2021 Hazardous Waste Scanning Project

File Form Naming Convention.

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Note 1: Each category is separated by a period "."
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Report, RCRA, 932106, 1992-10-01. Limited_RI_FS_DRAFT.pdf

WehranEnviroTech

DRAFT

LIMITED REMEDIAL INVESTIGATION/ FEASIBILITY STUDY (RI/FS)

FIRE TRAINING AREA NO. 1, IRP SITE 10
NIAGARA FALLS INTERNATIONAL AIRPORT (IAP)
NIAGARA FALLS IAP, NEW YORK
LIMITED RI/FS DRAFT REPORT

Prepared For

914 TACTICAL AIRLIFT GROUP
(AFRES)/LGC
Niagara Falls International Airport
Niagara Falls IAP, New York

October 1992

WEHRAN-NEW YORK, INC.
Grand Island, New York
and
BABINSKY KLEIN ENGINEERING, P.C.
Amherst, New York

AFB-1992-5-118

ineers • Scientists • Constructors

DRAFT

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WE Project No. 00640.03
October 1992

DRAFT

LIMITED RI/FS REPORT
TABLE OF CONTENTS

Page
Number

LIMITED RI/FS REPORT
TABLE OF CONTENTS

Page Number

LIMITED RI/FS REPORT
TABLE OF CONTENTS

TABLE OF CONTENTS

LIMITED RI/FS REPORT
TABLE OF CONTENTS

SELECTED REFERENCES

APPENDICES

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

DRAFT

A Limited Remedial Investigation/Feasibility Study (RI/FS) has been completed for Fire Training Area No. 1, IRP Site 10, at Niagara Falls International Airport (IAP), Niagara Falls, New York. The Limited RI/FS was performed in accordance with Wehran's Limited RI/FS Work Plan, Quality Assurance Project Plan, and Health and Safety Plan documents. The Limited RI/FS draft report for IRP Site 10 is intended to supplement and serve as an addendum to the Installation Restoration Program (IRP) RI/FS Report for Niagara Falls, IAP prepared by Science Applications International Corporation (SAIC), dated October 1990. The Limited RI/FS draft report for IRP Site 10 was prepared in a format consistent with the SAIC IRP RI/FS Report. Results from the report and other previous investigations have been reviewed in detail, and where appropriate, integrated into the focused evaluation of Fire Training Area No. 1, IRP Site 10.

A supplemental RI was completed and focused on obtaining additional soil and groundwater data from the IRP Site 10 Fire Training Area No. 1. Five soil borings were drilled and a monitoring well was installed in each boring. These additional monitoring wells complimented the five existing wells and were utilized to assess groundwater flow direction and the nature, extent, and movement of VOC contamination in the unconfined and bedrock aquifers.

Results of soil and groundwater characterization indicate that VOC contamination exists in the groundwater and is likely migrating towards Cayuga Creek. The probable source for the VOC groundwater contamination is confined to the IRP Fire Training Area No. 1. Sediment samples obtained from an unnamed drainage ditch were also contaminated. The likely mechanism for contaminant transport to the drainage ditch was run-off from the Fire Training Area No. 1.

The original Public Health Risk Assessment (RA) was updated to incorporate the new groundwater data obtained during the Limited RI Investigation. Also, toxicity factors (carcinogenic slope factors and reference doses) were verified and replaced were factors had changed. The findings of the updated RA do not vary substantially from the original SAIC estimate. The total carcinogenic and total non-carcinogenic hazards are still generally above the maximum acceptable hazards. The final risk estimates are incomplete due to the sparsity of soil data obtained for the Fire Training Site No. 1.

A focused feasibility study was performed to provide remedial alternatives on the basis of overall protection of human health and environment. The results of the Limited RI and updated RA were incorporated into the design of the remedial alternatives. The selected alternatives evaluated were:

1. No action with groundwater monitoring.
2. Limited action, deed restrictions, groundwater restriction with fencing.
3. Containment with a cap and groundwater collection and treatment.
4. Containment with a cap and groundwater treatment plus a slurry wall and source removal.

Alternative 1, is likely, to be ineffective in meeting the Applicable and Relevant and Appropriate Regulations (ARAR's). Alternative 2, may also not meet appropriate human health standards. Alternatives 3 and 4, provide reasonable protection to human health.

The recommended Alternative is Alternative 4. This alternative provides the greatest degree of long term effectiveness due to source removal.

ONE

1.0 INTRODUCTION

On behalf of Babinsky Klein Engineering (BKE), Wehran is pleased to submit this Limited Remedial Investigation/Feasibility Study (RI/FS) Draft Report to the United States Air Force for review and comment pursuant to RFP NGF-90-0545. The draft report presents the findings of the Limited RI/FS conducted for Fire Training Area No. 1, IRP Site 10, at Niagara Falls International Airport (IAP), Niagara Falls, New York. The Limited RI/FS was performed in accordance with Wehran's Limited RI/FS Work Plan, Quality Assurance Project Plan, and Health and Safety Plan documents. The Limited RI/FS draft report for IRP Site 10 is intended to supplement and serve as an addendum to the Installation Restoration Program (IRP) RI/FS Report for Niagara Falls IAP prepared by Science Applications International Corporation (SAIC), dated October 1990. The Limited RI/FS draft report for IRP Site 10 has been prepared in a format consistent with the SAIC IRP RI/FS Report. Results from the SAIC report and other previous investigations have been reviewed in detail and, where appropriate, integrated into the focused evaluation of Fire Training Area No. 1, IRP Site 10 during the Limited RI/FS.

1.1 PURPOSE OF THE LIMITED RI/FS PROGRAM

In September 1987, Science Applications International Corporation (SAIC) was contracted by the United States Air Force to perform an Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study (RI/FS) at Niagara Falls International Airport (IAP), Niagara Falls, New York. The IRP RI/FS program evaluated 13 discrete sites that were potentially contaminated based on the history of hazardous material/waste management practices at the Niagara Falls IAP. The objectives of the IRP RI/FS were to determine the nature and extent of environmental contamination occurring at the base as a result of past waste disposal practices, fuel spills, and fire-training activities; to perform a risk assessment based on the Remedial Investigation findings; and to provide a preliminary screening of remedial technologies for contaminated sites that warranted remediation. The first draft of the IRP RI/FS report was published in August 1990. This Draft Report was subsequently revised to address comments from the 914 Tactical Airlift Group (AFRES) and issued as a final draft in October 1990.

IRP Remedial Investigation activities conducted at Fire Training Area No. 1 confirmed the presence of contamination in groundwater and soils and provided a general characterization of shallow hydrogeologic conditions. According to the hypothetical scenario outlined in the baseline risk assessment performed by SAIC, groundwater contamination posed a significant health risk, while under the same scenario, no health risk was imposed by Site 10 soil contamination. Due to the limited number and spatial distribution of monitoring points established under the IRP RI/FS, the existing database was not sufficient to adequately characterize the nature and extent of groundwater contamination in both the overburden and shallow bedrock units underlying Fire Training Area No. 1, IRP Site No. 10. Based on the results of the baseline risk assessment and limitations in the existing database, Fire Training Are No. 1 (IRP Site No. 10) was recommended for additional investigation.

In September 1990, Babinsky-Klein Engineering, P.C. (BKE) was requested to perform a Limited RI/FS for IRP Site 10 - Fire Training Area No. 1 under their existing architectural/engineering contract with the AFRES at Niagara Falls IAP, New York. Wehran-New York, Inc. (Wehran) was subsequently retained by BKE to provide the required environmental services to perform the Limited RI/FS.

In accordance with the recommendation for additional study presented in the IRP RI/FS Report, a Limited RI/FS program was completed for Fire Training Area No. 1, IRP Site No. 10. The primary purposes of the Limited RI/FS program were to conduct a supplemental Remedial Investigation to further define the nature and extent of contamination associated with the former use of Fire Training Area No. 1; to update the baseline Risk Assessment; and to complete a Focused Feasibility Study which would lead to a decision on a selected remedial action(s) at this site. More specifically, the objectives of the limited RI/FS program can be summarized as follows:

Limited Remedial Investigation

- To collect additional data necessary to support the development and evaluation of remedial alternatives for the site.
- To further characterize the nature and extent of groundwater contamination in both the overburden and shallow bedrock units.
- To characterize sediment contamination.

- To further identify shallow subsurface geologic conditions.
- To adequately define groundwater flow conditions in both the overburden and shallow bedrock units.
- To establish a monitoring well network that adequately monitors contamination associated with the Fire Training Area No. 1.

Risk Assessment

- To provide an updated baseline risk assessment incorporating additional data collected during the Limited RI.

Limited Feasibility Study

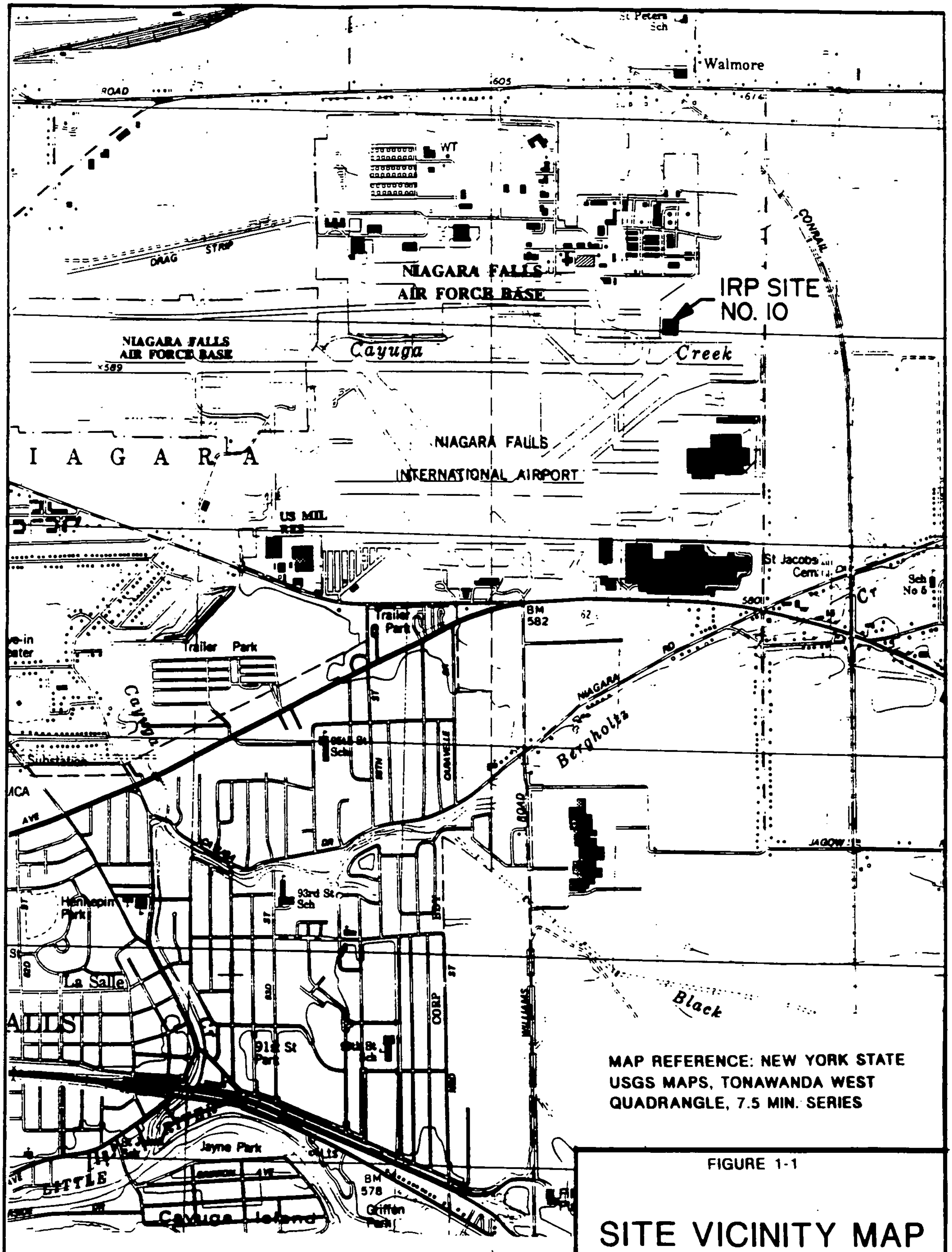
- To establish remedial response objectives and general response actions.
- To identify and screen remedial technologies.
- To develop and screen remedial alternatives.
- To recommend a remedial action that will meet the requirements of the established remedial response objectives and general response actions for the site.

The report presented herein has been specifically prepared as a supplement to the IRP RI/FS report, and includes the interpretation and evaluation of any new data and the impact on the RI for IRP Site 10, the Risk Assessment update, and the focused feasibility study completed for Fire Training Area No. 1.

1.2 IRP SITE NO. 10 BACKGROUND

1.2.1 Description and History of IRP Site No. 10

The Fire Training Area No. 1 site, herein referred to as IRP Site 10, is located in the extreme northeast corner of Niagara Falls IAP, just east of the Niagara Falls Air Force Base in the Town of Wheatfield, as shown in Figure 1-1. Figure 1-2 shows the location of Fire Training Area No. 1 at Niagara Falls IAP investigated as IRP Site 10 under the IRP RI/FS



MAP REFERENCE: NEW YORK STATE USGS MAPS, TONAWANDA WEST QUADRANGLE, 7.5 MIN. SERIES

FIGURE 1-1

SITE VICINITY MAP

NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10

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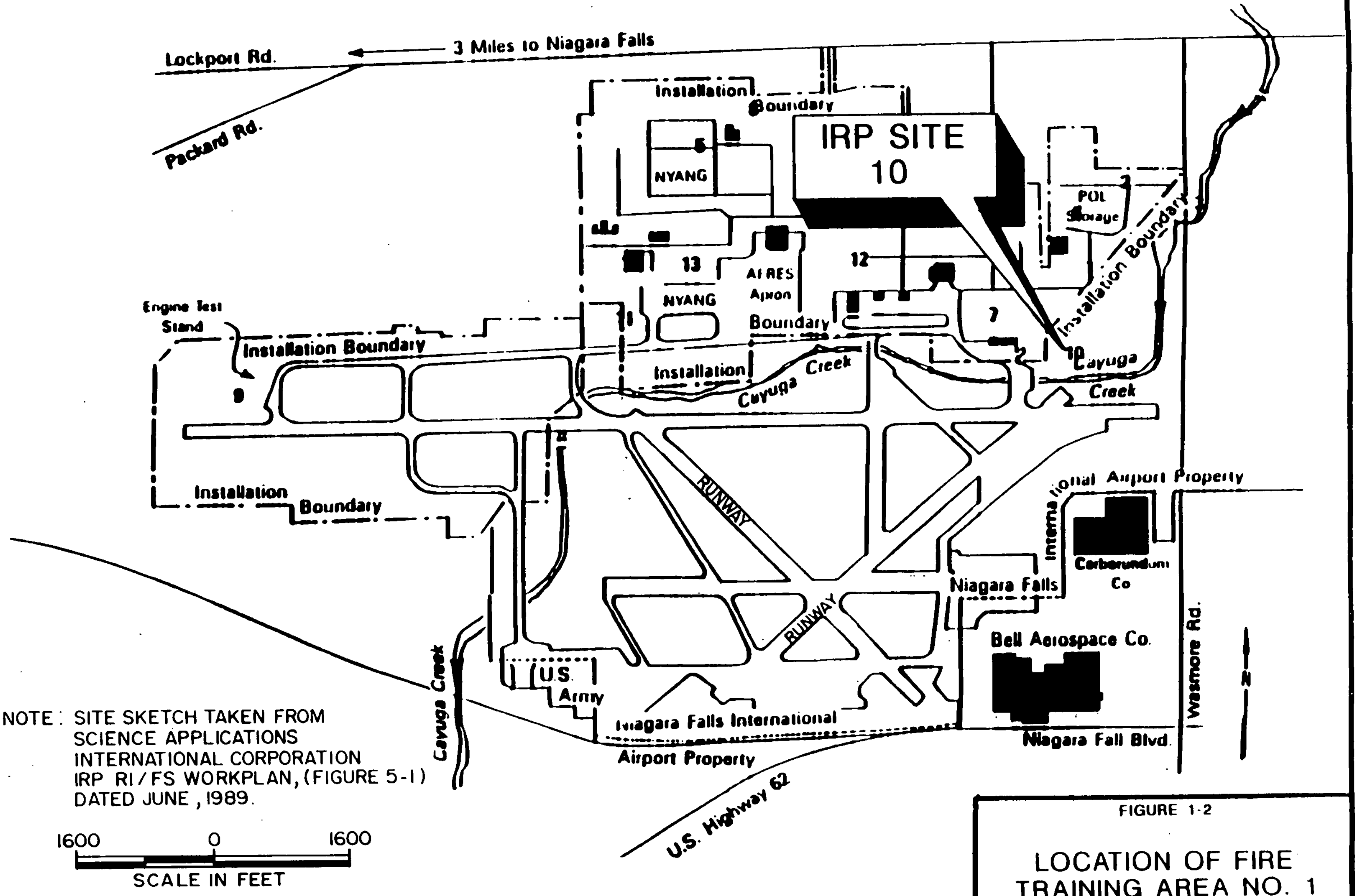
SCALE: 1"=2000'



NOTE: SITE SKETCH TAKEN FROM SCIENCE APPLICATIONS INTERNATIONAL CORPORATION IRP RI/FS WORKPLAN, (FIGURE 5-1) DATED JUNE, 1989.

WehranEnviroTech

FIGURE 1-2

LOCATION OF FIRE TRAINING AREA NO. 1 - IRP SITE 10

NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS · IRP SITE 10

program. The base map utilized for the Limited RI for IRP Site 10 is shown in Figure 1-3. This map illustrates the Limited RI/FS study area for IRP Site 10 depicting all monitoring points utilized in the evaluation of the site.

As shown in Figure 1-3, the former burn pit is approximately 100 feet in diameter and lies approximately 150 feet east of Building 726. The site, which is generally flat with a gentle slope to the south, is currently covered with heavy grasses and weeds. Cayuga Creek passes within about 1,000 feet east and 400 feet south of the site. A drainage swale runs from north to south approximately 50 feet west of the site. Surface drainage flows to the south in this swale and, in turn, discharges into Cayuga Creek which flows west and then south across the Niagara Falls IAP.

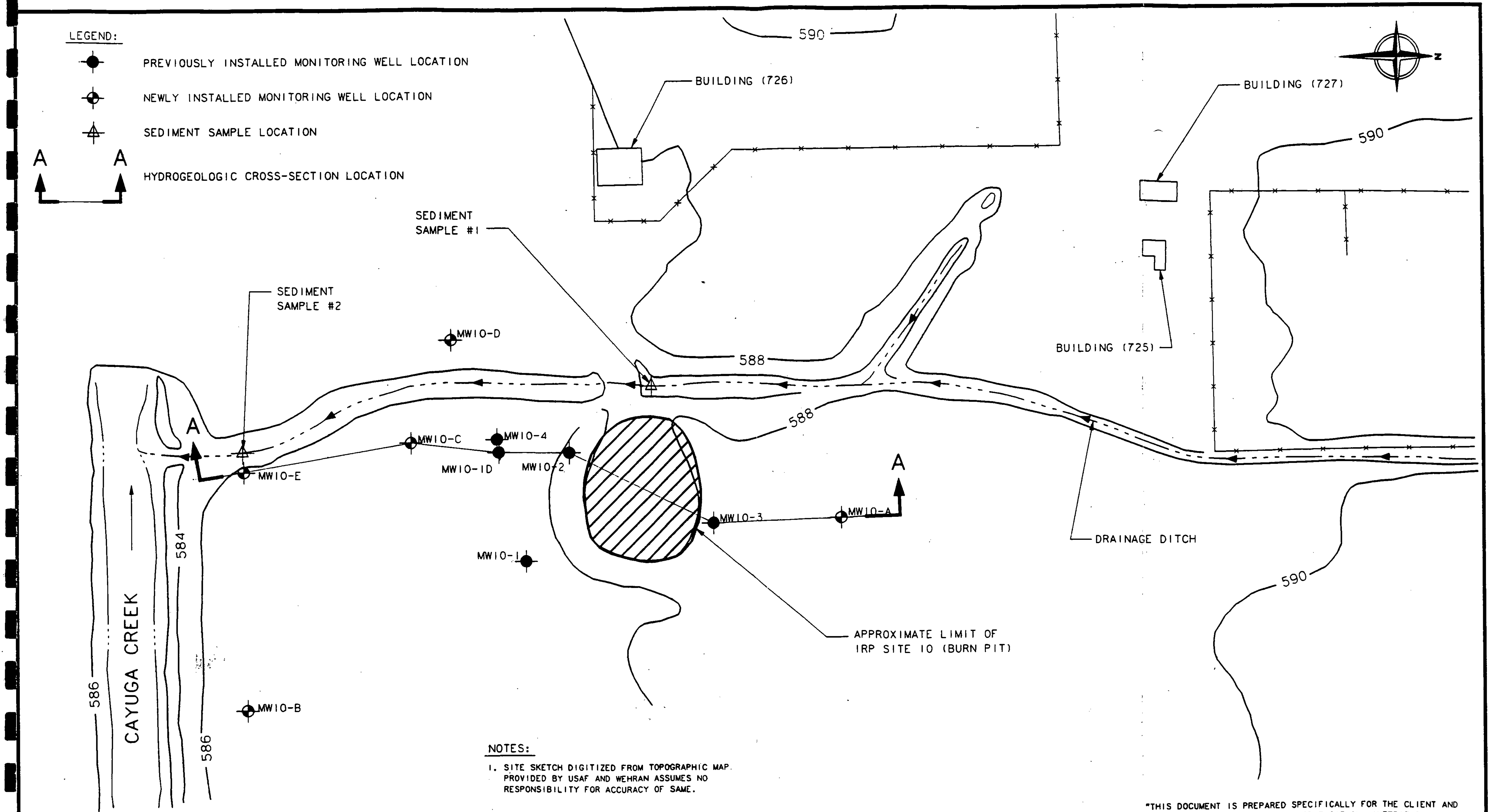
The site served as the base's principal fire training area during the late 1950's and early 1960's. A variety of combustible oils, solvents and jet fuel (JP-4) were burned in the pit and extinguished with fire-fighting foams during training exercises. The burn pit was probably constructed with an earthen berm around the burn area to contain the flammable liquids during fire training exercises.

1.2.2 Previous Investigations

Previous investigations conducted at the Fire Training Area No. 1 include the Phase I, Records Search (Engineering-Science, 1983), Phase II, Stage 1, Confirmation/ Quantification Study (SAIC, April 1986), and the IRP Remedial Investigation/Feasibility Study (SAIC, October 1990). Sampling of groundwater and soil were included in the Phase II, Stage 1 and IRP RI studies.

A brief description of the waste types and concentrations detected at the site during the Phase II, Stage 1 Field Investigation and the IRP RI/FS is provided in the following section. For more detailed discussion, the reader is referred to the specific reports summarizing above-noted investigations.

The results of the Phase II, Stage I Field Investigation indicated that the oil and grease levels in groundwater samples were less than 1 mg/L. Elevated levels of total organic carbon (TOC) (71.2 and 64.2 mg/L) were detected in two groundwater samples. Total dissolved solids (TDS) and total organic halides (TOX) levels in the surface water were higher upstream of the site than downstream. However, oil and grease levels in the



NOTES:

1. SITE SKETCH DIGITIZED FROM TOPOGRAPHIC MAP PROVIDED BY USAF AND WEHRAN ASSUMES NO RESPONSIBILITY FOR ACCURACY OF SAME.

2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929), HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

3CM:(00640.03.LDE)FIG BASEMAP 60
DWG: DT079209

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Wehran-New York, Inc.

Drawn By :
Checked By :
Date :

Scale
60 0 60
SCALE IN FEET

NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

IRP SITE 10
BASE PLAN

Figure: 1-3
Project No. 00640

sediment samples were high both upstream and downstream. The concentrations downstream were nearly three times higher than the upstream values. Elevated oil and grease levels in the sediment may be attributable to runoff from the hardstand area just west of the stream.

The results of the IRP RI/FS indicate that the soils at IRP Site 10 contain elevated levels of zinc, although they fall within the range established by the background borings. Chromium levels were elevated in a downgradient boring (650 mg/kg). Cadmium was also detected at levels above background (1.55 mg/kg). Beryllium and boron were detected at 0.556 and 76.2 mg/kg, respectively, at IRP Site 10 but did not appear in background borings. Other parameters which were detected at levels above those in the background borings include barium (1,420 mg/kg), lead (56.6 mg/kg), total petroleum hydrocarbons, and trichloroethene (0.010 to 0.190 mg/kg).

Laboratory analysis of groundwater samples collected from on-site monitoring wells during the IRP RI/FS indicated groundwater contamination by both volatile organic compounds and inorganic metals beneath IRP Site 10. Volatile organic compounds (VOCs) were detected in groundwater at all five existing well locations, with the highest concentrations found downgradient of the fire training area. Benzene was detected in groundwater samples at all four downgradient installations. Trichloroethene was found to occur at four well locations three of which were downgradient (including the single bedrock well) and one upgradient well. Vinyl chloride was detected in groundwater samples from one downgradient overburden well (MW-10-1) and the one downgradient bedrock well (MW-10-1D). Total xylenes, toluene and ethylbenzene were also detected at various well locations but levels did not exceed groundwater applicable or relevant and appropriate regulations (ARARs) established for these parameters. In addition, several inorganic metals (total) were detected in groundwater samples at levels above background established for the site. These include iron, manganese, lead, chromium, nickel, barium, copper, zinc, cobalt, molybdenum, and vanadium.

The distribution of contamination found in the unconsolidated water-bearing zone suggests the development of a VOC contamination plume with its major axis aligned parallel to the generalized groundwater flow direction.

Within the overburden groundwater flow regime, contaminants migrating south southwest away from IRP Site 10 would most likely be intercepted by Cayuga Creek to the south as the creek would serve as a natural discharge zone for shallow groundwater flow. The extent of groundwater contamination detected in the bedrock was unknown and required further evaluation.

1.3 REPORT ORGANIZATION

As previously noted, this draft report has been prepared in a format consistent with the IRP RI/FS report and should be included as an addendum to the SAIC document. Where appropriate, reference has been made to the IRP RI/FS report to avoid repetition in reporting. However, the Limited RI/FS draft report does present data collected from previous investigations where utilized in the evaluation of IRP Site 10.

This draft report for the Limited RI/FS for IRP Site 10 contains two volumes consisting of six major sections, including this Introduction, Section 1.0, plus an Executive Summary. Section 2.0 - Environmental Setting refers the reader to the SAIC IRP RI/FS report for a comprehensive discussion of the physical characteristics of the IRP study area. Section 3.0 details the Limited RI activities completed and the procedures utilized to complete each RI subtask. Section 4.0 presents a discussion of the results of the Limited RI and includes an evaluation of the local hydrogeology and the nature and extent of contamination found in each medium investigated. Section 5.0 presents the baseline risk assessment update. Section 6.0 provides the focused feasibility study completed for IRP Site 10. Test boring logs, analytical results, and other supporting documentation are included as Appendices in Volume II.

TWO

2.0 ENVIRONMENTAL SETTING

A comprehensive description of the site's environmental setting has been previously presented in Section 2.0 of the SAIC IRP RI/FS Report, dated October 26, 1990. The reader is referred to pages 2-1 through 2-58.

THREE

3.0 LIMITED REMEDIAL INVESTIGATION

3.1 REMEDIAL INVESTIGATION OVERVIEW

A supplemental field investigation was conducted at the Fire Training Area No. 1 site as part of the Limited Remedial Investigation. The purpose of this investigation was to provide additional field and analytical data to confirm and/or supplement data generated during the SAIC IRP RI/FS. New data, together with the existing database were utilized to further characterize the nature and extent of contamination associated with Fire Training Area No. 1 and facilitate the development and evaluation of remedial alternatives in a focused feasibility study.

In order to meet the specific objectives of the Limited Remedial Investigation outlined in Section 1.1, the following RI data collection subtasks were performed for this study:

- Performance of test borings
- Overburden and shallow bedrock monitoring well installation
- Monitoring well development
- Field survey
- Groundwater sampling of newly installed and existing wells
- Drainage ditch surface sediment sampling
- Composite sampling of drummed drill cuttings
- Water level monitoring
- Laboratory analysis of groundwater, sediment and drill cutting samples

The above-stated RI field subtasks were performed in accordance with the procedures outlined in the Limited RI/FS Work Plan and Quality Assurance Project Plan (QAPP) documents. A discussion summarizing the rationale and general procedures utilized to complete each task follows in Sections 3.2 through 3.5.

3.1.1 Field Program Scheduling

Following a notice to proceed with the Limited RI/FS program, the initial work performed under this contract consisted of revising the existing approved RI/FS Work Plan, Quality Assurance Project Plan (QAPP), and Health and Safety Plan prepared by SAIC, dated June 1989, to address the scope of work, methodologies and field procedures, and health and safety aspects for the supplemental field activities planned for Fire Training Area No. 1. The revised documents were submitted to the AFRES for review and comment in February 1991. Following review by the AFRES, New York State Department of Environmental Conservation (NYSDEC) and United States Environmental Protection Agency (USEPA), all the applicable comments were incorporated with the final revised documents being issued in February 1991, the Limited RI field program was initiated. Table 3-1 presents a summary of the Limited RI field investigation activity schedule.

