Engineering Report

FINAL SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT FOR THE ROCHESTER FIRE ACADEMY SITE

VOLUME I

City of Rochester
Rochester, New York

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SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT ROCHESTER FIRE ACADEMY SITE

VOLUME I

CITY OF ROCHESTER
ROCHESTER, NEW YORK

MAY 1992

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EXECUTIVE SUMMARY

1.0 BACKGROUND

The Rochester Fire Academy site is a 21-acre tract of land used as a training facility by the City of Rochester Fire and Police Departments. The site is located on the west bank of the Genesee River in the City of Rochester, Monroe County, New York in an urbanized area consisting mainly of commercial development. A 75 to 125-foot wide portion of the City of Rochester's Genesee Valley Park, which is traversed by a paved bicycle path, is located between the eastern site boundary and the Genesee River. A 7-foot high chain-link fence surrounds the entire site and extends across the Park area to the river's edge, thereby restricting access to the public. The site is bordered to the west by the former Genesee Valley Canal.

The Fire Academy site has been segregated into four distinct areas, three of which have been involved with the facility's chemical use and disposal. These areas of concern are the North Disposal Area, the South Disposal Area and the Training Grounds Area. The remaining area, the Police Firing Range/Obstacle Course, and two adjacent areas included in the Remedial Investigation study area, the Genesee Valley Park Area and the Genesee Valley Canal Area, are not believed to have received any potentially hazardous wastes.

The NYSDEC listed the Rochester Fire Academy site in the New York State Registry of Inactive Hazardous Waste Disposal Sites (Site No. 828015) and assigned the site a "Class 2" designation based upon the findings from State Superfund Phase I and Phase II studies. A remedial investigation was conducted in 1990 and the findings reported in a report entitled Remedial Investigation Report for the Rochester Fire Academy Site, dated May 1991. The RI report identified organic and inorganic contamination in on-site fill material; both on-site and off-site native soil; and in ground water beneath the South Disposal Area. To fully evaluate remedial alternatives for the site during the Feasibility Study (FS), additional data regarding:

- the hydraulic characteristics of the overburden water-bearing zone and its treatability;
- the verification of and the establishment of the lateral and vertical extent of soil contamination;

- the re-evaluation of the health risk based on more complete analytical data; and
- the assessment of the potential risk to the environment associated with site contaminants was required.

The scope of these activities was detailed in the Supplemental Remedial Investigation Work Plan, dated October 1991.

2.0 GEOLOGIC/HYDROGEOLOGIC CONDITIONS OF THE SOUTH DISPOSAL AREA

The Remedial Investigation identified the following stratigraphic sequence of geologic materials:

- fill of variable composition;
- alluvium associated with deposition of the Genesee River; and
- dolostone bedrock.

The saturated fill and alluvial sediments comprise the overburden water-bearing zone and the upper 10 to 20 feet of bedrock comprise the bedrock aquifer.

The geologic and hydrogeologic conditions at the site are fully described in the RI Report. Additional geologic and hydrogeologic data was collected from the South Disposal Area during the Supplemental RI. The investigation included the installation and hydraulic testing of two piezometers to provide hydraulic information from the lower overburden water-bearing zone and two four-inch diameter pumping wells installed to provide hydraulic information from the upper overburden water-bearing zone and to supply ground water for treatability testing.

The investigation identified the presence of heterogeneous alluvial sediments within and downgradient of the South Disposal Area. The density of these deposits increases at a depth of approximately 20 to 22 feet below grade where the alluvial sediments have till-like properties (i.e. poor sorting, very dense). Hydraulic testing results using slug test and "mini-rate" pump test methodologies estimated a range of hydraulic conductivities of 1.9 to 11 gpd/ft^2 for the saturated thickness of the alluvial deposits. West of the South Disposal Area a higher hydraulic conductivity value of approximately 70 gpd/ft^2 was determined for less dense sand and gravel alluvial deposits. The overburden water-bearing zone discharges to the Genesee River. Based upon the additional data collected from the South Disposal Area, the water balance calculation presented in the RI Report was revised. The lower hydraulic conductivity of the alluvial sediments determined from hydraulic testing reduced the estimated ground water outflow to the Genesee River from 573 reported in the original RI to 126 ft^3/day.

A ground water flow model was employed to simulate existing ground water flow conditions in the overburden. A finite-difference modeling grid was established over the South Disposal Area with model input parameters specified using data collected during the RI and the Supplemental RI field activities. The model was subsequently calibrated using trial and error methodology for use during the Feasibility Study to evaluate the hydraulic effects of various ground water remedial controls.

3.0 GROUND WATER TREATABILITY TESTING

The Remedial Investigation Report for the Rochester Fire Academy Site has demonstrated that organic, and to a lesser extent, inorganic contamination is present in the ground water in the South Disposal Area at elevated concentrations as compared to NYSDEC Class "GA" Ground Water Quality Standards. Desk-top and bench scale treatability testing was performed to evaluate the removal effectiveness of various technologies for volatile organic compounds, metals and PCBs. Desk-top evaluations included the assessment of three (3) different air stripping processes for removal of volatiles: shallow tray air stripping; bubble diffusion air stripping; and packed tower air stripping and GAC treatment for PCB removal. Untreated groundwater was collected during "mini-rate" pump testing and transported to Peroxidation Systems, Inc. (PSI) for bench scale treatability testing using advanced oxidation process (AOP) technology. Bench scale metals precipitation was also performed to mitigate air stripper scaling or AOP interference.

Shallow tray air stripping involves the use of a compact series of perforated trays and a high capacity blower to volatilize the contamination as the water passes over the trays. The unit is skid-mounted, and is fitted with a small effluent collection tank and discharge pump. Based on discussions with the manufacturer, North East Environmental Products, Inc., a properly sized unit will achieve better than 99% removal of the maximum observed

VOC concentrations in the overburden water bearing zone in the South Disposal Area. Scale build-up, a problem common to air strippers, can be removed from shallow tray units with a high pressure washer. Since the air stripping unit itself is approximately 7 feet tall, a 17-foot tall stack would have to be fitted to the unit to meet the Air Guide 1 criteria at start-up.

Bubble diffusion air stripping relies on a rectangular tank fitted with air spargers to volatilize contamination as water passes through the tank. Contaminated water is pumped to the influent side of the unit on a continual basis, and exits via a gravity overflow port. This technology is essentially identical to shallow tray air stripping in terms of effectiveness (i.e., it achieves better than 99% removal for the parameters of interest according to the manufacturer, Lowry Engineering) and is also implemented and maintained with a similar level of effort. Air emissions from the bubble diffusion unit would also be subject to Air Guide 1, and therefore a stack resulting in an emission height of 24 feet would be required at start-up.

In order to compare the effectiveness of packed tower air strippers to the shallow tray or bubble diffusion units, computer software was utilized to determine the design requirements for a tower achieving an equivalent removal efficiency of 99% for the same maximum VOC concentrations. The resulting design indicates that for a two-foot diameter column, with a packing height of 25 feet would be necessary to achieve the desired removal efficiency. Allowing for some space above and below the packing, a 30-foot tall tower, two-feet in diameter would mimic the removal efficiency of either the shallow tray or bubble diffusion air stripping units.

Untreated groundwater was collected from the 200 gallon HDPE tank during the pump test and transported to Peroxidation Systems, Inc. (PSI) for bench scale treatability testing using advanced oxidation process (AOP) technology. The PSI trade name for its AOP procedure is the perox-pure™ Process. This process destroys dissolved organic contaminants in water by means of chemical oxidation. Ultraviolet (UV) light catalyzes the chemical oxidation of organic contaminants in water by its combined effect upon the organic contaminants and its reaction with hydrogen peroxide. Based on the results of the bench-scale AOP testing, PSI reports that the best destruction rates were achieved using an H_2O_2 dosage of 100 mg/L at a pH of 5.0. Overall, the average destruction rate for the total organic component of the ground water as received was determined to be 2.16 min^{-1}.

Based on the data presented by PSI and their conclusions, it is evident that perox-pure™ Process will destroy the volatile organic contaminants found in the Rochester Fire Academy groundwater. However, inorganic compounds, such as the four metals-of-interest (viz., arsenic, iron, magnesium and manganese), will not be destroyed and may inhibit chemical oxidation. Therefore, metals precipitation technologies would operate in conjunction with the perox-pure™ process, if selected as the remedial alternative for groundwater treatment. Due to the absence of detectable PCBs in the collected mini-rate pump test water, the perox-pure™ process could not be evaluated for this parameter. However, AOP is a widely accepted and proven process for PCB destruction.

The bench scale metals testing was conducted to evaluate the performance of sodium hydroxide (NaOH) with and without sodium sulfide (Na_2S) to enhance metals removal from the groundwater using polymer as a coagulant aid. In general, test results indicate that iron and manganese can be effectively precipitated. Arsenic results are inconclusive since the untreated arsenic concentration was near the detection limit. Magnesium concentrations were not reduced from the raw ground water sample and therefore no precipitation was observed. Estimates of the amount of sludge generated as a result of the precipitation process are generally difficult to predict. An estimate of the amount of sludge which would be produced on an assumed flow rate of 15 gpm and the results of "mixed suspension" TSS analyses is 25 pounds per day.

4.0 SITE CONTAMINATION CHARACTERIZATION

The RI Report identified organic and inorganic contamination in the fill, native soil, sediment and ground water at the Rochester Fire Academy Site. Further soil sampling was required to establish the lateral and vertical extent of parameters of concern (viz. PCBs and select metals - arsenic, cadmium, copper, lead, mercury, silver and zinc). The scattered nature of the PCB soil contamination indicates that the contamination was deposited from multiple spill, disposal, and/or burning incidents. Additional soil samples were collected and analyzed for the full list of TCL parameters to confirm RI soil sample results. Results from the confirmatory sampling are consistent with the results from the RI in terms of general magnitude of concentrations and the identity of the compounds detected, thus confirming the adequacy of the RI soil data and the resulting data conclusions. Two additional background soil samples were collected and analyzed for the select metals. Including the confirmatory soil samples, a total of 84 soil samples were collected and analyzed. Plate 1 illustrates all soil sampling locations. The results for each area of the Fire Academy site are summarized as follows:

North Disposal Area - The data from the RI show that substantial concentrations of PCBs and metals occur within the fill material. Inorganic metals concentrations in the native soil outside the limits of the fill and below the areas of fill were detected within or slightly above levels for naturally occurring soil (Shacklette and Boerngen, 1984). Low levels of PCBs (greater than 1 mg/kg total Aroclors) occur in surficial soil along a seasonal drainage area.

Training Grounds Area - The Training Grounds Area was compartmentalized into three areas based upon current and historic use and areal photographs of the site. Samples were composited from subareas at six inch depth intervals to a total depth of two feet beneath the crushed stone in each area. A total of 112 grab samples were collected and 31 composite samples were submitted for analysis. PCBs were detected in 30 of the 31 composite samples. Concentrations of PCBs ranging from 3 to 85 mg/kg of total Aroclors were detected in composite samples from Area 1 (northern portion of the training grounds). Concentrations of PCBs in Area 2 (southern and eastern portion of the training grounds) are generally low (less than 1 mg/kg). Elevated levels of PCBs (up to 42 mg/kg) were detected within Subarea 2 of Area 3 (eastern portion of the training grounds area). Cadmium, copper and lead are present at concentrations substantially exceeding the common range occurring naturally in soil in the upper 12 inches of the soil/fill in Area 1. The concentrations of metals detected below 12-inches in Area 1 and all depths of Area 2 and Area 3 are within the common range of natural soil.

South Disposal Area - Substantial concentrations of organic and inorganic contaminants were identified in the incineration residue material during the RI. Samples were collected from the native soil and re-worked soil/fill outside of the area covered by incineration residue during the Supplemental RI. Samples were also collected from the native soil beneath the incineration residue. The horizontal extent of PCB and metal contamination of soil is limited to the re-worked soil and incineration residue within the fence lines. Only trace levels of PCBs (less than 1 mg/kg) were detected in the surrounding native soil and in the soil within 24 inches below the incineration residue. Metal concentrations detected in undisturbed soil were within the common range for naturally occurring soil (USEPA, April 1983 and Shacklette and Boerngen, 1984). A tarry residue observed within the incineration residue was analyzed for full TCL parameters. Analysis indicates that the material contains 44,000 mg/kg (4.4 %) Aroclor 1254, two pesticides, four polycyclic aromatic hydrocarbons, four phthalate esters, and lesser concentrations of phenol and di-nitroso-diphenylamine. A photoionization detector (PID) was used to quantitatively measure soil gas in excavated areas within the disposal area. Elevated PID readings indicate the local presence of volatile organic compounds within these depressed areas.

Genesee Valley Park Area - Surficial soil samples were collected from nine locations during the Supplemental RI. Including these collected during the RI, a total of 24 samples have been collected and analyzed from this area. Trace concentrations of PCBs (less than 1 mg/kg) were detected in 12 of 24 sampling locations. Elevated concentrations of PCBs (up to 14 mg/kg) and cadmium were detected in the southern portion of the Genesee Valley Park Area (generally opposite the South Disposal Area) and only near the bike path.

Police Obstacle Course/Firing Range Area - Four surficial soil samples were collected during the Supplemental RI to establish the extent of contamination in this Area. Based on data from both the RI and the Supplemental RI and a composite sample collected for the NYSDOH, this area exhibits only trace levels of PCBs (less than 1 mg/kg). Inorganic compounds are generally within the range of concentrations commonly detected in naturally occurring soil.

5.0 CONTAMINANT MIGRATION

Potential migration pathways identified include:

- overland runoff and mechanical transport of contaminated soil/fill material;
- continuous release of soluble constituents of low density free product in the area of MW-14S to ground water within the shallow overburden;
- migration of solubilized contaminants in the soil/fill into ground water due to infiltration of precipitation and/or contact with ground water; and
- lateral movement of contaminated ground water through the shallow overburden, with ultimate discharge to the Genesee River.

Mechanical transport of contaminated soil or fill particles by overland flow is expected to be minor due to the relatively flat topographic relief of the site. This expectation is further supported by the site water balance which indicates that surface runoff is only approximately 1% of the water leaving the South Disposal Area and the Training Grounds Area, and approximately 6% at the North Disposal Area.

The local extent of free-phase product was substantiated during the IRM field investigation (February 1992). No free product was observed in any of the well points installed within 20 feet of MW-14S. With the exception of an elevated soil gas vapor reading associated with discolored surface soil, all elevated readings were restricted to an area within 20 feet of MW-14S. The ground water flow velocity in this area was estimated to be less than 0.5 feet per year (Malcolm Pirnie, February 1992). Therefore, the free-phase product appears to be localized near MW-14S and the route of the fuel line. Extensive migration of the product is not predicted.

The major pathway of contaminant migration from the Rochester Fire Academy site is ground water flow from the overburden and bedrock water-bearing zone to the Genesee River. The primary contaminants migrating to the River from the site are volatile organics with a total loading of 77 Kg/yr, and total iron and manganese with a total loading of 278 Kg/yr. Based on the revised ground water discharge volume, the estimated total volatile organic contaminant load from the overburden water-bearing zone in the South Disposal Area to the Genesee River is approximately 37 Kg/yr.

6.0 PUBLIC HEALTH RISK ASSESSMENT

An assessment of potential health risks of site contaminants to those using the Rochester Fire Academy facility and those in the surrounding area was performed. The assessment addresses the consequences of "reasonable maximum exposure" to site contaminants. For this reason, the contaminant concentrations selected for the evaluation of exposure are either the 95th percent upper confidence limit on the mean, or the maximum concentration detected. This approach is conservative since, in some instances, these maximum values may be detected in subsurface soils or at a discrete location where exposure is highly unlikely. This type of an approach is consistent with that recommended by the USEPA.

The public health risk assessment is comprised of the identification of hazards, assessment of exposure, toxicity assessment and characterization of risk. City employees, site users, trespassers, bicycle path users, swimmers in the Genesee River and the general public were considered to be the potentially exposed population. Residences were excluded since there are no drinking water sources immediately downgradient of the site.

Approximately 40% and 20% of the samples respectively collected form the fill in the North and South Disposal Areas exceed the lower interim cleanup criteria for lead of 500 mg/kg recommended by the USEPA. Fewer than 10% of the samples collected from the Training Grounds Area and the Genesee Park Area exceeded this cleanup criteria for lead.

The cancer risk analysis indicates that PCBs and arsenic in soils are the main contributors to risk at the North and South Disposal Areas and PCBs and PAHs in the Training Grounds Area. The arsenic and iron concentrations of the Genesee River adjacent to the site, as well as upstream of the site, exceeded the criteria for human health. However, given the character of the upstream water quality, it appears unlikely that these exceedances are attributable to the Rochester Fire Academy site. Given the highly conservative nature of the exposure scenarios, no imminent threat to site users, nor to residents in the vicinity of the site, presently exists.

7.0 ENVIRONMENTAL RISK ASSESSMENT

An ecological risk assessment was performed to evaluate baseline risks, currently and in the future, in the absence of actions to control or mitigate site contamination; and to assist in determining the need for and the extent of, remediation. The baseline environmental conditions were assessed during a site visit to observe dominant vegetation and identify wildlife species. The assessment included an identification of the contaminants of concern and an evaluation of risk based on their potential effects on vegetation and wildlife inhabiting the site and its vicinity.

The ecological risk assessment concluded that, although the presence of four inorganic compounds, cadmium, iron, lead and zinc may be due, in part, from contamination at the site; the risk to wildlife from exposure to these compounds in the Genesee River is considered low. The risk to wildlife utilizing contaminated areas on-site appears to be somewhat higher, since the highest levels of contaminants detected were generally found on-site. Organisms lower on the food chain which utilize these areas can potentially pass contaminants up through the food chain, and game species such as mallards may pass contaminants to humans as well.

1.0 INTRODUCTION

1.1 SITE LOCATION AND DESCRIPTION

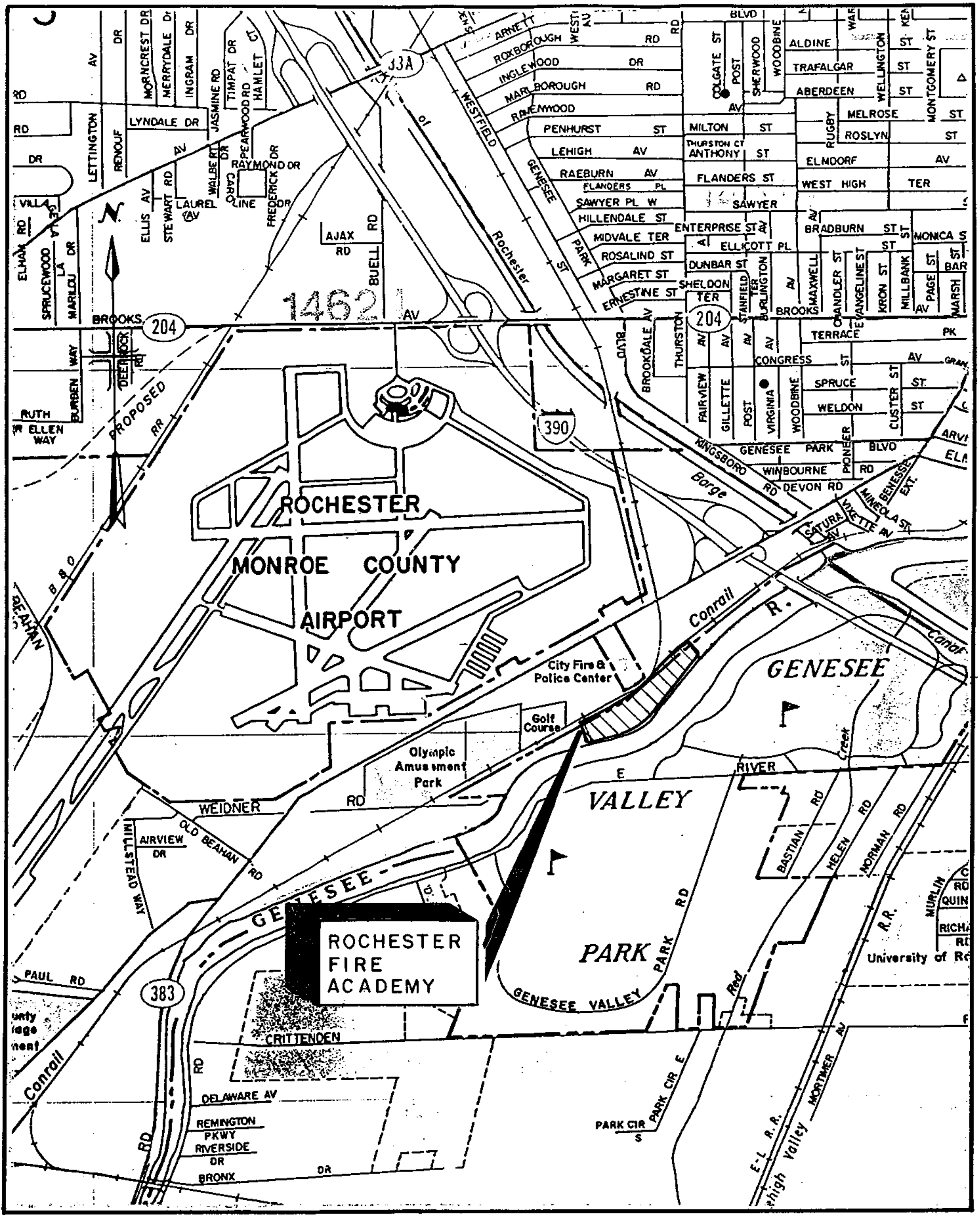
The Rochester Fire Academy site is a 21-acre tract of land used as a training facility by the City of Rochester Fire and Police Departments. This site is located on the west bank of the Genesee River at 1190 Scottsville Road in the City of Rochester, Monroe County, New York (Figure 1-1).

The site is bordered to the northwest by the former Genesee Valley Canal and the former Consolidated Railroad (ConRail) right-of-way (Figure 1-2). A 75- to 125-foot wide portion of the City of Rochester's Genesee Valley Park is located between the river bank and the southeastern edge of the Fire Academy site. The park is traversed by a paved bicycle path and encompasses a narrow New York State Department of Environmental Conservation (NYSDEC) designated wetland between the bicycle path and the west bank of the Genesee River. The City of Rochester has erected a 7-foot high chain-link fence around the perimeter of the site, including the portion of the Genesee Valley Park adjacent to the site, except where the Park borders the Genesee River. Consequently, the portion of the bicycle path located adjacent to the site is not presently accessible to the public.

The Fire Academy site consists of four distinct areas, three of which have been involved with chemical use and disposal (Figure 1-2). These three areas of concern are the North Disposal Area, the Training Grounds Area, and the South Disposal Area, which are 2.5, 5.4 and 0.8 acres in size, respectively. The remaining area, the Police Obstacle Course and Firing Range, and two adjacent off-site areas included in the Remedial Investigation study area, the Genesee Valley Park Area and the Genesee Valley Canal Area, are not believed to have received any potentially hazardous wastes.

The North Disposal area is generally flat and overgrown with small trees and underbrush. This area has approximately 1.4 acres of fill which was utilized for construction and demolition (C&D) debris disposal. Fill limits are depicted on Plate 1. Drums placed in this area were apparently crushed and buried using heavy construction equipment. A discontinuous layer of coarse-textured soil, foundry sand, refractory bricks, and miscellaneous debris covers the C&D materials. Drum fragments are visible at the face of the berm along the north-northwest edge of the fill area.

FIGURE 1-1



ROCHESTER FIRE ACADEMY
SUPPLEMENTAL RI
SITE LOCATION MAP

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ROC-07

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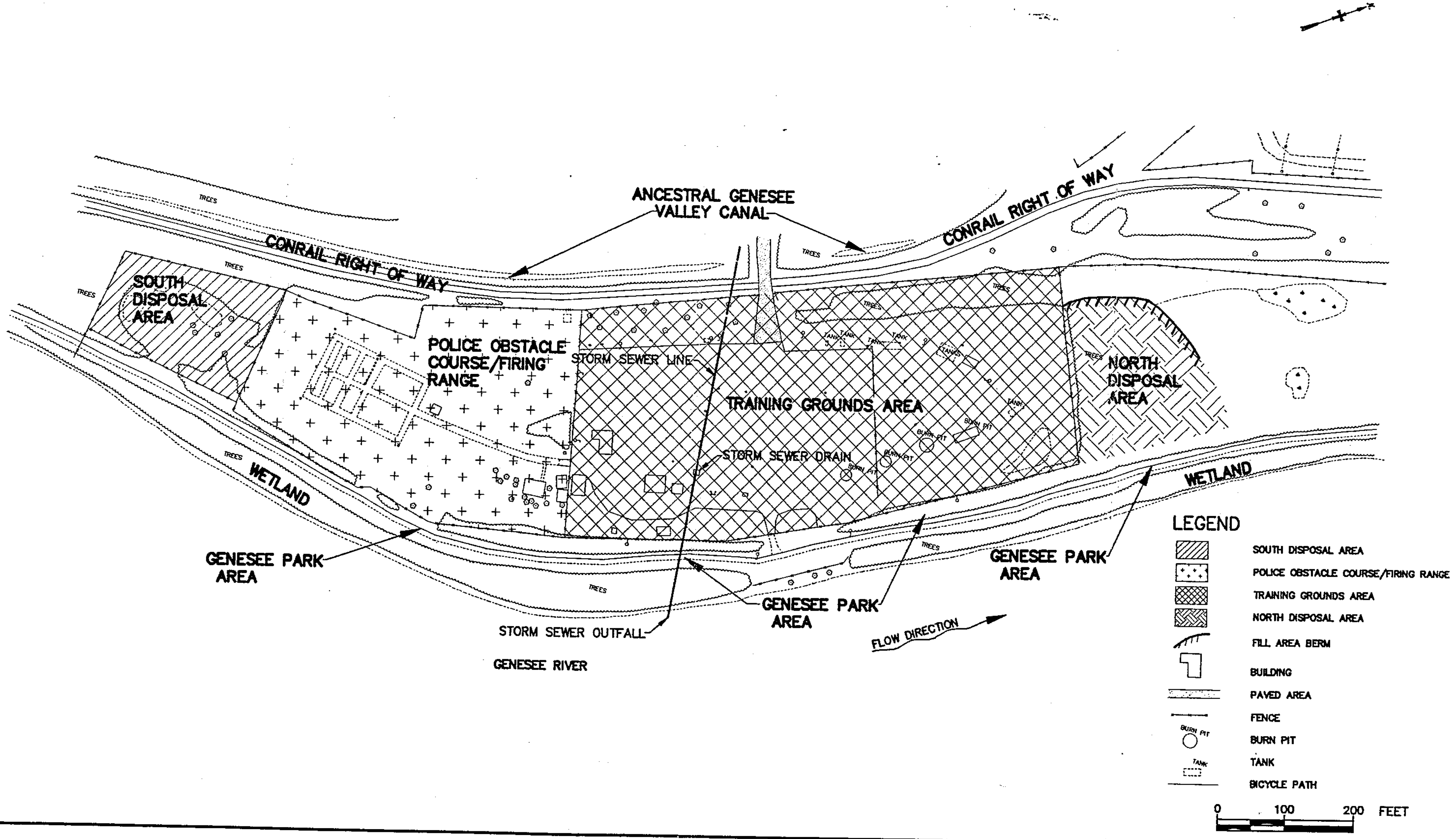
FIGURE 1–2



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SUPPLEMENTAL REMEDIAL INVESTIGATIONS

SPECIFIC AREAS AT ACADEMY SITE

CITY OF ROCHESTER

MARCH 1991

The Training Grounds Area encompasses approximately six (6) acres. A large portion of the Area has been used for fire fighting training exercises involving the controlled burning of a variety of fuel oils. The north end of the Area is occupied by fuel oil storage tanks, and burn pits. The burn pits were supplied with fuel from the storage tanks via an underground fuel transmission line. This practice has been abandoned. Water used in training exercises drains seasonally to a small surface runoff pond shown on Plate 1. Based on historic aerial photography, past practices allowed water to drain out of the Training Grounds past the vicinity of MW-15S to the Genesee River. The central portion of the Area is open and unoccupied. The southern portion of the Area is occupied by structures used for burning during fire training exercises. Approximately three inches of crushed #2 stone overlies a very dense, silty gravel-fill in the Training Grounds Area. Underlying the silty gravel-fill is native clayey silt or native silty sand. Beneath the crushed stone, the 1990 RI identified sporadic organic and inorganic contamination of the fill material.

The South Disposal Area is located in the southwest corner of the site. Drummed and uncontained wastes were disposed of in this area. Approximately 0.6 acres of the South Disposal Area were formerly used for the open air incineration of waste materials, which generated waste incineration residue (cinders, ash, and incombustible waste such as glass, nails, springs, and wire). The incineration residue is approximately 1 to 3 feet thick and covers an irregular area approximately 120 feet in length by 120 feet in width. The lateral extent of the incineration residue is illustrated on Plate 1. Reworked soil material, which was previously excavated from within the South Disposal Area, has been placed in piles around the incineration residue. The extent of the reworked soil is also depicted on Plate 1. A number of drums were previously removed from this area resulting in several depressions which have since filled with water.

1.2 SITE HISTORY

The Rochester Fire Academy has been owned and operated by the City of Rochester as a training facility used by the City's Fire and Police Departments since its inception in 1954. Prior to 1954, the area was undeveloped park land. During the period from approximately 1954 through 1980, the Fire Academy accepted flammable liquids from local industries and other sources for training activities. No records were kept on materials accepted by the Fire Department for burning practices. On-site personnel indicated that solvents, paint thinners and other organic chemicals in addition to metallic residue sludge-like materials were burned and/or disposed of at the Training Grounds and North and South Disposal Areas.

Aerial photographs taken during the period from 1961 to 1970 indicate that disposal activities had occurred in the North and South Disposal Areas. By 1976, other aerial photographs indicate that waste disposal activities in the Northern Disposal Area had ceased, although the Southern Disposal Area remained "disturbed". The New York State Department of Environmental Conservation (NYSDEC) began investigating the facility's disposal practices in 1980 and subsequently directed the removal of over 200 drums and numerous chemical reagent bottles from the surface of the three areas of concern. Late in 1981, Empire Soils Investigations of Buffalo, New York was retained by the City of Rochester to perform a soil sampling and analysis program. Inorganic and organic constituents were detected in soil samples collected from the Training Grounds Area. During 1982, the City of Rochester applied to the NYSDEC for a hazardous waste treatment, storage and disposal permit, but the application was rejected and the Fire Training Academy ceased the practice of using industrial wastes for training purposes. Subsequently, the Fire Academy Site was placed on the NYSDEC's Registry of Inactive Hazardous Waste Disposal Sites (Site No. 828015).

Based on the results of Phase I (Recra Research, Inc. 1983) and Phase II (Recra Research, Inc. 1985) State Superfund preliminary site assessments, the NYSDEC assigned the site a "Class 2" designation (i.e., posing a significant threat to human health or the environment) in late 1986 and directed the City of Rochester to remediate the site. The City of Rochester contracted Malcolm Pirnie, Inc. to perform a Remedial Investigation/ Feasibility Study (RI/FS) to determine the nature and extent of hazardous waste contamination at the site, evaluate potential risks, and identify feasible alternatives for site remediation. During the period of November 1989 through August 1990, Malcolm Pirnie conducted the remedial investigation field activities required by the RI scope of work.

The findings of the Remedial Investigation (hereafter termed the RI) were presented in a report entitled **Remedial Investigation Report for the Rochester Fire Academy Site,** dated May 1991. The RI report identified organic and inorganic contamination in on-site fill material; both on-site and off-site native soil; and ground water beneath the South

Disposal Area. In order to better define the lateral and vertical extent of soil contamination for the purpose of evaluating remedial alternatives for the site it was determined that further sampling and analysis would be required. In addition, pump test data were necessary to better establish the hydraulic characteristics of the aquifer for the purpose of evaluating ground water collection methods and to provide ground water for treatability evaluation.

1.3 PURPOSE AND SCOPE OF STUDY

Malcolm Pirnie conducted Supplemental RI field investigations during the period October 1991 to November 1991. The purpose of this document is to present the findings of the supplemental investigations. The objectives of the Supplemental RI were established by the City of Rochester and Malcolm Pirnie with recommendations and approval by the NYSDEC. These objectives were as follows:

- determine the extent of PCB and inorganic contamination in on-site soil/fill and in the Genesee Valley Park;
- define the hydraulic characteristics of the aquifer;
- determine the treatability of the ground water (for evaluation of ground water remedial alternatives);
- re-evaluate the health risk assessment based on the updated and expanded analytical data base;
- further assess the potential environmental risk associated with site contaminants; and
- confirm/verify RI soil sampling results.

The results of the RI and this Supplemental RI will be used to identify feasible alternatives for site remediation through a feasibility study of the site.

The scope of the Supplemental RI was identified in the Supplemental Remedial Investigation Work Plan, dated October 1991. This Work Plan identifies all field activities and methodology, including sample collection procedures, analytical protocol, and quality control procedures that were employed to perform the investigation.

During the course of the field investigative activities, a number of modifications to the scope of work and/or investigative procedures were recommended on the basis of new information discovered and/or mitigating circumstances encountered in the field. All such modifications were implemented after mutual agreement by Malcolm Pirnie, NYSDEC and City of Rochester. Documentation for all modifications is presented in Appendix A.

Collectively, the Work Plan and the documents presented in Appendix A define the specific methodology that was employed to generate the data presented in this document. This methodology will only be referenced and/or summarized in the text of this document as appropriate for interpretation of results and findings. The reader is referred to the Work Plan (Malcolm Pirnie, October 1991 and Appendix A for a detailed presentation of the specific investigative procedures and methods employed.

2.0 GEOLOGY/HYDROGEOLOGY OF SOUTH DISPOSAL AREA

2.1 SUMMARY OF SITE GEOLOGY/HYDROGEOLOGY

The general regional geologic and hydrogeologic conditions are described in the Remedial Investigation Report (May 1991) and are detailed in the work by Leverett (1902), Fairchild (1932a, 1932b), MacClintock and Apfel (1944), Muller (1965, 1967) and Muller et. al, 1988). A brief summary of the site geologic/hydrogeologic conditions is provided herein for completeness. Further information concerning the geologic and hydrogeologic conditions in the South Disposal Area was collected as part of the Supplemental Remedial Investigation and is discussed in detail in Section 2.3.

Geology

The site geologic and hydrogeologic conditions are described using data collected during the Remedial Investigation (RI) and the Supplemental RI field activities. The different materials encountered in stratigraphic order on-site include: surficial fill material; alluvium and dolostone bedrock.

The composition of the fill material observed on-site is area specific. In the North Disposal Area, the fill is composed of sand and silt with construction and demolition (C&D) debris and foundry sand that directly overlies native alluvial soil. The fill thickness in this area generally averages about four (4) feet. The fill in the Training Grounds Area is a silty fine to medium sand and gravel up to two (2) feet in thickness, and covers the entire Training Grounds Area. This fill material overlies native alluvial soil. A variety of fill material mantles the native alluvial soil in the South Disposal Area. These different types of fill will be described in further detail in Section 2.3.1.

Alluvium, attributed to depositional activities of the Genesee River, was encountered across the entire site. The depositional materials are bedded and have been subdivided into distinct units according to grain size and color. Grain sizes range from coarse gravel to clay size particles. The total thickness of these deposits ranges from about 19 to 38 feet.

The bedrock underlying the alluvial deposits across the entire site is a hard, gray dolostone of the Lockport Group. Fractures and solution voids are common in the upper 10 feet of this unit. The frequency of fractures was observed to decrease with depth.

Hydrogeology

Hydrostratigraphic units are sequences of geologic materials that possess similar hydrogeologic properties including hydraulic conductivity, storage and porosity. The hydrostratigraphy of the site, as derived from an assessment of hydraulic properties of the geologic units, is divided into two major units:

- an unconfined, overburden water-bearing zone consisting of fill material and alluvial clay, silt, sand and gravel; and
- a bedrock aquifer.

Since a confining unit is not present or of sufficient areal extent between these hydrostratigraphic units, some hydraulic communication between the two zones is expected. The degree of communication between the zones is a function of the contrasting hydraulic conductivities between the lower overburden and the upper bedrock. This relationship is discussed in greater detail in Section 2.4.

The overburden water-bearing zone at the Fire Academy site occurs within some areas of the fill material and alluvial deposits and generally occurs under unconfined (water table) conditions. The depth to this zone fluctuates seasonally from about 2.1 feet to nearly 5.0 feet below ground surface. Overburden ground water at the site generally discharges to the east toward the Genesee River with flow occurring in the direction of decreasing hydraulic head. The average hydraulic conductivity of this unit is $5 \text{ X } 10^{-4}$ cm/s (10.6 gpd/sq ft). However, in the western portion of the site (away from the River), a nearly six-fold greater permeability value was determined for a brown sand and gravel unit directly overlying bedrock. Recharge to this zone occurs principally through the infiltration of precipitation. The bedrock present beneath the site is water-bearing. Bedding-plane fractures, vertical fractures and solution voids are the principal water-bearing openings within the dolostone bedrock. The general direction of ground water flow in the upper portion of the bedrock aquifer is to the east-northeast toward the Genesee River. The hydraulic conductivity in the upper 10 feet of this zone is $2.1 \text{ X } 10^{-2}$ cm/s (445.2 gpd/sq ft). Recharge to the bedrock aquifer is principally through downward leakance from the overburden water-bearing zone as demonstrated by the downward hydraulic gradient in monitoring wells located west of the site. Hydraulic gradients in monitoring wells located near the eastern site boundary are upward, indicating bedrock aquifer discharge to the Genesee River (see Section 2.3.2).

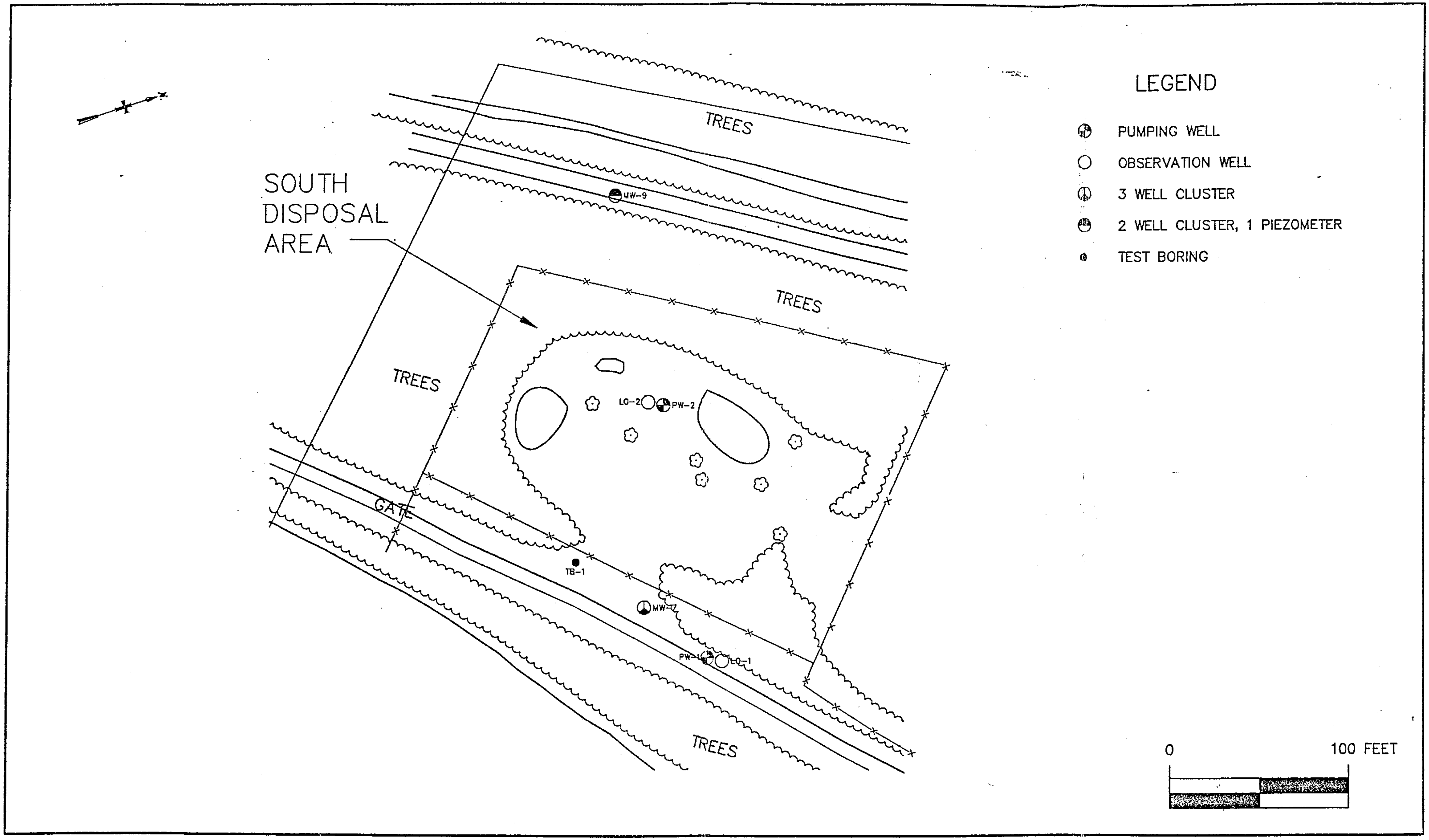
2.2 INVESTIGATIVE METHODOLOGY FOR THE SOUTH DISPOSAL AREA

Better definition of the geologic and hydrogeologic characteristics of the overburden water-bearing zone was required, as well as the treatability of the ground water to adequately evaluate ground water collection and treatment remedial alternatives. As originally proposed in the Supplemental RI Work Plan, a pumping well was to be installed in the vicinity of the South Disposal Area to satisfy these data requirements. Several observation wells and well points were to be installed and a 72-hour constant rate pump test was to be conducted to estimate the hydraulic parameters of the overburden water-bearing zone, examine the effects of pumping in the overburden on the bedrock aquifer, estimate the proportion of flow from the river during ground water withdrawal and supply ground water for treatability studies. However, based upon the geologic conditions encountered during borehole drilling, substantial modification was required to the scope of work defined in the Work Plan. This change in scope was documented in a letter dated November 6, 1991 from the City of Rochester to the NYSDEC (see Appendix A). The following sections describe the methodology used and the results of the field investigative program in the South Disposal Area.

