. The few estimated concentrations of surface water analytes detected are considerably lower than the established RTVs for aquatic receptors (Tables 4-8 and 4-9).

Aquatic receptors may be exposed to the six surface water analytes in the future if contaminated groundwater were to discharge into the Erie Barge Canal. The concentrations of the surface water analytes detected in groundwater from monitoring wells located adjacent to the barge canal were compared with the surface water data in order to assess whether future exposures would likely result in greater risks than are currently estimated. Analytical data for monitoring wells BR-111, BR-111D, BR-112A, BR-112D, and BR-113, and BR-113D are presented in Appendix B-1. Of the six pyridines selected as surface water analytes, only 2-CPL and 2,6-CPL were detected in these adjacent wells during the October and December 1995 groundwater sampling events. These are also the only two surface water analytes that were detected in Erie Barge Canal surface water samples collected during this sample event (i.e., November 1995). 2,6-CPL was detected in the adjacent monitoring wells at a maximum concentration that is only three to five times greater than the estimated concentrations detected in surface water samples collected during the same time period. On the other hand, 2-CPL was detected in the adjacent monitoring wells at a maximum concentration that is 20 to 75 times greater than the estimated concentrations detected in surface water samples collected during the same time period. The maximum detected concentrations of both of these analytes are less than the established surface water RTVs; and no risks to aquatic receptors would be expected even if they were to be exposed directly to the concentrations detected in groundwater in Phase II wells along the Erie Barge Canal.

The entire off-site groundwater data set was also evaluated because the surface water analytes were detected at highest concentrations in monitoring wells that are located some distance from the Erie Barge Canal (Appendix B-1). Maximum concentrations of the surface water analytes detected in the off-site groundwater data were compared to the established RTVs in order to estimate the likelihood of future aquatic impacts under worst-case exposure assumptions. Of the six surface water analytes, only pyridine was not detected in the Phase II groundwater monitoring wells (Appendix B-1). The maximum concentrations of 2,6-CPL, 2-CPL, and p-fluoroaniline exceed the surface water RTVs. 2,6-CPL was detected in groundwater at a maximum concentration of 15,000 µg/L, which exceeds the surface water RTV (4,700 µg/L) by approximately 3.2 times; the average concentration is below the surface water RTV. The maximum concentration of 2-CPL (84,000 µg/L) exceeds the surface water RTV (14,000 µg/L) by approximately 6 times. p-fluoroaniline was detected at a maximum concentration (320 µg/L) in Phase II groundwater samples, which is 10 times greater than the surface water RTV (32 µg/L). Considering the attenuation and dilution processes that would occur prior to ecological exposure occurring, these relatively minor exceedances of the surface water benchmarks by the maximum detected concentrations of these compounds in groundwater suggests that future risks associated with the groundwater discharge will similarly be minimal.

4.2.5.2 Risks to Semi-aquatic Wildlife Receptors in Barge Canal. Table 4-11 presents a comparison of the total body dose estimates to ingestion toxicity values for each of the three analytes detected in surface water. In all cases, HQs are several orders of magnitude below 1. These results indicate that risks to semi-aquatic wildlife receptors associated with exposure to pyridine compounds and p-fluoroaniline in the Erie Barge Canal are virtually non-existent. The semi-aquatic wildlife risk estimates are based on extremely conservative exposure assumptions.

4.2.5.3 Risks to Terrestrial Plants and Invertebrates. Risks to terrestrial plants and invertebrates were evaluated by comparing detected surface soil concentrations with available RTVs, and are presented in Tables 6-12 and 6-13 in the Phase I RI. Plant screening benchmarks for aluminum, chromium, lead, vanadium, and zinc were exceeded by the maximum concentrations of these inorganics detected in the 6 surface soil samples evaluated. Invertebrate screening benchmarks were exceeded by the maximum detected concentrations of chromium, copper, and zinc. HIs based on a comparison of the maximum detected surface soil CPC concentrations to toxicity screening benchmark values were 980 and 7.5 for plants and soil invertebrates, respectively.

As many of these potential risk drivers are naturally-occurring analytes, these risk estimates should be viewed in the context of background conditions. Although no site background data are available, regional background concentrations were compared to the surface soil inorganic analytical data (Table 4-10). The maximum detected concentration of chromium, mercury, nickel, silver, and zinc in the surface soil dataset evaluated in the Phase I ERA, exceeded the maximum range of background levels. Several analytes, including aluminum, lead, and vanadium, contributed to the plant risk estimates but were detected at maximum concentrations that are well within reported background concentration ranges. The HQ for aluminum represents nearly 90% of the HI for potential phytotoxicological effects; this inorganic was detected at a maximum concentration (8,700 mg/kg) which is considerably below the background concentration for the eastern USA (33,000 mg/kg). Chromium was also a substantial plant risk contributor, with a HQ of 75. The maximum chromium concentration is approximately 3 times greater than the maximum concentration detected in background samples; the average chromium concentration falls within the background range. It is important to note that the screening benchmark phytotoxicological value for chromium (2 mg/kg) is equal to the low end of the range of background concentrations. Consequently, the screening benchmark value for chromium is overly conservative because it is unlikely that plants could be adversely affected in most background situations. The average and maximum detected concentrations of zinc exceeded the maximum background level, however this analyte only contributed approximately 1 percent of the total potential risk to plants.

The Phase I ERA suggested that exposure to the maximum detected concentrations of chromium, copper, and zinc could potentially adversely affect soil invertebrates, although the risks appear to be minimal. Of these three risk contributors, copper was detected at concentrations that appear consistent with regional background concentrations (Table 4-10). The maximum detected concentrations of chromium and zinc exceed background ranges; the average zinc concentration also exceeds maximum background concentration (Table 4-10). Ecological risks associated with soil invertebrate exposures to these inorganic soil constituents are possible, although the toxicological benchmarks employed in the Phase I ERA are intended for use in risk screening only (Will and Suter, 1994). As indicated in the Phase I ERA, on-site habitat conditions appear to be most limiting to these receptor populations.

4.2.6 Ecological Risk Assessment Uncertainties

The general risk assessment uncertainties are discussed in the Phase I ERA. The risk uncertainties that apply to this assessment relate to the limited toxicological data available for all surface water analytes with the exception of pyridine. The RTVs developed for chloropyridines are considerably larger than the aquatic benchmark established for pyridine. This result is contrary to the anticipated increase in toxicological effect associated with increasing chlorination, which is also predicted with the ECOSAR program. It is likely that this effect is principally due to the large amount of toxicological data available for pyridines, and the inclusion of west coast salmonid species in the genus *Oncorhynchus* (e.g, pink salmon, chinook salmon, chum salmon, and coho salmon) that appear to be particularly sensitive to pyridine exposure. Although rainbow trout (*Oncorhynchus mykiss*) is distributed throughout the east coast, it does not occur in the warm water Erie Barge Canal (NYSDEC, 1994). The carp (*Cyprinus carpio*) is the species with the lowest LC_{50} value that would be expected to occur in this habitat, and this LC_{50} is 25 times greater than the sensitive pink salmon.

Although there is considerable uncertainty involved with exposure modeling to semi-aquatic wildlife, the fact that no risks were evident using very conservative exposure assumptions suggests that these uncertainties would not affect the general conclusions of this ERA.

4.2.7 Ecological Risk Assessment Summary and Conclusions

A supplemental ERA was conducted to address certain information gaps identified during the Phase I RI. In particular, the potential ecological risks associated with off-site surface water exposures in the vicinity of the Olin Plant site were evaluated in this ERA. This assessment focused on aquatic receptor and semi-aquatic wildlife exposures to selected pyridine compounds in the Erie Barge Canal. Measured, rather than modeled, surface water analytical data were used to assess the likelihood of adverse impacts to ecological receptor populations that exist in this habitat. Aquatic toxicity benchmarks were developed for all surface water analytes and were compared to the detected estimated surface water concentrations. Food chain-related exposures by semi-aquatic receptors were evaluated using bioconcentration factors to estimate fish tissue concentrations. Finally, potential risk associated with on-site surface soil exposure were reexamined based on a consideration of regional background conditions. The conclusions are listed below.

- Estimated concentrations of the three 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.

- 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 pyridines 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.

- The on-site surface soil constituents, chromium and zinc, exceed regional background concentration ranges and available toxicological benchmarks. However, the benchmarks are considered to be overly-conservative and habitat constraints most likely limit plant and soil invertebrate populations at the Olin Plant site.

5.0 CONCLUSIONS

This section presents the conclusions from the Phase II RI for: 1) assessment of the recovery well system, 2) the distribution, fate, and transport of chemicals, and 3) the human health and ecological risk assessments.

5.1 RECOVERY WELL SYSTEM (AQUIFER TESTING)

Preliminary testing of six overburden wells, proposed for aquifer testing, found most were capable of producing low yields (0.1 gpm or less). Efforts to improve yields through well rehabilitation were unsuccessful. These low yields observed in overburden wells are likely due to either natural properties of the overburden or well/formation clogging.

The pumping test performed in overburden extraction well W-1, a higher-yielding overburden well, indicated that the aquifer transmissivity is likely between 1.5 and 340 ft^2/d. This wide range of values resulted from limitations in the W-1 test data, caused by the influence of a precipitation event on groundwater levels. Regardless of where the actual overburden transmissivity lies within this range, it appears unlikely that the existing overburden extraction well spacing is achieving complete capture of overburden groundwater migrating off-site. A much closer well spacing would be required to achieve capture because the small saturated thickness in the overburden limits the area of groundwater flow an individual well can capture. An extraction well spacing of approximately 25 feet appears necessary for overburden wells to achieve capture.

Pumping tests performed in bedrock extraction wells BR-6A and BR-7A indicated that shallow bedrock aquifer transmissivity ranges from 250 to 350 ft^2/d, and that these wells are each capable of yields of more than 50 (BR-6A) and 20 (BR-7A) gpm. These results indicate that pumping from these wells should be capable of capturing shallow bedrock groundwater migrating off-site to the south and southwest. In addition, pumping from these wells may also be capable of effecting either partial or complete capture in the overburden by creating bedrock drawdowns that cause either an increase in vertical flow from the overburden or dewatering of the overburden. Additional analysis will be required to evaluate this possibility.

5.2 DISTRIBUTION, FATE, AND TRANSPORT OF CHEMICALS

The Phase II RI provided additional understanding of the distribution fate, and transport of site-related chemicals, as summarized in the following subsections.

5.2.1 Lab Sample Area

Subsurface Soil. Analytical results from subsurface soil samples at three additional locations at the Lab Sample Area show relatively low concentrations of site-related chemicals. Results from these borings and from the Phase I RI suggest this area is not a high-concentration source of site-related chemicals in groundwater.

Surface Soil. Mercury analysis results for two additional surface soil samples (SS-116 and SS-117) were one or more orders of magnitude less than the previously reported high concentration sample (SS-103), and show that the higher mercury concentration is isolated.

Groundwater. Carbon tetrachloride and methylene chloride were detected at high concentrations in one boring (SB-3). However, based on the soil sample results from this area, the presence of these chemicals is not likely related to the Lab Sample Area. These detections were interpreted to be part of an area-wide plume rather than the result of a chemical source in the Lab Sample Area.

5.2.2 Downgradient Investigations

Downgradient well installations and sampling, and surface water sampling provided additional information about the off-site extent of site-related chemicals in groundwater and surface water.

5.2.2.1 Groundwater.

Overburden. The areal distribution of site-related chemicals in overburden groundwater has, in general, been delineated. Site-related chemicals are interpreted to have not migrated beyond the new overburden well to the southeast (MW-114). To the west of the Olin Plant site, the overburden becomes unsaturated. Here the limit of saturation marks the western extent of chemicals in overburden groundwater. The Phase II analytical results support the findings of the Phase I RI, that concentrations of pyridines are distributed more widely than any other group of site related chemicals. Based on the analytical results, no additional overburden groundwater investigations are recommended.

Bedrock. Analytical results show site-related chemicals, specifically pyridines and selected VOCs, are present south and southwest of the Olin Plant site. Pyridines are distributed as far west as the Dolomite Products Quarry in the Town of Gates, where they were detected in groundwater seep samples. Pyridines have not been detected in the water that is pumped from the quarry to the Erie Barge Canal.

Neither the southern nor the western extent of site-related chemicals in bedrock groundwater has been fully delineated. Additional bedrock groundwater sampling in each of the these directions would be required to characterize the areal extent of these constituents.

5.2.2.2 Surface Water Surface water analytical results from the Erie Barge Canal show detections of chloropyridines in two out of five quarterly sampling events at upstream and downstream locations. Each detection is at an estimated concentration (less than the detection limit of 10 μg/L). The estimated concentrations were detected at SW-1, located upstream and upgradient of the Olin Rochester Plant site, as well as at the two downstream sampling locations conducted as part of the Phase II investigations. Monitoring conducted subsequent to the Phase II investigations showed detections of chloropyridines at SW-1, SW-2, SW-3, and locations both upstream and downstream. These results have been provided to NYSDEC in Olin's quarterly reports.

5.3 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

The baseline risk assessment is summarized in the following subsections:

5.3.1 Human Health Risk Assessment

Health risks were evaluated for potential exposures to off-site media at the Olin Plant, including groundwater (and associated inhalation exposures), surface water, and groundwater seeps. Chemicals of potential concern (CPCs) were selected on a medium- and location-specific basis. Generally, the CPCs identified were VOCs (particularly chlorinated compounds), SVOCs (primarily chloropyridines), and inorganics.

The exposure scenarios quantitatively evaluated include:

- current and potential future recreational exposures to surface water in the ErieBarge Canal,

- current and potential future industrial worker exposures to groundwater seeps at the Dolomite Products Quarry, and

- potential future industrial/commercial worker exposures to groundwater;

The USEPA acceptable risk level for noncarcinogenic risk of an HI of 1 was used to characterize potential noncancer risks. The USEPA risk range of $1x10^{-4}$ to $1x10^{-6}$ for carcinogenic risk was used to characterize potential cancer risks. Potential health risks characterized as exceeding the USEPA-acceptable risk level or range are considered significant, whereas those exceeding a level of $1x10^{-6}$ are considered by the NYSDOH to require additional evaluation (i.e., determine whether specific remedial goals need to be developed). The results of the risk assessment are as follows:

- No significant human health risks were identified for potential exposures to surface water in the Erie Barge Canal or to groundwater seeps in the Dolomite Products Quarry under current or potential future land use conditions; cancer risks did not exceed an excess lifetime cancer risk of 1×10^{-6}, and non-cancer risks did not exceed a hazard index of 1.

- Evaluation of potential future worker exposure to off-site groundwater used as industrial process water identified cancer risks above 1×10^{-6} but below 1×10^{-4} (i.e., within the USEPA acceptable cancer risk range) for mean groundwater concentrations. For maximum concentrations, however, carcinogenic risks were calculated to be 9×10^{-4}, above the upper end of the USEPA acceptable cancer risk range. Calculated non-cancer risks were elevated, but the majority of that risk appears to be attributable to iron and zinc associated with turbidity in groundwater samples. In addition, the iron and zinc concentrations detected in off-site wells were higher than any detections on-site. Therefore, risks are unlikely to be related to Olin operations. Because risks for potential future exposures to off-site groundwater used as industrial process water exceeded an excess lifetime cancer risk of 1×10^{-6} and a non-cancer hazard index of 1, remedial goals will be calculated for the Feasibility Study.

- Modelling a hypothetical future release of VOCs from groundwater used as process water to industrial facility air did not result in any exceedances of workplace air standards.

- Groundwater exceeded MCLs and New York Standards for several CPCs. No domestic use of the groundwater is anticipated. For aesthetic reasons, groundwater in the vicinity of the Olin Study Area is not used as a drinking water source. Naturally-occurring sulfide and dissolved gases preclude use of bedrock groundwater for drinking water.

5.3.2 Ecological Risk Assessment

A supplemental ERA was conducted to address certain information gaps identified during the Phase I RI, in particular, the potential ecological risks associated with off-site surface water exposures in the vicinity of the Olin Plant. This assessment focused on aquatic receptor and semi-aquatic wildlife exposures to selected pyridine compounds in the Erie Barge Canal. Measured, rather than modeled, surface water analytical data were used to assess the likelihood of adverse impacts to ecological receptor populations that exist in this habitat. Aquatic toxicity benchmarks were developed for all surface water analytes and were compared to the detected estimated surface water concentrations. Food chain-related exposures by semi-aquatic receptors were evaluated using bioconcentration factors to estimate fish tissue concentrations. Finally, potential risk associated with on-site surface soil exposure was reexamined based on a consideration of regional background conditions. The conclusions are listed below.

- Estimated concentrations of the three 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.

- Due to the low-magnitude, low frequency detections of estimated concentrations of pyridines, and the low uptake potential of the surface water analytes, bioconcentration hazards to semi-aquatic wildlife are considered insignificant.

- Based on concentrations of pyridines 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.

- The on-site surface soil constituents chromium and zinc exceed regional background concentration ranges and available toxicological benchmarks. However, habitat constraints most likely limit plant and soil invertebrate populations at the Olin Plant site. The site cover is sparsely vegetated and provides poor habitat for these populations.

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6.0 NEXT STEPS

Based on the information collected during the Phase I and II RIs and previous investigations, the following tasks are planned as future work:

- Continue to monitor surface water from the Erie Barge Canal for pyridines, to assess impacts to the Erie Barge Canal.
- Periodically collect and analyze groundwater seeping into the quarry and surface water discharging from the quarry into the Erie Barge Canal for the presence of pyridines at the Dolomite Products Quarry.
- Sample for pyridines from selected monitoring and/or industrial wells located west of the Erie Barge Canal and south of the Ness site to further assess the off-site distribution of pyridines in bedrock groundwater.
- Based on off-site results from the selected monitoring and industrial wells located west of the Erie Barge Canal, consider the installation of new bedrock monitoring wells to further evaluate the distribution of chemicals in groundwater.
- Further evaluate performance of the on-site groundwater recovery system and consider options for adjusting pumping rates to optimize capture.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ACGIH	American College of Governmental and Industrial Hygienists
AQUIRE	aquatic toxicity database
ASP	Analytical Services Protocol
ATSDR	Agency for Toxic Substances and Disease Registry
BCF	bioconcentration factor
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
CAS	Chemical Abstract Service
cm/sec	centimeters per second
CPCs	chemicals of potential concern
CSFs	cancer slope factors
2-CPL	2-chloropyridine
2,6-CPL	2,6-dichloropyridine
3-CPL	3-chloropyridine
4-CPL	4-chloropyridine
CSOAP	Combined Sewer Overflow Abatement Program
CV	chronic values
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene
ECOSAR	ecological structure activity relationship
EPC	exposure point concentration
ERA	ecological risk assessment
FID	flame ionization detector
ft	feet
ft/ft	feet per foot
gpm	gallons per minute
GPR	ground-penetrating radar
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
ID	inside diameter

IRIS	Integrated Risk Information System
J	estimated
K_{OC}	organic carbon partition coefficient
LOAEL	lowest observed adverse effects level
mg/kg	milligrams per kilogram
MS	matrix spike
MSB	matrix spike blank
MSBD	matrix spike blank duplicate
MSD	matrix spike duplicate
NCEA	National Center for Environmental Assessment
NYSDEC	New York State Department of Environmental Conservation
Olin	Olin Corporation, Chemicals Division
PCE	tetrachloroethene
PEL	permissible exposure limits
P-FAE	p-fluoroaniline
PID	photoionization detector
POTW	publicly-owned treatment works
PQL	practical quantitation limit
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RfD	reference dose
RI	remedial investigation
R_{ij}	risk factor
RME	reasonable maximum exposure
RTVs	reference toxicity values
S	coefficient
SAR	structure activity relationship
SQL	Sample Quantitation Limit
SVOCs	semivolatile organic compounds

TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
1,1,1-TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TIC	tentatively identified compounds
USEPA	U.S. Environmental Protection Agency
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
VC	vinyl chloride
VOCs	volatile organic compounds

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TABLE 2-2
BACKGROUND COMPARISON OF INORGANICS CONCENTRATIONS
SURFACE AND SUBSURFACE SOIL SAMPLES

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

ANALYTE	FREQUENCY OF DETECTION	RANGE		EASTERN U.S. BACKGROUND (ppm)(1)	USEPA REGION III RBC for INDUSTRIAL SOIL (mg/kg)(4)	LOCATIONS EQUAL TO OR GREATER THAN BACKGROUND																				
		MINIMUM	MAXIMUM			SS-101	SS-102	SS-103	SS-104	SS-105	SS-106	SS-107	SS-108	SS-109	SS-110	SS-111	SS-112	SS-113	SS-114	SS-115	SS-116	SS-117	SB-1	SB-2	SB-3	# Detections > Background
Aluminum	18 / 18	2700	18600	33000	NA																-	-				
Antimony	0 / 18	NA	NA	NA	410																-	-				
Arsenic	18 / 18	1.7	12	3 - 12 (1)	310									X							-	-				1
Barium	18 / 18	18.2	210	15 - 600	72000																-	-				
Beryllium	0 / 18	NA	NA	0 - 1.75	0.67																-	-				
Cadmium	15 / 18	0.1	1.8	0.1 - 1	510			X	X												-	-				2
Calcium	18 / 18	4900	97700	130 - 35000(2)	NA				X	X							X			X	-	-	X	X	X	7
Chromium	18 / 18	5.3	180	1.5 - 40(2)	5100		X		X												-	-		X		3
Cobalt	14 / 18	4.55	16.8	2.5 - 60(2)	61000																-	-				
Copper	18 / 18	2	300	1 - 50	38000				X		X										-	-				2
Cyanide	1 / 18	59.7	59.7	NA	20000																-	-				
Iron	18 / 18	6900	35800	17500 - 25000(2)	NA																-	-		X		1
Lead	18 / 18	4.9	530	200 - 500(3)	NA				X												-	-				1
Magnesium	18 / 18	2700	58900	100 - 5000	NA		X		X	X	X		X	X	X	X	X		X	X	-	-	X	X	X	14
Manganese	18 / 18	240	1300	50 - 5000	5100																-	-				
Mercury	14 / 20	0.04	214	0.001 - 0.2	310	X	X	X	X	X	X			X		X				X		X		X		11
Nickel	17 / 18	4.1	49	0.5 - 25	20000	X	X		X						X					X	-	-		X		6
Potassium	18 / 18	590	1900	8500 - 43000(2)	NA																-	-				
Selenium	1 / 18	0.8	1.4	0.1 - 3.9	5100																-	-				
Silver	16 / 18	0.1	0.95	NA	5100																-	-				
Sodium	18 / 18	222	2050	6000 - 8000	NA																-	-				
Thallium	0 / 18	NA	NA	NA	NA																-	-				
Vanadium	18 / 18	3.3	37.5	1 - 300	7200																-	-				
Zinc	18 / 18	24.1	640	9 - 50	310000	X	X	X	X	X	X	X		X	X	X	X	X		X	-	-		X		14
Number of analytes exceeding background -						3	5	3	9	4	4	1	1	3	3	3	3	2	1	5	0	1	2	7	2	

NOTE:

Frequency and range calculated from 15 surface soil samples collected during the Phase I RI (SS-101 to SS-115), 3 subsurface soil samples collected during the Phase II RI (SB-1, SB-2, and SB-3), and 2 surface soil samples (SS-116 and SS-117) collected during the Phase II RI for mercury only.