3.1.2 Identification and Role of Subcontractors

Wehran utilized subcontractors to perform specific subtasks during the Limited RI for IRP Site 10. Drilling subcontractor services were provided by Parratt Wolff of Syracuse, New York. Groundwater and sediment sample collection and laboratory analytical services were provided by General Testing Corporation, Rochester, New York.

3.2 TEST BORING AND MONITORING WELL INSTALLATION

A supplemental test boring and monitoring well program was completed as part of the Limited RI. Test borings were performed at new well locations to confirm subsurface geologic conditions, collect soil and rock samples for classification, and permit the installation of shallow overburden wells and double cased bedrock monitoring wells. A total of five new monitoring wells were installed in conjunction with the test boring drilling task. These newly-installed wells, combined with existing monitoring wells installed during previous investigations, provided the water quality data used to characterize the nature and extent of groundwater contamination beneath IRP Site 10 study area. Water level elevation data collected from these installations were used to determine groundwater flow directions in the overburden unit and upper bedrock unit.

Two of the new wells (MW10-C and MW10-D) were installed in the overburden unit. Monitoring well MW10-C is located downgradient approximately 120 feet south of

TABLE 3-1
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
SUMMARY OF RI FIELD INVESTIGATION ACTIVITIES

Subtask	Period of Performance	Total Number of Days
Subsurface Soil Borings and Bedrock Coring	11/18/91 - 11/26/91	7
Monitoring Well Installation	11/18/91 - 11/26/91	7
Monitoring Well Development	11/27/91, 12/02/91	2
Groundwater Level Measurements	12/09/91, 12/18/91	2
Groundwater and Sediment Sample Collection	12/09/91, 12/10/91	2
Surveying	11/21/91, 12/01/91	1
Drum Sampling (overburden drill cuttings)	12/23/91	1

the Fire Training Area No. 1 and MW10-D is located across the unnamed drainage swale approximately 120 feet southeast of the former burn pit. Both overburden wells were considered downgradient locations based on the SAIC IRP RI/FS results. The remaining three wells were installed in the upper portion of the bedrock to investigate the possibility of groundwater contamination in this unit and to provide additional information on groundwater flow conditions in the upper bedrock zone. Monitoring well MW10-A was located approximately 100 feet upgradient and north of the former burn pit, and wells MW10-B and MW10-E were positioned downgradient about 350 and 300 feet southeast and south of the site, respectively. The locations of the five new wells and the five existing wells are shown in Figure 1-3.

All test boring and monitoring well installation work was conducted under the direct observation and supervision of a Wehran geologist.

3.2.1 Test Boring and Material Sampling

Test borings were performed utilizing hollow-stem auger and rock core drilling techniques to successfully complete the test borings to depth and facilitate the installation of new monitoring wells. At each location, boreholes were advanced through the unconsolidated overburden material to the top of the bedrock using 4-1/4-inch inner diameter (ID) hollow-stem augers. At the three bedrock well locations, the borings were advanced into bedrock via the rock coring method.

Test borings completed at overburden well locations were advanced only to the top of bedrock as determined based on split-spoon refusal. Test borings performed at bedrock well locations were advanced approximately 15 feet into bedrock. At these locations, the augers were typically advanced 6 inches into weathered bedrock. A bentonite seal was then tremied through the augers and placed at the bottom of the borehole. Following emplacement of the bottom seal, the augers were removed and permanent 6-inch ID steel casing was immediately inserted into the borehole and hammered into the rock to seal off the upper unconsolidated unit from deeper bedrock zones. The 6-inch steel casing prevented cross-contamination between units during drilling and provided the outer casing for the double-cased bedrock wells. The remaining annulus around the permanent 6-inch casing was backfilled with uncontaminated drill cuttings (based on HNU readings). The bentonite seal was allowed to hydrate before proceeding with the drilling, typically overnight. After allowing the bentonite seal to hydrate, the remainder of the borehole was advanced utilizing rock coring techniques. An HQ-size double tube core barrel and diamond core bit were used to advance the boring to the target depth in the bedrock. Rock core samples were recovered, logged in the field and stored in specially designed wooden core boxes, which were properly labeled and retained for future reference. Core sample logging included visual lithologic classification, fracture/joint information, RQD values and recovery.

Encountered overburden materials were continuously sampled from ground surface to the top of bedrock. Continuous split-spoon samples were collected at 2-foot intervals in accordance with the procedures of the Standard Penetration Test (ASTM D1586). Representative portions of each split-spoon sample were visually classified and placed in labeled moisture-tight jars for storage. Soils were classified in accordance with the Unified Soil Classification System. Upon opening of each split-spoon, all soil samples were immediately screened for VOCs with an HNU photoionization detector (PID). Split-spoon soil samples not retained for storage, together with auger drill cuttings, were collected and contained in pre-cleaned 55-gallon steel drums. Soil samples and drill cuttings were screened for volatiles with the PID but did not exhibit readings above background and were, therefore, commingled, drummed, and labeled as non-volatile. The drums were properly labeled and moved to the designated staging area located in a fuel tank storage area just north of the site. USAF personnel assumed responsibility for ultimate disposal of the drummed non-volatile drill cuttings.

Geologic logs were prepared for each test boring based upon visual analysis of the soil and bedrock samples collected during the test boring program. Test boring logs are presented in Appendix A of this report.

3.2.2 Overburden and Bedrock Monitoring Well Installation

Monitoring well installation procedures are summarized below. Table 3-2 presents a summary of monitoring well specifications for all well installations at IRP Site 10.

Overburden Wells

Following completion of the two shallow test borings to the top of bedrock, overburden monitoring wells were installed at these locations (MW10-C and MW10-D). Overburden monitoring wells were constructed of 2-inch ID PVC flush joint Schedule 40

Table 3-2
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
SUMMARY OF MONITORING WELL SPECIFICATIONS

Monitoring Well No.	Ground Surface Elevation†	Bottom of Boring		Screened Interval				Sand Pack Dimensions				Bentonite Seal Dimensions				Top of Casing Elevation	
				Bottom		Top		Bottom		Top		Bottom		Top			
		Depth (ft bgs)	Elevation	Depth (ft bgs)	Elevation	Depth (ft bgs	Elevation	Depth (ft bgs)	Elevation	Depth (ft bgs	Elevation	Depth (ft bgs)	Elevation	Depth (ft bgs	Elevation	Inner	Outer
Newly Installed Monitoring Wells (Limited RI/FS)																	
MW10-A	588.08	20.00	568.08	19.90	568.18	9.90	578.18	20.00	568.08	7.60	580.48	7.60	580.48	5.60	582 48	590.12	590 55
MW10-B	586.71	19.20	567.51	19.00	567.71	11.50	576.21	19.20	567.51	9.50	577.21	9.50	577.21	7.50	579.21	588.84	588.99
MW10-C	586.95	9.60	577.35	9.30	577.65	4.30	582.65	9.60	577.35	3.00	583.95	3.00	583.95	1.00	585.95	589.11	589.57
MW10 D	587.49	9.50	577.99	9.00	578.49	6.00	581.49	9.50	577.99	4.00	583.49	4.00	583.49	1.50	585.99	589 49	589 65
MW10-E	586.52	25.10	561.42	24.85	561.67	18.10	571.42	25.10	561.42	12.30	574.22	12.30	574.22	9.60	577.02	588.24	588 41
Existing Monitoring Wells‡																	
MW10-1	587.43	8.80	578.63	8.80	578.63	5.80	581.63	8.80	578.63	3.80	583.63	3.80	583.63	2.80	584.63	589.92	
MW10-2	588.00	9.00	579.00	9.00	579.00	6.00	582.00	9.00	579.00	4.00	584.00	4.00	584.00	3.00	585.00	590.46	
MW10-3	588.37	9.90	578.47	9.90	578.47	6.90	581.47	9.90	578.47	4.90	583.47	4.90	583.47	3.90	584.47	590.76	
MW10-4	586.96	7.90	579.06	7.90	579.06	4.50	582.46	7.90	579.06	3.50	583.46	3.50	583.46	2.50	584.46	589 65	--
MW10-1 D	587.09	32.90	554.19	32.90	554.19	12.70	579.39	32.90	554.19	11.70	575.39	11.70	575.39	6.70	580.39	589.69	--

Notes:

† Elevation based on field survey performed by Wehran, November 1991, unless otherwise noted; elevation vertical control based on USGS elevation datum (NGVD 1929).

‡ For existing monitoring well installations, ground surface elevation and subsequent well detail elevations based on field survey performed by McIntosh and McIntosh, P.C. of Lockport, New York, for SAIC, September 1989. Top of Casing elevation based on more recent field survey performed by Wehran, November 1991.

ft bgs - feet below ground surface

TIC - Top of Inner PVC Casing

riser and screen. Each well was fitted with a factory machine-slotted (0.02-inch) screen set from the top of bedrock to just above the estimated depth of the water table at the time of installation. The selected screen interval was intended to interface with the water table to intercept any free-floating contaminants and allow for monitoring of water table fluctuation. All materials used in the well installation were new from the manufacturer. Well screens and casings were steam-cleaned prior to installation in the borehole.

To prevent clogging of the screen opening, a clean, coarse silica sand (Morie No. 1 size) was placed below, around, and extended a minimal of 1-foot above the top of the screen via the Tremie method. The grain size distribution and uniformity coefficient for the sand pack material is included in Appendix A. The augers were raised gradually and the sand was maintained at a level inside the augers to ensure a continuous sand pack across the screen interval. A 6-inch layer of fine filter sand was added above the coarser sand pack to prevent encroachment of the bentonite or cement-bentonite grout during installation. A minimum 2-foot bentonite seal was placed immediately above the filter pack and allowed to hydrate. Following placement of the bentonite seal, a neat-cement-bentonite grout mixture was placed into the remaining annulus from bottom up to ground surface via the Tremie method. The grout was allowed to set a minimum of 72 hours before the well was developed. To secure each location, a 6-inch ID steel protective casing with locking cap was installed over the PVC casing and extended 2 to 2-1/2 feet below grade. A concrete steel reinforced concrete pad was installed around each protective casing and sloped to divert runoff away from the installation. In addition, three, 3-inch by 6-foot cement-filled steel guard posts were installed around each well, recessed approximately 2 feet below grade to secure the location.

Bedrock Wells

Double-cased bedrock wells were installed in boreholes advanced into the upper zone of the bedrock via rock core drilling methods. Permanent 6-inch steel casing installed during borehole advancement served as the outer casing in the double-cased bedrock installation. Bedrock monitoring wells were constructed of 2-inch ID flush joint Schedule 40 PVC riser and well screens. Bedrock wells were fitted with 10 feet of 0.10-inch factory machine-slotted PVC screen. The bedrock wells were completed using the well installation procedures previously described. The bentonite pellet seal was placed below the bedrock/overburden contact to seal off the well within the bedrock unit. The augers were removed in concurrence with emplacement of the neat-cement-bentonite grout mixture.

As-built well construction diagrams for overburden wells (MW10-C and MW10-D) and bedrock monitoring wells (M10-A, B and E) are included on the test boring logs found in Appendix A.

3.2.3 Monitoring Well Development

Following completion of the monitoring wells, the installations were developed to restore the natural hydraulic properties of the formation, to as great an extent as possible, and ensure that the well was in proper hydraulic contact with the unit it screens. Development prepared the wells for subsequent water quality sampling and water level monitoring. Each new well installation was developed until such time that the quality of water obtained from the well was consistent with formational water quality. This condition was determined by monitoring groundwater pH, specific conductivity, temperature, and turbidity during development.

Prior to development, each well was sounded to confirm as-built well construction and determine the amount of siltation, if any. A static water level was then recorded to calculate the total well volume. A minimum of ten well volumes was removed from each well, or a minimum of three evacuation cycles was completed in slow recovery wells. Development was accomplished by bailing using a bottom-filling bailer. The wells were developed until water of a clear sand-free condition was obtained for the installation. Development was considered complete based on stabilization of pH, specific conductance, and temperature readings, as well as well volumes removed.

All purge/development water was containerized at the boring locations, then transported to the on-site staging area designated by base personnel where it was transferred to a common holding tank. Based on field observations (visual), field screening (organic vapor analyzer results), and analytical data, the purge/development water was characterized and disposal options recommended to Base personnel. Conditions and observations noted during development were recorded and are presented in Appendix B. It should be noted that due to the fine-grained materials of the overburden and clay-filled fractures in the bedrock, monitoring well water remained turbid throughout development.

3.3 FIELD SURVEY

Following completion of the monitoring well installation program, test boring/ monitoring well locations were field surveyed for both horizontal and vertical control. Surveying was conducted in accordance with the Limited RI/FS Work Plan and consistent with previous survey control established during the IRP RI/FS Field Investigation. Horizontal control is based on the New York State Plane Coordinate System (NAD, 1983); while vertical control is based on the United States Geological Survey Elevation Datum (NGVD, 1929). Ground surface and top of well casing elevations were obtained to the nearest one-hundredth (0.01) of a foot accuracy; horizontal location was observed to an accuracy of 1 foot. Field Survey data were reduced and then used to convert boring and groundwater level data to site control elevations that were subsequently used to prepare the site-specific maps presented herein. Well survey data are provided in Appendix A.

3.4 WATER LEVEL MONITORING

Two complete rounds of water level measurements were recorded from all IRP Site 10 monitoring wells as part of the Limited RI. Water level depths were manually recorded from the top of the inner PVC casing using an electronic water level meter. All water level measurements were recorded to an accuracy of one-hundredth (0.01) of a foot and converted to site control elevations. Synoptic water level elevation data were used to determine general groundwater flow directions and gradients in both the overburden and bedrock units. These data were utilized to generate equipotential contour maps in both plan and profile perspective for the IRP Site 10 study area.

3.5 SAMPLING AND ANALYSIS

Media sampled as part of the Limited RI/FS for Fire Training Area No. 1, IRP Site 10 included surface sediments, groundwater, and drummed drill cuttings (soil). Table 3-3 provides a summary of the sampling and analysis program conducted during the Limited RI. A brief description of field sampling procedures and laboratory analysis is provided below.

Table 3-3
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
SUMMARY OF SAMPLING AND ANALYSES PROGRAM

Parameter	Groundwater							Sediments		Drill Cuttings		
				QC Samples								
	Analytical Method	New Wells (No.)	Existing Wells (No.)	Duplicate	Equip. Blank	Field Blank	Trip Blank	Analytical Methods	Drainage Ditch (No.)	Analytical Methods	Non-Volatile Soils	Volatile Soils
Alkalinity - Carbonate Bicarbonate & Hydroxide	A403	5		1	1	1						
Common Anions (Choride, Fluoride, Nitrate, Sulfate, Orthophosphate)	A429	5		1	1	1						
Common Cations (Calcium, Magnesium, Sodium, Potassium)	SW 3050 SW 6010	5		1	1	1						
Specific Conductance (Field)	E 120.1	5		1	1	1						
pH (Field)	E 150.1	5		1	1	1						
Total Dissolved Solids	E 160.1	5		1	1	1						
Temperature	E 170.1	5		1	1	1						
Metal Screen (Total Metals) (Zinc, Chromium, Iron, Manganese, Barium, Aluminum Copper, Nickel, Potassium, Silicon, Boron)	E 200.7	5		1	1	1						
Metal Screen (Dissolved Metals) Test for any parameters which exceed part 703 standards based on total concentration results.	E 200.7	5										

Table 3-3
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
SUMMARY OF SAMPLING AND ANALYSES PROGRAM

Parameter	Groundwater			QC Samples				Sediments		Drill Cuttings		
	Analytical Method	New Wells (No.)	Existing Wells (No.)	Duplicate	Equip. Blank	Field Blank	Trip Blank	Analytical Methods	Drainage Ditch (No.)	Analytical Methods	Non-Volatile Soils	Volatile Soils
Lead	E 239.2	5		1	1	1						
Petroleum Hydrocarbons	E 418.1	5		1	1	1		SW 3550/ E 418.1	2			
Purgeable Halocarbons	SW 5030/ 8021	5	5	1	1	1	1					
Purgeable Aromatics	SW 5030/ 8021	5	5	1	1	1	1					
Volatile Organic Compounds									2			
Semi-Volatile Organic Compounds								SW 8240 SW 3550/ SW 8270	2			
TCLP ANALYSIS												
Metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag)											1	NA
Volatile Organic Compounds										SW 8240	1	NA
Semi-Volatile Organic Compounds										SW 3550/ 8270	1	NA
Pesticides										SW 8080	1	NA
Herbicides										SW 8150	1	NA

3.5.1 Sediment Sampling

Surface sediment was collected from two locations within the drainage ditch to the west of the site (see Figure 1-3). Sediment Sample 1 was collected upstream immediately adjacent to the former burn pit, and Sediment Sample 2 was collected downstream, just north of the confluence of the drainage ditch and Cayuga Creek. It should be noted, however, that Sediment Sample 1 cannot be considered upgradient relative to IRP Site 10, as this portion of the drainage ditch receives direct runoff from the~~e~~ former burn pit area. Sampling was performed using a stainless steel trowel that was decontaminated between sampling locations. The sediments were placed directly into appropriately labeled sample containers, and then packed in ice-filled coolers. The samples were maintained at 4°C or below, until they were delivered to the laboratory at the end of the day.

3.5.2 Groundwater Sampling

Groundwater samples were collected within 24 hours after purging three to five well volumes from each of the five new wells and the five previously installed wells. Stainless steel bailers were used for both purging and sampling. The decontaminated stainless steel bailer was lowered into ~~to~~ the well to a point below the static water level in order to collect a representative groundwater sample. The wells were purged and sampled beginning with the upgradient wells and progressing to the downgradient wells.

During sample collection, the stainless steel bailer was filled, removed from the well, and the groundwater dispensed into the appropriate containers in order of volatilization sensitivity. Preservatives were added in the field in order to meet analytical protocol. One additional groundwater sample was collected from each of the five new wells and field-filtered through a 0.45 micron filter. These samples were to be utilized in comparison testing for soluble metals. The samples were packaged and placed in ice-filled cooler chests which were maintained at 4°C or less, until they were delivered to the lab at the end of the day. All sampling and purging equipment were properly decontaminated between wells.

Purge and sampling information, field measurements and observations were recorded on groundwater monitoring field forms. These forms are presented in Section D of Appendix C in this report. As indicated on these forms, groundwater samples exhibited high turbidity consistent with the groundwater clarity observations recorded during well development.

3.5.3 Overburden Soil (Drummed Cuttings) Sampling

As indicated above, all drill cuttings as well as the excess split-spoon samples were placed in pre-cleaned 55 gallon steel drums. On the basis of PID monitoring of drill cuttings and split-spoon samples, all the samples and cuttings were considered to be non-volatile and co-disposed in appropriately labeled drums. The drums were placed in the designated staging area to await final disposal.

In order to characterize the containerized cuttings for proper disposal, a single composite sample consisting of soils from all the drums was taken for analysis. The procedures utilized to produce the composite sample are as follows:

- Drums containing borehole cuttings were opened and screened for volatile organics using a PID meter (no elevated levels were recorded).
- Samples of the cuttings were obtained from varied depths in each drum using a small diameter stainless steel hand auger, and placed in a stainless steel bowl.
- Once sampling was completed for all drums, the samples were mixed in the stainless steel bowl to form a composite sample for analysis.
- The composite sample was placed in appropriately labeled laboratory jars, in accordance with the QAPP and sent to the analytical laboratory.
- All sampling tools were decontaminated between each drum in accordance with the QAPP.

3.5.4 Field Quality Assurance/Quality Control Program

Prior to initiation of the field investigation and sampling program at IRP Site 10, a Quality Assurance Project Plan (QAPP) was prepared and approved. The procedures outlined in this document were followed rigorously so that the data quality objectives were achieved.

Additionally, as specified in the work plan, the following Quality Control (QC) samples were collected during the field sampling program:

- 1 Trip Blank
- 1 Field Blank

- 1 Equipment Blank
- 1 Field Duplicate

3.5.5 Laboratory Analytical Program

All analytical testing was performed in accordance with the methods and protocols outlined in Section 1.8 of the QAPP. As indicated, Contract Laboratory Protocols (CLP) were not required for the Limited RI/FS Program.

Analytical testing was performed on groundwater samples collected from all ten monitoring wells, sediment samples from two locations, and one composite sample of the drummed drill cuttings. Table 3-3 provides a summary of the number and type of analyses performed for each matrix. The analytical results for all samples are contained in Appendix C.

Organic Analysis

Two sediment samples and one composite sample of the drill cuttings which was subjected to Target Compound List Parameters (TCLP), were analyzed for volatile organics and semi-volatile organics. Ten groundwater samples and associated field QC blanks were analyzed for purgeable halocarbons and purgeable aromatics. Additionally, the composite sample of drill cuttings was analyzed for pesticides and herbicides.

Inorganic Analysis

Two sediment samples were analyzed for total petroleum hydrocarbons (TPH). One composite sample of the drill cuttings which was subjected to TCLP, was analyzed for the TCLP metals. The QC samples associated with the groundwater sampling, with the exception of the trip blank, were analyzed for metals, TPH, total dissolved solids (TDS), and common anions.

Analytical Problems

During analysis of sediment soil samples for target compound list semi-volatile organics by EPA Method 8270, the recovery of pyrene in the matrix spike duplicate of Sample 1 and the recovery of 4-Nitrophenol in the reference check sample were both outside QC limits and have been flagged accordingly (Appendix C).

No analytical or QC problems were encountered during analysis of groundwater samples for priority pollutant volatiles and target compound list volatiles by Method 8021 from SW-486. During the analysis for inorganic analytes, precision analysis performed in the MW-10-A groundwater sample for TDS, and nitrite showed percent relative errors outside QC acceptance and the matrix spike recovery for lead was also outside QC limits. These data have been flagged accordingly (refer to Appendix C). No other analytical or QC problems were encountered with inorganic analysis of groundwater samples.

The high relative percent difference in analytical results (inorganics) between groundwater samples MW-10-E and MW-10-E duplicate is most likely attributed to the suspended solids content of the groundwater during field sample collection. Although total suspended solids were not analyzed for, field observations of high turbidity during sampling and development suggest that difference in particulate content would account for differences during analysis for inorganics (i.e., metals - total). Inasmuch as these differences are recognized, the significance of the differences is considered minor due to the trace levels of these contaminants detected.

FOUR

4.0 DISCUSSION OF LIMITED RI RESULTS

This section provides an assessment of current conditions at IRP Site 10 based on the data collected during Wehran's Limited RI study and previous investigations. A discussion of the site-specific geologic and hydrogeologic conditions is provided as well as an evaluation of the nature and extent of contamination associated with Fire Training Area No. 1.

4.1 SITE-SPECIFIC GEOLOGY

Detailed descriptions of the formations encountered on-site are presented in the boring logs found in Appendix A. Subsurface information, obtained from the Limited RI test borings and borings performed during previous investigations, were utilized to identify subsurface geologic conditions (Appendix A). Table 4-1 presents a summary of the boring data utilized in the evaluation of IRP Site 10.

Subsurface data obtained from the Limited RI field investigation generally tend to substantiate the description of the site geology as presented in the IRP RI/FS Report. As previously indicated, the site is covered with a thin veneer of glacially-derived overburden sediments consisting of glaciolacustrine silts, sands and clay, and glacial till. Underlying the overburden deposits at relatively shallow depth is bedrock belonging to the Lockport Dolomite Formation.

4.1.1 Overburden

The entire Fire Training Area No. 1 study area is underlain by unconsolidated deposits of glacial origin. The overburden unit ranges in thickness from 5.2 feet at MW10-A to 9.9 feet at MW10-3 (refer to Table 4-1). Figure 4-1 presents an isopach map of the undifferentiated overburden unit. This map shows the spatial distribution of overburden thickness generally increasing to the south-southwest, with thickness contours depicting the influence of irregularities in the bedrock surface.

Glacial till forms the lower most unit of the overburden and lies unconformably on the Lockport Dolomite bedrock surface. The glaciolacustrine deposits overlie the glacial till deposits and represent the uppermost surficial soils at the site. These glacial deposits are similar in color and vary only slightly in texture, which makes it difficult to distinguish

Table 4-1
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
SUMMARY OF BORING DATA

Boring/Monitoring Well No.	Ground Surface Elevation	Bottom of Boring		Top of Glaciolacustrine Silt and Clay		Top of Glacial Till		Top of Bedrock	
		Depth (ft bgs)	Elevation	Depth (ft bgs)	Elevation	Depth (ft bgs)	Elevation	Depth (ft bgs)	Elevation
New Boring/Monitoring Well Locations[†]									
MW10-A	588.08	20.00	568.08	0.00	588.08	4.00	584.08	5.20	582.88
MW10-B	586.71	19.20	567.51	0.00	586.71	6.30	580.41	7.70	579.01
MW10-C	586.95	9.60	577.35	0.00	586.95	4.00	582.95	9.40	577.55
MW10-D	587.49	9.50	577.99	0.00	587.49	5.10	582.39	9.30	578.19
MW10-E	586.52	25.10	561.42	0.00	586.52	4.50	582.02	9.50	577.02
Existing Boring/Monitoring Well Locations[‡]									
MW10-1	587.43	8.80	578.63	0.00	587.43	7.00	580.43*	8.80	578.63
MW10-2	588.00	9.00	579.00	0.00	588.00	6.00	582.00*	9.00	579.00
MW10-3	588.37	9.90	578.47	0.00	588.37	7.00	581.37*	9.90	578.47
MW10-4	586.96	7.90	579.06	0.00	586.96	5.00	581.96*	7.90	579.06
MW10-1 D	587.09	32.90	554.19	0.00	587.09	6.50	580.59*	8.10	578.99

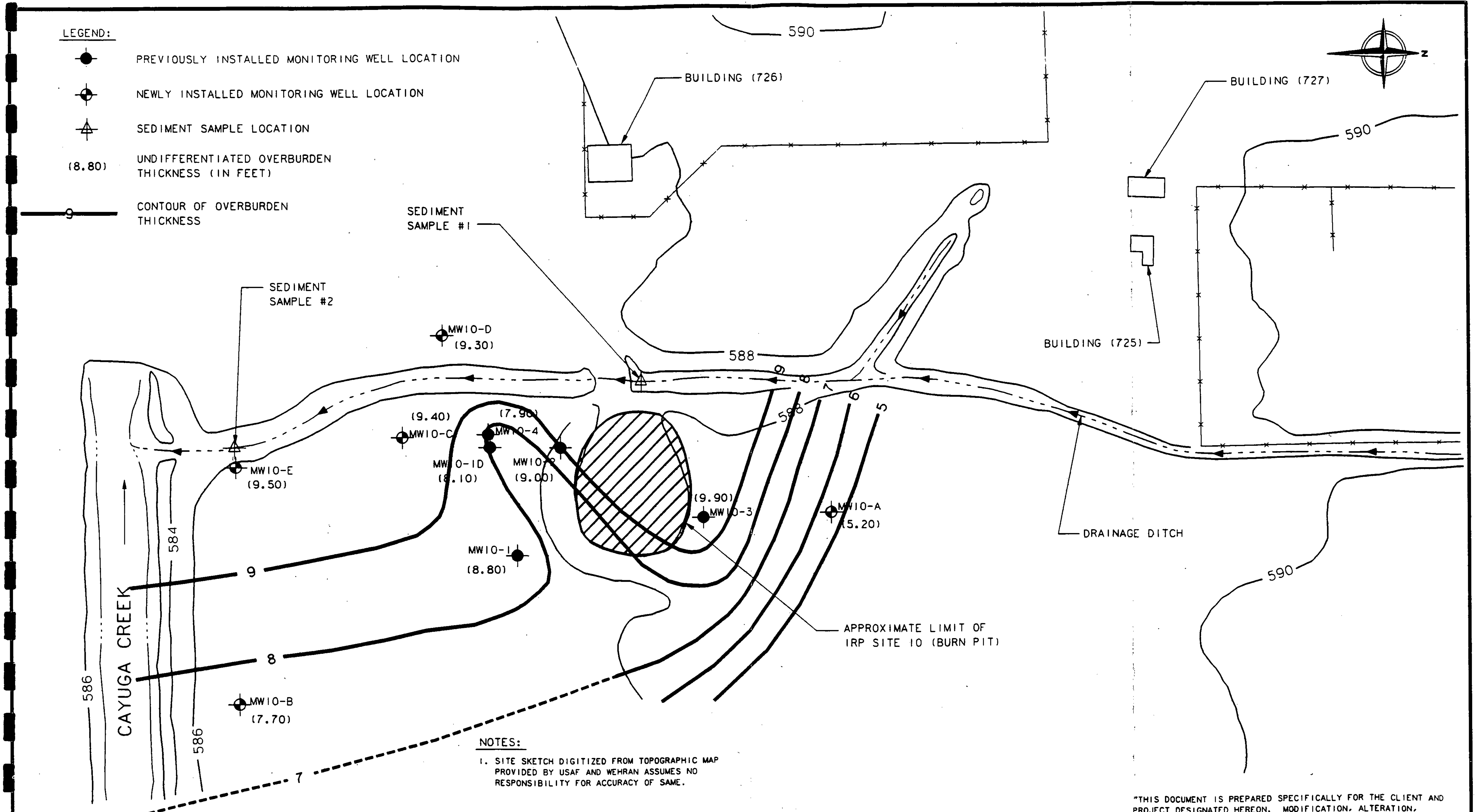
Notes:

[†] Elevation based on field survey performed by Wehran, November 1991; vertical control based on USGS elevation datum (NGVD 1929).

[‡] Existing boring elevation data based on field survey performed by McIntosh and McIntosh of Lockport, New York, for SAIC, September 1989; vertical control based on USGS elevation datum (NGVD 1929).

ft bgs – feet below ground surface

* Glacial Till contact inferred from past consultant logs and should only be considered approximate.