2.2.1 Borehole/Well Installations

In accordance with the Supplemental RI Work Plan, a pilot hole was drilled using 4-1/4 inch hollow stem augers and the borehole was continuously sampled using split-spoon samplers to the top of bedrock in the vicinity of the South Disposal Area (see location LO-1 in Figure 2-1). Split-spoon samples were logged, placed in one quart sample jars and submitted for grain size analysis. Sample descriptions (boring logs) are presented in Appendix B.1. Grain size analytical results are presented in Appendix B.2 and summarized in Table 2-1. The borehole was sampled to a total depth of 30 feet (top of bedrock). All split-spoon samples were submitted for sieve size analysis. As described in the borehole logs, the density of the overburden increased at a depth of approximately 20 feet below grade. Based on the density of the soil matrix, grain size and moisture content of the split-

FIGURE 2-1



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ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION

WELL AND BORING LOCATIONS

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spoon samples and the fact that only 1 foot of ground water was present in the augers upon borehole completion, it appeared that a fully penetrating pumping well installed at that location would not provide a sufficient yield to conduct a pump test as defined in the Supplemental RI Work Plan. Therefore, a two-inch diameter SCH-40 PVC piezometer was installed with a 10-foot screen (designated LO-1) at that location. The piezometer was installed in accordance with monitoring well installation procedures described in the RI Work Plan. The well construction diagram is presented in Appendix B.3. The piezometer screened the lower overburden material directly above the bedrock from 29.7 to 19.7 feet below grade and provides hydraulic information of the lower water-bearing zone.

A second pilot hole (TB-1) was drilled and continuously sampled about 80 feet south of the initial pilot hole (LO-1) to determine the geologic conditions in this area. The borehole encountered similar geologic conditions as were encountered in the initial pilot borehole with bedrock contacted at nearly 30 feet below grade. Sample descriptions (boring logs) are presented in Appendix B.1. Following borehole completion, the NYSDEC field representative and the City of Rochester were consulted and the borehole was abandoned. A cement/bentonite grout was tremied from the bottom of the borehole to ground surface to prevent downhole migration of contamination.

A third pilot hole (LO-2) was drilled and continuously sampled about mid-way between well clusters MW-7 and MW-9 within the South Disposal Area (see Figure 2-1) to determine the geologic conditions in this area. The sand and gravel alluvial deposits overlying the bedrock about 100 feet west of this location were much more permeable than the alluvial deposits closer to the river (demonstrated by slug test results from PZ-9). The pilot hole was anticipated to encounter these more permeable deposits. However, the borehole encountered similar geologic conditions to the two previous boreholes with minor interfingering of a brown stratified sand and gravel deposit. Sample descriptions (boring logs) are presented in Appendix B.1. The borehole was sampled to a total depth of 32.0 feet (top of bedrock). Similar to the first two pilot holes, the density of the overburden increased at a depth of approximately 22 feet below grade and it appeared that a fully penetrating pumping well installed at that location would not provide a sufficient yield for long-term pumping. Therefore, a two-inch diameter SCH-40 PVC piezometer was installed with a 10-foot screen (designated LO-2) at that location. The piezometer was installed in accordance with monitoring well installation procedures described in the RI Work Plan;

TABLE 2-1

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GRAIN SIZE ANALYSIS RESULTS FOR PW-1

Internal Sample (ft)	% Gravel	% Sand	% Fines (silt & clay)	D_{50}	Sample Description
0-2	11	15	74	<0.2 mm	brown clayey SILT, some fine sand, trace gravel
2-4	0	17	83	<0.1 mm	gray-brown clayey SILT, little fine sand
4-6	20	21	59	<0.1 mm	gray-brown SILT, some fine sand, little gravel
6-8	21	37	42	0.15 mm	brown
8-10	No Recovery				
10-12	26	35	39	0.15 mm	brown, clayey SILT, some fine sand, little gravel
12-14	25	35	40	0.15 mm	gray-brown clayey SILT, some fine sand, some f-m gravel
14-16	27	36	37	0.2 mm	gray clayey SILT, and fine-medium SAND, some gravel
16-18	26	39	35	0.25 mm	gray-brown fine-medium SAND and clayey SILT, some gravel
18-20	17	37	46	0.1 mm	gray clayey SILT and fine-medium SAND, little gravel
20-22	20	42	38	0.15 mm	gray fine-medium SAND and clayey SILT, little gravel
22-24	24	40	36	0.2 mm	brown fine-medium SAND and clayey SILT, some gravel
24-26	10	47	43	0.11 mm	brown fine-medium SAND and clayey SILT, little gravel
26.5-28	24	39	37	0.19 mm	gray-brown fine-medium SAND and clayey SILT, some gravel
28-30	30	35	35	0.3 mm	gray-brown fine-medium SAND, some clayey SILT, some gravel

however, the well was damaged during the installation of an adjacent pumping well and required replacement (described later in this section). The well was re-installed utilizing a five-foot screen after several attempts to install a ten foot screen directly above the top of rock failed due to borehole collapse during well installation. The final placement of the piezometer screened the denser lower overburden material from 28.5 to 23.5 feet below grade. The well construction diagram is presented in Appendix B.3.

Hydraulic information regarding the lower overburden water-bearing zone was acquired through slug testing of these wells. Additional hydraulic information regarding the upper saturated portion of the overburden water-bearing zone was required. After consultation with the City of Rochester and the NYSDEC, two shallow pumping wells were installed adjacent to the newly installed piezometers, LO-1 and LO-2 and "mini-rate" pump tests were conducted to determine the hydraulic conductivity in the vicinity of each well (details described in Section 2.2.3). Additionally, a "mini-rate" pump test was attempted in MW-7S to compare hydraulic conductivity results derived from this method of testing to previous slug test results.

Pump Well Installation

A pumping well was installed adjacent to each piezometer (designated as PW-1 and PW-2) to determine the hydraulic characteristics of the overburden water-bearing zone (see Figure 2-1). Boreholes were drilled adjacent to piezometers LO-1 and LO-2 with 6-1/4 inch hollow stem augers to the denser gray-brown sand and gravel deposits at respective depths of 20 and 22 feet below grade. A 4-inch diameter SCH-40 PVC well with a 10-foot section of screen was installed. The screen used is a continuous slot VEE-Wire type. This type of screen has a greater open area than conventional well screens and provides better flow from the formation to the well, thereby increasing the well efficiency during pumping. Well construction details for pumping wells PW-1 and PW-2 are presented in Appendix B.3. After installation of the pumping wells, a single well point was installed 8 and 9 feet, respectively from PW-1 and PW-2 (see Figure 2-1). Well points were outfitted with 3-foot screens and were installed in a borehole drilled to a depth of 10-feet with 4-1/4 inch augers. The boreholes were backfilled with native soil and bentonite pellets were packed around the riser at the ground surface to prevent surface infiltration. These well points would later provide water level information in the vicinity of the pumping wells during pump testing.

2.2.2 Pumping Well/Observation Well Development

Pumping and observation wells were developed using an electric centrifugal pump in conjunction with a PVC bailer. The bailer was used to surge the well and remove sediment precipitated on the bottom of the well. The intake position of the influent line to the pump was placed at several different levels within each of the well screens during ground water withdrawal. All water removed during development was discharged to a 1,000 gallon tank located within the fenced-in area of the South Disposal Area. Development continued in each well until 10 well volumes were removed and little change in the clarity of the water was observed or a turbidity value of less than 50 was achieved. Well development data sheets are presented in Appendix B.4.

2.2.3 "Mini-Rate" Pump Tests

"Mini-rate" pumping tests in conjunction with recovery data have been demonstrated to provide more reliable transmissivity estimates in relatively low permeability sediments than slug test data (Strausberg, 1982). Testing procedures are detailed in Appendix B.5. Concurrent "mini-rate" pumping tests were performed in wells PW-1 and PW-2 to determine hydraulic conductivity values of the less dense sand and gravel deposits in the upper portion of the alluvial sediments in the South Disposal Area and to provide ground water for treatability studies.

The pumping duration for each well was six hours and several hours of recovery data were subsequently collected. Drawdown was observed in the well points (located nearly 10 feet from the pumping well) within the first thirty minutes of pumping demonstrating a minimum area of influence of about 10 feet. Following testing of PW-1 and PW-2, a six-hour test was performed and recovery data collected in well MW-7S to compare hydraulic conductivity results derived from this method of testing to previous slug test results.

Electric centrifugal pumps powered by a portable generator were used to withdraw water from the wells during testing. An in-line ball valve installed on each 5/8-inch PVC discharge line was used to regulate the flow rate from each pump. Step testing, subsequent to well development, determined that the maximum inflow rate to each well was 0.25, 0.5 and 0.25 gpm for wells PW-1, PW-2 and MW-7S, respectively. Flow rates were measured during testing using a graduated 1 gallon measuring bucket and a stop watch. During the testing of PW-1 and PW-2, the constant rate, which was determined by the step test, was maintained for a period of six hours with about a 10% error in flow. The flow rate from MW-7S during testing varied considerably due to the relatively small casing volume in comparison to the four-inch diameter pumping wells. Flow in MW-7S was later adjusted during testing to maintain a constant head in the well and water level data during recovery was later analyzed. Water discharged during testing was routed to a 1,000 gallon holding tank until clear water was discharged from each pumping well and all leaks in the intake and discharge assembly were sealed. Discharge from the final three hours of pumping from PW-1 and PW-2 was routed to a 200 gallon HDPE tank with a floatable cover. Water from this tank was sampled for characterization and treatability testing upon the termination of pumping. Water level data was recorded in the pumping wells, the observation wells and MW-7S using transducer/data loggers. Water levels in the two well points were recorded manually using electronic water level indicators. Water level data recorded during "mini-rate" testing is presented in Appendix B.5.

The pump test data was analyzed using the methodology described by Strausberg and is the Jacob Straight-Line Method but accounts for de-watering effects of the unconfined aquifer. These analysis are presented in Appendix B.5. The reduced casing storage capacity of the smaller diameter well MW-7S caused inconsistent flow rates during testing and precluded an evaluation of the drawdown data; however, the recovery data collected was suitable for analysis. Resulting hydraulic conductivity values are summarized in Table 2-2.

During ground water withdrawal from the pumping wells PW-1 and PW-2, 1.1 and 3.8 feet of drawdown was observed in lower observation wells LO-1 and LO-2, respectively. This hydraulic response in the lower portion of the overburden water-bearing zone demonstrates good hydraulic communication between the upper and lower portions of the overburden aquifer. Approximately 1.2 and 1.5 feet of drawdown in wellpoints WP-1 and WP-2, respectively after six hours of pumping, indicates fairly rapid depletion of ground water held in storage in the upper portion of the overburden water-bearing zone.

2.2.4 Slug Testing

In-situ hydraulic conductivity testing was conducted in the two observation wells LO-1 and LO-2. Stainless steel slugs, five feet in length, were used to displace water in the wells. A pressure transducer/data logger was used to record testing data. Data was

TABLE 2-2

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SUMMARY OF HYDRAULIC CONDUCTIVITIES IN THE SOUTH DISPOSAL AREA

Well Number	Screened Interval (ft)	Mini-Rate Pump Test[1,2] (gpd/sq ft)	Slug Test (gpd/sq ft)
PW-1	10 - 20	2.2	-
PW-2	12 - 22	2.9	-
MW-7S	5 - 15	11	2.6
LO-1	20 - 30	-	9.5
LO-2	23.5 - 28.5	-	1.9
PZ-9	33 - 38	-	67.8

	Drawdown (gpd/ft^2)	Recovery (gpd/ft^2)	Average (gpd/ft^2)
PW-1	1.8	2.6	2.2
PW-2	3.4	2.3	2.9

NOTES:
(1) Flow rates for PW-1, PW-2 and MW-7S are 0.25, 0.5 and 0.25 gpm, respectively.
(2) Values for PW-1 and PW-2 represent an average value for drawdown and recovery data.

Conversion to cm/s: 1 cm/s = 21,200 gpd/sq ft.

downloaded from the data logger and analyzed using commercially available software employing the methods of Bouwer and Rice (1976). Testing results are presented in Appendix B.6. The resulting hydraulic conductivity values are similar to values determined for the upper portion of the overburden water-bearing zone. These values are presented in Table 2-2.

2.3 INVESTIGATIVE RESULTS

2.3.1 Geology of the South Disposal Area

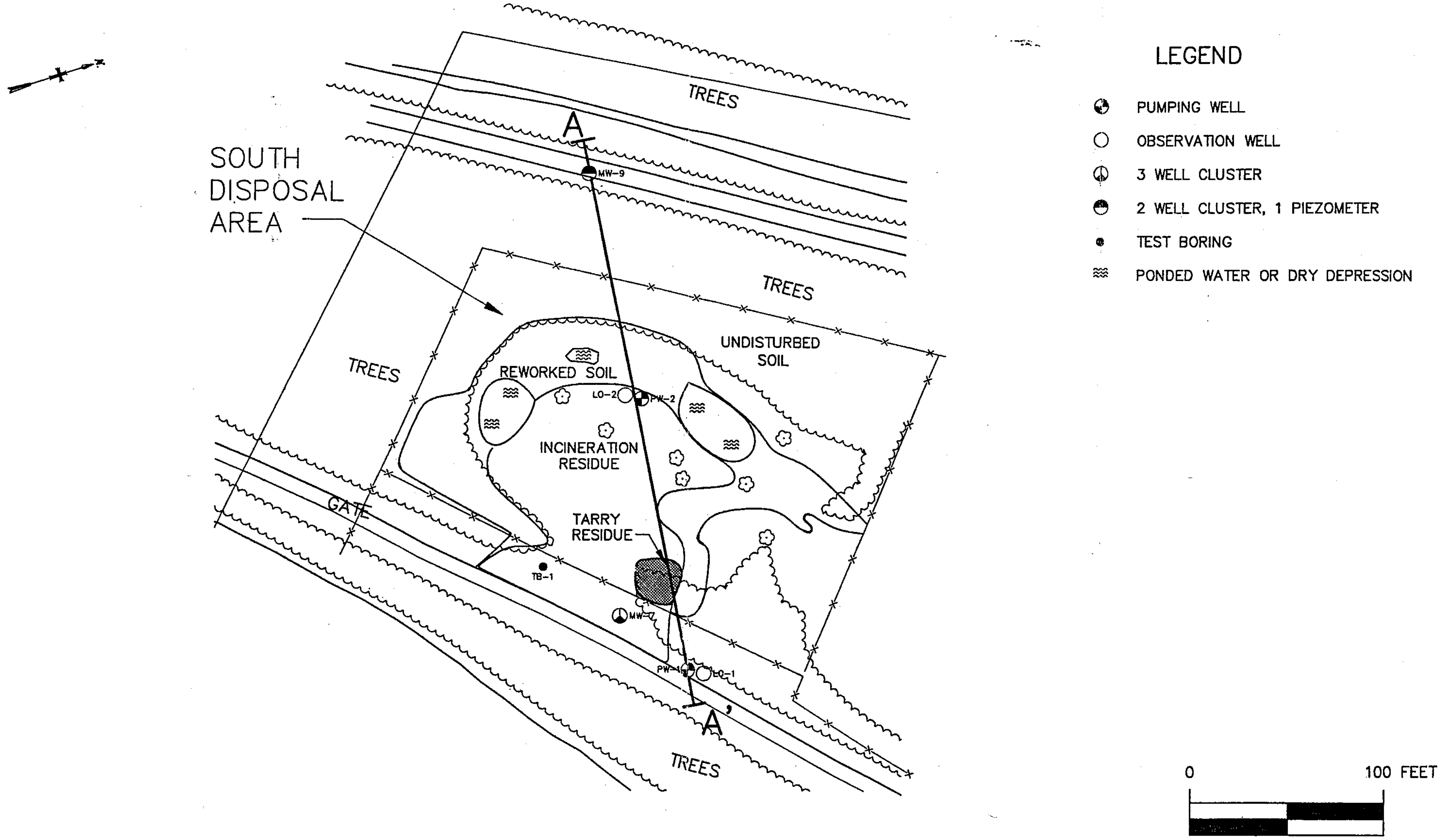
Information provided in the May 1991 report regarding the geologic conditions in the South Disposal is supplemented with data collected during this field investigation. Details concerning the conditions of the fill and alluvial deposits are provided below.

Fill

Several different fill types were observed in the South Disposal. Fill material generated from prior burning activities is located generally in the central portion of the South Disposal Area. The fill ranges in thickness from about three feet in the vicinity of the small pond to about six-inches near the gate to the disposal area and around the periphery of the fill. This fill generally overlies native alluvial soil. The bulk of the fill is a black cinder and ash residue material from the open air incineration of various substances. Magnesium metal, bricks, crushed drums and other C&D type material is intermixed with the fill. Samples were collected and analyzed for grain size distribution and percent organic content. These results are presented in Appendix G. A black-blue tar-like residue material was observed overlying re-worked soil near the gate to the South Disposal Area. This residue averaged about four-inches in thickness. Re-worked native soil from previous excavation and landfilling activities directly overlies native alluvial soil across a large portion of the area. This fill consists mainly of clayey silt and incorporates some charred-wood fragments and incineration residue material from previous burning activities. In areas where the soil has been piled, the fill is up to four feet thick. The surficial extent of these fill materials is presented in Figure 2-2.

Alluvial Deposits

Alluvial deposits are present as the native soil surface in this area and extends down to the top of bedrock. These deposits are described in detail in the RI Report. Borehole



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ROC-07-1DB

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SUPPLEMENTAL REMEDIAL INVESTIGATION

EXTENT OF FILL IN SOUTH DISPOSAL AREA

CITY OF ROCHESTER APRIL 1992

drilling and sampling during this Supplemental RI refined the stratigraphic relationships previously defined. These relationships are presented in a cross section line through the South Disposal Area (see Figure 2-2) with the stratigraphic profile displayed in Figure 2-3.

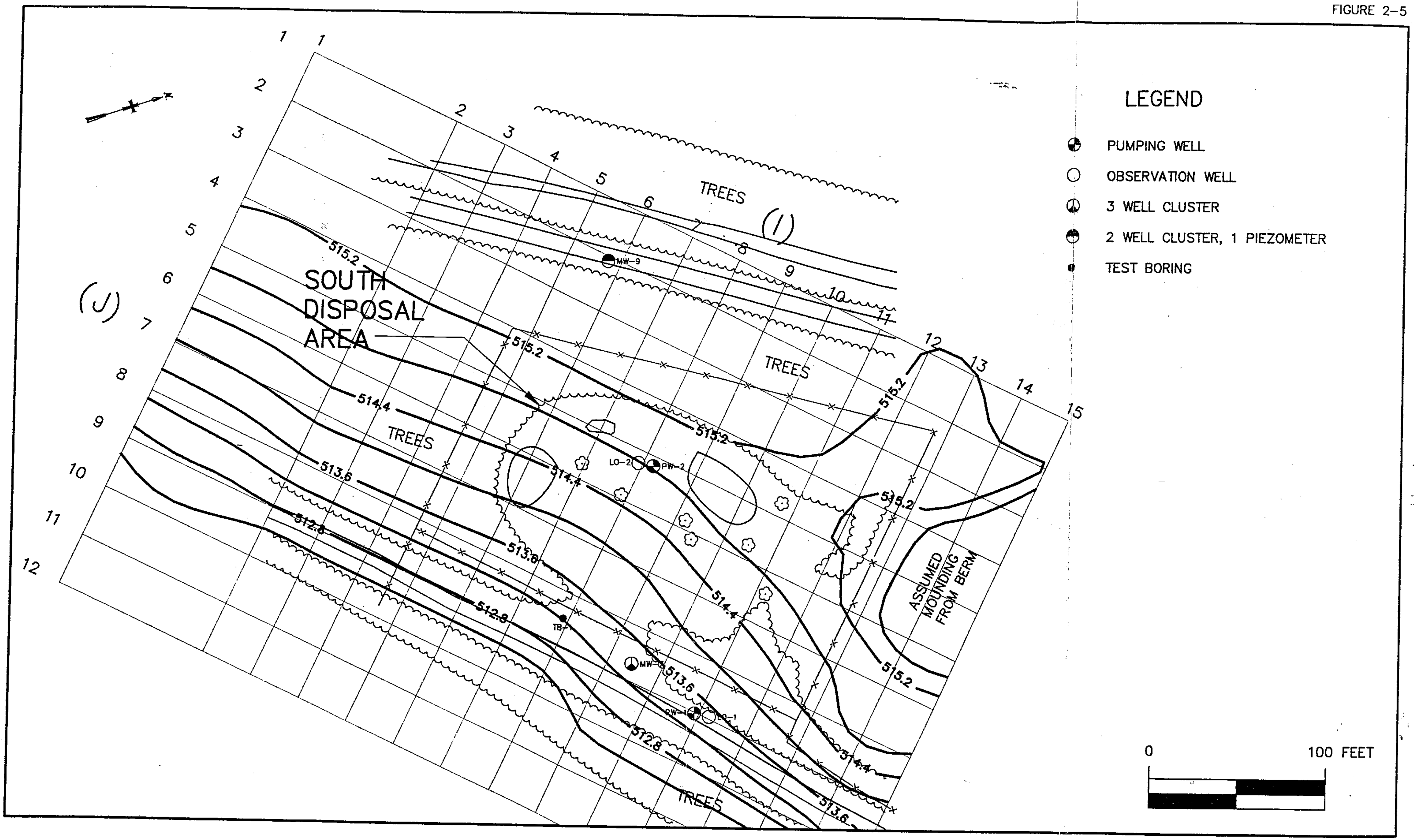
The distribution of alluvial sediments identified during the RI was better delineated through the Supplemental RI. As shown in Figure 2-3, compositional differences in the alluvial deposits occur in the vicinity of the South Disposal Area. Nearer to the river, brown silty sand and mottled gray-brown silty sand overlie a progressively dense poorly sorted gray-brown sand and gravel beginning at a depth of about 12 feet. The moisture content of the sand unit ranged from dry to wet. Moisture conditions within the sand and gravel ranged from moist to wet. At a depth of about 20 to 22 feet below grade, this alluvial unit has till-like properties (i.e. poor sorting, compact). The angularity of some of the gravel size material indicates that these sediments may be derived from alluvial transported till material. Some interfingering was observed between the less dense brown sand and gravel and the dense brown-gray sand and gravel near the central portion of the disposal area. Farther away from the river, brown clayey silt overlies a less dense brown sand and gravel. The relationship between the clayey silt and the silty sand units nearer to the Genesee River, as represented in this Supplemental RI report, has been modestly modified from the RI Report. In the central portion of the disposal area (in the vicinity of LO-2), the brown clayey silt was observed to overlie the silty sand unit. Moisture conditions in the clayey silt were dry to moist. Wet conditions were observed in the brown sand and gravel. The average thickness of the alluvial sediments in the South Disposal Area is about 32 feet.

2.3.2 Hydrogeology of the South Disposal Area

Information provided in the RI report regarding the hydrogeologic conditions within the overburden water-bearing zone in the South Disposal Area is supplemented with hydraulic data collected during this field investigation.

The overburden water-bearing zone occurs within the alluvial sediments in the vicinity of the South Disposal Area and is generally under unconfined conditions. The fine grained clayey silt in the western portion of the South Disposal Area contains a localized semi-perched condition as demonstrated by different hydraulic heads in the alluvial sediment. The direction of ground water flow in the alluvial sediments is to the east toward the Genesee River.

FIGURE 2-5



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ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION

CALIBRATED FLOW MODEL OUTPUT

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sensitivity of the model to changes in model input parameters was evaluated, to some degree, by changing model input parameters to values within a range of geologically reasonable values.

Input Parameters

Hydraulic Head:	The distribution of hydraulic head was determined from an isopotential map created from average seasonal water level data presented Figure 2-4. Head data used in the western portion of the model was reflective of water levels in the relatively more permeable loose sand and gravel in lieu of the semi-perched head value in the overlying clayey silt. This was appropriate since it was previously demonstrated in Section 2.3.2 that a majority of flow in the alluvial sediments in this area is through this material. Head data in the northern portion of the model grid is slightly higher than the local head field and reflects assumed mounding of the water table beneath the berm at the south end of the police firing range. The remaining head field maintains a fairly uniform gradient toward the river.
Hydraulic Conductivity:	The hydraulic conductivity values specified in the model reflect grain size and density changes within the alluvial sediments. The values selected represent model hydraulic conductivities determined by aquifer testing. These values ranged from nearly 70 gpd/sq ft, representative of the loose sand and gravel deposits on the western portion of the site, to about 2 gpd/sq ft in the vicinity of PW-2 and LO-2. The remainder of the alluvial deposits were simulated with a hydraulic conductivity value of 5 gpd/sq ft.
Source Bed Leakance Factor:	Downward leakance from the clayey silt layer (designated as the source bed) to the loose sand and gravel (see Figure 2-3) was simulated by specifying a leakance rate of 0.0005 gpd/ft. This calculation is shown in Appendix B.8. The hydraulic heads in the source bed were specified as heads resulting from the horizontal hydraulic gradient from MW-9S (el. 518.2) to PW-2 (el. 514.5).
Aquifer Bottom:	The bottom of the aquifer was selected as the base of the alluvial sediments at an elevation of 486 feet msl across the entire model grid. Aquifer testing suggests that the flow in the bedrock beneath the alluvial sediments will minimally impact the overlying alluvial sediments.
Recharge:	Recharge to the alluvial sediments occurs from the infiltration of precipitation through the fill and native soil. HELP

model simulations presented in the RI determined that the recharge from precipitation may be as high as 40% of the total precipitation in areas where clayey silt is not present. This equates to a recharge rate of approximately 0.02 gpd/sq ft. In areas where clayey silt is present, a value of 0.001 gpd/ sq ft was selected which is about 5% of the normal rate of recharge.

Storage Coefficient: The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. In an unconfined aquifer, aquifer storage is equivalent to the specific yield (Fetter, 1980). A value of 0.2 (unitless) was selected based on the grain size of the alluvial sediments. Storage coefficient values become of consequence during transient flow simulations. Steady-state simulations are achieved when the change in storage approaches 0; and therefore, storage coefficient values then become unimportant.

The input file containing model input parameters is presented in Appendix B.7.

2.4.3 Flow Model Calibration

Flow model calibration involves the process of adjusting model input parameters within measured and expected ranges of values until a good match between observed and model computed hydraulic heads occurs. During calibration, sensitivity to the adjustment of model specific input parameters provides insight to the relative importance of various parameters. Understanding parameter sensitivity provides the most efficient means of calibration using this trail-and-error methodology.

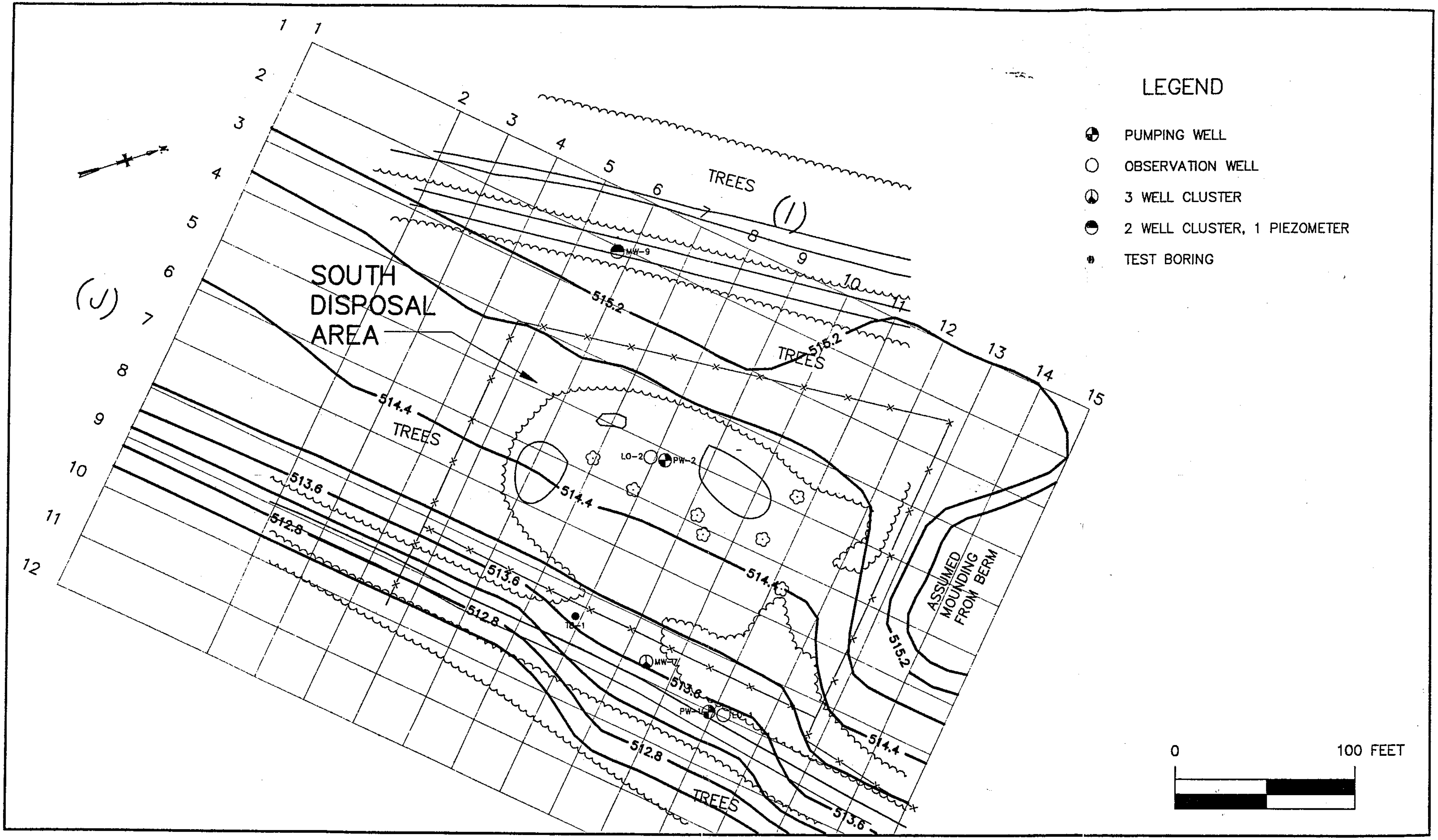
During model calibration, it was found that the head in the loose sand and gravel (PZ-9) rather than the clayey silt (MW-9S) was required as head input in order to obtain an acceptable head match. This meant that the head in the source bed (clayey silt) could be used to simulate the strong downward gradients observed in the vicinity of MW-9 and which leakance from this layer would recharge the underlying loose sand and gravel. Minor adjustments to the distribution of hydraulic conductivity and recharge were necessary to produce heads that more closely resembled the actual head field. These two parameters were determined to be the most sensitive to change.

Additionally, the southern no-flow boundary was extended an additional 60 feet to the south. This change did not influence the head field produced by the calibrated model, but was extended to minimize any potential boundary effects from future ground water remedial action simulations. The hydraulic head field produced by the calibrated flow model is presented in Figure 2-5. When compared with the water table map presented in Figure 2-4, the hydraulic heads produced by the model are similar to water level data used to create the water table map, thereby indicating good calibration of the flow model.

Following model calibration, the sensitivity of the hydraulic conductivity at the constant head river boundary was evaluated. The hydraulic conductivity at these nodes reflects the estimated leakance from the river should the area of influence from simulated ground water remedial controls reach the river. Hydraulic conductivities ranging from 0.1 to 1,000 gpd/sq ft were input as stream bed hydraulic conductivities to evaluate the impacts of stream bed leakance on the volume of water collected during predictive ground water withdrawal simulations. Ground water withdrawal was simulated using four nodes of high leakance, thereby simulating ground water withdrawal from a ground water collection trench 90 feet long with about 20 feet of drawdown located at nodes [I,J] 7,8; 8,8; 9,8; and 10,8 (see Figure 2-5). Ground water withdrawal volumes for each change in the hydraulic conductivity of the stream bed are presented in Table 2-3. This data indicates that the resulting flow rates from the simulated trench do not vary significantly for differing river bed hydraulic conductivities. Therefore, it was concluded that the hydraulic conductivity of the alluvial sediment was sufficiently low so as to minimize the effects of leakance from the stream bed during future simulations of ground water withdrawal.

Calibrated flow models are generally validated by simulating long-term pumping. However, long-term pump tests were not feasible and an attempt was made to simulate the short-term (6-hours) "mini-rate" pump testing using the calibrated flow model. Since this short-term pumping represents a transient condition, the value for the storage coefficient becomes the most model sensitive parameter. Aquifer storage coefficients are generally determined through long-term pump testing using fully penetrating observation wells. Determining potential transient flow conditions was not an objective of the hydraulic testing performed during the Supplemental RI. Therefore, a value was not determined for the storage coefficient and a range of values between 0.1 and 0.3 (unitless) were tested. Variations in drawdown in each simulated pumping well ranged from no drawdown for simulations using 0.3 to several feet for simulations using 0.1. To complicate these transient scenarios, the model assumes 100% well efficiency which in reality does not occur. The well

FIGURE 2–4



MALCOLM PIRNIE

ROC–07–024

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION
WATER TABLE MAP WITH
FINITE DIFFERENCE GRID

CITY OF ROCHESTER

APRIL 1992

The heterogeneity of the alluvial sediment produces variable flow conditions within the water-bearing zone. These variable flow conditions are mainly dependent upon the grain size and degree of sorting in the soil matrix and are directly related to the hydraulic conductivity of the soil. Slug test and "mini-rate" pump test-derived hydraulic conductivities are presented in Table 2-2. Hydraulic conductivity values east of the less dense brown sand and gravel unit range from 1.9 to 11 gpd/ft^2. Although heterogeneities in the alluvial deposits may produce zones with hydraulic conductivities that exceed this range, the average hydraulic conductivity of the entire saturated thickness of alluvial deposits within much of and down gradient of the South Disposal Area is about 5 gpd/ft^2. A much higher value of 67.8 gpd/ft^2 was determined for PZ-9 (located upgradient of the South Disposal Area). This higher value is representative of the flow through the less dense sand and gravel deposits east of PW-2. Although a value of 57.2 gpd/ft^2 was determined for MW-9S using slug test methodology, this value is not considered to be representative of the clayey silt since the top of the well screen is located within the gravel-rich railroad ballast fill material. A value of 0.004 gpd/ft^2 was obtained from shelby tube permeability testing and is considered to be a representative hydraulic conductivity. The rate of downward leakance caused by the vertical gradients created from the semi-perched condition in this area is 0.0005 gpd/ft. All significant horizontal flow in this area of the site is through these underlying coarser sediments. These Darcy calculations are presented in Appendix B.8. Recharge to the alluvial sediments is through the infiltration of precipitation. Nearer to the river, slight upward hydraulic gradients seasonally occur and a minor portion of flow from the bedrock recharges the overburden water-bearing zone. Discharge occurs from the overburden water-bearing zone to the Genesee River with minor flow discharging to the bedrock on a seasonal basis.

2.4 GROUND WATER FLOW MODELING

A ground water flow model was employed to evaluate the hydraulic effects of various ground water remedial controls. Prior to using a ground water flow model to simulate various ground water controls, the site hydrogeologic conditions must be conceptualized and the flow model is then calibrated to the conceptualized site conditions. The following discussions present the conceptual site model, a description of the flow model used and the calibration of the flow model to the conceptualized site conditions.

2.4.1 Site Conceptual Model

As described in Section 2.1, the site is underlain by alluvial deposits of varying composition and fractured dolostone. The sequence of these deposits in the vicinity of the South Disposal Area is presented in Figure 2-3. The hydrogeologic relationship between the different units is summarized below:

- Fine-grained clayey silt in the western portion of the disposal area produces a semi-perched water table condition in this area.
- Coarser loose sand and gravel material with relatively higher hydraulic conductivities directly overlies bedrock to the west of the disposal area.
- Toward the river to the east, silty sand units overlie dense sand and gravel deposits. These units have similar hydraulic properties and are considered to be a single hydrostratigraphic unit. The hydraulic conductivity of this unit is substantially less than the loose sand and gravel to the west.
- The water table elevation in the alluvial deposits is controlled by the effects of ground water recharge from precipitation. Nearer to the Genesee River, a minor component of flow from the bedrock to the alluvial sediments recharges the overburden water-bearing zone on a seasonal basis. Downward vertical hydraulic gradients in the vicinity of the clayey silt indicate that these water-bearing deposits recharge the coarser sediments below through vertical leakance.

A ground water flow model was used to simulate many of the pertinent flow conditions described in this conceptual flow model so that predictive simulations of ground water remedial controls and quantitative evaluations of their impacts on the water-bearing alluvial deposits could be made.

2.4.2 Model Description

The PLASM (Prickett-Lonnquist Aquifer Simulation Model [PLASMCMI, Version 1990]) ground water flow model, a widely recognized and well-documented computer code, was used to simulate steady-state two-dimensional ground water flow in the alluvial deposits. The model represents the flow field using a rectangular or square, node-centered finite-difference grid. It computes changes in head distribution across an area with time under steady or transient state, homogeneous or non-homogeneous and confined or unconfined conditions. The ground water flow model is capable of simulating the hydraulic conditions present in the overburden water-bearing zone and may be used to simulate remedial ground water controls.

The use of a three-dimensional ground water model was previously identified in the Supplemental RI Work Plan based on aquifer testing information from the RI at monitoring well cluster MW-9. The RI identified similar hydraulic characteristics for the lower overburden and bedrock water-bearing zone, thereby implying active hydraulic communication between these two zones. To simulate these conditions using a ground water flow model, a three-dimensional model would be necessary to account for simultaneous flow in the overburden and bedrock water-bearing zones. However, as described in the conceptual model, the Supplemental RI revealed that deposits with relatively low permeability values directly overlie bedrock in the South Disposal Area limits active hydraulic communication between the lower overburden and bedrock water-bearing zones. Therefore, the use of the PLASM flow model was determined to be more appropriate for simulation of the hydrogeologic characteristics of the overburden material in the South Disposal Area.

The numerical solutions to the Darcy ground water flow equations in the PLASM model are solved interactively through a finite-difference approach using the alternating direction implicit (ADI) method. Hydraulic properties of the aquifer (viz. hydraulic conductivity, saturated thickness, recharge, etc.) define model input parameters at grid line intersections (nodes). The model output consists of numerical values of aquifer head elevation distribution and a summary quantitative water balance calculation comprised of total ground water inflow/outflow, recharge/withdrawal and flow from/to storage at the end of each iterative time-step. Model steady-state conditions are achieved when model heads show relatively little change from a previous time-step, ground water inflow approximately equals ground water outflow and the volumetric change in ground water storage approaches zero. Assumptions inherent to the cross sectional model are that:

- Darcy's Law is valid and hydraulic head gradients are the only significant driving mechanism for fluid flow;
- Flow not parallel to the cross-sectional area is insignificant;

- Hydraulic conductivity and transmissivity are equal (aquifer thickness is assumed one foot thick);
- Porosity and hydraulic conductivity are constant with time; and
- Temperature and viscosity do not affect the velocity distribution.

Model Setup

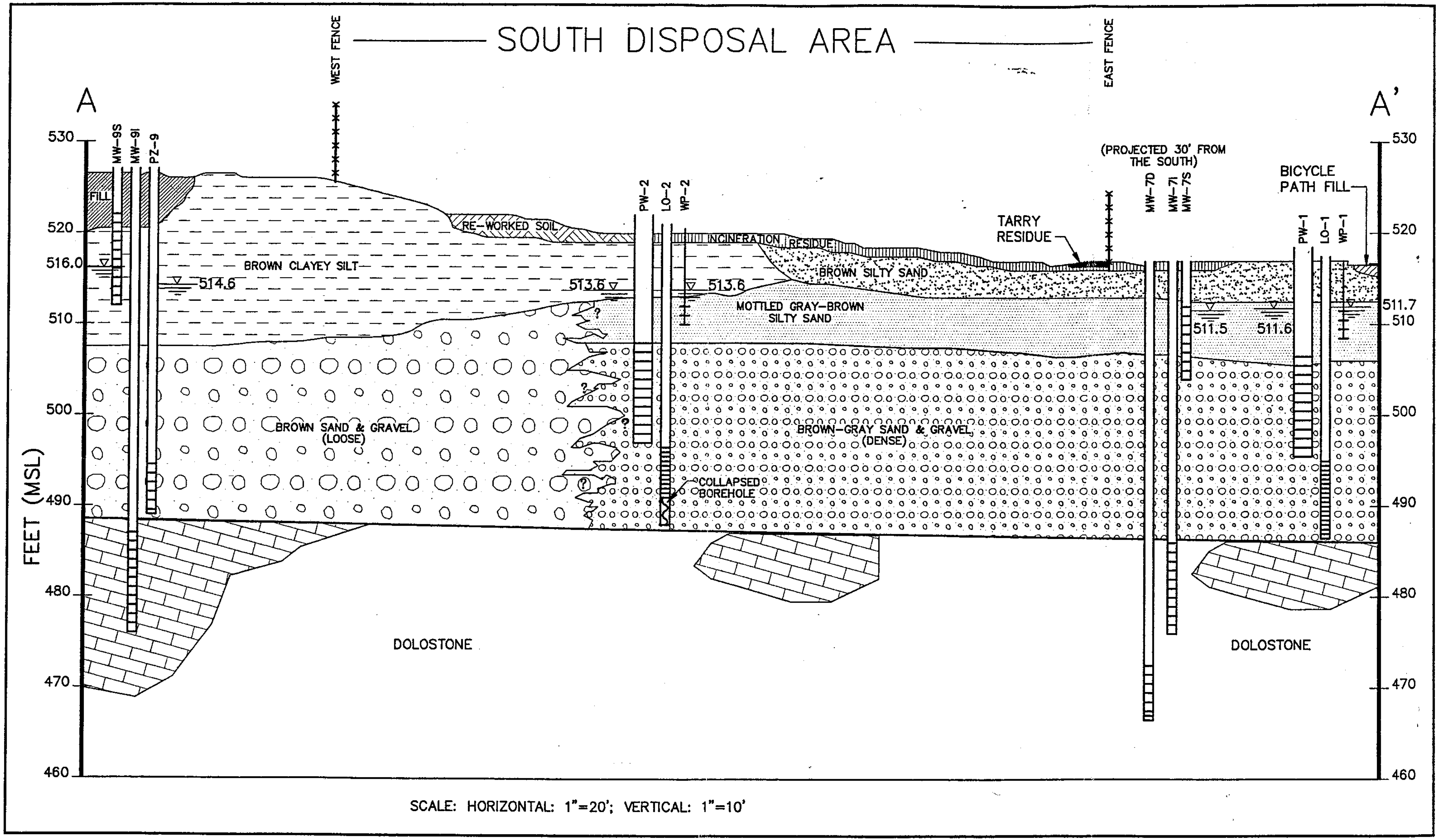
A finite-difference modeling grid consisting of 12 rows and 15 columns was established across the vicinity of the South Disposal Area as presented in Figure 2-4. Spacing of grid nodes is 90 feet in the southern portion of the grid and 30 feet across the remainder of the grid. The finite-difference grid is oriented with the general direction of ground water flow in the alluvial deposits.