(1) NYSDEC, Division of Technical and Administrative Guidance Memorandum on Determination of Soil Cleanup Objectives and Cleanup Levels, January, 1994.
(2) New York State background
(3) Typical average background levels in metropolitan or surburban areas or near highways, NYSDEC, 1994.
(4) USEPA, Region III, Risk-Based Concentration (RBC) Table, 3rd Quarter, 1994.

NA Background data or risk-based concentration not available

TABLE 2-1
NON-NUTRIENT INORGANICS DETECTED IN SUBSURFACE SOIL
LAB SAMPLE DISPOSAL AREA

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

		MEAN	RANGE (mg/kg)		LOCATION OF
INORGANIC	FREQUENCY OF DETECTS		MINIMUM	MAXIMUM	MAXIMUM
Aluminum	3 / 3	8865	3720	18600	SB-2
Arsenic	3 / 3	5.12	1.7	11.3	SB-2
Barium	3 / 3	44.1	18.2	92.3	SB-2
Cadmium	1 / 3	1	1	1	SB-3
Chromium	3 / 3	21.5	5.3	52.6	SB-2
Cobalt	2 / 3	10.6	4.4	16.6	SB-2
Copper	3 / 3	15.1	2	24.8	SB-2
Cyanide	1 / 3	59.7	59.7	59.7	SB-2
Lead	3 / 3	29.8	4.9	77.7	SB-2
Manganese	3 / 3	740	350	1300	SB-2
Mercury	3 / 3	0.17	0.04	0.42	SB-2
Nickel	3 / 3	17.6	4.1	41.1	SB-2
Silver	1 / 3	0.95	0.95	0.95	SB-2
Vanadium	3 / 3	10.5	3.3	24.1	SB-2
Zinc	3 / 3	110	24.1	272	SB-2

Note:

(1) Analytes that are essential human nutrients include: calcium, iron, magnesium, potassium, and sodium)

TABLE 2-3
HYDRAULIC CONDUCTIVITY TEST RESULTS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

WELL	TYPE			K (cm/sec)	Kave(cm/sec)
SHALLOW BEDROCK WELLS					
BR-111	FALLING HEAD			1.53E-02	
	RISING HEAD			5.26E-02	
					3.4E-02
BR-112A	FALLING HEAD			1.40E-04	
	RISING HEAD			1.40E-04	
					1.4E-04
BR-113	FALLING HEAD			7.33E-02	
	RISING HEAD			8.00E-02	
					7.7E-02
BR-114	FALLING HEAD			2.80E-02	
	RISING HEAD			3.40E-02	
					3.1E-02
RANGE		**8.0E-02**	**to**	**1.4E-04**	
DEEP BEDROCK WELLS					
BR-111D	FALLING HEAD			3.20E-03	
	RISING HEAD			3.00E-03	
					3.1E-03
BR-112D	FALLING HEAD			7.32E-03	
	RISING HEAD			6.60E-03	
					7.0E-03
BR-113D	FALLING HEAD			6.50E-03	
	RISING HEAD			6.90E-03	
					6.7E-03
RANGE		**7.3E-03**	**to**	**3.0E-03**	
OVERBURDEN WELLS					
MW-114	INSUFFICIENT WATER DEPTH AVAILABLE FOR TESTING				

NOTES:

K (cm/sec)	Hydraulic conductivity calculated in centimeters per second
Kave (cm/sec)	Average (arithmetic mean) hydraulic conductivity from rising and falling he

TABLE 2-4
SELECTED CHLOROPYRIDINE CONCENTRATIONS (1) IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	DATE	2,6-CPL	2-CPL	3-CPL	4-CPL	Pyridine	p-FAE	SUM OF VALUES (2)
ONSITE WELLS								
B-1	12-Sep-95	24	12	-	NA	NA	-	36
B-17	13-Sep-95	19000 J	120000	6200	NA	NA	400 E	145600
B-6	12-Sep-95	11000	42000	770	NA	NA	180 J	53950
E-1	12-Sep-95	350	1400	79	NA	NA	6 J	1835
E-3	12-Sep-95	120	82	-	NA	NA	29	231
OFFSITE WELLS								
MW-103	11-Sep-95	1 J	23	-	NA	NA	-	24
MW-104	11-Sep-95	51	130	-	NA	NA	-	181
MW-106	11-Sep-95	15000 J	84000	4000	NA	NA	320	103000
MW-107	11-Sep-95	1 J	14	-	NA	NA	-	15
MW-114	7-Dec-95	-	-	-	-	-	-	ND

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of 2,6-DCPE, 2-CPE, 3-CPE, and p-FAE used in contour plots shown in Section 3.0.

NA = Not analyzed

2,6-DCL = 2,6-Dichloropyridine
2-CPL = 2-Chloropyridine
3-CPL = 3-Chloropyridine
4-CPL = 4-Chloropyridine
p-FAE = p-Fluaroaniline

TABLE 2-5
SELECTED CHLOROPYRIDINE CONCENTRATIONS (1) IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	TYPE	DATE	2,6-CPL	2-CPL	3-CPL	4-CPE	Pyridine	p-FAE	SUM OF VALUES (2)
ONSITE WELLS									
BR-1		12-Sep-95	-	14	-	NA	NA	-	14
BR-101		11-Sep-95	2300	6700	560	NA	NA	-	9560
BR-102		12-Sep-95	110	660	10	NA	NA	17	797
BR-2		12-Sep-95	250	1600	38	NA	NA	24	1912
BR-2D		14-Sep-95	4 J	46	3 J	NA	NA	-	53
BR-3		12-Sep-95	9000	69000	4600	NA	NA	250	82850
BR-3D		14-Sep-95	1 J	91	6 J	NA	NA	-	98
BR-4	Duplicate	12-Sep-95	68	190	8 J	NA	NA	-	266
BR-4		12-Sep-95	77	220	8 J	NA	NA	-	305
BR-5A		12-Sep-95	82	230	2 J	NA	NA	37	351
BR-6		12-Sep-95	8800 J	74000	3300	NA	NA	25 J	86125
BR-8	Duplicate	13-Sep-95	1100	4400	72 J	NA	NA	210	5782
BR-8		13-Sep-95	1200	4900	130	NA	NA	180	6410
OFFSITE WELLS									
BR-103		11-Sep-95	0.5 J	15	-	NA	NA	-	15.5
BR-104		11-Sep-95	59	140	-	NA	NA	-	199
BR-105		11-Sep-95	750	12000	210	NA	NA	14	12974
BR-105D		11-Sep-95	32	1300	15	NA	NA	4 J	1351
BR-106		11-Sep-95	810	5800	250	NA	NA	24	6884
BR-107		11-Sep-95	-	17	-	NA	NA	-	17
BR-111		7-Dec-95	-	-	-	-	-	-	ND
BR-111D		7-Dec-95	-	-	-	-	-	-	ND
BR-112A		7-Dec-95	-	-	-	-	-	-	ND
BR-112D		7-Dec-95	-	4 J	-	-	-	-	4
BR-113	Duplicate	7-Dec-95	-	2 J	-	-	-	-	2
BR-113		7-Dec-95	-	2 J	-	-	-	-	2
BR-113D		7-Dec-95	1 J	76	-	-	-	-	77
BR-114		7-Dec-95	6 J	12	8 J	-	-	-	26
NESS-E		12-Sep-95	140	2200	8 J	NA	NA	-	2348
NESS-E		7-Dec-95	97	1300	-	-	-	2 J	1399
NESS-W		12-Sep-95	12	600	14	NA	NA	1 J	627
NESS-W		7-Dec-95	11	-	150	6 J	-	-	161

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of 2,6-DCPE, 2-CPE, 3-CPE, and p-FAE used in contour plots shown in Section 3.0.
NA = Not analyzed

2,6-CDL = 2,6-Dichloropyridine
2-CPL = 2-Chloropyridine
3-CPL = 3-Chloropyridine
4-CPL = 4-Chloropyridine
p-FAE = p-Fluaroaniline

TABLE 2-6
SELECTED VOC CONCENTRATIONS (1) IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	DATE	1,1,1-TCA	1,1-DCA	1,2-DCE	CCL4	CHCL3	MECL	PCE	TCE	SUM OF VALUES (2)
ONSITE WELLS										
B-1	12-Sep-95	-	-	-	-	-	-	-	-	ND
B-17	13-Sep-95	-	-	-	100000	35000	2800	3100	-	140900
B-6	12-Sep-95	-	-	2 J	-	-	-	-	-	2
E-1	12-Sep-95	-	-	10 J	420	680	33 J	17 J	-	1160
E-3	12-Sep-95	-	-	7 J	-	-	-	-	2 J	9
OFFSITE WELLS										
MW-103	11-Sep-95	-	-	-	-	-	-	-	-	ND
MW-104	11-Sep-95	-	-	-	-	-	-	-	1 J	1
MW-106	11-Sep-95	-	-	9 J	-	89	-	-	-	98
MW-107	11-Sep-95	-	2 J	-	-	-	-	-	-	2
MW-114	7-Dec-95	-	0.85	-	-	1.8	-	3.1	5.1	10.85

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of values used in contour plots shown in Section 3.0.

1,1,1-TCA = 1,1,1-Trichloroethane
1,1-DCA = 1,1-Dichloroethane
1,2-DCE = 1,2-Dichloroethene (Total)
CCL4 = Carbon Tetrachloride
TCE = Trichloroethene

CHCL3 = Chloroform
MECL = Methylene Chloride
PCE = Tetrachloroethene
TCE = Trichloroethene

TABLE 2-7
SELECTED VOC CONCENTRATIONS (1)
IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	SAMPLE TYPE	DATE	1,1,1-TCA	1,1-DCA	1,2-DCE	CCL4	CHCL3	MECL	PCE	TCE	SUM OF VALUES (2)
ONSITE WELLS											
BR-1		12-Sep-95	-	-	-	-	-	-	-	-	ND
BR-101		11-Sep-95	-	-	-	-	5400	31000	-	-	36400
BR-102		12-Sep-95	-	-	-	19 J	340	220	17 J	5 J	601
BR-2		12-Sep-95	-	-	73 J	14000	14000	9000	180	63 J	37316
BR-2D		14-Sep-95	-	-	1 J	-	5 J	-	-	-	6
BR-3		12-Sep-95	-	-	-	1700 J	14000	24000	-	-	39700
BR-3D		14-Sep-95	-	-	-	-	-	170	-	-	170
BR-4	Duplicate	12-Sep-95	-	-	2 J	-	-	3 J	-	-	5
BR-4		12-Sep-95	-	-	2 J	-	-	3 J	-	-	5
BR-5A		12-Sep-95	-	-	610	-	65	-	-	75	750
BR-6		12-Sep-95	-	-	-	750	6700	1400	190 J	-	9040
BR-6	Duplicate	13-Sep-95	-	-	18 J	-	-	-	-	-	18
BR-6		13-Sep-95	-	-	17 J	-	-	-	-	-	17
OFFSITE WELLS											
BR-103		11-Sep-95	-	-	24	-	-	-	-	-	24
BR-104		11-Sep-95	-	-	-	-	-	-	-	-	ND
BR-105		11-Sep-95	-	2 J	5 J	-	-	-	2 J	4 J	13
BR-105D		11-Sep-95	-	6 J	59	-	-	-	-	-	65
BR-106		11-Sep-95	-	28 J	490	-	7 J	-	-	9 J	534
BR-107		11-Sep-95	-	6 J	360	-	-	-	-	-	366
BR-111		26-Oct-95	-	-	-	-	-	-	-	-	ND
BR-111D		26-Oct-95	-	-	-	-	-	-	-	-	ND
BR-112A		27-Oct-95	-	-	-	-	0.41 J	-	-	-	0.41
BR-112D		27-Oct-95	0.89	35	48	-	-	-	-	2.4	86.29
BR-113	Duplicate	26-Oct-95	-	-	-	-	-	-	-	-	ND
BR-113		26-Oct-95	-	-	-	-	-	-	-	-	ND
BR-113D		26-Oct-95	0.85	35	36	-	1	-	-	1.6	74.45
BR-114		27-Oct-95	-	0.95	-	-	-	-	-	-	0.95
NESS-E		12-Sep-95	-	6 J	4 J	-	-	-	3 J	9 J	22
NESS-E	Duplicate	20-Nov-95	-	4.8	4.9	-	1	-	3.9	11	25.6
NESS-E		20-Nov-95	-	4.5	4.9	-	1.2	-	3.8	12	26.4
NESS-W		12-Sep-95	-	7 J	14	-	-	3 J	2 J	2 J	28
NESS-W		20-Nov-95	-	6.3	46	-	1.4	2.8 J	1.3	1.5	59.3

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.

(2) Sum of values used in contour plots shown in Section 3.0.

1,1,1-TCA =	1,1,1-Trichloroethane	CHCL3	Chloroform
1,1-DCA =	1,1-Dichloroethane	MECL	Methylene Chloride
1,2-DCE =	1,2-Dichloroethene (Total)	PCE	Tetrachloroethene
CCL4 =	Carbon Tetrachloride	TCE	Trichloroethene

TABLE 2-8
CHLORINATED ETHENE CONCENTRATIONS (1) IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	DATE	1,2-DCE	PCE	TCE	VC	SUM OF VALUES (2)
ONSITE WELLS						
B-1	12-Sep-95	-	-	-	-	ND
B-17	13-Sep-95	-	3100	-	-	3100
B-6	12-Sep-95	2 J	-	-	-	2
E-1	12-Sep-95	10 J	17 J	-	-	27
E-3	12-Sep-95	7 J	-	2 J	-	9
OFFSITE WELLS						
MW-103	11-Sep-95	-	-	-	-	ND
MW-104	11-Sep-95	-	-	1 J	-	1
MW-106	11-Sep-95	9 J	-	-	8 J	17
MW-107	11-Sep-95	-	-	-	-	ND
MW-114	7-Dec-95	-	3.1	5.1	-	8.2

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of values used in contour plots shown in Section 3.0.

1,2-DCE = 1,2-Dichloroethene (Total)
PCE = Tetrachloroethene
TCE = Trichloroethene
VC = Vinyl Chloride

TABLE 2-9
CHLORINATED ETHENE CONCENTRATIONS (1) IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	TYPE	DATE	1.2-DCE	PCE	TCE	VC	SUM OF VALUES (2)
BR-1		12-Sep-95	-	-	-	-	ND
BR-101		11-Sep-95	-	-	-	-	ND
BR-102		12-Sep-95	-	17 J	5 J	-	22
BR-2		12-Sep-95	73 J	180	63 J	17 J	333
BR-2D		14-Sep-95	1 J	-	-	-	1
BR-3		12-Sep-95	-	-	-	-	ND
BR-3D		14-Sep-95	-	-	-	-	ND
BR-4	Duplicate	12-Sep-95	2 J	-	-	17	19
BR-4		12-Sep-95	2 J	-	-	18	20
BR-5A		12-Sep-95	610	-	75	47	732
BR-6		12-Sep-95	-	190 J	-	-	190
BR-8	Duplicate	13-Sep-95	18 J	-	-	-	18
BR-8		13-Sep-95	17 J	-	-	-	17
OFFSITE WELLS							
BR-103		11-Sep-95	24	-	-	3 J	27
BR-104		11-Sep-95	-	-	-	-	ND
BR-105		11-Sep-95	5 J	2 J	4 J	2 J	13
BR-105D		11-Sep-95	59	-	-	30	89
BR-106		11-Sep-95	490	-	9 J	350	849
BR-107		11-Sep-95	360	-	-	280	640
BR-111		26-Oct-95	-	-	-	-	ND
BR-111D		26-Oct-95	-	-	-	-	ND
BR-112A		27-Oct-95	-	-	-	-	ND
BR-112D		27-Oct-95	48	-	2.4	67	117.4
BR-113	Duplicate	26-Oct-95	-	-	-	-	ND
BR-113		26-Oct-95	-	-	-	-	ND
BR-113D		26-Oct-95	36	-	1.6	33	70.6
BR-114		27-Oct-95	-	-	-	-	ND
NESS-E		12-Sep-95	4 J	3 J	9 J	4 J	20
NESS-E	Duplicate	20-Nov-95	4.9	3.9	11	4.9	24.7
NESS-E		20-Nov-95	4.9	3.8	12	4.3	25
NESS-W		12-Sep-95	14	2 J	2 J	9 J	27
NESS-W		20-Nov-95	46	1.3	1.5	60	108.8

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of values used in contour plots shown in Section 3.0.

1,2-DCE = 1,2-Dichloroethene (Total)
PCE = Tetrachloroethene
TCE = Trichloroethene
VC = Vinyl Chloride

TABLE 2-10
BTEX CONCENTRATIONS (1) IN OVERBURDEN GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	DATE	Benzene	Ethylbenzene	Toluene	Total Xylenes	SUM OF VALUES
ONSITE WELLS						
B-1	12-Sep-95	-	-	-	-	ND
B-17	13-Sep-95	-	-	280 J	-	280
B-6	12-Sep-95	30	3 J	70	2 J	105
E-1	12-Sep-95	-	-	12 J	31 J	43
E-3	12-Sep-95	44	-	-	-	44
OFFSITE WELLS						
MW-103	11-Sep-95	-	-	-	-	ND
MW-104	11-Sep-95	-	-	-	-	ND
MW-106	11-Sep-95	190	8 J	2300	27 J	2525
MW-107	11-Sep-95	-	-	-	-	ND
MW-114	7-Dec-95	0.64	-	0.55	0.59	1.78

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of values used in contour plots shown in Section 3.0.

TABLE 2-11
BTEX CONCENTRATIONS (1) IN BEDROCK GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

WELL	TYPE	DATE	Benzene	Ethylbenzene	Toluene	Total Xylenes	SUM OF VALUES (2)
ONSITE WELLS							
BR-1		12-Sep-95	-	-	-	-	ND
BR-101		11-Sep-95	400 J	790 J	26000	3800	30990
BR-102		12-Sep-95	30	-	21 J	-	51
BR-2		12-Sep-95	28 J	-	84 J	-	112
BR-2D		14-Sep-95	3 J	-	4 J	7 J	14
BR-3		12-Sep-95	-	-	310 J	-	310
BR-3D		14-Sep-95	5 J	1 J	11	10	27
BR-4	Duplicate	12-Sep-95	-	-	-	-	ND
BR-4		12-Sep-95	-	-	-	-	ND
BR-5A		12-Sep-95	82	-	26 J	-	108
BR-6		12-Sep-95	-	-	260 J	-	260
BR-8	Duplicate	13-Sep-95	66	-	45 J	-	111
BR-8		13-Sep-95	68	-	43 J	-	111
OFFSITE WELLS							
BR-103		11-Sep-95	2 J	-	-	-	2
BR-104		11-Sep-95	-	-	-	-	ND
BR-105		11-Sep-95	10	-	2 J	-	12
BR-105D		11-Sep-95	10	-	6 J	2 J	18
BR-106		11-Sep-95	86	4 J	230	6 J	326
BR-107		11-Sep-95	110	-	6 J	6 J	122
BR-111		26-Oct-95	1.6	1.1	0.59	2.8	6.09
BR-111D		26-Oct-95	240	38	14	41	333
BR-112A		27-Oct-95	-	-	0.24 J	0.28 J	0.52
BR-112D		27-Oct-95	22	3.2	0.54	1.8	27.54
BR-113	Duplicate	26-Oct-95	30	62	140	340	572
BR-113		26-Oct-95	31	61	130	340	562
BR-113D		26-Oct-95	24	1.3	1.1	2	28.4
BR-114		27-Oct-95	0.58	1.1	0.25 J	2.1	4.03
NESS-E		12-Sep-95	4 J	-	-	-	4
NESS-E	Duplicate	20-Nov-95	2.8	0.26 J	0.32 J	0.25 J	3.63
NESS-E		20-Nov-95	2.3	0.27 J	0.32 J	0.23 J	3.12
NESS-W		12-Sep-95	34	10	4 J	5 J	53
NESS-W		20-Nov-95	35	7.3	3.1	5.2	50.6

Notes:

(1) Concentrations reported in micrograms per liter (ug/l); "-" represents not detected.
(2) Sum of values used in contour plots shown in Section 3.0.