NOTES:

1. SITE SKETCH DIGITIZED FROM TOPOGRAPHIC MAP PROVIDED BY USAF AND WEHRAN ASSUMES NO RESPONSIBILITY FOR ACCURACY OF SAME.
2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929), HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

3CM: (00640.03.LDE)FIG OVERBURDEN ISOPACH
DWG: SW079203

WehranEnviroTech
Wehran-New York, Inc.

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NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

UNDIFFERENTIATED OVERBURDEN ISOPACH MAP

Figure: 4-1
Project No. 00640

between the glaciolacustrine and glacial till material. However, an attempt was made to define the contact between these materials, and are described separately below.

Glaciolacustrine Silt, Sand and Clay

The entire site appears to be covered with a layer of stratified glaciolacustrine silt, sand and clay deposits ranging in thickness from approximately 4 feet at MW10-A and MW10-C, to 6.3 feet at MW10-B. These glacial sediments are characterized by thinly-bedded to laminated, gray brown to reddish brown mottled silty clays. A general field description of this material, as per the Unified Soil Classification System, is as follows:

> "Red brown SILT, some Clay, trace very fine Sand to Red brown Silt and very fine Sand, damp, medium dense."

The boring logs in Appendix A present more specific and detailed soil descriptions of the glaciolacustrine deposits found across the site.

Glacial Till

Underlying the glaciolacustrine unit and immediately overlying the bedrock is a thin layer of unstratified, unsorted glacial till. This layer varies in thickness from 1.2 feet at MW10-A to 5.4 feet at MW10-C. A general field description of this unit is as follows:

> Red brown Silt and very fine Sand, little Clay, trace fine Gravel, moist and soft to medium stiff."

Gravel found in this unit generally consists of sub-rounded to sub-angular clasts of dolomite, shale, and crystalline rock. The boring logs in Appendix A present more specific and detailed soil descriptions of the glacial till found across the site.

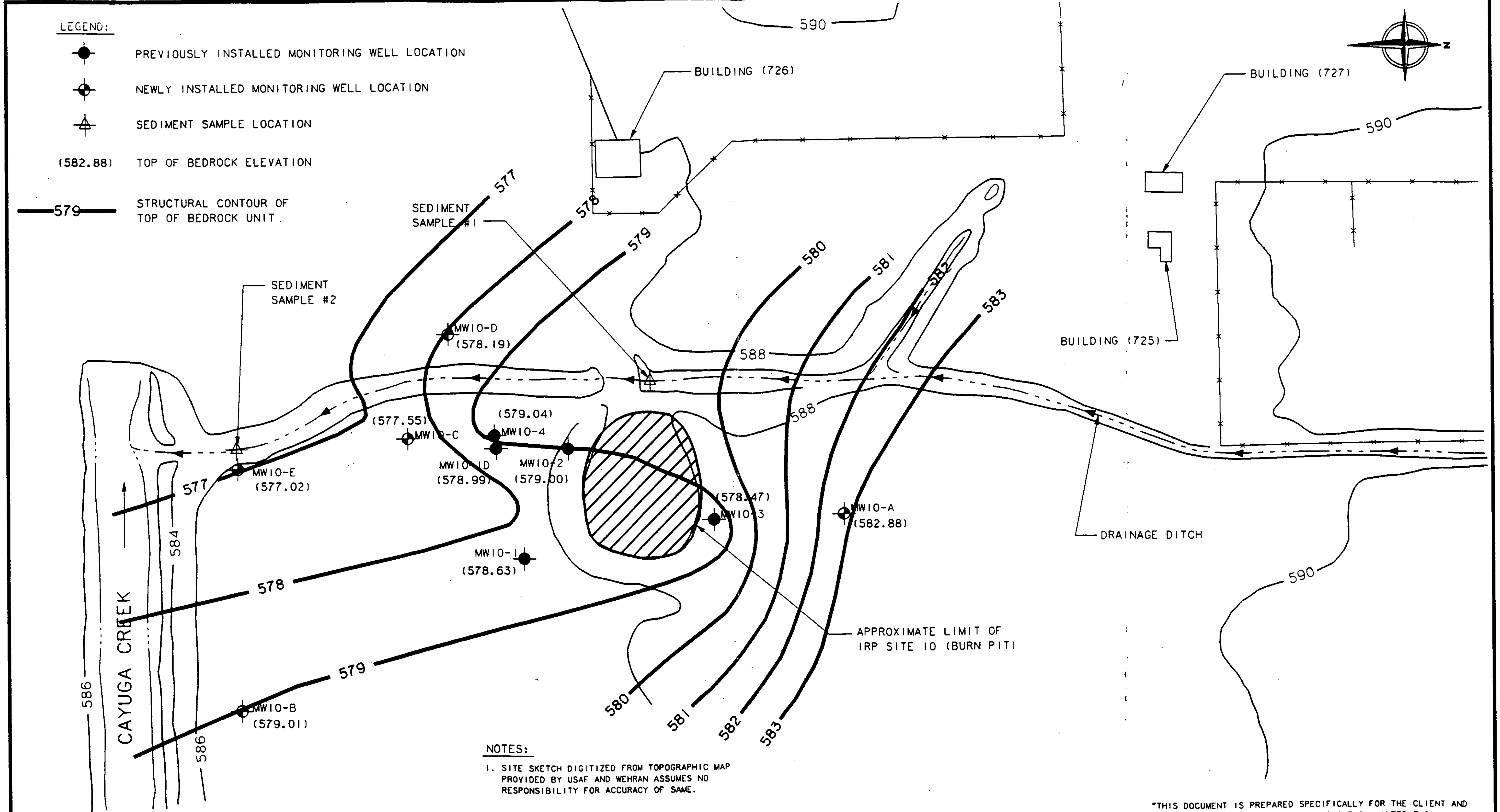
4.1.2 Bedrock

The entire site and surrounding area is underlain by the Lockport Dolostone which reportedly is approximately 180 feet thick in this area of Niagara Falls. As described by Johnston (1964), the Lockport is a dark gray to grayish brown dolomite, massive to thin bedded, locally containing algal reefs and small masses of gypsum. The lower portion of the unit tends to be gray to brown dolomite, locally containing gypsum and light gray coarse-grained limestone with shale dolomite at the base.

Bedrock encountered during the performance of IRP Site 10 borings appears to be consistent with the geology described in the literature. Bedrock was identified from the rock core samples obtained at borings MW10-A, MW10-B and MW10-E. Based on the HQ core samples, the dolostone bedrock is generally gray to dark gray, porous or vuggy (with gypsum), fossiliferous and massive. The Rock Quality Designation (RQD), a measure of the overall competency of the rock, ranged from 63 to 100 percent and is typically moderate to high averaging 85 percent for all nine core runs collected at the three borings. As indicated in the boring logs, the majority of the fractures are perpendicular to the core axis (horizontal) occurring along bedding planes. The upper 5 to 10 feet of the bedrock unit is generally more fractured than lower portions showing increasing competence with depth.

Figure 4-2 presents a contour map of the top of the bedrock unit developed based on the boring data available for the site (Table 4-1). As indicated in Figure 4-2, the bedrock surface is somewhat irregular, but overall exhibits a general slope to the southwest at approximately 0.02 to 0.04 ft/ft. Bedrock surface elevations range from a maximum of 582.88 feet at MW10-A, to a minimum of 577.02 feet at MW10-E.

The apparent irregularities in the rock surface may be natural, but are more likely reflective of the criteria utilized during the various drilling programs to define the "top of bedrock". For example, during the initial boring program (MW10-1, -2, and -3) soil samples were collected at 5-foot intervals. Consequently, the split-spoon samples were planned for 0 to 2 feet, 5 to 7 feet, and 10 to 12 feet. Since the bedrock is typically at 8 to 10 feet below ground surface, it falls within a non-sampling interval. This means that the augers were advanced following collection of the second split-spoon at the 5-foot level with the intent of stopping at 10 feet for the third sample. It is not indicated on the logs for these holes, but it appears likely that the augers were advanced to "refusal", with this depth being considered the "top-of-bedrock". Considering the fractured and weathered condition of the upper portion of the bedrock, as evidenced in Limited RI recent borings, it is probable that the augers could have been advanced a few inches to as much as a foot into the bedrock before reaching refusal. This would result in the reported top-of-bedrock in these holes being shown at elevations lower than the actual top-of-rock.



NOTES:

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2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929), HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

3CM:(00640.03.LDE)FIG TOP BEDROCK
DWG: SW079204

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Wehran-New York, Inc.

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LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

TOP OF BEDROCK
STRUCTURAL CONTOUR MAP

Figure: 4-2
Project No. 00640

4.2 SITE-SPECIFIC HYDROGEOLOGIC CONDITIONS

This section provides an understanding of local hydrogeologic conditions in the vicinity of Fire Training Area No. 1. Our discussion of the site-specific hydrogeology examines the mode of occurrence and direction of groundwater flow within the geologic framework described in Section 4.1, and subsequently provides a general conceptual model of groundwater flow. This conceptual groundwater flow model provides a critical understanding of the local groundwater flow system and serves as the basis for development of remedial alternatives to control groundwater contaminant migration.

4.2.1 Overburden

Within the overburden unit, groundwater occurs within the interstitial pore spaces of the unconsolidated glacial deposits. These glacial deposits consists primarily of low permeability silts and clays, and dense glacial till. Due to the similar low permeability characteristics of glaciolacustrine and glacial till materials, these unconsolidated, fine-grained deposits can be considered a single hydrostratigraphic unit with respect to groundwater flow.

Whereas groundwater will occur and move under unconfined conditions within the upper silt and clay deposits of the overburden unit, groundwater deeper within the unconsolidated deposits will exist under semi-confined to confined conditions due to the restrictive low permeability material above. Table 4-2 provides a summary of the water level elevation data collected from IRP Site 10 monitoring wells. Water levels recorded from overburden wells on January 15, 1992 indicate that the approximate depth to the zone of saturation ranges from 5.16 feet below ground surface (bgs) at MW10-3, to 6.47 feet (bgs) at MW10-D. However, water table depth estimates can only be considered approximate as overburden well screens did not interface with the water table (Table 4-2) during the January water level measurement period.

Figure 4-3 presents an overburden water level contour map developed using the January overburden water level elevation data. This map shows the elevation and configuration of the potentiometric surface for the unconsolidated deposits. This plan view perspective of the overburden potentiometric provides a generalized horizontal groundwater flow direction within the unconsolidated deposits. The principal horizontal flow component in the overburden is generally from north to south at a relatively uniform gradient of

Table 4-2
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
SUMMARY OF WATER LEVEL ELEVATION DATA

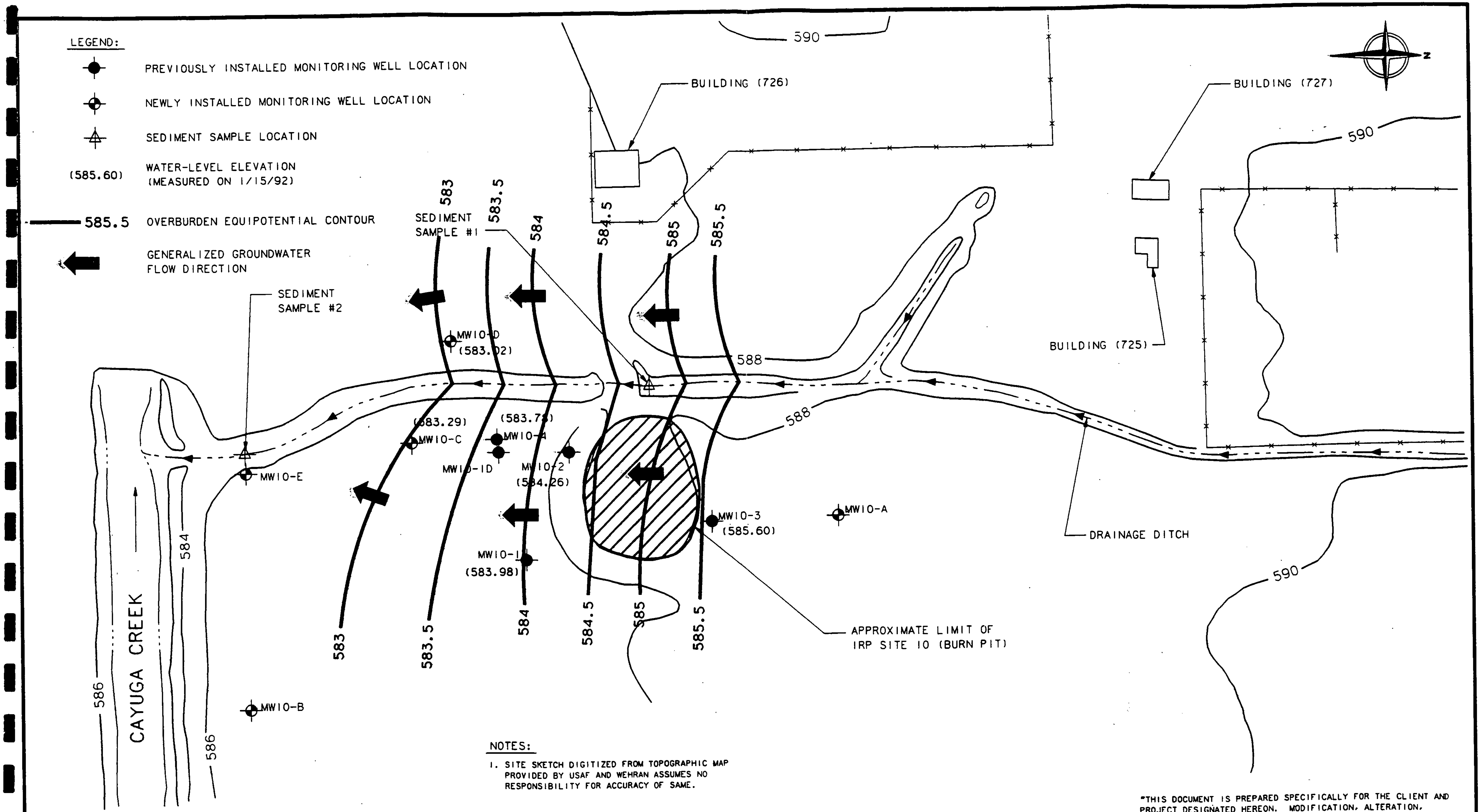
Monitoring Well No.	Reference Elevation* (TIC)	Ground Surface Elevation	Monitoring Well Screen Interval Elevations	Dec. 18, 1991 Water Level		Jan. 15, 1992 Water Level	
				Depth (ft bgs)	Elevation	Depth (ft bgs)	Elevation
Overburden Monitoring Wells							
MW10-1	589.92	587.39	578.63 to 581.63	7.80	582.12	5.94	583.98
MW10-2	590.46	587.99	579.00 to 582.00	7.30	583.16	6.20	584.26
MW10-3	590.76	588.25	578.47 to 581.47	5.85	584.91	5.16	585.60
MW10-4	589.65	587.08	579.06 to 582.46	6.95	582.70	5.92	583.73
MW10-C	589.11	586.95	577.65 to 582.65	7.27	581.84	5.82	583.29
MW10-D	589.49	587.49	578.49 to 581.49	7.24	582.25	6.47	583.02
Shallow Bedrock Monitoring Wells							
MW10-1 D	589.69	587.28	554.19 to 574.39	7.24	582.45	6.10	583.59
MW10-A	590.12	588.08	568.18 to 578.18	4.17	585.95	3.40	586.72
MW10-B	588.84	586.71	567.71 to 575.21	9.61	579.23	7.68	581.16
MW10-E	588.24	586.52	561.67 to 571.42	8.27	579.97	6.95	581.29

Notes:

* Elevation based on field survey performed by Wehran, November 1991; vertical control based on USGS elevation datum (NGVD 1929).

ft bgs – feet below ground surface

TIC – Top of Inner PVC Casing



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3CM: (00640.03.LDE)FIG OVERBURDEN WL
DWG: SW079205

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Date :

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60 0 60
SCALE IN FEET

NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

OVERBURDEN WATER-LEVEL CONTOUR MAP

Figure: 4-3
Project No. 00640

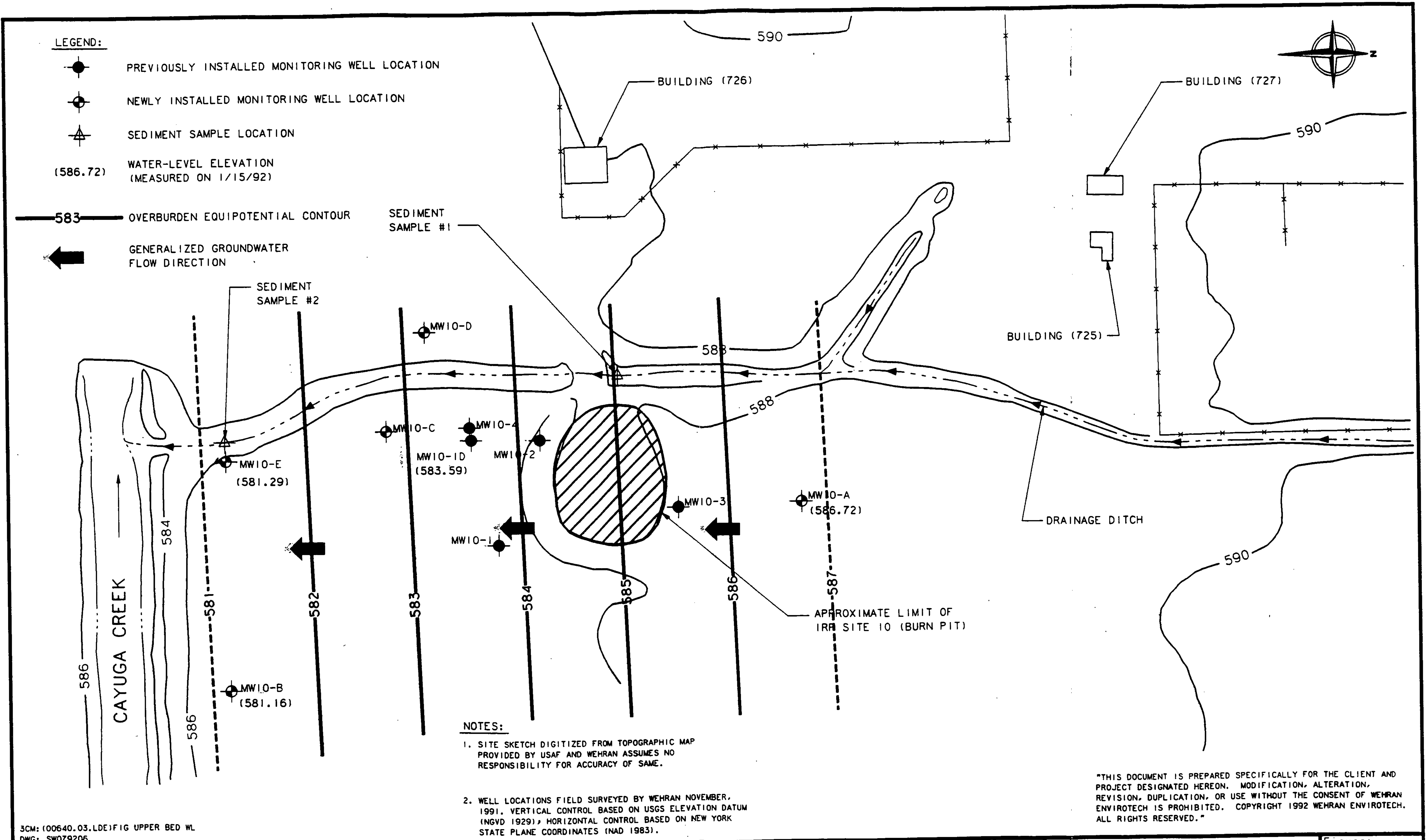
0.013 ft/ft. During periods of high water table conditions, horizontal flow will deviate from this general flow direction where groundwater discharges locally to the unnamed drainage ditch, with eventual drainage and discharge to Cayuga Creek to the south.

4.2.2 Bedrock

Groundwater occurs within the secondary fractures and joints of the Lockport Dolomite bedrock underlying IRP Site 10. The permeability, and in turn transmissivity of the bedrock, is dependent upon the interconnectedness of these secondary openings. Estimates of transmissivity of the Lockport Dolomite range from 300 gpd/ft to 68,000 gpd/ft; but an average of 2,300 gpd/ft is reportedly representative of the upper Lockport dolomite in the Niagara Falls region (LaSala, 1968). The upper water-bearing zone of the bedrock is typically more transmissive than deeper zones, as fracture frequency and size tend to decrease with depth.

HQ bedrock core samples retrieved from the Limited RI borings indicate that the upper 5 to 10 feet of the bedrock is generally more fractured than deeper zones encountered, and that the bedrock competence increased with depth. Based on the bedrock core samples and available geologic literature for the Lockport Dolostone, a range of permeabilities can conservatively be estimated for the upper zone of the bedrock. This shallow water-bearing zone appears to exhibit high to moderate permeability on the order of 10^{-3} to 10^{-5} cm/sec.

Water levels from wells screening the upper zone of the bedrock indicate that the shallow bedrock water-bearing unit is confined by the low permeability silts and clays of the overburden unit above. Water levels in bedrock wells were typically 2 to 5 feet above the surface of the bedrock (Tables 4-1 and 4-2). Figure 4-4 depicts the bedrock potentiometric surface based on the distribution of the limited bedrock hydraulic head data. The bedrock potentiometric surface ranges from approximate 586 elevation to 581 elevation, exhibiting a local uniform gradient of 0.014 ft/ft across the site. The generalized groundwater flow direction is from north to south within the shallow bedrock unit (Figure 4-4).



NOTES:

1. SITE SKETCH DIGITIZED FROM TOPOGRAPHIC MAP PROVIDED BY USAF AND WEHRAN ASSUMES NO RESPONSIBILITY FOR ACCURACY OF SAME.

2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929), HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

3CM:(00640.03.LDE)FIG UPPER BED WL
DWG: SW079206

WehranEnviroTech
Wehran-New York, Inc.

Drawn By :
Checked By :
Date :

Scale
60 0 60
SCALE IN FEET

NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

UPPER BEDROCK WATER-LEVEL CONTOUR MAP

Figure: 4-4
Project No. 00640

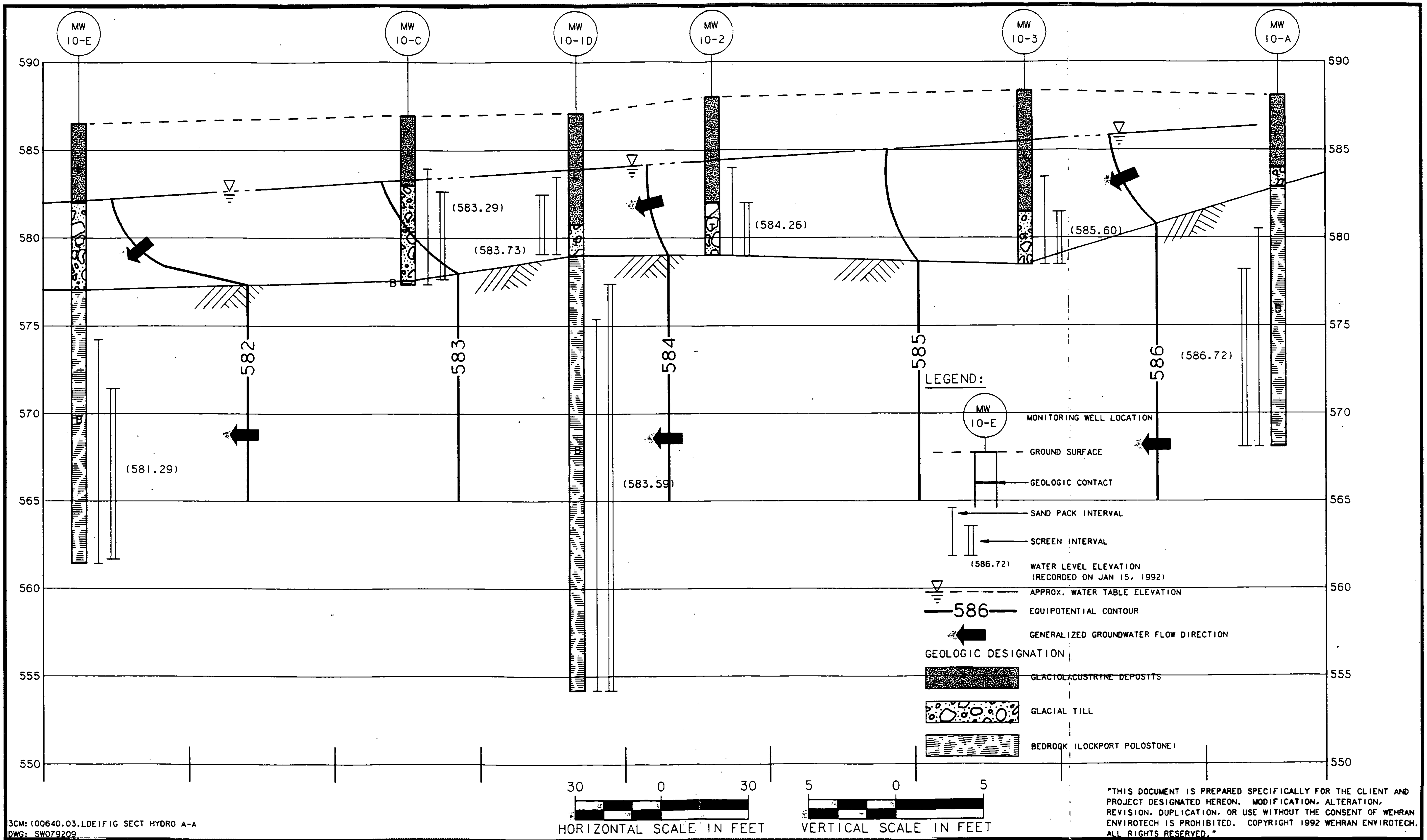
4.2.3 Conceptual Model of Groundwater Flow

Based on the geologic and hydrogeologic conditions described in the preceding sections, a conceptual model of groundwater flow and the hydraulic relationships between the overburden and shallow bedrock hydrostratigraphic units can be defined. In a pictorial sense, the essence of a conceptual model can be represented by plan and profile depictions illustrating the hydrostratigraphy, boundary conditions, head distributions, governing equipotentials, and consequent flow lines. Accordingly, the conceptual model of flow is discussed in terms of three-dimensional recharge to, and discharge from, each water-bearing unit.

The predominant horizontal flow directions have been identified for the overburden and upper bedrock based on the horizontal head distributions for each unit shown in Figures 4-3 and 4-4, respectively. A comparison of these maps indicates differences in hydraulic heads between the overburden and bedrock, where overburden water levels are everywhere, slightly higher in elevation than bedrock water levels. These differences in head suggest vertical gradients which provide an indication of the potential for downward flow from the overburden to the bedrock. A downward vertical gradient of 0.0085 ft/ft was identified at the MW10-1D location where MW10-4 combines to form a couplet well cluster.

A three-dimensional flow system is suggested by the vertical gradients identified that can best be illustrated in profile. Figure 4-5 shows Hydrogeologic Cross-Section A-A, which was constructed along the predominant horizontal flow direction for both hydrostratigraphic units and maximizes the use of available hydraulic head data. The hydrogeologic cross-section illustrates the general hydraulic relationships between hydrostratigraphic units as the delineation of equipotentials in profile reflect the horizontal and vertical gradients for the overburden and bedrock. The profile is schematic in that the equipotential geometries could be changed to show varying degrees of curvilinear horizontal/vertical flow due to the influence of heterogeneities in the hydrostratigraphic units. However, the profile provides a pictorial indication or guide of hydraulic head relations for the IRP Site 10 conceptual groundwater flow model.

Inasmuch as the equipotentials in plan and profile view indicate the potential for flow from one unit to another, the flux or movement of water within and across units needs to be addressed. The rate of flux or velocity of groundwater is not only governed by the hydraulic gradient, but by the hydraulic conductivity and porosity characteristics of the



3CM:(00640.03.LDE)FIG SECT HYDRO A-A
DWG: SW079209

WehranEnviroTech
Wehran-New York, Inc.

Drawn By :
Checked By :
Date :

Scale
AS SHOWN

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LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

HYDROGEOLOGIC CROSS-SECTION A-A

Figure: 4-5
Project No. 00640

geologic materials as well. Accordingly, conservative estimates of the velocity of groundwater moving within and across hydrostratigraphic units can simply be calculated employing the following variation of Darcy's law:

$$Vs = \frac{Ki}{7.48\ Ne}$$

Where:

Vs = seepage velocity in ft/day
K = hydraulic conductivity in gpd/ft^2
i = hydraulic gradient in ft/ft
Ne = effective porosity (dimensionless)

If we assume that the vertical and horizontal hydraulic conductivity (K) of the fine-grained unconsolidated deposits are the same, it is not unreasonable to further assume that both horizontal and vertical seepage velocities within the overburden would be very low. For example, taking a conservative estimate of K of 1 x 10^{-6} cm/sec (2.1.2E-2 gpd/ft^2) for the glacial deposits, an effective porosity estimate of 0.42 (Morris and Johnson, 1967), and the calculated horizontal gradient of 0.013 ft/ft (Figure 4-3), a horizontal seepage velocity can be calculated:

$$Vs = \frac{2.12\text{E-}2\ \text{gpd/ft}^2 \times 0.013\ \text{ft/ft}}{(7.48)\ (0.42} = 8.77\text{E-}5\ \text{ft/day} = 0.032\ \text{ft/year}$$

In other words, the time required for a particle of contaminated groundwater to pass horizontally through 1 foot of the overburden would be about 31-1/4 years. Considering that the vertical gradient across units is less than the horizontal gradient at IRP Site 10, the vertical seepage velocity within the overburden would be even lower. Where saturated thicknesses of the overburden approach 5 feet or more, the vertical migration of contaminants could require more than 150 years which translates into high attenuation within the glacial silts and clays and low potential for vertical release into the underlying bedrock.

doesn't it.