Generally, aquifer model boundaries correlate with regional or local ground water flow divides. However, for the purposes of simulating the effects of remedial ground water controls in the South Disposal Area, several boundaries not correlating with flow divides were specified at a sufficient distance from the areas of potential future simulated ground water controls so as to minimize the impacts of boundary effects on remedial action simulations. To represent model boundaries on the finite-difference grid, constant heads (that is, hydraulic heads that are not allowed to vary with time) were assigned to three model boundaries, and one no-flow boundary was used. The western boundary represents constants heads in the Genesee Valley Canal Area. The northern boundary of constant heads is reflective of the presumed slightly mounded ground water table beneath the berm at the south end of the Police Firing Range Area. The eastern boundary is a ground water flow divide and is simulated with a constant head for the Genesee River. A no-flow boundary was specified for the southern boundary with initial heads representing the horizontal hydraulic gradient from the east to the west.

Input Parameter Identification

The goal of the parameter identification was not to determine estimates of area-specific model input parameters, but to define a prediction problem (viz. simulation of various ground water remedial controls for the South Disposal Area). This prediction was to be made using a parameter set found by trial-and-error calibration of the PLASM model. The set of model input parameters used was selected from a range of determined values from field investigations and estimated values provided in the geologic literature. The

FIGURE 2-3



MALCOLM PIRNIE

ROC-07-SRI

LEGEND:

FILL
- ▨ RAIL ROAD BALLAST
- ▨ RE-WORKED SOIL
- ▥ INCINERATION RESIDUE
- ▨ BICYCLE PATH FILL

BEDROCK
- ▱ DOLOSTONE

OVERBURDEN
- BROWN CLAYEY SILT
- BROWN SILT SAND
- MOTTLED GRAY BROWN SILTY SAND
- BROWN SAND + GRAVEL (LOOSE)
- BROWN-GRAY SAND + GRAVEL (DENSE)

▽ WATER LEVEL FROM 11/18/91

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION
CROSS SECTION A-A'

CITY OF ROCHESTER

APRIL 1992

TABLE 2-3

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL RI

EVALUATION OF RIVER BED HYDRAULIC CONDUCTIVITY

Hydraulic Conductivity at Riverbed	Withdrawal Rate from Simulated Ground Water Control
0.1 gpd/sq ft	6,578 gpd
1.0 gpd/sq ft	6,597 gpd
100 gpd/sq ft	6,806 gpd
1,000 gpd/sq ft	6,830 gpd

efficiency depends on the type of installation, construction of the well and the formation the well is screening which directly influences the drawdown in the well. Therefore, these transient simulations were determined to be inconclusive and were terminated after several attempts to validate the model to the drawdowns resulting from the short-term pumping.

The calibrated flow model will be utilized during the Feasibility Study to evaluate the hydraulic effects of various ground water remedial controls. Approximately five remedial simulations will be performed and the results documented in the FS Report.

2.5 HYDROLOGY OF THE SOUTH DISPOSAL AREA

A water balance was performed for the North Disposal, the Training Grounds Area and the South Disposal Area in the RI Report. The water balance was used to partition quantities of water which factor into the hydrologic recharge/discharge relationship that exists for each area. Recharge is defined as all water entering the area either from infiltration of precipitation of ground water inflow from the west. Discharge is defined as all water exiting the area through discharge to the Genesee River or downward leakance of ground water from the overburden water-bearing zone to the bedrock aquifer that occurs during high water table conditions (generally Spring and early Summer). The average annual water balance (with minor bias of leakance from the overburden to the bedrock) can be expressed as follows:

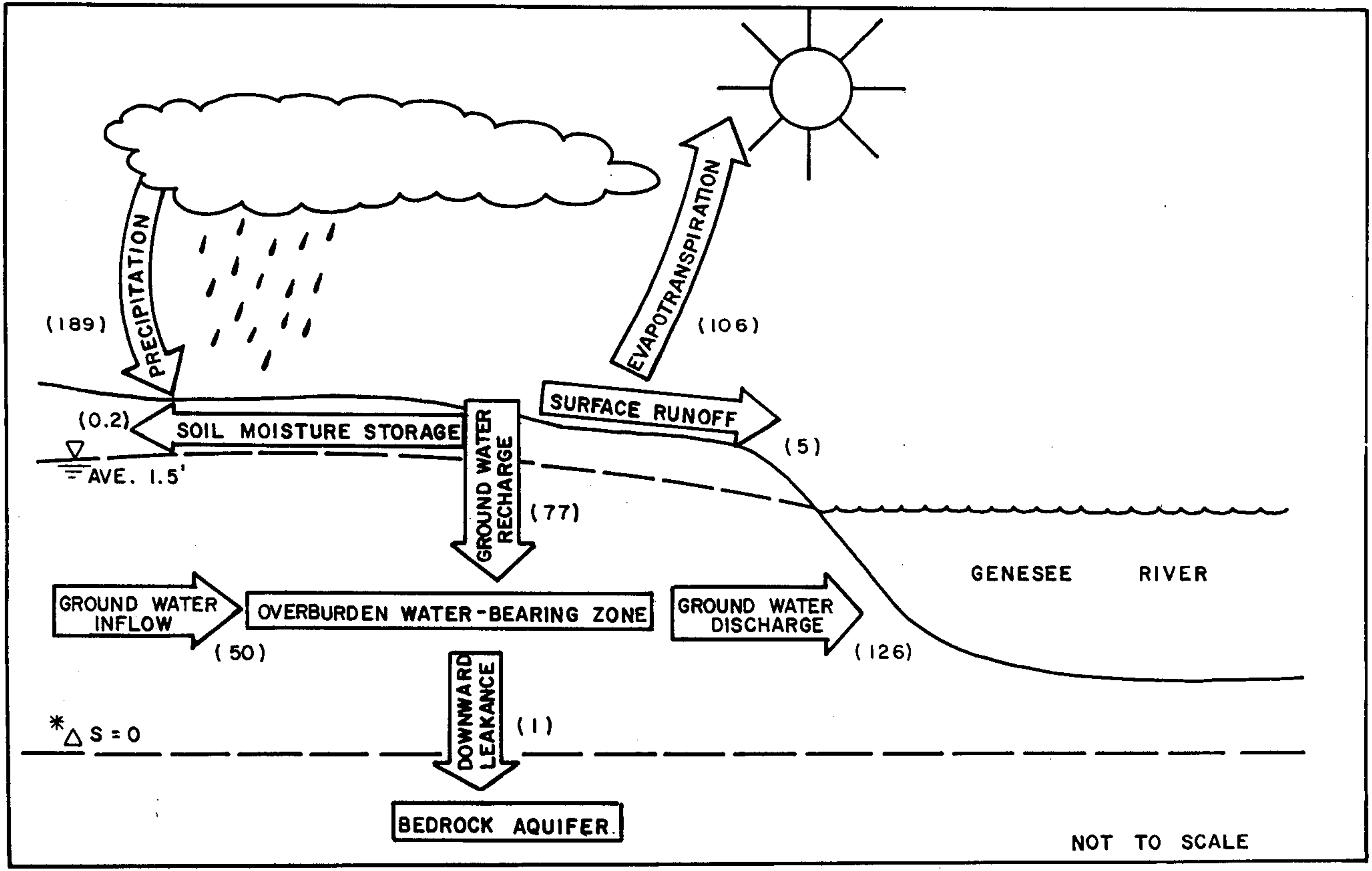
$$Q_I + Q_{GI} = Q_{GO} + Q_{DL} \pm \Delta S$$

where:

Q_I = average annual infiltration from precipitation
Q_{GI} = average ground water inflow
Q_{GO} = average ground water outflow to Genesee River
Q_{DL} = seasonal downward leakance
ΔS = change in ground water storage.

Values for each of these terms representing a portion of the hydrologic budget for each area are specified in the RI Report. The additional hydraulic information collected during the Supplemental RI regarding ground water flow in the South Disposal Area warranted modification to the water budget. This modification is primarily a result of lower hydraulic conductivity value for the gray-brown sand and gravel established during the Supplemental RI than was previously estimated. Using an average hydraulic conductivity value of 5 gpd/ft^2 (0.66 ft/day) determined for the overburden water-bearing zone, a hydraulic gradient of 0.014 ft/ft determined from the estimated average water level in PW-2 and the Genesee River and the previously used cross sectional area of 5,440 ft^2, the resulting average ground water inflow is 50 ft^3/day. The ground water infiltration and downward leakance volumes were determined as 77 ft^3/day and 1 ft^3/day, respectively in the RI Report. Assuming the change in storage is 0 ft^3/day based on a steady state condition, the resulting ground water outflow to the Genesee River is 126 ft^3/day. The revised hydrologic budget for the South Disposal Area is presented graphically in Figure 2-6.

FIGURE 2-6



NOTE: (VALUE) - VOLUMES ARE AVERAGE ANNUAL VALUES EXPRESSED IN CUBIC FEET/DAY.

✱ CHANGE IN STORAGE = 0 STEADY STATE CONDITIONS ASSUMED.

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ROC - 04

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL RI
SOUTH DISPOSAL AREA
WATER BALANCE

CITY OF ROCHESTER, NEW YORK
APRIL 1992

3.0 GROUND WATER TREATABILITY TESTING

3.1 INTRODUCTION

The RI Report for the Rochester Fire Academy Site has demonstrated that organic, and to a lesser extent, inorganic contamination is present in the groundwater in the South Disposal area at elevated concentrations as compared to NYSDEC Class "GA" Ground Water Quality Standards. Section 7.3.1.3 of the RI report details the levels of contamination detected. In general, organic contamination in the ground water reflects the nature and extent of organic contamination present in the soil/fill material overlying the aquifer. The leaching of organic contaminants from the soil/fill material liberates moderate to high concentrations of chlorinated volatile organic hydrocarbons and trace concentrations of phenolic compounds and PCB's to the ground water. Iron and other trace metals were detected in the South Disposal Area in excess of observed upgradient conditions, but this is consistent with a change in the oxidation-reduction properties of the overburden water bearing zone to more reducing conditions.

In order to evaluate potential remedial alternatives for the ground water, the hydraulic characteristics of the aquifer and the treatability of the ground water must be defined. As detailed in the Supplemental RI Work Plan, several treatment technologies were proposed for evaluation using overburden ground water collection from a 72-hour constant-rate pump test in the South Disposal Area:

- pilot-scale air stripper testing of side-by-side shallow tray and bubble diffusion units for removal of volatile organic contaminants;
- granular activated carbon (GAC) mini-column testing for PCB removal;
- bench-scale AOP testing for volatile organic and PCB removal; and
- bench-scale jar testing for arsenic, iron, manganese and magnesium precipitation.

The initial Supplemental RI field information collected prior to installation of the proposed pumping well indicated that the yield from the lower overburden was substantially lower than anticipated, and the plan for a 72-hour constant rate pump test was subsequently abandoned. As a result of the change in the pump-test scope and resulting volumes of water collected, modifications to the treatability testing approach were also necessary. In particular, pilot-scale evaluations of the shallow tray and bubble diffusion air stripping units could not be undertaken because both units have minimum operating ranges of 1 gpm, and the combined mini-rate pump test production rate was 0.75 gpm. Desk-top evaluations of these air stripping units (as well as a computer-simulated packed tower evaluation) were performed instead. Furthermore, the low volume of water generated during the mini-rate pump test did not allow for daily characterization of the untreated ground water as originally intended. Rather, a single grab sample was taken from the 200 gallon HDPE ground water collection tank and analyzed for Method 8010/8020 VOCs, metals (i.e., arsenic, iron, manganese and magnesium), water quality parameters and PCBs. The results of these analyses are presented in Table 3-1. A discussion of the results of the ground water characterization sampling and the various treatability test evaluations is provided in Sections 3.2 through 3.6.

3.2 DISCUSSION OF GROUND WATER CHARACTERIZATION DATA

The data presented in Table 3-1 indicate that the majority of the VOC contaminants present in the pump-test water were within the same order of magnitude as observed during the RI, with the exception of: vinyl chloride; 1,2-dichloroethylene; acetone; methylene chloride; and 1,1,1-trichloroethylene. Vinyl chloride was detected at an order of magnitude higher than previously observed, however this concentration was qualified on the basis of calibration blank contamination. The remaining VOCs identified above were present at a minimum of one order of magnitude lower than concentrations in the overburden ground water detected during the RI, and acetone and methylene chloride (common laboratory reagents) were also qualified on the basis of blank contamination. Similar VOC concentrations in the untreated ground water were found by the subcontractor performing the bench-scale AOP testing (Peroxidation Systems, Inc. - see Section 3.5), which warranted spiking the samples during one of the AOP test runs.

The results of the metals analyses show that magnesium is on the same order of magnitude as detected in the past. The arsenic concentration is several orders of magnitude less than previously found, and manganese and iron were one order of magnitude less.

TABLE 3-1

ROCHESTER FIRE ACADEMY
PUMP TEST GROUND WATER CHARACTERISTICS(1)

Contaminant	Concentration
Metals (mg/l):	
Arsenic	0.002(2)
Iron	1.49
Magnesium	45.3
Manganese	0.044
Water Quality Parameters (mg/l):	
Hardness	487 mg equivalent CaCO$_3$/l
Acidity	313 mg equivalent CaCO$_3$/l
Alkalinity (Bicarbonate)	370 mg equivalent CaCO$_3$/l
Chloride	79.0
Nitrate	0.32
Phosphorus (Total)	0.04
Sulfate	44.0
Sulfide	3.0
Total Dissolved Solids	640
Volatile Organics (ug/l):	
Vinyl Chloride	220(3)
Chloroethane	75
Acetone	150(4)
Methylene Chloride	7(5)
1,1-Dichloroethene	8
1,1-Dichloroethane	1,000(3)
1,2-Dichloroethene (Total)	450(3)
Chloroform	2(6)
1,2-Dichloroethane	46
2-Butanone	83
1,1,1-Trichloroethane	290(3)
Trichloroethene	230(3)
Benzene	3(6)
4-Methyl-2-Pentanone	130
Tetrachloroethene	8
Toluene	120
Ethylbenzene	4(6)
Xylene (Total)	20

NOTES:

(1) Only those compounds detected in the sample are presented in this table.

(2) Concentration is between instrument detection limit and contract required detection limit.

(3) Compound was detected in the undiluted sample at a concentration above the calibration limit. Concentration presented in Table was determined from the analysis of a 1:10 dilution of the sample.

(4) Acetone was detected in Blanks A and B at concentrations of 9 ug/l and 10 ug/l, respectively.

(5) Methylene Chloride was detected in Blanks A and B at concentrations of 5 ug/l and 21 ug/l, respectively.

(6) Estimated value - compound was detected at a concentration above the detection limit of the instrument but below the lower limit of the calibration.

Although jar testing for arsenic precipitation was undertaken, the control sample contained arsenic at a concentration below the analytical detection limit, therefore it was not possible to evaluate the removal efficiency of this parameter.

A sample was taken from the 200 gallon HDPE collection tank for PCB analysis, however PCBs were not present above the analytical detection limit, therefore it was not possible to perform GAC mini-column testing. A desk-top evaluation of the effectiveness of GAC in removing PCBs was completed, however.

3.3 AIR STRIPPING

Air stripping is an effective means for removing volatile organic contamination from groundwater, and can be achieved through several means. Desk-top evaluations of three (3) different air stripping processes were evaluated for implementation at the Rochester Fire Academy site: shallow tray air stripping; bubble diffusion air stripping; and packed tower stripping.

Air stripping transfers volatile contaminants from water to air, therefore the process is subject to the New York State guidance criteria for air emissions (i.e., Air Guide 1). This guidance document places specific concentration limits on contaminant loadings to the atmosphere from a point source emission, and takes a number of factors into consideration including the stack height. In order to compare contaminant loadings from an air stripper to the Air Guide-1 limits, it is first necessary to estimate the ground water production rate from a model collection system. Assuming a 210 foot long trench in the South Disposal Area having a drawdown of 10 feet, a conservative estimate of the maximum steady-state production rate is 15 gpm. At start-up, however, the production rate may be as high as 40 gpm. The Air Guide-1 atmospheric loading analyses for air stripping of the overburden ground water in the South Disposal Area under both steady-state and start-up conditions (i.e., 15 and 40 gpm, respectively) are presented in Appendix C1. For the purpose of these evaluations, the volatile organic parameter concentrations are conservatively assumed to be the maximum values observed in the shallow overburden in the South Disposal Area during any of the sampling events, and the air stripping unit is assumed to have a removal efficiency of 99 percent. As indicated in Appendix C1, an emission elevation of approximately 15 feet would be required in order to meet the Air Guide-1 criteria at a steady-state production rate of 15 gpm, and an emission elevation of 24 feet would be required at start-up.

Based on available overburden ground water data in the South Disposal Area, the emissions from the air stripping unit may contain vinyl chloride, a carcinogen which is strictly regulated in New York State and which may require vapor-phase controls (e.g., GAC adsorption) regardless of meeting Air Guide-1 annual and short-term guidance concentrations. However, Air Guide 1 provides that the need for vapor-phase controls for vinyl chloride may be waived if the atmospheric loading of this contaminant is less than one tenth of one pound per hour. Since the vinyl chloride loading is anticipated to meet this limit at both start-up and steady-state conditions described above, and since the operation would be part of an environmental remediation program, it is anticipated that vapor-phase controls would not be required if air stripping were to be implemented at the Rochester Fire Academy site.

An evaluation of each of the three air stripping technologies identified above follows.

3.3.1 Shallow Tray Air Stripping

Shallow tray air stripping involves the use of a compact series of perforated trays and a high capacity blower to volatilize the contamination as the water passes over the trays. The unit is skid-mounted, and is fitted with a small effluent collection tank and discharge pump. Level controls monitor the effluent sump and prevent the discharge pump from running dry. Based on discussions with the manufacturer, North East Environmental Products, Inc., a properly sized unit will achieve better than 99% removal of the maximum observed VOC concentrations in the overburden water bearing zone in the South Disposal Area. Scale build-up, a problem common to air strippers, can be removed from shallow tray units with a high pressure washer. Since the air stripping unit itself is approximately 7 feet tall, a 17-foot tall stack would have to be fitted to the unit to meet the Air Guide 1 criteria at start-up.

3.3.2 Bubble Diffusion Air Stripping

Bubble diffusion air stripping relies on a rectangular tank fitted with air spargers to volatilize contamination as water passes through the tank. Contaminated water is pumped to the influent side of the unit on a continual basis, and exits via a gravity overflow port.

This technology is essentially identical to shallow tray air stripping in terms of effectiveness (i.e., it achieves better than 99% removal for the parameters of interest according to the manufacturer, Lowry Engineering) and is also implemented and maintained with a similar level of effort. Air emissions from the bubble diffusion unit would also be subject to Air Guide 1, and therefore a stack resulting in an emission height of 24 feet would be required at start-up.

3.3.3 Packed Tower Air Stripping

Packed towers represent the most traditional form of air stripping. Volatilization occurs by pumping the contaminated ground water to the top of a column packed with dispersion media, which enhances transfer of the VOC contaminants to a low-velocity counter-current air stream as the water passes through the column. In order to compare the effectiveness of packed tower air strippers to the shallow tray or bubble diffusion units, computer software was utilized to determine the design requirements for a tower achieving an equivalent removal efficiency of 99% for the same maximum VOC concentrations. The ground water flow rate of 40 gpm was assumed based on an estimate of the start-up production of a full-scale collection system, with a typical air-to-water ratio of 60:1. The resulting design indicates that for a two-foot diameter column, a packing height of 25 feet would be necessary to achieve the desired removal efficiency. Allowing for some space above and below the packing, a 30-foot tall tower, two feet in diameter would mimic the removal efficiency of either the shallow tray or bubble diffusion air stripping units. The variables and output from the computer simulation are provided in Appendix C.2.

Although packed towers are relatively simple to construct, they pose some operational problems that are more readily addressed with the shallow tray or bubble diffusion-type units. For example, scale build-up in a packed tower on the packing media can lower removal efficiency and block air and/or water flow (particularly in small diameter units such as described above), and usually requires removal of the media for cleaning or replacement. In addition, cold temperatures might necessitate warming the water and/or air prior to entering the tower to prevent ice build-up, whereas the size of the shallow tray or bubble diffusion strippers would allow for enclosure of the entire unit in a heated building.

3.4 GRANULAR ACTIVATED CARBON

Low concentrations of polychlorinated biphenyls (PCBs) (up to 5 μg/L) were detected during the second and third rounds of groundwater sampling conducted as part of the RI. Discharges of treated groundwater to any water body or to the Monroe County Division Pure Waters district would have to meet the criteria of no detectable PCBs. Because air stripping does not inherently remove PCBs, post-treatment with granular activated carbon (GAC) could be implemented downstream of the air stripper to remove PCBs.

Because of the absence of PCBs in the sample collected from the combined mini-rate pump test effluent, minicolumn or other bench-scale isotherm testing to determine contaminant breakthrough time was not possible. Isotherm data obtained from Calgon Corporation (a leading supplier of GAC and GAC systems) for the PCB Aroclor 1254 indicated that one gram of GAC has the capacity to adsorb up to 5 milligrams of Aroclor 1254 before breakthrough will occur. The highest concentration of Aroclor 1254 found in groundwater from the South Disposal Area was 0.005 mg/l. At a groundwater flow rate of 15 gpm, one 55-gallon drum containing 165 pounds of GAC could theoretically operate for approximately 2.5 years before experiencing detectable breakthrough of Aroclor 1254, assuming an analytical detection limit of 0.5 ppb.

PCBs adsorb strongly to particulate matter, therefore removal of particulates from the groundwater is crucial for efficient removal of PCBs. Typically the GAC itself will remove particles greater than 15 microns in size. If the groundwater is visibly turbid, however, use of a diatomaceous earth filter or other in-line bag or cartridge filter might be required upstream of the GAC.

A particular consideration for PCB removal with GAC drum units is that the carbon is not usually loaded to the breakthrough point. Rather, the GAC is taken out of service based upon Toxic Substances Control Act (TSCA) disposal considerations. For example, at a loading of less than 50 mg/kg, the spent GAC would not be subject to TSCA disposal considerations, while at loadings between 50 and 500 mg/kg the spent GAC could be disposed of at a TSCA regulated facility. Assuming a maximum loading of 50 mg/kg to the operating conditions described above, one 55 gallon drum of GAC could theoretically remain in service for approximately 9 days before requiring disposal at a non-TSCA facility.

Assuming a maximum loading of 500 mg/Kg, one drum of GAC could theoretically remain in service for approximately 90 days before requiring disposal at a TSCA-regulated facility.

3.5 ADVANCED OXIDATION PROCESS

Untreated groundwater was collected from the 200 gallon HDPE tank during the pump test and transported to Peroxidation Systems, Inc. (PSI) for bench scale treatability testing using advanced oxidation process (AOP) technology. The Peroxidation Systems report is included as Appendix C.3.

The PSI trade name for its AOP procedure is the perox-pure™ Process. This process destroys dissolved organic contaminants in water by means of aggressive chemical oxidation from the hydroxyl radical. Ultraviolet (UV) light catalyzes the chemical oxidation of organic contaminants in water by its combined effect upon the organic contaminants and its reaction with hydrogen peroxide (H_2O_2). The bench scale perox-pure™ treatability study was designed to provide data on the removal of volatile organics and PCBs from the overburden ground water in the South Disposal Area. This data was intended to allow for full-scale treatment criteria and cost predictions.

A summary of the AOP procedure and results are included in this report as Sections 3.5.1 and 3.5.2, respectively.

3.5.1 perox-pure™ Testing Procedure

Five (5) **perox-pure™** treatment tests were performed by PSI on the Rochester Fire Academy ground water. These tests were designed to determine the effects of pH and H_2O_2 dosage on the rate of VOC and PCB destruction. Prior to performing any of the five runs, PSI filtered the samples through a 3-micron filter cartridge. Filtration was determined necessary by Peroxidation Systems in order to remove particulates which have an adverse effect at the bench-scale level and retain PCBs. The H_2O_2 dosage was varied in each test from 25 to 100 mg/l. In Tests 4 and 5, the initial pH was adjusted from 7 to 5 s.u.

The as-received ground water contained lower than expected concentrations of 1,1,1-TCA, acetone and methylene chloride. Since these contaminants were part of a group of potential oxidation rate limiting compounds, the sample was spiked with these contaminants (in test 5 only) to the maximum concentrations found in the overburden ground water from the South Disposal Area. In addition, the absence of detectable PCBs in the pump test samples prohibited evaluating the AOP process for PCB destruction.

The five tests were allowed to run in the bench-scale UV unit for 4.2 minutes each. Samples were collected during each test at 0 mins (i.e., untreated sample)., 0.7 mins., 1.4 mins., 2.8 mins., and 4.2 mins. At these retention times, samples of the treated water were collected in 40 ml septum vials for VOC analysis using EPA Methods 601/602. An untreated sample (0 mins. reaction time) was also collected in the same manner.

3.5.2 Performance Evaluation of the perox-pure™ Process

Analytical test results for Tests 1 through 5 are shown in Table 3 of the PSI January 1992 report, presented in Appendix C.3. Analyses for the contaminants shown were performed by PSI. In all tests, 1,1-DCA, 1,2-DCA and methylene chloride were destroyed to below the analytical detection limit of 2 μg/L in under 2.8 minutes of oxidation time. The remaining parameters required upwards of 4.2 minutes of oxidation time to be destroyed to below the detection limit, and the sample spiked with 1,1,1-TCA was only reduced to 15 ug/l after 4.2 minutes. The initial chloroform concentration was below the analytical detection limit in each of the tests performed, however RI data for the South Disposal Area indicated only a trace of chloroform in the ground water on one occasion, and spiking was not determined necessary. 1,1,1-TCA was determined to be the rate limiting compound in Tests 1 through 5.

Based on the results of the bench-scale AOP testing, PSI reports that the best destruction rates were achieved using an H_2O_2 dosage of 100 mg/l at a pH of 5.0. Overall, the average destruction rate for the total organic component of the ground water as received was determined to be 2.16 min^{-1}. Malcolm Pirnie, Inc. provided PSI with three (3) potential discharge criteria for organic concentrations in the treated water: New York State Class GA ground water quality standards (Case 1); New York State Class B surface water quality standards (Case 2); and a total organic concentration of less than 2 mg/l in accordance with Monroe County Pure Waters Div. requirements (Case 3). Peroxidation Systems has included capital cost and operating requirements to meet each of these criteria in its report.

Based on the data presented by PSI and their conclusions, it appears that perox-pure™ Process will destroy the volatile organic contaminants found in the Rochester Fire Academy groundwater. However, inorganic compounds, such as the four metals-of-interest (viz., arsenic, iron, magnesium and manganese), will not be destroyed and may inhibit chemical oxidation. Therefore, metals precipitation technologies would be required to operate in conjunction with the perox-pure™ process, if selected as the remedial alternative for groundwater treatment. Due to the absence of detectable PCBs in the collected mini-rate pump test water, the perox-pure™ process could not be evaluated for this parameter. However, AOP is a widely accepted and proven process for PCB destruction.

3.6 BENCH SCALE METALS TESTING PROCEDURE

3.6.1 General

As discussed previously, metals precipitation would be considered necessary as a pretreatment step if AOP or packed column aeration were implemented at the Fire Academy site. The bench scale metals testing was conducted on one aliquot of composited groundwater samples collected from two pumping wells. The purpose of the testing was to evaluate the performance of sodium hydroxide (NaOH) with and without sodium sulfide (Na_2S) to enhance metals removal from the groundwater using polymer as a coagulant aid. Sodium hydroxide was used to adjust the pH of the groundwater samples in the jars to pH of 8.5, 9.5 and 10.5 prior to the addition of the coagulant aids.

A titration curve was developed by adding NaOH to the groundwater sample. The purpose of the titration curve was to establish dosages of precipitant needed to adjust the pH of the solution in order to promote removal of metals via precipitation.

A standard six-paddle mixer with 1-liter jars was used to conduct the jar tests. The mixer was equipped with speed control device to regulate mixing speeds.

Visible variations in the size and amount of floc formation were recorded (pictures were also taken) for each jar. After preliminary polymer screening, jar tests were performed using the selected polymer at the "best" dosage for turbidity reduction. Total suspended solids analyses were performed on the "mixed suspension" from the three 9.5 pH samples in order to provide an indication of sludge production. Supernatant samples were collected from each jar (using a large syringe with a wide tip opening) after settling for 30 minutes and analyzed for total suspended solids.

3.6.2 Titration Curve Development

The groundwater sample used for the titration had an initial pH of 7.2 s.u. and a temperature of 20.1 degrees celsius. As shown in Table 3-2, 31.4 milliliters of 0.1N NaOH was required to adjust the sample pH from 7.2 to 11 s.u. Each beaker utilized during jar testing was filled with 1000 ml of groundwater and therefore required a larger volume of 0.1N NaOH to adjust the pH (viz., 40 milliliters of 0.1N NaOH were required to adjust the pH to 9.5 during the jar tests rather than 14 milliliters required during the titration).

3.6.3 Rapid Polymer Screening Procedure

Initial jar tests were conducted to establish a suitable polymer type and dosage for subsequent jar testing. Preliminary screening was conducted at a target pH of 9.5 s.u., using a sodium hydroxide dosage of 40 mg/l in combination with sodium sulfide at a dosage of 5 mg/l. The polymer selection and dosage were determined based on an evaluation of the supernatant turbidity.

The performance of the following polymers were evaluated at dosages of 0, 0.5, 1.0, 1.5 and 2.0 mg/l:

- Deartek 2410 (anionic polymer); and
- Deartek 2417 (cationic polymer).

The polymer screening was completed following the procedure identified in the Supplemental Remedial Investigation Work Plan for the Rochester Fire Academy Site. Results for the rapid polymer screening jar tests are presented in Table 3-3. Examination of this table indicates that the Deartek 2410 anionic polymer added to the groundwater sample at a dosage of 2.0 mg/l reduced the turbidity to 19.1 NTU. This was the lowest turbidity recorded and was selected as the most suitable polymer and dosage for use in subsequent jar testing.

3.6.4 Bench Scale Metals Removal Test

Following polymer screening, the effect of pH on metals removal was evaluated. Each jar test was completed using the procedure outlined in the Work Plan.

All mixed suspension and supernatant samples were analyzed on-site for turbidity and TSS. Supernatant samples were preserved after collection and shipped to Energy &

TABLE 3-2

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION

METALS PRECIPITATION TREATABILITY TESTING
TITRATION CURVE DATA

Volume 0.1N NaOH added (ml)	Sample pH	Volume 0.1N NaOH added (ml)	Sample pH
0	7.23	28.1	10.89
1	7.54	28.2	10.89
2	8.12	28.3	10.89
3	8.43	28.4	10.89
4	8.67	28.5	10.89
5	8.84	28.6	10.90
6	8.97	28.7	10.90
7	9.02	28.8	10.90
8	9.04	28.9	10.90
9	9.06	29.0	10.91
10	9.11	29.2	10.91
11	9.19	29.4	10.93
12	9.29	29.6	10.94
13	9.40	29.8	10.95
14	9.51	30.0	10.97
15	9.61	30.1	10.97
16	9.72	30.2	10.97
17	9.82	30.3	10.97
18	9.92	30.4	10.98
19	10.02	30.5	10.98
20	10.11	30.6	10.98
21	10.21	30.7	10.99
22	10.31	30.8	10.99
23	10.41	30.9	10.99
24	10.51	31.0	10.99
25	10.61	31.1	10.99
26	10.72	31.2	10.99
27	10.81	31.3	10.99
28	10.89	31.4	11.00

NOTES:

Initial Sample Volume: 200 ml
Initial Sample Temperature: 20.1°C.

TABLE 3-3

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION

RAPID POLYMER SCREENING TEST RESULTS

Polymer Name/Type	Sodium Hydroxide Conc. (0.1N NaOH)		Sodium Sulfide Conc. (1.0% Na_2S)		Polymer Conc.		Target pH (s.u.)	Final pH (s.u.)	Final Turbidity (NTU)
	(mg/L)	(ml)	(mg/L)	(ml)	(mg/L)	(ml)			
0.1% Deartek 2410/Anionic:									
Jar 1	40	40	5	0.5	0.5	0.5	9.5	9.32	52.6
Jar 2	40	40	5	0.5	1.0	1.0	9.5	9.30	44.3
Jar 3	40	40	5	0.5	1.5	1.5	9.5	9.30	54.1
Jar 4	40	40	5	0.5	2.0	2.0	9.5	9.45	19.1
0.1% Deartek 2417/Cationic:									
Control	40	40	5	0.5	0	0	9.5	9.42	53.3
Jar 1	40	40	5	0.5	0.5	0.5	9.5	9.44	42.2
Jar 2	40	40	5	0.5	1.0	1.0	9.5	9.48	45.4
Jar 3	40	40	5	0.5	1.5	1.5	9.5	9.54	39.6
Jar 4	40	40	5	0.5	2.0	2.0	9.5	9.45	29.7

NOTE:

Raw Groundwater Turbidity = 25.0 NTU

Environmental Engineering Inc. for total metals analyses of the following inorganic parameters:

- arsenic;
- iron;
- magnesium; and
- manganese.

Metals removal data from each jar test are presented in Table 3-4. In general, test results indicate that iron and manganese can be effectively precipitated. Arsenic results are inconclusive since the untreated arsenic concentration was near the detection limit. Magnesium concentrations were not reduced from the raw ground water sample and therefore no precipitation was observed.

The following visual observations were recorded during the jar testing:

- During settling, the floc size was noticeably larger at all three pH's when combined with the highest dosage of sodium sulfide (5 mg/l);
- The floc exhibited a whitish brown color (likely due to the presence of manganese);
- The floc in jars tested at pH 8.5 and 9.5 s.u. all settled at approximately the same rate while the floc in the pH 10.5 s.u. jars when combined with 3 and 5 mg/l of sodium sulfide settled slightly faster than the floc in the pH 10.5 s.u. jar with no sodium sulfide addition;
- The control jar test appeared to have the most turbid supernatant (as supported by results presented in Table 3-4); and
- The pH 10.5 s.u. jars appeared to have the clearest supernatant.

As presented in Table 3-4, the turbidity levels in the pH 8.5 and 9.5 s.u. supernatant samples were not significantly reduced when compared to the control sample. However, the pH 10.5 s.u. supernatant samples were reduced by greater than 90 percent of the control sample. Varying the sodium sulfide dosage did not significantly impact the clarity of the supernatant in any of the three pH solutions.

Total suspended solids (TSS) analyses produced similar results. Computing the average TSS removal for the three pH 10.5 s.u. solutions reveals that greater than 86 percent of the suspended solids were removed.

TABLE 3-4

ROCHESTER FIRE ACADEMY
SUPPLEMENTAL REMEDIAL INVESTIGATION

METALS PRECIPITATION TREATABILITY TESTING RESULTS

Polymer Name/Type	Sodium Hydroxide Conc. (1N NaOH)		Sodium Sulfide Conc. (1.0% Na_2S)		Polymer Conc.		Target pH (s.u.)	Final pH (s.u.)	Final Turbidity (NTU)	TSS		Arsenic (µg/l)	Iron (µg/l)	Magnesium (µg/)	Manganese (µg/L)
	(mg/l)	(ml)	(mg/l)	(ml)	(mg/l)	(ml)				Suspended	Decant (mg/)				
0.1% Deartek 2410/Anionic:															
Jar 1	15	1.5	0	0	2.0	2.0	8.5	8.40	19.9			3.50B	370	44,400	17.30
Jar 2	15	1.5	3	0.3	2.0	2.0	8.5	8.40	13.0			1.10U	316	38,900	14.1B
Jar 3	15	1.5	5	0.5	2.0	2.0	8.5	8.41	13.0			1.10U	334	41,100	10.7B
Jar 4	42	4.2	0	0	2.0	2.0	9.5	9.40	17.4	137	19	1.10U	110	42,900	3.0U
Jar 5	42	4.2	3	0.3	2.0	2.0	9.5	9.41	12.8	80	11	1.10U	106	40,300	3.0U
Jar 6	42	4.2	5	0.5	2.0	2.0	9.5	9.40	18.7	53	21	1.10U	124	39,400	3.0U
Jar 7	71	7.1	0	0	2.0	2.0	10.5	10.47	1.5		1	1.10U	65.0U	39,500	3.0U
Jar 8	71	7.1	3	0.3	2.0	2.0	10.5	10.52	1.9		1	3.90B	65.0U	38,500	3.0U
Jar 9	71	7.1	5	0.5	2.0	2.0	10.5	10.40	1.7		2	1.20B	65.0U	37,300	3.0U
Control	0	0	0	0	2.0	2.0	–	7.36	20.0		10	1.40B	1250	39,500	37.1
Raw Groundwater	–	–	–	–	–	–	–	–	25.0		–	1.80B	1490	45,300	44.1

NOTES:

B = Values were below five times the detection limit and therefore the resulting value may be of lower precision.

U = Values were below detection limits and actual values are less than the indicated value.

The following conclusions are based on the results of the jar testing conducted to complete this task:

- Sodium sulfide addition at dosages ranging from 0 mg/l to 5 mg/l, did not significantly impact the metals settled supernatant concentrations, but did appear to reduce sludge volume;
- Iron and manganese can be effectively precipitated at pH levels ranging from 9.5 to 10.5 s.u.;
- Magnesium will not be effectively precipitated at pH levels ranging from 8.5 to 10.5 s.u.; and
- Supernatant clarity is best achieved at pH 10.5 s.u. as supported by both turbidity and TSS results.

The metals precipitation evaluation was conducted by performing a series of bench scale jar tests to evaluate the effect of varying the dosage of sodium sulfide while raising the pH of the groundwater solution to precipitate the four metals-of-interest (viz., arsenic, iron, magnesium and manganese) from solution. There is an optimum pH for precipitation of each metal when several different metals must be simultaneously removed from a solution. The pH is generally adjusted to achieve the best overall removal.

3.6.5 Estimated Sludge Production

Estimates of the amount of sludge generated as a result of the precipitation process are generally difficult to predict. An estimate of the amount of sludge which would be produced based on an assumed flow rate of 15 gpm and the results of "mixed suspension" TSS analyses as presented in Table 3-4 for the Jar 4 sample (pH = 9.5 s.u. and 0 mg/l sodium sulfide) is 25 pounds per day, using the following calculation:

Dry Weight Sludge Production (lbs/day) =

Flow Rate (gpm) * TSS (mg/l) * 1440 min/day * 8.34 x 10^{-6} L-lbs/mg-gal

4.0 SITE CONTAMINANT CHARACTERIZATION

4.1 GENERAL

The RI Report identified organic and inorganic contamination in the fill, native soil, sediment, and ground water at the Rochester Fire Academy site. The analytical results for soil and fill material presented in the RI Report were supplemented by additional soil sampling and analysis performed in November 1991. Documentation for the sampling procedures and rationale has been presented in the Supplemental Remedial Investigation Work Plan.

Samples collected for the RI and the 1991 Supplemental RI were analyzed for the parameters listed in Table 4-1. Sampling events are categorized as Rounds 1, 2, or 3 of the RI, Supplemental, or DEC Confirmation based on the analytical protocols and parameter list that were established for each sampling event by agreement with NYSDEC. As shown on Table 4-1, all environmental samples collected during Round 1 were analyzed for parameters included on the 1987 New York State Contract Laboratory Protocol Target Compound List. Analytical parameters that were detected at elevated concentrations during Round 1 sampling were selected as parameters of interest and analyzed for in Round 2 samples. Analytical methods for Round 2 were modified from Round 1 to obtain a lower detection limit (by GC methods) for the parameters of interest. Round 3 was conducted at the request of NYSDEC to confirm specific analytical results obtained during Rounds 1 and 2.

Analytical parameters for the Supplemental RI were selected based on the relative magnitude and toxicity of contaminants detected in all previous sampling Rounds, and on the analysis of site contaminant migration that was presented in the RI Report. These analytical parameters are termed the parameters of concern and include PCBs, arsenic, cadmium, copper, lead, mercury, silver, and zinc. The sampling objective was to better define the lateral and vertical extent of contamination in native soil and fill material. In addition, a limited number of samples were collected during the Supplemental RI at the request of NYSDEC to confirm the analytical results and conclusions reported in the RI Report. These samples are categorized as DEC Confirmation samples, and were analyzed for a more comprehensive parameter list than were the Supplemental RI samples.