TABLE 2-12
INORGANICS DATA SUMMARY (1) FOR GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

INORGANIC	FREQUENCY	RANGE (ug/l) MINIMUM	MAXIMUM	MEDIAN (2) CONCENTRATION
Aluminum	10 / 10	86.6	16600	2105
Antimony	2 / 10	5.4	57.6	BDL
Arsenic	6 / 10	6.2	371	8
Barium	10 / 10	36.7	174	133
Beryllium	5 / 10	0.21	2.1	BDL
Cadmium	3 / 10	0.72	98.4	BDL
Calcium	10 / 10	135000	1220000	202500
Chromium	6 / 10	2	102	6
Cobalt	6 / 10	1.7	34.6	5
Copper	9 / 10	1.6	70700	15
Iron	10 / 10	2540	864000	18300
Lead	9 / 10	2.3	4750	18
Magnesium	10 / 10	28800	357000	77850
Manganese	10 / 10	54.1	8640	808
Mercury	3 / 10	0.54	7.7	BDL
Nickel	8 / 10	1.6	514	13
Potassium	10 / 10	4040	171000	12800
Selenium	2 / 10	7.1	17.7	BDL
Silver	3 / 10	1.1	33.4	BDL
Sodium	10 / 10	12200	6490000	124100
Vanadium	8 / 10	3.9	74.8	6
Zinc	10 / 10	17.6	2780000	110

Notes:

(1) Data reported for 9 offsite shallow and deep bedrock wells and 1 offsite overburden well; Samples collected November 20, 1995.

(2) Median concentration selected from average of 6th and 7th ranking values from population of 10 samples and 2 duplicate samples. "BDL" or below detection limit is reported for frequencies of 50% or less.

Theis
470 (- high + low)

Table 2-13
BR-7A and BR-6A Pumping Test Results

Olin Chemicals Phase II RI Report
Rochester, NY

470

BR-7A Pumping Test						
Well	**Distance to BR-7A (ft)**	**Apparent Drawdown**	**Interpreted Maximum Drawdown**	**Analysis Method**	**T (ft^2/ day)**	**S**
BR-7A	0.25	7.2 ft at 1890 min	7.6	Hantill	350	N/A
PZ-105	145	0.44 ft at 1683 min	0.63	Theis (Jacob)	330 (400)	0.004 0.003
PZ-106	480	0.35 ft at 1688 min	0.46	Theis (Jacob)	300 (310)	0.001 0.0009
PZ-107	530	0.21 ft at 1685 min	0.41	Theis (Jacob)	300 (470)	0.0009 0.0007
PZ-103	155	0.10 ft at 1380 min	0.14	Theis (Jacob)	610 (880)	0.02 0.02
PZ-104	205	None	None	N/A		
BR-3A	265	None	None	N/A		
BR-8	265	None	None	N/A		

318

337 ave
500

~40' sep

BR-6A Pumping Test						
Well	**Distance to BR-6A (ft)**	**Apparent Drawdown (ft)**	**Interpreted Maximum Drawdown**	**Analysis Method**	**T (ft^2/day)**	**S**
BR-6A	0.25	8.67 at 1060 min	8.34	Theis (Jacob)	250 (300)	NA
PZ-105	134	1.55 at 1060 min	1.23	Theis (Jacob)	700 (900)	0.0006 (0.0004)
PZ-106	245	1.00 at 1060 min	0.66	Theis (Jacob)	700 (870)	0.004 0.003
BR-2A	350	0.34 at 1028 min	0.20	Theis (Jacob)	1300 NA	0.009 NA
PZ-107	270	1.00 at 1060 min	0.7 (est)	No fit		
BR-7A	375	4.5 at 840 min	4.3 (est)	Insufficient data		
BR-3A	125	None	None	N/A		
PZ-103	400	None	None	N/A		

Notes:

T = Transmissivity
S = Storativity

TABLE 3-1
PHYSIO-CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm-m3/mol)	Koc (ml/g) (2)
VOCs						
1,1,1-Trichloroethane	71-55-6	1.3492	1330	1.20E+02	2.80E-02	152
1,1-Dichloroethane	75-34-3	1.175	5500	2.30E+02	5.70E-03	30
1,1-Dichloroethene	75-35-4	1.218	2250	6.00E+02	1.54E-01	65
1,2-Dichlorobenzene	95-50-1	1.35	118	1.47E+00	1.90E-03	1700
1,2-Dichloroethane	107-06-2	1.25	7990	8.56E+01	1.10E-03	14
1,2-Dichloropropane	78-87-5	1.16	2700	4.20E+01	1.54E-01	51
2-Hexanone	591-78-6	0.83	35000	1.00E+01	3.78E-05	14.8
4-Methyl-2-pentanone	108-10-1	0.8006	19000	6.00E+00	6.77E-05	19
Acetone	67-64-1	0.791	miscible	2.70E+02	3.67E-05	2.2
Benzene	71-43-2	0.871	1750	9.52E+01	5.46E-03	65
Bromoform	75-25-2	2.89	3010	5.00E+00	5.32E-04	116
Carbon Disulfide	75-15-0	1.263	2940	3.60E+02	1.23E-02	54
Carbon Tetrachloride	56-23-5	1.59	758	1.10E+02	2.30E-02	439
Chlorobenzene	108-90-7	1.1	491	1.17E+01	3.40E-03	330
Chloroform	67-66-3	1.489	7220	1.51E+02	3.80E-03	44
Chloromethane	74-87-3	0.991	6500	7.60E+02	9.90E-03	5.5
Dibromochloromethane	124-48-1	2.38	4540	7.60E+01	4.59E-03	107
Ethyl Benzene	100-41-4	0.867	153	7.00E+00	8.43E-03	220
Methyl ethyl ketone	78-93-3	0.805	268000	7.75E+01	5.14E-05	4.51
Methylene chloride	75-09-2	1.325	18000	4.11E+02	2.60E-03	8.8
Tetrachloroethene	127-18-4	1.626	484	1.85E+01	2.30E-02	364
Toluene	108-88-3	0.867	1550	2.84E+01	6.60E-03	120
Trichloroethene	79-01-6	1.4679	1470	7.43E+01	8.90E-03	126
Vinyl Chloride	75-01-4	0.912	2670	7.60E+02	6.90E-01	8.2
p-Xylene	106-42-3	0.86	198	8.82E+00	7.04E-03	238
trans-1,2-Dichloroethene	156-60-5	1.26	6300	3.24E+02	6.60E-03	59
SVOCs						
1,2,4-Trichlorobenzene	120-82-1	1.574	48.8	2.90E-01	1.42E-03	9200
1,3-Dichlorobenzene	541-73-1	1.288	133	2.28E+00	3.60E-03	1700
1,4-Dichlorobenzene	106-46-7	1.458	73.8	1.18E+00	1.60E-03	1700
2,4,6-Trichlorophenol	88-06-2	1.49	434	1.20E-02	4.82E-06	2000
2,4-Dimethylphenol	105-67-9	1.036	7870	2.60E-02	5.31E-07	96
2,4-Dinitrotoluene	121-14-2	1.521	280	2.17E-04	1.86E-07	251
2,6-Dichloropyridine	2402-78-0	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	110-75-8	1.048	18900	2.68E+01	1.99E-04	11.7

TABLE 3-1
PHYSIO-CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm-m3/mol)	Koc (ml/g) (2)
2-Chlorophenol	95-57-8	ND	11400	2.35E+00	3.49E-05	73
2-Chloropyridine	109-09-1	1.205	2000	1.00E+00	ND	ND
2-Methylnaphthalene	91-57-6	0.994	25.4	4.50E-02	3.31E-04	7940
3-Chloropyridine	626-60-8	1.194	ND	ND	ND	ND
4-Chloropyridine	7379-35-3	ND	ND	ND	ND	ND
Acenaphthene	83-32-9	1.069	3.93	2.15E-03	2.40E-04	4600
Anthracene	120-12-7	1.25	0.073	6.00E-06	5.90E-05	14000
Benzo(a)anthracene	56-55-3	ND	0.014	2.10E-07	4.50E-06	1380000
Benzo(a)pyrene	50-32-8	ND	0.00005	5.60E-09	3.72E-05	5500000
Benzo(b)fluoranthene	205-99-2	ND	0.014	5.00E-07	1.18E-05	550000
Benzo(g,h,i)perylene	191-24-2	ND	0.0003	1.03E-10	1.25E-07	1600000
Benzo(k)fluoranthene	207-08-9	ND	0.0043	5.10E-07	3.94E-05	550000
Benzoic acid	65-85-0	1.265	2900	7.05E-03	3.92E-07	54.4
Butylbenzylphthalate	85-68-7	1.1	2	2.12E-05	4.35E-06	17000
Chrysene	218-01-9	1.274	0.002	6.40E-09	9.60E-07	200000
Di-n-butylphthalate	84-74-2	1.046	9.2	1.00E-05	1.30E-06	1390
Di-n-octylphthalate	117-84-0	0.986	0.34	1.40E-04	5.50E-06	19000
Dibenzo(a,h)anthracene	53-70-3	ND	0.014	1.00E-10	2.61E-09	3300000
Dibenzofuran	132-64-9	1.089	10	3.37E-05	7.45E-07	9120
Diethylphthalate	84-66-2	1.12	680	3.50E-03	1.50E-06	69
Dimethylphthalate	131-11-3	1.189	2120	4.19E-03	5.05E-07	17.4
Fluoranthene	206-44-0	1.252	0.26	9.20E-06	9.41E-06	38000
Fluorene	86-73-7	1.203	1.98	6.00E-04	8.40E-05	7300
Hexachlorobenzene	118-74-1	2.044	0.006	2.58E-03	1.70E-03	3900
Hexachlorobutadiene	87-68-3	1.675	3.23	2.00E+00	1.03E-02	29000
Hexachloroethane	67-72-1	2.09	50	4.00E-01	3.89E-03	20000
Indeno(1,2,3-c,d)pyrene	193-39-5	ND	0.00053	1.00E-10	6.85E-08	1600000
N-Nitrosodiphenylamine	86-30-6	1.23	35	6.69E-04	5.00E-06	648
Naphthalene	91-20-3	1.152	31.7	7.80E-02	4.20E-04	940
Phenanthrene	85-01-8	1.025	1.29	1.20E-04	3.90E-05	14000
Phenol	108-95-2	1.07	93000	3.41E-01	3.95E-07	14.2
Pyrene	129-00-0	1.271	0.135	4.50E-06	8.86E-06	38000
Pyridine	110-86-1	0.982	miscible	2.00E+01	8.85E-06	3.02
bis(2-Chloroethyl)ether	111-44-4	1.22	10200	7.10E-01	1.31E-05	13.9
bis(2-Ethylhexyl)phthalate	117-81-7	0.99	0.4	2.00E-07	4.40E-07	87400

TABLE 3-1
PHYSIO-CHEMICAL PROPERTIES OF SELECTED CHEMICALS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Chemical Name	CAS Number	Specific Gravity	Water Solubility (mg/L)	Vapor Pressure (mmHg)	Henry's Law (1) (atm-m3/mol)	Koc (ml/g) (2)
p-Fluoroaniline	371-40-4	1.1725	ND	ND	ND	ND
p-Nitroaniline	100-01-6	1.424	800	1.50E-03	3.41E-07	15.1

NOTES:

VOC = Volatile Organic Compounds
SVOC = Semivolatile Organic Compounds
Koc = Organic carbon partion coefficient
mg/L = milligrams per liter
mmHg = millimeters of mercury
atm-m3/mol = Atmosphere-cubic meters per mole
ml/g = milliliters per gram
ND = No Data

1) Range of H (atm-m3/mol)	Degree of Volatility
H < 3.0E-07	non-volatile
3.0E-07 < H < 1.0E-05	low volatility
1.0E-05 < H < 1.0E-03	moderate volatility
H > 1.0E-03	high volatility

2) Degree of Adsorption	Koc	Degree of Mobility
very weak	< 10	very high
weak	10 - 100	high
moderate	100 - 1000	moderate
moderate to strong	1000-10000	low
strong	10000-1000000	very low
very strong	>100000	extremely low

TABLE 4-1
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration		Mean of all Samples**	Federal MCL	CPC?	COMMENTS
			Minimum	Maximum				
OFFSITE GROUNDWATER* (mg/L)								
VOLATILE ORGANIC COMPOUNDS								
1,1,1-Trichloroethane	0.0005 - 0.05	2 / 19	0.0008	0.0009	0.0050	0.2	No	Toxicity Screen[1]
1,1,2,2-Tetrachloroethane	0.0005 - 0.05	1 / 19	0.0009	0.001	0.0050	-	No	Toxicity Screen[1]
1,1-Dichloroethane	0.0005 - 0.05	10 / 19	0.0009	0.035	0.0092	-	No	Toxicity Screen[1]
1,2-Dichloroethene (Total)	0.0005 - 0.01	10 / 19	0.004	0.49	0.0573	0.07	Yes	Class[2]
2-Butanone	0.001 - 0.05	1 / 19	0.055	0.055	0.0066	-	No	Toxicity Screen[1]
Acetone	0.01 - 0.1	4 / 19	0.014	1.2	0.0774	-	No	Toxicity Screen[1]
Benzene	0.0005 - 0.01	14 / 19	0.0006	0.24	0.0413	0.005	Yes	
Carbon Disulfide	0.0005 - 0.05	9 / 19	0.0003	0.036	0.0070	-	No	Toxicity Screen[1]
Chlorobenzene	0.0005 - 0.01	5 / 19	0.001	1.4	0.0856	0.1	No	Toxicity Screen[1]
Chloroethane	0.001 - 0.05	1 / 19	0.003	0.003	0.0054	-	No	Toxicity Screen[1]
Chloroform	0.0005 - 0.01	6 / 19	0.0004	0.089	0.0077	0.08	No	Toxicity Screen[1]
Ethylbenzene	0.0005 - 0.01	10 / 19	0.0003	0.062	0.0089	0.7	No	Toxicity Screen[1]
Methylene Chloride	0.003 - 0.05	1 / 19	0.003	0.003	0.0065	0.005	No	Toxicity Screen[1]
Tetrachloroethene	0.0005 - 0.05	3 / 19	0.001	0.004	0.0048	0.005	Yes	Class[2]
Toluene	0.01 - 0.01	14 / 19	0.0002	2.3	0.1435	1	No	Toxicity Screen[1]
Total Xylenes	0.01 - 0.01	13 / 19	0.0002	0.34	0.0247	10	No	Toxicity Screen[1]
Trichloroethene	0.0005 - 0.05	7 / 19	0.001	0.012	0.0047	0.005	Yes	Class[2]
Vinyl Acetate	0.005 - 0.05	1 / 9	0.025	0.025	0.0064	-	No	Toxicity Screen[1]
Vinyl Chloride	0.001 - 0.01	10 / 19	0.002	0.35	0.0442	0.002	Yes	
SEMIVOLATILE ORGANIC COMPOUNDS								
1,2-Dichlorobenzene	0.01 - 0.01	1 / 9	0.003	0.004	0.0048	0.6	No	Toxicity Screen[1]
2,4-Dimethylphenol	0.01 - 0.01	1 / 9	0.002	0.002	0.0047	-	No	Toxicity Screen[1]
2,6-Dichloropyridine	0.01 - 0.01	15 / 23	0.0005	15	0.7384	-	Yes	
2-Chloropyridine	0.01 - 0.01	19 / 23	0.002	84	4.6343	-	Yes	
2-Methylnaphthalene	0.01 - 0.01	2 / 9	0.002	0.014	0.0054	-	No	Toxicity Screen[1]
2-Methylphenol	0.01 - 0.01	1 / 9	0.0009	0.0009	0.0045	-	No	Toxicity Screen[1]
3-Chloropyridine	0.01 - 0.01	8 / 23	0.007	4	0.2023	-	Yes	
4-Chloropyridine	0.01 - 0.01	1 / 13	0.006	0.006	0.0051	-	Yes	Class[2]
4-Methylphenol	0.01 - 0.01	3 / 9	0.001	0.008	0.0046	-	No	Toxicity Screen[1]
bis(2-Chloroethyl)ether	0.01 - 0.01	1 / 9	0.006	0.009	0.0053	-	No	Toxicity Screen[1]
bis(2-Ethylhexyl)phthalate	0.01 - 0.01	6 / 9	0.001	0.016	0.0052	0.006	No	Toxicity Screen[1]
Butylbenzylphthalate	0.01 - 0.01	1 / 9	0.0007	0.0007	0.0045	-	No	Toxicity Screen[1]
Di-n-butylphthalate	0.01 - 0.01	2 / 9	0.0008	0.002	0.0042	-	No	Toxicity Screen[1]
Naphthalene	0.01 - 0.01	3 / 9	0.001	0.016	0.0052	-	No	Toxicity Screen[1]
p-Fluoroaniline	0.01 - 0.01	7 / 23	0.001	0.32	0.0197	-	No	Toxicity Screen[1]
INORGANICS								
Aluminum		9 / 9	0.0866	16.6	4.0034	0.2#	No	Toxicity Screen[1]
Antimony	0.0051 - 0.0051	2 / 9	0.0054	0.0576	0.0060	0.006	No	Toxicity Screen[1]
Arsenic	0.0053 - 0.0053	5 / 9	0.0062	0.371	0.0332	0.05	Yes	
Barium		9 / 9	0.0367	1.54	0.2033	2	No	Toxicity Screen[1]
Beryllium	0.0002 - 0.0002	4 / 9	0.0003	0.0021	0.0004	0.004	No	Toxicity Screen[1]
Cadmium	0.0004 - 0.0004	2 / 9	0.0012	0.0984	0.0062	0.005	Yes	
Calcium		9 / 9	135	1220	322.7778	-	Yes	
Chromium	0.001 - 0.001	6 / 9	0.002	0.102	0.0128	0.1	No	Toxicity Screen[1]

TABLE 4-1
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Mean of all Samples**	Federal MCL	CPC?	COMMENTS
Cobalt	0.0016 – 0.0016	5 / 9	0.0017	0.0346	0.0046	–	No	Toxicity Screen[1]
Copper	0.0011 – 0.0011	8 / 9	0.0016	70.7	4.4574	1.3*	Yes	
Iron		9 / 9	2.54	864	110.1289	0.3#	Yes	
Lead	0.0014 – 0.0014	8 / 9	0.0023	4.75	0.3136	0.015*	Yes	Toxicity Value[3]
Magnesium		9 / 9	28.8	357	111.5889	–	Yes	
Manganese		9 / 9	0.0541	5.97	0.8991	0.05#	No	Toxicity Screen[1]
Mercury	0.0002 – 0.0002	2 / 9	0.00054	0.0077	0.0010	0.002	No	Toxicity Screen[1]
Nickel	0.0014 – 0.0014	7 / 9	0.0016	0.514	0.0407	0.1	No	Toxicity Screen[1]
Potassium		9 / 9	4.04	171	29.7333	–	Yes	
Selenium	0.005 – 0.005	2 / 9	0.0071	0.0177	0.0039	0.05	No	Toxicity Screen[1]
Silver	0.0011 – 0.0011	2 / 9	0.0011	0.0334	0.0027	0.1#	No	Toxicity Screen[1]
Sodium		9 / 9	12.2	6490	873.5000	–	Yes	
Vanadium	0.0016 – 0.0016	7 / 9	0.0039	0.0748	0.0111	–	No	Toxicity Screen[1]
Zinc		9 / 9	0.0176	2780	174.5142	5#	Yes	
MISCELLANEOUS PARAMETERS								
Methanol	1 – 1	1 / 12	0.98	0.98	0.54	–	No	Toxicity Screen[1]

NOTES:
** Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.
* – Action Level
# – Secondary Standard
– = No standard available for this compound
Toxicity Screen[1] – Chemicals with low ratios (i.e., less than 0.01) are not considered chemicals of potential concern (CPCs)
Class[2] – Chemical is a transformation or parent compound of a chemical selected as a CPC;
or belongs to a class of compounds where one member of the class has been selected as a CPC.
Toxicity Value[3] – No toxicity data available.

ACRONYMS:
mg/L – milligrams per liter
SQL – Sample Quantitation Limit
MCL – Maximum Contaminant Level; Drinking Water Regulations and Health Advisories, U.S. Environmental Protection Agency Office of Water, May 1995.
CPC – Chemical of Potential Concern

Sample Locations:
[a] – Based on samples QS-1 through QS-4, September 1995 and QS-4 and duplicate October 1995; BR-111, BR-111D, BR-112A, BR-112D, BR-113 and duplicate, BR-113D, and BR-114 October and December 1995; NESS E, NESS W, September, November, and December 1995 plus NESS E duplicate November 1995; BR-103 through BR-107 and BR-105D, MW-103, MW-104, MW-106, and MW-107 September 1995.