Using a conservatively higher estimate of permeability for the Lockport dolostone, and assuming predominantly horizontal flow (Figure 4-5), a horizontal seepage velocity for this unit is provided:

K = 1.00E-3 cm/sec (21.18 gpd/ft^2)
i = 0.014 ft/ft (Figure 4-4)
Ne = 0.30 (Morris and Johnson, 1967)
Vs = 0.132 ft/day = 48.23 ft/year

Results of the above analysis suggest that groundwater movement within the overburden unit should be restricted by the low permeability silt and clay material, and that these deposits probably act as a barrier to vertical migration of contaminants to the underlying bedrock. In contrast, groundwater within the upper fractured bedrock zone has the potential to move at relatively higher rates than in the overburden. Therefore, once contaminants reach the bedrock unit, the potential rate of contaminant migration is much greater in this unit. Based on this simple model of groundwater flow, preferential groundwater migration of contaminants probably occurs within the upper bedrock unit and generally flows horizontally from the north to the south.

In summary, the conceptual model of groundwater flow is relatively simple and straightforward comparable to the site-specific geology identified for Fire Training Area No. 1. Local recharge to groundwater in the overburden unit is derived primarily form infiltration of precipitation and flow from saturated unconsolidated deposits upgradient of the site. Groundwater slowly moves along an hydraulic gradient from areas of high hydraulic head (elevation) to areas of lower hydraulic head (elevation). Groundwater in the overburden unit moves laterally, in a predominant north to south flow direction discharging into Cayuga Creek, and may locally discharge to the unnamed drainage ditch during high water table periods. Groundwater also discharges vertically, recharging the higher permeability bedrock unit, albeit slowly. In addition, the bedrock also receives recharge from groundwater flow within the bedrock upgradient of the site. Groundwater within the upper bedrock zone moves horizontally in a north to south flow direction. The predominant flow component within the bedrock is most likely horizontal due to the predominantly horizontal fractures that tend to decrease with depth.

4.3 NATURE AND EXTENT OF CONTAMINATION

Sediments, groundwater, and drill cuttings were investigated at IRP Site 10 to provide additional analytical data regarding contaminant levels and their distribution in the various media to supplement the previous investigations. The following subsections discuss the analytical results for each media of concern.

4.3.1 Sediment Analysis

During the on-site investigation, two sediment samples were collected from the drainage ditch located immediately west of the site. Sediment sample locations are shown in Figure 1-3. When flowing, the ditch drains southward into Cayuga Creek. At the time of sampling, no flow was observed; however, there was some localized ponding within the ditch.

Sediment Sample 1 (upstream) was collected from the bottom area of the ditch, adjacent to the burn pit area. Sediment Sample 2 (downstream) also collected from the bottom area of the ditch at a location approximately ten feet north of the confluence of the ditch and Cayuga Creek. All sampling was performed in accordance with procedures outlined in the Work Plan. Samples were transported to the analytical testing laboratory which were received the day after sampling. Analyses were performed on the samples as outlined in the QAPP and Work Plan, and in Table 3-3.

Results of the sediment analytical results are presented in Appendix C and summarized in Table 4-3. The following presents a discussion of the analytical data for the sediments as presented in Table 4-3:

- Total petroleum hydrocarbons (TPH) were detected in both sediment samples. The sample adjacent to the fire training area exhibited a level of 192 ug/g, whereas the sample at the confluence of the drainage ditch and Cayuga Creek was at 50.9 ug/g. The presence of TPH in the sediments could be related to the fuels which were burned during the fire training exercises. However, the drainage ditch collects and transports run-off from other areas of the base upgradient of IRP Site 10, which include at least one fuel storage area.
- Pyrene was the only semi-volatile organic compound detected in the sediments in the drainage ditch. The concentration (340 ug/kg) is only slightly above

Table 4-3
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
ANALYTICAL RESULTS - SEDIMENTS

Parameter (units)	Detection Limits	Sample Field I.D.	
		Sediment 1	Sediment 2
EPA Method SW3550/E418.1 Petroleum Hydrocarbons (ug/g)		192	50.9
EPA Method SW 8240 Volatile organics (ug/kg)	See (Appendix C)	ND	ND
EPA Method SW 3550/8270 Semivolatile Organics (ug/kg)	See (Appendix C)		
Pyrene	330	ND	340
Others	(Appendix C)	ND	ND

ND – Not Detected

the detection limit of 330 ug/kg. Pyrene was not detected in any of the previous soil or groundwater samples from IRP Site 10 and may not be related to the fire training activities.

4.3.2 Groundwater Analysis

Analysis of groundwater samples included inorganic analyses of groundwater samples from the five new wells, and organic analysis of all ten new and existing IRP Site 10 wells. Table 4-4 summarizes the analytical results for all of the groundwater analyses. Table 4-5 provides a summary of the groundwater quality measured in the field during the Limited RI sampling event.

4.3.2.1 Inorganics

Unfiltered groundwater samples were collected from the five new wells and analyzed for 15 metals. The results as reported in Table 4-4 are very comparable to the total metal concentrations reported for groundwater samples from the five existing wells in the IRP RI/FS Report. As stated in the previous report, the elevated metal levels found in groundwater at the site are not considered to be the result of hazardous waste management activities at the site. The evidence indicates that the elevated metals concentrations are a result of naturally occurring metals found in the suspended sediment. The most common of these metals are calcium, iron, manganese, magnesium, aluminum, and zinc. The basic constituents of the dolomitic bedrock are calcium and magnesium. Minerals commonly associated with the Lockport Dolomite include but are not limited to sphalerite (ZnS) and galena (PbS). Elevated levels of silica, iron and aluminum are believed to be associated with the glacial sediments at the site which consist of clay minerals (phyllosilicales) that may contain various concentrations of aluminum, silica, magnesium, calcium, sodium and other less common metals such as nickel or lithium.

In order to investigate the relationship between the metals concentrations and suspended sediment in the samples, duplicate groundwater samples were taken during the initial sampling event and filtered prior to analyses. The filtered samples were analyzed for those metals which occurred in the corresponding unfiltered sample at concentrations exceeding NYSDEC Part 703 standards for Class GA waters. As indicated in Table 4-4, the soluble concentrations for most of the metals, with the exception of magnesium, are considerably lower than the total metals concentration for the unfiltered samples. This

Table 4-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
ANALYTICAL RESULTS – GROUNDWATER

Parameter (units)	Detection Limits	ARARs	Existing Well Installations					Newly Installed Wells						Equipment Blank	Field Blank	Trip Blank
			MW10-1	MW10-2	MW10-3	MW10-4	MW10-1D	MW10-A	MW10-B	MW10-C	MW10-D	MW10-E	MW10-E Duplicate			
EPA Method SW 5030/8021 Volatile Organics/ Purgeable Halocarbons (ug/l)																
Vinyl Chloride	2	2.0	76.3	ND	ND	ND	1160	ND	ND	ND	ND	ND	ND	ND	ND	ND
CIS-1,2-Dichloroethene	1	NL	202	7530	73.3	3210	13100	ND	ND	121	ND	6.81	11.1	ND	ND	ND
Chloroform	1	100	ND	ND	42.6	ND	ND	ND	ND	ND	ND	ND	1.76	ND	ND	ND
1,1,1-Trichloroethane	1	5.0	ND	ND	1.73	ND	ND	ND	ND	ND	ND	ND	1.97	ND	ND	ND
Carbon Tetrachloride	1	5.0	ND	ND	9.96	ND	ND	ND	ND	ND	ND	ND	1.15	ND	ND	ND
1,2-Dichloropropane	1	5.0	ND	ND	3.17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	1	5.0	6.95	20800	124	3450	1720	ND	ND	497	ND	ND	1.36	ND	ND	ND
Tetrachloroethene	1	5.0	ND	ND	1.14	ND	ND	ND	ND	ND	ND	ND	1.78	ND	ND	ND
Others	See Appendix C		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

NL – Not Listed
ND – Not Detected
N – Spiked sample recovery not within control limits

Table 4-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
ANALYTICAL RESULTS – GROUNDWATER

Parameter (units)	Detection Limits	ARARs	Existing Well Installations					Newly Installed Wells						Equipment Blank	Field Blank	Trip Blank
			MW10-1	MW10-2	MW10-3	MW10-4	MW10-1D	MW10-A	MW10-B	MW10-C	MW10-D	MW10-E	MW10-E Duplicate			
EPA Method SW 5030/8021 Volatile Organics/ Purgeable Aromatics (ug/l)																
Benzene	2	ND	8 04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	2	5.0	4 32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Others	See Appendix C		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA Method E 200.7 * Metals (Total) † (mg/l)																
Aluminum	0.1	NL	2.53	12.7	35.1	7.0	0 696	35.2	20.3	6.81	8.23	3.51	15.6	ND	ND	--
Barium	0.1	1.0	0.263	0.13	0.332	0.089	0 122	0.52	0.38	0.21	0.24	0.27	0.33	ND	ND	--
Boron	0.25	1.0	0.074	<0.01	<0.01	<0.01	0 057	ND	ND	ND	ND	ND	ND	ND	ND	--
Calcium	0.5	NL	203	288	69.7	2330	2600	337	480	228	415	543	833	ND	ND	--
Chromium	0.01	0.05	<0.010	0.033	0.051	<0.010	<0.010	0.0484	0.0279	0.017	0.0185	0.0108	0.0342	ND	ND	--
Copper	0.01	0.20	0.019	0.064	0.098	0.015	<0.010	0.107	0.0308	ND	ND	ND	0.0954	ND	ND	--
Iron	0.05	0.30	4.74	17.6	58.0	11.1	2.08	41.5	18.2	5.68	7.25	3.09	15.1	ND	ND	--
Lead (Furnace)	0.005	0.03	<0.050	0.052	0.206	<0.050	<0.050	0.0099 N	0.0529 N	0.0086 N	0.0096 N	0.0076 N	0.0169 N	ND	ND	--

Notes: * or as indicated for those metals analyzed by alternate methods

† Metals (total) Analytical Results for Existing Wells (MW10-1, -2, -3, -4, -1D) taken from SAIC IRP RI/FS Report dated October 1990

NL – Not Listed

ND – Not Detected

Table 4-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
ANALYTICAL RESULTS – GROUNDWATER

Parameter (units)	Detection Limits	ARARs	Existing Well Installations					Newly Installed Wells						Equipment Blank	Field Blank	Trip Blank
			MW10-1	MW10-2	MW10-3	MW10-4	MW10-1D	MW10-A	MW10-B	MW10-C	MW10-D	MW10-E	MW10-E Duplicate			
EPA Method E 200.7 * Metals (Total) (mg/l) †																
Magnesium	0.5	35	97.4	148 0	31.7	97.3	71.6	170	158	90.2	164	121	242	ND	ND	--
Manganese	0.005	0.30	0.973	0.723	2.64	2.69	0.254	0.783	0.606	0.544	0.409	0.193	0.854	ND	ND	--
Nickel	0.02	NL	<0.015	0.028	0.079	0.028	<0.015	0.0563	ND	ND	ND	ND	0.0329	ND	ND	--
Potassium	0.25	NL	2 11	4.04	7.79	2.84	1.2	12.1	59.6	3.11	4.1	1.74	3.92	ND	ND	--
Silica	0.004	NL	9.6	27 4	61.6	16.1	7 08	4.78	5.17	5.76	7.08	4.78	5.12	ND	ND	--
Sodium	0.1	20	27.3	19.3	7.73	81.1	11.5	9.69	25.8	18.2	26.7	8.88	5.74	0.156	0.216	--
Zinc	0.01	0.30	0.147	1.11	2.89	0.292	0 087	3.75	1.14	0.18	0 412	0 188	0.745	ND	ND	--
Metals (Soluble) (mg/l)																
Aluminum	0.1	0.10	--	--	--	--	--	5.05	3.12	0.112	0.608	0.137	--	--	--	--
Iron	0.05	0.30	--	--	--	--	--	3.4	2.17	0.0631	0.382	0 389	--	--	--	--
Lead	0.005	0.03	--	--	--	--	--	ND	0.0282	ND	ND	ND	--	--	--	·
Magnesium	0.5	35	--	--	--	--	--	59.5	76.2	74	142	104	--	--	--	--
Manganese	0.005	0.30	--	--	--	--	--	0.101	0.104	0.361	0.189	0.0831	--	--	--	--
Sodium	0.1	20	--	--	--	--	--	ND	8.37	ND	27.8	ND	--	--	--	--
Zinc	0.01	0.30	--	--	--	--	--	0.4	0.175	ND	0.147	0.0277	--	--	--	--

Notes: * or as indicated for those metals analyzed by alternate methods

† Metals (total) Analytical Results for Existing Wells (MW10-1, -2, -3, -4, -1D) taken from SAIC IRP RI/FS Report dated October 1990.

ND – Not Detected

N – Spiked sample recovery not within control limits

Table 4-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
ANALYTICAL RESULTS – GROUNDWATER

Parameter (units)	Detection Limits	ARARs	Existing Well Installations					Newly Installed Wells						Equipment Blank	Field Blank	Trip Blank
			MW10-1	MW10-2	MW10-3	MW10-4	MW10-1D	MW10-A	MW10-B	MW10-C	MW10-D	MW10-E	MW10-E Duplicate			
EPA Method 418.1 (mgll)																
Total Petroleum Hydrocarbons	0.1	NA	NA	NA	NA	NA	NA	ND	1.68	ND	0.4	ND	ND	ND	ND	--
Miscellaneous Inorganics (mgll)																
Total Dissolved Solids (E160.1)	10	500	NA	NA	NA	NA	NA	773	1880	1020	2130	2180	2200	ND	ND	--
Common Anions (A429)																
Fluoride	0.1	1.5	NA	NA	NA	NA	NA	0.515	0.844	0.455	1.08	1.17	1.32	ND	ND	--
Chloride	1.0	250	NA	NA	NA	NA	NA	21.3	18.7	50.6	26.7	16.9	15	ND	ND	--
Sulfate	0.1	250	NA	NA	NA	NA	NA	256	1040	361	1220	259	1350	ND	ND	--

Notes: * or as indicated for those metals analyzed by alternate methods

† Metals (total) Analytical Results for Existing Wells (MW10-1, -2, -3, -4, -1 D) taken from SAIC IRP RI/FS Report dated October 1990.

NA – Not Appilcable

ND – Not Detected

N – Spiked sample recovery not within control limits

Table 4-5

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - SITE 10

SUMMARY OF GROUNDWATER QUALITY FIELD MEASUREMENTS

Well No.	Temp. (°C)	pH	Specific Conductance (umhos/cm)	Water Clarity
MW10-1	10	7.35	1435	Muddy
MW10-2	9.5	7 65	1245	Muddy Red
MW10-3	9	7 74	1165	Cloudy
MW10-4	9	7.82	930	Cloudy
MW10-1D	9.5	7.58	1225	Muddy
MW10-A	9	7.67	935	Muddy Reddish Tint
MW10-B	10	8.14	1595	Muddy Greyish Tint
MW10-C	9.5	7.64	985	Muddy Reddish Tint
MW10-D	10	7.76	1665	Muddy
MW10-E	9	7.79	1545	Muddy
Equip. Blank	11.5	8.06	55.25	Clear
Field Blank	9	8.05	54.75	D.I. Water

Samples Collected 12/9/91

generally substantiates the idea that suspended sediment is the primary source of metals in the samples. The following presents a comparison of metal levels measured in groundwater at IRP Site 10 with the ARARs:

- Total and soluble levels of aluminum exceeded the 0.10 mg/l ARAR in all five wells as established by New York State Water Quality Standards. Total concentrations varied from 35.2 mg/l in MW10-A to 3.51 mg/l in MW10-E; while soluble levels ranged from 5.05 mg/l in MW10-A to 0.112 mg/l in MW10-C.
- Iron levels in all wells for both total and soluble metals analyses exceeded the 0.300 mg/l state ARAR. Total iron levels ranged from 41.5 mg/l in MW10-A to 3.09 mg/l in MW10-E. Soluble concentrations varied from 3.40 mg/l in MW10-A to 0.382 mg/l in MW10-D.
- Total and soluble lead measured at 0.0529 mg/l and 0.0282 mg/l, respectively, in well MW10-B exceed the New York State ARAR 0.025 mg/l.
- Magnesium exceeds the New York State ARAR of 35 mg/l for both total and soluble levels in all wells.
- Total manganese concentration in all wells and soluble manganese in MW10-C exceed the New York State ARAR of 0.30 mg/l.
- The New York State ARAR of 20 mg/l for sodium was exceeded in MW10-B and MW10-D for the unfiltered samples, and in MW10-D for the filtered samples.
- Total zinc in MW10-A, MW10-D, and MW10-E (duplicate) and soluble zinc in MW10-A exceeded the New York State ARAR of 0.30 mg/l.

4.3.2.2 Organics

Groundwater samples were collected from all ten monitoring wells at IRP Site 10 for analyses of organic compounds. Analyses for purgeable halocarbon (GC Method 8021), for purgeable aromatics (GC Method 8020), and total petroleum hydrocarbons (Method E418.1) were performed. Groundwater analytical results are summarized in Table 4-4. As indicated, a number of volatile organic compounds and TPH were detected in some of the downgradient wells. Groundwater obtained from wells in the immediate vicinity of the burn pit showed the greatest number of parameters above detection limits. No organic parameters were detected in the upgradient bedrock well (MW10-A). The following presents a comparison of organic compounds measured in the IRP Site 10 monitoring wells with ARARs:

- Benzene and toluene were only detected in MW10-1 at 8.04 ug/l and 4.32 ug/l, respectively. The benzene level exceeds the "non-detect" New York State Water Quality ARAR; however, the toluene levels do not exceed the ARARs.
- Trichloroethene (TCE) and 1,2-dichloroethene (a common biotransformation product of TCE) were detected in all five of the existing wells and two of the new downgradient wells. TCE concentrations were highest in MW10-2, MW10-4, and MW10-1D which are immediately downgradient of the burn pit at levels of 20,800 ug/l, 3450 ug/l, and 1,720 ug/l. Concentrations decrease rapidly as the distance from the burn pit increases. Although TCE was detected in MW10-E at 1.36 ug/l, this is below the New York State Water Quality ARAR of 5.0 ug/l. The highest concentrations of 1,2-dichloroethene were also found in MW10-2, MW10-4, and MW10-1D at 7,530 ug/l, 3,210 ug/l and 13,100 ug/l, respectively. The lowest detected level of 6.81 ug/l was measured in MW10-E. No ARAR has been established for Cis-1,2-DCE in groundwater.
- Vinyl chloride, another common biotransformation product of TCE, was detected in MW10-1 and MW10-1D at 76.3 ug/l and 1,160 ug/l, respectively. Both these levels exceed the New York State ARAR of 2 ug/l.
- Other organic compounds were detected in the groundwater at MW10-3 which is located on the upgradient edge of the burn pit, and the duplicate sample from MW10-E. These included chloroform; 1,1,1-trichloroethane; carbon tetrachloride and tetrachloroethene at concentrations of 42.6 ug/l to 1.76 ug/l; 1.73 ug/l to 1.97 ug/l; 9.96 ug/l to 1.15 ug/l; and 1.14 ug/l to 1.78 ug/l, respectively. With the exception of chloroform and carbon tetrachloride in MW10-3, these values are only slightly above the detection

limit of 1.0 ug/l. Additionally, 1,2-dichloropropane was measured at 3.17 ug/l in MW10-3. These values are all below the respective New York State ARARs.

- Total petroleum hydrocarbons (TPH) were measured at 1.68 mg/l and 0.40 mg/l in MW10-B and MW10-D, respectively. No ARAR has been established for TPH in groundwater.

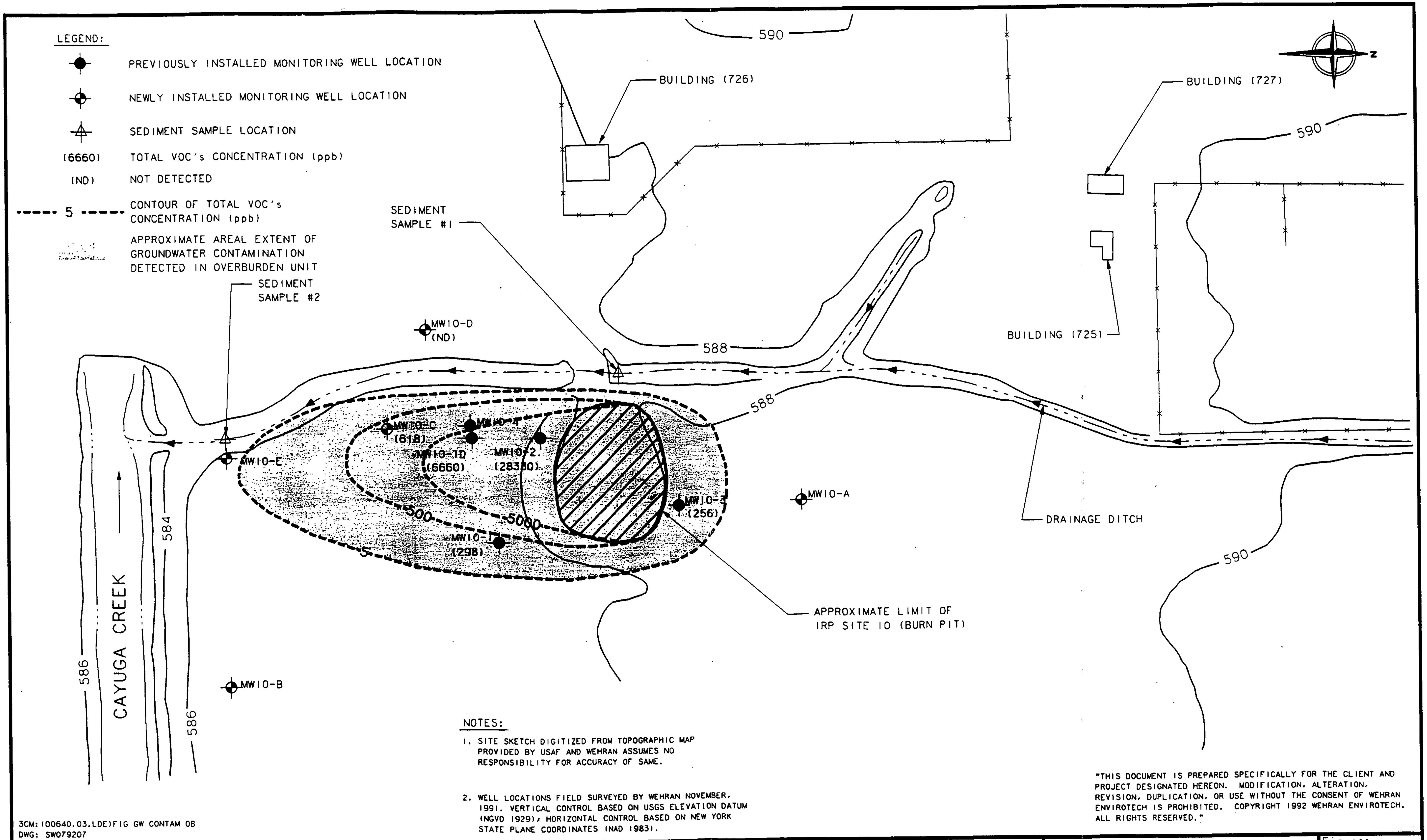
Total volatile organic compounds (VOCs) detected in monitoring wells were utilized to delineate the extent of groundwater contamination in both the overburden and shallow bedrock units. The extent of groundwater contamination based on VOCs is shown for overburden and bedrock in Figures 4-6 and 4-7, respectively. In general, these figures illustrate a plume of VOC contamination in each unit emanating from the source area (fire training area No. 1) and migrating southward downgradient along the predominant groundwater flow direction.

4.3.2.3 *Indicator Parameters*

The following presents a comparison of the indicator parameters or general chemistry analyses with ARARs, if available, for groundwater samples from the five new wells.

- Total dissolved solids (TDS) ranged from 773 mg/l to 2,200 mg/l in all wells, which exceeds the 500 mg/l secondary drinking water standard.
- Sulfate levels exceed the 250 mg/l New York State ARAR in all wells, ranging from 256 mg/l to 1,350 mg/l.
- Chloride levels range from 15.0 mg/l to 50.6 mg/l and do not exceed the New York State ARAR of 250 mg/l.
- Fluoride levels range from 0.455 mg/l to 1.32 mg/l.

As previously reported in the IRP RI/FS Report, these values are typically representative of the poor water quality in the Lockport Dolomite which is described as very hard, and moderately to highly mineralized.



LEGEND:

●	PREVIOUSLY INSTALLED MONITORING WELL LOCATION
⊕	NEWLY INSTALLED MONITORING WELL LOCATION
△	SEDIMENT SAMPLE LOCATION
(6660)	TOTAL VOC's CONCENTRATION (ppb)
(ND)	NOT DETECTED
----- 5 -----	CONTOUR OF TOTAL VOC's CONCENTRATION (ppb)
▒	APPROXIMATE AREAL EXTENT OF GROUNDWATER CONTAMINATION DETECTED IN OVERBURDEN UNIT

NOTES:

1. SITE SKETCH DIGITIZED FROM TOPOGRAPHIC MAP PROVIDED BY USAF AND WEHRAN ASSUMES NO RESPONSIBILITY FOR ACCURACY OF SAME.
2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929), HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

3CM: (00640.03.LDE)FIG GW CONTAM OB
DWG: SW079207

WehranEnviroTech
Wehran-New York, Inc.

Drawn By : ______
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Date : ______

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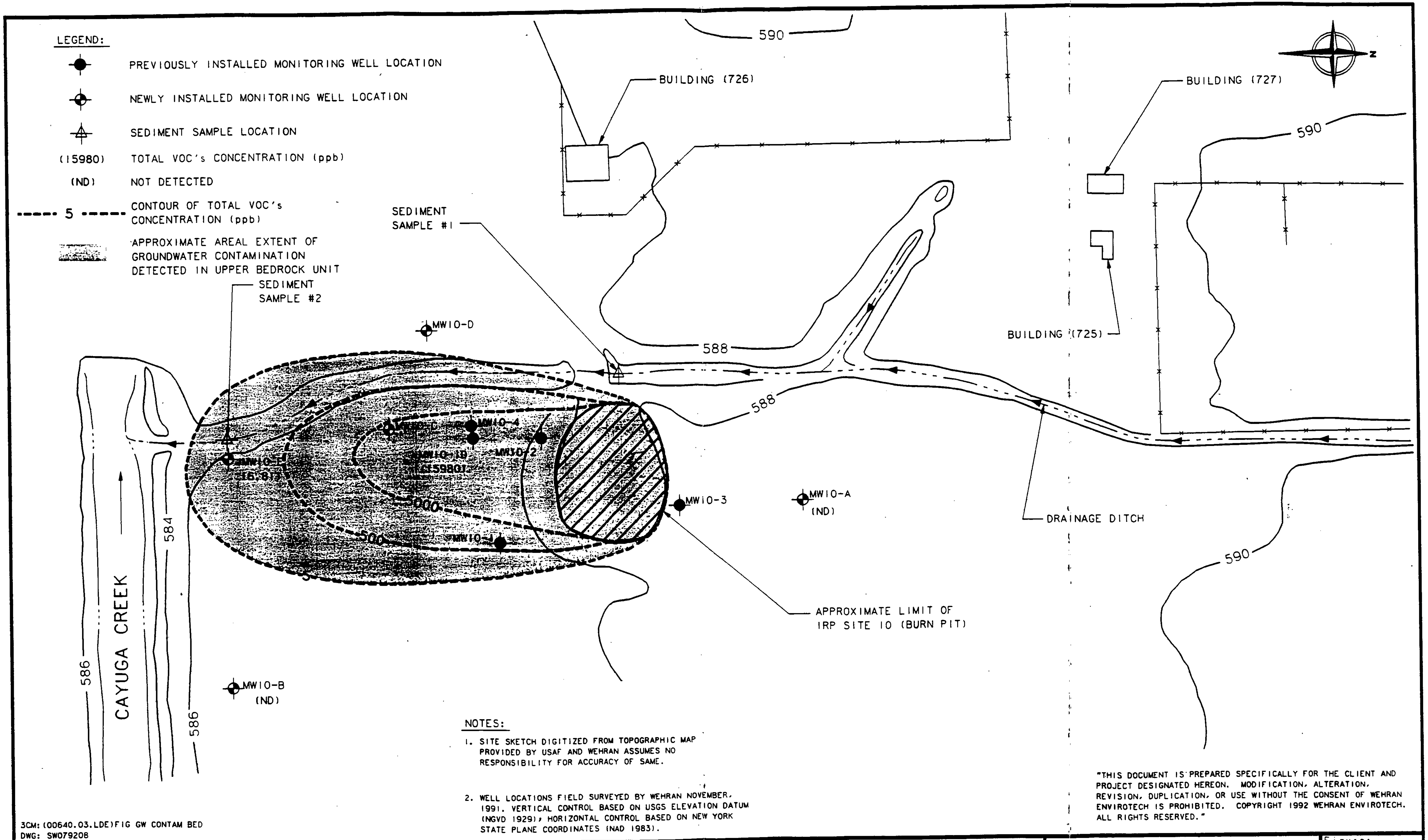
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

EXTENT OF GROUNDWATER CONTAMINATION IN OVERBURDEN (TOTAL VOC's - ppb)

Figure: 4-6
Project No. 00640



NOTES:

1. SITE SKETCH DIGITIZED FROM TOPOGRAPHIC MAP PROVIDED BY USAF AND WEHRAN ASSUMES NO RESPONSIBILITY FOR ACCURACY OF SAME.