TABLE 4-1

ROCHESTER FIRE ACADEMY
ANALYTICAL METHODS AND PARAMETERS

Sampling Round	Parameters	Methodology	Laboratory(4)
Round 1	TCL Volatile Organics	1987 NYS CLP	GTC
	TCL Semi-Volatile Organics	1987 NYS CLP	GTC
	TCL Pesticides/PCBs	1987 NYS CLP	GTC
	TCL Metals	1987 NYS CLP	E_3I
	2,3,7,8 TCDD (Dioxin)	(2)	CCI
	Remediation Assessment Parameters	(1)	TOX
Round 2	Halogenated Volatile Organics	Method No. 8010(3)	GTC
	Aromatic Volatile Organics	Method No. 8020(3)	GTC
	PCBs	Method No. 8080(3)	GTC
	Acid Extractable Organics	Method No. 8270(3)	GTC
	Select Total Metals	(3)	E_3I
	Remediation Assessment Parameters	(1)	TOX
Round 3	TCL Volatile Organics	1987 NYS CLP	GTC
	TCL Semi-Volatile Organics	1987 NYS CLP	GTC
	TCL PCBs	1987 NYS CLP	GTC
Supplemental RI	TCL PCBs	1989 ASP CLP	E_3I
	Select Metals(5)	1989 ASP CLP	E_3I
DEC Confirmation	TCL Volatile Organics	1989 ASP CLP	E_3I
	TCL Semi-Volatile Organics	1989 ASP CLP	E_3I
	TCL Pesticides/PCBs	1989 ASP CLP	E_3I
	TCL Metals	1989 ASP CLP	E_3I
	Cyanide	1989 ASP CLP	E_3I

NOTES:

1987 NYS CLP: 1987 New York State Contract Laboratory Protocols
1989 NYS CLP: 1989 Analytical Services Protocols Contract Laboratory Protocols
TCL: NYS-CLP Target Compound List

(1) Ground water samples only analyzed for alkalinity, bicarbonate, hardness, TKN, NH_3, phosphate, SO_4, sulfide, COD, TOC, Oil and Grease, TDS, pH, and specific conductivity in accordance with Methods of Chemical Analysis for Water and Wastes. USEPA, Cincinnati, Ohio, EPA 600/4-79-020, Revised March 1983.

(2) Method presented in laboratory report. Only soil sample nos. SS-6, SS-7, SS-10, SS-12, MW-15S and BKGD were analyzed for Dioxin.

(3) From Test Methods for Evaluation of Solid Waste USEPA-OSWER SW-846, Third Edition, Nov. 1986.

(4) GTC - General Testing Corp. E_3I - Energy & Environmental Engineering, Inc.
TOX - Toxicon, Inc. CCI - Compuchem, Inc.

(5) Arsenic, Cadmium, Copper, Lead, Mercury, Silver, and Zinc.

Laboratories performing analyses of all environmental samples collected during the RI program are also identified in Table 4-1. The detailed laboratory reports of analytical results for the RI are provided in the RI Report. Analytical results for the Supplemental RI are provided in Appendix D. In addition, a report of the results of an analytical data validation performed to assess the quality of the data is presented as Appendix E. The data validation report indicates that the analytical data is valid and useful for the purpose of completing the investigation.

This section of the Supplemental RI Report summarizes the contaminant characterization of soil/fill which was presented in the RI Report; discusses the scope of the Supplemental RI soil/fill sampling program; and presents the supplemental analytical results. A summary of the RI sampling program in its entirety showing the number and types of samples for each sampling event is shown in Table 4-2.

4.2 SUMMARY OF RI ANALYTICAL RESULTS

Based on the historic land use and waste disposal practices discussed in Section 1.0, the Rochester Fire Academy site has been divided into the following areas:

- North Disposal Area
- Training Grounds Area
- South Disposal Area
- Genesee Valley Park Area
- Firing Range Area

The scattered nature of the organic and inorganic contamination identified during the RI indicates that the contamination was deposited from multiple spill, disposal and/or burning incidents. The soil/fill sampling locations of both the RI and the Supplemental RI sampling events are illustrated on Plate 1. The soil/fill analytical results reported in the RI Report are presented herein in Appendix F. A brief discussion summarizing the character and magnitude of contamination detected in each area during the RI sampling program is presented in this Section.

4.2.1 North Disposal Area

Contamination in the North Disposal Area is primarily inorganic in nature and appears to be limited to the visual extent of the fill material. The fill exhibits substantial concentrations of iron, cadmium, copper, lead, and silver. Organic contamination consists of chlorinated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), phthalate esters, and PCBs at low to trace concentrations.

4.2.2 Training Grounds Area

A substantial amount of the contamination identified in soil/fill of the Training Grounds Area is believed associated with historic spills and leaks of various types of fuels that have been used in the northern part of the Area, based on aerial photography and anecdotal information. Maximum concentrations of volatile organics, PAHs, phthalate esters, and PCBs, occur in soil/fill in the vicinity of the above-ground fuel storage tanks and a buried fuel transmission line. An accumulation of free product in the vicinity of MW-14S contributes to soil contamination by direct contact with unsaturated soils. However, lower levels of volatile organics, PAHs, phthalates, and PCBs are present at portions of the Area that are removed from the storage tanks and the fuel transmission line. The inorganic contaminants, cadmium, lead, and antimony, have been detected at elevated concentrations in the Training Grounds Area.

4.2.3 South Disposal Area

The highest levels of organic contamination in the South Disposal Area consist primarily of chlorinated hydrocarbons and PCBs. However, a large variety of additional organic compounds were identified at low concentrations. Inorganic contamination is primarily iron, cadmium, copper, lead, and silver. The RI sampling results indicated that both organic and inorganic contamination is closely associated with the incineration residue.

4.2.4 Genesee Valley Park Area

Low to trace concentrations of volatile organics occur opposite the South Disposal Area within the Genesee Valley Park Area. Low concentrations of cadmium and lead were detected in the Genesee Valley Park Area; however, several of the data points were flagged due to quality control limitations.

TABLE 4-2

ROCHESTER FIRE ACADEMY
SUMMARY OF ENVIRONMENTAL SAMPLING EVENTS[1]

Sampling Point	Analytical Protocol[2]	Sampling Event	Soil/Fill	Sediment	Surface Water	Ground Water
Test Pits	Round 1	4/90	11			
Shallow Borings	Round 1	4/90	8			
Surficial Soil	Round 1	4/90	21			
Monitoring Wells	Round 1	4/90	3			
Monitoring Wells	Round 1	5/90				21
Monitoring Wells	Round 2	8/90				21
Monitoring Wells	Round 3	10/90				10
On-Site Ponds	Round 1	5/90			3	
Drainage Swales	Round 1	5/90		2	2	
Genesee River	Round 1	5/90		4	4	
Genesee River	Round 2	8/90		4		
Surficial Soil	Suppl. RI	11/91	29			
Surficial Soil	DEC Confirmation	11/91	6			
Shallow Borings	Suppl. RI	11/91	49			
TOTAL			127	10	9	52

NOTE:

1. Number of analyses per matrix per sampling event, not including QC samples. Blanks indicate no sample.
2. Analytical protocol for each round is shown in Table 4-1.

4.2.5 Firing Range Area

The Firing Range Area has little organic or inorganic contamination in soil at the locations sampled. Organic contaminants were detected at only low concentrations. Inorganic contaminant concentrations are near or below background soil concentrations.

4.3 SUPPLEMENTAL RI SOIL SAMPLING PROGRAM

4.3.1 General

Based on the analytical results and evaluation of contaminant migration and health risks performed in the RI report, the parameters of concern for supplemental sampling was reduced to PCBs and seven metals (arsenic, cadmium, copper, lead, mercury, silver, and zinc). This Section describes the number and type of soil/fill samples collected from each Area during the Supplemental RI, and presents the Supplemental analytical results.

Sampling Methodologies

Surficial soil/fill samples were collected with a stainless steel spoon in accordance with the sampling procedures for surficial soils defined in the RI/FS Work Plan/Quality Assurance Plan (Malcolm Pirnie, June 1988).

Subsurface soil samples were collected in the Training Grounds Area and beneath surficial fill in the North Disposal Area, and the South Disposal Area. In the Training Grounds Area and the South Disposal Area, the surficial fill was removed with a shovel prior to sampling. In the North Disposal Area augering was performed through the fill to expose the underlying soil material. Subsurface soil samples were collected using stainless steel split spoon samplers. The split spoon sampler was driven for six inches and the soil was retrieved from the sampler and placed in the appropriate sample container. Subsequent depths were sampled through the same split spoon hole unless the walls of the hole collapsed, in which case a new hole was sampled. All subsurface soil/fill samples were collected from the unsaturated zone.

All sampling equipment was decontaminated prior to each grab sample in accordance with the equipment cleaning protocol in the RI/FS Work Plan/Quality Assurance Plan (Malcolm Pirnie, October 1989).

Physical Sample Description

A summary of field observations made for each grab sample is presented in Appendix G. These observations include physical descriptions, depth of sample, and total organic vapor measurements (if obtained). A summary of results from grain size analyses on representative samples from the soil/fill material at the site is presented in Appendix H.

4.3.2 Background Soil Sampling

Two surficial soil samples (BS-1 and BS-2) were collected from native soil in the wooded areas adjacent to the site to supplement existing inorganic background soil data obtained during the RI. Sampling locations are illustrated on Plate 1.

The concentrations of inorganic parameters detected in background soil during the RI and Supplemental RI are presented in Table 4-3. As shown in Table 4-3, the background concentrations of metals in the soil surrounding the site falls well within the common range of concentrations from the eastern United States reported in the literature (Shacklette and Boerngen, 1984). In addition, background data indicates that contamination has not extended beyond the fenced limits of the site's western boundary.

4.3.3 DEC Confirmatory Sampling

Six (6) surficial soil samples were collected at locations selected by the NYSDEC to confirm sampling results from the RI. These sampling locations are distributed throughout the Fire Academy Site as follows: Training Grounds Area (1 sample); Firing Range Area (1 sample); Genesee Valley Park (4 samples). Sampling locations are shown on Plate 1.

Analytical results for the NYSDEC confirmatory samples are summarized on Table 4-4. The results for organic and inorganic parameters are consistent with the results from the RI in terms of the general magnitude of concentrations and the identity of the compounds detected, thus confirming the adequacy of the RI data collected and the resulting data conclusions. Sample DEC-6, which exhibits generally higher concentrations than the other confirmatory samples, was collected in an area of discolored soil along the bike path outside of the South Disposal Area.

The information provided by these samples with respect to the assessment of contamination present in each Area will be addressed below in the discussions specific to each Area.

TABLE 4-3

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

INORGANIC ANALYTES DETECTED IN SOIL AT BACKGROUND LOCATIONS

Parameter (mg/kg dry wgt)	BKGD(1)	BS1(2)	BS2(2)	Concentrations of Inorganics in Natural Soils(3)	
				Common Range	Common Mean
Aluminum	18,500	na	na		
Antimony	<11	na	na		
Arsenic	2.8	5.20	4.90	1-50	5
Barium	102 J	na	na		
Beryllium	0.58 J	na	na		
Cadmium	<0.21	<0.96	<0.92	0.01-0.7	0.06
Calcium	40,400	na	na		
Chromium	24.6	na	na		
Cobalt	10.4 J	na	na		
Copper	13.1	14.2	7.40	2-100	30
Iron	25,500 J	na	na		
Lead	<6.7	9.00	23.7	2-200	10
Magnesium	11,000	na	na		
Manganese	451 J	na	na		
Mercury	<0.11	<0.13	<0.12	0.01-0.34(4)	0.12
Nickel	21.7	na	na		
Potassium	3,800	na	na		
Selenium	<0.42	na	na		
Silver	<0.67	1.20	<0.69	0.01-5	0.05
Sodium	229 J	na	na		
Thallium	<0.42	na	na		
Vanadium	37.8	na	na		
Zinc	54.7 J	57.9	47.4	10-300	50

NOTES:

(1) = Sampling results from May 1991 Remedial Investigation Report
(2) = Sampling results from 1991 Supplemental RI
(3) = Obtained from USEPA Office of Solid Waste and Emergency Response, Hazardous Waste Land Treatment, SW-874 (April 1983)
(4) = Obtained from Shacklette and Boerngen (1984)
J = Estimated value due to limitations identified during quality control review.
na = not analyzed

TABLE 4-4

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

NYSDEC CONFIRMATORY SOIL SAMPLING RESULTS
ORGANIC ELEMENTS (mg/kg dry wgt)

LOCATION: SAMPLE NO.	GP/BP DEC1	GP/BP DEC2	TG DEC3	FR DEC4	GP/BP DEC5	GP/BP DEC6	GP/BP DEC6RE$^{(1)}$
Volatile Compounds$^{(2)}$:							
Methylene Chloride	0.020 B	0.011 B	0.007 B	0.008 B	0.011 B	0.014 B	NA
Acetone	0.014 B	<0.011	0.011 BJ	0.006 BJ	<0.013	0.008 BJ	NA
1,1,1-Trichloroethane	0.002 J	<0.006	<0.006	0.006	<0.006	<0.007	NA
Trichloroethene	<0.007	<0.006	<0.006	<0.006	<0.006	0.004 J	NA
Semi-Volatile Compounds$^{(2)}$:							
Dimethylphthalate	<0.450	<0.380	<0.390	<0.410	<0.420	0.063 J	0.056 J
Diethylphthalate	<0.450	<0.380	<0.390	<0.410	<0.420	2.1	1.9
Phenanthrene	0.11 J	<0.380	<0.390	<0.410	0.053 J	0.078 J	0.080 J
Di-n-butylphthalate	<0.450	<0.380	<0.390	<0.410	<0.420	0.16 J	0.17 J
Pyrene	0.15 J	<0.380	<0.390	<0.410	0.095 J	0.096 J	0.091 J
Benzo(a)anthracene	0.091 J	<0.380	<0.390	<0.410	0.048 J	<0.460	<0.460
Chrysene	0.11 J	<0.380	<0.390	<0.410	0.062 J	0.066 J	0.067 J
Bis(2-ethylhexyl)phthalate	<0.450	<0.380	<0.390	<0.410	<0.420	0.35 J	0.35 J
Di-n-octylphthalate	<0.450	<0.380	<0.390	<0.410	<0.420	0.46 UJ	0.46U J
Benzo(b)fluoranthene	0.10 J	<0.380	<0.390	<0.410	<0.420	0.060 J	0.066 J
Benzo(k)fluoranthene	0.10 J	<0.380	<0.390	<0.410	<0.420	0.055 J	0.071 J
Benzo(a)pyrene	0.084 J	<0.380	<0.390	<0.410	0.058 J	0.46U J	0.46 UJ
Indeno(1,2,3-cd)pyrene	<0.450	<0.380	<0.390	<0.410	<0.420	0.46U J	0.46 UJ
Dibenz(a,h)anthracene	<0.450	<0.380	<0.390	<0.410	<0.420	0.46U J	0.46 UJ
Benzo(g,h,i)-perylene	<0.450	<0.380	<0.390	<0.410	<0.420	0.46U J	0.46 UJ
Pesticide/PCBs$^{(2)}$							
Endosulfan I	<0.011	<0.009	<0.009	0.010	<0.010	0.32 J	NA
4,4'-DDE	<0.022	<0.018	<0.019	<0.020	0.0092 J	<0.110	NA
Endosulfan Sulfate	0.014 J	<0.018	<0.019	<0.020	0.039	<0.110	NA
Aroclor 1254	<0.220	<0.180	<0.190	<0.200	<0.200	14	NA
Aroclor 1260	<0.220	0.055 J	0.081 J	<0.200	0.25	<1.10	NA

(continued)

TABLE 4-4 (Continued)

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

NYSDEC CONFIRMATORY SOIL SAMPLING RESULTS
INORGANIC ELEMENTS (mg/kg, dry wgt)

LOCATION: SAMPLE NO.:	GP/BP DEC1	GP/BP DEC2	TG DEC3	FR DEC4	GP/BP DEC5	GP/BP DEC6
Aluminum	8,770	4,980	3,320	12,400	8,250	11,300
Antimony	<8.90	<9.00	<7.40	<8.10	<9.30	12.1 BJ
Arsenic	6.30 J	4.70 J	4.80 J	3.70 J	5.60 J	18.2 J
Barium	53.6	32.3	13.2	56.0	50.5	313
Beryllium	0.42	<0.22	0.22	0.43	0.33	0.32
Cadmium	<0.89	<0.90	<0.74	<0.81	1.10	328
Calcium	2,750 J	98,200 J	135,000 J	11,600 J	3,710 J	11,200 J
Chromium	9.80	6.80	4.40	13.6	9.70	162
Cobalt	5.80	3.10	2.20	5.40	5.50	13.4
Copper	16.3	17.7	5.90	11.4	18.9	1090
Iron	17,500 J	10,800 J	9,320 J	19,800 J	16,300 J	22,800 J
Lead	31.4	46.2	17.8	17.7	25.3	964
Magnesium	2,980	28,500	60,300	5,710	3,020	6,950
Manganese	292 J	412 J	240 J	249 J	258 J	375 J
Mercury	0.27	<0.12	<0.11	<0.11	<0.12	0.80
Nickel	15.9	10.7	6.50	11.5	15.7	86.3
Potassium	1,320	991	1,530	1080	885	1060
Selenium	<0.49	<0.50	<0.41	<0.44	<0.49	0.75 J
Silver	<0.67	<0.67	<0.56	<0.61	<0.70	2.20
Sodium	44.5	104	123	84.6	<41.9	72.2
Thallium	<0.49	0.62	<0.41	0.48	0.58	<0.48
Vanadium	16.9	11.5	6.70	22.7	13.1	17.7
Zinc	61.5 J	58.9 J	10.7 J	44.9 J	60.1 J	767 J
Cyanide	<2.90	<2.90	<2.30	<2.60	<3.00	8.80

LEGEND:

(1) = Re-analysis of DEC6 to bring analytical results into better control.
(2) = Only those analytes detected above analytical detection limits at one or more locations are presented.
GP/BP = Genesee Park, East of Bicycle Path
TG = Training Grounds
FR = Police Firing Range
B = Detection limit estimated due to blank contamination.
NA = Not Analyzed
J = Estimated value due to limitations identified during the quality control review.
UJ = Not detected. Detection limit estimated due to low internal standard areas.

4.3.4 North Disposal Area

Sampling Approach

During the RI sampling program at the North Disposal Area eight (8) samples were collected from the fill material, and two (2) samples were collected from the native soil at locations near the limits of the fill. No contamination, except for very low concentrations of certain volatile and semi-volatile organics, was detected at locations removed from the fill material.

During the Supplemental RI additional samples were taken from the surficial native soil at six (6) locations beyond the limits of the fill (ND-1 to ND-6) to assess the extent of lateral migration. Subsurface samples were collected at three (3) locations (NDB-1 to NDB-3) to assess the extent of vertical migration in native soils beneath the fill. These samples were collected at 6-inch intervals in the upper 2 feet of soil or until saturated soils were encountered. Only a single sample was collected at location NDB-3, since saturated soil conditions were encountered at the base of the fill. Sampling locations area illustrated on Plate 1.

Sampling Results

Analytical results from the Supplemental RI are shown on Table 4-5. Refer to Appendix F for analytical results from the RI. The PCBs and seven metals of concern detected during both RI programs are discussed below.

> **PCBs** – Trace to low concentrations of PCB Aroclor 1254 (0.16 to 10 mg/kg) and Aroclor 1260 (0.16 to 9.7 mg/kg) were found in six of eight samples from the fill material during the RI.
>
> Surficial soil samples collected beyond the visual limits of waste disposal exhibit low to trace levels of PCBs (0.027 to 1.9 mg/kg Aroclor 1260 and 0.16 to 0.26 mg/kg Aroclor 1254). The highest PCB concentrations in native soil were found at ND-2 and ND-3. Locations ND-2 and ND-3 are in or near a shallow drainage swale and are near a steeply sloped berm at the edge of the fill. The swale may receive runoff from the fill material.
>
> Trace concentrations of PCB Aroclor 1254 (0.10 mg/kg) and Aroclor 1248 (0.010 to 0.0.046 mg/kg) were detected beneath the waste material at borings NDB-2 and NDB-3 at a depth of 0 to 24 inches.
>
> **Inorganic Parameters** – As shown in Table 4-6, concentrations of the seven (7) metals of concern in the fill material are elevated above the common range reported in the literature for natural (uncontaminated) soil.

TABLE 4-5

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOIL OF THE NORTH DISPOSAL AREA

		PCBs(3) (mg/kg, dry wgt)				TOTAL METALS (mg/kg, dry wgt)						
Sample Location	Depth(1)	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
ND-1	0-6	<0.110	<0.220	0.27	0.27	9.0	<0.87	22.4	60.1	<0.13	<0.66	97.2 J
ND-2	0-6	<0.550	<1.10	1.9	1.9	14.4	<0.92	24.0	55.1	<0.12	1.10	140 J
ND-3	0-6	<0.560	<1.10	1.2	1.2	16.9	1.10	31.4	102	0.25 J	1.70	198 J
ND-4	0-6	<0.110	0.26	<0.230	0.26	11.1	<0.97	32.5	59.6	<0.14	1.50	143 J
ND-5	0-6	<0.110	0.16 J	<0.220	0.16 J	9.40	<0.91	18.3	48.3	<0.12	0.93	88.2 J
ND-6	0-6	<0.110	0.16 J	<0.220	0.16 J	6.40	<0.83	36.7	59.9	<0.12	<0.63	120 J
	Depth(2)											
NDB-1	0-6	<0.100	<0.200	<0.200	<0.200	10.5	<0.85	11.5	17.3	<0.12	1.20	94.0 J
	6-12	<0.100	<0.210	<0.210	<0.210	15.3	<0.86	9.80	18.4	<0.12	1.30	9.10 J
	12-18	<0.096	<0.190	<0.190	<0.190	10.8	<0.84	19.1	15.6	<0.12	1.20	86.8 J
	18-24	<0.099	<0.200	<0.200	<0.200	6.60	<0.82	9.30	10.7	<0.12	0.84	63.3 J
NDB-2	0-6	<0.099	0.10 J	<0.200	0.10 J	8.70	<0.79	21.4	154 J	<0.11	<0.60	148 J
	6-12	<0.095	<0.190	<0.190	<0.190	8.90	<0.80	15.1	38.0	<0.12	1.30	216 J
	12-18	0.010 J	<0.160	<0.160	0.010	7.20	1.00	14.4	13.0	<0.11	0.92	67.7 J
	18-24	0.046 J	<0.190	<0.190	0.046	6.90	<0.78	17.2	11.1	<0.11	0.82	59.5 J
NDB-3	0-6	0.033 J	<0.200	<0.200	0.033 J	5.60	<0.82	14.2	8.60	<0.12	<0.61	49.7 J

NOTES:

(1)	=	Depth in inches below ground surface.
(2)	=	Depth in inches below base of fill material.
(3)	=	Only Aroclors found above analytical detection limits at a minimum of one location are presented.
J	=	Estimated value due to limitations identified during the quality control review.

TABLE 4-6
CITY OF ROCHESTER, ROCHESTER FIRE ACADEMY, SUPPLEMENTAL RI
COMPARISON OF INORGANIC CONCENTRATIONS TO NATURAL SOILS, NORTH DISPOSAL AREA

	CONCENTRATIONS OF INORGANIC PARMETERS DETECTED ON-SITE						CONCENTRATIONS OF INORGANICS IN NATURAL SOILS (1)	
	NATIVE SOIL (4)			FILL MATERIAL (5)				
PARAMETER (mg/kg)	CONCENTRATION RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	CONCENTRATION RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	COMMON RANGE	COMMON MEAN
Arsenic	5.8-16.9	9.9	0/8	8.3-69	28.8	1/8	1 - 50	5
Cadmium	<0.2-1.10	0.48	1/8	2.6-20.1	8.4	8/8	0.01 - 0.7	0.06
Copper	12.7-36.7	24.1	0/8	29.8-51,700	8,330	6/8	2 - 100	30
Lead	16.2-102	57.3	0/8	830-7,860	3,524	8/8	2 - 200	10
Mercury	<0.12-0.43	0.15	1/8	0.16-1.60	0.58	5/8	0.01 - 0.3	0.03
Silver	<0.6-1.7	0.81	0/8	<0.6-47.6	7.6	2/8	0.01 - 5	0.05
Zinc	54.4-198	114	0/8	246-6,190	2,004	7/8	10 - 300	50

NOTES:

(1) USEPA Office of Soild Waste and Emergency Response, Hazardous Waste Land Treatment, SW-846 (April, 1983).

(2) Shacklette and Boerngen (1984)

(3) Values below the detection limit were averaged at one-half the reported detection limit.

(4) Includes ND-1 to ND-6, TP-1, and SS-1

(5) Includes TP-2 to TP-5, SS-2 to SS-4, and B-1

Surficial soil samples from native soil exhibit concentrations of arsenic, copper, lead, silver, and zinc that are within the common range of metals in naturally-occurring soils. One occurrence each of mercury and cadmium were detected (at ND-3 and SS-1) at concentrations slightly greater than the common range for naturally occurring soils (see Table 4-3). Subsurface native soil samples exhibit concentrations of metals within the common range of concentrations in natural soil and do not indicate any trends with depth.

Summary

Sampling results indicate that the levels of inorganic contaminants detected beyond the visual limits of the fill material are within or slightly above the concentrations reported for naturally occurring soils. Low levels of PCBs (>1 mg/kg total Aroclors) occur in surficial soil along a possible drainage swale. However, data from the RI show that substantial concentrations of PCBs and metals occur in the fill material.

4.3.5 Training Grounds Area

Sampling Approach

The Supplemental RI sampling was conducted to determine the horizontal and vertical extent of contamination in the gravelly fill and the unsaturated zone of the underlying native soil. Based on areal photographs and both current and historic use, the Training Grounds Area was compartmentalized into three areas. These three areas (designated as Area 1, Area 2, and Area 3) are identified on Plate 1. Soil sampling locations were selected representing a spacing of approximately 100 feet in Areas 1 and Areas 2. Historic records indicated that Area 3 is less likely to have been contaminated from site activities, therefore a spacing of 125 feet was selected for sampling.

Each area was further subdivided into separate subareas to facilitate sample compositing. As shown on Plate 1, Area 1 consists of 5 subareas (identified as subareas 1A through 1E); Area 2 consists of 3 subareas (subareas 2A through 2C); and Area 3 consists of 2 subareas (subareas 3A and 3B). Two to three sampling locations were selected in each subarea for a total of 28 sampling locations.

Grab samples were collected at 6-inch intervals in the upper two feet of soil/fill or until saturated soils were encountered below the base of the crushed stone from each location. The grab samples from the 0" to 6" interval in each subarea were composited. Subareas 1B and 1C; 1D and 1E; 2A and 2B were composited together for the 6" to 12", 12" to 18", and 18" to 24" intervals. A total of 112 grab samples were collected, and a total of 31 composite samples were submitted for analysis. Each composite sample number has an alphanumeric format indicating the Subarea and sampling depth (viz. sample 1A06 is a composite sample collected from Subarea 1A, 0 to 6" below the base of the crushed stone).

A description of each of the 112 grab samples, the total organic vapor readings obtained from each sample, and a summary of the compositing schedule are provided in Appendix G.

Sampling Results

Analytical results from the Supplemental RI are shown on Table 4-7. Refer to Appendix F for analytical results from the RI. The PCBs and seven metals of concern detected during both RI programs are discussed below.

PCBs — PCBs were detected in 30 of 31 composite samples of soil/fill material, which were collected from a depth of 0 to 24 inches in sampling Areas 1, 2, and 3. However, only trace concentrations of PCBs (0.052 to 0.43 mg/kg total Aroclors) were detected in subareas 2A, 2B, 2BC, 2C, and 3A at all depths. Concentrations of PCBs ranging from 3.0 mg/kg to 85 mg/kg total Aroclors were detected in the composite samples from Area 1.

PCB concentrations in Area 1 decreased with depth below the 0 to 12-inch intervals to trace levels in all sampling areas except area 1DE. Soil/fill samples 1DE1218 and 1DE1824 are each a composite of 6 grab samples. The PCB occurrence at depth may be at grab sample location 1D3, which exhibited black staining and elevated total organic vapor readings of (see sample descriptions in Appendix G).

Sampling area 3B exhibited 42 mg/kg total PCBs in the 0 to 6-inch interval; however, only trace levels of PCBs were detected in Area 3B below 6 inches.
PCBs were also detected at concentrations of 31 mg/kg to 2.4 mg/kg total Aroclors in sampling areas 1C, 1D, and 1E (at locations SS-7, B-2, MW-14S, and TP-6; see Appendix F during the RI. These results are primarily composite samples of the 0 to 24 inch depth interval. A PCB concentration of 1.7 mg/kg was detected in area 2B at location SS-12 during the RI. Based on the 1991 sampling results, the occurrence of PCBs at SS-12 appears to have a limited extent.

Inorganic Parameters — The concentration range and mean of the seven metals of concern in on-site soil/fill is compared to the range of concentrations reported in the literature for natural soils (the common range) in Table 4-8. The concentrations of metals detected in sampling Area 1 (below 12 inches), Area 2 (all depths), and Area 3 (all depths) are within the common range of soil concentrations.

TABLE 4-7

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOILS OF THE TRAINING GROUNDS AREA

		PCBs$^{(2)}$ (mg/kg, dry wgt.)				Total Metals (mg/kg, dry wgt)						
Area & Sub-Area	**Depth$^{(1)}$ (inches)**	**Aroclor 1248**	**Aroclor 1254**	**Aroclor 1260**	**Total Aroclors**	**Arsenic**	**Cadmium**	**Copper**	**Lead**	**Mercury**	**Silver**	**Zinc**
1 A	0-6	1.10 J	16 J	9.4 J	26.5 J	5.50	3.90	87.7	1210 J	0.17 J	0.89	196 J
1 A	6-12	0.720	7.5 J	6.7 J	14.9 J	5.70	9.10	38.3	205 J	0.11 J	<0.59	126 J
1 A	12-18	0.15	0.39	0.17 J	0.71 J	5.10	<0.74	10.0	13.2 J	<0.11	<0.56	49 J
1 A	18-24	0.26	0.12 J	<0.190	0.38	4.20	<0.84	11.9	6.5 J	<0.11	<0.63	61.4 J
1 B	0-6	<0.180	0.26 J	0.37	0.63 J	4.80	<0.83	18.0	64.2 J	<0.11	<0.62	32.8 J
1 C	0-6	<1.80	25 J	20 J	45 J	3.50	2.80	21.5	154 J	0.17 J	<0.60	70.2 J
1 BC	6-12	26	59	<3.90	85	3.60	3.20	30.8	4380 J	<0.11	<0.60	74.7 J
1 BC	12-18	0.065 J	0.10 J	<0.190	0.165 J	6.20	<0.83	12.5	19.6 J	<0.12	<0.62	48.9 J
1 BC	18-24	0.15	0.053 J	<0.210	0.203 J	6.70	<0.86	13.6	14.2 J	<0.12	<0.65	53.3 J
1 D	0-6	<0.450	1.10	7.3 J	8.4J J	5.20	4.00	65.5	558 J	0.19 J	<0.58	111 J
1 E	0-6	0.690	4.8 J	4.4 J	9.89 J	6.20	4.60	297	390 J	0.59 J	0.86	368 J
1 DE	6-12	<0.440	1.4	2.4	3.8	4.10	1.90	41.4	77.8 J	0.50 J	<0.58	75.0 J
1 DE	12-18	<0.490	0.33 J	2.7 J	3.03 J	4.90	<0.86	25.8	18.3 J	<0.10	<0.64	91.0 J
1 DE	18.24	<0.490	9.3	<0.990	9.3	8.30	<0.85	27.4	154 J	<0.12	<0.64	73.1 J
2 A	0-6	0.050 J	0.17 J	0.073 J	0.293 J	2.70	<0.71	9.20	32.7	<0.11	<0.53	38.1 J
2 A	(0-6)	(0.091 J)	(0.19 J)	(0.12 J)	(0.401 J)	(2.80)	(1.40)	(9.30)	(37.4)	<0.11	<0.52	(36.7 J)
2 B	0-6	0.042 J	<0.200	0.16 J	0.202 J	3.60	1.80	21.1	52.4	<0.11	<0.58	74.2 J
2 AB	6-12	<0.100	0.052 J	0.200 J	0.052 J	5.20	<0.78	7.80	28.5	<0.11	<0.59	30.3 J
2 AB	12-18	<0.110	0.079 J	<0.220	0.079 J	5.00	<0.81	9.00	13.9 J	<0.11	<0.60	33.5 J
2 AB	18-24	0.15	<0.230	<0.230	0.15	5.10	<0.84	11.2	13.3 J	<0.12	<0.63	42.9 J
2 C	0-6	0.054 J	0.21	0.17 J	0.434 J	3.60	1.60	71.1	178 J	<0.11	<0.61	71.8 J
2 C	6-12	0.063 J	0.15 J	0.56	0.773 J	5.40	<0.80	17.5	15.3 J	<0.10	<0.60	42.9 J
2 C	12-18	<0.094	0.072 J	<0.190	0.072 J	4.60	<0.73	12.2	7.8 J	<0.12	<0.44	50.1 J
2 C	18-24	<0.093	0.074 J	0.033 J	0.107 J	7.90	<0.80	13.2	12.6 J	0.11	<0.60	49.7 J

(Continued)

TABLE 4-7 (Continued)

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOILS OF THE TRAINING GROUNDS AREA

		PCBs[2] (mg/kg, dry wgt)				Total Metals (mg/kg, dry wgt)						
Sub-Area	Depth[1] (inches)	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
3 A	0-6	0.074 J	0.058 J	<0.190	0.132 J	2.00	0.95	3.40	15.1	<0.10	<0.54	10.9 J
3 A	6-12	<0.094	0.082 J	<0.190	0.082 J	4.70	<0.74	5.50	26.7	<0.10	<0.55	8.50 J
3 A	12-18	<0.110	0.056 J	<0.220	0.056 J	4.90	<0.78	10.0	15.9	<0.10	<0.58	44.1 J
3 A	18-24	0.15	<0.210	<0.210	0.15	5.80	<0.83	11.3	19.6	<0.11	<0.62	50.1 J
3 B	0-6	<1.60	42	<3.30	42	2.50	1.50	8.40	34.9	<0.11	<0.52	23.2 J
3 B	6-12	<0.170	0.58	<0.340	0.58	3.70	<0.75	48.6	29.0	<0.10	<0.56	45.5 J
3 B	12-18	<0.097	0.088 J	<0.190	0.088 J	5.60	0.75	9.90	13.7	<0.10	<0.54	30.9 J
3 B	18-24	<0.110	<0.210	<0.210	<0.210	4.10	<0.80	12.1	13.3	<0.10	<0.60	50.4 J
DEC-3		<0.094	<0.190	0.081 J	0.081 J	4.80 J	<0.74	5.90	17.8	<0.11	<0.56	10.7 J

NOTES:

(1) = Depth in inches below base of the crushed stone.

(2) = Only Aroclors found above analytical detection limits at a minimum of one location are presented.

( ) = Blind Duplicate.

J = Estimated value due to limitations identified during the quality control review.

TABLE 4-8
CITY OF ROCHESTER, ROCHESTER FIRE ACADEMY, SUPPLEMENTAL RI
COMPARISON OF INORGANIC CONCENTRATIONS TO NATURAL SOILS, TRAINING GROUNDS AREA

	CONCENTRATIONS OF INORGANIC PARAMETERS DETECTED ON–SITE						CONCENTRATIONS OF INORGANICS IN NATURAL SOILS (1)	
PARAMETER (mg/kg)	CONCENTRATION RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	CONCENTRATION RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	COMMON RANGE	COMMON MEAN
	AREA 1 (0" to 12") (4)			AREA 1 (12" to 24") (5)				
Arsenic	3.5–8.8	4.9	0/15	4.2–8.3	5.9	0/8	1 – 50	5
Cadmium	<0.83–9.1	3.5	10/15	<0.74–<0.86	–	0/8	0.01 – 0.7	0.06
Copper	18–297	56	1/15	10–27	17	0/8	2 – 100	30
Lead	64–4380	565	8/15	65–154	37.6	0/8	2 – 200	10
Mercury	<0.10–0.59	0.21	2/15	<0.10–<0.12	–	0/8	0.01 – 0.34 (2)	0.03
Silver	<0.58–0.89	0.23	0/15	<0.56–<0.65	–	0/8	0.01 – 5	0.05
Zinc	33–368	113	1/15	49–91	62.7	0/8	10 – 300	50
	AREA 2 (0" to 24") (6)			AREA 3 (0" to 24") (7)				
Arsenic	2.8–8.3	4.3	0/15	2.0–5.8	4.1	0/9	1 – 50	5
Cadmium	0.22–1.8	0.65	4/15	<0.74–1.5	0.60	0/9	0.01 – 0.7	0.06
Copper	6.6–188	29.2	1/15	3.4–49	13.7	0/9	2 – 100	30
Lead	7.8–178	30.1	0/15	8.4–35	19.7	0/9	2 – 200	10
Mercury	<0.10–0.21	0.07	0/15	<0.10–<0.11	–	0/9	0.01 – 0.34 (2)	0.03
Silver	<0.53–<0.63	–	0/15	<0.52–<0.62	–	0/9	0.01 – 5	0.05
Zinc	11–224	56	0/15	8.5–50	33.4	0/9	10 – 300	50

NOTES:

(1) USEPA Office of Solid Waste and Emergency Response Hazardous Waste Land Treatment, SW–874 (April, 1983)

(2) Shacklette and Boerngen (1984)

(3) Values below detection limit were averaged at one–half the reported detection limit.

(4) Values from Table 4–15, SS–5 to SS–8, B–2, MW–14, and TP–6.

(5) Values from Table 4–15.

(6) Values from Table 4–15, SS–10 to SS–12, B–4, and TP–8.

(7) Values from Table 4–15, and MW–13.

Cadmium, copper, lead, were detected at levels substantially exceeding the common range in the upper 12 inches of Area 1. In addition, zinc and mercury were detected at concentrations slightly exceeding the common range.

Summary

PCBs, cadmium, copper, and lead, with lesser amounts of zinc and mercury are present in the upper 12 inches of the soil/fill material (underlying the crushed stone) in Area 1 of the Training Grounds Area. Metals concentrations detected outside of Area 1 during both the RI and Supplemental RI sampling events are within the common range of concentrations for uncontaminated soil.

PCB (and metal) concentrations in Area 1 decrease with depth. Concentrations above 1 mg/kg total Aroclors were not detected below 12 inches, except locally. Outside of Area 1, PCBs concentrations above 1 mg/kg may be present in the upper 6-inches of fill throughout Area 3B, and at a localized sampling point in Area 2B.

Based on data from the RI, volatile organics, PAHs, phthalate esters, and PCBs occur in the vicinity of the aboveground fuel storage tanks, a buried fuel transmission line, and at lower levels, across the Training Grounds Area.

4.3.6 South Disposal Area

Sampling Approach

During the RI, samples of incineration residue were collected at TP-10/10A, TB-11/11A, B-6; and from the reworked soil at SS-19, TP-9, and B-7. Substantial concentrations of organic and inorganic contaminants were identified in the incineration residue (see Appendix F). During the Supplemental RI the reworked soil was further characterized by sampling at locations SD-2, SD-6, and SD-10. The soil/fill at SD-5 was a mixture of reworked soil and incineration residue, therefore it is categorized as incineration residue. Areas of undisturbed soil within the South Disposal Area were sampled at SD-1, SD-3, SD-4, SD-7, SD-8, and SD-9 to assess the extent of lateral migration of contaminants from the incineration residue.

A localized occurrence of a tarry incineration residue was observed during the Supplemental RI soil/fill sampling program. This material is described as a soft, black tar or asphalt-like subsistence with a solvent odor. It occurs as a 4-inch thick layer, approximately 20 feet by 20 feet in area, which underlies 2 to 3 inches of topsoil and overlies reworked soil or undisturbed soil. The extent of the tarry residue is shown on Plate 1. A sample was collected and designated as SDPROD.

Subsurface samples were collected beneath the incineration residue at SDB-1 and SDB-2 to assess the extent of vertical migration of contaminants. Samples were collected at 6-inch intervals in the upper two feet of soil. At each location the native soil was a brown clayey silt.

During the Supplemental RI sampling event, two of three ponded areas previously identified during the RI in the South Disposal Area were dry. These ponded areas are excavations created during the removal of drums from the South Disposal Area. The deepest excavation extends below the seasonal low water table. In one area (see Figure 4-1) numerous broken amber glass laboratory reagent bottles were observed on the sediment of the dry pond. A soil gas survey was performed with an HNu photoionization detector at each dry pond to determine whether organic vapors are present in the pond sediment.

Soil gas survey results and approximate monitoring locations from the Supplemental RI are presented on Figure 4-1. Total organic vapors were detected at concentrations ranging from 30 to 300 ppm at two (2) depressions. These results further substantiate the presence of total volatile organics (TVOs) detected in the incineration residue (33 to 366 mg/kg TVOs) and in pond sample PS-3 (2.1 mg/l TVOs) during the RI sampling.

Sampling Results

Analytical results from the Supplemental RI are shown on Table 4-9. Refer to Appendix F for analytical results from the RI. The PCBs and seven metals of concern detected during both RI programs are discussed below.