TABLE 4-2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
ERIE BARGE CANAL SURFACE WATER

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Mean of all Samples[1]	CPC?	Comments
BARGE CANAL SURFACE WATER[a] (mg/L)							
SEMIVOLATILE ORGANIC COMPOUNDS							
2,6-Dichloropyridine	0.01 - 0.017	7 / 34	0.0003	0.005	0.005	Yes	
2-Chloropyridine	0.01 - 0.011	16 / 34	0.0001	0.039	0.008	Yes	
3-Chloropyridine	0.01 - 0.021	5 / 34	0.001	0.002	0.0048	Yes	
QUARRY OUTFALL WATER[b] (mg/L)							
SEMIVOLATILE ORGANIC COMPOUNDS							
2,6-Dichloropyridine	NA	3 / 3	0.007	0.032	0.021	Yes	
2-Chloropyridine	NA	3 / 3	0.018	0.16	0.900	Yes	
3-Chloropyridine	NA	3 / 3	0.0004	0.011	0.0058	Yes	

NOTES:

[1] - Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.

ACRONYMS:
mg/L - milligrams per liter
SQL - Sample Quantitation Limit
CPC - Chemical of Potential Concern

Sample Locations:
[a] - Based on samples SW-1 through SW-12, QO-2D1, QO-2D2, QO-2U1, QO-2U2 collected April, June, and September 1996 and April and June 1997.
[b] - Based on sample QO-2 collected June and September 1996 and June 1997

TABLE 4–3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER SEEPS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration		Mean of all Samples[1]	CPC?	Comments
			Minimum	Maximum			
GROUNDWATER SEEP IN QUARRY[a] (mg/L)							
SEMIVOLATILE ORGANIC COMPOUNDS							
2–Chloropyridine	NA	8 / 8	0.004	3.2	1.174	Yes	
3–Chloropyridine	0.01 – 0.01	6 / 8	0.007	0.12	0.039	Yes	
2,6–Dichloropyridine	0.01 – 0.01	7 / 8	0.004	1	0.334	Yes	
p–Fluoroaniline[b]	0.01 – 0.01	2 / 5	0.002	0.005	0.0044	Yes	

NOTES:

[1] – Mean of all samples is arithmetic average of all detections plus one–half the SQL for non–detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.

ACRONYMS:

mg/L – milligrams per liter
SQL – Sample Quantitation Limit
CPC – Chemical of Potential Concern

Sample Locations:

[a] – Based on samples QS–2 and QS–3 sampled 9/95, and sample QS–4 sampled 9/95, 10/95, 3/96, 6/96, 9/96, and 12/96.

[b] – Based on samples QS–2 and QS–3 sampled 9/95, and sample QS–4 sampled 9/95 and 10/95; elevated reporting limits for QS–4 sampled 3/96, 6/96, 9/96, and 12/96. precluded use in risk assessment.

TABLE 4-4
SUMMARY OF RECEPTORS AND EXPOSURE PATHWAYS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

RECEPTOR	EXPOSURE PATHWAY
CURRENT AND FUTURE USE	
Recreational boater/swimmer at Barge Canal	Dermal Contact with surface water Incidental Ingestion of surface water
Quarry Worker at the Dolomite Quarry	Dermal Contact with groundwater seeps
FUTURE USE	
Off-site industrial worker	Dermal Contact with groundwater used as industrial processs water Inhalation of volatile compounds released from industrial process water

TABLE 4-5
QUANTITATIVE RISK SUMMARIES BY MEDIA

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

		MEAN		MAXIMUM	
		Total Cancer Risk	**Total Hazard Index**	**Total Cancer Risk**	**Total Hazard Index**
CURRENT AND FUTURE USE					
SURFACE WATER					
Ingestion and Dermal Contact with Surface Water in Barge Canal:	Recreational Child	9E-09	0.00001	1E-07	0.00007
	Recreational Adult	1E-08	0.00001	2E-07	0.00006
TOTAL: Recreational Swimmer		**2E-08**	**NA**	**3E-07**	**NA**
GROUNDWATER SEEP					
Dermal Contact with Groundwater Seep in Dolomite Quarry:	Quarry Worker	7E-08	0.00003	2E-07	0.00007
TOTAL: Quarry Worker		**7E-08**	**0.00003**	**2E-07**	**0.00007**
FUTURE USE					
OFFSITE GROUNDWATER					
Dermal Contact with Offsite Groundwater:	Worker	7E-05	4	9E-04	29
TOTAL: Industrial/Commercial Worker		**7E-05**	**4**	**9E-04**	**29**

NA - Not Additive; child and adult hazard indices are not additive.

TABLE 4–6
QUANTITATIVE RISK SUMMARIES BY RECEPTOR

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, N.Y.

		MEAN		MAXIMUM	
		Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
CURRENT AND FUTURE USE					
RECREATIONAL SWIMMER					
Ingestion and Dermal Contact with Surface Water in Barge Canal:	Recreational Child	9E–09	0.00001	1E–07	0.00007
	Recreational Adult	1E–08	0.00001	2E–07	0.00006
TOTAL: Recreational Swimmer		**2E–08**	**NA**	**3E–07**	**NA**
QUARRY WORKER					
Dermal Contact with Groundwater Seep in Dolomite Quarry:	Quarry Worker	7E–08	0.00003	2E–07	0.00007
TOTAL: Quarry Worker		**7E–08**	**0.00003**	**2E–07**	**0.00007**
FUTURE USE					
INDUSTRIAL/COMMERCIAL WORKER					
Dermal Contact with Offsite Groundwater:	Worker	7E–05	4	9E–04	29
TOTAL: Industrial/Commercial Worker		**7E–05**	**4**	**9E–04**	**29**

NA – Not Additive; child and adult hazard indices are not additive.

TABLE 4-7
POTENTIAL SOURCES OF UNCERTAINTY

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

UNCERTAINTY	EFFECT	JUSTIFICATION
Likelihood of exposure pathways	Overestimate	Future pathways may not actually occur.
Exposure assumptions (e.g., frequency, duration)	Overestimate	Parameters selected are conservative estimates of exposure.
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time as a result of degradation.
Extrapolation of animal toxicity data to humans.	Unknown, probably overestimate	Animals and humans differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses in the environment.
Use of linearized, multistage model to derive cancer slope factors.	Overestimate	Model assumes a non-threshold, linear-at-low-dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Model results in a 95% upper confidence limit of the cancer risk. The true risk is unlikely to be higher and may be as low as zero.
Summation of effects (cancer risks and hazard indices) from multiple substances.	Unknown	The assumption that effects are additive ignores potential synergistic and/or antagonistic effects. Assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce tumors or other toxic effects in different organs or systems.
Use of uncertainty factors in the derivation of reference doses	Unknown	Ten-fold uncertainty factors are incorporated to account for various sources of uncertainty. Although some data seem to support the ten-fold factor, its selection is somewhat arbitrary.
Some analytes, such as the chloropyridines, are evaluated using surrogate toxicity values.	Unknown	Although the toxicity values used are from structurally similar compounds, the actual toxicity of the evaluated compound is not established in IRIS or HEAST.

TABLE 4-8
SURFACE WATER SAMPLING RESULTS
UPSTREAM OF QUARRY OUTFALL

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Analyte [a]	Frequency of Detection	Average Concentration (ug/l) [b]	Maximum Concentration (ug/l) [c]	Toxicity Benchmark [d]
2,6-Dichloropyridine	15/36	4.1	5.0	4,700
2-Chloropyridine	23/36	11	45	14,000
3-Chloropyridine	7/36	4.6	3.0	12,900

NOTES:

[a] These analytes were detected in surface water collected above the quarry outfall, from the following sample locations, SW-1, SW-2, SW-3, SW-7, SW-8, SW-9, SW-11, and SW-12.

[b] The average concentration is calculated with one-half the reporting limit used as the value for non-detects.

[c] The maximum concentration represents the highest detected concentration.

[d] The development of aquatic toxicity benchmarks is described in Section 4.2.4.1.

-- = Analyte not detected.

TABLE 4-9
SURFACE WATER SAMPLING RESULTS ADJACENT TO AND DOWNSTREAM OF THE QUARRY OUTFALL

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Analyte [a]	Frequency of Detection	Average Concentration (µg/L) [b]	Maximum Concentration (µg/L) [c]	Toxicity Benchmark [d]
2,6-Dichloropyridine	--	--	--	4,700
2-Chloropyridine	9/20	3.5	4	14,000
3-Chloropyridine	--	--	--	12,900

NOTES:

[a] Thesa analytes were detected in surface water collected above the quarry outfall, from the following sample locations QO-2N1, QO-2N2, QO-2S1, QO-2S2, SW-4, SW-5, and SW-6.

[b] The average concentration is calculated with one-half the reporting limit used as the value for non-detects.

[c] The maximum concentration represents the highest detected concentration.

[d] The development of aquatic toxicity benchmarks is described in Section 4.2.4.1.

-- = Analyte not detected.

Units are in µg/L

TABLE 4-10
COMPARISON OF SURFACE SOIL INORGANIC CONCENTRATIONS EVALUATED IN THE PHASE I HBA WITH REGIONAL BACKGROUND RANGES [a]

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Analyte	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of Detects	Mean of all Samples	Eastern USA Background [b]
Aluminum	6 / 6	3,900	8,700	6,533	6,533	33,000
Arsenic	6 / 6	2.7	12	5.4	5.4	3 - 12**
Barium	6 / 6	37	110	60	60	15 - 600
Cadmium	6 / 6	0.1	0.8	0.5	0.5	0.1 - 1.0
Calcium	6 / 6	4,900	95,000	42,983	42,983	130 - 35,000**
Chromium	6 / 6	8.2	150	28.0	28.0	1.5 - 40**
Cobalt	3 / 6	5	7.1	5.5	3.9	2.5 - 60**
Copper	6 / 6	8.6	48	20.6	20.6	1 - 50
Iron	6 / 6	12,000	17,000	13,833	13,833	17,500 - 25,000
Lead	6 / 6	12	140	73.7	73.7	[c]
Magnesium	6 / 6	2,700	50,000	17,508	17,508	100 - 5,000
Manganese	6 / 6	240	760	428	428	50, - 5,000
Mercury	4 / 6	0.2	0.4	0.28	0.20	0.001 - 0.2
Nickel	6 / 6	13	62	23.6	23.6	0.5 - 25
Potassium	6 / 6	630	1,200	892.5	892.5	8,500 - 43,000**
Selenium	1 / 6	0.8	0.8	0.8	0.4	0.1 - 3.9
Silver	6 / 6	0.1	0.7	0.4	0.4	NA
Sodium	6 / 6	260	1,400	647.5	647.5	6,000 - 8,000
Vanadium	6 / 6	12	20	16.9	16.9	1 - 300
Zinc	6 / 6	65	240	150	150	9 - 50

NOTES

a. Includes samples SS-102, SS-105, SS-109, SS-112, SS-113, and SS-115. Concentrations in mg/kg.

b. NYSDEC, 1994. "Determination of Soil Cleanup Objectives and Cleanups Levels"; TAGM 4046. Appendix A, Table 4. Ranges indicated with a double asterisk are based on New York State background levels.

c. Average background levels in metropolitan or suburban areas or near highways typically range from 200 - 500 mg/kg.

Shading indicates analytes where the maximum detected concentration exceeds the range of background concentrations.

TABLE 4-11
SEMI-AQUATIC RISK ESTIMATES FOR SURFACE WATER ANALYTES

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

	Maximum Surface Water Conc. (μg/L)	BCF [a]	Tissue Concentration (mg/kg) [b]	Ingestion Rate [c] (kg/day)	Body Weight [d] (kg)	Total Body Dose [e] (mg/kgBW-d)	Reference [f] Toxicity Value (mg/kgBW-d)	Hazard Quotient (unitless)
BELTED KINGFISHER								
(Ceryle alcyon)								
2,6-Dichloropyridine	5	20	0.1	0.067	0.148	0.0453	2.6	1.7E-02
2-Chloropyridine	45	5	0.225	0.067	0.148	0.1019	2.6	3.9E-02
3-Chloropyridine	3	5	0.015	0.067	0.148	0.0068	2.6	2.6E-03
RACCOON								
(Procyon lotor)								
2,6-Dichloropyridine	5	20	0.1	0.214	3.99	0.0054	2.6	2.1E-03
2-Chloropyridine	45	5	0.225	0.214	3.99	0.0121	2.6	4.6E-03
3-Chloropyridine	3	5	0.015	0.067	0.148	0.0068	2.6	2.6E-03

NOTES:

[a] Fish BCFs for 2,6-chloropyridine and 2-chloropyridine are calculated values, obtained using a SAR model.

[b] Tissue concentration is calculated by multiplying the detected surface water concentration by the BCF, units converted to ppm.

[c] Ingestion rates for the belted kingfisher and raccoon were obtained from Nagy (1987) and USEPA (1993), respectively.

[d] Body weights for the belted kingfisher and raccoon were obtained from Opresko et al. (1993) and USEPA (1993), respectively.

[e] Total body dose is calculated by multiplying the tissue concentration by the ingestion rate and dividing by the body weight.

[f] Reference toxicity values are presented in Appendix D, Table D-7, of the Phase I Remedial Investigation.

TABLE 4-12
AQUIRE DATA SUMMARY

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Name	Reliability [a]	Organism Latin	Organism Common	Age	Exposure Regimen [b]	Test Conditions [c]	Effect [d]	Endpoint	Effect Concentration	Accession Number [e]
Pyridine	1	Cyprinus carpio	Carp	4-5CM	24 H	FW; LAB	MOR	LC50	47500	200530
Pyridine	1	Cyprinus carpio	Carp	4-5CM	48 H	FW; LAB	MOR	LC50	35000	206646
Pyridine	1	Cyprinus carpio	Carp	4-5CM	96 H	FW; LAB	MOR	LC50	26000	206647
Pyridine	2	Crangon septemspinosa	Sand shrimp	6.4-8.3 CM, 2.4-4.5 G	96 H	SW; LAB	MOR	LC50	>50000	207264
Pyridine	3	Xenopus laevis	Clawed toad	Early cleavage to mid-blastula *	96 H	FW; LAB	ABN		10000	213886
Pyridine	2	Gambusia affinis	Mosquitofish	Adult, female	24 H	FW; LAB	MOR	LC50	1350000	215420
Pyridine	2	Gambusia affinis	Mosquitofish	Adult, female	48 H	FW; LAB	MOR	LC50	1350000	215421
Pyridine	2	Gambusia affinis	Mosquitofish	Adult, female	96 H	FW; LAB	MOR	LC50	1300000	215422
Pyridine	2	Gambusia affinis	Mosquitofish	Adult, female	96 H	FW; LAB	MOR		1000000	215423
Pyridine	2	Tetrahymena pyriformis	Ciliate	Log phase	72 H	FW; LAB	GRO	EC50	1193700	215541
Pyridine	3	Lepomis humilis	Orangespotted sunfish	4-6 G	1 H	FW; LAB	MOR	LC100	1477000	215587
Pyridine	4	Scenedesmus quadricauda	Green algae	NR	NR	LAB *	PGR		120000	217623
Pyridine	2	Lepomis macrochirus	Bluegill	Fingerlings, 38-76 MM	96 H	FW; LAB	MOR	LC0	2400000	218058
Pyridine	2	Daphnia magna	Water flea	NR	24 H	FW; LAB	MOR	LC50	2114000	218465
Pyridine	2	Daphnia magna	Water flea	NR	48 H	FW; LAB	MOR	LC50	944000	218466
Pyridine	2	Tetrahymena pyriformis	Ciliate	10 G, growth phase	72 H	FW; LAB	GRO	EC50	1211000	218482
Pyridine	4	Chilomonas paramecium	Cryptomonad	NR	48 H	LAB *	PGR		3900	218799
Pyridine	2	Daphnia magna	Water flea	24 H	24 H	FW; LAB	MOR	LC50	240000	220914
Pyridine	3	Daphnia magna	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	1140000	225532
Pyridine	3	Daphnia pulex	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	520000	225533
Pyridine	3	Daphnia pulex	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	630000	225534
Pyridine	3	Daphnia cucullata	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	2390000	225535
Pyridine	3	Daphnia cucullata	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	2550000	225536
Pyridine	3	Daphnia magna	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	1210000	225537
Pyridine	3	Daphnia magna	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	1120000	225538
Pyridine	3	Daphnia magna	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	1570000	225539
Pyridine	3	Daphnia magna	Water flea	< 24 H	48 H	FW; LAB	MOR	LC50	1940000	225540
Pyridine	2	Scenedesmus quadricauda	Green algae	Initial culture turbidity reported	7 D	LAB *	PGR		120000	227293
Pyridine	2	Entosiphon sulcatum	Flagellate	Initial culture turbidity reported	72 H	LAB *	PGR		3500	227294
Pyridine	3	Kuhlia sandvicensis	Aholehole	30-60 mm	0.033	SW; LAB	BEH		20000	229477
Pyridine	2	Ambystoma mexicanum	Salamander	3-4 wk	48 H	FW; LAB	MOR	LC50	950000	235077
Pyridine	2	Xenopus laevis	Clawed toad	3-4 wk	48 H	FW; LAB	MOR	LC50	1400000	235078
Pyridine	3	Oncorhynchus mykiss	Rainbow trout	Fingerling, <= 10 cm	24 H	FW; LAB	STR		5000	236353
Pyridine	3	Lepomis macrochirus	Bluegill	Fingerling, <= 10 cm	24 H	FW; LAB	STR		5000	236354
Pyridine	3	Petromyzon marinus	Sea Lamprey	Larvae, 8-13 cm	24 H	FW; LAB	STR		5000	236355
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryo	24 H	FW; LAB	MOR	LC50	3800000	238233
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryo	48 H	FW; LAB	MOR	LC50	2570000	238234
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryo	72 H	FW; LAB	MOR	LC50	2340000	238235
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryo	5 D	FW; LAB	MOR	LC50	1620000	238236
Pyridine	2	Xenopus laevis	Clawed toad	Tailbud embryo	24 H	FW; LAB	MOR	LC50	9550000	238237
Pyridine	2	Xenopus laevis	Clawed toad	Tailbud embryo	48 H	FW; LAB	MOR	LC50	3390000	238238
Pyridine	2	Xenopus laevis	Clawed toad	Tailbud embryo	72 H	FW; LAB	MOR	LC50	2820000	238239
Pyridine	2	Xenopus laevis	Clawed toad	Tailbud embryo	96 H	FW; LAB	MOR	LC50	2460000	238240
Pyridine	2	Xenopus laevis	Clawed toad	Tailbud embryo	5 D	FW; LAB	MOR	LC50	1000000	238241
Pyridine	2	Xenopus laevis	Clawed toad	Larvae	24 H	FW; LAB	MOR	LC50	1660000	238242
Pyridine	2	Xenopus laevis	Clawed toad	Larvae	48 H	FW; LAB	MOR	LC50	1590000	238243
Pyridine		Xenopus laevis	Clawed toad	Larvae	72 H	FW; LAB	MOR	LC50	1200000	238244