2. WELL LOCATIONS FIELD SURVEYED BY WEHRAN NOVEMBER, 1991. VERTICAL CONTROL BASED ON USGS ELEVATION DATUM (NGVD 1929); HORIZONTAL CONTROL BASED ON NEW YORK STATE PLANE COORDINATES (NAD 1983).

WehranEnviroTech
Wehran-New York, Inc.

Drawn By : ______
Checked By : ______
Date : ______

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NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS-IRP SITE 10
NIAGARA FALLS NIAGARA COUNTY NEW YORK

EXTENT OF GROUNDWATER
CONTAMINATION IN BEDROCK
(TOTAL VOC's - ppb)

Figure: 4-7
Project No. 00640

4.3.3 Drill Cuttings

A composite sample of the drummed drill cuttings (soil) was collected and analyzed for TCLP, to characterize the materials for future disposal. Based on HNu readings during drilling, the soils were free of any volatiles and were consequently co-disposed. The analytical results from the TCLP testing are presented in Table 4-6. As indicated, all parameters were below detection limits with the exception of barium which was measured at 0.55 mg/l. This level is below the maximum allowable contaminant level of 100 mg/l for TCLP analysis.

4.4 SIGNIFICANCE OF FINDINGS

Additional subsurface and analytical data collected during the Limited RI supplement data collected during previous investigations at Fire Training Area No. 1 - IRP Site 10. Results of the Limited RI for IRP Site 10 yield the following conclusions.

Geology

The site geology consists of a thin veneer of unconsolidated glacial deposits overlying bedrock occurring at shallow depths, typically less than 10 feet bgs. The overburden unit includes surficial glaciolacustrine sands, silts and clays underlain by dense unsorted glacial till which everywhere mantles the bedrock. The bedrock unit belongs to the Lockport Dolomite Formation and is typically a hard dolomite exhibiting primarily horizontal fractures that tend to decrease in frequency and size with depth.

Hydrogeology

Groundwater occurs within the interstitial pore spaces in the overburden unit and within the secondary openings (fractures and joints) in the bedrock. Within the overburden unit groundwater moves horizontally in a north to south flow direction (Figure 4-3). Deviations of this general flow direction may occur in the overburden unit during high water table periods where groundwater discharges locally into the unnamed drainage ditch (gaining stream). Conversely, during periods of low water table conditions, the unnamed drainage ditch will serve to recharge the groundwater in the overburden (losing stream). Although surface water data are not available, it is assumed that groundwater discharges from the overburden to Cayuga Creek downgradient of the site.

TABLE 4-6
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
ANALYTICAL RESULTS - DRILL CUTTINGS

TCLP Analysis (units)	Detection Limits	Non-volatile Cuttings Composite Sample
EPA Method SW 8240 TCLP Volatile Organics (µg/ℓ)	See Appendix C	ND
EPA Method 8270 TCLP Semi-volatile Organics (µg/ℓ)	See Appendix C	ND
GC Method 8080 TCLP Pesticides (µg/ℓ)	See Appendix C	ND
GC Method 8150 TCLP Herbicides (µg/ℓ)	See Appendix C	ND
TCLP Extraction Metals (mg/l)		
Barium	0.1	0.551
Others	See Appendix C	ND

ND - Not Detected

Within the bedrock, groundwater also moves horizontally from north to south (Figure 4-4). Groundwater within the upper bedrock zone may discharge locally to Cayuga Creek or be part of a more regional flow system discharging further away from the site. In any case, due to the limitations in the IRP Site 10 databse, the hydraulic relationship between the bedrock groundwater flow system and local surface water could not be ascertained undr the limited RI/FS program.

A vertical component of flow was identified between the overburden and bedrock and suggests that the bedrock is slowly being recharged by the low permeability glacial deposits above. Vertical flow within the shallow bedrock is assumed to be negligible due to the primarily horizontal fractures and increasing bedrock competency with depth. The conceptual model of groundwater flow is illustrated in Figure 4-5.

Sediment Contamination

Total Petroleum Hydrocarbon (TPH) contamination was detected in sediment samples collected from the drainage ditch located adjacent to the former burn pit which flows from north to south emptying into Cayuga Creek (Figure 1-3). The presence of TPH in the drainage ditch sediments are most likely associated with runoff of residual fuels burned during past fire training exercises. Local topography suggests that runoff from the IRP Site 10 area drains directly into the unnamed drainage swale west of the site and, in turn, moves south within the drainage ditch and subsequently empties into Cayuga Creek. However, the drainage ditch does receive runoff from upgradient areas of the base, one of which is a fuel storage area. Pyrene was the only semi-volatile contaminant detected in the sediment samples. Pyrene was not detected in any soil or groundwater samples during the Limited RI or previous investigations and therefore is not considered to be associated with former Fire Training Area No. 1 activities.

Groundwater Contamination

Elevated metal levels were found in groundwater samples from both overburden and bedrock wells. Detected levels generally exceeded established ARARs for specific inorganic parameters. As stated in the IRP RI/FS report, the elevated metal levels found in groundwater are not considered to be a result of past hazardous waste handling or management practices, but rather occur naturally in the overburden and dolomitic bedrock units. As documented in the literature, groundwater within the Lockport Dolomite is typically of poor quality and is generally described as hard, moderately to highly mineralized. Glacial deposits comprising the overburden unit were derived chiefly from the regional Lockport dolomite bedrock and also exhibit poor water quality. As indicated from the analysis of soluble metals, suspended solids in groundwater samples from both units are the primary source of the metals (total) detected.

Contamination from organic compounds was found in groundwater samples from both overburden and bedrock monitoring wells. Within the overburden unit, volatile organic compounds (VOCs) were detected downgradient and immediately upgradient of the former burn pit. The greatest number of parameters detected, as well as the highest levels of contaminants, were found in wells in the immediate vicinity of the Fire Training Area. VOCs detected upgradient of the site are attributed to surface runoff and subsequent infiltration of contaminants into the unconsolidated deposits during operation of the Fire Training Area. TPH was detected at a single downgradient overburden well at very low levels.

The extent of groundwater contamination within the overburden is delineated in Figure 4-6 based on the distribution of total VOC. Based on the analytical data and conceptual model of groundwater flow, a narrow plume of VOC contaminated within the overburden is slowly migrating downgradient of the burn pit, and ultimately may discharge south to Cayuga Creek and west to the unnamed drainage ditch.

VOC contamination was also detected within groundwater occurring in the upper bedrock unit. The highest levels of contamination were found near the former burn pit and decrease rapidly further downgradient. TPH was also detected in a single bedrock well, at a very low concentration.

The presence of VOC groundwater contamination in the upper bedrock unit suggests one or more mechanisms for contaminant transport from the former burn pit area to the bedrock. One scenario that would provide for the vertical migration of contaminants directly from the pit to the bedrock would be that the former burn pit was excavated to surface of the bedrock thus providing a direct transport mechanism via vertical seepage into the rock from the pit. A second transport mechanism would be vertical seepage from the pit through unconsolidated deposits of relatively higher permeability than those encoutnered during the limited RI test boring program.

Coupled with the downward vertical gradients identified between the overburden and bedrock units, high permeability soils underlying the burn pit would allow for vertical migration of contaminants into the bedrock. A third possible transport mechanism for contaminants to reach the bedrock would be if the low permeability glacial till reported to mantle the bedrock, was actually fractured thus providing conduits for seepage from the source of contamination above the bedrock unit below. Regardless of the actual contaminant transport mechanism, the contaminant found within the bedrock is attributed to the former burn pit source area.

The extent of groundwater contamination within the bedrock based on total VOC contamination is shown in Figure 4-7. As with the overburden unit, an elongated plume of VOC contamination is delineated with its longest axis parallel with the north to south horizontal flow direction within the bedrock. A comparison of estimated seepage velocities suggest that contamination within the bedrock can move much faster than in the fine-grained unconsolidated deposits, and therefore has the greater potential for off-site migration.

Soil Contamination

Previous investigations identified soil contamination in the vicinity of the former pit. Screening of soils during Limited RI borings and analytical testing of drill cuttings revealed no soil contamination. Based on these results, it is assumed that soil contamination is limited to the immediate vicinity of the Fire Training Area and that contaminants in the unsaturated soils are not widespread. Therefore, within the unsaturated zone of the overburden unit, it is assumed that the source area of contamination is limited to the general proximity of the Fire Training Area No. 1 former burn pit.

FIVE

5.0 RISK ASSESSMENT UPDATE

A public health risk assessment (RA) was completed for the Niagara AFB site by Science Applications International Corporation (SAIC) as part of their 1990 RI report. The purpose of the following revised RA was to update the estimated human health risks associated with IRP Site 10. The update was based on two principal types of revisions:

- Verification of toxicity factors (carcinogenic slope factors, SFs, and reference doses, RfDs), and replacement of factors which had changed.
- Inclusion of the groundwater database collected by Wehran as part of the April 1992 Limited RI/FS for IRP Site 10.

The overall RA approach was not altered. Exposure assumptions and calculation methodologies were derived from the SAIC report. Section 4.1.4 and Appendix G of the original SAIC RA were available for Wehran review. Other sections potentially relevant to the interpretation of the SAIC RA (the remainder of Section 4.0 and Appendix E, which was cited as providing additional information on methods, assumptions, and toxicity) were not provided. The extent to which these gaps affect the updated RA cannot be determined. Relevant tables from the SAIC report are included for reference in Appendix D. Toxicological profiles appear in Appendix E.

The RA does not thoroughly address risks through direct contact pathways, as no surface soil data are available. The final risk estimates therefore are incomplete. Comments on database and methodology which affect the final risk estimates appear in Section 5.4.

5.1 REVIEW OF TOXICITY FACTORS

5.1.1 Toxicity Factor Revisions

SAIC obtained toxicity factors or the information used to derive them primarily from two sources: EPA's Integrated Risk Information System (IRIS) database, and EPA's Health Effects Assessment Summary Tables (HEAST), dated 1989. These are appropriate sources, and the respective updates used were IRIS searches completed in April 1992 and the 1991 HEAST document. Although the IRIS database is theoretically up to date, certain entries may lag, and the HEAST may contain more recent information. For each chemical where the IRIS and HEAST differed, the reference most recently updated for that chemical was used.

Table 5-1 details the updated toxicity factors and is intended as an adjunct to Table G-4 of the SAIC RA (Appendix D). Because not all constituents included in the SAIC RA were detected at IRP Site 10, Table 5-1 contains fewer chemicals than Table G-4.

Most of the toxicity factors did not require alteration. Those that did, fell into two categories:

- Factors which EPA changed, added or withdrew
- Factors which were inappropriately derived or applied

The following provides a brief discussion of each constituent for which a revised toxicity factor was used.

Benzene

According to IRIS, an oral RfD for benzene is still pending. SAIC developed an RfD of 3.6 x 10^{-4} mg/kg-day based on the "Acceptable Daily Intake" (ADI) presented in EPA's 1985 Drinking Water Criteria Document[1]. This appears to be a reasonable derivation and has been retained. However, to provide consistency with EPA's current approach of expressing RfDs to only one significant figure, a value of 4 x 10^{-4} mg/kg-day was used in the updated RA.

Cadmium

EPA provides two RfDs, one based on water ingestion, and one on food ingestion. The difference is due to variation in gastrointestinal absorption efficiency. SAIC used the water value for both groundwater and soil ingestion exposures. However, absorption from food is likely to be more representative of absorption from soil, which is generally poor due to matrix effects. Therefore, the water RfD of 5 x 10^{-4} mg/kg-day was replaced with the soil RfD of 1 x 10^{-3} mg/kg-day for the soil exposure pathway.

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[1] Drinking Water Criteria for Benzene. Office of Drinking Water.

TABLE 5-1
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
SUMMARY OF TOXICITY FACTORS

Parameter	Oral Carcinogenic Slope Factor	Weight-of-Evidence (oral route) (1)	Chronic Oral Reference Dose
Acetone	NA	D	0.1
Barium	NA	D	0.05 (2)
Benzene	2.9E-02	A	0.0004 (3)
Beryllium	4.3E+00	B2	0.005
Boron	NA	D	0.09
Cadmium	NA	D	0.0005 (water) 0.001 (food)
Carbon tetrachloride	1.3E-01	B2	0.0007
Chloroform	6.1E-03	B2	0.01
Chromium (4)	NA	D	1
Copper	NA	D	0.04 (5)
cis-1,2-Dichloroethene	NA	D	0.01
1,2-Dichloropropane	6.8E-02	B2	NA
Ethylbenzene	NA	D	0.1
Fluoride	NA	D	0.06
Lead	NA	B2	NA
Manganese	NA	D	0.1
Methylene chloride	7.5E-03	B2	0.06
Molybdenum	NA	D	0.004
Nickel	NA	D	0.02
Tetrachloroethene	5.1E-02	B2	0.01
Toluene	NA	D	0.2
1,1,1-Trichloroethane	NA	D	0.09
Trichloroethene	1.1E-02 (6)	B2	NA
Vanadium	NA	D	0.007
Vinyl chloride	1.9E+00	A	0.001 (7)
Xylenes (total)	NA	D	2
Zinc	NA	D	0.2 (8)

NA - Not applicable or not available.

(1) - Carcinogenic Weight-of-Evidence categories: A: Known human carcinogen; B2: Probable human carcinogen; D: Not classified.

(2) - Value updated in HEAST 1991; differs from value of 0.07 on IRIS, last updated 8/01/90.

(3) - Calculated from an acceptable intake of 0.025 mg/day as follows:
RfD = (0.025 mg/day)/70 kg = 0.0004 mg/kg-day
(USEPA, 1985. Drinking Water Criteria Document for Benzene. Office of Drinking Water).

(4) - Assumes trivalent form.

(5) - Calculated from drinking water standard of 1.3 mg/l, which is based on chronic GI effects:
RfD = (1.3 mg/l x 2 l/day)/70 kg = 0.037 mg/kg-day.

(6) - Value removed from IRIS pending further review.

(7) - Calculated from a longer-term drinking water health advisory of 0.046 mg/l as follows:
RfD = (0.046 mg/l x 2 l/day)/70 kg = 0.0013 mg/kg-day.

(8) - Value under review.

Chromium

SAIC used toxicity factors based on hexavalent chromium, Cr(+6), which is a far more toxic form of the metal than the more typically occurring trivalent form, Cr(+3). Cr(+6) is generally associated with chromate industries, while combustion processes produce Cr(+3) (ATSDR, 1989)[2]; based on IRP Site 10's use as a fire training (combustion) area, Cr(+3) would be anticipated to predominate. Therefore, the RfD for Cr(+6) (5 x 10-3 mg/kg-day) has been replaced with the RfD for Cr(+3) (1 x 10^0 mg/kg-day).

Copper

SAIC derived an RfD of 3.7 x 10^{-2} mg/kg-day from the drinking water maximum contaminant level (MCL) of 1.3 mg/l. Since this MCL is based on chronic human health (gastrointestinal) effects, the derivation is appropriate and has been retained. However, the value has been adjusted to one significant figure (4 x 10^{-2} mg/kg-day) for use in the updated RA.

Lead

SAIC derived an RfD for lead of 1.4 x 10-3 mg/kg-day, apparently based on the MCL of 5 mg/l([3]. However, the EPA currently considers development and use of an RfD for lead to be inappropriate. Therefore, this RfD was deleted from the revised RA. The EPA does not at present provide formal guidance as to how to assess human health risks associated with lead exposure.

The current carcinogenicity Weight-of-Evidence classification for lead of B2 (probable human carcinogen) is presented in the updated RA, although there is no slope factor allowing quantitation of risk.

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[2] Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Chromium. U.S. Public Health Service.

[3] Table G-4 provides an erroneous footnote for the lead RfD.

Manganese

The RfD for manganese was changed from 2 x 10^{-1} to 1 x 10^{-1}. This update appeared on IRIS on August 1, 1990.

Molybdenum

There is no IRIS file for molybdenum, but an RfD of 4 x 10^{-3} mg/kg-day appears in the 1991 HEAST (there was no listing in the 1989 HEAST). This RfD has been added to the revised RA.

Toluene

The RfD for toluene was changed from 3 x 10^{-1} to 2 x 0^{-1}. This update appeared on IRIS on August 1, 1990.

Trichoroethene

There is no RfD for trichloroethylene (TCE). SAIC used the RfD of 1 x 10^{-2} developed for tetrachloroethylene (PCE). There appears to be no technical basis for this (these are not isomers of the same chemical). Therefore, this RfD has been deleted from the updated RA.

Vinyl Chloride

The SF for vinyl chloride has been changed from 2.3 x 10^{1} (mg/kg-day)$^{-1}$ to 1.9 x 10^{1} (mg/kg-day)$^{-1}$. The revised value appears in the 1991 HEAST. There is no IRIS file for this chemical.

SAIC derived an RfD for vinyl chloride of 1.3 x 10^{-2} mg/kg-day from the longer-term drinking water health advisory of 0.046 mg/l. Since this health advisory is based on a chronic (lifetime) no observed adverse effects level (NOAEL), the derivation is appropriate and has been retained. However, the value has been adjusted to one significant figure (1 x 10^{-3} mg/kg-day) for use in the updated RA.

Revisions to the toxicity factors are noted in the updated toxicity factor risk calculation tables (5-8 through 5-11).

5.1.2 Revised Risk Calculations

Tables 5-2 through 5-5, and 5-6 through 5-7 present the original SAIC calculations of exposure and risk through the groundwater and soil pathways, respectively. These calculations correspond to those presented in SAIC Tables 4-58 and 4-59 (Appendix S). All represented risks and hazards are adjusted to one significant figure, as directed by EPA[4]. These calculations are shown for reference for comparison to the revised calculations.

Tables 5-8 and 5-9 show the updated carcinogenic risks and noncarcinogenic hazards, respectively, for the groundwater exposure pathway, using the revised toxicity factors and the original SAIC data. Aluminum and cobalt were excluded from the updated tables as there are no Sfs, RfDs or Weight-of-Evidence classifications for these constituents. The revised multichemical (total) carcinogenic risk is slightly reduced (from 5×10^{-4} to 4×10^{-4}). Due to the required rounding to one significant figure, the change is not apparent in the individual chemical risks, but is actually attributable to the slight decrease in the SF for vinyl chloride. The Hazard Index (HI) drops from 1×10^{1} to 3×10^{0}. This is due to the omission of an RfD for trichloroethene. Because TCE has some degree of toxicity which would result in an HQ greater than zero, were an RfD available, it is not possible to determine which HI estimate is most accurate. However, as discussed above, there is currently no RfD for TCE, so no quantification is possible.

Tables 5-10 and 5-11 present the revised risks and hazards for the soil exposure pathway. The carcinogenic risk total remains unchanged at 5×10^{-8}. The HI drops from 1×10^{-2} to 4×10^{-3}. This is attributable to the omission of an RfD for lead and use of the Cr(III) RfD for chromium, which more than offset the doubled HQ for manganese resulting from the revised RfD. Neither the carcinogenic risk nor noncarcinogenic hazard for the soil pathway is significant overall, since both risk estimates are well below the maximum acceptable values (typically 10^{-6}-10^{-4} for carcinogenic risk and 10^{0} for the HI).

5.2 DATA UPDATE

As part of the Limited RI/FS conducted in 1992, Wehran collected an additional round of groundwater samples from both new and existing wells. This database replaces the SAIC groundwater database and was used in estimating final risks through the

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[4] Risk Assessment Guidance for Superfund, Part I: Human Health Evaluation Manual. Office of Solid Waste and Emergency Response.

Table 5-2
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
INTAKE THROUGH GROUNDWATER INGESTION
(original SAIC calculations)

Parameter	CDI(c) (mg/kg/day)	CDI(nc) (mg/kg/day)	CW (mg/l)	IR (l/day)	EF (days/year)	ED (years)	BW (kg)	AT(c) (years)	AT(nc) (years)
ORGANICS									
Benzene	2.2E-04	7.8E-04	8.00E-02	1	250	20	70	25550	7300
Ethylbenzene	3.1E-06	1.1E-05	1.10E-03	1	250	20	70	25550	7300
Methylene chloride	4.3E-03	1.5E-02	1.54E+00	1	250	20	70	25550	7300
Toluene	3.9E-06	1.4E-05	1.40E-03	1	250	20	70	25550	7300
Trichloroethene	1.8E-02	6.3E-02	6.43E+00	1	250	20	70	25550	7300
Vinyl chloride	1.0E-04	3.5E-04	3.60E-02	1	250	20	70	25550	7300
Xylenes	5.0E-06	1.8E-05	1.80E-03	1	250	20	70	25550	7300
INORGANICS									
Aluminum	3.2E-02	1.1E-01	1.16E+01	1	250	20	70	25550	7300
Barium	5.2E-04	1.8E-03	1.87E-01	1	250	20	70	25550	7300
Chromium	5.6E-05	2.0E-04	2.00E-02	1	250	20	70	25550	7300
Cobalt	2.5E-05	8.8E-05	9.00E-03	1	250	20	70	25550	7300
Copper	1.1E-04	3.9E-04	4.00E-02	1	250	20	70	25550	7300
Lead	2.0E-04	7.0E-04	7.20E-02	1	250	20	70	25550	7300
Manganese	4.1E-03	1.4E-02	1.46E+00	1	250	20	70	25550	7300
Molybdenum	2.0E-05	6.8E-05	7.00E-03	1	250	20	70	25550	7300
Nickel	8.4E-05	2.9E-04	3.00E-02	1	250	20	70	25550	7300
Vanadium	7.0E-05	2.4E-04	2.50E-02	1	250	20	70	25550	7300
Zinc	2.5E-03	8.9E-03	9.05E-01	1	250	20	70	25550	7300

CDI (carc) and CDI (nc)
= Chronic daily intakes for carcinogenic and noncarcinogenic effects (mg/kg/day)
= (CW x IR x EF x ED)/(BW x AT)
CW = Average chemical concentration in groundwater (mg/l)
IR = Intake rate = 1 l/day
EF = Exposure frequency = 5 days/week x 50 weeks/year = 250 days/year
ED = Exposure duration = 20 years
BW = Body weight = 70 kg
AT = Averaging time = 70 years = 25550 days (carc)
= 20 years = 7300 days (nc)

Table 5-3
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
CARCINOGENIC RISK THROUGH GROUNDWATER INGESTION
(original SAIC calculations)

Parameter	RISK	CDI(c) (mg/kg/day)	SF (mg/kg/day)-1	WEIGHT-OF EVIDENCE
ORGANICS				
Benzene	6E-06	2.2E-04	2.9E-02	A
Ethylbenzene	-	3.1E-06	NA	D
Methylene chloride	3E-05	4.3E-03	7.5E-03	B2
Toluene	-	3.9E-06	NA	D
Trichloroethene	2E-04	1.8E-02	1.1E-02	B2
Vinyl chloride	2E-04	1.0E-04	2.3E+00	A
Xylenes	-	5.0E-06	NA	D
INORGANICS				
Aluminum	-	3.2E-02	NA	D
Barium	-	5.2E-04	NA	D
Chromium	-	5.6E-05	NA	D
Cobalt	-	2.5E-05	NA	D
Copper	-	1.1E-04	NA	D
Lead	-	2.0E-04	NA	D
Manganese	-	4.1E-03	NA	D
Molybdenum		2.0E-05	NA	D
Nickel	-	8.4E-05	NA	D
Vanadium	-	7.0E-05	NA	D
Zinc	-	2.5E-03	NA	D
TOTAL	5E-04			

RISK = Carcinogenic risk over a 70-year lifetime
= CDI(c) x SF
CDI (c) = Chronic daily intake (mg/kg/day)
SF = Carcinogenic slope factor based on oral exposure (mg/kg/day)-1
Weight-of Evidence: A - Known Human Carcinogen
B1/B2 - Probable Human Carcinogen
C - Possible Human Carcinogen
D - Not Classified
NA - Not available or not applicable

Table 5-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
NONCARCINOGENIC HAZARD THROUGH GROUNDWATER INGESTION
(original SAIC calculations)

Parameter	HQ	CDI(nc) (mg/kg/day)	RfD (mg/kg/day)
ORGANICS			
Benzene	2E+00	7.8E-04	3.60E-04
Ethylbenzene	1E-04	1.1E-05	1.00E-01
Methylene chloride	3E-01	1.5E-02	6.00E-02
Toluene	5E-05	1.4E-05	3.00E-01
Trichloroethene	6E+00	6.3E-02	1.00E-02
Vinyl chloride	3E-01	3.5E-04	1.30E-03
Xylenes	9E-06	1.8E-05	2.00E+00
INORGANICS			
Aluminum	-	1.1E-01	NA
Barium	4E-02	1.8E-03	5.00E-02
Chromium	4E-02	2.0E-04	5.00E-03
Cobalt	-	8.8E-05	NA
Copper	1E-02	3.9E-04	3.70E-02
Lead	5E-01	7.0E-04	1.40E-03
Manganese	7E-02	1.4E-02	2.00E-01
Molybdenum	-	6.8E-05	NA
Nickel	1E-02	2.9E-04	2.00E-02
Vanadium	3E-02	2.4E-04	7.00E-03
Zinc	4E-02	8.9E-03	2.00E-01
HI	1E+01		

HQ = Hazard Quotient = CDI(nc)/RfD
HI = Hazard Index = Sum of HQs
CDI(nc) = Chronic daily intake (mg/kg/day)
RfD = Chronic reference dose for oral exposure (mg/kg/day)
NA - Not available or not applicable

Table 5-5
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
INTAKE THROUGH SOIL EXPOSURE
(original SAIC calculations)

Parameter	CDI(c) (mg/kg/day)	CDI(nc) (mg/kg/day)	CS (mg/kg)	IR (mg/day)	EF (days/year)	ED (years)	BW (kg)	AT(c) (years)	AT(nc) (years)
ORGANICS									
Acetone	8.9E-10	3.1E-09	2.00E-02	100	40	20	70	25550	7300
Trichloroethene	4.0E-09	1.4E-08	9.00E-02	100	40	20	70	25550	7300
INORGANICS									
Aluminum	2.8E-04	9.9E-04	6.30E+03	100	40	20	70	25550	7300
Barium	2.3E-05	8.2E-05	5.21E+02	100	40	20	70	25550	7300
Beryllium	1.2E-08	4.1E-08	2.60E-01	100	40	20	70	25550	7300
Cadmium	3.2E-08	1.1E-07	7.10E-01	100	40	20	70	25550	7300
Chromium	1.0E-05	3.5E-05	2.25E+02	100	40	20	70	25550	7300
Cobalt	2.8E-07	9.6E-07	6.15E+00	100	40	20	70	25550	7300
Copper	6.5E-07	2.3E-06	1.46E+01	100	40	20	70	25550	7300
Lead	1.2E-06	4.1E-06	2.61E+01	100	40	20	70	25550	7300
Manganese	2.7E-05	9.5E-05	6.08E+02	100	40	20	70	25550	7300
Nickel	6.1E-07	2.1E-06	1.36E+01	100	40	20	70	25550	7300
Vanadium	7.7E-07	2.7E-06	1.73E+01	100	40	20	70	25550	7300
Zinc	1.7E-05	6.1E-05	3.91E+02	100	40	20	70	25550	7300

CDI (carc) and CDI (nc)
= Chronic daily intakes for carcinogenic and noncarcinogenic effects (mg/kg/day)
= (CS x IR x EF x ED x 1E-06 kg/mg)/(BW x AT)
CS = Average chemical concentration in soil column (mg/kg)
IR = Intake rate = 100 mg/day
EF = Exposure frequency = 2 days/week x 20 weeks/year = 40 days/year
ED = Exposure duration = 20 years
BW = Body weight = 70 kg
AT = Averaging time = 70 years = 25550 days (carc)
= 20 years = 7300 days (nc)

Table 5-6
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
CARCINOGENIC RISK THROUGH SOIL EXPOSURE
(original SAIC calculations)

Parameter	RISK	CDI(c) (mg/kg/day)	SF (mg/kg/day)-1	WEIGHT-OF EVIDENCE
ORGANICS				
Acetone	-	8.95E-10	NA	D
Trichloroethene	4E-11	4.03E-09	1.1E-02	B2
INORGANICS				
Aluminum	-	2.82E-04	NA	D
Barium	-	2.33E-05	NA	D
Beryllium	5E-08	1.16E-08	4.3	B2
Cadmium	-	3.18E-08	NA	D
Chromium	-	1.01E-05	NA	D
Cobalt	-	2.75E-07	NA	D
Copper	-	6.52E-07	NA	D
Lead	-	1.17E-06	NA	D
Manganese	-	2.72E-05	NA	D
Nickel	-	6.08E-07	NA	D
Vanadium	-	7.74E-07	NA	D
Zinc	-	1.75E-05	NA	D
TOTAL	5E-08			

RISK = Carcinogenic risk over a 70-year lifetime
= CDI(c) x SF
CDI (c) = Chronic daily intake (mg/kg/day)
SF = Carcinogenic slope factor based on oral exposure (mg/kg/day)-1
Weight-of Evidence: A - Known Human Carcinogen
B1/B2 - Probable Human Carcinogen
C - Possible Human Carcinogen
D - Not Classified
NA - Not available or not applicable