> **PCBs** – Trace concentrations of PCBs (0.017 to 0.11 mg/kg total Aroclor) were detected in samples of undisturbed soils. Reworked soil samples exhibited local occurrences of low levels of PCBs (>1 mg/kg) at locations SD-6 and SS-19. All incineration residue samples exhibit elevated concentrations of PCBs. Since the concentrations of PCBs decrease to trace levels in the undisturbed soil sample locations near the perimeter fenceline, the extent of PCB contamination (greater than 1 mg/kg) appears limited to the incineration residue and low levels of PCBs in the reworked soil.
>
> Trace concentrations of PCBs (0.032 mg/kg to 0.95 mg/kg total Aroclors) were detected in the undisturbed soil within 24 inches below the incineration residue at locations SDB-1 and SDB-2.
>
> **Metals** – Metal concentrations in undisturbed soil, reworked soil, and incineration residue are summarized in Table 4-10. In general, metals were detected in the

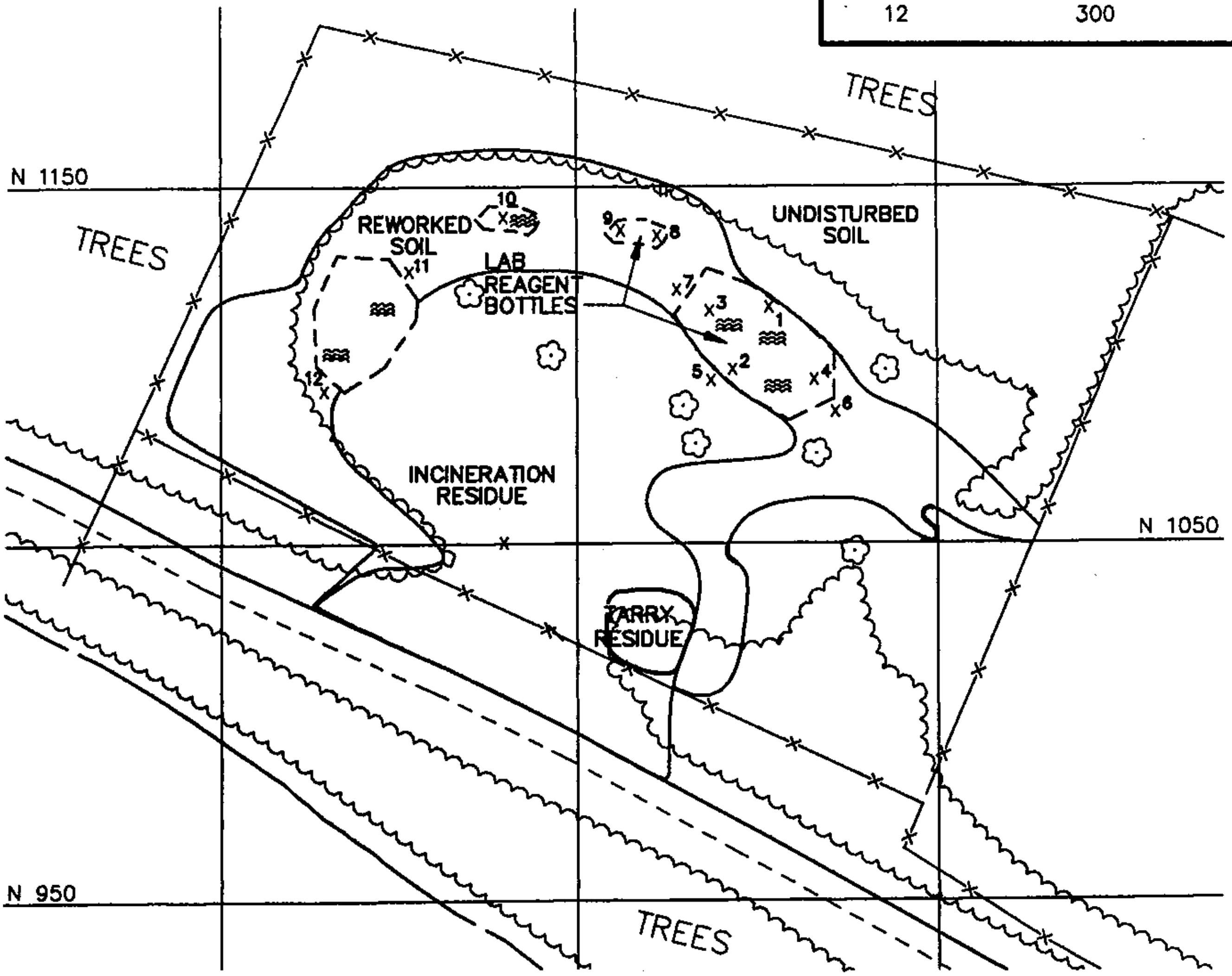
FIGURE 4-1

SOIL GAS SURVEY RESULTS

LOCATION	HNu READING (ppm)
1	300
2	200
3	300
4	180
5	30
6	1.0
7	2.0
8	1.0
9	.08
10	.02
11	100
12	300

LEGEND

$\overset{10}{x}$	APPROXIMATE SOIL GAS MEASUREMENT LOCATION
≋	PONDED WATER OR DRY DEPRESSION



ROCHESTER FIRE ACADEMY
SOUTH DISPOSAL AREA

LOCATION OF SOIL GAS MEASUREMENTS

CITY OF ROCHESTER
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ROC-07-F41

TABLE 4-9

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOIL OF THE SOUTH DISPOSAL AREA

		PCBs$^{(3)}$ (mg/kg, dry wgt)			TOTAL METALS (mg/kg, dry wgt)						
Sample Location / Type	Depth$^{(1)}$	Aroclor 1254	Aroclor 1260	Total Aroclors	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
SD-1 / Und	0-6	0.11J	<0.200	0.11 J	4.80	<0.95	18.1	38.7	<0.12	0.76	69.5 J
SD-2 / Rwkd	0-6	<0.226	0.31 J	0.31 J	5.10	<0.90	15.7	45.7	<0.12	<0.67	64.3 J
SD-3 / Und	0-6	<0.200	0.031 J	0.031 J	4.32	<0.82	16.9	194 J	<0.12	0.68	54.7 J
SD-4 / Und	0-6	0.081J	<0.200	0.081 J	4.00	<0.91	7.70	38.2	<0.13	0.82	51.7 J
SD-5 / Incin	0-6	83	<4.10	83	21.7	31.4 J	273 J	2260 J	0.11	<0.68	252 J
SD-5 / Incin	(0-6)	(87)	<4.10	(87)	(40.4)	(33.8 J)	(400 J)	(1920 J)	(0.11)	(0.75)	(450 J)
SD-6 / Rwkd	0-6	17J	8.8J	25.8 J	5.40	20.4 J	140 J	394 J	0.15	0.80	498 J
SD-7 / Und	0-6	0.13J	<0.190	0.13 J	5.20	<0.90	36.2 J	73.8 J	<0.11	<0.68	73.7 J
SD-8 / Und	0-6	0.017J	<0.220	0.017 J	6.90	<0.91	14.7 J	140 J	0.15	<0.68	64.6 J
SD-9 / Und	0-6	0.031J	0.070J	0.101 J	6.00	<0.85	17.3 J	47.6	0.12	0.70	96.0 J
SD-10 / Rwkd	0-6	0.038J	<0.210	<0.038 J	6.00	<0.83	29.6 J	51.0 J	<0.11	<0.62	62.9 J
	Depth$^{(2)}$										
SDB-1 / Und	0-6	0.57J	0.38J	0.95 J	2.90	4.90J	29.0 J	12.6	<0.11	<0.62	36.9 J
	6-12	0.12J	0.083J	0.203 J	4.10	<0.83	25.9 J	6.10	<0.11	<0.62	29.9 J
	12-18	0.071J	<0.190	0.071 J	2.80	<0.84	14.6 J	5.30	<0.11	<0.63	30.9 J
	18-24	0.055J	0.092J	0.147 J	3.70	<0.83	13.0 J	6.30	<0.11	<0.62	34.3 J
SDB-2 / Und	0-6	0.11 J	<0.200	0.11 J	6.20	<0.89	30.0 J	11.9 J	<0.11	0.71	64.2 J
	(0-6)	(0.11 J)	<0.200	(0.11 J)	(5.40)	<0.94	(27.2 J)	(10.4)	<0.12	<0.71	(64.5 J)
	6-12	0.068 J	<0.200	0.068 J	5.90	<0.86	21.2 J	11.2 J	<0.12	<0.64	52.7 J
	12-18	0.032 J	<0.200	0.032 J	5.30	<0.89	16.9 J	7.40	<0.11	<0.67	43.4 J
	18-24	<0.200	<0.200	<0.200	5.10	<0.83	16.0 J	7.90	<0.11	<0.62	43.3 J

NOTES:

(1) = Depth in inches below ground surface.
(2) = Depth in inches below base of fill material.
(3) = Only Aroclors found above analytical detection limits at a minimum of one location are presented.
( ) = Blind Duplicate.
J = Estimated value due to limitations identified during the quality control review.

Sample Type:
Und - Undisturbed soil
Rwkd - Reworked soil

TABLE 4-10

CITY OF ROCHESTER, ROCHESTER FIRE ACADEMY, SUPPLEMENTAL RI
COMPARISON OF INORGANIC CONCENTRATIONS TO NATURAL SOILS, SOUTH DISPOSAL AREA

PARAMETER (mg/kg)	CONCENTRATIONS OF INORGANIC PARMETERS DETECTED ON-SITE									CONCENTRATIONS OF INORGANICS IN NATURAL SOILS (1)	
	INCINERATION RESIDUE (4)			REWORKED SOIL (5)			UNDISTURBED SOIL (6)				
	RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	RANGE	MEAN (3)	# OCCUR. ABOVE COMMON RANGE/ # SAMPLES	COMMON RANGE	COMMON MEAN
Arsenic	7.5-52.5	34.4	2/4	4.4-16.3	7.1	0/6	4.0-6.9	5.2	0/6	1 - 50	5
Cadmium	32.6-151	82.1	4/4	<0.2-20.4	3.8	2/6	<0.82-<0.95	-	0/6	0.01 - 0.7	0.06
Copper	337-13,300	6,302	4/4	13-140	40	1/6	7.7-36.2	18.5	0/6	2 - 100	30
Lead	382-4,880	2,953	4/4	<6-721	203	2/6	38.2-194	89	0/6	2 - 200	10
Mercury	0.11-3.2	1.25	2/4	<0.11-0.15	0.10	0/6	<0.11-0.15	0.09	0/6	0.01 - 0.3	0.03
Silver	<0.60-50.5	13	1/4	<0.6-0.80	0.39	0/6	<0.68-0.82	0.72	0/6	0.01 - 5	0.05
Zinc	351-6,720	3,315	4/4	39.5-498	130	1/6	51.7-96.0	68	0/6	10 - 300	50

NOTES:
(1) USEPA Office of Solid Waste and Emergency Response
Hazardous Waste Land Treatment, SW-874 (April, 1983)
(2) Shacklette and Boerngen (1984)
(3) Values below detection limit were averaged at one-half the reported detection limit.
(4) Includes TP-10, TP-11, B-6, and SD-5.
(5) Includes SD-2, SD-6, SD-10, SS-19, TP-9, and B-7.
(6) Includes SD-1, SD-3, SD-4, SD-7, SD-8, and SD-9.

incineration residue at concentrations above those typically detected in naturally occurring soils. Concentrations of metals in the reworked soil were generally within the range for naturally occurring soils with the exception of SD-6 and SS-19.

Metal concentrations detected in undisturbed soil were within the common range for natural soil.

All incineration residue samples exhibited concentrations of cadmium, copper, lead, and zinc above the common range. Arsenic, mercury, and silver were elevated locally.

Cadmium was detected above the common range in the upper 6 inches below the incineration residue at SDB-1. This sample also had the highest total Aroclors (0.95 mg/kg) of the subsurface samples collected in the Supplemental RI. Metal concentrations in all other subsurface samples were within the common range for naturally occurring soils (see Table 4-9).

Tarry Residue – An analysis of the tarry residue (see Table 4-11) indicates that the residue contains 44,000 mg/kg (4.4%) Aroclor 1254. The material also contains two pesticides, aldrin (1200 mg/kg) and endosulfan-2 (770 mg/kg); four polycyclic aromatic hydrocarbons (24.1 mg/kg total PAHs); four phthalate esters (456 mg/kg total phthalates); and smaller concentrations of phenol and di-nitroso-diphenylamine.

Summary

The horizontal extent of PCB and metal contamination of soil in the South Disposal Area is limited to the reworked soil and incineration residue within the fence lines. As discussed in Section 4.3.7, however, the incineration residue also occurs outside of the fence in the Genesee Valley Park Area. A tarry residue containing high concentrations of PCBs and other organics occurs in a limited area within the South Disposal Area. Based on data from the RI, the incineration residue also contains substantial levels of volatile organics and low levels of phthalate esters. Although volatile organics have been detected at only trace concentrations in the reworked soil, the soil gas results suggest that higher concentrations may be present locally.

TABLE 4-11

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SOUTH DISPOSAL AREA - TARRY RESIDUE

SAMPLE NO.	SDPROD RE⁽¹⁾
Parameter⁽²⁾	
Semi-Volatile Compounds (mg/kg, dry wgt):	
Phenol	3 J
Naphthalene	3.9 J
2-Methylnaphthalene	10 J
Phenanthrene	6.8 J
Crysene	3.4
Dimethylphthalate	3.4 J
Diethylphthalate	63
Di-n-butylphthalate	40
Bis(2-ethylhexyl)phthalate	350
Di-nitroso-diphenylamine	13 J
Pesticides/PCBs (mg/kg, dry wgt):	
Aroclor-1254	44,000
Aldrin	1,200
Endosulfan 2	770 J

NOTE:

(1) = Re-analysis of the orignal sample (designated SDPROD) to bring analytical results into better control.

(2) = Only those analytes found above analytical detection limits are presented.

J = Estimated value due to limitations identified during the quality control review.

4.3.7 Genesee Valley Park Area

Sampling Approach

Additional surficial soil sampling was performed to determine the extent of the PCB and inorganic contamination identified during the RI in the Genesee Valley Park Area. Nine (9) surficial soil samples (GP-1 to GP-9) were collected at sampling locations identified on Plate 1. Soil sampling was concentrated in the southern portion of the Park Area due to PCB contamination identified in the South Disposal Area during the RI and evidence that this portion of the Area was a former haul road to the South Disposal Area. A total of 24 surficial soil, swale sediment, or shallow boring samples have been collected from the Genesee Valley Park Area.

Sampling Results

Analytical results from the Supplemental RI are shown on Table 4-12. Refer to Appendix F for analytical results from the RI. The PCBs and seven metals of concern detected during both RI programs are discussed below.

PCBs — Trace concentrations of PCBs (0.055 mg/kg to 0.89 mg/kg) were detected at 12 of 24 sampling locations. Concentrations of PCBs greater than 1 mg/kg were detected at 2 locations. These locations are opposite the South Disposal Area and in drainage swales, identified overland flow routes, and at localized points along the bike path as far north as location B-8.

Metals — Elevated concentrations of copper (1090 mg/kg), cadmium (328 mg/kg), lead (964 mg/kg), and zinc (767 mg/kg) were detected in surficial soil at DEC-6. These metal concentrations are similar to concentrations detected during the RI in the incineration residue which is present in the South Disposal Area and in the Genesee Valley Park Area across the bike path from DEC-6. The sample is described as a silty gravel subbase fill for the bike path (see Appendix G). Incineration residue may have been incorporated into the fill during construction of the bike path.

Cadmium was detected at concentrations exceeding the range of cadmium concentrations typically detected in naturally occurring soils at eight surficial soil sampling locations in the Genesee Park Area. These locations include surficial soil at SS-9, SS-14, DEC-5, GP-5, GP-6, SS-17, DEC-6, and GP-9. With the exception of DEC-6 (discussed above) all occurrences of elevated cadmium range from (1.1 to 17.4 mg/kg cadmium. Similar to the discussion of PCBs above, all of these sampling locations (including DEC-6) are related via the mechanism of transport of contamination from the South Disposal Area. The source of cadmium at these locations may be migration from the South Disposal Area via sediment transport or

TABLE 4-12
CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOIL OF THE GENESEE VALLEY PARK AREA

	PCBs(2) (mg/kg, dry wgt)			TOTAL METALS (mg/kg, dry wgt)						
Sample Location(1)	Aroclor 1254	Aroclor 1260	Total Aroclors	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
GP-1	0.20	<0.190	0.20	7.50	<0.87	25.9	51.1	<0.13	0.67	75.4 J
GP-2	0.14 J	<0.240	0.14 J	7.50	<0.96	17.4	39.9	<0.13	<0.72	70.7 J
(GP-2)	(0.25)	<0.240	0.25	(7.90)	<0.96	(17.2)	(32.6)	<0.13	<0.72	(70.2 J)
GP-3	0.14 J	<0.180	0.14 J	3.50	<0.72	11.8	19.3	<0.10	<0.54	39.9 J
GP-4	<0.190	<0.190	<0.190	5.90	<0.84	15.3 J	32.5	<0.11	<0.63	50.6 J
GP-5	0.54 J	0.35J	0.89 J	14.3	17.4 J	37.3 J	83.5	<0.11	<0.71	84.2 J
GP-6	0.14 J	0.22	0.36 J	15.0	5.40 J	18.1 J	32.7	<0.11	<0.61	59.0 J
GP-7	<0.190	<0.190	<0.190	6.3	<0.84	10.9 J	19.0	<0.10	<0.63	45.5 J
GP-8	0.19 J	<0.200	0.19 J	6.80	<0.88	12.3 J	30.5	<0.11	0.66	54.7 J
GP-9	1.2 J	0.74 J	1.94 J	6.20	12.4 J	35.7 J	47.2	<0.11	<0.63	73.8 J
DEC-1	<0.220	<0.220	<0.220	6.30 J	<0.89	16. 3	31.4	0.27	<0.67	61.5 J
DEC-2	<0.180	0.055 J	0.055 J	4.70 J	<0.90	17.7	46.2	<0.12	<0.687	58.9 J
DEC-5	<0.200	0.25	0.25	5.60 J	1.10	18.9	25.3	<0.12	<0.70	60.1 J
DEC-6	14	<1.10	14	18.2 J	328	1090	964	0.80	2.20	767 J

NOTE:
(1) = All samples collected from 0 to 6 inches below ground surface.
(2) = Only Aroclors found above analytical detection limits at a minimum of one location are presented.
( ) = Blind Duplicate.
J = Estimated value due to limitations identified during the quality control review.

overland flow of contaminated runoff. DEC-6 is present immediately adjacent to the limits of the incineration residue.

Swale sediment at SWSD-2 also exhibited elevated zinc (328 mg/kg) and cadmium (4.3 mg/kg). The source of metal contaminated sediment is also suspected to be the South Disposal Area for which the swale provides drainage.

Summary

PCBs and cadmium occur at elevated concentrations in the southern half of the Genesee Valley Park Area and only near the bike path. Elevated concentrations of contaminants have not been detected near the river bank. Metals other than cadmium occur at elevated concentrations only near the South Disposal Area. The frequency of detection and the magnitude of contamination is highest near the South Disposal Area. Based on data from the RI, organics other than PCBs are present at only trace concentrations.

4.3.8 Police Obstacle Course/Firing Range Area

Sampling Approach

PCBs were identified at low concentrations in one sample in the Firing Range Area during the RI. A total of four (4) additional surficial soil samples were collected during the Supplemental RI to establish the extent of contamination in this Area. Sample locations are shown on Plate 1.

A composite sample was collected prior to excavation of soil for a new obstacle course at locations selected by the NYSDOH and analyzed separately from the Supplemental RI samples. This sample is designated DOH and the discrete sampling locations are shown on Plate 1.

Sampling Results

Analytical results are presented on Table 4-13.

Organic Parameters – PCBs were detected at trace concentrations ranging from 0.058 mg/kg to 0.67 mg/kg total Aroclors.

Metals – Cadmium was detected at a concentration of 6.7 mg/kg at PF-2, and at concentrations near the upper range for natural soils at PF-3 and DOH.

TABLE 4-13

CITY OF ROCHESTER
ROCHESTER FIRE ACADEMY - SUPPLEMENTAL RI

SUMMARY OF ANALYTES DETECTED IN SURFICIAL AND SUBSURFACE SOIL OF THE POLICE FIRING RANGE AREA

	PCBs(3) (mg/kg, dry wgt)			TOTAL METALS (mg/kg, dry wgt)						
Sample Location(1)	Aroclor 1254	Aroclor 1260	Total Aroclors	Arsenic	Cadmium	Copper	Lead	Mercury	Silver	Zinc
PF-1	0.058 J	<0.170	0.058 J	2.40	<0.76	8.50	32.2	<0.10	<0.57	25.4 J
PF-2	0.25 J	0.42 J	0.67 J	5.60	6.20	23.6	72.8	0.12	0.62	58.5 J
PF-3	<0.180	<0.180	<0.180	4.30	0.77	12.8	38.9	<0.11	<0.55	43.8 J
PF-4	<0.190	<0.190	<0.190	3.80	<0.79	18.0	27.9	<0.11	<0.59	49.6 J
DEC-4	<0.200	<0.200	<0.200	3.70 J	<0.81	11.4	17.7	<0.11	<0.61	44.9 J
DOH(2)				5.44	0.67	17.2	66.6	0.05	0.66	5.38

NOTES:

(1) = Samples collected from a depth of 0 to 6 inches below ground surface.
(2) = Composite of four (4) grab samples collected at a depth of 0 to 4 inches below ground surface.
(3) = Only Aroclors found above analytical detection limits at a minimum of one location are presented.
J = Estimated value due to limitations identified during the quality control review.

Summary

Based on data from both the RI and the Supplemental RI, soil in the Police Obstacle Course/Firing Range Area exhibits only trace levels of PCBs, PAHs, and volatile organics. Inorganic contaminants are generally within the range concentrations detected in naturally occurring soil.

5.0 CONTAMINANT MIGRATION

5.1 CONTAMINANT PATHWAYS

Field investigations of the Rochester Fire Academy site indicate that contaminated ground water, generated as a result of dissolution of chemical constituents of the waste fill and contaminated soil, is moving off-site. Figure 5-1 schematically illustrates potential contaminant migration pathways for the Rochester Fire Academy site as identified during field investigations. Identified pathways include:

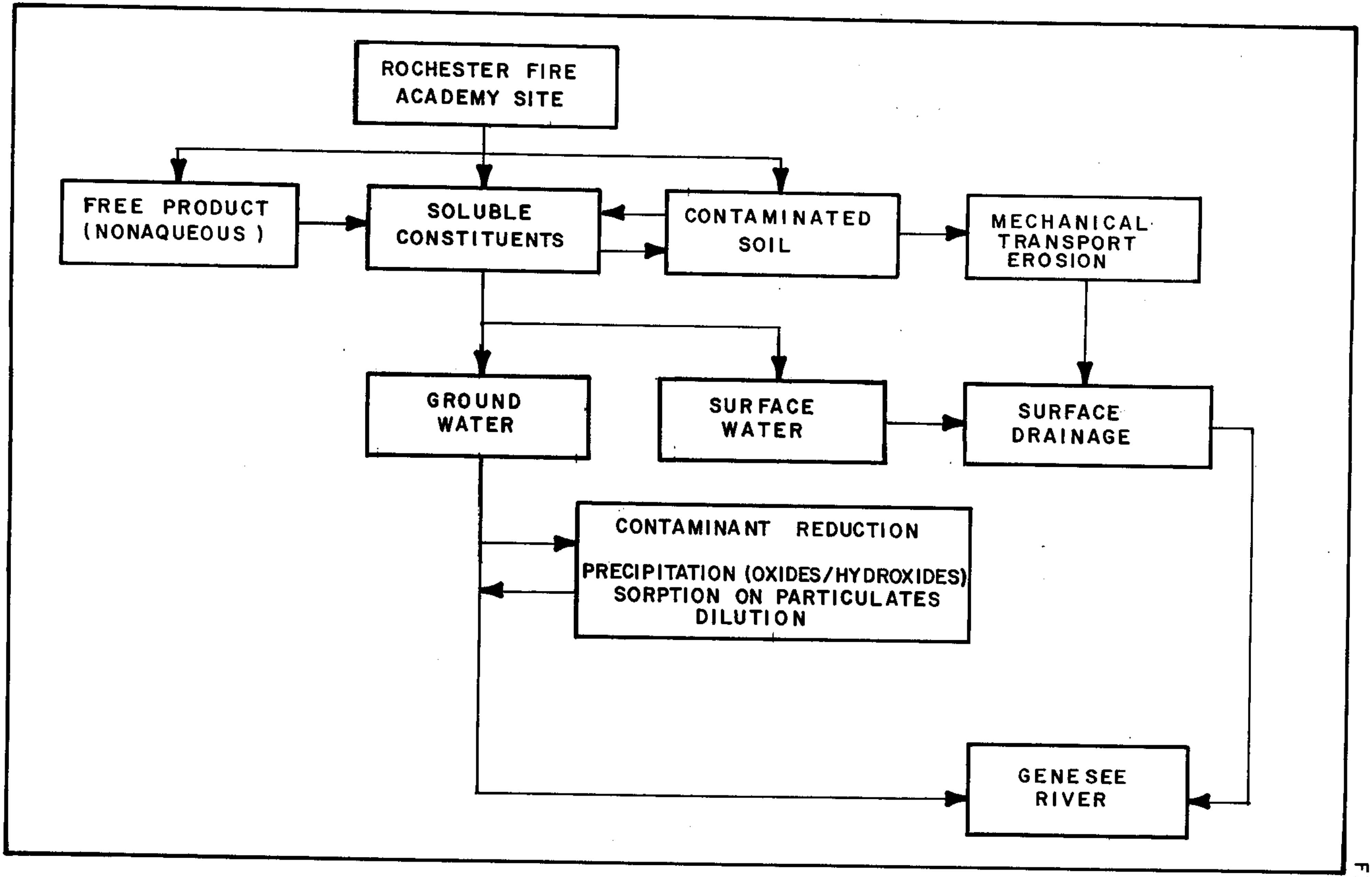
- overland runoff and mechanical transport of contaminated soil/fill material;
- continuous release of soluble constituents of the non-aqueous phase liquid located in the area of MW-14S to ground water within the shallow overburden;
- migration of solubilized contaminants in the soil/fill into ground water due to infiltration of precipitation and/or contact with ground water; and
- lateral movement of contaminated ground water through the shallow overburden, with ultimate discharge to the Genesee River.

A visual inspection of the site was also performed to determine the presence of underground utilities which might also act as a migration pathway. Each of these pathways is discussed in more detail in the following sections.

5.2 ASSESSMENT METHODOLOGY

5.2.1 Free-Product (Well M-14S)

During the RI, approximately 1.5 feet of slightly viscous golden-colored free-phase product was observed in MW-14S. The thickness of the free-product, as measured in the well using an oil-water level indicator, is an apparent thickness rather than a true thickness (Testa et al. 1989). The difference between the true and apparent thickness is attributed to both the contrast in specific gravity between the free-product and water and the fact that free-product is immiscible in water. This results in the free-product perching on the capillary fringe above the actual water table. With penetration of the capillary fringe by the



MALCOLM PIRNIE

ROC - 04

FIGURE 5 - 1

ROCHESTER FIRE ACADEMY
RI/ FS
SCHEMATIC OF POLLUTANT MIGRATION
(PATHWAYS / FATE)

CITY OF ROCHESTER, NEW YORK

APRIL 1992

monitoring well, free-product migrates into the well bore. The water surface within the well is lower than the top of the surrounding capillary fringe, thus allowing product to flow into the well. This in turn depresses the water level in the well until density equilibrium is attained. Therefore, a greater apparent product thickness is measured in the well than actually exists in the formation (Testa et al. 1989).

The immiscible product will remain perched on the water table and will migrate in the direction of ground water flow. The same free-product was not observed in any of the other nearby wells or borings completed in the shallow water-bearing zone; however, the nearest monitor location is greater than 150 feet away from MW-14S.

Based on the results of the RI, the free product in the Training Ground Area was identified as requiring an Interim Remedial Measure (IRM). In November 1991, an IRM field investigation was conducted to further define the extent and the potential for migration of the free product. The investigation included the installation of well points, a detailed soil gas survey in the vicinity of MW-14S, and an assessment of local ground water flow rates. Results of the IRM investigation were reported in Malcolm Pirnie, Inc. (February 1992) and are summarized in Section 5.3.1.

5.2.2 Overland Flow/Mechanical Transport

Mechanical transport of contaminated soil or fill particles by overland flow is expected to be minor due to the relatively flat topographic relief of the site. Site topography is illustrated in Plate 2. This expectation is further supported by the site water balance (see Section 6.1.1 in the RI Report) which indicates that surface runoff is only approximately 1% of the water leaving the South Disposal Area and the Training Grounds Area, and approximately 6% at the North Disposal Area.

Furthermore the City has implemented surface drainage control measures that tend to limit the mechanical transport of soil/fill particles from the site. The Training Grounds Area is covered by approximately 3-6 inches of crushed stone, and water in the vicinity of the burn pits is drained into a retention pond in the northeast corner of the Area. A swale has been constructed that collects surface runoff from the South Disposal Area, the Firing Range Area, and the southeastern portion of the Training Grounds Area. This swale also traps sediment that may be transported.

Sampling and analysis of surficial soil and sediment in the Genesee Valley Park Area (see Section 4.3.7) has demonstrated that low concentrations of contaminants occur locally along the bicycle path. Occurrences of PCBs at concentrations greater than 1 mg/kg are summarized as in Section 4.3.7.

The low concentrations and localized occurrence of the contamination detected in the Genesee Valley Park Area during the RI and the Supplemental RI suggest that the mechanical transport of contaminated soil/fill particles is not a currently active migration pathway. The flat topography and the diversion of runoff to on-site ponds or specific swales limits uncontrolled overland flow into the Park from the west. Similarly, the contaminants detected along the bike path are not likely to reach the Genesee River by overland flow. No substantial contamination has been detected at sampling sites adjacent to the Genesee River bank (viz. GP-4, GP-7, and GP-8). Therefore, actual contaminant loadings to the river via this pathway were not assessed.

5.2.3 Ground Water

Contaminant loadings to the Genesee River via the ground water pathway were calculated for the North Disposal Area, the Training Grounds Area, and the South Disposal Area using site water balance data presented in Section 6.1.1 of the RI Report and contaminant concentration data presented in Section 4.0. Consideration made in these calculations included:

- ground water from the overburden water bearing zone is the primary source of contaminant loading to the river. An estimate of loading from the upper bedrock zone was also performed because the bedrock ground water most likely discharges directly to the river.
- the quantity of contaminants in the overburden zone was not corrected for upgradient potential background sources (viz. hydraulically upgradient of the site); and
- loading calculations were made for the following groups of parameters:
    - total volatile organics,
    - total semi-volatile organics,
    - total PCBs,
    - total iron and manganese,
    - total metals (viz. As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Sb, Se, Ag, Tl, and Zn) excluding Fe and Mn.

All data collected during the RI from monitoring wells located along the Genesee River (viz. MW-11S in the North Disposal Area; MW-8S, MW-12S, MW-15S in the Training Grounds Area; and MW-7S in the South Disposal Area) were utilized to calculate separate average concentrations of the above-specified groups of contaminants for each study Area as shown in Table 5-1. Contaminant loadings to the Genesee River were calculated using an estimated ground water outflow of 207 ft^3/day for the North Disposal Area; 1,033 ft^3/day for the Training Grounds Area (see Section 6.1.1 of the RI Report); and 126 ft^3/day for the South Disposal Area (see Section 2.0) and the average ground water concentrations as described above.

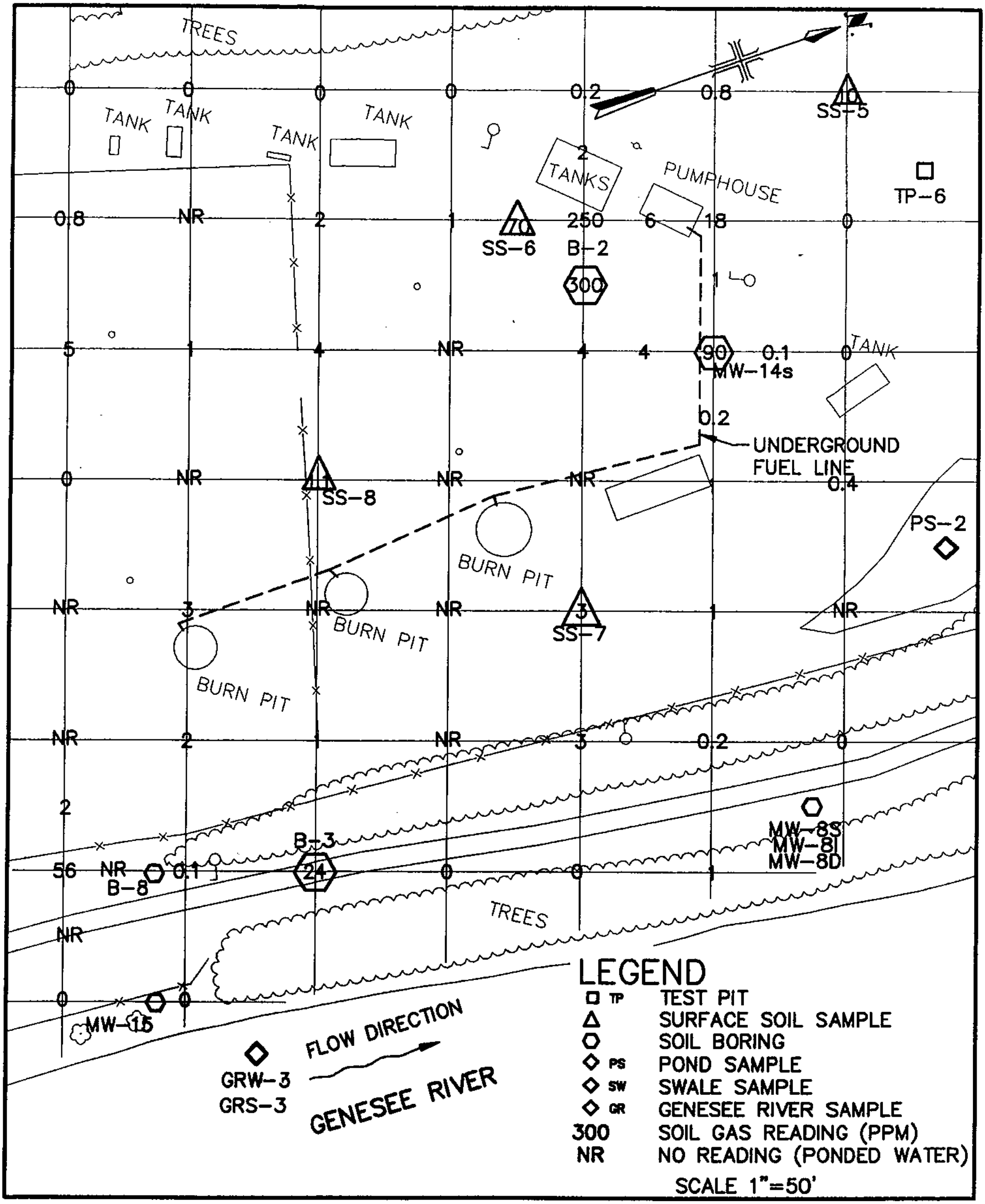
An identical calculation was performed for the upper bedrock zone assuming a saturated thickness of 10 feet (the thickness of the monitoring interval). Average concentrations were determined from all analyses at upper bedrock wells located along the River (viz. MW-11I and MW-16I in the North Disposal Area; MW-8I and MW-12I in the Training Grounds Area; and MW-7I in the South Disposal Area) as shown in Table 5-2. Ground water contaminant loadings were calculated using estimated ground water outflows of 431 ft^3/day for the North Disposal Area; 2392 ft^3/day for the Training Grounds; and 476 ft^3 day for the South Disposal Area (see Appendix I).

5.2.4 Underground Utilities Investigation

Underground utilities that were identified on-site include: a) a stormwater drain (see Figure 1-2); and b) a fuel line (see Figure 5-2), both in the Training Grounds Area. The stormwater drain carries stormwater from an area east of the site to an outfall located along the Genesee River. During the RI, water generated during the training exercises was observed being pumped from the training structures to the stormwater drain. An oily sheen was observed to be discharging from the stormwater drain outfall to the Genesee River. Test pit TP-7 was excavated in order to examine the bedding material beneath the sewer. However, only recompacted soil was observed indicating that there is little potential for contaminant migration in the subsurface along the pipe.

The fuel line was formerly used to carry fuel oil from a storage tank via a pump house to four (4) burn pits used for training exercises (see Figure 5-2). Based on observations at MW-14S, it is known that free product has leaked to the water table. The cause of the problem is most likely a leak in the pipe rather than the tank, because the pipe

FIGURE 5-2



MALCOLM PIRNIE

ROC-04-F82

ROCHESTER FIRE ACADEMY
REMEDIAL INVESTIGATIONS
SOIL GAS SURVEY RESULTS
NEAR MW-14S

CITY OF ROCHESTER

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reportedly requires more pumping when not used for a period of time, and three (3) shut-off valves are used to isolate the pipe from the tank. After recognizing the problem, the City closed all valves back to the tank and discontinued the use of the fuel line in October 1989. The City is presently pursuing the removal and disposal of fuel from the tanks.

A search was undertaken for additional outfalls along the River bank, but no other outfalls were observed.

5.3 CONTAMINANT LOADINGS

5.3.1 Free Product Migration

Soil gas survey results from the 1991 IRM Investigation indicated that organic vapor concentrations were elevated near the fuel storage tanks and near MW-14S. However, at the time of the soil gas survey, vapor levels decreased substantially at distances of 25 feet from the location of MW-14S. Therefore, based on soil gas survey results, the occurrence of free product at MW-14S appeared to be localized. Soil gas survey results in the vicinity of the fuel line are shown on Figure 5-2. High readings near the fuel tank are attributed to spillage during the transfer of fuel to the tanks. The high reading at MW-14S is attributed to free-product. Due to ponded water at the time of the survey, soil gas readings were not obtained from the vicinity of the fuel line along the burn pits.

The local extent of free-phase product was substantiated during the IRM field investigation. No free product was observed in any of the wellpoints installed within 20 feet of MW-14S. With the exception of an elevated organic vapor reading associated with discolored surficial soil, all elevated 1991 IRM investigation soil gas readings were restricted to an area within 20 feet of MW-14S. Based on a hydraulic conductivity of 4.4×10^{-6} cm/s, a hydraulic gradient of 0.015 ft/ft and an estimated porosity of 20%, the ground water flow rate within the native clayey silt in the vicinity of MW-14S is estimated to be less than 0.5 feet per year (Malcolm Pirnie, February 1992). Therefore, the free-phase product appears to be localized near MW-14S and the route of the fuel line. Extensive migration of the product is not predicted.

5.3.2 Ground Water Migration

Calculated contaminant loadings to the Genesee River from the Rochester Fire Academy site via the ground water pathway are summarized in Tables 5-1 and 5-2. Examination of the data in Table 5-1 for the overburden water bearing zone indicates that the yearly loading of semi-volatile organics, PCBs, and total trace metals is very low. Total volatile organics (37 Kg per year) and total iron/manganese (171 Kg per year) are the primary contaminants migrating off-site via shallow ground water to the river.

The primary source of ground water contamination in the Training Grounds Area appears to be the leaching of contaminated soil by the infiltration of precipitation, and by ground water that comes into direct contact with contaminated soil during periods of high ground water levels (two to three feet BGS). Soluble constituents of the free phase product may also contribute to the organic load. Dissolved phase constituents are conservatively assumed to move at the same rate as groundwater flow. The dissolved organic plume might be expected to migrate in an easterly direction at a rate of approximately 22 feet per year, based on a hydraulic gradient of 0.009 ft/ft, a hydraulic conductivity of 4.3 x 10^{-4} cm/s (1.2 ft/day), and a porosity of 0.20. These flow conditions are representative of the saturated silty sands that occur near the river (viz., at MW-8S). Substantially lower flow rates are at and west of MW-14S. Organic contamination is absent in the overburden well at MW-8S, which is 160 feet downgradient from MW-14S, but the age of the fuel oil leak is unknown.

Table 5-2 presents contaminant loadings from the upper bedrock aquifer to the Genesee River. After further evaluation of the contaminant loadings from the upper bedrock performed during the RI, the loading from the Training Grounds Area was revised. This revision is based upon the use of questionable data in the loading calculation. As discussed in the RI Report, anomalously high concentrations of volatile organic compounds were detected in monitoring well MW-12I during one round of ground water sampling. VOCs were not detected in two additional rounds of sampling. It was concluded that the anomalous detection of VOCs during the one round of sampling was attributable to cross-contamination of sampling equipment following the sampling of the contaminated well cluster MW-7. Therefore, the results from the first round of sampling were excluded from the revised VOC loading calculation presented herein and summarized in Table 5-1. The revised loading from the bedrock aquifer in the Training Grounds Area is 5.6 Kg/yr.

TABLE 5-1

ROCHESTER FIRE ACADEMY RI
OVERBURDEN GROUND WATER LOADING TO THE GENESEE RIVER

Parameter	NORTH DISPOSAL AREA		TRAINING GROUNDS AREA		SOUTH DISPOSAL AREA		Total*
	Average Concentration^2 mg/L	Load to River* Kg/yr	Average Concentration^3 mg/L	Load to River* Kg/yr	Average Concentration^4 mg/L	Load to River* Kg/Yr	Load to River (Kg/yr
Total Volatile Organics	0	0	0.026	0.28	28.7	37	37
Total Semi-Volatile Organics	0.013	0.028	0.005	0.05	0.114	0.15	0.23
Total PCBs	0	0	0	0	0.004	0.005	0.005
Total Iron and Manganese	17.2	37	10.4	111	17.8	23	171
Total Trace Metals^1	0.167	0.36	0.081	0.86	0.254	0.33	1.6

NOTES:
1. Total Trace Metals include: Ba, Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn.
2. Average of all analyses at MW-11S.
3. Average of all analyses at MW-8S, MW-12S.
4. Average of all analyses at MW-7S.
5. Sample calculation for Total Volatile Organics: 28.7 mg/L x 28.3 L/ft^3 x 126 ft^3/day x 10^{-6} Kg/mg x 365 day/yr = 37 Kg/yr.