TABLE 4-12
AQUIRE DATA SUMMARY

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Name	Reliability [a]	Organism Latin	Organism Common	Age	Exposure Regimen [b]	Test Conditions [c]	Effect [d]	Endpoint	Effect Concentration	Accession Number [e]
Pyridine	2	Xenopus laevis	Clawed toad	Larvae	96 H	FW; LAB	MOR	LC50	1090000	238245
Pyridine	2	Xenopus laevis	Clawed toad	Larvae	5 D	FW; LAB	MOR	LC50	1050000	238246
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryos	24 H	FW; LAB	ABN	EC50	2190000	238247
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryos	48 H	FW; LAB	ABN	EC50	1550000	238248
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryos	72 H	FW; LAB	ABN	EC50	1350000	238249
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryos	96 H	FW; LAB	ABN	EC50	1200000	238250
Pyridine	2	Xenopus laevis	Clawed toad	Mid-blastula embryos	5 D	FW; LAB	ABN	EC50	850000	238251
Pyridine	2	Daphnia magna	Water flea	NR	24 H	FW; LAB		EC50	520000	242388
Pyridine	2	Daphnia magna	Water flea	NR	24 H	FW; LAB		EC0	266000	244902
Pyridine	2	Selenastrum capricornutum	Green algae	NR	4 H	LAB *	PSE		1000000	250321
Pyridine	2	Scenedesmus quadricauda	Green algae	NR	8 D	LAB *	PGR		120000	257350
Pyridine	2	Anacystis aeruginosa	Blue-green algae	NR	8 D	LAB *	PGR		28000	257351
Pyridine	3	Oryzias latipes	Medaka, high-eyes	2 cm, 0.2 g	24 H	FW; LAB	MOR	LC50	400000	272147
Pyridine	3	Oryzias latipes	Medaka, high-eyes	2 cm, 0.2 g	48 H	FW; LAB	MOR	LC50	330000	272148
Pyridine	2	Selenastrum capricornutum	Green algae	Log phase	96 H	FW; LAB	PGR		50000	275679
Pyridine	2	Chlorella pyrenoidosa	Green algae	Log phase	48 H	FW; LAB	PGR		150000	275680
Pyridine	2	Scenedesmus pannonicus	Green algae	Log phase	48 H	FW; LAB	PGR		280000	275681
Pyridine	2	Aedes aegypti	Mosquito	3rd instar	48 H	FW; LAB	MOR	LC50	130000	275682
Pyridine	2	Culex pipiens	Mosquito	3rd instar	48 H	FW; LAB	MOR	LC50	66000	275683
Pyridine	2	Hydra oligactis	Hydra	Budless	48 H	FW; LAB	MOR	LC50	1150000	275684
Pyridine	2	Lymnaea stagnalis	Great pond snail	3-4 wk	48 H	FW; LAB	MOR	LC50	360000	275685
Pyridine	2	Oncorhynchus mykiss	Rainbow trout	5-8 wk	48 H	FW; LAB	MOR	LC50	560000	275686
Pyridine	2	Oryzias latipes	Medaka, high-eyes	4-5 wk	48 H	FW; LAB	MOR	LC50	1560000	275687
Pyridine	2	Pimephales promelas	Fathead minnow	3-4 wk	48 H	FW; LAB	MOR	LC50	115000	275688
Pyridine	3	Tetrahymena pyriformis	Ciliate	NR	60 H	FW; LAB	PSR	EC50	1.67858	279907
Pyridine	2	Tetrahymena pyriformis	Ciliate	NR	60 H	FW; LAB	PSR	EC50	1678580	281136
Pyridine	2	Daphnia magna	Water flea	< 24 H	24 H	FW; LAB	IMM	EC50	495000	286460
Pyridine	2	Daphnia magna	Water flea	< 24 H	30 D	FW; LAB	MOR		25000	286461
Pyridine	2	Daphnia magna	Water flea	< 24 H	7 D	FW; LAB	GRO		25000	286462
Pyridine	2	Daphnia magna	Water flea	< 24 H	15 D	FW; LAB	REP		25000	286463
Pyridine	1	Artemia salina	Brine shrimp	Nauplii	24 H	SW; LAB	IMM	EC50	1318400	289901
Pyridine	1	Artemia salina	Brine shrimp	Stage II nauplii	24 H	SW; LAB	IMM	EC50	831800	290022
Pyridine	1	Artemia salina	Brine shrimp	Stage II nauplii	24 H	SW; LAB	IMM	EC50	489400	290023
Pyridine	2	Oncorhynchus mykiss	Rainbow trout	10-40 g	96 H	FW; LAB	MOR	LD50	651.87 [f]	293992
Pyridine	4	Brachydanio rerio	Zebrafish	NR	96 H	LAB *	MOR	LC50	> 512000	295635
Pyridine	4	Leuciscus idus	Silver or golden orfe	NR	96 H	LAB *	MOR	LC50	> 512000	295636
Pyridine	2	Tubificidae	Oligochaete	NR	48 H	FW; LAB	MOR	LC50	1300000	296383
Pyridine	2	Chironomus thummi	Midge	NR	48 H	FW; LAB	MOR	LC50	229000	296384
Pyridine	2	Erpobdella octoculata	Leech	NR	48 H	FW; LAB	MOR	LC50	2400000	296385
Pyridine	2	Asellus aquaticus	Aquatic sowbug	NR	48 H	FW; LAB	MOR	LC50	220000	296386
Pyridine	2	Lymnaea stagnalis	Great pond snail	NR	48 H	FW; LAB	MOR	LC50	350000	296387
Pyridine	2	Dugesia lugubris	Flatworm	NR	48 H	FW; LAB	MOR	LC50	1900000	296388
Pyridine	2	Hydra oligactis	Hydra	NR	48 H	FW; LAB	MOR	LC50	1150000	296389
Pyridine	2	Corixa punctata	Water boatman	NR	48 H	FW; LAB	MOR	LC50	30000	296390
Pyridine	2	Gammarus pulex	Scud	NR	48 H	FW; LAB	MOR	LC50	182000	296391
Pyridine	2	Ischnura elegans	Dragonfly	NR	48 H	FW; LAB	MOR	LC50	410000	296392
Pyridine	2	Nemoura cinerea	Stonefly	NR	48 H	FW; LAB	MOR	LC50	254000	296393

TABLE 4-12
AQUIRE DATA SUMMARY

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Name	Reliability [a]	Organism Latin	Organism Common	Age	Exposure Regimen [b]	Test Conditions [c]	Effect [d]	Endpoint	Effect Concentration	Accession Number [e]
Pyridine	2	Cloeon dipterum	Mayfly	NR	48 H	FW; LAB	MOR	LC50	165000	296394
Pyridine	1	Oncorhynchus kisutch	Coho salmon	4.0(3.5-4.5) cm, 0.5(0.3-0.9)	24 H	FW; LAB	MOR	LC50	4300	300092
Pyridine	1	Oncorhynchus tshawytscha	Chinook Salmon	6.8(5.8-7.5) cm, 2.7(1.4-3.8)	24 H	FW; LAB	MOR	LC50	3200	300093
Pyridine	1	Oncorhynchus keta	Chum salmon	4.5(3.9-5.0) cm, 0.5(0.3-0.8)	24 H	FW; LAB	MOR	LC50	4000	300094
Pyridine	1	Oncorhynchus gorbuscha	Pink salmon	3.5(3.4-3.7) cm, 0.2(0.2-0.2)	24 H	FW; LAB	MOR	LC50	1300	300095
Pyridine	1	Oncorhynchus nerka	Sockeye salmon	3.9(3.5-4.3) cm, 0.5(0.3-0.6)	24 H	FW; LAB	MOR	LC50	6900	300096
Pyridine	1	Oncorhynchus mykiss	Rainbow trout	4.1(3.7-4.5) cm, 0.7(0.4-0.9)	24 H	FW; LAB	MOR	LC50	4600	300097
Pyridine	1	Oncorhynchus kisutch	Coho salmon	4.0(3.5-4.5) cm, 0.5(0.3-0.9)	48 H	FW; LAB	MOR	LC50	4000	300098
Pyridine	1	Oncorhynchus tshawytscha	Chinook Salmon	6.8(5.8-7.5) cm, 2.7(1.4-3.8)	48 H	FW; LAB	MOR	LC50	2900	300099
Pyridine	1	Oncorhynchus keta	Chum salmon	4.5(3.9-5.0) cm, 0.5(0.3-0.8)	48 H	FW; LAB	MOR	LC50	4000	300100
Pyridine	1	Oncorhynchus gorbuscha	Pink salmon	3.5(3.4-3.7) cm, 0.2(0.2-0.2)	48 H	FW; LAB	MOR	LC50	1200	300101
Pyridine	1	Oncorhynchus nerka	Sockeye salmon	3.9(3.5-4.3) cm, 0.5(0.3-0.6)	48 H	FW; LAB	MOR	LC50	6900	300102
Pyridine	1	Oncorhynchus mykiss	Rainbow trout	4.1(3.7-4.5) cm, 0.7(0.4-0.9)	48 H	FW; LAB	MOR	LC50	4600	300103
Pyridine	1	Oncorhynchus kisutch	Coho salmon	4.0(3.5-4.5) cm, 0.5(0.3-0.9)	72 H	FW; LAB	MOR	LC50	3800	300104
Pyridine	1	Oncorhynchus tshawytscha	Chinook Salmon	6.8(5.8-7.5) cm, 2.7(1.4-3.8)	72 H	FW; LAB	MOR	LC50	2900	300105
Pyridine	1	Oncorhynchus keta	Chum salmon	4.5(3.9-5.0) cm, 0.5(0.3-0.8)	72 H	FW; LAB	MOR	LC50	3900	300106
Pyridine	1	Oncorhynchus gorbuscha	Pink salmon	3.5(3.4-3.7) cm, 0.2(0.2-0.2)	72 H	FW; LAB	MOR	LC50	1200	300107
Pyridine	1	Oncorhynchus nerka	Sockeye salmon	3.9(3.5-4.3) cm, 0.5(0.3-0.6)	72 H	FW; LAB	MOR	LC50	6900	300108
Pyridine	1	Oncorhynchus mykiss	Rainbow trout	4.1(3.7-4.5) cm, 0.7(0.4-0.9)	72 H	FW; LAB	MOR	LC50	4600	300109
Pyridine	1	Oncorhynchus kisutch	Coho salmon	4.0(3.5-4.5) cm, 0.5(0.3-0.9)	96 H	FW; LAB	MOR	LC50	3800	300110
Pyridine	1	Oncorhynchus tshawytscha	Chinook Salmon	6.8(5.8-7.5) cm, 2.7(1.4-3.8)	96 H	FW; LAB	MOR	LC50	2900	300111
Pyridine	1	Oncorhynchus keta	Chum salmon	4.5(3.9-5.0) cm, 0.5(0.3-0.8)	96 H	FW; LAB	MOR	LC50	3700	300112
Pyridine	1	Oncorhynchus gorbuscha	Pink salmon	3.5(3.4-3.7) cm, 0.2(0.2-0.2)	96 H	FW; LAB	MOR	LC50	1100	300113
Pyridine	1	Oncorhynchus nerka	Sockeye salmon	3.9(3.5-4.3) cm, 0.5(0.3-0.6)	96 H	FW; LAB	MOR	LC50	6300	300114
Pyridine	1	Oncorhynchus mykiss	Rainbow trout	4.1(3.7-4.5) cm, 0.7(0.4-0.9)	96 H	FW; LAB	MOR	LC50	4600	300115
Pyridine	5	Pimephales promelas	Fathead minnow	31 d, 18.1 mm, 0.100 g	96 H	FW; LAB	MOR	LC50	93800	302666
Pyridine	5	Pimephales promelas	Fathead minnow	32 d, 20.6 mm, 0.140 g	96 H	FW; LAB	MOR	LC50	106000	302715
Pyridine	2	Mytilus edulis	Common bay mussel	1.4-2.6 g	96 H	SW; LAB	PHY		100000	313187
Pyridine	2	Daphnia magna	Water flea	NR	24 H	FW; LAB		EC100	1430000	314412
2-Chloropyridine	2	Tetrahymena pyriformis	Ciliate	NR	60 H	NR; LAB	GRO	EC50	657770	1101077
4-Chloropyridine, H	2	Tetrahymena pyriformis	Ciliate	NR	60 H	FW; LAB	PSR	EC50	826030	1081482
2,6-Dichloropyridin	2	Crangon septemspinosa	Sand shrimp	6.4-8.3 cm, 2.4-4.5 g	96 H	SW; LAB	MOR	LC50	>43000	1006933
3-Chloropyridine	2	Tetrahymena pyriformis	Ciliate	NR	60 H	NR; LAB	GRO	EC50	619680	1101072
4-Fluoroaniline	3	Oncorhynchus mykiss	Rainbow trout,donaldson tr	Fingerling, <= 10 cm	24 H	FW; LAB	STR*		5000(*)	1031586
4-Fluoroaniline	3	Lepomis macrochirus	Bluegill	Fingerling, <= 10 cm	24 H	FW; LAB	STR*		5000(*)	1031587
4-Fluoroaniline	3	Petromyzon marinus	Sea lamprey	Larvae, 8-13 cm	24 H	FW; LAB	STR*		5000(*)	1031588
4-Fluoroaniline	1	Pimephales promelas	Fathead minnow	32 d, 20.4 mm, 0.138 g	96 H	FW; LAB	MOR	LC50	16900	1102473

NOTES:

All units are in ug/l, except where noted.

[a] These values are codes which indicate the reliability of a study as established by the Environmental Protection Agency. 1 = meets all criteria, 2 = meets some criteria, 3 = does not meet criteria, and 4 = not reviewed.

[b] Values describe the exposure period followed in the study; H = hours, D = days.

[c] These codes describe general test conditions; FW = freshwater, SW = salt water, LAB = laboratory study, and NR = not reported.

[d] These are the categories which describe the type of endpoint effects observed in the study; PRG = population growth, MOR = mortality, IMM = immobility, GRO = growth, BEH = behavior, ABN = abnormality, PSE = photosynthisis, PHY = physiological, PSR = population size reduction, STR = stress.

[e] This number is a unique identifyer assigned to each record in the AQUIRE data base.

[f] Units are in ug/kg.

* = Refers to additional information provided in the AQUIRE database.

TABLE 4-13
SUMMARY OF ECOSAR MODEL INPUTS

OLIN CHEMICALS PHASE II RI REPORT
ROCHESTER, NEW YORK

Analyte	CAS Number	Water Solubility (mg/l) [a]	Molecular Weight (g/mole) [b]	Melting Point (deg.C)	Physical State	Log Kow [c]
2,6-Dichloropyridine	2402-78-0	--	147.99 [e]	NA	NA	2.15
2-Chloropyridine	109-09-1	--	113.55 [e]	NA	Liquid [d]	1.33
3-Chloropyridine	626-60-8	--	113.55 [e]	NA	NA	1.38
4-Chloropyridine	626-61-9	--	113.55 [e]	NA	NA	1.28
Pyridine	110-86-1	--	79.11	-41.6 [b]	Liquid [b]	0.67
p-Fluoroaniline	371-40-4	--	111.13	-1.9 [b]	Liquid [b]	1.15

NOTES:

[a] Available chemical data indicate that all analytes are at least slightly miscible.

[b] Values obtained from the The Merck Index (1989), unless otherwise noted.

[c] LogKow values are literature values (Hansch and Leo, 1979). Values for pyridine, 2-chloropyridine, and 3-chloropyridine are an average of the values presented in this reference.

[d] MDL Information System (1994).

[e] Molecular weights obtained from the Dictionary of Chemical Names and Synonyms (Howard and Neal, 1992)

Kow = Octanol-water partition coefficient.

NA = not available

Table 4-14
Summary of ECOSAR Model Equations Utilized in Surface Water Assessment

Olin Chemicals Phase II RI Report
Rochester, New York

Chemical Class	SAR Description [b]	SAR Equation	Reference
Neutral Organics	Daphnid 48-h LC_{50}	Log 48-h LC_{50} = 1.72 - 0.91 log K_{ow}	Hermans et al., 1984.
Neutral Organics	Green Algae 96-h EC_{50}	Log 96-h EC_{50} = 1.466 - 0.885 log K_{ow}	Calamari et al., 1983 Galassi, S., and Vighi, M., 1981 USEPA, 1991.
Neutral Organics	Fish 14-d LC_{50}	Log 14-d LC_{50} = 1.87 - 0.871 log K_{ow}	Konemann, H., 1981.
Neutral Organics	Daphnid 16-d LC_{50}	Log 16-d LC_{50} = 0.27 - 0.64 log K_{ow}	Hermans et al., 1984.
Neutral Organics	Daphnid 16-d LC_{50}	Log 16-d EC_{50} = 0.05 - 0.72 log K_{ow}	Hermans et al., 1984.
Neutral Organics	Earthworm 14-d LC_{50}	Log 14-d LC_{50} = 1.405 - 0.308 log K_{ow}	Neuhauser et al., 1986. Neuhauser et al., 1985.
Neutral Organics	Fish 96-h LC_{50}	Log LC_{50} = 0.94 log K_{ow} + 1.75	Veith et al., 1983.
Neutral Organics	Green Algae Chronic Value	Log ChV = 0.036 - 0.634 log K_{ow}	Calamari et at., 1983. Galassi, S., and Vighi, M., 1981 USEPA, 1991.
Neutral Organics	Fish 28-d BCF	Log BCF = 0.79 log K_{ow} - 0.40	Veith, G.D., and Kosian, P., 1982.
Neutral Organics	Fish Chronic Value	Log ChV = 0.72 - 0.87 log K_{ow}	USEPA, 1991.
Anilines	Fish 96-h LC_{50}	Log 96-h LC_{50} = 0.956 - 0.739 log K_{ow}	Vieth, G.D., and Broderius, S.J., 1987.

See note at end of table

Table 4-14 (Continued)
Summary of ECOSAR Model Equations Utilized in Surface Water Assessment

Olin Chemicals Phase II RI Report
Rochester, New York

Chemical Class	SAR Description [a]	SAR Equation	Reference
Anilines	Daphnid 48-h LC_{50}	Log 48-h LC_{50} = $^{-}$1.623 - 0.271 log K_{ow}	Canton, J.H., and Adema, D.M.M., 1978. Kuhn et al., 1989. Sloof et al., 1983.
Anilines	Fish 14-d LC_{50}	Log 14-d LC_{50} = 1.02 - 0.988 log K_{ow}	Hermans et al., 1984.
Anilines	Green Algae Chronic Value	Log ChV = $^{-}$0.411 - 0.588 log K_{ow}	Sloof et al., 1983.
Anilines	Fish Chronic Value	Log ChV = $^{-}$1.516 - 0.625 log K_{ow}	Bresch et al., 1990. Call et al., 1987. USEPA, 1990. USEPA, 1991. Van Leeuwen et al., 1990.
Anilines	Daphnid Chronic Value	Log ChV = $^{-}$3.12 - 0.36 log K_{ow}	USEPA, 1990.

Note:

[a] USEPA, 1994.

[b] Additional information is provided in Appendix E.

FEASIBILITY STUDY REPORT

ARCH CHEMICALS
ROCHESTER PLANT SITE
ROCHESTER, NEW YORK

RECEIVED
JAN 2 0 2000
DER/HAZ WASTE REMED
REGION 8

Submitted to:

Division of Environmental Remediation
New York State Department of Environmental Conservation
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JANUARY 2000

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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^{TM}. 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 x 10^{-5} to 7.7 x 10^{-3} centimeters per second (cm/sec) in the overburden. In the shallow bedrock, estimates range from 4.0 x 10^{-5} to 11.7 x 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 x 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.

<u>Current and Continuing Land Use</u> 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.

<u>Potential Future Land Use</u> 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).

APPENDIX C

PHYSICAL/CHEMICAL DATA FOR CHLOROPYRIDINES

Table 1. Soil Analysis Report

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REPORT NUMBER
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ACCOUNT NO.
8697

GROWER
MAN LI WU/ARCH
350 KNOTTER DR
CHESHIRE CT 06410

TO:
ARCH CHEMICALS INC

350 KNOTTER DRIVE
CHESCHIRE CT 06410-

COPY TO:

90001

SOIL ANALYSIS REPORT

(SEE EXPLANATION ON BACK)

INFO SHEET # 6

LAB NUMBER	SAMPLE IDENTIFICATION	ORGANIC MATTER WALKLEY BLACK PERCENT RATE	PHOSPHORUS P1 (WEAK BRAY) ppm RATE	PHOSPHORUS P2 (STRONG BRAY) ppm RATE	PHOSPHORUS BICARBONATE P ppm RATE	NEUTRAL AMMONIUM ACETATE (EXCHANGEABLE) POTASSIUM K ppm RATE	MAGNESIUM Mg ppm RATE	CALCIUM Ca ppm RATE	SODIUM Na ppm RATE	pH SOIL pH 1:1	pH BUFFER INDEX	CATION EXCHANGE CAPACITY C.E.C. meq/100g	PERCENT BASE SATURATION (COMPUTED) % K	% Mg	% Ca	% H	% Na
58054	1	4.1H	22H	47H		157VH	149H	1603VH		8.0		9.7	4.2	12.9	83.0	0.0	

NITRATE - N (FIA) IN ppm	lbs/A	IN ppm	lbs/A	IN ppm	lbs/A	Total lbs/A	SULFUR S ICAP ppm RATE	DTPA EXTRACTION ZINC Zn ppm RATE	MANGANESE Mn ppm RATE	IRON Fe ppm RATE	COPPER Cu ppm RATE	BORON B WATER SOLUBLE ppm RATE	EXCESS LIME RATE	SOLUBLE SALTS 1:1 mmhos/cm RATE	% SAND	% SILT	% CLAY	Soil TYPE		
													L		60	32	8	SALDAM		

COMMENTS:

Ken Pohlman/John Menghini
Al Rev 8.0 DH S41 Z 7
(203)271-4047

Table 2. Calculation of Adsorption Coefficients in Soil

2,6-dichloropyridine	Dried soil weight (m, g)	Volume (ml) (Vo)	Conc. in soiless sample (ppm)	Quantity (ug) in soiless sample (ug)	Conc. Remained in solution (Ce, ppm)	K'_{ads}	Average K'ads	Average $K'_{oc,\,ads}$
1	2.598	15	3.4	50	2.2	3.22	3.73	91
2	2.578	15	3.4	50	1.9	4.23		

2-chloropyridine								
1	2.597	15	4.1	61	2.9	2.27	2.32	57
2	2.609	15	4.1	61	2.9	2.37		

3-chloropyridine								
1	2.577	15	3.4	51	2.4	2.37	2.42	59
2	2.586	15	3.4	51	2.4	2.47		

Table 3. Calculation of Desorption Coefficients in Soil

2,6-dichloropyridine	Dried soil weight (g) (m)	Quantity (ug) in soilless sample (ug)	First Wash C1 (ppm)	Second wash C2 (ppm)	Sol. Volume V (ml)	K'_{des}	Average K'_{des}	Average $K'_{oc, des}$
1	2.598	50.25	0.88	0.59	13.64	0.27	0.58	14
2	2.578	50.25	0.88	0.63	13.70	0.89		

2-chloropyridine								
1	2.597	61.2	0.78	0.23	13.64	4.03	4.45	109
2	2.609	61.2	0.78	0.22	13.51	4.87		

3-chloropyridine								
1	2.577	51.3	0.74	0.33	13.68	1.61	2.00	49
2	2.586	51.3	0.74	0.27	13.66	2.39		

Table 3. The Distribution of Each Test Chemical in the Soil and Solution after the Adsorption and Desorption Steps

2,6-dichloropyridine	ppm (ug/g) in soil adsorption	ppm (ug/ml) in solution adsorption	ppm (ug/g) in soil desorption	ppm (ug/ml) in solution desorption
1	18	6.93	0.34	1.25
2	21.18	8.20	1.16	1.32
2-chloropyridine				
1	17.25	6.64	2.91	0.72
2	17.85	6.87	3.35	0.68
3-chloropyridine				
1	14.85	5.76	1.34	0.83
2	15.3	5.92	1.84	0.77

Chloropyridine Vapor Pressures

Data is from existing vapor-pressure charts.
The charts can be reconstructed.
Plotting on a 1/T x-axis and a logarithmic y-axis gives a straight line.
Low-temperature DCP vapor pressures are extrapolated considerably from measured data points.
yhisfids

Vapor pressures (mm Hg)

Component	CAS #	25 F	50 F	75 F	100 F	125 F	150 F		175 F	200 F	225 F
Pyridine	110-86-1	4	9.5	20	42	79	141		232	378	585
2-PCL	109-09-1	0.3	0.9	2.4	4.5	10.2	20		37	66	134
3-PCL	626-60-8	0.6	1.6	3.9	9	18	35		66	114	192
4-PCL	626-61-9	Not demonstrated because pure 4-PCL is unstable. Plant experience indicates vapor pressure almost identical to 3-PCL.									
2,3 DCP	2402-77-9	0.07	0.2	0.5	1.2	2.6	5.3		9.6	17	29
2,4 DCP	16452-80-2	0.09	0.2	0.7	1.4	3.3	6		11.5	20	34
2,5 DCP	16110-09-1	0.09	0.2	0.7	1.5	3.4	6.8		13	23	39
2,6 DCP	1402-78-0	0.06	0.2	0.5	1	2.2	4.4		7.8	14	24

Distillation Behavior

All of these compounds azeotrope with water.