Table 5-7
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
NONCARCINOGENIC HAZARD THROUGH SOIL EXPOSURE
(original SAIC calculations)

Parameter	HQ	CDI(nc) (mg/kg/day)	RfD (mg/kg/day)
ORGANICS			
Acetone	3E-08	3.1E-09	1.0E-01
Trichloroethene	1E-07	1.4E-08	1.0E-01
INORGANICS			
Aluminum	-	9.9E-04	NA
Barium	2E-03	8.2E-05	5.0E-02
Beryllium	8E-06	4.1E-08	5.0E-03
Cadmium	2E-04	1.1E-07	5.0E-04
Chromium	7E-03	3.5E-05	5.0E-03
Cobalt	-	9.6E-07	NA
Copper	6E-05	2.3E-06	3.7E-02
Lead	3E-03	4.1E-06	1.4E-03
Manganese	5E-04	9.5E-05	2.0E-01
Nickel	1E-04	2.1E-06	2.0E-02
Vanadium	4E-04	2.7E-06	7.0E-03
Zinc	3E-04	6.1E-05	2.0E-01
HI	1E-02		

HQ = Hazard Quotient = CDI(nc)/RfD
HI = Hazard Index = Sum of HQs
CDI(nc) = Chronic daily intake (mg/kg/day)
RfD = Chronic reference dose for oral exposure (mg/kg/day)
NA - Not available or not applicable

Table 5-8
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
CARCINOGENIC RISK THROUGH GROUNDWATER INGESTION
(original SAIC data - updated toxicity factors)

Parameter	RISK	CDI(c) (mg/kg/day)	SF (mg/kg/day)-1	WEIGHT-OF EVIDENCE
ORGANICS				
Benzene	6E-06	2.2E-04	2.9E-02	A
Ethylbenzene	-	3.1E-06	NA	D
Methylene chloride	3E-05	4.3E-03	7.5E-03	B2
Toluene	-	3.9E-06	NA	D
Trichloroethene	2E-04	1.8E-02	1.1E-02	B2
Vinyl chloride	2E-04	1.0E-04	1.9E+00 * (1)	A
Xylenes	-	5.0E-06	NA	D
INORGANICS				
Barium	-	5.2E-04	NA	D
Chromium	-	5.6E-05	NA	D
Copper	-	1.1E-04	NA	D
Lead	-	2.0E-04	NA	B2 * (2)
Manganese	-	4.1E-03	NA	D
Molybdenum	-	2.0E-05	NA	D
Nickel	-	8.4E-05	NA	D
Vanadium	-	7.0E-05	NA	D
Zinc	-	2.5E-03	NA	D
TOTAL	4E-04			

RISK = Carcinogenic risk over a 70-year lifetime
= CDI(c) x SF
CDI (c) = Chronic daily intake (mg/kg/day)
SF = Carcinogenic slope factor based on oral exposure (mg/kg/day)-1
Weight-of Evidence: A - Known Human Carcinogen
B1/B2 - Probable Human Carcinogen
C - Possible Human Carcinogen
D - Not Classified
* - Value differs from SAIC report
(1) - Value obtained from 1991 HEAST (updated in 1990)
(2) - B2 classification not presented in SAIC report
NA - Not available or not applicable

Table 5-9
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
NONCARCINOGENIC HAZARD THROUGH GROUNDWATER INGESTION
(original SAIC data - updated toxicity factors)

Parameter	HQ	CDI(nc) (mg/kg/day)	RfD (mg/kg/day)	
ORGANICS				
Benzene	2E+00	7.8E-04	4E-04	* (1)
Ethylbenzene	1E-04	1.1E-05	1E-01	
Methylene chloride	3E-01	1.5E-02	6E-02	
Toluene	7E-05	1.4E-05	2E-01	* (2)
Trichloroethene	-	6.3E-02	NA	* (3)
Vinyl chloride	3E-01	3.5E-04	1E-03	
Xylenes	9E-06	1.8E-05	2E+00	
INORGANICS				
Barium	4E-02	1.8E-03	5E-02	
Chromium	2E-04	2.0E-04	1E+00	* (4)
Copper	1E-02	3.9E-04	4E-02	* (1)
Lead	-	7.0E-04	NA	* (5)
Manganese	1E-01	1.4E-02	1E-01	* (2)
Molybdenum	2E-02	6.8E-05	4E-03	* (6)
Nickel	1E-02	2.9E-04	2E-02	
Vanadium	3E-02	2.4E-04	7E-03	
Zinc	4E-02	8.9E-03	2E-01	
HI	3E+00			

HQ = Hazard Quotient = CDI(nc)/RfD

HI = Hazard Index = Sum of HQs

CDI(nc) = Chronic daily intake (mg/kg/day)

RfD = Chronic reference dose for oral exposure (mg/kg/day)

* - Value differs from SAIC report

(1) - Value, which was derived by SAIC, has been rounded to 1 significant figure in conformance with EPA-derived RfDs

(2) - Last revised on IRIS 8/01/90

(3) - No RfD available; SAIC used RfD for PCE, but not justified

(4) - Value is based on Cr(+3) vs. Cr(+6)

(5) - EPA considers development of an RfD for Pb inappropriate

(6) - Value was not available in 1989 HEAST; taken from 1991 HEAST

NA - Not available or not applicable

Table 5-10
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
CARCINOGENIC RISK THROUGH SOIL EXPOSURE
(original SAIC data - updated toxicity factors)

Parameter	RISK	CDI(c) (mg/kg/day)	SF (mg/kg/day)-1	WEIGHT-OF EVIDENCE
ORGANICS				
Acetone	-	8.95E-10	NA	D
Trichloroethene	4E-11	4.03E-09	1.1E-02	B2
INORGANICS		-		
Barium	-	2.33E-05	NA	D
Beryllium	5E-08	1.16E-08	4.3	B2
Cadmium	-	3.18E-08	NA	D
Chromium	-	1.01E-05	NA	D
Copper	-	6.52E-07	NA	D
Lead	-	1.17E-06	NA	B2 *
Manganese	-	2.72E-05	NA	D
Nickel	-	6.08E-07	NA	D
Vanadium	-	7.74E-07	NA	D
Zinc	-	1.75E-05	NA	D
TOTAL	5E-08			

RISK = Carcinogenic risk over a 70-year lifetime
= CDI(c) x SF
CDI (c) = Chronic daily intake (mg/kg/day)
SF = Carcinogenic slope factor based on oral exposure (mg/kg/day)-1

Weight-of Evidence:	
A	Known Human Carcinogen
B1/B2	Probable Human Carcinogen
C	Possible Human Carcinogen
D	Not Classified

* - Value differs from SAIC report; obtained from 1991 HEAST
NA - Not available or not applicable

Table 5-11
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
NONCARCINOGENIC HAZARD THROUGH SOIL EXPOSURE
(original SAIC data - updated toxicity factors)

Parameter	HQ	CDI(nc) (mg/kg/day)	RfD (mg/kg/day)
ORGANICS			
Acetone	3E-08	3.1E-09	1E-01
Trichloroethene	-	1.4E-08	NA * (1)
INORGANICS			
Barium	2E-03	8.2E-05	5E-02
Beryllium	8E-06	4.1E-08	5E-03
Cadmium	1E-04	1.1E-07	1E-03 * (2)
Chromium	1E-06	9.6E-07	1E+00 * (3)
Copper	6E-05	2.3E-06	4E-02 * (4)
Lead	-	4.1E-06	NA * (5)
Manganese	1E-03	9.5E-05	1E-01 * (6)
Nickel	1E-04	2.1E-06	2E-02
Vanadium	4E-04	2.7E-06	7E-03
Zinc	3E-04	6.1E-05	2E-01
HI	4E-03		

HQ = Hazard Quotient = CDI(nc)/RfD
HI = Hazard Index = Sum of HQs
CDI(nc) = Chronic daily intake (mg/kg/day)
RfD = Chronic reference dose for oral exposure (mg/kg/day)
* - Value differs from SAIC report
(1) - SAIC used the RfD for tetrachloroethene; not technically justified
(2) - The RfD based on food (vs. water) consumption is more appropriate for estimating hazard through soil ingestion
(3) - Value is based on Cr(+3) vs. Cr(+6)
NA - Not available or not applicable

groundwater ingestion pathway. The overall methodology used by SAIC has not been altered. Section 5.4 provides comments on this methodology.

The Wehran database is presented in Table 5-12 (adapted from Table 4-5 of the April 1992 Limited RI/FS report). Table 5-13 provides a summary of the chemicals of potential concern and their average values for use in the RA. In accordance with SAIC's methodology, the values used in the RA are arithmetic means of all sampling points, with half the detection limit used where the constituent was undetected. It also appears as if SAIC listed all detected constituents without applying a selection process for chemicals of potential concern; in view of the relatively small number of chemicals, this is a valid approach and has been retained. However, constituents lacking toxicity factors and Weight-of-Evidence classifications (aluminum, boron, calcium, iron, magnesium, potassium, silica, sodium, chloride and sulfate), as well as analytes which do not represent individual chemicals (total petroleum hydrocarbons and total dissolved solids)) were omitted from Table 5-13 and the updated RA, as there is no mechanism for including them in the quantitative risk evaluation. For inorganics, only total (vs. dissolved) concentrations were considered.

Tables 5-14 through 5-16 present the final calculations for intake, carcinogenic risk and noncarcinogenic hazard through the groundwater pathway, based on the Wehran, 1992 groundwater database. The multichemical carcinogenic risk of 9×10^{-4} (Table 5-15) is slightly higher than the risk of 4×10^{-4} based on the SAIC data (Table 5-8). This is attributable to a higher average vinyl chloride concentration observed in the Wehran data set, which is only partially offset by slightly lower measured trichloroethene concentrations. The updated HI of 9×10^{0} (Table 5-16) is also higher than the HI of 3×10^{0} using the SAIC database. The principal reasons are higher detected concentrations of chromium and vinyl chloride, and the presence of cis-1,2-dichloroethene, which was not found previously. These offset the slightly lower HQ for benzene. Overall, none of these changes is especially significant, as, in all cases, both sets of risks and hazards are above but within an order of magnitude of the maximum acceptable value (10^{-4} for total carcinogenic risk and 10^{0} for total HI). Tables 5-17 and 5-18 summarize the final updated carcinogenic risks and noncarcinogenic hazards. As no new soil data were collected as part of the 1992 Wehran Limited RI/FS, the original SAIC soil data have been retained. The soil risks are negligible compared to groundwater and do not contribute significantly to the final risk estimates.

Table 5-12
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
ANALYTICAL RESULTS FOR GROUNDWATER

PARAMETER	Detection Limit	WELL										
		10-1	10-2	10-3	10-4	10-1D	10-A	10-B	10-C	10-D	10-E	10-E-DUP
EPA METHOD SW 5030/8021 VOLATILE ORGANICS PURGEABLE HALOCARBONS (ug/l)												
VINYL CHLORIDE	2	76.3	ND	ND	ND	1160	ND	ND	ND	ND	ND	ND
CIS-1,2-DICHLOROETHENE	1	202	7530	73.3	3210	13100	ND	ND	121	ND	6.81	11.1
CHLOROFORM	1	ND	ND	42.6	ND	ND	ND	ND	ND	ND	ND	1.76
1,1,1-TRICHLOROETHANE	1	ND	ND	1.73	ND	ND	ND	ND	ND	ND	ND	1.97
CARBON TETRACHLORIDE	1	ND	ND	9.96	ND	ND	ND	ND	ND	ND	ND	1.15
1,2-DICHLOROPROPANE	1	ND	ND	3.17	ND	ND	ND	ND	ND	ND	ND	ND
TRICHLOROETHENE	1	6.95	20800	124	3450	1720	ND	ND	497	ND	ND	1.36
TETRACHLOROETHENE	1	ND	ND	1.14	ND	ND	ND	ND	ND	ND	ND	1.78
PURGEABLE AROMATICS (ug/l)												
BENZENE	2	8.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOLUENE	2	4.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EPA METHOD E 200.7 TOTAL METALS (mg/l)												
ALUMINUM	0.1	NA	NA	NA	NA	NA	35.2	20.3	6.81	8.23	3.51	15.6
BARIUM	0.1	NA	NA	NA	NA	NA	0.52	0.38	0.21	0.24	0.27	0.33
BORON	0.25	NA	NA	NA	NA	NA	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U
CALCIUM	0.5	NA	NA	NA	NA	NA	337	480	228	415	543	833
CHROMIUM	0.01	NA	NA	NA	NA	NA	0.0484	0.0279	0.017	0.0185	0.0108	0.0342
COPPER	0.01	NA	NA	NA	NA	NA	0.107	0.0308	0.01 U	0.01 U	0.01 U	0.0954
IRON	0.05	NA	NA	NA	NA	NA	41.5	18.2	5.68	7.25	3.09	15.1
LEAD (Furnace)	0.005	NA	NA	NA	NA	NA	0.0099N	0.0529 N	0.0086 N	0.0096 N	0.0076 N	0.0169 N
MAGNESIUM	0.5	NA	NA	NA	NA	NA	170	158	90.2	164	121	242

NA - Not analyzed

ND - Not detected

Table 5-12
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
ANALYTICAL RESULTS FOR GROUNDWATER

PARAMETER	Detection	WELL										
	Limit	10-1	10-2	10-3	10-4	10-1D	10-A	10-B	10-C	10-D	10-E	10-E-DUP
TOTAL METALS (mg/l)												
MANGANESE	0.005	NA	NA	NA	NA	NA	0.783	0.606	0.544	0.409	0.193	0.854
NICKEL	0.02	NA	NA	NA	NA	NA	0.0563	0.02 U	0.02 U	0.02 U	0.02 U	0.0329
POTASSIUM	0.25	NA	NA	NA	NA	NA	12.1	59.6	3.11	4.1	1.74	3.92
SILICA	0.004	NA	NA	NA	NA	NA	4.78	5.17	5.76	7.08	4.78	5.12
SODIUM	0	NA	NA	NA	NA	NA	9.69	25.8	18.2	26.7	8.88	5.74
ZINC	0.01	NA	NA	NA	NA	NA	3.75	1.14	0.18	0.412	0.188	0.745
DISSOLVED METALS (mg/l)												
ALUMINUM		NA	NA	NA	NA	NA	5.05	3.12	0.112	0.608	0.137	
IRON		NA	NA	NA	NA	NA	3.4	2.17	0.0631	0.382	0.389	
LEAD		NA	NA	NA	NA	NA		0.0282				
MAGNESIUM		NA	NA	NA	NA	NA	59.5	76.2	74	142	104	
MANGANESE		NA	NA	NA	NA	NA	0.101	0.104	0.361	0.189	0.0831	
SODIUM		NA	NA	NA	NA	NA		8.37		27.8		
ZINC		NA	NA	NA	NA	NA	0.4	0.175		0.147	0.0277	
EPA METHOD 418.1 (mg/l)												
TPH	0.1	NA	NA	NA	NA	NA	ND	1.68	ND	0.4	ND	ND
MISC. INORGANICS (mg/l)												
TDS (E160.1)	10	NA	NA	NA	NA	NA	773	1880	1020	2130	2180	2200
FLUORIDE	0.1	NA	NA	NA	NA	NA	0.515	0.844	0.455	1.08	1.17	1.32
CHLORIDE	1	NA	NA	NA	NA	NA	21.3	18.7	50.6	26.7	16.9	15
SULFATE	0.1	NA	NA	NA	NA	NA	256	1040	361	1220	259	1350

NA - Not analyzed

ND - Not detected

page 2 of 2

Table 5-13
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
SUMMARY OF ANALYTICAL RESULTS FOR GROUNDWATER

PARAMETER	WELL										
	MW-10-1	MW-10-2	MW-10-3	MW-10-4	MW-10-1D	MW-10-A	MW-10-B	MW-10-C	MW-10-D	MW-10E (1)	AVERAGE (mg/l)
ORGANICS (ug/l)											
BENZENE	8.04	200 *	1 *	25 *	100 *	1 *	1 *	10 *	1 *	1 *	3.48E-02
CARBON TETRACHLORIDE	1 *	100 *	9.96	12.5 *	50 *	0.5 *	0.5 *	5 *	0.5 *	0.825	1.81E-02
CHLOROFORM	1 *	100 *	42.6	12.5 *	50 *	0.5 *	0.5 *	5 *	0.5 *	1.13	2.14E-02
CIS-1,2-DICHLOROETHENE	202	7530	73.3	3210	13100	0.5 *	0.5 *	121	0.5 *	8.955	2.42E+00
1,2-DICHLOROPROPANE	1 *	100 *	3.17	12.5 *	50 *	0.5 *	0.5 *	5 *	0.5 *	0.25 *	1.73E-02
TETRACHLOROETHENE	1 *	100 *	1.14	12.5 *	50 *	0.5 *	0.5 *	5 *	0.5 *	1.14	1.72E-02
TOLUENE	4.32	200 *	1 *	25 *	100 *	1 *	1 *	10 *	1 *	1 *	3.44E-02
1,1,1-TRICHLOROETHANE	1 *	100 *	1.73	12.5 *	50 *	0.5 *	0.5 *	5 *	0.5 *	1.235	1.73E-02
TRICHLOROETHENE	6.95	20800	124	3450	1720	0.5 *	0.5 *	5	0.5 *	0.93	2.61E+00
VINYL CHLORIDE	76.3	200 *	1 *	25 *	1160	1 *	1 *	10 *	1 *	1 *	1.48E-01
TOTAL INORGANICS (mg/l)											
ALUMINUM	NA	NA	NA	NA	NA	35.2	20.3	6.81	8.23	9.555	1.60E+01
BARIUM	NA	NA	NA	NA	NA	0.52	0.38	0.21	0.24	0.3	3.30E-01
BORON	NA	NA	NA	NA	NA	0.125 *	0.125 *	0.125 *	0.125	0.125 *	1.25E-01
CALCIUM	NA	NA	NA	NA	NA	337	480	228	415	688	4.30E+02
CHROMIUM	NA	NA	NA	NA	NA	0.0484	0.0279	0.017	0.0185	0.0225	2.69E-02
COPPER	NA	NA	NA	NA	NA	0.107	0.0308	0.005 *	0.005	0.0502 *	3.96E-02
FLUORIDE	NA	NA	NA	NA	NA	0.515	0.844	0.455	1.08	1.245	8.28E-01
LEAD	NA	NA	NA	NA	NA	0.0099	0.0529	0.0086	0.0096	0.01225	1.87E-02
MANGANESE	NA	NA	NA	NA	NA	0.783	0.606	0.544	0.409	0.5235	5.73E-01
NICKEL	NA	NA	NA	NA	NA	0.0563	0.01 *	0.01 *	0.01	0.02145 *	2.16E-02
ZINC	NA	NA	NA	NA	NA	3.75	1.14	0.18	0.412	0.4665	1.19E+00

NA - Not analyzed.
(1) - Concentrations are average of results for sample and duplicate.
* - Concentrations are based on half the detection limit, where the detection limit = method detection limit x the dilution factor.

Table 5-14
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
INTAKE THROUGH GROUNDWATER INGESTION
(1992 Wehran data)

Parameter	CDI(c) (mg/kg/day)	CDI(nc) (mg/kg/day)	CW (mg/l)	IR (l/day)	EF (days/year)	ED (years)	BW (kg)	AT(c) (years)	AT(nc) (years)
ORGANICS									
Benzene	9.7E-05	3.4E-04	3.48E-02	1	250	20	70	25550	7300
Carbon Tetrachloride	5.1E-05	1.8E-04	1.81E-02	1	250	20	70	25550	7300
Chloroform	6.0E-05	2.1E-04	2.14E-02	1	250	20	70	25550	7300
cis-1,2-Dichloroethene	6.8E-03	2.4E-02	2.42E+00	1	250	20	70	25550	7300
1,2-Dichloropropane	4.8E-05	1.7E-04	1.73E-02	1	250	20	70	25550	7300
Tetrachloroethene	4.8E-05	1.7E-04	1.72E-02	1	250	20	70	25550	7300
Toluene	9.6E-05	3.4E-04	3.44E-02	1	250	20	70	25550	7300
1,1,1-Trichloroethane	4.8E-05	1.7E-04	1.73E-02	1	250	20	70	25550	7300
Trichloroethene	7.3E-03	2.6E-02	2.61E+00	1	250	20	70	25550	7300
Vinyl chloride	4.1E-04	1.4E-03	1.48E-01	1	250	20	70	25550	7300
INORGANICS									
Barium	9.2E-04	3.2E-03	3.30E-01	1	250	20	70	25550	7300
Boron	3.5E-04	1.2E-03	1.25E-01	1	250	20	70	25550	7300
Chromium	7.5E-05	2.6E-04	2.69E-02	1	250	20	70	25550	7300
Copper	1.1E-04	3.9E-04	3.96E-02	1	250	20	70	25550	7300
Fluoride	2.3E-03	8.1E-03	8.28E-01	1	250	20	70	25550	7300
Lead	5.2E-05	1.8E-04	1.87E-02	1	250	20	70	25550	7300
Manganese	1.6E-03	5.6E-03	5.73E-01	1	250	20	70	25550	7300
Nickel	6.0E-05	2.1E-04	2.16E-02	1	250	20	70	25550	7300
Zinc	3.3E-03	1.2E-02	1.19E+00	1	250	20	70	25550	7300

CDI (carc) and CDI (nc)
= Chronic daily intakes for carcinogenic and noncarcinogenic effects (mg/kg/day)
= (CW x IR x EF x ED)/(BW x AT)
CW = Average chemical concentration in groundwater (mg/l)
IR = Intake rate = 1 l/day
EF = Exposure frequency = 5 days/week x 50 weeks/year = 250 days/year
ED = Exposure duration = 20 years
BW = Body weight = 70 kg
AT = Averaging time = 70 years = 25550 days (carc)
= 20 years = 7300 days (nc)

Table 5-15
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
CARCINOGENIC RISK THROUGH GROUNDWATER INGESTION
(1992 Wehran data)

Parameter	RISK	CDI(c) (mg/kg/day)	SF (mg/kg/day)-1	WEIGHT-OF EVIDENCE
ORGANICS				
Benzene	3E-06	9.73E-05	2.9E-02	A
Carbon Tetrachloride	7E-06	5.05E-05	1.3E-01	B2
Chloroform	4E-07	5.98E-05	6.1E-03	B2
cis-1,2-Dichloroethene	-	6.78E-03	NA	D
1,2-Dichloropropane	3E-06	4.85E-05	6.8E-02	B2
Tetrachloroethene	2E-06	4.82E-05	5.1E-02	B2
Toluene	-	9.63E-05	NA	D
1,1,1-Trichloroethane	-	4.84E-05	NA	D
Trichloroethene	8E-05	7.30E-03	1.1E-02	B2
Vinyl chloride	8E-04	4.13E-04	1.9E+00	A
INORGANICS				
Barium	-	9.23E-04	NA	D
Boron	-	3.49E-04	NA	D
Chromium	-	7.51E-05	NA	D
Copper	-	1.11E-04	NA	D
Fluoride	-	2.31E-03	NA	D
Lead	-	5.21E-05	NA	B2
Manganese	-	1.60E-03	NA	D
Nickel	-	6.02E-05	NA	D
Zinc	-	3.33E-03	NA	D
TOTAL	9E-04			

RISK = Carcinogenic risk over a 70-year lifetime
= CDI(c) x SF
CDI (c) = Chronic daily intake (mg/kg/day)
SF = Carcinogenic slope factor based on oral exposure (mg/kg/day)-1
Weight-of Evidence: A - Known Human Carcinogen
B1/B2 - Probable Human Carcinogen
C - Possible Human Carcinogen
D - Not Classified
NA - Not available or not applicable

Table 5-16
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
NONCARCINOGENIC HAZARD THROUGH GROUNDWATER INGESTION
(1992 Wehran data)

Parameter	HQ	CDI(nc) (mg/kg/day)	RfD (mg/kg/day)
ORGANICS			
Benzene	9E-01	3.4E-04	4E-04
Carbon Tetrachloride	3E-01	1.8E-04	7E-04
Chloroform	2E-02	2.1E-04	1E-02
cis-1,2-Dichloroethene	2E+00	2.4E-02	1E-02
1,2-Dichloropropane	-	1.7E-04	NA
Tetrachloroethene	2E-02	1.7E-04	1E-02
Toluene	2E-03	3.4E-04	2E-01
1,1,1-Trichloroethane	2E-03	1.7E-04	9E-02
Trichloroethene	-	2.6E-02	NA
Vinyl chloride	1E+00	1.4E-03	1E-03
INORGANICS			
Barium	6E-02	3.2E-03	5E-02
Boron	1E-02	1.2E-03	9E-02
Chromium	3E-04	2.6E-04	1E+00
Copper	1E-02	3.9E-04	4E-02
Fluoride	1E-01	8.1E-03	6E-02
Lead	-	1.8E-04	NA (1)
Manganese	6E-02	5.6E-03	1E-01
Nickel	1E-02	2.1E-04	2E-02
Zinc	6E-02	1.2E-02	2E-01
HI	5E+00		

HQ = Hazard Quotient = CDI(nc)/RfD

HI = Hazard Index = Sum of HQs

CDI(nc) = Chronic daily intake (mg/kg/day)

RfD = Chronic reference dose for oral exposure (mg/kg/day)

(1) - EPA considers development of an RfD for Pb inappropriate

NA - Not available or not applicable

Table 5-17

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - IRP SITE 10

FINAL MULTIPATHWAY CARCINOGENIC RISKS

(1992 Wehran groundwater data; SAIC soil data)

Parameter	SOIL EXPOSURE	GROUNDWATER EXPOSURE	TOTAL
ORGANICS			
Acetone	-	-	-
Benzene	-	3E-06	3E-06
Carbon Tetrachloride	-	7E-06	7E-06
Chloroform	-	4E-07	4E-07
cis-1,2-Dichloroethene	-	-	-
1,2-Dichloropropane	-	3E-06	3E-06
Tetrachloroethene	-	2E-06	2E-06
Toluene	-	-	-
1,1,1-Trichloroethane	-	-	-
Trichloroethene	4E-11	8E-05	8E-05
Vinyl chloride	-	8E-04	8E-04
INORGANICS			
Barium	-	-	-
Beryllium	5E-08	-	5E-08
Boron	-	-	
Cadmium	-	-	-
Chromium	-	-	-
Copper	-	-	-
Fluoride	-	-	-
Lead	-	-	-
Manganese	-	-	-
Nickel	-	-	-
Vanadium	-	-	-
Zinc	-	-	-
TOTAL	5E-08	9E-04	9E-04

Table 5-18
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - IRP SITE 10
FINAL MULTIPATHWAY NONCARCINOGENIC HAZARDS
(1992 Wehran groundwater data; SAIC soil data)

Parameter	SOIL EXPOSURE	GROUNDWATER EXPOSURE	TOTAL
ORGANICS			
Acetone	3E-08	-	3E-08
Benzene	-	9E-01	9E-01
Carbon Tetrachloride	-	3E-01	3E-01
Chloroform	-	2E-02	2E-02
cis-1,2-Dichloroethene	-	2E+00	2E+00
1,2-Dichloropropane	-	-	-
Tetrachloroethene	-	2E-02	2E-02
Toluene	-	2E-03	2E-03
1,1,1-Trichloroethane	-	2E-03	2E-03
Trichloroethene	-	-	-
Vinyl chloride	-	1E+00	1E+00
INORGANICS			
Barium	2E-03	6E-02	7E-02
Beryllium	8E-06	-	8E-06
Boron	-	1E-02	1E-02
Cadmium	1E-04	-	1E-04
Chromium	1E-06	3E-04	3E-04
Copper	6E-05	1E-02	1E-02
Fluoride	-	1E-01	1E-01
Lead	-	-	-
Manganese	1E-03	6E-02	6E-02
Nickel	1E-04	1E-02	1E-02
Vanadium	4E-04	-	4E-04
Zinc	3E-04	6E-02	6E-02
TOTAL	4E-03	5E+00	5E+00

5.3 RISK SUMMARY

Figures 5-1 and 5-2 summarize the risks and hazards for the three scenarios: the original SAIC calculations; the original SAIC database with updated toxicity factors; and the final risk estimates using updated toxicity factors, the SAIC soil database and the Wehran groundwater database (Tables 5-17 and 5-18). All three sets of risk estimates are similar, in that they indicate that both carcinogenic risks and noncarcinogenic hazards are above the typical maximum acceptable range, but not by more than an order of magnitude. Given the large number of uncertainties involved in risk assessment (see Section 5.5), as well as in the sampling and analyses from which chemical databases are derived, none of these risks can be considered to differ substantially.

5.4 COMMENTS ON SAIC METHODOLOGY

The SAIC RA generally followed current acceptable RA guidance in deriving the risk estimates. The following comments apply to assumptions, approaches and presentations used by SAIC and the impact, if any, on the final risk estimates.

Significant Figures

SAIC was inconsistent in retaining significant figures. For instance, the number of significant figures in chemicals in the groundwater database varied from three to six. SFs and RfDs were expressed to three places, although EPA gives them to two and one, respectively. EPA guidance also specifically directs that final risk and hazard estimates be reported to one figure only, which represents an understanding as to the level of uncertainty. These are presentation issues and do not affect the final risk estimates. Corrections were made in the updated RA.