* Estimated

TABLE 5-2

ROCHESTER FIRE ACADEMY RI
UPPER BEDROCK GROUND WATER LOADING TO THE GENESEE RIVER

Parameter	NORTH DISPOSAL AREA		TRAINING GROUNDS AREA		SOUTH DISPOSAL AREA		Total*
	Average Concentration[2] mg/L	Load to River* Kg/yr	Average Concentration[3] mg/L	Load to River* Kg/yr	Average Concentration[4] mg/L	Load to River* Kg/Yr	Load to River Kg/yr
Total Volatile Organics	0.028	0.12	0.225	5.6	7.0	34	39.72
Total Semi-Volatile Organics	0.001	0.004	0.004	0.10	0.012	0.06	0.16
Total PCBs	0	0	0	0	0.001	0.005	.005
Total Iron and Manganese	4.7	21	3.4	84	0.35	1.7	107
Total Trace Metals[1]	0.14	0.62	0.14	3.5	0	0	4.1

NOTES:

1. Total Trace Metals include: Ba, Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, Zn.
2. Average of all analyses at MW-11I and MW-16I.
3. Average of all analyses at MW-8I, MW-12I.
4. Average of all analyses at MW-7I.

* Estimated.

Organic contamination is present at the upper bedrock well at MW-8I. The source of the organic contamination in the upper bedrock at MW-8I may be the fill from the Training Grounds, since a) a downward hydraulic gradient exists between the overburden and bedrock (at least seasonally), b) there is no confining layer known to underlie the Training Grounds at MW-14S, and c) the rate of ground water flow in the upper bedrock is comparatively high. For example, based on a hydraulic gradient of 0.006 ft/ft, a hydraulic conductivity of 1.9 x 10^{-2} cm/s (53.9 ft/day), and a porosity of 0.05, the ground water flow rate in the upper bedrock would be 6.5 ft/day or nearly 2400 feet per year.

In contrast to the Training Grounds Area, the overburden ground water in the South Disposal Area exhibits higher concentrations of organic contaminants than does the bedrock aquifer. This probably results from the close proximity of monitoring well MW-7S to the source of contamination.

5.4 SUMMARY

The major pathway of contaminant migration from the Rochester Fire Academy Site is ground water flow to the Genesee River. The primary contaminants migrating to the River are volatile organics with a total loading of 77 Kg/year, and total iron and manganese with a total loading of 278 Kg/year. Volatile organics originate from the leaching of contaminated soil/fill material and, locally, from the solubilization of free phase product. Total iron/manganese loading is produced from the mobilization of naturally occurring metals, which results in part from the release of waste oils and oxidizable materials to the shallow ground water. Trace metals, if present in the aquifer matrix or the waste materials, are not being mobilized, under the existing conditions, to a degree that would contribute a substantial load to the river.

6.0 PUBLIC HEALTH RISK ASSESSMENT

6.1 HAZARD IDENTIFICATION

This section of the report presents an assessment of potential health risks of site contaminants to those using the Rochester Fire Academy facility and those in the surrounding area. The objectives of this risk assessment are to provide an analysis of baseline risks in the absence of any major action to control or mitigate site contamination, and to assist in determining the need for remediation. This assessment also provides a basis for comparing a variety of remedial alternatives, to determine which will be most protective of human health and the environment.

This risk assessment follows the guidance contained in the U.S. Environmental Protection Agency's (USEPA) Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part A). Interim Final (1989e) which is a companion document to USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (1988a). Supplemental guidance on human health evaluation procedures utilized in this assessment are referenced (USEPA, 1989c; 1991; 1992a; 1992b).

This baseline public health risk assessment is comprised of four elements, representing a number of tasks:

- Hazard Identification - in which site data are reviewed to identify potential chemicals of concern;
- Exposure Assessment - in which contaminant releases are analyzed; exposed populations/habitats identified; potential exposure pathways determined; exposure concentrations for pathways selected; and contaminant intakes for pathways estimated;
- Toxicity Assessment - in which qualitative and quantitative toxicity information is reviewed; and appropriate toxicity values presented; and
- Risk Characterization - in which the likelihood and magnitude of potential adverse health and environmental effects are characterized, the uncertainty of the process discussed; and risk information summarized.

This section of the report follows the step-wise approach to risk assessment outlined above, beginning with an identification of the potential chemicals of concern (hazard identification).

6.1.1 Data Evaluation

The analytical results from the RI and the Supplemental RI have been discussed in detail in Section 4.0 of this report. For the purposes of the public health risk assessment, these data are reviewed below in order to identify contaminants of potential concern and representative concentrations in the affected media. Each of the four areas where contamination was found (i.e., the North Disposal Area, the Training Ground Area, the South Disposal Area and Genesee Valley Park) are evaluated separately, as is the stretch of the Genesee River which is adjacent to the Genesee Valley Park.

SOILS

Inorganics - Relevant information for the selection of inorganic chemicals of potential concern is presented in Tables 6-1 through 6-4. This information consists of:

- Frequency of detection, or, the number of samples in which the chemical was quantified, divided by the total number of samples collected;
- Fraction above common range, or, the number of samples containing the chemical in concentrations above the range typically encountered in uncontaminated natural soils, divided by the total number of samples collected;
- Fraction above site background, or, the number of samples containing the compound at levels above the concentration measured in site background, divided by the total number of samples collected;
- Cancer weight-of-evidence, a classification system used by the USEPA to evaluate the potential carcinogenicity of a chemical based on epidemiological and animal studies. Group A indicates that the chemical is a human carcinogen, having sufficient evidence of carcinogenicity in humans. Group B indicates that the chemical is a probable human carcinogen (B1 - limited evidence of carcinogenicity in humans; B-2 - sufficient evidence of carcinogenicity in animals and inadequate or lack of human data). Group C includes "possible" human carcinogens, having limited evidence of carcinogenicity in animals and inadequate or no human data. Group D includes those chemicals which are not classifiable as to human carcinogenicity (having inadequate or no evidence).
- Essential nutrients - chemicals that are dietary requirements. If they are present at low concentrations and are toxic only at very high doses (such as iron, magnesium,

TABLE 6-1

Selection of Inorganic Parameters of Potential Public Health Concern
North Disposal Area Soils

Parameter	Frequency of Detection	Fraction above Common Range(1)	Fraction above Site Background(2)	Cancer Weight-of-Evidence	Essential Nutrient	Oral RfD(3)	Oral Slope Factor (4)	Selected for Evaluation?
Aluminum	10/11	0	0	--				
Antimony	3/11	0.27	0.27	--		X		
Arsenic	19/20	0.05	0.95	A		X	X	Yes
Barium	10/11	0.09	0.73	--		X		Yes
Beryllium	5/11	0.09	0.18	B2		X	X	
Cadmium	10/20	0.45	0.5	B1		X	X	Yes
Calcium	10/11	--	0.36	--	X			
Chromium	10/11	0	0.73	--		X		Yes
Cobalt	10/11	0.09	0.36	--				
Copper	19/20	0.3	0.9	D		X		Yes
Iron	10/11	--	0.36	--	X			
Lead	19/20	0.4	0.9	B2				Yes
Magnesium	10/11	0.73	0.55	--	X			
Manganese	10/11	0	0.27	D		X		
Mercury	11/20	0	0.55	D		X		Yes
Nickel	10/11	0	0.45	A		X		Yes
Potassium	10/11	--	0	--	X			
Selenium	7/11	0.27	0.64	D	X	X		
Silver	10/20	0.1	0.5	D		X		Yes
Sodium	10/11	--	0.45	--				
Thallium	1/11	0	0.09	--				
Vanadium	10/11	0	0	--		X		
Zinc	19/20	0.35	0.85	D		X		Yes

NOTES:

(1) Fraction of samples which exceed the range of concentrations in natural soils, as referenced in Section 4.
(2) Fraction of samples which exceed the background concentration in on-site soils, as referenced in Section 4.
(3) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of an EPA established value.
(4) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of an EPA established value.
A = Human Carcinogen
B1,B2 = Probable human carcinogen
D = Not classifiable as to carcinogenicity
-- = No data

TABLE 6-2

Selection of Inorganic Parameters of Potential Public Health Concern Training Grounds Soils

Parameter	Frequency of Detection	Fraction above Common Range(1)	Fraction above Site Background(2)	Cancer Weight-of-Evidence	Essential Nutrient	Oral RfD(3)	Oral Slope Factor (4)	Selected for Evaluation?
Aluminum	14/14	0	0	–				
Antimony	3/14	0.21	0.21	–		X		
Arsenic	24/24	0	0.88	A		X	X	Yes
Barium	14/14	0	0	–		X		
Beryllium	14/14	0	0	B2		X	X	
Cadmium	19/14	0.58	0.79	B1		X	X	Yes
Calcium	14/14	–	0.86	–	X			
Chromium	14/14	0	0.21	–		X		
Cobalt	13/14	0	0.07	–				
Copper	24/24	0.08	0.29	D		X		Yes
Iron	14/14	–	0	–	X			
Lead	24/24	0.25	1	B2				Yes
Magnesium	14/14	0.93	0.93	–	X			
Manganese	14/14	0	0	D		X		
Mercury	7/24	0	0.29	D		X		Yes
Nickel	13/14	0	0.07	A		X		
Potassium	14/14	–	0	–	X			
Selenium	2/14	0	0.14	D	X	X		
Silver	2/24	0	0.14	D		X		
Sodium	14/14	–	–	–				
Thallium	2/14	0	0.14	–				
Vanadium	13/14	0	0	–		X		
Zinc	24/24	0.04	0.5	D		X		Yes

NOTES:

(1) Fraction of samples which exceed the range of concentrations in natural soils, as referenced in Section 4.
(2) Fraction of samples which exceed the background concentration in on-site soils, as referenced in Section 4.
(3) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(4) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.
A = Human Carcinogen
B1,B2 = Probable human carcinogen
D = Not classifiable as to carcinogenicity
– = No data

TABLE 6-3

Selection of Inorganic Parameters of Potential Public Health Concern
South Disposal Area Soils

Parameter	Frequency of Detection	Fraction above Common Range$^{(1)}$	Fraction above Site Background$^{(2)}$	Cancer Weight-of-Evidence	Essential Nutrient	Oral RfD$^{(3)}$	Oral Slope Factor $^{(4)}$	Selected for Evaluation?
Aluminum	6/8	0	0.13	--				
Antimony	2/8	0.25	0.25	--		X		Yes
Arsenic	20/20	0.05	0.9	A		X	X	Yes
Barium	6/8	0	0.38	--		X		Yes
Beryllium	4/8	0	0	B2		X	X	
Cadmium	7/20	0.35	0.35	B1		X	X	Yes
Calcium	6/8	--	0.38	--	X			
Chromium	6/8	0	0.38	--		X		Yes
Cobalt	6/8	0.13	0.5	--				
Copper	20/20	0.25	0.8	D		X		Yes
Iron	6/8	--	0.38	--	X			
Lead	16/20	0.30	0.8	B2				Yes
Magnesium	6/8	0.75	0.5	--	X			
Manganese	6/8	0	0.63	D		X		Yes
Mercury	8/20	0	0.35	D		X		Yes
Nickel	6/8	0.25	0.5	A		X		Yes
Potassium	6/8	--	0	--	X			
Selenium	3/8	0.25	0.38	D	X	X		
Silver	7/20	0.05	0.3	D		X		Yes
Sodium	6/8	--	0.5	--				
Thallium	2/8	0	0.25	--				
Vanadium	6/8	0	0	--		X		
Zinc	18/20	0.15	0.65	D		X		Yes

NOTES:

(1) Fraction of samples which exceed the range of concentrations in natural soils, as referenced in Section 4.
(2) Fraction of samples which exceed the background concentration in on-site soils, as referenced in Section 4.
(3) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(4) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.
A = Human Carcinogen
B1,B2 = Probable human carcinogen
D = Not classifiable as to carcinogenicity
-- = No data

TABLE 6-4

Selection of Inorganic Parameters of Potential Public Health Concern
Genesee Valley Park Soils

Parameter	Frequency of Detection	Fraction above Common Range(1)	Fraction above Site Background(2)	Cancer Weight-of-Evidence	Essential Nutrient	Oral RfD(3)	Oral Slope Factor (4)	Selected for Evaluation?
Aluminum	14/14	0	0	--				
Antimony	1/14	0.07	0.07	--		X		
Arsenic	23/23	0	1	A		X	X	Yes
Barium	14/14	0	0.07	--		X		
Beryllium	12/14	0	0	B2		X	X	
Cadmium	10/23	0.35	0.43	B1		X	X	Yes
Calcium	14/14	--	0.29	--	X			
Chromium	14/14	0	0.07	--		X		
Cobalt	14/14	0	0.07	--				
Copper	23/23	0.04	0.74	D		X		Yes
Iron	14/14	--	0	--	X			
Lead	21/23	0.04	0.91	B2				Yes
Magnesium	14/14	0.5	0.36	--	X			
Manganese	14/14	0	0.07	D		X		
Mercury	7/23	0	0.36	D		X		Yes
Nickel	14/14	0	0.21	A		X		
Potassium	14/14	--	0	--	X			
Selenium	6/14	0	0.43	D	X	X		
Silver	4/23	0	0.09	D		X		
Sodium	13/14	--	0.07	--				
Thallium	4/14	0	0.21	--				
Vanadium	14/14	0	0	--		X		
Zinc	23/23	0.04	0.65	D		X		Yes
Cyanide	1/14	--	--	D				

NOTES: (1) Fraction of samples which exceed the range of concentrations in natural soils, as referenced in Section 4.
(2) Fraction of samples which exceed the background concentration in on-site soils, as referenced in Section 4.
(3) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(4) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.

A = Human Carcinogen
B1,B2 = Probable human carcinogen
D = Not classifiable as to carcinogenicity
-- = No data

calcium and potassium), they need not be considered in quantitative risk assessments.

- Oral RfD - The RfD, or reference dose, is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects. The tables indicate which compounds have RFDs established by the USEPA for the ingestion route of exposure.

- Oral Slope Factor - The cancer slope factor, previously known as the cancer potency factor, is an estimate developed by the USEPA of a carcinogen's dose:response relationship. The slope factors are estimated through the use of mathematical extrapolation models such as the linearized multistage model, for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses, consistent with the data. The table indicates availability of cancer slope factors for ingestion, as developed by the USEPA.

The final column indicates which inorganic chemicals have been selected for evaluation in this risk assessment. All of the factors presented in the table were considered in the selection process. The availability of toxicological criteria (i.e., RfDs and cancer slope factors) were considered key to selection.

In summary, the inorganic chemicals selected for evaluation in this risk assessment are noted below with an "X".

SELECTED INORGANIC PARAMETERS OF POTENTIAL PUBLIC HEALTH CONCERN

Inorganics	North Disposal Area	Training Ground Area	South Disposal Area	Genesee Park Area
Antimony			X	
Arsenic	X	X	X	X
Barium	X		X	
Cadmium	X	X	X	X
Chromium	X		X	
Copper	X	X	X	X
Lead	X	X	X	X
Manganese			X	
Mercury	X	X	X	X
Nickel	X		X	
Silver	X		X	
Zinc	X	X	X	X

Organics - Acetone, methylene chloride and bis(2-ethylhexyl)phthalate were not included in the selection process because low concentrations of these substances were attributed to laboratory-introduced contamination on the basis of QC sample results.

The organic chemicals of potential concern were selected using a similar approach to that for the inorganic chemicals, with information presented in Tables 6-5 through 6-8. Because organic chemicals are not naturally part of the soil matrix, no comparisons can be made to "background". The organic chemicals were selected on the basis of frequency of detection, cancer weight-of-evidence, and availability of toxicological criteria.

Of the organic chemicals (volatiles, semi-volatiles, polychlorinated biphenyls and pesticides) detected in soils on-site, those selected for analysis in this risk assessment (as indicated by an "X") consist of:

SELECTED ORGANIC PARAMETERS OF POTENTIAL PUBLIC HEALTH CONCERN

Organics	North Disposal Area	Training Grounds Area	South Disposal Area	Genesee Valley Park
Benzene		X	X	
2-Butanone			X	X
Chloroform			X	
1,1-Dichloroethane			X	
1,2-Dichloroethane			X	
1,2-Dichloroethene			X	X
Ethyl Benzene		X	X	
4-Methyl,2-Pentanone			X	X
1,1,2,2-Tetrachloroethane			X	
Tetrachloroethene	X		X	
Toluene	X	X	X	X
1,1,1-Trichloroethane	X		X	
Trichloroethene	X		X	X
Vinyl Chloride			X	
Xylenes		X	X	
Butyl Benzyl Phthalate	X	X		
Di-n-butyl phthalate	X	X	X	X
Diethyl phthalate	X	X	X	X
Naphthalene	X			
cPAHs	X	X		X
tPAHs	X	X		X
Aroclor 1254	X	X	X	X
Aroclor 1260	X	X	X	X

TABLE 6-5

Selection of Organic Parameters of Potential Public Health Concern
North Disposal Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD$^{(1)}$	Oral Slope Factor$^{(2)}$	Selected for Evaluation?
VOLATILE ORGANICS						
Chlorobenzene	1/11	0.001	D	X		
Chloroform	1/11	0.002	B2	X	X	
1,1-Dichloroethane	2/11	0.002-0.01	C	X		
1,2-Dichloroethane	1/11	0.001	B2		X	
1,2-Dichloroethene	3/11	0.002-0.04	D	X		
Tetrachloroethene	9/11	0.004-0.039	B2	X	X	Yes
Trichloroethene	8/11	0.004-0.063	B2		X	Yes
1,1,1-Trichloroethane	5/11	0.001-0.006	--	X		Yes
1,1,2,2-Tetrachloroethane	2/11	0.001	C		X	
Toluene	4/11	0.002-0.012	D	X		Yes
SEMI-VOLATILES						
Benzoic Acid	2/11	0.20-0.25	D	X		
Bis(2-chloroisopropyl)ether	3/11	0.12-0.34	--	X		
Butybenzylphthalate	4/11	0.11-0.68	C	X		Yes
Di-n-butylphthalate	5/11	0.12-0.64	--	X		Yes
Diethylphthalate	4/11	0.04-0.54	D	X		Yes
Di-n-octyl phthalate	1/11	0.15	--	X		
Isophorone	1/11	0.17	C		X	
2-Methylnaphthalene	5/11	0.053-0.61	--			
Naphthalene	4/11	0.035-0.41	D	X		Yes

TABLE 6-5

Selection of Organic Parameters of Potential Public Health Concern
North Disposal Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD[1]	Oral Slope Factor[2]	Selected for Evaluation?
4-Nitrophenol	1/11	0.16	–			
cPAHs	4/11	0.1-0.88	B2		X	Yes
tPAHs	6/11	0.1-1.2	–	X		Yes
POLYCHLORINATED BIPHENYLS						
Aroclor-1254	5/20	0.10-10B2	B2		X	Yes
Aroclor - 1260	8/20	0.162-9.7	B2		X	Yes

NOTES:

[1] Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
[2] Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.

A = Human carcinogen
B2 = Probable human carcinogen: sufficeint evidence in animals and inadequate or no evidence in humans.
C = Possible human carcinogen.
D = Not classifiable as to carcinogenicity.
– = No data.
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons.
tPAHs = Total polynuclear aromatic hydrocarbons.

TABLE 6-6

Selection of Organic Parameters of Potential Public Health Concern
Training Grounds Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD$^{(1)}$	Oral Slope Factor$^{(2)}$	Selected for Evaluation?
VOLATILE ORGANICS						
Benzene	1/14	0.89	A		X	Yes
2-Butanone	2/14	0.01-0.011	D			
Chlorobenzene	1/14	0.005	D	X		
Chloroform	1/14	0.002	B2	X	X	
1,1-Dichloroethane	1/14	0.019	C	X		
1,2-Dichloroethene	1/14	0.007	D	X		
Ethylbenzene	3/14	3.2-26	D	X		Yes
Tetrachloroethene	1/14	0.001	B2	X	X	
Toluene	5/14	0.001-350	D	X		Yes
Xylenes	4/14	0.78-210	D	X		Yes
SEMI-VOLATILES						
Benzoic Acid	1/14	0.12	D	X		
Butylbenzylphthalate	4/14	0.087-120	C	X		Yes
Diethylphthalate	5/14	0.21-29	D	X		Yes
Di-n-butylphthalate	10/14	0.046-77	--	X		Yes
Dibenzofuran	1/14	0.46	D			
3,3'-Dichlorobenzidine	1/14	0.44	B2		X	
Dimethylphthalate	1/14	0.091	--	X		
4,6-Dinitro-2-methylphenol	1/14	2.4	--			
Isophorone	1/14	0.27	C		X	

TABLE 6-6

Selection of Organic Parameters of Potential Public Health Concern
Training Grounds Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD(1)	Oral Slope Factor(2)	Selected for Evaluation?
2-Methylnaphthalene	4/14	0.42-150	–			
4-Methylphenol	1/14	13	–			
Naphthalene	2/14	2.2-100	D	X		
N-nitrodiphenylamine	1/14	0.043	B2		X	
4-Nitroaniline	1/14	1.1	–			
2-Nitrophenol	1/14	0.12	–			
cPAHs	9/14	0.036-9.4	B2		X	Yes
tPAHs	10/14	0.036-9.4	–	X		Yes
Pentachlorophenol	2/14	0.18-1.4	B2	X	X	
POLYCHLORINATED BIPHENYLS						
Aroclor-1248	4/24	0.042-0.074	B2		X	Yes
Aroclor-1254	10/24	0.058-42	B2		X	Yes
Aroclor-1260	16/24	0.024 - 31	B2		X	Yes

NOTES:

(1) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(2) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.

A = Human carcinogen
B2 = Probable human carcinogen: sufficeint evidence in animals and inadequate or no evidence in humans.
C = Possible human carcinogen.
D = Not classifiable as to carcinogenicity.
– = No data.
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons.
tPAHs = Total polynuclear aromatic hydrocarbons.

TABLE 6-7

Selection of Organic Parameters of Potential Public Health Concern
South Disposal Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD[(1)]	Oral Slope Factor[(2)]	Selected for Evaluation?
VOLATILE ORGANICS						
Benzene	2/8	0.001-0.009	A		X	Yes
2-Butanone	3/8	0.018-7.9	D			Yes
Chloroethane	1/8	0.11	–			
Chloroform	3/8	0.005-0.51	B2	X	X	Yes
1,1-Dichloroethane	6/8	0.16-26	C	X		Yes
1,1-Dichloroethene	2/8	0.017-0.20	C	X	X	
1,2-Dichloroethane	4/8	0.043-1.6	B2		X	Yes
1,2-Dichloroethene	6/8	0.091-250	D	X		Yes
Ethylbenzene	4/8	0.006-0.82	D	X		Yes
4-Methyl-2-Pentanone	3/8	2.6-3.5	–			Yes
1,1,2,2-Tetrachloroethane	3/8	1.3-3.5	C		X	Yes
Tetrachloroethene	6/8	0.002-140	B2	X	X	Yes
Trichloroethene	7/8	0.006-110	B2		X	Yes
1,1,1-Trichloroethane	5/8	0.055-14	–	X		Yes
1,1,2-Trichloroethane	1/8	0.014	C	X	X	
Toluene	5/8	0.023-5.3	D	X		Yes
Vinyl Chloride	4/8	0.061-3.0	A		X	Yes
Xylenes	5/8	0.040-8.7	D	X		Yes
SEMI-VOLATILES						
Benzoic Acid	2/8	0.69-0.83	D	X		

TABLE 6-7

Selection of Organic Parameters of Potential Public Health Concern
South Disposal Area Soils

Parameter	Frequency of Detection	Range (mg/kg)	Cancer Weight-of-Evidence	Oral RfD[(1)]	Oral Slope Factor[(2)]	Selected for Evaluation?
Di-n-butylphthalate	6/8	0.22-3.7	–	X		Yes
Di-n-octylphthalate	1/8	0.15	–	X		
Diethylphthalate	6/8	0.43-51	D	X		Yes
Phenol	2/8	3.0-3.3	D	X		
cPAHs	1/8	0.28	B2		X	Yes
tPAHs	1/8	0.65	–	X		Yes
POLYCHLORINATED BIPHENYLS						
Aroclor-1254	14/20	0.017-190	B2		X	Yes
Aroclor-1260	7/20	0.031 - 330	B2		X	Yes

NOTES:

(1) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(2) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.

A = Human carcinogen
B2 = Probable human carcinogen: sufficient evidence in animals and inadequate or no evidence in humans.
C = Possible human carcinogen.
D = Not classifiable as to carcinogenicity.
– = No data.
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons.
tPAHs = Total polynuclear aromatic hydrocarbons.

TABLE 6-8

Selection of Organic Parameters of Potential Public Health Concern
Genesee Valley Park Soils

Parameter	Frequency of Detection	Range (mg/-kg)	Cancer Weight-of-Evidence	Oral RfD$^{(1)}$	Oral Slope Factor$^{(2)}$	Selected for Evaluation?
VOLATILE ORGANICS						
2-Butanone	2/14	0.011-0.013	D	X		Yes
Chloroform	1/14	0.002	B2	X	X	
1,1-Dichloroethane	1/14	0.003	C	X		
1,1-Dichloroethene	1/14	0.003	C	X	X	
1,2-Dichloroethene	2/14	0.002-0.19	D	X		Yes
4-Methyl-2-Pentanone	2/14	0.003-0.43	B2			Yes
Tetrachloroethene	1/14	0.002	B2	X	X	
Trichloroethene	4/14	0.002-0.52	B2		X	Yes
1,1,1-Trichloroethane	2/14	0.002-0.17	–	X		
Toluene	2/14	0.001-0.002	D	X		Yes
SEMI-VOLATILES						
Butylbenzylphthalate	1/14	0.059	C	X		
4-Chlorophenylphenylether	1/14	0.38	–			
Di-n-butylphthalate	6/14	0.16-0.41	–	X		Yes
Di-n-octylphthalate	2/14	0.38-0.46	–	X		
Dibenzofuran	1/14	0.012	D			
1,4-Dichlorobenzene	1/14	0.046	C	X	X	
Diethylphthalate	4/14	0.10-2.1	D	X		Yes
Dimethylphthalate	1/14	0.063	–			
Isophorone	1/14	0.20	C		X	

TABLE 6-8

Selection of Organic Parameters of Potential Public Health Concern
Genesee Valley Park Soils

Parameter	Frequency of Detection	Range (mg/-kg)	Cancer Weight-of-Evidence	Oral RfD$^{(1)}$	Oral Slope Factor$^{(2)}$	Selected for Evaluation?
2-Methylnaphthalene	2/14	0.027-0.059	–			
3-Nitroaniline	1/14	1.9	–			
2-Nitrophenol	1/14	0.07	–			
Pentachlorophenol	1/14	0.8	B2	X	X	
cPAHs	6/14	0.089-2.0	B2		X	Yes
tPAHs	6/14	0.025-2.2	–	X		Yes
POLYCHLORINATED BIPHENYLS						
Aroclor-1254	11/23	0.14-14	B2		X	Yes
Aroclor-1260	10/23	0.055-2.5	B2		X	Yes
PESTICIDES						
4,4'-DDE	1/14	0.0092	–			
Endosulfan I	1/14	0.32	–			
Endosulfan Sulfate	2/14	0.014-0.039	–			

NOTES:

(1) Oral reference dose for evaluation of non-carcinogenic effects. Table indicates availability of a USEPA established value.
(2) Oral slope factor for evaluation of carcinogenic effects. Table indicates availability of a USEPA established value.

A = Human carcinogen
B2 = Probable human carcinogen: sufficient evidence in animals and inadequate or no evidence in humans.
C = Possible human carcinogen.
D = Not classifiable as to carcinogenicity.
– = No data.
cPAHs = Carcinogenic polynuclear aromatic hydrocarbons.
tPAHs = Total polynuclear aromatic hydrocarbons.

GROUND WATER

In Table 6-9, applicable New York State standards are compared with the maximum contaminant concentrations detected in overburden and bedrock ground water beneath the North Disposal Area, the Training Grounds Area and the South Disposal Area. As indicated, ground water standards were exceeded for vinyl chloride, trichloroethylene, phenol, PCBs, iron, manganese, and lead. However, there is no current or proposed future use of ground water at or downgradient of the Rochester Fire Academy.

An analysis was performed in Section 8.0 of the RI report, in which contaminant transport to the Genesee River from on-site ground water was modeled, based upon the assumption that the site would remain in its current, unremediated condition. Total loadings to the river from the overburden and the upper bedrock were reported for total volatile organics, total semi-volatile organics, total PCBs, total iron and manganese, and total trace metals. For the purposes of this assessment, estimated contaminant concentrations in surface water as a result of loadings from ground water are compared with applicable criteria based on fish consumption (see Section 6.1.4).

SURFACE WATER/SEDIMENT

Analytical results for the Genesee River are presented in Tables 7-33 and 7-34 (surface water) and Table 7-35 (sediment) of the RI report.

As indicated, no organic chemicals (including PCBs) were detected in surface water samples. Immediately downstream from the South Disposal Area, surface water samples were found to contain slightly elevated concentrations of a series of metals. A comparison of the maximum concentrations (downstream of the South Disposal Area) with upstream concentrations and with the New York State ambient water quality standards for Class B streams (or, in their absence, standards for a higher quality stream) is provided below. Exceedances of the New York State standards are highlighted in bold.

TABLE 6-9

COMPARISON OF MAXIMUM CONTAMINANT CONCENTRATIONS IN GROUND WATER WITH NEW YORK STATE PART 703 GROUND WATER STANDARDS

(Class GA Ground waters)

(All units in mg/l)

Chemical	6 NYCRR Part 703 Ground water Standard	NORTH DISPOSAL AREA Overburden	NORTH DISPOSAL AREA Bedrock	TRAINING GROUNDS AREA Overburden	TRAINING GROUNDS AREA Bedrock	SOUTH DISPOSAL AREA Overburden	SOUTH DISPOSAL AREA Bedrock
Volatiles							
1,1-Dichloroethene		--	--	3.2	0.30	0.12	0.25
1,1-Dichloroethane		--	--	0.062	0.003	0.69	0.59
1,2-Dichloroethene (total)		--	0.075	0.009	4.7	30	--
Chloroform	0.1	--	--	--	--	--	--
1,2-Dichloroethane		--	0.006	0.005	--	0.021	0.013
Vinyl Chloride	0.005	--	0.055	1.9	4.5	0.084	0.17
Acetone		--	--	0.026	--	1.6	0.48
Methylene Chloride		--	--	0.002	--	0.58	--
2-Butanone		--	--	--	--	0.15	0.037
Trichloroethane		--	--	0.007	--	--	--
1,1,1-Trichloroethane		--	--	--	--	7.9	2.6
Bromodichloromethane		--	--	--	--	0.009	0.003
Trichloroethene	0.01	--	--	0.10	0.022	0.46	2.6
Benzene	ND	--	--	0.12	--	0.009	--
4-Methyl 2-Pentanone		--	--	--	--	0.16	0.89
Tetrachloroethene		--	--	--	0.002	0.088	0.038
Toluene		--	--	0.30	--	0.91	10
Chlorobenzene		--	--	--	--	0.008	--
Ethylbenzene		--	--	0.16	--	0.34	0.006
Total Xylenes		--	--	0.49	--	2.3	0.38

TABLE 6-9

COMPARISON OF MAXIMUM CONTAMINANT CONCENTRATIONS IN GROUND WATER WITH NEW YORK STATE PART 703 GROUND WATER STANDARDS

(Class GA Ground waters)

(All units in mg/l)

Chemical	6 NYCRR Part 703 Ground water Standard	NORTH DISPOSAL AREA		TRAINING GROUNDS AREA		SOUTH DISPOSAL AREA	
		Overburden	Bedrock	Overburden	Bedrock	Overburden	Bedrock
Semi-Volatiles							
Phenol	0.001	--	--	--	--	0.017	--
2-Methylphenol		--	--	--	--	0.010	--
4-Methylphenol		--	--	--	--	0.050	--
2,4-Dimethylphenol		--	--	--	--	0.014	--
Pentachlorophenol	0.021	--	--	--	--	0.001	--
Benzoic Acid		--	--	--	--	0.012	--
Benzoyl Alcohol		--	--	--	0.002	--	--
Nitrobenzene		--	--	--	0.001	--	--
Naphthalene		--	--	--	--	--	--
2-Methylnaphthalene		--	--	--	0.004	--	--
Diethylphthalate		--	--	--	--	0.083	0.010
N-nitrosodiphenylamine		--	--	--	--	--	--
Di-n-butylphthalate	0.77	--	--	--	--	--	--
Bis (2-ethylhexyl) phthalate		0.013	0.005	0.005	0.01	0.006	0.022
Bis (2-chloroethoxy) methane		--	--	--	0.002	--	--
PCBs							
Aroclor-1254	0.001	--	--	0.0049	--	0.005	0.003

TABLE 6-9

COMPARISON OF
MAXIMUM CONTAMINANT CONCENTRATIONS IN GROUND WATER WITH NEW YORK STATE PART 703 GROUND WATER STANDARDS

(Class GA Ground waters)

(All units in mg/l)

Chemical	6 NYCRR Part 703 Ground water Standard	NORTH DISPOSAL AREA		TRAINING GROUNDS AREA		SOUTH DISPOSAL AREA	
		Overburden	Bedrock	Overburden	Bedrock	Overburden	Bedrock
Inorganics							
Aluminum		12	0.87	31	2.25	3.8	0.79
Antimony		--	--	--	--	--	--
Arsenic	0.025	0.007	0.001	0.011	0.003	0.010	0.010
Barium	1.0	0.070	0.135	0.20	0.21	0.15	0.155
Beryllium		--	--	0.001	--	--	--
Cadmium	0.01	--	0.001	0.002	0.001	0.002	--
Calcium		100	155	208	445	124	226
Chromium	0.05	0.017	--	0.042	0.010	0.001	0.008
Cobalt		0.014	0.13	0.030	--	--	--
Copper	<0.2	0.015	--	0.015	0.007	0.019	0.007
Iron	0.3	18	14.1	71	7.6	18	3.8
Lead	0.025	--	0.032	0.40	--	0.059	0.060
Magnesium		81	53.8	111	97	70	59
Manganese	0.3	1.8	1.8	7.7	0.42	1.9	0.12
Mercury	0.002	--	--	--	0.0002	--	--
Nickel		0.026	--	0.064	--	--	--
Potassium		1.0	2.7	4.7	3.8	2.9	2.3
Selenium	0.01	--	--	--	--	0.002	--
Silver	0.05	--	--	--	--	--	--
Sodium		2	31	71.5	81	18.5	47
Thallium		--	--	--	--	--	--
Vanadium		0.018	--	0.054	--	--	--
Zinc	<0.3	0.065	0.064	0.22	0.13	0.082	0.12

	Maximum Concentration (mg/l)	Upstream Concentration (mg/l)	NYS Ambient Water Quality Standard (mg/l)
Aluminum	**4.03**	**3.35**	0.1
Arsenic	0.002J	0.001J	0.19
Barium	0.064J	0.053J	1.0
Chromium	0.011	0.013	0.05
Cobalt	**0.011J**	**0.016J**	0.005
Copper	0.013J	0.007J	19.8
Iron	**7.1**	**5.3**	0.3
Lead	ND	ND	6.9
Magnesium	16.2	12.4	35
Manganese	0.154	0.109	0.3
Vanadium	0.007J	0.005J	0.014
Zinc	**0.466**	**0.032**	0.03

As indicated above, concentrations of four inorganics measured upstream of the site exceed the New York State ambient water quality criteria for Class B streams. Of these, the maximum concentrations exceeded upstream concentrations for aluminum, iron and zinc. Of these, zinc is of potential human health significance and will be considered in the evaluation of exposures associated with swimming in the Genesee River.

Risks associated with ingestion of fish are evaluated by comparison of projected surface water quality with New York State ambient water quality criteria which are established to protect human health in Section 6.1.4.

Toluene was detected at low concentrations in all river sediment samples, including the upstream sample. No other volatile organic chemicals were detected in sediment samples. Concentrations of inorganic chemicals in sediment adjacent to and downstream of the site were not elevated relative to concentrations in upstream sediment. No PCBs were detected in any sediment sample collected. Therefore, there appears to be no potential site related health threat associated with existing sediment quality.

6.1.2 Environmental Transport and Distribution

The environmental fate and transport of chemicals detected on-site are important factors in determining the ultimate hazard to people in the vicinity of the site. After a chemical is released to the environment, it may be transformed physically (i.e., by volatilization, precipitation), chemically (i.e., by photolysis, hydrolysis, oxidation, reduction, etc.), or biologically (i.e., by biodegradation). Alternatively, it may be accumulated in one or more media (including biomass), or may be transported (i.e., convected downstream in water or on suspended sediment or through the atmosphere).

The environmental fate and transport mechanisms of selected chemicals are presented in Appendix I. This information is incorporated into the analysis below with the objective of identifying the likely point of exposure for each.

6.2 EXPOSURE ASSESSMENT

Probable exposure routes (i.e., ingestion, dermal contact) based on the media contaminated and the anticipated activities at the exposure points are identified below. Due to the nature of the site surface (i.e., gravel-covered in some areas and vegetated in others), inhalation of contaminated dust particles is not considered to be a significant exposure route at the Rochester Fire Academy site.

6.2.1 Setting

The Rochester Fire Academy is a 21 acre site, which has been used for fire and police department training since 1954. Land use in the vicinity of the facility is urbanized and is commercially developed along the west side of the site. The site is adjoined to the north and south by park land. Most outdoor training activity occurs at the Training Grounds and Obstacle Course/Firing Range. The Training Grounds Area has been covered with a 3- to 6-inch layer of crushed stone.

6.2.2 Exposure Pathways

A number of exposure pathways are possible. These pathways are identified and discussed below.

SOIL/FILL

Three areas of soil/fill contamination on the Fire Academy site have been identified as a result of the remedial investigation and supplemental work:

- the North Disposal Area;

- the Training Grounds; and
- the South Disposal Area.

Additionally, some contamination has been identified in soils collected along the bicycle path in Genesee Valley Park. The boundaries of each of these areas are depicted in Figure 1-2.

While soil contamination is most pronounced in the South and North Disposal Areas, there is little potential for human exposure, except possibly by trespassers. No city employees, police trainees or fire fighter trainees have reason to enter the South or North Disposal Areas, except for purposes related to the RI/FS. Their activities during these events would be governed by health and safety protocols, and therefore, have not been evaluated in this report.

The North Disposal Area is fenced and posted to restrict access on all sides with the exception of the unfenced river bank. Casual trespassing can occur along the bicycle path, and may occur in the North Disposal Area. Therefore, the potential exposure of trespassers in the North Disposal Area (inadvertent soil ingestion and dermal contact) has been evaluated.

The South Disposal Area is entirely fenced, locked and posted with warning signs. Therefore, trespassing is unlikely under current conditions. However, there is still a potential that the area may be accessible in the future, therefore exposure (inadvertent soil ingestion and dermal contact) has been evaluated.

The Training Grounds are used by the City Fire and Police Departments. A 3- to 6-inch deep layer of crushed stone has been placed over soil in the actively-used portions of the training grounds to limit contact with contaminated soil. This analysis considers a worst-case (although unlikely) exposure scenario, that there is still some potential for dermal contact and inadvertent ingestion of soil, based on the fact that the crushed stone does not form an impermeable barrier to soil contaminants. Training officers may spend up to 309 hours a year at the training ground (Malcolm Pirnie, Inc., 1990) and so their potential for exposure is evaluated.

As indicated above, soil contamination has been identified in Genesee Valley Park adjacent to the bicycle path. Thus, some inadvertent ingestion of and limited dermal contact with soils may also occur.

GROUND WATER

Ground water is not a source of drinking water in the area, and there are no wells downgradient of the site which would be affected by site contaminants. The significance of identifying contaminants in the ground water, however, is that ground water may serve as a potential source of surface water contamination.

SURFACE WATER

The portion of the Genesee River near the site is Class B, i.e., suitable for point contact recreation. However, in accordance with Chapter 44-7 of the City of Rochester Code, swimming in the Genesee River within the city limits is prohibited. There is some "small craft" boating, and the river is fished quite often. Game fish include walleye, small mouth bass and northern pike. Those potentially at high risk because of specific behavior patterns include persons who may eat large amounts of locally caught fish. Based on available data, there are no subsistence fishermen who rely solely on this stretch of the Genesee River for their fish supply. Recreational fishing (not subsistence fishing) is determined most appropriate for this analysis.

Therefore, potential exposure to site contaminants may result from: dermal contact with and inadvertent consumption of contaminants in surface water during swimming; and ingestion of fish.

6.2.3 Summary

In summary, the potential pathways of human exposure evaluated in this report, by location, consist of:

- North Disposal Area
    - trespassers (soil ingestion and skin contact)
- Training Grounds
    - training officers (soil ingestion and skin contact)
- South Disposal Area
    - trespassers (soil ingestion and skin contact)
- Genesee Valley Park
    - bicyclists (soil ingestion and skin contact)
- Genesee River

- residents (skin contact with, and ingestion of water during swimming; and ingestion of fish)

These exposure pathways are presented in Table 6-10, along with pertinent information on possible exposures to site contaminants, and reasons for selection or exclusion of various exposure scenarios.

6.2.4 Estimates of Contaminant Intake

A quantitative assessment of potential human exposure is derived through use of the equations presented in Tables 6-11 through 6-14 (USEPA, 1989e). Application of these equations results in intake or absorbed dose (expressed in mg/kg-day) which is then presented in Tables 6-17 through 6-25 as a "chronic daily intake" (or CDI). The assumptions adopted in this analysis are described below.