Pyridine-water azeotrope boils at 92.6C. The azeotrope is 57% pyridine and is homogeneous.

2-PCL-water azeotrope boils at about 97C. The azeotrope is roughly 37% 2-PCL and is heterogeneous.
3-PCL and 4-PCL also azeotrope with water at roughly 96-97C. Compositions are presumed to be similar to the 2-PCL-water azeotrope. These azeotropes are heterogeneous.

2,6 DCP-water azeotrope boils at 99C. The azeotrope is roughly 17% DCP and is heterogeneous.
Other DCP's also azeotrope with water, presumably with similar temperatures and compositions.

Physical Properties of Pyridines

Component	Water Solubility[1] (20°C), g/100 mL	Boiling Point (°C)	Flash Point (°F) (closed cup method)	Specific Gravity	Melting Point (°C)	Density $d^{20}4$	log Poct[2]	Koc[3] adsorption	Koc[3] desorption	Henry's Law Constant[4] atm-m3/mole
Pyridine	miscible	115.5	154	0.982	-42	0.983	*0.65*	*negligible*	*negligivle*	*8.90E-06*
2-PCl	*2.5*	170.5-171	149	1.200	-46	1.205	*1.22*	*57*	*109*	*1.40E-05*
3-PCL	*3.09*	149-149.5	150	1.194	-61	1.2 (25°C)	*1.33*	*59*	*49*	*1.80E-05*
4-PCL	*N.A.*		Expected to be similar to 3-PCL							
2,6 DCP	*0.09*	211-212	190	Solid	87	0.59	*2.01*	*91*	*14*	*2.00E-04*

1. Water solubilities were determined at Arch Bioicides's Cheshire facility. 4-PCl was found to decompose in natural environment.
2. Octanol-Water Partition Coefficients were determiend at Arch Bioicdes' Cheshire facility.
3. The adsorption/desorption of 2-PCl, 3-PCl, and 2,6 DCP were deletermined at Arch Biocides' Cheshire facility.
   Result for pyridine was obtained from "Registery Toxic Effect of Chemical Subtance" by National Institute of Occupational Safety and Health, 9/3, 1998
4. Henry's Law Constants were determined or estimated at Arch Biocides' Cheshire facility.

11 = 11.

[illegible] L 25 /100 mL × 1L [illegible] = 25 g/L × 1L/[illegible] = .02[illegible] = 2.5%

[illegible]

[illegible]

S = 25[illegible] ppm

log K_{oc} = 3.64 − 0.55 log S = 1.22 (K_{oc} 17)

C_S = f × cw × Kd = .009

[illegible] (.050) (17)

SCO = [illegible] = .7 ppm ~ 1 ppm

3-PCL

S = 30900 ppm

K_{oc} = 15

C_S = .008

SCO = 800 ppb

Pyridine data was obtained from S. Hawrne, R. Sievers, and R. Barkley, "Organic Emissions From Shale Oil Wastewaters And Their Implications For Air Quality", Environ. Sci. Tech.; 19:922-7; 1985.

5. The other data were obtained from the following sources:

Belistein CD&S. 1998. Frankfurt, Germany
CRC Handbook of Chemistry and Physics, 71st Edition, 1990. D.R. Linde ed. CRC Press, Inc., FL, MI and MA.
Kirk-Othmer Encyclopedia of Chemical Technology, 4th Edition, 1996. Kroschwitz, J and M. Howe-Grant eds, Wiley & Sons, NY, NY.
Sigma-Aldrich-Fluka MSDS on CD-ROM, 2/98-4/98, Aldrich Chemical Co., Milwaukee, WI
Ullmann's Encyclopedia of Industrial Chemistry, 5th Edition, 1993. Elvers, B., Hawkins, S., Russey W., and G. Schulz, eds., VCH, Weinheim, Germany.
K. Miyake et al., 1987, Chem Pharm Bull, 35(1) 377-388.
M. Abraham et al., 1994, J. Pharm. Sci., 83(8) 1085-1100.

Toxicology Data for Pyridines

Component	LD_{50} oral rats mg/kg	LD_{50} inhal. rats ppm/h	LD_{50} I.P. mouse mg/kg
Pyridine	891	8800	N.A.
2-PCl	342	500	N.A.
3-PCL	N.A.	N.A.	235
4-PCL			
2,6 DCP	237	>6000	275

TABLE 1-2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT SOIL

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples
Onsite Facility Surface (0-2 inches) Soil[a] (mg/kg)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2-Methylnaphthalene	0.36 - 0.4	3 / 5	0.038	0.54	0.22
Acenaphthene	0.36 - 0.36	4 / 5	0.013	3.9	0.88
Acenaphthylene	0.36 - 0.4	2 / 5	0.028	0.087	0.16
Anthracene		5 / 5	0.013	10	2.2
Benzo(a)anthracene		5 / 5	0.15	34	7.6
Benzo(a)pyrene		5 / 5	0.19	27	6.2
Benzo(b)fluoranthene		5 / 5	0.27	35	8.3
Benzo(g,h,i)perylene		5 / 5	0.11	11	2.5
Benzo(k)fluoranthene		5 / 5	0.19	22	5.1
Chrysene		5 / 5	0.21	37	8.3
Dibenzo(a,h)Anthracene	0.36 - 0.4	3 / 5	0.055	2.9	0.71
Dibenzofuran	0.36 - 0.4	3 / 5	0.035	2.3	0.57
Fluoranthene		5 / 5	0.34	74	16.3
Fluorene	0.36 - 0.4	3 / 5	0.079	4.8	1.1
Indeno(1,2,3-c,d)Pyrene		5 / 5	0.086	15	3.3
Naphthalene	0.36 - 0.4	3 / 5	0.022	0.37	0.17
Phenanthrene		5 / 5	0.12	48	10.4
Pyrene		5 / 5	0.24	62	14.0
INORGANICS					
Aluminum		5 / 5	2700	12000	6710
Arsenic		5 / 5	1.8	4.8	3.3
Chromium		5 / 5	5.4	180	52.8
Cobalt	4.8 - 4.8	4 / 5	5.3	15	7.2
Lead		5 / 5	12	530	138
Manganese		5 / 5	270	1200	455
Mercury	0.1 - 0.1	3 / 5	0.2	210	42.5
Onsite Non-Facility Surface (0-2 inches) Soil[c] (mg/kg)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2-Methylnaphthalene	0.36 - 0.36	4 / 6	0.016	0.087	0.11
Acenaphthene	0.36 - 0.36	5 / 6	0.016	0.27	0.10
Acenaphthylene	0.36 - 0.36	4 / 6	0.012	0.17	0.11
Anthracene	0.36 - 0.36	5 / 6	0.03	0.48	0.18
Benzo(a)anthracene		6 / 6	0.041	1.6	0.64
Benzo(a)pyrene		6 / 6	0.04	1.2	0.56
Benzo(b)fluoranthene		6 / 6	0.075	2	1.0
Benzo(g,h,i)perylene		6 / 6	0.063	0.22	0.15
Benzo(k)fluoranthene		6 / 6	0.043	1.3	0.70
Chrysene		6 / 6	0.07	1.5	0.76
Dibenzo(a,h)Anthracene	0.36 - 0.4	2 / 6	0.014	0.11	0.14
Dibenzofuran	0.36 - 0.36	4 / 6	0.024	0.15	0.12
Fluoranthene		6 / 6	0.12	2.8	1.2
Fluorene	0.36 - 0.46	3 / 6	0.049	0.27	0.17
Indeno(1,2,3-c,d)Pyrene		6 / 6	0.033	0.4	0.20
Naphthalene	0.36 - 0.52	3 / 6	0.019	0.061	0.13
Phenanthrene		6 / 6	0.054	1.9	0.67
Pyrene		6 / 6	0.11	3	1.2
INORGANICS					
Aluminum		6 / 6	3900	8700	6533
Arsenic		6 / 6	2.7	12	5.4
Barium		6 / 6	37	110	60.0
Cadmium		6 / 6	0.1	0.8	0.5
Chromium		6 / 6	8.2	150	28.0
Cobalt	4.4 - 5	3 / 6	5	7.1	3.9
Copper		6 / 6	8.6	48	20.6

TABLE 1-1
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT SOIL GAS[1]

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

COMPOUND	FREQUENCY OF DETECTION	MINIMUM DETECTED CONCENTRATION (µG/L)	MAXIMUM DETECTED CONCENTRATION (µG/L)	TLV[2] (µG/L)	MAXIMUM CONCENTRATION EXCEEDS STANDARD?
1,1-Dichloroethene	17 / 87	0.1	1.7	20	No
Carbon Tetrachloride	33 / 87	0.1	38	31	Yes
Chloroform	27 / 87	0.1	23	49	No
Methylene Chloride	13 / 87	0.1	2.4	174	No
Tetrachloroethene	25 / 87	0.1	8.5	170	No
Trichloroethene	12 / 87	0.1	2.3	269	No
cis-1,2-Dichloroethene	5 / 87	0.1	1.8	793[3]	No
trans-1,2-dichloroethene	4 / 87	0.2	1.3	793[3]	No

Notes:

[1] Soil gas samples used for evaluation included all soil gas sample locations, as described in Section 2.

[2] from: ACGIH, 1993. 1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, 1993.

[3] Value is for total 1,2-dichloroethene

Acronyms:
µg = microgram
L = liter
TLV = Threshold Limit Value

TABLE 1-2
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
SOIL

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples
Lead		6 / 6	12	140	73.7
Manganese		6 / 6	240	760	428
Mercury	0.1 - 0.1	4 / 6	0.2	0.4	0.20
Nickel		6 / 6	13	62	23.6
Vanadium		6 / 6	12	20	16.9
Onsite Subsurface (0-10 feet) Soil[b] (mg/kg)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2,6-Dichloropyridine	0.36 - 0.38	20 / 24	0.007	3.1	0.23
2-Chloropyridine	0.36 - 0.38	21 / 24	0.011	12	0.79
2-Methylnaphthalene	0.34 - 0.48	10 / 24	0.014	0.54	0.16
3-Chloropyridine	0.34 - 0.52	8 / 24	0.017	2.9	0.26
Acenaphthene	0.34 - 0.48	15 / 24	0.007	3.9	0.31
Acenaphthylene	0.34 - 0.48	8 / 24	0.012	0.17	0.15
Anthracene	0.34 - 0.48	17 / 24	0.013	10	0.61
Benzo(a)anthracene	0.34 - 0.48	18 / 24	0.041	34	1.9
Benzo(a)pyrene	0.34 - 0.48	18 / 24	0.039	27	1.6
Benzo(b)fluoranthene	0.34 - 0.48	18 / 24	0.075	35	2.2
Benzo(g,h,i)perylene	0.34 - 0.48	18 / 24	0.017	11	0.63
Benzo(k)fluoranthene	0.34 - 0.48	18 / 24	0.033	22	1.4
Chrysene	0.34 - 0.48	18 / 24	0.061	37	2.1
Dibenzo(a,h)Anthracene	0.34 - 0.48	9 / 24	0.014	2.9	0.26
Dibenzofuran	0.34 - 0.48	10 / 24	0.024	2.3	0.25
Fluoranthene	0.34 - 0.48	18 / 24	0.12	74	4.0
Fluorene	0.34 - 0.48	9 / 24	0.047	4.8	0.39
Indeno(1,2,3-c,d)Pyrene	0.34 - 0.48	18 / 24	0.027	15	0.84
Naphthalene	0.34 - 0.52	10 / 24	0.007	0.37	0.15
Phenanthrene	0.34 - 0.48	19 / 24	0.032	48	2.6
Pyrene	0.34 - 0.48	18 / 24	0.11	62	3.5
Pyridine	0.34 - 0.52	7 / 24	0.013	8.4	0.48
INORGANICS					
Aluminum		13 / 13	2700	12000	6750
Arsenic		13 / 13	1.8	12	4.9
Chromium		13 / 13	5.4	180	36.1
Cobalt	4.4 - 5	9 / 13	5	15	5.5
Lead		13 / 13	12	530	94.2
Manganese		13 / 13	240	1200	440
Mercury	0.1 - 0.1	8 / 13	0.2	210	16.5

NOTES:

Sample Locations:

[a] - Based on samples SS-103, -104, -108, -110, -111.

[b] - Based on samples SS-101 through -105, SS-108 through -115, T-106, -120, -122, -124, -129, -133, -136, -137 , -139, -152, -159

[c] - Based on samples SS-102, -105, -109, -112, -113, -115.

Acronyms:

SQL - Sample Quantitation Limit
CPC - Chemical of Potential Concern
mg - milligram
kg - kilogram

TABLE 1-3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	MCL
OVERBURDEN GROUNDWATER: ON-SITE^a (mg/L)						
VOLATILE ORGANIC COMPOUNDS						
1,2-Dichlorobenzene	0.0008 - 0.1	25 / 41	0.0005	2.4	0.087	0.6
1,2-Dichloroethane	0.001 - 0.28	2 / 41	0.013	0.093	0.0086	0.005
Benzene	0.0008 - 0.16	28 / 41	0.0007	0.062	0.012	0.005
Bromoform	0.001 - 0.2	5 / 41	0.003	0.54	0.027	0.1
Carbon tetrachloride	0.002 - 0.4	8 / 41	0.0006	17	0.77	0.005
Chlorobenzene	0.001 - 0.004	29 / 41	0.0004	2.5	0.14	0.1
Chloroform	0.001 - 0.004	18 / 41	0.001	50	2.20	0.1
Methylene chloride	0.001 - 0.004	15 / 41	0.002	35	1.01	0.005
Tetrachloroethene	0.002 - 0.008	18 / 41	0.0006	2	0.10	0.005
Toluene	0.001 - 0.001	28 / 41	0.0004	4.6	0.18	1
Trichloroethene	0.002 - 0.12	23 / 41	0.0005	0.39	0.014	0.005
Vinyl chloride	0.001 - 0.24	3 / 41	0.002	0.012	0.0057	0.002
SEMIVOLATILE ORGANIC COMPOUNDS						
1,2,4-Trichlorobenzene	0.002 - 0.052	5 / 38	0.01	1.4	0.069	0.07
1,3-Dichlorobenzene	0.002 - 0.052	5 / 38	0.0008	0.04	0.0040	0.6
1,4-Dichlorobenzene	0.002 - 0.043	7 / 38	0.001	0.077	0.0068	0.075
2,6-Dichloropyridine	0.006 - 0.014	35 / 38	0.002	44	2.7	-
2-Chloropyridine		38 / 38	0.0009	400	33.2	-
2-Methylnaphthalene	0.002 - 0.04	2 / 38	0.001	0.046	0.0032	-
3-Chloropyridine	0.001 - 0.028	24 / 38	0.002	18	1.2	-
4-Chloropyridine	0.004 - 0.028	10 / 38	0.0005	1.3	0.056	-
Acenaphthene	0.001 - 0.036	3 / 38	0.001	0.042	0.0032	-
Anthracene	0.001 - 0.032	1 / 38	0.16	0.16	0.0059	-
Benzo(a)anthracene	0.002 - 0.04	1 / 38	0.41	0.41	0.013	0.0001
Benzo(a)pyrene	0.001 - 0.024	1 / 38	0.34	0.34	0.010	0.0002
Benzo(b)fluoranthene	0.002 - 0.048	2 / 38	0.001	0.47	0.015	0.0002
Benzo(g,h,i)perylene	0.001 - 0.032	1 / 38	0.045	0.045	0.0029	-
Benzo(k)fluoranthene	0.002 - 0.052	1 / 38	0.19	0.19	0.0078	0.0002
Bis(2-Chloroethyl)ether	0.001 - 0.004	25 / 38	0.002	0.69	0.063	-
Bis(2-ethylhexyl)phthalate	0.002 - 0.032	22 / 38	0.0003	0.34	0.015	0.006
Chrysene	0.001 - 0.024	2 / 38	0.0004	0.33	0.010	0.0002
Dibenzo(a,h)Anthracene	0.001 - 0.028	1 / 38	0.019	0.019	0.0019	0.0003
Fluoranthene	0.001 - 0.032	3 / 38	0.0005	0.99	0.028	-
Fluorene	0.001 - 0.034	1 / 38	0.061	0.061	0.0035	-
Indeno(1,2,3-c,d)Pyrene	0.001 - 0.024	1 / 38	0.069	0.069	0.0031	0.0004
Naphthalene	0.001 - 0.034	3 / 38	0.003	0.006	0.0020	-
Phenanthrene	0.001 - 0.036	2 / 38	0.0005	0.3	0.0099	-
Pyrene	0.002 - 0.038	2 / 38	0.007	0.66	0.020	-
Pyridine	0.004 - 0.028	23 / 38	0.0001	98	4.1	-
p-Fluoroaniline	0.004 - 0.028	27 / 38	0.001	0.92	0.084	-
PESTICIDES/PCBs						
Heptachlor Epoxide	0.0001 - 0.01	1 / 4	0.015	0.015	0.0050	0.0002
beta-BHC	0.006 - 0.006	2 / 4	0.0004	0.3	0.067	-
gamma-BHC (Lindane)	0.0001 - 1E-04	3 / 4	0.0001	0.042	0.015	0.0002

TABLE 1-3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
OVERBURDEN GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	MCL
INORGANICS						
Aluminum	0.09 - 0.09	30 / 32	0.14	630	51.2	0.2#
Antimony	0.003 - 0.004	8 / 32	0.004	0.009	0.0026	0.006
Arsenic	0.004 - 0.004	29 / 32	0.003	0.92	0.12	0.05
Barium		32 / 32	0.031	8.6	1.1	2
Beryllium	0.003 - 0.003	4 / 32	0.0038	0.029	0.0033	0.004
Cadmium	0.0002 - 2E-04	31 / 32	0.0002	0.11	0.013	0.005
Calcium		32 / 32	5.3	2300	447	-
Chromium	0.01 - 0.01	24 / 32	0.01	2.3	0.14	0.1
Cobalt	0.02 - 0.02	13 / 32	0.021	0.45	0.053	-
Copper	0.01 - 0.01	30 / 32	0.01	3.6	0.30	1.3
Iron		32 / 32	0.4	2500	251	0.3#
Lead		31 / 31	0.002	2.7	0.26	0.015*
Magnesium		31 / 31	3.2	720	109	-
Manganese		32 / 32	0.065	56	8.0	0.05#
Mercury	0.0004 - 4E-04	15 / 32	0.0004	0.63	0.021	0.002
Nickel	0.03 - 0.03	21 / 32	0.033	1.8	0.18	0.1
Potassium	0.5 - 0.5	31 / 32	1.2	44	12.4	-
Sodium		32 / 32	11	2300	533	-
Zinc	0.01 - 0.01	31 / 32	0.01	22	1.54	5#
OVERBURDEN GROUNDWATER: OFF-SITE[b] (mg/L)						
VOLATILE ORGANIC COMPOUNDS						
1,2-Dichloroethane	0.001 - 0.014	2 / 31	0.014	0.17	0.0068	0.005
Benzene	0.0008 - 8E-04	14 / 31	0.0007	0.21	0.021	0.005
Chlorobenzene	0.001 - 0.001	11 / 31	0.001	0.62	0.044	0.1
Chloroform	0.001 - 0.004	4 / 31	0.001	1.5	0.084	0.1
Methylene chloride	0.001 - 0.008	2 / 31	0.2	2.5	0.088	0.005
Tetrachloroethene	0.002 - 0.008	4 / 31	0.0007	0.34	0.016	0.005
Trichloroethene	0.001 - 0.002	11 / 31	0.0006	0.3	0.020	0.005
Vinyl chloride	0.001 - 0.012	4 / 31	0.009	0.018	0.0022	0.002
SEMIVOLATILE ORGANIC COMPOUNDS						
2,6-Dichloropyridine	0.004 - 0.032	15 / 26	0.0005	6	0.52	-
2-Chloropyridine	0.004 - 0.032	18 / 26	0.0009	60	5.61	-
3-Chloropyridine	0.004 - 0.032	8 / 26	0.002	4.5	0.27	-
Bis(2-Chloroethyl)ether	0.001 - 0.008	8 / 26	0.0007	0.13	0.011	-
Bis(2-ethylhexyl)phthalate	0.001 - 0.008	11 / 26	0.001	0.026	0.0029	0.006
Dibenzofuran	0.001 - 0.006	2 / 26	0.003	0.003	0.0010	-
Pyridine	0.004 - 0.032	12 / 26	0.0004	6.5	0.30	-
p-Fluoroaniline	0.004 - 0.032	7 / 26	0.0008	2.1	0.12	-
INORGANICS (mg/l)						
Aluminum		15 / 15	0.36	260	45.2	0.2#
Arsenic	0.004 - 0.004	13 / 15	0.003	0.15	0.041	0.05
Barium		15 / 15	0.033	3.1	0.70	2
Beryllium	0.003 - 0.003	2 / 15	0.01	0.011	0.0027	0.004
Cadmium	0.0002 - 2E-04	14 / 15	0.0003	0.03	0.0044	0.005

TABLE 1-3
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT OVERBURDEN GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concen-tration	Maximum Detected Concen-tration	Mean of all Samples	MCL
Calcium		15 / 15	75	3500	638	-
Chromium	0.01 - 0.01	11 / 15	0.011	0.52	0.087	0.1
Cobalt	0.02 - 0.02	7 / 15	0.029	0.23	0.046	-
Iron		14 / 14	2.1	780	125	0.3#
Lead	0.002 - 0.002	13 / 14	0.002	0.64	0.11	0.015*
Magnesium		15 / 15	20	740	143	-
Manganese		15 / 15	0.18	37	6.67	0.05#
Mercury	0.0004 - 4E-04	3 / 15	0.0004	0.013	0.0011	0.002
Nickel	0.03 - 0.03	10 / 15	0.034	0.61	0.13	0.1
Potassium		15 / 15	1.3	42	11.7	-
Sodium		15 / 15	9.5	2200	353	-

NOTES:

MCL - Maximum Contaminant Level for community drinking water systems
- = No MCL listed for this compound
* - Action Level
# - Secondary Standard
mg/L - milligrams per liter
SQL - Sample Quantitation Limit
CPC - Chemical of Potential Concern
Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects.