Verification of Concentration Averaging

The SAIC report states that soil and groundwater concentrations used in the exposure estimates were derived as arithmetic averages of all sampling points, with half the detection limit used for undetected values. This is an acceptable approach. However, for organic constituents in groundwater, the derivation of the values could not be confirmed by using the data points presented in Table 4-54 to calculate the mean concentrations in Table 4-58. It is possible that dilution factors, which were not presented in these tables,

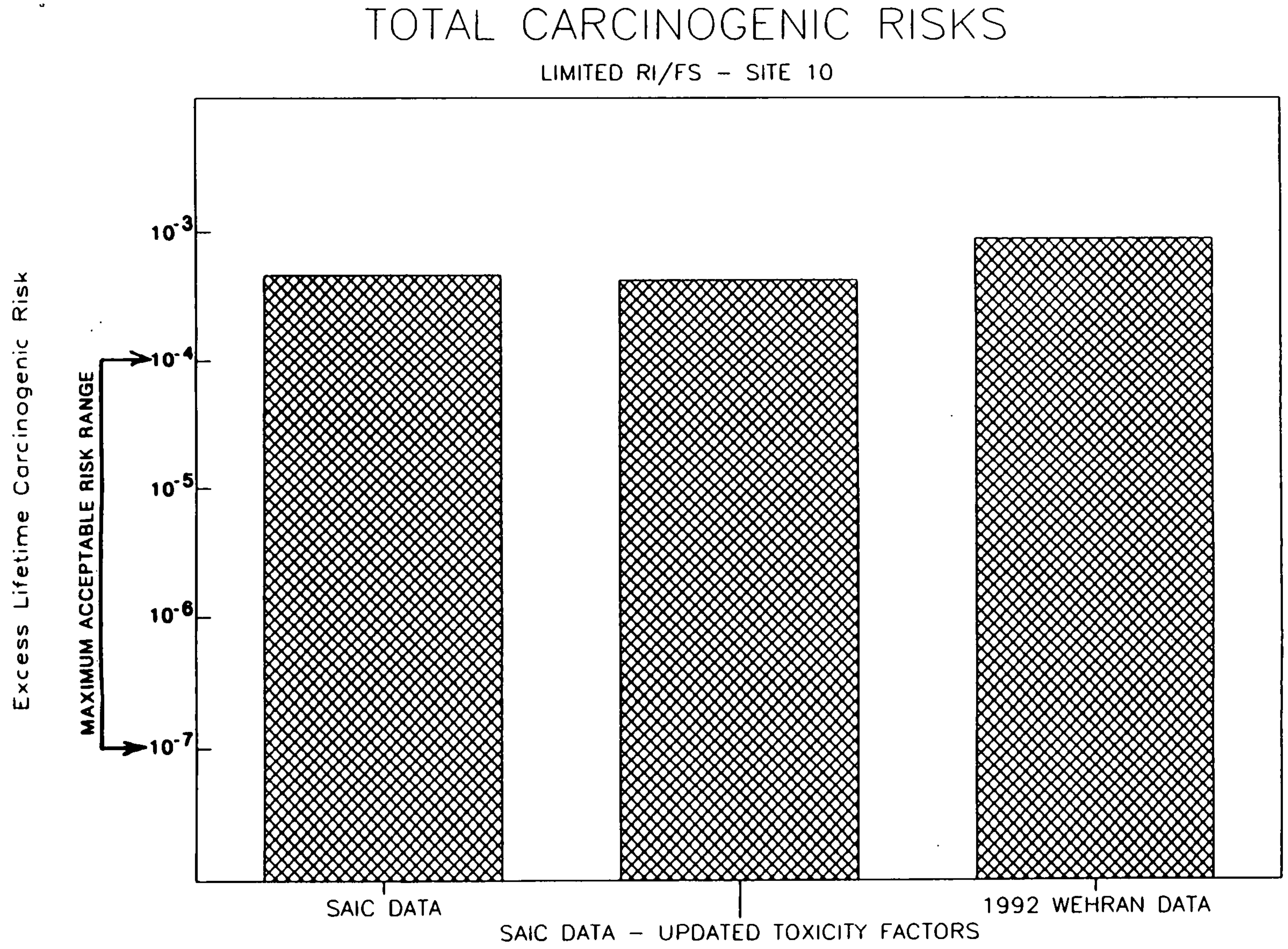

FIGURE 5-1

TOTAL CARCINOGENIC RISKS

NIAGARA FALLS, NEW YORK

WehranEnviroTech
Wehran-New York, Inc.

[illegible] CARCINOGENIC [illegible]

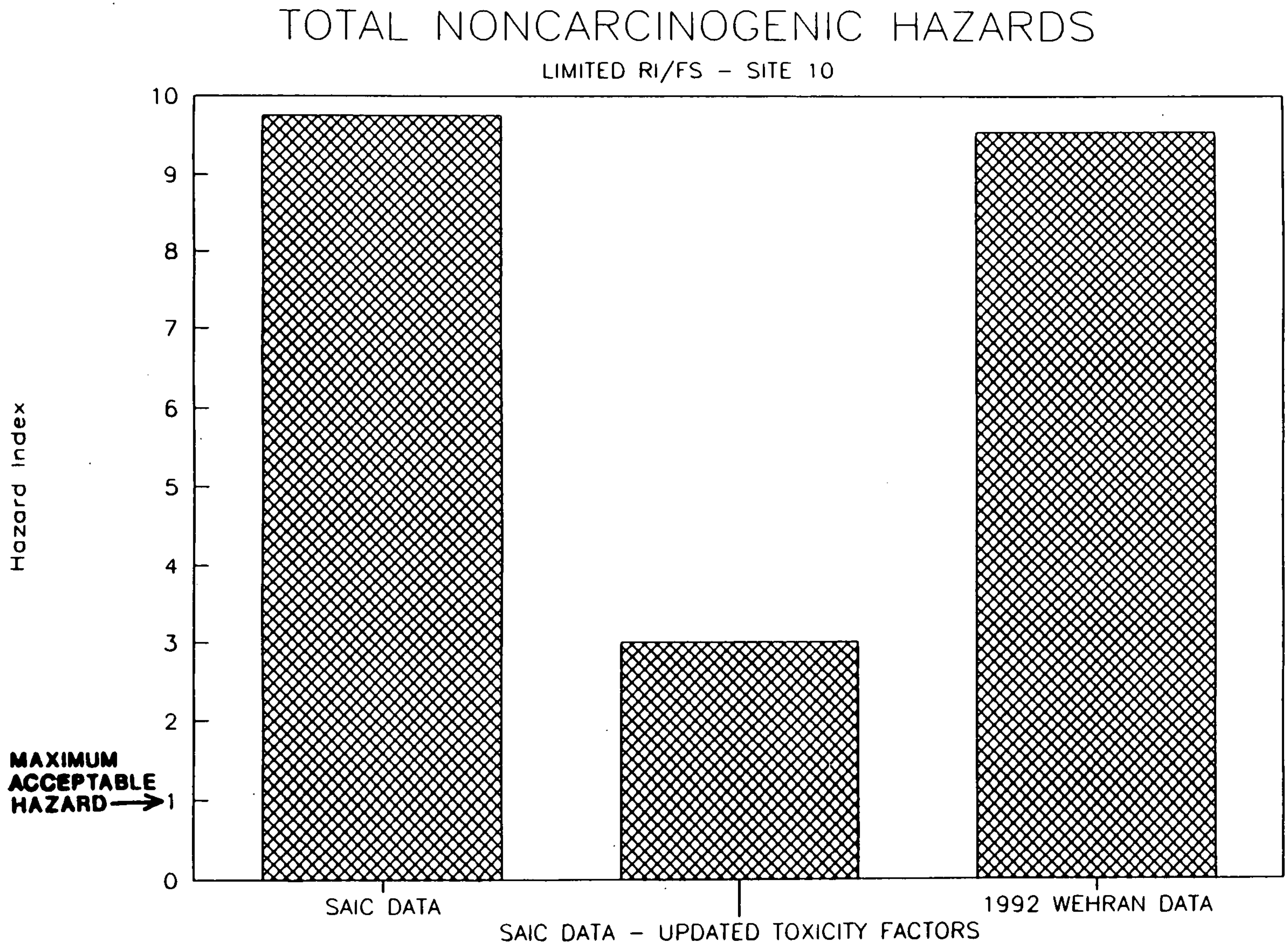

FIGURE 5-2

TOTAL NONCARCINOGENIC HAZARDS

NIAGARA FALLS, NEW YORK

WehranEnviroTech
Wehran-New York, Inc.

altered the actual detection limits. In addition, apparent inconsistencies were identified in the averaging of inorganics for soil (Tables 4-53 and 4-59): for boron, nondetects were apparently excluded altogether, and for cadmium, the derivation of the average value (0.71 mg/kg)) could not be confirmed.

None of the values were changed in applying the soil database to the updated RA, as it is not clear without reviewing the remainder of Section 4.0 and Appendix E of the SAIC report whether there was justification for the discrepancies noted.

Data Validation

The SAIC database does not appear to have undergone a formal data validation review prior to its incorporation into the RI and RA. Although a discussion was provided in Section 4.1.4.1.4, and certain comments appear in Tables 4-53 and 4-54 regarding method blank contamination and other QA/QC excursions, it does not appear as if the data were qualified based on QA/QC information. While the typical assignation of a "J" (estimated value) flag to data points would not impact the risk calculations, method blank data are often used to change detected values to nondetects; this could have a significant impact. Acetone, and methylene chloride, for example, were identified in the method blank(s) associated with every sample in which these constituents were reported. These are common laboratory contaminants, and EPA data validation guidelines[5] indicate that any sample value which does not exceed the blank value x the dilution factor at least **ten-fold** be changed to nondetect. Based on the method blank concentration and dilution information presented in Section 4.1.4.1.4, all of these organic hits should have been excluded from the RA. However, since the groundwater database was replaced and the soil exposures did not contribute significantly to risk, such changes would not have had a material impact on the final updated risks.

Wells Included

SAIC averaged all groundwater monitoring points to derive the groundwater concentration for use in the RA. However, one of these wells (MW10-3) is upgradient of IRP Site 10, and should probably not have been included in the average. In addition, only

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[5] USEPA, 1988. Laboratory Data Validation. Functional Guidelines for Evaluating Organics Analyses. Hazardous Site Evaluation Division.

one of the wells (MW10-1D) is in bedrock. Since the SAIC report (Section 4.1.4.1.2) states that the water-bearing zone at IRP Site 10 is likely to be bedrock, it is questionable how meaningful the overall average is from a site groundwater use perspective.

The updated Wehran groundwater database includes five additional wells: one upgradient bedrock, two downgradient overburden, and two downgradient bedrock. Since the averaging methodology was retained, this remains a major source of uncertainty in the final risk estimates.

Soil Data Included

There is apparently no surface soil database for IRP Site 10. The SAIC database consists of an average of three soil column samples. Based on the sample nomenclature, two were from the boring for well MW10-1D and one from MW10-4. These are subsurface data from 5.4 feet to 8.1 feet deep and are overlapping in intervals covered. They are not continuous, and no indication as to how these samples were selected could be found. Regardless, the use of subsurface data in quantifying human health risks is highly questionable, since there is no clear mechanism by which incidental ingestion of materials more than 5 feet below surface could occur. It is assumed that SAIC intended the subsurface data to be representative of what might appear at the surface. Whether this assumption is supported by site-specific data related to soil homogeneity or source is unknown. This is a major source of uncertainty in the soil risk estimates, and precludes any conclusions about soil impacts on public health. However, as discussed above, this deficiency is unlikely to have significant impact on the final estimates due to the small overall contribution of soils to total risk.

5.5 UNCERTAINTIES

The uncertainty evaluation for the original RA, presented in Sections 4.1.1.2.4.1 and 4.1.1.2.4.3 of the SAIC report, was not available for review. However, the types of uncertainties present in the original and updated RAs are likely to be similar. These include:

- The accuracy of the chemical database, especially regarding the use of estimated or below-detection limit values.

- The actual extent of human contact with contaminated materials.
- Uncertainty in the toxicity factors (SFs and RfDs), such as:
    - animal-to-human extrapolations
    - assumptions about the existence of thresholds
    - differences in study designs and data quality used to derive toxicity values
    - additivity assumptions
    - the assumption of a linear dose-response relationship for all carcinogens
    - the application of conservative safety factors and upper-bound risk estimates in deriving toxicity factors
- Omission of chemicals for which no toxicity factors exist.

With the exception of the final source of uncertainty, these sources of bias generally result in overestimates of risk. In the IRP Site 10 RA, the only chemical with known carcinogenic potential (Weight-of-Evidence A or B) omitted from the final carcinogenic risk estimates due to the absence of an SF was lead. Chemicals with potential noncarcinogenic toxicity omitted due to the lack of RfDs were trichloroethene, 1,2-dichloropropane and lead. In cases where a basis for developing an RfD could be found (benzene, copper and vinyl chloride), the derived RfD estimates were used in the RA; although these derived RfDs are likely to be less reliable than EPA-generated estimates, their inclusion is believed to reduce the potential for risk underestimation which would exist were the chemicals excluded altogether from the hazard indices.

Uncertainties associated with the SAIC data use methodology, especially pertaining to groundwater, were addressed in Section 5.4.

SIX

6.0 FOCUSED FEASIBILITY STUDY

The purpose of the Focused Feasibility Study (FFS) is to provide an early solution-related engineering analysis of general response options at Site 10. This FFS report contains three sections:

Section 1.0 – describes the development of applicable or relevant and appropriate requirements (ARARs) and other criteria; the designation and description of media requiring remediation; the identification of appropriate remedial action objectives; the development of general response actions for each remedial objective; the determination of feasible technologies associated with each general response action; and the screening of technologies based on effectiveness, implementability, and relative cost. This section represents Phase I screening.

Section 2.0 – describes the assembly of technologies (retained in Section 1.0) into remedial action alternatives; and the remedial action alternatives are screened on the basis of effectiveness; implementability, and cost. Remedial alternatives which warrant more detailed evaluation are identified and retained for detail in Section 3.0. This section represents Phase II screening.

Section 3.0 – describes the evaluation of retained remedial alternatives on the basis of overall protection of human health and the environment; short-term effectiveness; long-term effectiveness; reduction of toxicity, mobility or volume; implementability; cost; and compliance with ARARs. This section represents Phase III screening.

6.1 REMEDIAL ACTION OBJECTIVES, GENERAL RESPONSE ACTIONS AND TECHNOLOGY SCREENING (PHASE I)

6.1.1 Introduction

The Feasibility Study (FS) is a progressive screening process. This section addresses Phase I of the FS process which involves the identification and screening of feasible remedial technologies. Phase II includes the subsequent assembly of retained technologies into remedial alternatives for further evaluation. The five steps in Phase I that lead to the development of remedial alternatives are:

Step 1 - Development of Remedial Action Objectives - Remedial action objectives are established during the first step of Phase I. These consist of medium-specific environmental goals to facilitate the development of remedial alternatives that will be protective of human health and the environment. Remedial action objectives specify the media and constituents of concern, potential exposure routes and receptors, and acceptable compound levels or ranges of levels for each potential exposure route, based on potentially Applicable or Relevant and Appropriate Requirements (ARARs) and or/risk calculations. Section 6.1.2 discusses ARARs for the facility. Section 6.1.3 evaluates which media are of concern in the study area. This evaluation provides the basis for defining remedial action objectives for the project in Section 6.1.4.

Step 2 - Determination of Potentially Appropriate General Response Actions - Appropriate general response actions are developed during this step (Section 6.1.5). This involves the identification of general categories of remedial actions, each of which could provide a remedy or be incorporated into a coordinated remedy for each media of concern. General response actions are selected such that either by themselves, or in combination with other general response actions, they will satisfy the remedial action objectives.

Step 3 - Identification and Characterization of Volumes or Areas of Media to be Evaluated - This step takes into account the characteristics of the media of concern and requirements for protectiveness to identify the volumes and areas to which the general response actions apply. This step is addressed in Section 6.1.3 of the FS, where the flow and concentration basis for the evaluation of remedial measures is developed.

Step 4 - Identification and Screening of Technologies - Based on the general response actions for the media of concern, feasible technology types and technology process options are identified and screened in Section 6.1.6. Technology types are general categories of technologies (e.g., physical/chemical treatment). Technology process options are defined as specific processes within a technology type (e.g., chemical precipitation). The objective of this screening is to eliminate those technologies that are not technically appropriate for the media of concern.

Step 5 - Evaluation of Technology Process Options - In this step (Section 6.1.7) the feasible technology types and technology process options that passed the initial screening are further evaluated on the basis of effectiveness, implementability, and relative cost.

Remedial action objectives and general response actions are both medium-specific. The risk assessment evaluated all environmental media (groundwater, surface water, air, soil, and sediments) to establish the existing or baseline health risks associated with the contamination found to be present in Fire Training Area No. 1, referred to as IF Site 10 (Site 10). The media of concern identified via the risk assessment for the Site 10 area are groundwater (both the unconsolidated aquifer and the upper fractured bedrock water-bearing zones) and contaminated soil.

6.1.2 Applicable or Relevant and Appropriate Requirements (ARARS) and Other Criteria

The determination of ARARs for media in the study area is an essential precursor to the proper definition of site-related problems that require remedial action. ARARs are used to: 1) determine the appropriate remediation goals; 2) scope and formulate remedial action alternatives; and 3) govern the implementation and operation of the selected action.

6.1.2.1 Definition of ARARs and Other Criteria

Applicable or Relevant and Appropriate Requirements (ARARs)

ARARs may include the following: 1) any standard, requirement, criterion, or limitation promulgated under Federal environmental law; and 2) any promulgated standard, requirement, criterion or limitation under a State environmental or facility-siting law that is more stringent than the associated Federal standard, requirement, criterion or limitation.

A requirement may be either "applicable" or "relevant and appropriate" to a site-specific remedial action. "Applicable" requirements are promulgated remediation standards, standards of control, or limitations that are generally enforceable under Federal or State law. These requirements specifically address a hazardous substance, a remedial action, a location, or other site-specific condition.

"Relevant and appropriate" requirements are Federal and State standards, criteria, or limitations that are not legally applicable to the project, but which address problems sufficiently similar to those found.

To-Be-Considered (TBC) Materials

"To-Be-Considered" materials are advisories or guidance issued by the Federal or State government (e.g., reference doses) that are not generally enforceable and do not have the status of potential ARARs. However, where specific ARARs are not available, guidance documents or advisories may be considered in determining the necessary level of remediation.

6.1.2.2 Identification of Potential ARARs and TBCs

In the following subsections, potential ARARs and TBCs are identified and discussed for the Niagara Falls International Airport project. The two functional groups of potential ARARs and TBCs which have been evaluated are: 1) chemical-specific ARARs/TBCs (i.e., requirements that set protective remediation levels for the chemicals of concern, or indicate an acceptable limit of discharge associated with a remedial action); and 2) action-specific ARARs/TBCs, i.e., requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous wastes or contaminants.

The ARARs and TBCs developed for groundwater and soil are based on information presented in the Remedial Investigation and the Risk Assessment. Where appropriate, the New York State Department of Environmental Conservation (NYSDEC) document, "Cleanup Policy and Guidelines (Draft, October 1991)" serves as a guidance.

Potential Chemical-Specific ARARs and TBCs - Groundwater

Organic compounds and metals are present in the groundwater at greater-than-laboratory method detection limits. Some of these compounds are regulated in potential water supplies by the Federal Maximum Contaminant Levels (MCLs), which are ARARs. In addition, the NYSDEC regulates the ambient water quality of surface water and groundwater under 6 NYCRR Parts 701-705. The ARARs (Federal MCLs and State Standards for groundwater) and TBCs (Federal Secondary MCLs) are presented in Table 6-1.

Potential Chemical-Specific ARARs and TBCs - Soils

Since there are no ARARs for soils in New York, the impact of soils in proximity to the overburden aquifer system beneath Site 10 needs to be evaluated. By quantifying the transport processes from soil to groundwater, a relationship between residual soil contamination and the expected downgradient groundwater concentration at potential exposure points can be determined. Using this relationship and applicable ARARs that must be met for groundwater at the exposure points, acceptable soil concentrations can be back-calculated. However, no information concerning the soils was collected during the Remedial Investigation. Because of the nature of the groundwater contaminated plume, it is assumed that the pit area is still a source of groundwater contamination. Therefore, to eliminate potential future migration of the contaminants from the soil matrix to the groundwater, it is assumed that remediation of the soils must be considered and no attempt was made to model the leaching of contaminants from the soils. This Feasibility Study does not develop soil cleanup levels which must be developed during the implementation of the remedy.

Potential Action-Specific ARARs/TBCs

A number of potential action-specific ARARs have been identified for possible remedial alternatives, as discussed below. Requirements for each remedial alternative that passes the initial screening are discussed in more detail in Section 6.2.

Air Emissions

NYSDEC uses both Annual and Short-term Guideline Concentrations (AGCs and SGCs) to establish appropriate control requirements under 6 NYCRR Part 212. The

Page 1 of 2

Table 6-1
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
POTENTIAL GROUNDWATER CHEMICAL-SPECIFIC ARARs AND TBCs

Compound	ARARs		TBCs
	Federal MCLs (mg/L)	**NYSDEC Class GA Standards (mg/L)**	**Federal Secondary MCLs (mg/L)**
Volatiles			
Benzene	.005	.0007	-
Carbon Tetrachloride	.005	.005	-
Chloroform	.100	.007	-
1,2 Dichlorethylene (cis)	.070	.005*	-
1,2 Dichloropropane	.005	.005*	-
Tetrachloroethylene	.005	.005*	-
Toluene	1.000	.005*	-
1,1,1 Trichloroethane	.200	.005*	-
Trichloroethylene	.005	.005	-
Vinyl chloride	.002	.002	-
Inorganics			
Aluminum	-	-	.05-.20
Barium	2.000	1.000	-
Boron	-	1.000	-
Calcium	-	-	-
Chloride	250.000	250.000	250.0
Chromium	.100	.050	-
Copper	1.300	.200	1.0
Fluoride	4.000	1.500	2.0
Iron	-	.300**	.3
Lead	.015	.025	-
Magnesium	-	-	-
Manganese	-	.300**	.05
Nickel	0.100	-	-
Potassium	-	-	-
Silica	-	-	-
Sodium	-	20.000	-

Table 6-1

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - IRP SITE 10

POTENTIAL GROUNDWATER CHEMICAL-SPECIFIC ARARs AND TBCs

	ARARs		TBCs
Compound	Federal MCLs (mg/L)	NYSDEC Class GA Standards (mg/L)	Federal Secondary MCLs (mg/L)
Sulfate	400/500	250.000	250.0
Total Dissolved Solids	-	500.000	500.0
Zinc	-	.300	5.0

* Additional substance included in the Groundwater Principal Organic Contaminant Standard of 5 ug/L.

** Iron + Manganese total not to exceed .500 mg/L.

following description is taken from the "New York State Air Guide-1: Guidelines for the Control of Toxic Ambient Air Contaminants (Draft, 1991)". "AGCs are ambient Annual average-based Guideline Concentrations and are developed to protect the environment and public health from effects which may be associated with long-term exposure to the contaminant. Calculated annual impacts for each contaminant from a source being considered should be evaluated against its AGC. To preclude any significant health or environmental effects which might be associated with acute exposures to sources of air contaminants, SGCs are (determined)." Contaminants with HIGH toxicity ratings require "99 percent or greater" pollution control or the application of "Best Available Control Technology". Additionally, the maximum annual average ambient impact should not exceed the AGC nor should the maximum one hour, short-term impact, exceed the SGC. If the hourly emission rate is less than 0.1 pound per hour, and the ambient impact is less than both the AGC and the SGC, the no control option may be considered by the Regional Air Pollution Control Engineers (RAPCEs). The AGCs and SGCs for the compounds of concern at this site are indicated in Table 6-2.

Surface Water Discharge

A State Pollution Discharge Elimination System (SPDES) permit is required for any new discharge to surface water. Water quality criteria from 6 NYCRR Parts 701-705 would be applied in conjunction with available stream dilution capacity to this discharge. The Cayuga Creek is a Class B stream. The water quality criteria for surface water discharge are presented in Table 6-3.

6.1.3 Media to be Evaluated in this Focused Feasibility Study

6.1.3.1 Groundwater

Based on the analysis of groundwater samples collected from the ten monitoring wells, the concentration of groundwater contaminants appear to be highest in the immediate vicinity of the former burning pit. Groundwater contaminants appear to be migrating in a southerly direction from this source area (in both the overburden and bedrock) toward Cayuga Creek with the prevailing groundwater flow direction. The concentrations of groundwater contaminants appear to decrease to the south with increasing distance from the former burning pit. The groundwater contaminants are generally undetectable in the

Table 6-2

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - IRP SITE 10

POTENTIAL GROUNDWATER ACTION-SPECIFIC ARARs

AIR EMISSIONS

Compound	Toxicity Rating*	ARARs	
		NYSDEC AGCs (ug/m^3)	NYSDEC SGCs (ug/m^3)
Volatiles			
Benzene	H	1.2E-01	30.0
Carbon Tetrachloride	H	7.0E-02	1,300.0
Chloroform	M	23.0	980.0
1,2 Dichlorethylene (cis)	M	1900.0	190,000.0
1,2 Dichloropropane	M	1.5E-01	83,000.0
Tetrachloroethylene	M	7.5E-02	81,000.0
Toluene	L	2000.0	89,000.0
1,1,1 Trichloroethane	L	1000.0	450,000.0
Trichloroethylene	M	4.5E-01	33,000.0
Vinyl chloride	H	2.0E-02	1,300.0

* H=High, M=Moderate, and L=Low.

Table 6-3

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - IRP SITE 10

POTENTIAL GROUNDWATER ACTION-SPECIFIC ARARs FOR SURFACE WATER DISCHARGE

Compound	ARARs
	NYSDEC Class B Standards (mg/L)
Volatiles	
Benzene	0.05
Carbon Tetrachloride	0.05
Chloroform	0.05
1,2 Dichlorethylene (cis)	0.05
1,2 Dichloropropane	0.05
Tetrachloroethylene	0.05
Toluene	0.05
1,1,1 Trichloroethane	0.05
Trichloroethylene	0.05
Vinyl chloride	0.05
Inorganics	
Aluminum (dissolved)	.100
Barium	-
Chloride	-
Chromium (dissolved)	0.51
Copper (dissolved)	0.030**
Fluoride	5.74**
Iron	.300
Lead (dissolved)	.013**
Manganese	-
Nickel (dissolved)	.220**
Sodium	-
Sulfate	-
Total Dissolved Solids	500.000
Zinc (Dissolved)	.03

* 6 NYCRR Section 702.15 for substances that do not have an applicable health (water source) standard in Section 703.5 of this title, a general organic guidance value of 50 ug/l for an individual organic substance shall be used.

** Based on assumed hardness: 300 mg/l as $CaCO_3$

downgradient wells furthest (approximately 150 to 200 feet) from the former burn pit (MW10-D, MW10-E, and MW10-B), with the exception of the detection of 6.81 ug/l of cis-1,2-dichloroethene in MW10-E (see Figures 4-6 and 4-7).

Table 6-4 presents a comparison of the maximum groundwater contaminant concentrations with the ARARs to determine the extent of the contamination. There is no significant difference in the quality of water and areal extent of contamination in overburden and bedrock aquifers based on a comparison of Figures 4-6 and 4-7. In the case of indicator parameters, the average groundwater concentration was calculated from data collected at wells MW10-A through MW10-E. These parameteres are representative of poor water quality in the Lockport Dolomite and are not the result of past hazardous waste handling. The average concentrations in Table 6-4 represent the design influent concentrations for any required groundwater treatment system.

In the groundwater, five volatile organics (benzene, chloroform, cis-1,2-dichloroethylene, trichloroethylene, and vinyl chloride) and five inorganics (iron, lead, manganese, sodium, and zinc), and two indicator parameters (sulfate and total dissolved solids) exceed the ARARs. A TBC for aluminum was also exceeded.

In order to determine if ARARs have been exceeded due to activities at Site 10, organic and inorganic concentrations at monitoring wells MW10-A, MW10-B, MW10-D, and MW10-E were averaged. The average concentration for the five organics of concern are as follows: benzene (ND), chloroform (.35 ug/l), cis-12-dichloroethylene (3.58 ug/l), trichloroethylene (0.27 ug/l), and vinyl chloride (ND). These concentrations are below the corresponding ARARs. The average concentrations for the five inorganics are as follows: iron (18.0 mg/l), lead (.019 mg/l), manganese (.57 mg/l), sodium (15.4 mg/l), and zinc (1.25 mg/l). With the exception of sodium, these inorganics exceed the ARARs. However, for sodium, the concentrations in MW10-B (25.8 mg/l) and MW10-D (26.7 mg/l) exceed the ARAR of 20 mg/l. The average concentration of aluminum in the wells outside the extent of contamination is 16.6 mg/l which exceeds the TBC of 0.2 mg/l. The average total dissolved solids and sulfate concentrations in these wells are 1,835 mg/l and 825 mg/l, respectively. Both of these values exceed ARARs.