The sample data obtained are only "snapshots" of contamination over the site and its surroundings. In order to determine the contaminant concentrations to which one might be exposed over many years, it is necessary to evaluate the entire data set in order to develop "representative" concentrations. The USEPA suggests that the upper confidence limit (i.e., the 95 percent upper confidence limit) on the average of all the data may be used for evaluating reasonable maximum exposures (USEPA, 1989e). The equation used in this analysis is:

$$UCL = e^{(x + 0.5s*s + sH/\sqrt{(n-1)})}$$

Where:

UCL = 95th upper confidence limit on the mean

e = constant (natural log)

x = the mean of the transformed data

s = the standard deviation of the transformed data

H = statistic for computing a one-sided upper 95% confidence limit on a lognormal mean

n = sample size

TABLE 6-10

ROCHESTER FIRE ACADEMY

SUMMARY OF EXPOSURE PATHWAYS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM AND EXPOSURE POINT	PATHWAY SELECTED FOR EVALUATION?	REASON FOR SELECTION OR EXCLUSION
Residents	Ingestion of contaminated water from drinking water sources downgradient of the site	No	There are no drinking water sources in the immediate vicinity of the site. Drinking water is provided by the City of Rochester water supply system.
City Employees/ Trainees/ Trespassers	Direct contact with or inadvertent ingestion of chemicals of potential concern in soil on the site	Yes	Contaminated soil may be dermally absorbed or ingested during training exercises at Training Area (however, this area has been covered with 3" of crushed stone). Trespassers may contact or ingest soils in North (or South) Disposal Area.
Path Users	Direct contact with or inadvertent ingestion of chemicals of potential concern in soil in Park	Yes	Bicyclists may contact contaminated soil along bicycle path.
General Public	Dermal contact with or inadvertent ingestion of contaminated water during swimming	Yes	This portion of Genesee River is Class B -- suitable for point contact recreation.
General Public	Ingestion of contaminated fish from Genesee River.	Yes	Fishing is a permitted use of Class B streams in New York State. Fishing has occurred in Genesee River.

TABLE 6-11

ROCHESTER FIRE ACADEMY

EXPOSURE ASSESSMENT: INGESTION OF CHEMICALS IN SOIL

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged, in days).

Variable Values:

CS:	95% upper confidence limit on the average soil data or maximum value
IR:	100 mg/day (age groups greater than 6 years old, USEPA, 1989b)
CF:	10^{-6} kg/mg
FI:	1.0
EF:	32 days/year (NDA, SDA, GVA); 39 days/year (TGA)
ED:	30 years
BW:	70 kg (adult, average; USEPA, 1989b)
AT:	Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year), and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

NDA = North Disposal Area
SDA = South Disposal Area
TGA = Training Grounds Area
GVP = Genesee Valley Park

TABLE 6-12

ROCHESTER FIRE ACADEMY

EXPOSURE ASSESSMENT: DERMAL CONTACT WITH CHEMICALS IN SOIL

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged,in days).

Variable Values:

CS: 95% upper confidence limit on the average soil data or maximum value

CF: 10^{-6} kg/mg

SA: 3120 cm^2 (NDA); 820 cm^2 (TGA); 3120 cm^2 (SDA); 3120 cm^2 (GVA)

AF: 1.45 mg/cm^2 -- potting soil (for hands; USEPA 1988b; 1989b)

ABS: 0.01 (cadmium), 0.06 (PCBs); all others, not evaluated quantitatively (USEPA, 1992a)

EF: 32 days/year (NDA, SDA, GVA); 39 days/year (TGA)

ED: 30 years

BW: 70 kg (adult, average; USEPA, 1989b)

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year), and 70 year lifetime for carcinogenic effects (i.e., 70 years x 365 days/year).

NDA = North Disposal Area
SDA = South Disposal Area
TGA = Training Grounds Area
GVP = Genesee Valley Park

TABLE 6-13

ROCHESTER FIRE ACADEMY

EXPOSURE ASSESSMENT: INGESTION OF CHEMICALS IN SURFACE WATER WHILE SWIMMING

Equation:

$$Intake\ (mg/kg/day) = \frac{CW \times CR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
CR = Contact Rate (liters/hour)
ET = Exposure Time (hours/event)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged,in days).

Variable Values:

CW: maximum chemical concentration detected in surface water

CR: 50 ml/hour

ET: 2.6 hours/day

EF: 32 days/year

ED: 30 years

BW: 70 kg (adult, average; USEPA, 1989b)

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year).

Reference: USEPA, 1989e

TABLE 6-14

ROCHESTER FIRE ACADEMY

EXPOSURE ASSESSMENT: DERMAL CONTACT WITH CHEMICALS IN SURFACE WATER

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Chemical-Specific Permeability Constant (cm/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Volumetric Conversion Factor for Water (1 liter/1,000 cm^3)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged,in days).

Variable Values:

CW: maximum contaminant concentration detected in surface water

SA: 19,400 cm^2

PC: 5×10^{-4} cm/hour (USEPA, 1992a)

ET: 2.6 hours/day

EF: 32 days/yr

ED: 30 years

CF: 1 liter/1,000 cm^3

BW: 70 kg (adult, average; USEPA, 1989b)

AT: Pathway-specific period of exposure for noncarcinogenic effects (i.e., ED x 365 days/year)

For all samples in which the chemical of potential concern was not positively identified, this analysis assigns a value of 1/2 the contract-required quantitation limit (CRQL). If there is great variability in measured concentrations, the upper confidence limit on the average concentration may be high, and occasionally exceed the maximum detected value. In these cases, the maximum detected concentration was used to estimate exposure concentrations. This may be considered a conservative approach to exposure assessment.

In evaluating soil ingestion as a route of exposure, an average ingestion rate of 100 mg/day is used; this value is representative for age groups greater than 6 years old. The "fraction ingested" (FI) is based on an estimate of the fraction of soil that is presumed to be contaminated. For this analysis, it is assumed that 100% of the soil contacted is contaminated with concentrations equivalent to the upper confidence limit on the average (or maximum detected concentration). However, it should be noted that the contamination is mostly localized, and this approach may overestimate exposures.

The exposure frequency (EF) used in the soil exposure pathways was assumed to be once a week from April through November (8 months) (whenever there is no snow cover) for a total of 32 days/year. The exception is for training officers at the Training Grounds Area, who are reported to spend 309 hours per year training recruits (Malcolm Pirnie, Inc. 1990) On an 8-hour work day basis, this translates to an exposure frequency of 39 days/year.

The exposure duration (ED) is assumed to be 30 years (the national upper-bound 90th percentile time at one residence), based on recommendations contained in the supplemental guidance to the USEPA's human health evaluation manual (USEPA, 1991).

The body weight (70 kg or about 154 lbs.) is the average weight of an American adult (USEPA, 1989e).

The averaging time selected depends on the type of toxic effect being assessed. When evaluating exposures for long term non-cancer effects, intakes are calculated by averaging intakes over the period of exposure. For carcinogens, intakes are calculated by prorating the total cumulative dose over a lifetime (i.e., lifetime average daily intake). This distinction is consistent with the hypothesis that the mechanism of action for each of these effects is different. The approach for carcinogens is based on the assumption that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime.

For the assessment of dermal contact with chemicals in soil, the evaluation considers exposures to arms and hands of adult males (3120 cm^2; USEPA, 1989e). The exception is for training officers, whose exposures are assumed to be limited to hands (820 cm^2; USEPA, 1989e), which may become contaminated when boots are removed following training.

The USEPA has recently provided guidance which advises against performing a quantitative assessment of dermal exposure to environmental contaminants in soil, with the exception of cadmium and PCBs in this analysis (USEPA, 1992a). The dermal absorption factors cited in Table 6-12 are the maximum values in a range of 0.1 to 1 percent (1 percent is equivalent to 0.01) for cadmium; and a range of 0.6 to 6 percent (or 0.06) for PCBs (USEPA, 1992a).

In the evaluation of exposures resulting from swimming, the "swimming season" is assumed to extend from June through September, with swimming occurring twice a week (or 32 days/year). An ingestion rate of 50 ml/hour is assumed, based on USEPA estimates (USEPA, 1989e). An exposure time (ET) of 2.6 hours is assumed; this is the national average for swimming (USEPA, 1989e). The maximum chemical concentration detected in surface water is exceeded by the upper confidence limit on the average; therefore the maximum value is used.

The skin surface area (SA) is assumed to be the entire body of an adult male (19,400 cm^2; USEPA, 1989e). A default permeability constant (PC) for water is used in the absence of a chemical-specific permeability constant. For zinc, non-cancer effects are the only health hazards of concern, therefore the absorbed dose has been calculated for non-carcinogenic effects only.

Once exposures have been quantified, they are compared with health-protective criteria and used to estimate health risks.

6.3 TOXICITY ASSESSMENT

The inherent toxicity of selected chemicals of potential concern is reviewed, in Appendix I. Guidance levels for the evaluation of the likelihood and magnitude of harm to health are presented in Tables 6-15 and 6-16. The basis for these criteria is also provided.

TABLE 6-15
ROCHESTER FIRE ACADEMY
TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

Chemical	Chronic RfD (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/RfD Source	Uncertainty and Modifying Factors
INORGANICS					
Antimony	4E-04	—	Altered blood chemistry	Water/HEAST	UF=1000
Arsenic	3E-04	—	Keratosis/Hyperpigmentation	Water/HEAST	MF=1/UF=3
Barium	7E-02	Medium	Increased blood pressure	Water/IRIS	UF=3/MF=1
Beryllium	5E-03	Low	No adverse effects	Water/IRIS	UF=100/MF=1
Cadmium	5E-04	High	Significant proteinuria	Water/IRIS	UF=10/MF=1
Chromium	1E+00	Low	No effects reported	Diet/IRIS	UF=100/MF = 10
Copper	3.7-02(1)	—	Local GI irritation	Water/HEAST	—
Lead	NA	—	—	—	—
Manganese	1E-01	Medium	CNS Effects	Food/IRIS	UF=1/MF=1
Mercury	3E-04	—	Kidney effects	Food/HEAST	UF=1000
Nickel	2E-02	—	Decreased body and organ weights	Food/IRIS	UF=100/MF=3
Silver	5E-03	—	Argyria	Intravenous /HEAST	UF=3
Vanadium	7E-03	—	No effects observed	/HEAST	UF=100
Zinc	2E-01	—	Therapeutic dosage	/HEAST	UF=10
VOLATILES					
Benzene	—	—	—	—	—
2-Butanone	5E-02	—	CNS/Fetotoxicity	Air/HEAST	UF=1
Chloroform	1E-02	Medium	Liver cysts	Oral/IRIS	UF=1000/MF=1
1,1-Dichloroethane	1E-01	—	Kidney damage	Air/HEAST	UF=1000
1,2-Dichloroethane	—	—	—	—	—
1,2-Dichloroethene	2E-02	Low	Increased serum alkaline phosphatase	Water/IRIS	UF=1000/MF=1
Ethyl Benzene	1E-01	Low	Liver and kidney toxicity	Gavage/IRIS	UF=1000/MF=1

TABLE 6-15
ROCHESTER FIRE ACADEMY
TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

Chemical	Chronic RfD (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/RfD Source	Uncertainty and Modifying Factors
4-Methyl 2-Pentanone	5E-02	–	Liver and kidney effects	Gavage/HEAST	UF=1000/MF=1
1,1,2,2-Tetrachloroethane	—	—	—	—	—
Tetrachloroethene	1E-02	Low	Hepatotoxicity	Gavage/IRIS	UF=1000/MF=1
Toluene	2E-01	Medium	Changes in liver and kidney weights	Gavage/IRIS	UF=1000/MF=1
1,1,1-Trichloroethane	9E-02	Low	No adverse effects	Inhalation/IRIS	UF=1000/MF=1
Trichloroethene	—	—	—	—	—
Vinyl Chloride	—	—	—	—	—
Xylenes	2E+00	Medium	Hyperactivity	Gavage/IRIS	UF=100/MF=1
SEMI-VOLATILES AND PCBs					
Butylbenzyl phthalate	2E-01	Low	Altered organ weights	Diet/IRIS	UF=1000/MF=1
Di-n-butyl phtalate	1E-01	Low	Increased Mortality	Diet/IRIS	UF=1000/MF=1
Diethyl phthalate	8E-01	—	Reduced body weight	Diet/HEAST	UF=1000
Naphthalene	4E-03	—	Decreased body weight gain	Gavage/HEAST	UF=10,000
tPAHs	3E-02$^{(2)}$	—	Renal effects	Gavage/HEAST	UF=3,000
PCBs	—	—	—	—	—

[1] Based on the USEPA drinking water standard of 1.3 mg/l.

[2] RfD for pyrene, the most stringent assigned to the PAH compounds.

— = Not Available

HEAST = Health Effects Assessment Summary Tables (USEPA, 1991)

IRIS = Integrated Risk Information System (USEPA database) (IRIS, 1992)

MF = Modifying Factor, to account for uncertainty in the test program.

UF = Uncertainty Factor, to account for inter- and intraspecies extrapolation and extrapolation from subchronic to chronic exposures.

TABLE 6-16

ROCHESTER FIRE ACADEMY

TOXICITY VALUES: POTENTIAL CARCINOGENIC EFFECTS

Chemical	Slope Factor (SF) (mg/kg-day)$^{-1}$	Weight-of-Evidence Classification	Type of Cancer	SF Basis/SF Source
INORGANICS				
Arsenic	1.75	A	Skin	Water/IRIS
Beryllium	4.3	B2	Unspecified	Water/IRIS
Lead	—	B2	—	—/IRIS
VOLATILES				
Benzene	2.9E-02	A	Leukemia	Inhalation/IRIS
Chloroform	6.1E-03	B2	Kidney	Gavage, drinking water/IRIS
1,2-Dichloroethane	9.1E-02	B2	Hemangiosarcomas	Gavage/IRIS
1,1,2,2-Tetrachloroethane	2.0E-01	C	Hepatocellular Carcinomas	Gavage/IRIS
Tetrachloroethene	5.1E-02	B2	Liver	Gavage/HEAST
Trichloroethene	1.1E-02	B2	Liver	Gavage/HEAST
Vinyl Chloride	1.9E+00	A	Lung	Diet/HEAST
SEMI-VOLATILES AND PCBs				
cPAHs	1.15E+01(1)	ND	Stomach	Diet/ HEAST
PCBs	7.7E+00	B2	Liver	Diet/HEAST

NOTES:

(1) Slope factor for benzo(a) pyrene, the most potent carcinogenic PAH.

-- = Not Available
ND = Not Determined
A = Human Carcinogen
B2 = Probable Human Carcinogen
C = Possible Human Carcinogen
IRIS = Integrated Risk Information System (USEPA data base) (IRIS, 1992)
HEAST = Health Effects Assessment Summary Tables (USEPA, 1991)

6.3.1 Non-Carcinogenic Effects

The potential for non-cancer health effects is evaluated by comparing an estimated intake (CDI) over a specified time period (e.g., a lifetime) with a reference dose (RfD) derived for a similar exposure period. This ratio of exposure to toxicity is called a hazard quotient. The non-cancer hazard quotient assumes that there is a level of exposure (i.e., the RfD) below which it is unlikely for even sensitive populations to experience adverse health effects. If the hazard quotient exceeds 1, there may be concern for potential non-cancer effects. The greater the hazard quotient above unity, the greater the level of concern.

For the dermal route of exposure to contaminated soils, the USEPA currently recommends that quantitative analysis not be performed for contaminants other than cadmium, PCBs and dioxin (USEPA, 1992a). So, for this site, cadmium and PCBs are evaluated quantitatively for dermal exposure. No RfDs are available for the dermal route of exposure. In their absence, the oral RfDs are used, adjusted for absorption (USEPA 1989e). As there is no listed RfD for PCBs, cadmium is the only contaminant evaluated quantitatively for non-cancer effects associated with dermal exposure. The absorption adjustment for cadmium is 0.10 (USEPA, 1992b).

No RfDs are available for the evaluation of exposures to lead. The USEPA believes that meaningful health-protective criteria (i.e., oral and inhalation reference doses) cannot be developed for lead, because there is insufficient evidence for a threshold for many of its noncancer effects, particularly in infants and young children, and people have a baseline of environmental exposure (e.g., from paint, diet, indoor dust and soil). Lead exposure is typically evaluated, not by comparison with reference doses, but by considering changes in blood lead levels; most toxicity endpoints associated with exposure to lead can be correlated with blood lead levels. Blood lead levels (PbB) are reported in micrograms of lead per deciliter of blood (ug/dl). The USEPA is in the review stages of developing an Exposure/Uptake/Biokinetic Model for Lead, which allows the user to predict blood lead levels in infants and children exposed to lead in the environment. This model focuses on the exposure of infants and young children, because they are believed to be more susceptible to the non-cancer effects of lead for a variety of reasons: (1) sensitivity of developing organ systems to lead; (2) behavior (mouthing and pica) that increases contact with lead from dust and soil; (3) physiological differences resulting in greater gastrointestinal absorption efficiency and greater deposition of airborne lead in the respiratory tract; and (4) transplacental transfer of lead that establishes a lead burden in the fetus.

Deleterious health effects include impaired or delayed mental and physical development, impaired heme biosynthesis, and decreased serum vitamin D levels. The USEPA reports that, although considerable controversy remains regarding low lead exposure (correlated with blood lead levels below 10 ug/dl), the weight of evidence indicates that in infants and children, exposure-effect relationships extend to blood lead levels of 10 - 15 ug/dl and possibly lower.

The USEPA model has not been officially released to date, and does not represent policy. Additionally, it has limited applicability, in that its focus is on children and infants in residential settings. In the interim, the USEPA has recommended that sites be evaluated with respect to interim cleanup criteria of 500 - 1,000 mg/kg, "protective for direct contact at residential settings" (USEPA, 1989c; 1992b). Soil lead levels at each of the four areas at the Rochester Fire Academy site will be discussed in light of these interim cleanup criteria, below.

North Disposal Area - Of the samples collected from the fill material, the drainage area, and the marshy area to the north of the North Disposal Area, lead concentrations ranged from non-detect to 7,860 mg/kg. Of the 20 samples analyzed, eight samples (or 40 percent) contained lead in concentrations in excess of the lower interim cleanup criteria of 500 mg/kg. These samples were collected from the fill material.

South Disposal Area - Of the samples collected from the fill/incinerator residue and native soil, lead levels ranged from not detected to 4,880 mg/kg. Of the 20 samples analyzed, four samples (or 20 percent) contained lead concentrations in excess of the lower interim cleanup criteria of 500 mg/kg. Three of these four samples were from the incineration residue and one was from the reworked soil.

Training Grounds - Of the samples collected in the sandy gravelly fill, lead concentrations ranged from 8.4 to 1,210 mg/kg. Of the 45 samples analyzed, four samples (or about 9 percent) contained lead levels in excess of 500 mg/kg. These four samples were located in sampling Area 1 in the northern portion of the Training Grounds Area.

Genesee Park Area - Of the samples collected within the Genesee Park, lead concentrations ranged from non-detect to 964 mg/kg. One sample out of 23 (or less than

5 percent) contained lead in excess of 500 mg/kg. This sample was located opposite the South Disposal Area.

6.3.2 Carcinogenic Effects

Regardless of the mechanism of effect, risk assessment methods generally derive from the hypothesis that thresholds for cancer induction by carcinogens do not exist and that the dose:response relationship is linear at low doses. The methods require extrapolation from high dose animal studies to evaluate low dose exposure to humans. In the absence of adequate information to the contrary, a linearized, multistage, non-threshold low-dose extrapolation model is recommended by USEPA as the most appropriate method for assessing chemical carcinogens. USEPA emphasizes that this procedure leads to a plausible upper limit to the risk that is consistent with some proposed mechanisms of carcinogenesis.

Through application of this approach, USEPA has derived estimates of incremental excess cancer risk from lifetime exposure to potential carcinogens. This is accomplished by establishing the carcinogenic potency of the chemical substance through critical evaluation of the various test data and the fitting of dose:response data to a low dose extrapolation model. The slope factor (which describes the dose:response relationship at low doses) is expressed as a function of intake (i.e., per mg/kg/day). This expression incorporates standard pharmacological considerations such as body weight (typically assumed to be 70 kg or about 154 lbs for an average adult). The slope factors presented in Table 6-16 are used here to estimate finite, upper limits of risk at low dose levels administered over a lifetime. The linear low-dose cancer risk equation is:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

Risk = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer;

CDI = chronic daily intake averaged over 70 years (mg/kg-day); and

SF = slope factor, expressed in $(\text{mg/kg-day})^{-1}$

This linear equation is valid only at low risk levels (i.e., below estimated risks of 0.01). This approach does not necessarily give a realistic prediction of risk. The true value of the risk at trace ambient concentrations is unknown, and may be as low as zero.

There are no assigned slope factors for dermal exposure (skin contact). In their absence, slope factors for oral exposure are used. This will tend to overestimate risk for carcinogens which exert their effects systemically. The USEPA's current guidance, as it affects this analysis, permits quantitative analysis of dermal exposures to contaminants in soil for cadmium and PCBs only. As there is no assigned slope factor for oral exposure to cadmium, PCBs are the only compounds evaluated quantitatively for carcinogenic risk due to dermal exposure.

There are no USEPA-established slope factors assigned to lead. The USEPA has classified lead as a probable human carcinogen because some lead compounds cause tumors in experimental animals, and has assigned zero as the current maximum contaminant level goal (MCLG) for lead in drinking water. Despite these actions, the USEPA recommends that quantitative estimates of carcinogenic potency of lead not be used for the purposes of risk assessment (IRIS, 1992).

6.3.3 Mixtures

The USEPA has developed guidelines to evaluate the overall potential for non-cancer and cancer effects posed by multiple chemicals. For the assessment of non-cancer effects, a hazard index approach is used. This approach assumes that subthreshold exposures to several chemicals at the same time could result in an adverse health effect. It assumes that the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures. The hazard index is equal to the sum of the hazard quotients. When the hazard index exceeds unity, there may be concern for potential health effects. Generally, hazard indices are only used in the evaluation of a mixture of chemicals that induce the same effect by the same mechanism of action. In this analysis, the hazard quotients of a mixture of compounds which have different effects is used as a screening-level approach. This approach could overestimate the potential for effects.

For the assessment of cancer effects, the individual risks associated with exposure to each carcinogen are summed. This represents an approximation of the precise equation for combining risks which accounts for the joint probabilities of the same individual developing cancer as a consequence of exposure to two or more carcinogens. This additive approach assumes independence of action by the chemicals involved (i.e., that there are no synergistic or antagonistic chemical interactions and all chemicals produce the same effect, i.e., cancer).

6.4 RISK CHARACTERIZATION

The magnitude of risks associated with exposures to contaminants in surficial soil on the site, in the Genesee Valley Park, and in the Genesee River, are evaluated in this section, and presented in Tables 6-17 through 6-25. Potential non-cancer health effects, those associated with long-term chronic exposure to soil, are assessed through application of reference doses presented in Table 6-15. Carcinogenic risks are quantified using the slope factors presented in Table 6-16. The cumulative impact of exposure from inadvertent ingestion and skin contact is estimated.

6.4.1 Non-carcinogenic Effects

North Disposal Area - As presented in Table 6-17, the chemical-specific hazard quotients for soil ingestion by trespassers are considerably less than unity (1) for all chemicals. As indicated, the pathway hazard indices and the total exposure hazard index is less than unity, indicating that adverse, noncarcinogenic health effects are unlikely.

Training Grounds Area - As presented in Table 6-18, the chemical-specific hazard quotients for soil ingestion and dermal contact by training officers are less than unity (1) for all chemicals.

As indicated, the pathway hazard indices are well below unity. The total exposure hazard index is also well below unity, indicating minimal concern.

South Disposal Area - As presented in Table 6-19, the chemical-specific hazard quotients for soil ingestion and soil contact by trespassers are considerably less than unity (1). As indicated, the pathway hazard indices and total exposure hazard index are less than unity.

Genesee Valley Park - As presented in Table 6-20, the chemical-specific hazard quotients for soil ingestion and dermal contact by park visitors are less than unity (1) for

TABLE 6-17

ROCHESTER FIRE ACADEMY
CHRONIC HAZARD INDEX ESTIMATES
(NON-CANCER EFFECTS)

NORTH DISPOSAL AREA

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Ingestion of Chemicals in Soil by Trespassers				
Arsenic	3.5E-06	No	3E-04	0.01
Barium	5.2E-04	No	7E-02	0.007
Cadmium	2.5E-06	No	5E-04	0.005
Chromium	4.3E-05	No	1E+00	0.00004
Copper	1.1E-03	No	3.7E-02	0.03
Mercury	1.4E-07	No	3E-04	0.0005
Nickel	5.1E-06	No	2E-02	0.0003
Silver	5.0E-07	No	5E-03	0.0001
Zinc	6.4E-04	No	2E-01	0.003
Tetrachloroethene	6.9E-09	No	1E-02	<0.000001
Toluene	5.5E-10	No	2E-01	<0.000001
1,1,1-Trichloroethane	4.5E-10	No	9E-02	<0.000001
Butyl Benzyl Phthalate	7.4E-08	No	2E-01	<0.000001
Di-n-Butyl Phthalate	1.1E-07	No	1E-01	0.000001
Diethyl Phthalate	6.8E-08	No	8E-01	<0.000001
Naphthalene	3.8E-08	No	4E-03	0.000009
tPAHs	3.0E-07	No	3E-02	0.00001
Pathway Hazard Index = 0.06				

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Dermal Contact with Chemicals in Soil by Trespassers				
Cadmium	1.1E-06	Yes	5E-04	0.02
Pathway Hazard Index = 0.02				
Total Exposure Hazard Index = 0.08				

CDI = Chronic Daily Intake
RfD = Reference Dose for Non-Carcinogenic Effects (IRIS, 1992; USEPA, 1991)
Hazard Quotient = CDI   RfD

Reference: USEPA, 1989e

TABLE 6-18

ROCHESTER FIRE ACADEMY
CHRONIC HAZARD INDEX ESTIMATES
(NONCANCER EFFECTS)
TRAINING GROUNDS

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Ingestion of Chemicals in Soil by Training Officers				
Arsenic	7.9E-07	No	3E-04	0.003
Cadmium	5.0E-07	No	5E-04	0.0001
Copper	1.1E-05	No	3.7E-02	0.0003
Mercury	2.1E-08	No	3E-04	0.00007
Zinc	2.0E-05	No	2E-01	0.0001
Ethyl Benzene	4.0E-06	No	1E-01	0.00004
Toluene	5.3E-05	No	2E-01	0.0003
Xylenes	3.2E-05	No	2E+00	0.00002
Butyl Benzyl Phthalate	6.1E-06	No	2E-01	0.00003
Di-n-Butyl Phthalate	6.0E-06	No	1E-01	0.00006
Diethyl Phthalate	1.1E-06	No	8E-01	0.000001
tPAHs	6.6E-06	No	3E-02	0.0002
Pathway Hazard Index = 0.005				
CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Dermal Contact with Chemicals in Soil by Training Officers				
Cadmium	6.0E-08	Yes	5E-04	0.001
Pathway Hazard Index = 0.001				
Total Exposure Hazard Index = 0.006				

CDI = Chronic Daily Intake
RfD = Reference Dose for Non-Carcinogenic Effects (IRIS, 1992; USEPA, 1991)
Hazard Quotient = CDI RfD

Reference: USEPA, 1989e

TABLE 6-19

ROCHESTER FIRE ACADEMY
CHRONIC HAZARD INDEX ESTIMATES

(NONCANCER EFFECTS)

SOUTH DISPOSAL AREA

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Ingestion of Chemicals in Soil by Trespassers				
Antimony	4.0E-06	No	4E-04	0.01
Arsenic	2.2E-06	No	3E-04	0.007
Barium	2.7E-04	No	7E-02	0.004
Cadmium	1.3E-05	No	5E-04	0.03
Chromium	8.3E-03	No	1E+00	0.00008
Copper	1.6E-03	No	3.7E-02	0.04
Manganese	3.6E-04	No	1E-01	0.004
Mercury	7.9E-08	No	3E-04	0.0003
Nickel	8.6E-05	No	2E-02	0.004
Silver	3.4E-07	No	5E-03	0.00007
Zinc	5.5E-04	No	2E-01	0.003
2-Butanone	9.9E-07	No	5E-02	0.00002
Chloroform	6.4E-08	No	1E-02	0.00006
1,1-Dichloroethane	3.3E-06	No	1E-01	0.0003
1,2-Dichloroethene	3.1E-05	No	2E-02	0.002
Ethyl Benzene	1.0E-08	No	1E-01	0.000001
4-Methyl 2-Pentanone	4.4E-07	No	5.0E-02	0.000008
Tetrachloroethene	1.8E-05	No	1E-02	0.002
Toluene	6.6E-07	No	2E-01	0.000003
1,1,1,-Trichloroethane	1.8E-06	No	9E-02	0.000002
Xylenes	1.1E-07	No	2E+00	<0.000001
Di-n-Butyl Phthalate	4.6E-060	No	1E-01	0.000004
Diethyl Phthalate	6.4E-05	No	8E-01	0.000007
Pathway Hazard Index = 0.1				

TABLE 6-19

ROCHESTER FIRE ACADEMY
CHRONIC HAZARD INDEX ESTIMATES

(NONCANCER EFFECTS)

SOUTH DISPOSAL AREA

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Dermal Contact with Chemicals in Soil by Trespassers				
Cadmium	5.8E-06	Yes	5E-04	0.1
Pathway Hazard Index = 0.1				
Total Exposure Hazard Index = 0.2				

CDI = Chronic Daily Intake
RfD = Reference Dose for Non-Carcinogenic Effects (IRIS, 1992; USEPA, 1991)
Hazard Quotient = CDI/RfD

Reference: USEPA, 1989e

TABLE 6-20

ROCHESTER FIRE ACADEMY

CHRONIC HAZARD INDEX ESTIMATES (NONCANCER EFFECTS)

GENESEE VALLEY PARK

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Ingestion of Chemicals in Soil by Park Visitors				
Arsenic	1.1E-06	No	3E-04	0.004
Cadmium	3.8E-06	No	5E-04	0.008
Copper	6.5E-06	No	3.7E-02	0.0002
Mercury	1.8E-08	No	3E-04	0.00006
Zinc	1.3E-05	No	2E-01	0.00006
2-Butanone	8.6E-10	No	5E-02	<0.000001
1,2-Dichloroethene	1.9E-09	No	2E-02	<0.000001
4-Methyl 2-Pentanone	4.0E-09	No	5E-02	<0.000001
Toluene	2.5E-10	No	2E-01	<0.000001
Di-n-Butyl Phthalate	3.5E-08	No	1E-01	<0.000001
Diethyl Phthalate	4.9E-08	No	8E-01	<0.000001
tPAHs	3.3E-07	No	3E-02	0.00001
Pathway Hazard Index = 0.01				
Exposure Pathway: Dermal Contact with Chemicals in Soil by Park Visitors				
Cadmium	1.7E-06	Yes	5E-04	0.03
Pathway Hazard Index = 0.03				
Total Exposure Hazard Index = 0.04				

CDI = Chronic Daily Intake
RfD = Reference Dose for Non-Carcinogenic Effects (IRIS, 1992; USEPA, 1991)
Hazard Quotient = CDI/RfD

Reference: USEPA, 1989e

all chemicals. The sum of the hazard quotients for each exposure pathway is below unity. The total exposure hazard index is also well below unity, indicating minimal concern.

Genesee River - Exposure resulting from inadvertent ingestion of surface water was quantified based upon the maximum detected zinc concentration measured immediately downstream of the South Disposal Area. The analysis indicated a hazard quotient well below unity, indicating minimal concern (Table 6-21).

6.4.2 Carcinogenic Risks

North Disposal Area - As presented in Table 6-22, exposures to arsenic and PCBs at this site contribute most significantly to the total incremental cancer risk estimate of about 10 in one million.

Training Grounds - As presented in Table 6-23, the total incremental cancer risk calculated for exposures at this location is heavily weighted by exposures to PCBs and carcinogenic PAHs. The estimate is 40 in one million.

South Disposal Area - As presented in Table 6-24, the total incremental cancer risk calculated for this location is largely attributable to exposures to PCBs and arsenic. The risk estimate is relatively high for this site, at 400 in one million. It should be noted that the exposure scenario developed for this location assumes that trespassers may gain access to it, even though access is currently impeded.

Genesee Valley Park - As presented in Table 6-25, risks associated with inadvertent contact with and ingestion of contaminated soils may result in risks of some concern. The incremental cancer risk calculated for this location is 5 in one million. It should be noted that at this location, the contamination is relatively localized, and there is a very low probability that visitors would be exposed to the extent evaluated here.

6.4.3 Genesee River

In Section 8.3 of the RI report, the methodology for estimating contaminant loadings to the Genesee River from the Rochester Fire Academy site is discussed, and total loadings of each group of chemicals is provided in Table 8-1 for each of three source areas (i.e., the North Disposal Area, the Training Grounds Area and the South Disposal Area).

Chemical-specific contaminant concentrations are presented in Table 6-26 under the heading "Water Quality Adjacent to Site". The first value in that column is data from

TABLE 6-21

ROCHESTER FIRE ACADEMY

CHRONIC HAZARD INDEX ESTIMATES
(NONCANCER EFFECTS)

GENESEE RIVER

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	RfD (MG/KG-DAY)	HAZARD QUOTIENT
Exposure Pathway: Ingestion of Chemicals in Surface Water by Swimmers				
Zinc	7.6E-05	No	2E-01	0.0004
Pathway Hazard Index = 0.0004				
Exposure Pathway: Dermal Contact with Chemicals in Surface Water by Swimmers				
Zinc	5.4E-06	Yes	2E-01	0.00003
Pathway Hazard Index = 0.00003				
Total Exposure Hazard Index = 0.0004				

CDI = Chronic Daily Intake
RfD = Reference Dose for Non-Carcinogenic Effects (IRIS, 1992; USEPA, 1991)
Hazard Quotient = CDI/RfD

Reference: USEPA, 1989e

TABLE 6-22

ROCHESTER FIRE ACADEMY

CANCER RISK ESTIMATES

NORTH DISPOSAL AREA

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	SF (MG/KG-DAY)	CHEMICAL SPECIFIC RISKS
Exposure Pathway: Ingestion of Chemicals in Soil by Trespassers				
Arsenic	1.5E-06	No	1.75	2.6E-06
Tetrachloroethene	3.0E-09	No	5.1E-02	1.5E-10
Trichloroethene	3.0E-09	No	1.1E-02	3.3E-11
cPAHs	5.9E-08	No	1.15E+01	6.8E-07
PCBs	2.1E-07	No	7.7E+00	1.7E-06
Total Pathway Risk = 5.0E-06				
Exposure Pathway: Dermal Contact with Chemicals in Soil by Trespassers				
PCBs	5.8E-07	Yes	7.7E+00	4.5E-06
Total Pathway Risk = 4.5E-06				
Total Risk at this Location = 1.0E-05				

TABLE 6-23

ROCHESTER FIRE ACADEMY

CANCER RISK ESTIMATES

TRAINING GROUNDS

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	SF (MG/KG-DAY)	CHEMICAL SPECIFIC RISKS
Exposure Pathway: Ingestion of Chemicals in Soil by Training Officers				
Arsenic	3.4E-07	No	1.75	6.0E-07
Benzene	3.7E-09	No	2.9E-02	1.1E-10
cPAHs	9.8E-08	No	11.5	1.1E-06
PCBs	2.7E-06	No	7.7	2.1E-05
Total Pathway Risk = 2.3E-05				
Exposure Pathway: Dermal Contact with Chemicals in Soil by Training Officers				
PCBs	2.0E-06	Yes	7.7	1.5E-05
Total Pathway Risk = 1.5E-05				
Total Risk at this Location = 4.0E-05				

TABLE 6-24

ROCHESTER FIRE ACADEMY

CANCER RISK ESTIMATES

SOUTH DISPOSAL AREA

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	SF (MG/KG-DAY)	CHEMICAL SPECIFIC RISKS
Exposure Pathway: Ingestion of Chemicals in Soil by Trespassers				
Arsenic	9.6E-07	No	1.75	1.7E-06
Benzene	4.8E-10	No	2.9E-02	1.4E-11
Chloroform	2.7E-08	No	6.1E-03	1.7E-10
1,2-Dichloroethane	8.6E-08	No	9.1E-02	7.8E-09
1,1,2,2-Tetrachloroethane	1.9E-07	No	2.0E-01	3.8E-08
Trichloroethane	5.9E-06	No	1.1E-02	6.5E-08
Vinyl Chloride	1.6E-07	No	1.9E+00	3.1E-07
PCBs	1.3E-05	No	7.7E+00	1.0E-04
Total Pathway Risk = 1.0E-04				
Exposure Pathway: Dermal Contact with Chemicals in Soil by Trespassers				
PCBs	3.6E-05	Yes	7.7E+00	2.7E-04
Total Pathway Risk = 2.7E-04				
Total Risk at this Location = 4.0E-04				

TABLE 6-25

ROCHESTER FIRE ACADEMY

CANCER RISK ESTIMATES

GENESEE VALLEY PARK

CHEMICAL	CDI (MG/KG-DAY)	CDI ADJUSTED FOR ABSORPTION	SF (MG/KG-DAY)	CHEMICAL SPECIFIC RISKS
Exposure Pathway: Ingestion of Chemicals in Soil by Park Visitors				
Arsenic	4.5E-07	No	1.75	7.9E-07
Trichloroethene	2.1E-09	No	1.1E-02	2.3E-11
PCBs	1.2E-07	No	7.7	9.5E-07
cPAHs	8.6E-08	No	11.5	9.9E-07
Total Pathway Risk = 2.7E-06				
Exposure Pathway: Dermal Contact with Chemicals in Soil by Park Visitors				
PCBs	3.4E-07	Yes	7.7	2.6E-06
Total Pathway Risk = 2.6E-06				
Total Risk at this Location = 5.0E-06				

TABLE 6-26

Comparison with USEPA Ambient Water Quality Standards for Human Health (All units in $\mu g/l$)

Chemical	USEPA Ambient Water Quality Std	Basis for Standard	Current Upstream Water Quality	Exceedence of Standard	Projected Site-Related Water Quality			Exceedence of Standard
					GRW-2	GW	Total[2]	
					GRW-2	GW	Total[2]	
VOLATILES								
Chlorobenzene	488	Public health	ND	NO	ND	0.00003	0.00003	NO
SEMI-VOLATILES								
Phenol	300	Water & fish consumption	ND	NO	ND	0.00006	0.00006	NO
Bis(2-ethylhexyl) phthalate	50000	Fish consumption	10	NO	11	0.0002	11	NO
PCBs								
Aroclor-1254	0.000079	Fish consumption	ND	NO	ND	0.00005	0.00005	NO
INORGANICS								
Aluminum	—	—	3350	NO	4030	0.2	4030	NO
Arsenic	0.0175	Fish consumption	1	YES	2	0.0001	2	YES
Beryllium	0.117	Fish consumption	ND	NO	ND	0.000006	0.000006	NO
Cadmium	10	Water & fish consumption	ND	NO	ND	0.00002	0.00002	NO
Chromium (VI)	50	Water & fish consumption	13	NO	11	0.0003	11	NO
Cobalt	—	—	16	NO	ND	0.0005	0.0005	NO
Copper	—	—	7	NO	13	0.0002	13	NO
Iron	300	Water & fish consumption	5300	YES	7100	0.6	7100	YES
Lead	50	Water & fish consumption	ND	NO	ND	0.003	0.003	NO
Nickel	100	Fish consumption	ND	NO	ND	0.0005	0.0005	NO
Selenium	10	Water & fish consumption	ND	NO	ND	0.000006	0.000006	NO
Vanadium	—	—	5	NO	ND	0.0004	0.0004	NO
Zinc	—	—	32	NO	466	0.002	466	NO

NOTES:

— = Not Available ND = Not Detected

[1] All listed standards are set on the basis of human health protection.

[2] Total is a combination of current water quality (GRW-2) and projected water quality from ground water (GW).

sampling location GRW-2 (immediately downstream of the South Disposal Area). This sampling location was chosen as it contained the highest levels of those detected midstream and downstream of the site. The second value in that column ("GW") is the incremental surface water contaminant concentration calculated on the basis of the contaminant loadings to the river. The mass of each contaminant was computed using the approach described in Section 8.3 of the RI report. The incremental surface water concentration was derived by dividing this mass by the volume of Genesee River discharge for a comparable time period.

Ambient water quality criteria have been established to protect humans from ingestion of unacceptable levels of contaminants in water and fish. As the Genesee River is a Class B stream, it is not to be used as a drinking water supply, but it may be used for fishing. Therefore, where available, the criteria for ingestion of fish (only) have been presented in Table 6-26. As indicated, projected water quality adjacent to the site exceed the USEPA criteria for arsenic and iron, although upstream water quality also exceed these criteria.

6.4.4 Public Welfare

No imminent threat to site users, nor to residents in the vicinity of the site, presently exists.

6.5 CONCLUSIONS

The analysis presented above addresses the consequences of "reasonable maximum exposure" to site contaminants. For this reason, the contaminant concentrations selected for the evaluation of exposure are either the 95th percent upper confidence limit on the mean, or the maximum concentration detected. This approach is conservative since, in some instances, these maximum values may be detected in subsurface soils or at a discrete location where exposure is highly unlikely. Furthermore, frequent exposure to on- and off-site contaminants was also assumed for the purpose of this evaluation, even though actual exposures either may not occur or may be very limited. This approach is consistent with that recommended by the USEPA.

The areas evaluated do not pose concern related to non-cancer effects of PCBs and cadmium for the exposure scenarios evaluated. [The evaluation of lead concentrations in soils indicated exceedances of USEPA's interim lead cleanup criteria (protective for direct contact at residential settings) at the North and South Disposal Areas, Training Grounds, and Genesee Valley Park (one exceedance only).]

The cancer risk analysis indicates that PCBs and arsenic in soils are the main contributors to risk at the North and South Disposal Areas; PCBs and carcinogenic PAHs in the Training Grounds and PCBs in the Genesee Valley Park.