Sample Locations:

[a] - Based on samples B-1 through B-11, B-17, C-1, C-2A, C-3 through C-5, E-1 through E-4, N-1 though N-3, S-1 though S-4, T-121, T-122, T-129, T-134, T-138, T-148, T-151, T-159, W-1 though W-5.

[b] - Based on samples B-14 though B-16, EC-1, MW-103, MW-104, MW-106 through MW-108, MW-2, MW-3, MW-G6, MW-G8, MW-G9, PZ-101, PZ-108, T-102, T-103, T-107, T-112, T-115, T-126, T-142 through T-145, T-147, T-150, T-154, T-155, T-157

TABLE 1-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples	MCL	NY State Groundwater Quality Class GA
BEDROCK GROUNDWATER: ON-SITE[a] (mg/L)							
VOLATILE ORGANIC COMPOUNDS							
1,2-Dichlorobenzene	0.001 - 0.4	10 / 15	0.0009	0.35	0.076	0.6	0.0047
1,2-Dichloroethane	0.001 - 0.56	1 / 15	0.58	0.58	0.067	0.005	0.005
1,2-Dichloroethene (total)	0.002 - 0.8	8 / 15	0.001	0.097	0.055	0.07/0.1	0.005
4-Methyl-2-pentanone	0.002 - 0.8	2 / 15	0.006	0.069	0.045	-	-
Acetone	0.008 - 0.7	7 / 15	0.044	4.1	0.49	-	-
Benzene	0.0008 - 0.32	11 / 15	0.002	0.21	0.052	0.005	0.0007
Bromodichloromethane	0.001 - 0.56	2 / 15	0.016	0.38	0.050	0.1	0.05
Bromoform	0.001 - 0.04	5 / 15	0.37	65	4.78	0.1	0.05
Carbon disulfide	0.004 - 0.16	5 / 15	0.28	37	3.35	-	-
Carbon tetrachloride	0.002 - 0.08	6 / 15	0.18	620	48.4	0.005	0.005
Chlorobenzene	0.001 - 0.001	14 / 15	0.0008	3.6	0.36	0.1	0.005
Chloroform	0.001 - 0.001	12 / 15	0.004	320	29.1	0.1	0.007
Dibromochloromethane	0.001 - 0.48	4 / 15	0.027	7.2	0.53	0.1	0.05
Ethylbenzene	0.0006 - 0.36	2 / 15	0.004	0.16	0.030	0.7	0.005
Methylene chloride	0.001 - 0.001	13 / 15	0.058	78	10.8	0.005	0.005
Tetrachloroethene	0.002 - 0.04	9 / 15	0.0007	2.1	0.33	0.005	0.005
Toluene	0.001 - 0.001	13 / 15	0.004	7.2	0.99	1	0.005
Total Xylenes	0.002 - 0.92	5 / 15	0.001	0.96	0.11	10	0.005
Trichloroethene	0.002 - 0.2	7 / 15	0.002	0.75	0.10	0.005	0.005
Vinyl chloride	0.001 - 0.48	4 / 15	0.005	0.085	0.032	0.002	0.002
SEMIVOLATILE ORGANIC COMPOUNDS							
1,2,4-Trichlorobenzene	0.002 - 0.004	3 / 15	0.009	0.42	0.030	0.07	0.005
1,3-Dichlorobenzene	0.002 - 0.003	1 / 15	0.06	0.062	0.0050	0.6	0.005
1,4-Dichlorobenzene	0.001 - 0.002	2 / 15	0.004	0.035	0.0030	0.075	0.0047
2,4-Dichlorophenol	0.004 - 0.004	1 / 15	0.004	0.004	0.0021	-	0.001 **
2,6-Dichloropyridine	0.006 - 0.006	14 / 15	0.0006	22	4.8	-	-
2-Chlorophenol	0.004 - 0.006	1 / 15	0.003	0.003	0.0023	-	0.001 **
2-Chloropyridine	0.048 - 0.048	14 / 15	0.006	280	48.0	-	-
3-Chloropyridine	0.006 - 0.006	13 / 15	0.003	19	2.67	-	-
4-Chloroaniline	0.002 - 0.002	9 / 15	0.004	0.07	0.021	-	-
4-Chloropyridine	0.004 - 0.006	2 / 15	0.001	0.04	0.0052	-	-
4-Methylphenol	0.004 - 0.004	1 / 15	0.001	0.001	0.0019	-	0.001 **
4-Nitroaniline	0.001 - 0.001	1 / 15	0.0008	0.0008	0.0005	-	-
Benzoic acid	0.01 - 0.011	5 / 15	0.001	1.1	0.10	-	-
Bis(2-Chloroethyl)ether	0.001 - 0.002	12 / 15	0.002	0.68	0.17	-	0.001
Bis(2-ethylhexyl)phthalate	0.001 - 0.002	11 / 15	0.001	0.03	0.0084	0.006	0.05
Hexachlorobutadiene	0.004 - 0.004	2 / 15	0.003	0.004	0.0022	-	-
Hexachloroethane	0.002 - 0.004	3 / 15	0.004	0.26	0.023	-	-
Pyridine	0.006 - 0.006	13 / 15	0.003	45	5.7	-	-
p-Fluoroaniline	0.006 - 0.006	11 / 15	0.0003	0.88	0.22	-	-
PESTICIDES/PCBs							
4,4'-DDE		1 / 2	0.0001	0.0001	0.0001	-	ND
4,4'-DDT	0.0002 - 2E-04	1 / 2	0.0001	0.0002	0.0001	-	ND
Endosulfan II		1 / 2	0.0001	0.0001	0.0001	-	-
Endosulfan Sulfate	0.0001 - 1E-04	1 / 2	0.0001	0.0001	0.0001	-	-

TABLE 1-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Mean of all Samples	MCL	NY State Groundwater Quality Class GA
Endrin	0.0002 - 2E-04	1 / 2	0.0001	0.0001	0.0001	0.002	ND
Heptachlor Epoxide	0.0001 - 1E-04	1 / 2	0.017	0.017	0.0085	0.0002	ND
gamma-BHC (Lindane)		2 / 2	0.0003	0.031	0.016	0.0002	ND
INORGANICS							
Aluminum	0.09 - 0.09	13 / 15	0.092	6.9	1.4	0.2#	-
Antimony	0.003 - 0.008	2 / 15	0.004	0.007	0.0023	0.006	0.003
Arsenic	0.003 - 0.004	13 / 15	0.003	0.13	0.027	0.05	0.0025
Barium	0.03 - 0.03	14 / 15	0.045	1.1	0.25	2	1
Calcium		14 / 14	4.1	820	180	-	-
Chromium	0.01 - 0.01	6 / 15	0.011	0.099	0.016	0.1	0.05
Iron		15 / 15	0.12	300	31.3	0.3#	0.3
Lead	0.002 - 0.002	10 / 13	0.002	0.024	0.0064	0.015*	0.025
Magnesium		14 / 14	1.3	150	38.1	-	35
Manganese		15 / 15	0.012	2.2	0.38	0.05#	0.3
Nickel	0.03 - 0.03	3 / 15	0.034	0.11	0.024	0.1	-
Potassium		15 / 15	2.5	110	25.9	-	-
Sodium		15 / 15	50	3700	1256	-	20
Vanadium	0.02 - 0.02	6 / 15	0.021	6.6	0.48	-	-
Zinc	0.01 - 0.01	13 / 15	0.018	1.6	0.18	5#	0.3
BEDROCK GROUNDWATER: OFF-SITE[b] (mg/L)							
VOLATILE ORGANIC COMPOUNDS							
1,1-Dichloroethane	0.002 - 0.17	6 / 10	0.002	0.025	0.0000	-	0.005
1,2-Dichlorobenzene	0.001 - 0.001	7 / 10	0.001	5.8	0.69	0.6	0.0047
1,2-Dichloroethane	0.001 - 0.14	1 / 10	0.08	0.08	0.016	0.005	0.005
1,2-Dichloroethene (total)	0.002 - 0.2	7 / 10	0.002	0.58	0.089	0.07/0.1	0.005
Acetone	0.008 - 0.7	1 / 10	0.76	0.76	0.12	-	-
Benzene		10 / 10	0.001	0.18	0.063	0.005	0.0007
Carbon disulfide	0.004 - 0.4	1 / 10	0.004	0.004	0.026	-	-
Chlorobenzene	0.001 - 0.001	7 / 10	0.002	1.7	0.29	0.1	0.005
Chloroform	0.001 - 0.13	3 / 10	0.003	0.092	0.020	0.1	0.007
Methylene chloride	0.001 - 0.001	6 / 10	0.002	10	1.5	0.005	0.005
Tetrachloroethene	0.002 - 0.2	3 / 10	0.001	0.016	0.013	0.005	0.005
Toluene	0.001 - 0.001	8 / 10	0.002	2.2	0.33	1	0.005
Total Xylenes	0.002 - 0.24	5 / 10	0.0008	0.038	0.021	10	0.005
Trichloroethene	0.002 - 0.2	6 / 10	0.001	0.069	0.020	0.005	0.005
Vinyl chloride	0.001 - 0.12	7 / 10	0.002	0.23	0.045	0.002	0.002
SEMIVOLATILE ORGANIC COMPOUNDS							
1,4-Dichlorobenzene	0.002 - 0.002	1 / 10	0.034	0.034	0.0040	0.075	0.0047
2,6-Dichloropyridine	0.006 - 0.006	8 / 10	0.0007	8.4	1.7	-	-
2-Chloropyridine		10 / 10	0.004	50	10.6	-	-
2-Methylnaphthalene	0.002 - 0.002	2 / 10	0.003	0.015	0.0026	-	-
2-Methylphenol	0.004 - 0.05	1 / 10	0.009	0.009	0.0052	-	0.001 **
3-Chloropyridine	0.006 - 0.006	7 / 10	0.013	2.1	0.44	-	-
4-Chloroaniline	0.002 - 0.002	5 / 10	0.007	0.31	0.048	-	-
4-Chloropyridine	0.004 - 0.006	2 / 10	0.0003	0.01	0.0032	-	-
4-Methylphenol	0.004 - 0.042	2 / 10	0.002	0.017	0.0054	-	0.001 **
Benzoic acid	0.008 - 0.011	3 / 10	0.001	0.073	0.013	-	-

TABLE 1-4
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BEDROCK GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	**Range of SQLs**	**Frequency of Detection**	**Minimum Detected Concen-tration**	**Maximum Detected Concen-tration**	**Mean of all Samples**	**MCL**	**NY State Groundwater Quality Class GA**
Bis(2-Chloroethyl)ether	0.001 - 0.002	6 / 10	0.006	0.15	0.027	-	0.001
Pyridine	0.006 - 0.006	7 / 10	0.006	1.8	0.28	-	-
p-Fluoroaniline	0.006 - 0.006	8 / 10	0.006	1.2	0.24	-	-
INORGANICS							
Aluminum		10 / 10	0.16	1.4	0.52	0.2#	-
Antimony	0.003 - 0.004	2 / 10	0.003	0.004	0.0018	0.006	0.003
Arsenic	0.003 - 0.004	3 / 10	0.005	0.042	0.0071	0.05	0.0025
Calcium		9 / 9	87	2200	371	-	-
Chromium	0.01 - 0.01	2 / 10	0.01	0.011	0.0059	0.1	0.05
Copper	0.01 - 0.01	2 / 10	0.012	0.31	0.033	1.3*	0.2
Iron		9 / 9	0.18	6.4	2.2	0.3#	0.3
Magnesium		9 / 9	25	400	86	-	35
Manganese		10 / 10	0.03	0.62	0.22	0.05#	0.3
Potassium		10 / 10	6.7	210	31.7	-	-
Sodium		10 / 10	31	15000	1904	-	20

NOTES:
Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects.
* - Action Level
# - Secondary Standard
** - Total phenols limit of 1.0 µg/L
\- = No standard available for this compound

ACRONYMS:
mg/L - milligrams per liter
SQL - Sample Quantitation Limit
CPC - Chemical of Potential Concern
ND - Not detectable
GA = Groundwater classification level per New York State Groundwater Quality Reguations (6 NYCRR part 701-705)
DDE = Dichlorodiphenyldichloroethylene
DDT = Dichlorodiphenyltrichloroethylene
BHC = Benzenehexachloride
MCL = Maximum Contaminant Level for community drinking water systems

Sample Locations:
[a] - Based on samples BR-1 through BR-8, BR-2D, BR-3D, PZ-105 through PZ-107.
[b] - Based on samples BR-103 through BR-108, BR-105D, PZ-102 through PZ-104.

TABLE 1-5
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT GROUNDWATER

ARCH CHEMICALS FEASIBILITY STUDY REPORT
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Mean of all Samples	MCL
OFFSITE GROUNDWATER[a] (mg/L)						
VOLATILE ORGANIC COMPOUNDS						
1,2-Dichloroethene (Total)	0.0005 - 0.01	10 / 19	0.004	0.49	0.057	0.07
Benzene	0.0005 - 0.01	14 / 19	0.0006	0.24	0.041	0.005
Tetrachloroethene	0.0005 - 0.05	3 / 19	0.001	0.004	0.0048	0.005
Trichloroethene	0.0005 - 0.05	7 / 19	0.001	0.012	0.0047	0.005
Vinyl Chloride	0.001 - 0.01	10 / 19	0.002	0.35	0.044	0.002
SEMIVOLATILE ORGANIC COMPOUNDS						
2,6-Dichloropyridine	0.01 - 0.01	15 / 23	0.0005	15	0.74	-
2-Chloropyridine	0.01 - 0.01	19 / 23	0.002	84	4.63	-
3-Chloropyridine	0.01 - 0.01	8 / 23	0.007	4	0.20	-
4-Chloropyridine	0.01 - 0.01	1 / 13	0.006	0.006	0.0051	-
INORGANICS						
Arsenic	0.0053 - 0.0053	5 / 9	0.0062	0.371	0.033	0.05
Cadmium	0.0004 - 0.0004	2 / 9	0.0012	0.0984	0.0062	0.005
Calcium		9 / 9	135	1220	323	-
Copper	0.0011 - 0.0011	8 / 9	0.0016	70.7	4.46	1.3*
Iron		9 / 9	2.54	864	110	0.3#
Lead	0.0014 - 0.0014	8 / 9	0.0023	4.75	0.31	0.015*
Magnesium		9 / 9	28.8	357	112	-
Potassium		9 / 9	4.04	171	30	-
Sodium		9 / 9	12.2	6490	874	-
Zinc		9 / 9	0.0176	2780	175	5#

NOTES:
** Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.
* - Action Level
# - Secondary Standard
- = No standard available for this compound

ACRONYMS:
mg/L - milligrams per liter
SQL - Sample Quantitation Limit
MCL - Maximum Contaminant Level; Drinking Water Regulations and Health Advisories, USEPA Office of Water, May 1995.
CPC - Chemical of Potential Concern

Sample Locations:
[a] - Based on samples QS-1 through QS-4, Sept. 1995 and QS-4 and duplicate Oct. 1995; BR-111, BR-111D, BR-112A, BR-112D, BR-113 and duplicate, BR-113D, and BR-114 Oct. and Dec. 1995; NESS E, NESS W, Sept, Nov, and Dec. 1995 plus NESS E duplicate Nov. 1995; BR-103 through BR-107 and BR-105D, MW-103, MW-104, MW-106, and MW-107 Sept. 1995.

TABLE 1-6
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
BARGE CANAL SURFACE WATER

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration Minimum	Detected Concentration Maximum	Mean of all Samples[1]
BARGE CANAL SURFACE WATER[a] (mg/L)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2,6-Dichloropyridine	0.01 - 0.02	7 / 34	0.0003	0.005	0.005
2-Chloropyridine	0.01 - 0.01	16 / 34	0.0001	0.039	0.008
3-Chloropyridine	0.01 - 0.02	5 / 34	0.001	0.002	0.0048
QUARRY OUTFALL WATER[b] (mg/L)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2,6-Dichloropyridine	NA	5 / 5	0.007	0.032	0.024
2-Chloropyridine	NA	5 / 5	0.018	0.16	0.100
3-Chloropyridine	NA	5 / 5	0.0004	0.011	0.0069

NOTES:

[1] - Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.

ACRONYMS:
mg/L - milligrams per liter
SQL - Sample Quantitation Limit
CPC - Chemical of Potential Concern

Sample Locations:

[a]- Based on samples SW-1 through SW-12, QO-2D1, QO-2D2, QO-2U1, QO-2U2 collected April, June, and Sept. 1996 and April and June 1997.

[b]- Based on sample QO-2 collected April, June, and Sepbember 1996 and April and June 1997.

TABLE 1-7
CHEMICALS OF POTENTIAL CONCERN FOR THE HUMAN HEALTH RISK ASSESSMENT
GROUNDWATER SEEPS

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

Compound	Range of SQLs	Frequency of Detection	Detected Concentration		Mean of all Samples
			Minimum	Maximum	
GROUNDWATER SEEP IN QUARRY[a] (mg/L)					
SEMIVOLATILE ORGANIC COMPOUNDS					
2-Chloropyridine	NA	8 / 8	0.004	3.2	1.17
3-Chloropyridine	0.01 - 0.01	6 / 8	0.007	0.12	0.039
2,6-Dichloropyridine	0.01 - 0.01	7 / 8	0.004	1	0.33
p-Fluoroaniline[b]	0.01 - 0.01	2 / 5	0.002	0.005	0.0044

NOTES:

Mean of all samples is arithmetic average of all detections plus one-half the SQL for non-detects. If mean concentration exceeds maximum concentration, only maximum concentration will be used in evaluation.

ACRONYMS:
mg/L - milligrams per liter
SQL - Sample Quantitation LImit
CPC - Chemical of Potential Concern

Sample Locations:

[a] - Based on samples QS-2 and QS-3 sampled 9/95, and sample QS-4 sampled 9/95, 10/95, 3/96, 6/96, 9/96, and 12/96.

[b] - Based on samples QS-2 and QS-3 sampled 9/95, and sample QS-4 sampled 9/95 and 10/95; elevated reporting limits for QS-4 sampled 3/96, 6/96, 9/96, and 12/96. precluded use in risk assessment.