The arsenic and iron concentrations at sampling stations located both upstream and adjacent to the site exceeded the criteria for human health. Given the character of the upstream water quality, these water quality standard exceedances do not appear to be attributable to the Rochester Fire Academy site.

7.0 ECOLOGICAL RISK ASSESSMENT

This section presents an assessment of potential environmental risks associated with contaminants detected at the Rochester Fire Academy site. The objectives of this assessment are (1) to provide an analysis of baseline risks, currently and in the future, in the absence of actions to control or mitigate site contamination, and (2) to assist in determining the need for and extent of remediation.

The ecological risk assessment (ERA) follows guidance contained in the U.S. Environmental Protection Agency's (USEPA) Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (USEPA, 1989) which is a companion document to USEPA's RI/FS guidance document, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988).

7.1 ECOLOGICAL RESOURCES

On April 14, 1992, Malcolm Pirnie, Inc. conducted a site investigation at the Rochester Fire Academy to assess baseline environmental conditions. During the investigation, dominant vegetation was identified and wildlife observations recorded.

7.1.1 Vegetation Inventory

The North Disposal Area is sparsely wooded and is comprised primarily of eastern cottonwood saplings and small trees, and tartarian honeysuckle shrubs. The area to the north of the Disposal Area is a dense, wet woods comprised mostly of trees with some shrubs. Hummocks are interspersed within ponded areas containing large black willow and white ash trees, smaller ashleaf maple, red maple and eastern cottonwood trees, and viburnum shrubs. Along the west and north edges of these wet areas are large honey locust and white oak trees, smaller shingle oak trees, and tartarian honeysuckle shrubs. Along the entire length of the east (Genesee River) side of the site, there are large sugar maple, black willow, Eastern cottonwood and shingle oak trees, smaller red oak and pin oak trees, and hawthorn and Tartarian honeysuckle shrubs.

The South Disposal Area has three small ponded areas, one of which is vegetated with cattails. The center of this Disposal Area is cleared and contains incineration and tarry residues. Along the edges, the vegetation is comprised of Eastern cottonwood and white ash trees, and willow, Tartarian honeysuckle and hawthorn shrubs. Vegetation inventoried during the April 14 field survey is listed in Table 7-1.

Between the North and South Disposal Areas is an area cleared of natural vegetation with gravel, grass, concrete structures, and open burn pits associated with the Police and Firemen's Training facilities. Along the northwest and east sides of this area are extensions of the vegetation types found in the North Disposal Area. To the northwest, there are large white ash, red maple, honey locust, white oak and Eastern cottonwood trees, and willow and red-osier dogwood shrubs. To the east, there are white oak, red oak, Eastern cottonwood, shingle oak, sugar maple and red maple trees, and hawthorn shrubs. Along part of the western edge there are large planted red maple trees. In the northwest corner, below the tree vegetation, there is a wet area vegetated with red-osier dogwood and willow shrubs, and herbaceous vegetation such as woolgrass, soft rush, cattail and teasel. There is also an area covered by sphagnum moss east of the wet area.

According to New York State Freshwater Wetlands mapping, there are no State-regulated wetlands on the Fire Academy site. The site, however, is located adjacent to State Wetland RH-2, which runs in a narrow strip of the Genesee Valley Park along the Genesee River. Wetland RH-2 is a Class II wetland and is described as a deciduous shrub swamp in an urbanized area associated with permanent open water (the Genesee River).

7.1.2 Wildlife Inventory

Wildlife inventoried during the April 14, 1992 field survey are listed in Table 7-2. Mature trees along the Genesee River contain numerous cavities which birds are utilizing for nesting. Tree swallow and common flicker were observed nesting in this area. Other species, such as downy woodpecker, blue jay and warblers, feed and potentially nest in the woods north of the North Disposal Area. American robin, blue jay and red-winged blackbird feed and perch in the northwest corner of the Training Grounds Area. A pair of mallards was observed utilizing the ponded areas in the South Disposal Area.

Woodchucks have been seen in the South Disposal Area and the Fire and Police Training Areas, and they probably have a network of tunnels in these areas. Raccoon tracks, red fox scat, and Eastern chipmunks were observed along the Genesee River's edge.

TABLE 7-1

VEGETATION INVENTORY

Trees

Scientific Name	Common Name
Acer negundo	Ashleaf Maple
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Fraxinus americana	White Ash
Gleditsia triacanthos	Honey Locust
Populus deltoides	Eastern Cottonwood
Quercus alba	White Oak
Quercus imbricaria	Shingle Oak
Quercus muehlenbergii	Chinquapin Oak
Quercus palustris	Pin Oak
Quercus rubra	Red Oak
Salix nigra	Black Willow
Salix spp.	Willow

Shrubs

Amorpha fruticosa	False Indigo Bush
Cornus stolonifera	Red-Osier Dogwood
Crataegus spp.	Hawthorn
Lonicera tatarica	Tartarian Honeysuckle
Salix spp.	Willow
Viburnum rafinesquianum	Shortstalk Arrowwood

Herbaceous

Dipsacus sylvestris	Teasel
Juncus effusus	Soft Rush
Scirpus cyperinus	Wool Grass
Typha latifolia	Cattail

TABLE 7-2
WILDLIFE INVENTORY

Birds

Scientific Name	Common Name
Agelaius phoeniceus	Red-winged Blackbird
Anas platyrhynchos	Mallard
Cathartes aura	Turkey Vulture
Colaptes auratus	Common Flicker
Corvus brachyrhynchos	American Crow
Cyanocitta cristata	Blue Jay
Iridoprocne bicolor	Tree Swallow
Parulidae Family	Warblers
Picoides pubescens	Downy Woodpecker
Turdus migratorius	American Robin

Mammals

Marmota monax	Woodchuck
Procyon lotor	Raccoon
Tamiasciurus hudsonicus	Red Squirrel
Tamias striatus	Eastern Chipmunk
Vulpes vulpes	Red Fox

Reptiles and Amphibians

Hyla crucifer	Spring Peeper
Thamnophis sirtalis	Common Garter Snake

Fish*

Alosa pseudoharengus	Alewife
Ambloplites roprestris	Rock Bass
Catostomus commersoni	White Sucker
Cyprinius carpio	Carp
Dorosoma cepedianum	Gizzard Shad
Esox lucius	Northern Pike
Etheostoma nigrum	Johnny Darter
Ictalurus nebulosus	Brown Bullhead
Labidesthes sicculus	Brook Silverside
Lempomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth Bass

TABLE 7-2 (Continued)

WILDLIFE INVENTORY

Fish (Continued)

Scientific Name	Common Name
Micropterus salmoides	Largemouth Bass
Notemogonus chrysoleucas	Golden Shiner
Notropis atherinoides	Emerald Shiner
Notropis hudsonius	Spottail Shiner
Perca flavescens	Yellow Perch
Pomoxis nigromaculatus	Black Crappie
Roccus americana	White Perch
Stizostedion vitreum	Walleye

*Source: Monroe County DOH, 1986.

Red squirrels were found feeding and are potentially nesting north of the North Disposal Area.

Garter snakes have been seen along the Genesee Valley Canal area and there are most likely other snakes in this area, as well as in the North and South Disposal Areas. Spring peepers were heard in the ponded areas north of the North Disposal Area and in the South Disposal Area, and it is likely that there are other amphibians in these areas as well.

According to the "Genesee River Sediment Toxics Survey" report (Monroe County DOH, 1986), the fish community inhabiting the lower Genesee River exhibits an overall low diversity primarily as a result of heavy sediment loads carried by the river from the upper watershed. The Sediment Toxics Survey report lists various fish studies which have been conducted in the lower Genesee River. Impingement studies conducted in 1976 for Rochester Gas and Electric at the Beebee Power Station (located downstream of the site and upstream of the Lower Falls) found alewives, smelt and gizzard shad to be the most common species. Fish net surveys conducted in this area identified nineteen fish species including emerald shiner, rock bass, redhorse sucker, white sucker and channel catfish. Fish surveys conducted in the Barge Canal in 1979 and 1980 identified fifteen major canal species, including pumpkinseed and bluegill sunfish, yellow perch, rock, smallmouth and largemouth bass, carp, emerald and golden shiner, black crappie, northern pike, brook silverside, brown bullhead and walleye. The fish species listed in the Wildlife Inventory (Table 6-27) are all potentially found in the Genesee River in the area of the site.

No threatened or endangered plants, animals, or habitats were found on the site during the April 1992 survey. Information regarding the potential presence of threatened and endangered species and significant habitat from the Natural Heritage/Significant Habitat Units in Latham, NY indicated that no potential impacts on threatened, endangered or special concern species, rare plant, animal or natural community occurrences or significant habitats have been identified at this site.

7.2 POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

Habitats which presently exist on and in the vicinity of the Fire Training Academy site include wooded upland and wetland areas, emergent wetland and the open water of the

Genesee River. The main areas of concern with regard to wildlife on the site are the on-site ponded/wetland areas and the Genesee River in the vicinity of the site.

As discussed above, various wildlife species were observed on the Rochester Fire Training Academy site during the April 14, 1992 field survey. Bird species include perching birds such as blue jays and warblers, and waterfowl such as mallards. Various mammals and signs of recent mammal inhabitance were observed throughout the wooded portions of the site, and several reptiles and amphibians were seen as well. Past fish surveys have identified various fish species inhabiting the Genesee River.

Mammals and song birds utilizing the site vicinity could be exposed to contamination through ingestion of plant material and surface water. Wildlife ingesting aquatic and hydrophytic vegetation can be exposed to contaminants which have been taken up from sediments and water in the wetlands. Also, direct contact with water and sediments can occur during feeding and nesting activities, and on a constant basis for aquatic organisms which may inhabit the Genesee River. Aquatic organisms, such as frogs and turtles may be exposed to contaminants via ingestion of plant material, other organisms and sediments, as well as by direct contact with water and with sediments stirred up during feeding and nesting activities. Terrestrial wildlife can also come into contact with water and sediments while feeding and may directly ingest contaminants through these media. Benthic organisms living in Genesee River sediments may accumulate contaminants from the sediments and pass these contaminants to higher life forms through the food chain.

7.3 HAZARD IDENTIFICATION

7.3.1 Selection of Chemicals of Potential Concern

During the Remedial Investigation, surface water samples were taken at nine locations on- and off-site: on-site at three pond locations and two drainage swale locations and; off-site at four Genesee River locations. Sediment samples were taken at six locations: on-site at the two drainage swale locations and; off-site at the four Genesee River locations. No sediment samples were taken at the three on-site pond locations. This risk assessment is based upon the analytical results of these surface water and sediment samples, presented in Tables 7-31 and 7-35 of the original RI report.

Contaminants detected in surface water and sediment on the site and in the Genesee River were compared with available New York State standards and guidance values to determine which compounds may be of concern with respect to the Rochester Fire Academy site (Table 7-3). For surface waters, New York State Ambient Water Quality Criteria (NYCRR Title 6, Chapter X, Parts 701 and 702) and Guidance Values (NYDEC, 1990) were utilized, for Class B waters.

For sediments, the NYSDEC Guidance Document (1989) for deriving sediment criteria was utilized. The criteria derived from this guidance document are presented in Table 7-3. The sediment criteria used for the site were based upon a default value of 2% Total Organic Carbon (TOC), since the actual TOC of the sediments is unknown. It should be noted that the NYSDEC Guidance Document for sediment criteria is used as guidance by the NYSDEC's Division of Fish and Wildlife and is neither a standard nor a policy of the Department. Also, the Sediment Criteria Document lists criteria for several inorganic compounds (arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc). The criteria given are derived from available toxicity data for these compounds. Also given in this document are pre-industrial (background) concentrations of these inorganics in Great Lakes sediments. For each of the compounds, the criterion is lower than the background level. Therefore, these criteria should not be considered clean-up levels, but rather an indication that some adverse effect may occur at concentrations above the criteria.

Where no criteria could be calculated based upon the guidance document, background soil concentrations for New York State (NYDEC, undated) were utilized for comparison. Since no background sediment concentrations are available, surface soil background levels were utilized. However, sediment would be expected to naturally have slightly higher levels of some compounds (particularly inorganics), since sediment areas are natural deposition zones, and higher organic contents of sediments tend to more readily adsorb these compounds.

If criteria or guideline values were exceeded, the compounds were chosen as compounds of concern for this assessment. The list was refined by considering frequency of detection, frequency and magnitude of criteria exceedance, and other properties of the compounds which may affect exposure and toxicity. Based upon these factors, the following

TABLE 7-3

HAZARD ASSESSMENT: ECOLOGICAL RISK
ROCHESTER FIRE ACADEMY SITE

CHEMICAL	FREQUENCY AND RANGE OF DETECTION:								NYDEC AWQC(1) Class B (mg/L)	NYDEC Sediment Criteria (2) (mg/kg)	Potential Concern
	SURFACE WATER				SEDIMENT						
	On-Site		Off-Site		On-Site		Off-Site				
	Frequency	Range (mg/L)	Frequency	Range (mg/L)	Frequency	Range (mg/kg)	Frequency	Range (mg/kg)			
VOLATILES											
Acetone	2/5	0.010 B	1/4	0.010 B	2/2	0.052 B – 0.082 B	4/8	0.014 B – 0.016 B	–		
Vinyl Chloride	1/5	0.026 J	0/4		0/2		0/8		0.0003 (H)		
1,1 Dichloroethane	1/5	0.25	0/4		0/2		0/8		0.005 (H)		
total-1,2-Dichloroethene	1/5	0.71	0/4		0/2		0/8		–		
Chloroform	1/5	0.016 J	0/4		0/2		0/8		0.002 (H)		
1,2-Dichloroethane	1/5	0.30	0/4		0/2		0/8		0.0008 (H)		
1,1,1 Trichloroethane	1/5	0.48	0/4		0/2		0/8		0.005 (H)		
Carbon Tetrachloride	1/5	0.039	0/4		0/2		0/8		0.0004 (H)		
Trichloroethene	1/5	0.26	0/4		1/2	0.002 J	0/8		0.011 (GV,H)	0.04 (H)	
Tetrachloroethene	1/5	0.014 J	0/4		1/2	0.003 J	0/8		0.001 (GV,H)	0.016 (H)	
Toluene	1/5	0.028	0/4		0/2	0.001 J	4/8	0.001 J – 0.049	0.005 (H)	0.03 (H)	YES
Methylene Chloride	0/5		0/4		2/2	0.008 B – 0.009 B	8/8	0.006 B – 0.018 B			
2-Butanone	0/5		0/4		1/2	0.029	1/8	0.013 B			
SEMIVOLATILES											
Bis(2-ethylhexyl)phthalate	5/5	0.010 B – 0.013 B	4/4	0.010 B – 0.011 B	1/2	0.61 B	4/8	0.43 B – 0.51 B	0.0006	2.4 (A)	YES
Phenanthrene	0/5		0/4		0/2		1/8	0.12 J		2.78 (A)	
Fluoranthene	0/5		0/4		1/2	0.13 J	1/8	0.16 J	0.05 (H)	38 (H)	
Phenol	1/5	0.003 J	0/4		0/2		0/8		0.005		
2-Methylphenol	1/5	0.002 J	0/4		0/2		0/8		0.001 (H)		
4-Methylphenol	1/5	0.003 J	0/4		0/2		0/8		0.001 (H)		
2,4-Dimethylphenol	1/5	0.001 J	0/4		0/2		0/8		0.001 (H)		
Diethylphthalate	1/5	0.003 J	0/4		0/2		0/8		0.05 (H)		
PESTICIDES/PCBs											
Aroclor – 1254	0/5		0/4		1/2	11	0/4			0.012 (W)	YES
Aroclor – 1260	0/5		0/4		0/2		0/4				

TABLE 7-3 (Continued)

HAZARD ASSESSMENT: ECOLOGICAL RISK
ROCHESTER FIRE ACADEMY SITE

CHEMICAL	FREQUENCY AND RANGE OF DETECTION:								NYDEC AWQC(1) Class B (mg/L)	NYDEC Sediment Criteria (2) (mg/kg)	Potential Concern
	SURFACE WATER				SEDIMENT						
	On-Site		Off-Site		On-Site		Off-Site				
	Frequency	Range (mg/L)	Frequency	Range (mg/L)	Frequency	Range (mg/kg)	Frequency	Range (mg/kg)			
INORGANICS											
Aluminum	5/5	0.767 - 7.62	4/4	3.02 - 4.03	2/2	10500 - 11200	4/4	9450 - 11700	0.1	-	YES
Arsenic	5/5	0.002 J - 0.010 J	4/4	0.001 J - 0.002 J	2/2	5.2 - 7.6	8/8	4.3 - 8.5	0.19	5	
Barium	5/5	0.029 J - 0.237	4/4	0.048 - 0.064 J	2/2	57.6 J - 75.4	4/4	52.2 - 66.7	1.0 (H)	-	
Beryllium	0/5		0/4		2/2	0.34 J - 0.37 J	4/4	0.38 J - 0.46 J	1.1	-	
Cadmium	3/5	0.001 J	0/4		2/2	0.38 J - 4.3	1/8	0.35 B	0.0015/0.0018 (3)	0.8	YES
Calcium	5/5	35 - 71.2	4/4	50.9 - 69.9	2/2	4000 - 5010	4/4	9490 - 11200	-	-	
Chromium	5/5	0.011 - 0.02	3/4	0.01 - 0.013	2/2	12.5 - 30.7	4/4	12.1 J - 17.9 J	0.273/0.340 (3)	26	
Cobalt	3/5	0.009 J - 0.025	2/4	0.011 J - 0.016 J	2/2	7.9 J - 9.0 J	4/4	9.2 J - 12.3 J	0.005	-	YES
Copper	5/5	0.009 J - 1.76	4/4	0.004 J - 0.013 J	2/2	22.4 - 27.3	4/4	16 - 20.4	0.016/0.020 (3)	19	YES
Iron	5/5	1.98 - 13.8	4/4	5.3 - 7.1	2/2	16400 - 17400	8/8	13600 - 22500	0.3	24,000	YES
Lead	4/5	0.044 - 0.145	0/4		2/2	46.9 - 49	7/8	16.6 - 29.9	0.005/0.007 (3)	27	YES
Magnesium	5/5	9.97 - 13.8	4/4	11.7 - 16.2	2/2	2740 - 2990	4/4	5350 - 6010	35 (H)	-	
Manganese	5/5	0.077 - 0.988	4/4	0.109 - 0.154	2/2	182 - 343	8/8	221 - 541	0.3 (H)	428	
Mercury	2/5	0.0002 J	4/4		0/2		1/8	0.17	0.0002	0.11	
Nickel	1/5	0.015 J	0/4		2/2	13.4 - 18.1	4/4	20.2 - 22	0.123/0.151 (3)	22	
Potassium	5/5	1.98 J - 6.09	4/4	2.57 J - 3.68 J	2/2	1570 - 1870	4/4	1050 J - 1630	-	-	
Selenium	0/5		0/4		1/2	0.70 J	0/4		0.001	-	
Silver	2/5	0.003 J - 0.004 J	0/4		1/2	1.6 J	2/4	1.0 J - 1.2 J	0.0001	-	
Sodium	5/5	2.1 J - 8.64	4/4	25.2 - 34.2	2/2	87.3 J - 119 J	4/4	104 J - 148 J	-	-	
Vanadium	5/5	0.005 J - 0.013 J	2/4	0.005 J - 0.007 J	2/2	24.6 - 22.5	4/4	16.6 - 19	0.014	-	
Zinc	5/5	0.086 - 1.22	4/4	0.032 - 0.466	2/2	93.9 - 328	4/4	59.6 - 71.2	0.03	85	YES

(1) NYDEC (1990) Ambient Water Quality Standards, Class B unless otherwise designated as:
(H) = Human-based Standard
(GV) = Guidance Value

(2) NYDEC, 1989. (H) = Human-based; (W) = Wildlife Residue-based; (A) = Aquatic Toxicity-based.

(3) First value based on average on-site water hardness of 140 ppm;
Second value based on average off-site water hardness of 183 ppm.

B = Estimated detection limit due to blank contamination.
J = Estimated value due to limitations identified during the quality control review.

compounds were chosen as chemicals of potential concern for the Rochester Fire Academy site Ecological Risk Assessment:

- Aluminum
- Bis (2-ethylhexyl) Phthalate
- Cadmium
- Cobalt
- Copper
- Iron
- Lead
- PCBs
- Toluene
- Zinc

7.3.2 Description and Effects of Contaminants

Descriptions of the bioaccumulation potential and toxicity of the chemicals of potential concern, with regard to various aquatic and terrestrial organisms, are given in Appendix J of this document.

7.4 RISK EVALUATION

Aluminum - Aluminum was detected at all of the surface water sampling locations, both on-site and in the Genesee River. The Ambient Water Quality Criterion (AWQC) of 0.1 mg/L was exceeded at all of the locations, the highest level found on-site at station SWSW-1. In the Genesee River, there was no significant difference between the upstream, midstream and downstream samples. There is currently no NY State Sediment Criterion for aluminum. However, the concentrations detected both on-site and in the Genesee River were within the range of background levels (1,000 - 25,000 mg/kg) found in NY State soils. As with the surface water samples, the sediment samples in the Genesee River showed no appreciable difference in aluminum concentrations between upstream and downstream sediment.

Aluminum can bioaccumulate in plants and fish but is not known to biomagnify in terrestrial food chains. The effects of aluminum on laboratory animals are controversial, and it has not been determined whether effects are permanent or transitory. Based on the above, it appears that aquatic organisms could be at greater potential risk from exposure to aluminum in the study area than terrestrial wildlife, since aquatic species would be exposed to surface water on a regular, if not constant, basis. Due to the presence of aluminum at elevated levels (e.g. above AWQC), and considering the uncertainties regarding the effects of aluminum, the risk to wildlife from exposure to this compound in surface water in the study area is considered moderate. Since aluminum concentrations in sediment were within background levels, it appears that wildlife are at low risk from the presence of this compound in on-site and Genesee River sediments.

Bis (2-ethylhexyl) Phthalate - In surface water, bis (2-ethylhexyl) phthalate was detected above the AWQC of 0.0006 mg/L at all locations, the highest concentration found on-site at station PS-1. All sediment samples had concentrations of this compound below the NY State Sediment Criterion of 2.4 mg/kg. There was no difference between upstream, midstream and downstream concentrations in either the Genesee River water or sediment samples.

Bis (2-ethylhexyl) phthalate is a lipophilic compound which can be metabolized by fish and animals. It is known to bioaccumulate and is more likely to bioconcentrate in aquatic organisms than in warm blooded animals since cold blooded animals metabolize phthalates more slowly than warm blooded ones. Predatory fish species would tend to accumulate this compound at a rate equal to or greater than bottom-feeders, since the prey consumed would not metabolize the phthalate to a great degree prior to ingestion by the carnivore. Waterfowl and terrestrial wildlife would tend to be at a lower risk than fish and other aquatic species due to their more transitory nature and more infrequent contact with surface water. Due to the bioaccumulation potential of bis (2-ethylhexyl) phthalate and its presence in surface waters above the AWQC, the potential risk to aquatic organisms from this compound in surface water in the study area is considered moderate to high. Since this compound was detected at concentrations below the Sediment Criterion, the potential risk from contact with contaminated sediments in the study area is considered to be negligible.

Cadmium - Cadmium was not detected in surface water samples on-site or in the Genesee River. In sediment, cadmium was detected in the downstream Genesee River sample GRS-4 (second round) and in both drainage swale samples, SWSD-1 and SWSD-2. The NY State Sediment Criterion of 0.8 mg/kg was exceeded at SWSD-2 only.

Cadmium is strongly accumulated by all organisms, both through food and water. Since cadmium was not detected in surface water in the study area, the potential risk from this compound from exposure to surface water is negligible. Wildlife ingesting or coming into contact with sediment in the drainage swale along the eastern edge of the site are at potentially high risk since the Sediment Criterion was exceeded in this swale by a large margin. The remaining study area sediments exhibited cadmium levels below the criterion, and therefore present little or no risk to wildlife from exposure to this compound.

Cobalt - Cobalt was detected in two Pond samples (PS-2 and PS-3), one drainage swale sample (SWSW-1), in the upstream Genesee River sample (GRW-1) and in one midstream Genesee River (GRW-3) sample. Concentrations detected were all above the NY State AWQC of 0.005 mg/L. The highest level (0.025 mg/L) was found at PS-2. The cobalt concentration at the midstream Genesee River location was slightly lower than at the upstream location. There is currently no NY State Sediment Criterion for cobalt. Concentrations in sediment were all within the range of background concentrations (2.5 - 60 mg/kg) in NY State.

Although the AWQC for cobalt was exceeded at all locations detected, this compound is considered an essential element and is generally not bioaccumulated to excessive concentrations. Therefore, the potential risk to wildlife from the presence of this compound in surface water is considered moderate. Since cobalt levels in sediment were within the background range for soils, the potential risk from exposure to cobalt in site vicinity sediments is considered negligible.

Copper - Copper was detected at all of the surface water sampling locations, the highest level (1.76 mg/L) detected on-site at PS-3. The AWQC of 0.016 mg/L for on-site waters (calculated based upon an average on-site water hardness of 140 mg/L) was exceeded in all three Pond samples and in one drainage swale sample (SWSW-1). The average hardness was calculated based upon actual sampling data from the site. The Genesee River samples were below the AWQC of 0.020 mg/L (calculated based upon an average Genesee River water hardness of 183 mg/L). Sediment concentrations exceeded the NY State Sediment Criterion of 19 mg/kg in both drainage swale samples (SWSD-1 and SWSD-2), and in the upstream Genesee River sample (GRS-1) and one midstream Genesee River sample (GRS-3). The highest sediment concentration was detected on-site at SWSD-2.

Copper has been shown to have a low potential for bioconcentration in fish. The bioconcentration potential for molluscs is higher, and may reach a bioconcentration factor of 30,000. However, no evidence exists to indicate that biomagnification through the food chain exists. Health effects include liver and kidney damage, increased blood pressure and decreased survival. Since most of the on-site waters exceeded the AWQC for copper, the potential risk through this medium appears to be moderate, considering the low biomagnification potential of this compound. Little or no risk is apparent through surface water exposure to wildlife inhabiting the Genesee River, since the AWQC was not exceeded. Since copper has a low biomagnification potential, and the concentrations detected in the sediment samples were either below or very close to the Sediment Criterion, the potential risk to wildlife from exposure to this compound in sediments is considered to be moderate to low.

Iron - Iron was detected in all of the surface water samples, the highest concentration detected on-site at SWSW-1. The AWQC of 0.3 mg/L was exceeded at all locations. There was no significant difference in iron concentrations between the upstream and downstream Genesee River samples. One midstream sample (GRW-2) was slightly higher than the upstream sample. Concentrations of iron in sediment samples were below the NY State Sediment Criterion of 2.4% (24,000 mg/kg) at all locations sampled.

Although iron was found in all surface water samples at concentrations above the AWQC, the potential risk from exposure to iron in this medium is considered moderate to low, due to the low toxicity of this compound. Since sediment iron concentrations were below the Sediment Criterion, the potential risk from exposure to iron in study area sediments is considered negligible.

Lead - Lead was detected in surface water in all on-site pond samples and in one drainage swale (SWSW-1) sample, the highest level detected (0.145 mg/L) at PS-3. The AWQC of 0.007 mg/L for on-site waters (calculated based on a hardness of 140 mg/L) was exceeded at all locations detected. This compound was not detected in the Genesee River water samples. Sediment lead concentrations exceeded the NY State Sediment Criterion of 27 mg/kg in both drainage swales and in the downstream Genesee River sample (GRS-4). The midstream and downstream Genesee River samples were slightly higher than the upstream sample. The highest sediment concentration was detected on-site at SWSD-1.

Although lead is bioaccumulated by aquatic organisms, it is generally not biomagnified; bioconcentration factors tend to decrease as trophic level increases. In general, freshwater plants and invertebrates tend to bioconcentrate lead to a greater degree than freshwater fish. Lead has been shown to accumulate in plants, invertebrates, birds and mammals, but does not seem to be biomagnified in terrestrial food chains. Effects of lead exposure include developmental effects, lethality, reproductive and neurological effects. Since the AWQC was exceeded in all on-site surface water samples, and the Sediment Criterion was exceeded in the two drainage swales, wildlife utilizing the on-site surface waters are at moderate to high risk from lead exposure. Wildlife inhabiting the Genesee River are at little or no risk from lead through contact with or ingestion of surface water and/or sediment since no lead was detected in the river water samples, and the downstream Genesee River sediment sample only slightly exceeded the Sediment Criterion.

PCBs - PCBs were not detected in surface waters on-site or in the Genesee River. Aroclor 1254 was detected in sediment in one drainage swale (SWSD-2) only, at a level of 11 mg/kg, which exceeds the NY State Sediment Criterion of 0.012 mg/kg.

Potential risk to exposure to PCBs in surface water in the study area is negligible, since no PCBs were detected in any of the surface water samples. The overall study area risk to PCBs appears to be very low since only one sampling location had detectable levels of one Aroclor. However, any wildlife utilizing the drainage swale along the eastern edge of the site may be at moderate to high risk, since the Sediment Criterion was exceeded at this location. A study conducted by the U.S. Army Corps of Engineers (1988) concluded that sediments containing 14 and 27 mg/kg PCB had a significant deleterious effect on fish fecundity and frequency of reproduction. Although there are no known fish inhabiting the drainage swale, a concentration of 11 mg/kg may produce harmful effects on other aquatic species, such as frogs, which could potentially utilize this area. No PCBs were detected in the Genesee River, which is the receiving body for this swale.

Toluene - Toluene was detected at one of three on-site surface water samples (PS-3) at a level of 0.028 mg/l, but was not detected in the Genesee River. This compound was detected in sediment in one drainage swale (SWSD-2) and at all Genesee River sediment sampling locations, the highest level (0.049 mg/kg) detected at the downstream Genesee River station (GRS-4). A sediment criterion of 0.030 mg/kg was calculated for toluene based upon the NYSDEC Guidance Document (1989). This criterion was derived based upon the NY State AWQ Guidance Value (not a criterion) of 0.005 mg/L (human health value), a sediment/organic carbon partition coefficient (K_{oc}) of 300 L/kg and a default of 2% Total Organic Carbon for on-site and Genesee River sediments, as follows:

Sediment Criterion, mg/g OC = (AWQC, mg/L) x (K_{oc}, L/kg) x (1 kg/1,000 g OC)

Where: AWQC = NY State Ambient Water Quality Criterion;
K_{oc} = sediment/organic carbon partition coefficient and;
1 kg/1,000 g OC is a unit conversion factor.

The result is then multiplied by the total organic carbon content of the sediment to achieve the site specific criterion. The criterion for toluene was derived as follows:

(0.005 mg/L) x (300 L/kg) x (1 kg/1,000 g OC) = 0.0015 mg/g OC

0.0015 mg/g OC x 20 g OC/kg = 0.03 mg/kg

Levels of toluene in sediment exceeded this criterion at the downstream Genesee River sampling location (GRS-4). It should be noted, however, that the AWQC used for the calculation of this criterion is a human-health based Guidance Value. No AWQC exists for the protection of freshwater aquatic life; however, the USEPA (1986) lists an acute LOEL (Lowest Observable Effect Level) for toluene of 17.5 mg/L. Using this value, the Sediment Criterion is calculated as 105 mg/kg, significantly higher than the 0.03 mg/kg calculated using the human health based AWQC. Multiplying by a safety factor of 0.01 to account for chronic effects, the resultant Sediment Criterion would be 1.05 mg/kg. None of the sediment samples exceed this calculated Sediment Criterion.

Although toluene was detected in one of the on-site surface water samples at a level above the human health based AWQC, the potential risk to wildlife from exposure to toluene through this medium is negligible. No NYS AWQC for the protection of wildlife exists for toluene; EPA's acute criterion for fresh water is 17.5 mg/l (no EPA fresh water chronic value is available). The very low frequency of detection of this compound at a relatively low level renders the potential risk to wildlife negligible from exposure to toluene in surface water. The risk to aquatic life from exposure to toluene in sediments in the study area is also considered negligible, since the concentrations detected in sediment were below the Sediment Criterion calculated using the LOEL for freshwater aquatic life, as shown above.

Zinc - Zinc was detected in surface water at all sampling locations, the highest level detected at PS-3. The AWQC of 0.03 mg/L was exceeded in all samples. There was no significant difference in zinc concentrations between upstream and downstream samples in the Genesee River. One midstream sample (GRW-2) was higher than the upstream sample. Sediment concentrations of zinc were below the NY State Sediment Criterion of 85 mg/kg in all samples in which zinc was detected. No zinc was detected at SWSD-1; the highest sediment concentration was found on-site at SWSD-2.

Zinc has been shown to bioaccumulate in freshwater animal tissues, although studies indicate that it is not biomagnified through the food chain. Risk to wildlife from exposure to zinc in sediment in the study area is considered to be low due to the low biomagnification potential of this compound and the detected concentrations below the Sediment Criterion. Although the AWQC was exceeded in all surface water samples, zinc is a common trace constituent of natural waters and is a required trace element in the metabolism of most organisms. The toxicity of zinc in fresh water depends upon many factors including water hardness, ionic strength, pH, alkalinity, the physical and chemical state of the zinc, the toxicity of each form of zinc and the degree of interconversion to be expected among the various forms (USEPA, 1980). Since all of these variables are not known for the Rochester Fire Academy site, it is difficult to determine the level of risk involved for exposure to zinc in surface waters at the site. Based upon the criteria exceedances, it appears that the risk to wildlife would be moderate to high, but it is possible that other factors are influencing the toxicity of this compound, or that organisms are zinc-tolerant in the general area of the site.

7.5 SUMMARY OF RISK EVALUATION

7.5.1 General

The Ecological Risk Assessment prepared for the Rochester Fire Academy site is based upon actual sampling of surface waters and sediment conducted at the site. Contaminants were found in various media, including surface water and sediments. Actual levels of contaminants in vegetation and wildlife inhabiting the site and its vicinity were not determined; therefore, quantitative assignment of actual risks to the various species of concern due to the contaminants found cannot be performed. Additional investigative activities would be needed to quantitatively determine actual impacts, if any.

Some uncertainty is also involved in determining the potential risk to wildlife of inorganic compounds present at a site. It should be noted that, for many inorganics, the toxicity and availability of the compounds is dependent on many factors including water chemistry, the form which the particular compound is in at a site, and the presence of other compounds within the media. The analysis of inorganics is generally for the pure form, and it is unknown whether the compounds are present in any other state at the site. Also, inorganic compounds are ubiquitous in the environment and many are considered essential nutrients for aquatic and terrestrial wildlife. Inorganic compounds are typically present in road runoff and may enter an aquatic system through many anthropogenic sources. The Fire Academy site is located in a commercially developed urban area. Therefore, it is unlikely that the presence of these compounds in the Genesee River is necessarily attributable to the Rochester Fire Academy site. The following paragraphs summarize the results of the risk evaluation presented in Section 7.4 for all of the compounds of concern.

7.5.2 On-Site Wildlife and Aquatic Risks

Due to the presence of aluminum at elevated (as compared to the AWQC) levels, and considering the uncertainties regarding the effects of aluminum, the risk to wildlife from exposure to this compound in surface water in the study area is considered moderate. Since aluminum concentrations in sediment were within background levels, it appears that wildlife are at low risk from the presence of this compound in on-site and Genesee River sediments.

The potential risk to aquatic organisms from bis(2-ethylhexyl)phthalate in surface water in the study area is considered moderate to high, due to its bioaccumulation potential and its presence in surface waters above the AWQC. Since this compound was detected at concentrations below the Sediment Criterion, the potential risk from contact with contaminated sediments in the study area is considered to be negligible.

Since cadmium was not detected in surface water in the study area, the potential risk from this compound from exposure to surface water is negligible. Wildlife ingesting or coming into contact with sediment in the drainage swale along the eastern edge of the site are at potentially high risk since the Sediment Criterion was exceeded in this swale by a large margin. The remaining study area sediments exhibited cadmium levels below the criterion, and therefore present little or no risk to wildlife from exposure to this compound.

Although the AWQC for cobalt was exceeded at all locations detected, the potential risk to wildlife from the presence of this compound in surface water is considered moderate since this compound is considered an essential element and is generally not bioaccumulated to excessive concentrations. Since cobalt levels in sediment were within the background range for soils, the potential risk from exposure to cobalt in site vicinity sediments is considered negligible.

Since most of the on-site waters exceeded the AWQC for copper, the potential risk through this medium appears to be moderate, considering the low biomagnification potential of this compound. Little or no risk is apparent through surface water exposure to wildlife inhabiting the Genesee River, since the AWQC was not exceeded. Since copper has a low biomagnification potential, and the concentrations detected in the sediment samples were either below or very close to the Sediment Criterion, the potential risk to wildlife from exposure to this compound in sediments is considered to be moderate to low.

Although iron was found in all surface water samples at concentrations above the AWQC, the potential risk from exposure to iron in this medium is considered moderate to low, due to the low toxicity of this compound. Since sediment iron concentrations were below the Sediment Criterion, the potential risk from exposure to iron in study area sediments is considered negligible.

Since the AWQC for lead was exceeded in all on-site surface water samples, and the Sediment Criterion was exceeded in the two drainage swales, wildlife utilizing the on-site surface waters are at moderate to high risk from lead exposure. Wildlife inhabiting the Genesee River are at little or no risk from lead through contact with or ingestion of surface water since no lead was detected in the river water samples, and the downstream Genesee River sediment sample only slightly exceeded the Sediment Criterion.

Potential risk to exposure to PCBs in surface water in the study area is negligible, since no PCBs were detected in any of the surface water samples. The overall study area risk to PCBs appears to be very low since only one sampling location had detectable levels of one Aroclor. However, wildlife utilizing the drainage swale along the eastern edge of the site may be at moderate to high risk, since the Sediment Criterion was exceeded at this location. Although there are no known fish inhabiting the drainage swale, a concentration of 11 mg/kg may produce harmful effects on other aquatic species, such as frogs, which could potentially utilize this area.

Since toluene was not detected in any of the surface water samples, the potential risk to wildlife from exposure to toluene through this medium is negligible. The risk to aquatic life from exposure to toluene in sediments in the study area is also considered negligible, since the concentrations detected in sediment were below the Sediment Criterion calculated using the LOEL for freshwater aquatic life.

Risk to wildlife from exposure to zinc in sediment in the study area is considered to be low due to the low biomagnification potential of this compound and the detected concentrations below the Sediment Criterion. Although the AWQC was exceeded in all surface water samples, zinc is a common trace constituent of natural waters and is a required trace element in the metabolism of most organisms. Since the toxicity of zinc in fresh water depends upon many variables which are not known for the Rochester Fire Academy site, it is difficult to determine the level of risk involved for exposure to zinc in surface waters at the site. Based upon the criteria exceedances, it appears that the risk to wildlife would be moderate to high, but it is possible that other factors are influencing the toxicity of this compound, or that organisms are zinc-tolerant in the general area of the site.

7.5.3 Genesee River Water/Sediment Quality

Chemical-specific contaminant concentrations are presented in Tables 6-26 and 6-27 under the heading "Projected Site-Related Water Quality". The first value in that column is data from sampling location GRW-2 (immediately downstream of the South Disposal Area). This sampling location was chosen as it contained the highest levels of those detected midstream and downstream of the site. The second value in that column ("GW") is the incremental surface water contaminant concentration calculated on the basis of the ground water contaminant loadings to the river. The mass of each contaminant was computed using the approach described in Section 8.3 of the RI report. The incremental surface water concentration was derived by dividing this mass by the volume of Genesee River discharge for a comparable time period.

As indicated in Table 6-27, the existing upstream water quality exceeds criteria for the protection of aquatic life for bis (2-ethylhexyl) phthalate, aluminum, cobalt, iron and zinc. The projected water quality adjacent to the site was also found to exceed criteria for these five contaminants, only. As indicated by column "GW", the off-site migration of contaminants from the Fire Academy site ground water would not be expected to have an analytically measurable impact on the surface water quality adjacent to or down stream from the site.

In the Genesee River, contaminant concentrations in surface water downstream of the contaminated areas of the site exceeded the upstream concentration for iron and zinc only. In sediment, downstream concentrations exceeded upstream concentrations for cadmium, lead and toluene. Surface soils in the North and South Disposal Areas were found to have high levels of iron, cadmium, copper, lead and silver. In the Training Grounds Area, cadmium, lead and antimony were found at elevated levels. In surface water, the highest levels of iron and zinc were found on-site at SWSW-1 and P-3, respectively. In sediment, the highest levels of cadmium and lead were found on-site at SWSD-2 and SWSD-1, respectively. The highest toluene level was detected at the downstream Genesee River location, GR-4. From this, it appears that the presence of cadmium, iron, lead and zinc found in the Genesee River may be partially due to runoff from the Fire Academy site. However, according to the Genesee River Sediment Toxics Survey (Monroe County DOH, 1986), toluene was detected at elevated levels (higher than was detected at the Fire Academy site) both up and downstream of the Gates-Chili-Ogden Treatment Plant, located upstream of the Fire Academy site, as well as downstream of Kodak, located well downstream of the site. This would indicate that toluene concentrations detected in the Genesee River downstream of the site are most likely not a result of site activities, but are representative of other sources upstream of the site.

7.6 CONCLUSIONS

Although the presence of the four inorganic compounds, cadmium, iron, lead and zinc may be due, in part, from contamination at the Rochester Fire Academy site, the risk to wildlife from exposure to these compounds in the Genesee River is considered low, for the reasons stated in Section 7.4 and summarized above. The risk to wildlife utilizing contaminated areas on-site appears to be somewhat higher, since the highest levels of contaminants detected were generally found on-site. During the April 14, 1992 field survey, wildlife species were observed utilizing both the North and South Disposal Areas. Organisms lower on the food chain which utilize these areas can potentially pass contaminants up through the food chain, and game species such as mallards may pass contaminants to humans as well.

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