TABLE 1-8
SUMMARY OF RECEPTORS AND EXPOSURE PATHWAYS

ARCH CHEMICALS, FEASIBILITY STUDY
ROCHESTER, N.Y

RECEPTOR	EXPOSURE MEDIUM	EXPOSURE PATHWAY	EXPOSURE FREQUENCY/ DURATION	REPORT	
				PHASE I	PHASE II
CURRENT AND FUTURE LAND USE					
On-Site Facility commercial/industrial worker	Surface Soil and Soil Gas	Incidental Ingestion, Dermal Contact, Inhalation of Particulates and Volatiles	250 days per yr / 25 yrs	X	
On-Site Non-Facility commercial/industrial worker	Surface Soil and Soil Gas	Incidental Ingestion, Dermal Contact, Inhalation of Particulates and Volatiles	250 days per yr / 25 yrs	X	
Older child and adult recreational boater/swimmer at Erie Barge Canal	Surface Water	Incidental Ingestion, Dermal Contact	15 days per yr / 30 yrs		X
Adult recreational angler at Erie Barge Canal	Surface Water	Ingestion of fish taken from Barge Canal	1 meal per day / 30 yrs		X [a]
Quarry worker at Dolomite Products Quarry	Groundwater Seeps	Dermal Contact	15 days per yr / 10 yrs		X

TABLE 1-8
SUMMARY OF RECEPTORS AND EXPOSURE PATHWAYS

ARCH CHEMICALS, FEASIBILITY STUDY
ROCHESTER, N.Y

RECEPTOR	EXPOSURE MEDIUM	EXPOSURE PATHWAY	EXPOSURE FREQUENCY/ DURATION	REPORT	
				PHASE I	PHASE II
FUTURE LAND USE					
On-site construction worker [b]	Soil (0 to 10 ft) and Soil Gas	Incidental Ingestion, Dermal Contact, Inhalation of Particulates and Volatiles	30 days per yr or 180 days per yr / 1 yr	X	
	Onsite Overburden Groundwater	Incidental Ingestion, Dermal Contact, Inhalation of Volatiles	30 days per yr or 180 days per yr / 1 yr	X	
Off-site construction worker [b]	Offsite Overburden Groundwater	Incidental Ingestion, Dermal Contact, Ihalation of Volatiles	30 days per yr or 180 days per yr / 1 yr	X	
Off-site commercial/industrial worker	Offsite Overburden and Bedrock Groundwater	Dermal Contact, Inhalation of Volatiles (to water used as industrial process water)	250 days per yr / 25 yrs		X

Notes:

[a] Exposure evaluated in interim response to Phase II RI comments (submitted to NYSDEC/ NYSDOH, November, 1996), and included as Appendix D-3 in the Phase II RI Report.

[b] Exposures evaluated for both 1-month and 6-month durations.

TABLE 1-9
QUANTITATIVE RISK SUMMARIES BY RECEPTOR

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
CURRENT AND CONTINUING USE				
Facility Commerical/Industrial Worker - On-Site				
Facility Industrial/Commercial Worker Contact with On-Site Surface Soil:				
Incidental Ingestion, Dermal Contact, Inhalation of Particulates and Volatiles				
TOTAL: Facility Industrial/Commercial Worker - On-Site	1E-05	0.08	5E-05	0.4
Non-Facility Commerical/Industrial Worker - On-Site				
Non-Facility Industrial/Commercial Worker Contact with On-Site Surface Soil:				
Incidental Ingestion, Dermal Contact, Inhalation of Particulates and Volatiles				
TOTAL: Non-facility Industrial/Commercial Worker - On-Site	3E-06	0.02	6E-06	0.04
Recreational Boater/Swimmer				
Older Child and Adult Boater/Swimmer Contact with Erie Barge Canal Surface Water:				
Incidental Ingestion and Dermal Contact				
TOTAL: Recreational Boater/Swimmer	2E-08	1E-05	3E-07	0.00007
Recreational Angler				
Recreational Adult Angler at Erie Barge Canal:				
Ingestion of Fish Taken from Erie Barge Canal				
TOTAL: Recreational Angler	Not Evaluated		2E-07	0.0001
Quarry Worker				
Adult Quarry Worker Contact with Groundwater Seeps at Dolomite Products Quarry:				
Dermal Contact				
TOTAL: Quarry Worker	7E-08	3E-05	2E-07	0.00007

TABLE 1-9
QUANTITATIVE RISK SUMMARIES BY RECEPTOR

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
POTENTIAL FUTURE LAND USE				
On-Site Construction Worker				
Construction Worker One Month Contact with Soil (0-10 feet):				
Incidental Ingestion, Dermal Contact, Inhalation of Particulates	3E-06	47	1E-05	134
Construction Worker One Month Contact with Onsite Overburden Groundwater:				
Incidental Ingestion, Dermal Contact, Inhalation of Volatiles	1E-04	80	4E-03	1098
TOTAL: Onsite Construction Worker - One Month	1E-04	127	4E-03	1232
Construction Worker Six Month Contact with Onsite Soil (0-10 feet):				
Incidental Ingestion, Dermal Contact, Inhalation of Particulates	2E-05	46	9E-05	131
Construction Worker Six Month Contact with Onsite Overburden Groundwater:				
Incidental Ingestion, Dermal Contact, Inhalation of Volatiles	8E-04	79	2E-02	1076
TOTAL: Onsite Construction Worker - Six Months	8E-04	125	2E-02	1207
Off-Site Construction Worker				
Construction Worker One Month Contact with Offsite Overburden Groundwater:				
Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Offsite Construction Worker - One Month	5E-07	39	4E-06	281
Construction Worker Six Month Contact with Offsite Overburden Groundwater:				
Incidental Ingestion, Dermal Contact, Inhalation of Volatiles				
TOTAL: Offsite Construction Worker - Six Months	3E-06	38	2E-05	276
Off-Site Commercial/Industrial Worker				
Contact with Off-Site Groundwater used as Industrial Process Water				
Dermal Contact and Inhalation of Volatiles				
TOTAL: Off-Site Commercial/Industrial Worker	7E-05	4	9E-04	29

☐ - value exceeds Cancer Risk of 1x10^{-6} or Hazard Index of 1

TABLE 1-10
QUANTITATIVE RISK SUMMARIES BY MEDIA

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
CURRENT AND CONTINUING LAND USE				
SURFACE SOIL (0 - 2 inches)				
Surface Soil: Onsite Facility Industrial/Commercial Worker				
Incidental Ingestion of Onsite Facility Surface Soil: Industrial/Commercial Worker	1E-05	0.08	5E-05	0.4
Dermal Contact with Onsite Facility Surface Soil: Industrial/Commercial Worker	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Onsite Facility	4E-08	0.001	1E-07	0.004
TOTAL: Onsite Facility Industrial/Commercial Worker	**1E-05**	**0.08**	**5E-05**	**0.4**
Surface Soil: Onsite Non-Facility Industrial/Commercial Worker				
Incidental Ingestion of Onsite Non-facility Surface Soil: Industrial/Commercial Worker	3E-06	0.02	6E-06	0.04
Dermal Contact with Onsite Non-facility Surface Soil: Industrial/Commercial Worker	ND	0.0001	ND	0.0002
Inhalation Exposure to Particulates and Volatiles from Onsite Non-facility	2E-08	0.001	1E-07	0.002
TOTAL: Onsite Non-Facility Industrial/Commercial Worker	**3E-06**	**0.02**	**6E-06**	**0.04**
SURFACE WATER				
Erie Barge Canal Surface Water: Older Child and Adult Boater/Swimmer				
Incidental Ingestion of Surface Water: Older Child and Adult Boater/Swimmer	4E-09	0.000005	7E-08	0.00003
Dermal Contact with Surface Water: Older Child and Adult Boater/Swimmer	2E-08	0.000009	2E-07	0.00005
TOTAL: Recreational Boater/Swimmer	**2E-08**	**0.00001**	**3E-07**	**0.00007**
Erie Barge Canal Surface Water: Adult Recreational Angler				
Ingestion of Fish Taken from Erie Barge Canal: Adult Recreational Angler	Not Evaluated		2E-07	0.0001
TOTAL: Recreational Angler	Not Evaluated		**2E-07**	**0.0001**
GROUNDWATER SEEPS				
Dolomite Quarry Groundwater Seeps: Adult Quarry Worker				
Dermal Contact with Surface Water: Adult Quarry Worker	7E-08	0.00003	2E-07	0.00007
TOTAL: Quarry Worker	**7E-08**	**0.00003**	**2E-07**	**0.00007**
POTENTIAL FUTURE LAND USE				
SOIL (0-10 feet)				
Onsite Construction Worker (1 Month Exposure)				
Incidental Ingestion of Soil (0-10 feet): Construction Worker (1 Month Exposure)	2E-07	0.5	2E-06	5
Dermal Contact with Soil (0-10 feet): Construction Worker (1 Month Exposure)	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Soil (0-10 feet):	3E-06	46	1E-05	129
TOTAL: Onsite Construction Worker - 1 Month	**3E-06**	**47**	**1E-05**	**134**
Onsite Construction Worker (6 Month Exposure)				
Incidental Ingestion of Soil (0-10 feet): Construction Worker (6 Month Exposure)	1E-06	0.5	1E-05	5
Dermal Contact with Soil (0-10 feet): Construction Worker (6 Month Exposure)	ND	ND	ND	ND
Inhalation Exposure to Particulates and Volatiles from Soil (0-10 feet):	2E-05	45	8E-05	126
TOTAL: Onsite Construction Worker - 6 Months	**2E-05**	**46**	**9E-05**	**131**

TABLE 1-10
QUANTITATIVE RISK SUMMARIES BY MEDIA

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, N.Y.

	MEAN		MAXIMUM	
	Total Cancer Risk	Total Hazard Index	Total Cancer Risk	Total Hazard Index
ON-SITE OVERBURDEN GROUNDWATER				
Onsite Construction Worker (1 Month Exposure)				
Incidental Ingestion of Onsite Overburden Groundwater: Construction Worker (1 Month Exposure)	2E-06	23	3E-05	306
Dermal Contact with Onsite Overburden Groundwater: Construction Worker (1 Month Exposure)	1E-04	57	4E-03	792
Inhalation Exposure to Volatiles from Onsite Overburden Groundwater:	6E-09	0.00003	1E-07	0.001
TOTAL: Onsite Construction Worker - 1 Month	**1E-04**	**80**	**4E-03**	**1098**
Onsite Construction Worker (6 Month Exposure)				
Incidental Ingestion of Onsite Overburden Groundwater: Construction Worker (6 Month Exposure)	1E-05	23	2E-04	300
Dermal Contact with Onsite Overburden Groundwater: Construction Worker (6 Month Exposure)	8E-04	56	2E-02	776
Inhalation Exposure to Volatiles from Onsite Overburden Groundwater:	4E-08	0.00003	9E-07	0.001
TOTAL: Onsite Construction Worker - 6 Months	**8E-04**	**79**	**2E-02**	**1076**
OFF-SITE OVERBURDEN GROUNDWATER				
Offsite Construction Worker (1 Month Exposure)				
Incidental Ingestion of Offsite Overburden Groundwater: Construction Worker (1 Month Exposure)	3E-07	6	2E-06	47
Dermal Contact with Offsite Overburden Groundwater: Construction Worker (1 Month Exposure)	2E-07	32	2E-06	234
Inhalation Exposure to Volatiles from Offsite Overburden Groundwater:	4E-10	0.000003	9E-09	0.00008
TOTAL: Offsite Construction Worker - 1 Month	**5E-07**	**39**	**4E-06**	**281**
Offsite Construction Worker (6 Month Exposure)				
Incidental Ingestion of Offsite Overburden Groundwater: Construction Worker (6 Month Exposure)	2E-06	6	1E-05	46
Dermal Contact with Offite Overburden Groundwater: Construction Worker (6 Month Exposure)	1E-06	32	1E-05	230
Inhalation Exposure to Volatiles from Offsite Overburden Groundwater:	3E-09	0.000003	5E-08	0.00008
TOTAL: Offsite Construction Worker - 6 Months	**3E-06**	**38**	**2E-05**	**276**
PHASE II SAMPLING LOCATIONS OFFSITE OVERBURDEN AND BEDROCK GROUNDWATER				
Full-Time Commercial/Industrial Worker				
Dermal Contact with Offsite Groundwater used as Proces Water: Full-Time Commercial/Industrial Worker	7E-05	4	9E-04	29
Inhalation Exposure to Volatiles from Process Water:	No Exceedances of Criteria			
TOTAL: Full-Time Commerical/Industrial Worker	**7E-05**	**4**	**9E-04**	**29**

☐ - value exceeds Cancer Risk of 1×10^{-6} or Hazard Index of 1

ND - No dermal absorption data for CPCs available in "Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B. January, 1992" to calculate exposures and risks.

TABLE 2-1
CHEMICAL-SPECIFIC ARARS AND SCGS

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

REGULATORY LEVEL	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN RI/FS
Federal	SDWA - MCLs [40 CFR 141.11 - 141.16]	Relevant and Appropriate	MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	Because groundwater is not currently used for drinking water in the vicinity of the Arch Site, the SDWA is not applicable, but is relevant and appropriate.
	Federal AWQC	Relevant and Appropriate	Federal AWQC includes; (1) health-based criteria developed for 95 carcinogenic and noncarcinogenic compounds; and (2) water quality parameters. AWQC, for the protection of human health, provides levels for exposure from drinking water and consuming aquatic organisms and from consuming just fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release; this determines whether AWQC are relevant and appropriate.	AWQC will be used, where appropriate, in the development of clean-up levels for discharges to surface water.
State	New York Department of Public Health Public Water Systems [Subpart 5-1]	Relevant and Appropriate	This requirement outlines MCLs that are not to be exceeded in public water supplies. Where MCLs have been exceeded, action is required to comply with regulatory standards.	Because groundwater is not used for drinking water in the vicinity of the Arch Site, these standards are not applicable, but is relevant and appropriate.
Federal Guidance and Criteria To Be Considered	USEPA Reference Doses (RfDs) and Risk Reference Concentrations (RfCs)	To Be Considered	RfDs/RfCs are estimates of a daily exposure level for the human population without an appreciable risk of deleterious effects during a lifetime.	USEPA RfDs/RfCs are used to characterize risks due to noncarcinogens in various media.
	USEPA Health Advisories (HAs)	To Be Considered	HAs are issued as nonregulatory guidance. HA values represent the concentration of contaminants in drinking water at which adverse health effects would not be expected to occur. HAs are established for one-day and ten-day exposure durations.	USEPA HAs are used to evaluate noncarcinogenic effects for oral exposures of shorter durations.
State Guidance and Criteria to Be Considered	New York State Department of Environmental Conservation TAGM HWR-94-4046 Soil Cleanup Objectives	To Be Considered	This guidance document sets forth the numeric criteria for the cleanup of organic and inorganic contaminants in soils.	Criteria for Site contaminants will be evaluated in establishing preliminary remediation goals for contaminated soils.
	USEPA Human Health Carcinogen Assessment Group Cancer Slope Factors (CSFs)	To Be Considered	Carcinogenic effects present the most up-to-date information on cancer risk potency derived from USEPA's Human Health Carcinogen Assessment Group.	USEPA CSFs are used to compute the individual incremental cancer risk resulting from exposure to certain compounds.

Notes:

ARARs = Applicable or Relevant and Appropriate Requirements
AWQC = Ambient Water Quality Criteria
CFR = Code of Federal Regulations
CSF = Cancer Slope Factor
MCL = Maximum Contaminant Level
mg/L = milligrams per liter
NYCRR = New York Code of Rules and Regulations
ppm = parts per million

RfC = Risk Reference Concentration
RfD = Risk Reference Dose
RI/FS = Remedial Investigation/ Feasibility Study
SCG = Standards, Criteria, and Guidelines
SDWA = Safe Drinking Water Act
µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter
USEPA = U.S. Environmental Protection Agency

TABLE 2-2
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

COMPOUNDS	NY STATE GROUNDWATER QUALITY-CLASS GA (µG/L)	FEDERAL MCL (µG/L)
VOLATILE ORGANIC COMPOUNDS		
Chloromethane	5	
Bromoethane		
Vinyl chloride	2	2
Chloroethane		
Methylene Chloride	5	(5)
Acetone		
Carbon disulfide		
1,1-Dichloroethene	5	7
1,1-Dichloroethane	5	
1,1,1-Trichloroethene (total)	5	200
cis-1,2-Dichloroethene	5	70
trans-1,2-Dichloroethene	5	100
Chloroform	7	
1,2-Dichloroethane	5	5
2-Butanone		
1,1,1-Trichloroethane	5	200
Carbon tetrachloride	5	5
Vinyl acetate		
Bromodichloromethane	50 G	
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	
Trichloroethene	5	5
Dibromochloromethane	50 G	
1,1,2-Trichloroethane	5	5
Benzene	0.7	5
trans-1,3-Dichloropropene	5	
Bromoform	50 G	
4-Methyl-2-Pentanone		
2-Hexanone	50 G	
Tetrachloroethene	5	5
1,1,2,2-Tetrachloroethane	5	
Toluene	5	1,000
Ethylbenzene	5	700
Styrene	5	100
Xylenes (Total)	5	10,000
SEMIVOLATILE ORGANIC COMPOUNDS		
Phenol (Total)	1	
bis(2-Chloroethyl)ether	1.0	
2-Chlorophenol	+	
1,3-Dichlorobenzene	5	600
1,4-Dichlorobenzene	4.7	75
Benzyl alcohol		
1,2-Dichlorobenzene	4.7	600
2-Methylphenol	+	

TABLE 2-2
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

COMPOUNDS	NY STATE GROUNDWATER QUALITY-CLASS GA (µG/L)	FEDERAL MCL (µG/L)
SEMIVOLATILE ORGANIC COMPOUNDS (continued)		
bis(2-Chloroisopropyl)ether		
4-Methylphenol	+	
N-Nitroso-di-n-propylamine		
Hexachloroethane		
Nitrobenzene	5	
Isophorone	50 G	
2-Nitrophenol	+	
2,4-Dimethylphenol	+	
Benzoic Acid		
bis(2-Chloroethoxy)methane		
2,4-Dichlorophenol	+	
1,2,4-Trichlorobenzene	5	70
Napthalene	10 G	
4-Chloroanaline		
Hexachlorobutadiene	5	
4-Chloro-3-methylphenol	+	
2-Methylnapthalene		
Hexachlorocyclopentadiene	5	50
2,4,6-Trichlorophenol	+	
2,4,5-Trichlorophenol	+	
2-Chloronapthalene	10	
2-Nitroaniline		
Dimethylphthalate	50 G	
2,6-Dinitrotoluene	5	
3-Nitroanaline		
Acenapthene	20 G	
2,4-Dinitrophenol	+	
4-Nitrophenol	+	
Dibenzofuran		
2,4-Dinitrotoluene		
Diethylphthalate	50 G	
4-Chlorophyl-phenylether		
Fluorene	50 G	
4-Nitroaniline		
4,6-Dinitro-2-mehtylphenol	+	
N-Nitrosodiphenylamine	50 G	
4-Bromophenyl-phenylether		
Hexachlorobenzene	0	1
Pentachlorophenol	+	1
Phenanthrene	50 G	
Anthracene	50 G	
Di-n-butylphthalate	50	
Fluoranthene	50 G	
Pyrene	50 G	

(continued)

TABLE 2-2
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

COMPOUNDS	NY STATE GROUNDWATER QUALITY-CLASS GA (µG/L)	FEDERAL MCL (µG/L)
SEMIVOLATILE ORGANIC COMPOUNDS (continued)		
Butylbenzylphthalate	50 G	
3,3-Dichlorobenzidene		
Benzo(a)anthracene	0.002G	(0.1)
Chrysene	0.002 G	(0.2)
bis (2-Ethylhexyl)phthalate	50	
Di-n-octylphthalate	50 G	
Benzo(b)fluoranthene	0.002 G	(0.2)
Benzo(k)fluoranthene	0.002 G	(0.2)
Benzo(a)pyrene	ND	(0.2)
Indeno(1,2,3-cd)pyrene	0.002G	(0.4)
Dibenz(a,h)Anthracene		(0.3)
Benzo(g,h,i)perylene		
PESTICIDE/PCBs		
alpha-BHC	ND	0.2
beta-BHC	ND	0.2
delta-BHC	ND	0.2
gamma-BHC (Lindane)	ND	4
Heptachlor	ND	0.4
Aldrin	ND	
Heptachlor epoxide	ND	0.2
Endosulfan I		
Dieldrin***	ND	
4,4'-DDE	ND	
Endrin	ND	(2)
Endosulfan II		
4,4'-DDD	ND	
Endosulfan sulfate		
4,4'-DDT	ND	
Methoxychlor	35	40
Endrin ketone		
alpha-Chlordane	0	2
gamma-Chlordane	0	2
Toxaphene	ND	3
PCB	0.5	0
INORGANICS		
Aluminum		
Antimony	3 G	6
Arsenic	25	50
Barium	1,000	2,000
Beryllium	3 G	4
Cadmium	10	5
Calcium		
Chromium	50	100
Cobalt		

TABLE 2-2
SUMMARY OF GROUNDWATER AND SURFACE WATER STANDARDS AND GUIDANCE

ARCH CHEMICALS FEASIBILITY STUDY
ROCHESTER, NEW YORK

COMPOUNDS	NY STATE GROUNDWATER QUALITY-CLASS GA (µG/L)	FEDERAL MCL (µG/L)
INORGANICS (continued)		
Copper	200	TT1,300
Cyanide	100	200
Iron	300	
Lead	25	TT 15
Magnesium	35,000 G	
Manganese	300	
Mercury	2	2
Nickel		(100)
Potassium		
Selenium	10	50
Silver	50	
Sodium	20000	
Thallium	4 G	2
Vanadium		
Zinc	300	
WATER QUALITY PARAMETERS		
pH		
Dissolved solids	500 mg/L	
DO		

Sources:

Federal MCLs from 40 CFR 141.
Federal MCLs in parentheses are proposed (from 54FR22062, 55FR30370, and 56FR3521).
Federal Ambient Water Quality Critieria, May 1, 1991.

New York State Groundwater Quality standards taken from 6NYCRR 703 (September 1, 1991) and Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values (November 15, 1991). New York State Public Water Supply MCLs taken from 10 NYCRR 5-1 (March 11, 1992).

Notes:

G = Guidance values taken from New York State Division of Water Technical and Operational Guidance Series (Ambient Water Quality Standards and Guidance Values, November 15, 1991).
TT = Treatment Technique Action Level
MCL = Maximum Contaminant Level
ND = Not detectable
( ) = MCLs and MCLGs in parentheses are proposed.
µg/L = micrograms per liter
mg/L = milligrams per liter
ng/L = nanograms per liter