In summary, these wells are therefore outside the extent of groundwater contamination , i.e., there is no background or upgradient source of VOCs, and the test burn area appears to be the only source of VOCs for Area 10, with the exception of lead and

Table 6-4
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – IRP SITE 10
COMPARISON OF GROUNDWATER ARARs AND GROUNDWATER CONTAMINATION

Compound	ARARs (mg/L)	Maximum Groundwater Concentration (mg/L)	Average Groundwater Concentration (mg/L)
Volatiles			
Benzene	.0007	.00804	.00134
Carbon Tetrachloride	.005	.00996	.00166
Chloroform	.007	.0426	.0071
1,2 Dichlorethylene (cis)	.005	13.100	4.040
1,2 Dichloropropane	.005	.00317	.00053
Tetrachloroethylene	.005	.00114	.00019
Toluene	.005	.00432	.00072
1,1,1 Trichloroethane	.005	.00173	.00029
Trichloroethylene	.005	20.800	4.433
Vinyl chloride	.002	1.160	.206
Inorganics			
Aluminum	.200*	35.1	10.81
Barium	1.000	.332	.191
Boron	1.000	.074	.027
Chromium	.050	.051	.022
Copper	.200	.098	.034
Iron	.300	58.0	16.5
Lead	.015	.206	.069
Manganese	.300	2.69	1.30
Nickel	.100	.079	0.28
Sodium	20.0	81.1	27.5
Zinc	.300	2.89	.78
Indicator Parameters			
Chloride	250.000	50.6	24.9
Fluoride	1.500	1.32	0.90
Sulfate	250.000	1350	748
Total Dissolved Solids	500.000	2200	1697

* TBC

manganese, inorganic contamination at the site appears to be caused by background water quality.

The average degree of contamination, as shown in Table 6-4, was conservatively determined for treatment evaluation purposes by averaging the contaminant concentrations from monitoring wells MW10-1, MW10-2, MW10-4, MW10-1D, and MW10-C (wells immediately downgradient of Site 10), and MW10-3 (well on the upgradient edge of the burn pit).

6.1.3.2 Soils

Based on the groundwater contamination and the proximity of the pit area over the maximum groundwater contaminant concentration levels, soils in the vicinity of the pit area are considered to be a potential and continuing source of groundwater contamination. Therefore, the soils in and around the pit area are potential media of concern and will be evaluated in this Limited RI/FS effort.

Based on the estimated location of the former burn pit, and the lateral extent of groundwater contaminant and geologic data collected during the RI, the extent of soil contamination can be indirectly inferred. The lateral extent of the area of highest soil contamination in the unsaturated zone can be assumed to encompass the boundaries of the original burn pit indicated in the RI, and possibly extending a short distance in all directions from this area. This would result in a relatively circular area of contamination with a radius of 100 to 150 feet. The vertical extent of this source area of groundwater contamination can be estimated to extend to bedrock interface (at a depth of approximately 10 feet below grade).

6.1.4 Remedial Action Objectives

The development of remedial action objectives is the first step toward developing remedial alternatives for affected site media. The objective of any site remedial action is to protect human health and the environment.

6.1.4.1 Groundwater

Site remedial action objectives have been defined to address the following site-related concerns for the on-site groundwater: 1) ARARs for several organic and inorganic compounds are exceeded in the on-site groundwater; and 2) the potentiometric surface contour maps presented in the RI suggest the horizontal groundwater flow direction is such that the unconsolidated aquifer has the potential to discharge to the Cayuga Creek.

Based on these concerns, the remedial action objectives developed for the on-site groundwater are the following: 1) restore groundwater quality to meet ARARs; and 2) prevent further migration of groundwater contaminants to the Cayuga Creek.

6.1.4.2 Contaminated Soil

While the former burn pit area is accessible to the base personnel and there is a potential for exposure to the soils through dermal contact, incidental ingestion and fugitive dust inhalation routes, the revised risk calculations in Section 5.1.2 indicate that the carcinogenic risk and non-carcinogenic hazard for the soil pathway are both well within the acceptable range. Therefore, prevention of soil contact is not required. The soils remain as a potential and continuing source of groundwater contamination. Based on the data collected to date, the remedial action objective with regard to soils is to prevent continued degradation of groundwater quality by soil contamination.

6.1.5 Determination of Appropriate General Response Actions

The second step of Phase I is to determine appropriate general response actions for site remediation. General response actions are broad categories of activities that, by themselves or in combination with other general response actions, will satisfy the remedial action objectives.

6.1.5.1 General Response Actions for Groundwater Remediation

General response actions that are potentially appropriate for the on-site groundwater at Site 10 are the following:

- No Action
- Limited Action

- Containment
- Collection
- Treatment
- Disposal

6.1.5.2 General Response Actions for Soil Remediation

General response actions that are potentially appropriate for the on-site contaminated soils at Site 10 are the following:

- No Action
- Limited Action
- Containment
- Removal
- Treatment
- Disposal

6.1.6 Identification and Screening of Remedial Technologies

The goal of this step in the FS process is to identify one or more technically feasible remedial technologies for each general response action. These technologies can then be grouped as appropriate to form remedial alternatives meeting the remedial action objectives. The screening criteria employed to eliminate remedial technologies which are not technically suitable for the Site 10 area were based on a consideration of:

- The physical and hydrogeological characteristics of the site;
- The physical and chemical properties of the contaminants of concern in soil and groundwater; and
- Characteristics and technical requirements associated with the available remedial technologies with respect to the site-specific conditions (including effectiveness, useful life, operations and maintenance requirements, performance records, and constructability).

The technology screening process was conducted individually for each of the two media of concern to individually establish the fulfillment of the respective remedial active objectives for both the groundwater and contaminated soil. Results of the technology identification and screening process for the groundwater and contaminated soil media are presented in Tables 6-5 and 6-6, respectively. Tables 6-5 and 6-6 present a brief description of each technology, along with the result of screening, including the reason for elimination where appropriate.

6.1.7 Evaluation of Technology Process Options

Once applicable technologies are identified, technology process options are developed to correspond to the technologies. In this step, the technology process options considered to be implementable (those retained in Tables 6-5 and 6-6) are evaluated in greater detail in order to select one or more process to represent each technology type. Process options are evaluated on the basis of three criteria: effectiveness, implementability, and cost. The primary emphasis is on effectiveness. The criteria are defined as follows:

Effectiveness - Each technology process option is evaluated on effectiveness relative to other process options within the same technology type. The evaluation focuses on three factors:

- The ability of process options to handle estimated volumes of contaminated media and for meeting the remedial action objectives.
- The likely impacts to human health and the environment during the construction and implementation phase of remediation.
- The proven performance and reliability of the technology for remediating the medium of concern under existing site conditions.

Implementability - This criterion encompasses both the technical and administrative feasibility of implementing the technology process option. Emphasis is placed on the following:

- The ability to construct the technology of the site.

TABLE 6-5
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - SITE 10
IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES
GROUNDWATER

GROUNDWATER GENERAL RESPONSE ACTION	GENERAL TECHNOLOGY (1)	SPECIFIC TECHNOLOGY (1)	TECHNOLOGY DESCRIPTION	SCREENING RESULT
CONTAINMENT	CAPS	MULTI MEDIA	Combination of vegetative layer, clay, sand, and synthetic membrane	Potentially applicable
		SINGLE LAYERED	Low permeability soil liner	Eliminated - not as effective as multimedia cap
	SUBSURFACE BARRIERS	SLURRY WALLS	Vertical trench excavated under a slurry	Potentially applicable
		GROUTED BARRIERS	Injection of grout to reduce groundwater flow in formation	Eliminated - difficult to implement and not reliable
		SHEET PILING	Pilings of wood, steel, or concrete	Eliminated - not as effective as other impermeable barriers
		BOTTOM SEALING	Grouting or block displacement to form a horizontal bottom seal	Eliminated - difficult to seal within saturated zone
COLLECTION	EXTRACTION WELLS	EXTRACTION WELLS	Pumping wells to extract groundwater	Potentially applicable
		EXTRACTION/ INJECTION	Pumping wells to extract with injection wells for flushing	Eliminated - due to complexity of bedrock aquifer
	SUBSURFACE DRAINS	SUBSURFACE DRAINS	Subsurface drains installed arround the perimeter	Potentially applicable

Note:

(1) Shading indicates that a technology has been eliminated in the screening process.

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TABLE 6–5
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES
GROUNDWATER

GROUNDWATER GENERAL RESPONSE ACTION	GENERAL TECHNOLOGY (1)	SPECIFIC TECHNOLOGY (1)	TECHNOLOGY DESCRIPTION	SCREENING RESULT
DISCHARGE	ON-SITE DISCHARGE	TO SURFACE WATER	Discharge untreated groundwater to surface water bodies on-site	Eliminated - will not meet ARARs
	OFF-SITE DISCHARGE	OFF-SITE TREATMENT	Transport and treat contaminated groundwater at off-site facility	Eliminated - the cost of off-site treatment is prohibitive
		TO POTW	Discharge untreated groundwater to POTW	Eliminated - will not meet ARARs
		TO SURFACE WATER	Discharge untreated groundwater to off-site surface water	Eliminated - will not meet ARARs
TREATMENT DISCHARGE	BIOLOGICAL	AEROBIC	Transformation of organics via aerobic microorganisms	Eliminated - unproven for chlorinated organics
		ANAEROBIC	Transformation of organics via anaerobic microorganisms	Eliminated - not cost effective for low strength waste
	PHYSICAL	AIR STRIPPING	Removal of VOCs in groundwater by transfer to gaseous phase	Potentially applicable
		STEAM STRIPPING	Removal of VOCs by steam	Eliminated - no technological advantage relative to air stripping.
		CARBON ADSORPTION	Adsorption of VOCs onto activated carbon	Eliminated - absorbtion of Vinyl chloride and Benzene is not effective
		MEMBRANES	Concentration of organic and inorganic species by reverse osmosis or ultrafiltration	Eliminated - due to the complex nature of the technology without advantage

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Note:

(1) Shading indicates that a technology has been eliminated in the screening process.

TABLE 6–5
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES
GROUNDWATER

GROUNDWATER GENERAL RESPONSE ACTION	GENERAL TECHNOLOGY (1)	SPECIFIC TECHNOLOGY (1)	TECHNOLOGY DESCRIPTION	SCREENING RESULT
	CHEMICAL	OXIDATION	Destruction of organics by oxidation using ozone/UV or ozone/peroxide	Potentially applicable
		PRECIPITATION	Alteration of chemical equilibria to reduce solubility of metals	Potentially applicable as pretreatment for metals removal
	ON-SITE DISCHARGE	SURFACE WATER	Discharge treated groundwater to surface water bodies on-site	Potentially applicable
	OFF-SITE DISCHARGE	POTW	Discharge treated groundwater to POTW	Potentially applicable
		SURFACE WATER	Discharge treated groundwater to off-site surface water	Eliminated – no advantage over on-site discharge
IN-SITU TREATMENT	BIO-RECLAMATION	AEROBIC	In-situ stimulation and enhancement of aerobic degradative processes	Eliminated – low permeability soils/ unproven for chlorinated organics
		ANAEROBIC	In-situ stimulation and enhancement of anaerobic degradative processes	Eliminated – not proven technology

Note:

(1) Shading indicates that a technology has been eliminated in the screening process.

TABLE 6-6
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES
SOIL

SOIL/WASTE GENERAL RESPONSE ACTION	GENERAL TECHNOLOGY	SPECIFIC TECHNOLOGY	TECHNOLOGY DESCRIPTION	SCREENING RESULT
CONTAINMENT	CAPS	MULTI MEDIA	Combination of vegetative layer, sand, and synthetic membrane	Potentially applicable
		SINGLE LAYERED	Low permeability soil liner	Eliminated – not as effective as multi-media cap
	SUBSURFACE BARRIERS	SLURRY WALLS	Vertical trench excavated under a slurry	Potentially applicable
		GROUTED BARRIERS	Injection of grout to reduce groundwater flow in formation	Eliminated – difficult to implement and not reliable
		SHEET PILING	Pilings of wood, steel, or concrete	Eliminated – not as effective as other impermeable barriers
		BOTTOM SEALING	Grouting or block displacement to form a horizontal bottom seal	Eliminated – difficult to seal within saturated zone
EXCAVATION/ DISPOSAL		EXCAVATION	Excavate unconsolidated overburden including the unsaturated zone	Potentially applicable
		DISPOSAL	Dispose soils (including contaminated porewaters) in treatment and disposal facility	Potentially applicable

NOTE:

(1) Shading indicates that a technology has been eliminated in the screening process.

TABLE 6-6

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS – SITE 10

IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

SOIL

SOIL/WASTE GENERAL RESPONSE ACTION	GENERAL TECHNOLOGY	SPECIFIC TECHNOLOGY	TECHNOLOGY DESCRIPTION	SCREENING RESULT
REMOVAL/ON-SITE TREATMENT	REMOVAL	EXCAVATION	Excavate unconsolidated overburden including the unsaturated zone	Potentially applicable
	THERMAL	ON-SITE INCINERATION	Destruction of organics by oxidation using on-site rotary kiln	Eliminated - not practical for Site 10 due to expected low waste volume
		OFF-SITE INCINERATION	Destruction of organics by oxidation using off-site rotary kiln	Potentially applicable
		THERMAL DESORPTION	Removal of VOCs and semi-VOCs by oxidation at a lower temperature	Eliminated - off-site facilities not available
	PHYSICAL/ CHEMICAL	STABILIZATION/ SOLIDIFICATION	Stabilization of contaminants by chemical reagents	Eliminated - not practical for Site 10 due to complex mixture of contaminants
		SOIL WASHING	Mobilization and extraction of contamination	Potentially applicable
		VACUUM EXTRACTION	Removal of VOCs and semi-VOCs by transfer of gaseous phase	Eliminated - not effective due to low permeability of overburden
IN-SITU TREATMENT	BIO RECLAMATION	AEROBIC	In-situ stimulation and enhancement of aerobic degradation process	Eliminated - low permeability soils/ unproven for chlorinated organics
		ANAEROBIC	In-situ stimulation and enhancement of anaerobic degradation process	Eliminated - not proven technology
	PHYSICAL/ CHEMICAL	STABILIZATION/ SOLIDIFICATION	Stabilization of contaminants by chemical reagents	Eliminated - not practical for VOCs
		SOIL FLUSING	Mobilization and extraction of contamination	Eliminated - not effective due to low permeability and heterogenuity of soils
		VACUUM EXTRACTION	Removal of VOC and semi-VOC by transfer of gaseous phase	Eliminated - not effective due to low permeability of overburden

NOTE:

(1) Shading indicates that a technology has been eliminated in the screening process.

- The ability to obtain necessary permits for any off-site action.
- The availability (including capacity) of treatment, storage and disposal services, where applicable.
- The availability of necessary equipment and skilled workers to implement the technology.

Cost - At this stage of the evaluation, costs are developed on a relative and qualitative basis as "low", "moderate", or "high". Detailed cost estimates are not generated for each technology. Relative capital and operation and maintenance (O&M) costs, based on engineering judgement, are used to compare technology process options within the same technology type. The cost criterion plays only a limited role in the screening of technologies at this stage in the FS.

The following subsections present the evaluations of the technology process options for groundwater and soil.

6.1.7.1 Groundwater Technology Process Options

•Containment

•Multi-Media Cap

Description - Capping involves the installation of an impermeable barrier over the contaminated soil to restrict access and reduce infiltration of precipitation into the soil.

Cap materials can either be natural or synthetic. Commonly used materials include low permeability clay, such as bentonite; and synthetic membranes such as high density polyethylene (HPDE) and polyvinyl chloride (PVC) membranes. A typical multi-media cap consists of 6 inches of compacted subgrade, a 40 mil very low density polyethylene (VLDPE) geomembrane as an impermeable barrier, 24 inches of protective cover, and 6 inches of soil which would support vegetation.

Caps must be designed and constructed to provide long-term minimization of migration of liquids through the closed site, function with minimum maintenance, promote drainage and minimize erosion of the cover, accommodate settling and subsidence to maintain the cover's integrity, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils.

Effectiveness - Capping provides an effective means of controlling the mobility of contaminants from the vadose zone to the groundwater. The cap would aid in meeting a remedial action objective by effectively eliminating the mobility of contaminants into the groundwater. However, capping alone will not eliminate further migration of contaminants from the source area (test burn area).

Implementability - Capping is readily implementable at this site. The equipment and resources are readily available for the capping option.

Cost - The capital costs are moderate for a media-media cap. O&M costs would be relatively low.

Screening - Capping could be effective in reducing the migration of contaminants from the contaminated soil in the unsaturated zone to the groundwater and is therefore retained for incorporation into the remedial response alternatives.

- ***Slurry Wall***

Description - A slurry wall barrier is often used, either alone or in conjunction with a low permeability cap, to minimize groundwater flow into and/or out of a contaminated area. Thus, slurry walls could be used to minimize groundwater inflow to the site and/or contaminated groundwater discharge from the site.

A slurry wall is constructed in a vertical trench that is excavated under slurry and then backfilled with impermeable material. This slurry, which usually consists of a mixture of water and bentonite or cement-bentonite, acts essentially like a drilling fluid. It hydraulically shores the trench to prevent collapse and simultaneously forms a filter cake on the trench walls to prevent high fluid losses into the surrounding soil.

Effectiveness - A slurry wall could be used to reduce further contaminant migration in the on-site overburden aquifer but not the bedrock aquifer. Because a slurry wall would only be keyed into the top of bedrock, containment of bedrock groundwater would not be achieved. No adverse impacts to human health and the environment would result during implementation of this option.

Implementability - Slurry wall construction is relatively straightforward and the necessary equipment and skilled labor required to construct such a wall are readily available. The site poses no obvious difficulties for slurry wall construction. Any soils excavated during construction would require proper treatment/disposal.

Cost - Capital costs for installation of a slurry wall around the contaminated soils of the burning area would be moderate. O&M costs would be low to moderate depending on the extent of monitoring required.

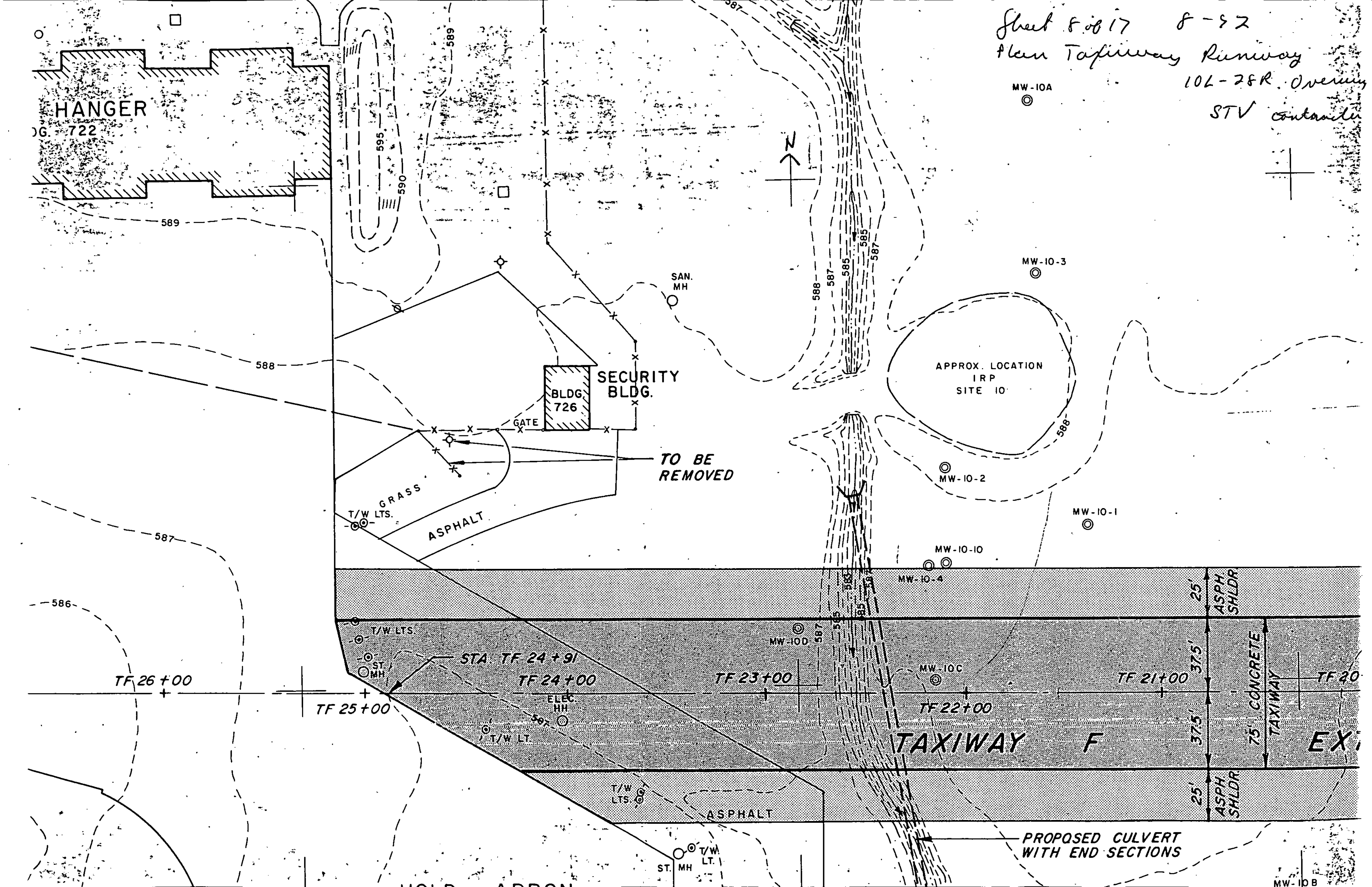
Screening - Slurry walls could be effective in reducing/diverting the flow of groundwater at the site and are therefore retained for incorporation into the remedial alternatives.

- ***Collection***
    - ***Extraction Wells***

Description - Construction of an extraction well system involves drilling the well hole, installing the casing, grouting and sealing the annular space, installing well screens, fittings, graded filter material and gravel pack, installing pump systems and developing the wells.

Effectiveness - Extraction wells are the standard technology for long-term groundwater collection from depths where interceptor trenches are of low feasibility. The recovered groundwater would require treatment prior to off-site discharge. There would be minimal adverse impacts to human health or the environment expected in the short-term with the installation of extraction wells.

Sheet 8 of 17   8-92
Plan Taxiway Runway
10L-28R Overrun
STV contractor



#2

- On-site — EXISTING PERMIT
6 lb/day TTO

Frank Nerone

- discharge off-site 1 lb/day
- whole permit ~~for~~ off-site discharge

- Price 1000 gallons

Lift ticket

lb/day - TCE .15
1.2 Dichlo .4
meth Chlor. 0.5
Vinyl Chlo .4

2000 ppm

surveilance of other contaminants

- 100,000 gall/day max

- Timing - June 91 → agreed 1st permit Feb 92
- Pricing $1.43 /1000 gallons

- un NCSO #1 Frank Nerone

3 MAIN USERS
- Bell &
- Carborundum
- AKC

Extraction wells have several possible modes of failure: well failure, pump failure, and power failure. Well failure can occur through the clogging and corrosion of gravel packs or the breakage or blocking of well screens. Well failure is a slow, progressive process that can be remedied without seriously sacrificing the performance of the system. Pump and power failure usually occur without warning. The impact of pump failure can be minimized by providing a spare pump. Power failure does not pose a serious threat to the performance of the groundwater recovery system, since these failures can generally be rectified in a short period of time.

As indicated in Appendix F, the required groundwater extraction system consists of a single bedrock pumping well. The estimated hydraulic conductivity is 1.00 x 10^{-3} cm/sec for the bedrock aquifer. Since extraction wells are applicable for hydraulic conductivities greater than 1 x 10^{-6} cm/sec, extraction wells will be effective for this site. - in Bedrock

Implementability - Extraction wells are readily implementable at this site. The materials and labor needed for well installation are readily available. Cuttings from well installation would require proper disposal.

Cost - The capital cost for a well extraction system would be moderate. O&M costs would be low to moderate.

Screening - Extraction wells are a proven technology for groundwater removal. Therefore, this option is retained for further evaluation.

- ***Perimeter Drains/Trench Drains***

Description - Trench drains are constructed by excavating a trench into the stratum of concern, several feet below the ground water table, placing a perforated drainage pipe encapsulated in filter fabric near the bottom of the trench, surrounding the pipe with several feet of crushed stone or gravel, and backfilling the remainder of the trench with soil. The permeable materials surrounding the pipe create a passive drainage path, allowing the water to flow into it. The passive trench drain system ties into regularly spaced sumps that are used to pump water from the system.

Trench drains can be used both to collect uncontaminated groundwater from upgradient of the site, to reduce flow volume through the contaminated zone, and to remove contaminated groundwater for treatment.

Effectiveness - Trench drains have the advantage of being able to encompass large capture zones. In addition, the installation of a highly impermeable barrier on the downgradient wall of the trench can minimize migration of site-related chemical constituents past the trench. However, trenches are relatively inflexible and may be difficult to locate at sites where many physical constraints exist. There could be minimal short-term impacts to human health and the environment during construction due to exposure to contaminated groundwater and soils. Soils excavated during trench installation would require proper disposal.

Implementability - The construction of trench drains is relatively straightforward and requires readily available equipment and labor. The site does not have the physical constraints (underground tanks, buried utilities, roads, buildings) that would affect the implementability of trenches.

Trench soil disposal will not adversely impact implementation of this collection technology.

Cost - In general, moderate capital costs and low O&M costs are associated with a trench drain system.

Screening - Because of the effectiveness for collecting groundwater over a large area, perimeter/trench drains are retained for incorporation in the remedial response alternatives.

- ***Groundwater Treatment***
  - ***Air Stripping***

Description - Air stripping is a mass transfer process in which volatile contaminants in the liquid phase are transferred into the gaseous phase. Air stripping of contaminated groundwater is governed by the equilibrium relationship of Henry's law. Henry's law states that the partial pressure of a gas or volatile compound in the air above a dilute aqueous solution is directly proportional to its concentration in the solution. Mathematically,

$$P_a = (H_a)(X_a)$$

Where:

P_a = partial pressure of compound A in air (atmospheres)
Ha = Henry's law constant for compound A (atmospheres)
X_a = mole fraction of A in solution, dimensionless

Two general types of air strippers are employed in treating groundwater for volatile organics: packed towers and shallow trays. Because the capital cost of the shallow tray systems is significantly higher than that of the packed tower systems and O&M costs are comparable, only the packed tower will be evaluated. Transfer of volatile organics from water to air is most efficiently accomplished in a packed tower, with countercurrent flow of air and water. This configuration provides a high level of turbulence and a very large surface area for mass transfer. A packed-tower air stripper consists of the tower shell, packing material, tower internals including the liquid distributor and redistributor, packing support plates, and demister pad; pumps and piping for the water; and a blower to provide air to the base of the tower. Typical construction materials for the tower shell are fiber-reinforced plastic, aluminum, coated carbon steel, and stainless steel. Various types of plastic packing are available in a range of sizes and shapes. Various new plastic packing have been designed with open structures and many edges or points to minimize pressure drop while increasing the wetted surface area available for air/water contact and mass transfer. Feed distributors maintain uniform evenly distributed flow of the water throughout the packed tower, which is critical to efficient operation.

Effectiveness - Air stripping is used to remove dissolved volatile organic compounds from contaminated groundwater and is most effective on compounds with Henry's Law constants greater than 1.0×10^{-4} atmospheres-cubic meters/mole. Following are the Henry's Law constants (atmospheres-cubic meter/mole in solution at 20°C) for the selected contaminants of concern at this site:

Benzene	4.40×10^{-3}
Carbon Tetrachloride	2.14×10^{-2}
Chloroform	3.33×10^{-3}
cis-1,2-Dichloroethylene	2.97×10^{-3}
1,2 Dichloropropane	2.23×10^{-3}
Tetrachloroethylene	1.30×10^{-2}
Toluene	5.19×10^{-3}
1,1,1-Trichloroethane	1.32×10^{-2}
Trichloroethylene	7.64×10^{-3}
Vinyl chloride	2.18×10^{-2}

These values indicate that air stripping is a well suited and effective method for removal of these contaminants of concern found at the site.

Practical feed concentrations are limited to about 100 mg/l total organics. In this application, using the design concentration for each contaminant, the total toxic organics in the feed would be approximately 10 mg/l. A properly designed and operated packed-tower air stripper can achieve greater than 99 percent removal of volatile organics from water.

Implementation of this technology should not have an adverse health impact.

Implementability - The materials and labor needed to install an air stripper are readily available. Prior to the waste stream entering the air stripper, pre-treatment measures should be considered. These measures include: 1) removal of suspended solids; and 2) removal of dissolved metals (iron, manganese, calcium and magnesium). Although suspended solids were not analyzed in the RI, a comparison of total and soluble metals concentrations indicates that TSS concentrations are in excess of 30 to 190 mg/l. Suspended solids concentrations to the packed tower should be less than 5 to 10 mg/l. Residuals from an air stripping process include the treated water and contaminated off-gas. Treatment of the off-gas may, if required to meet regulatory requirements, may be accomplished through utilization of vapor phase carbon or fume incineration. ✓

The packed tower is a well understood technology. There is a considerable theoretic foundation established for the system which has been widely used in the process industry. There are alternative configurations available which could be considered in the final design.

Cost - The cost for installing an air stripper is low, but overall system costs will be moderate if air emission controls are required. The O&M cost is generally low and depends on the frequency of packing replacement. Again, off-gas treatment increases the O&M costs to moderate or high levels.

Screening - This option is applicable to the treatment of volatile organic compounds in the groundwater and is therefore retained for further evaluation.

- ***Chemical Oxidation***

Description - Liquid phase chemical oxidation is a process in which the oxidation state of a substance is increased, and involves the loss of electrons by the (oxidized) compound. Oxidizing agents most often supply oxygen during the oxidation process, however other electron acceptors can be utilized. Some of the most effective oxidants (also known as reducing agents which donate electrons) include: fluorine, hydroxyl radical, ozone and hydrogen peroxide.

With the exception of fluorine, hydroxyl radicals have the highest oxidation potential of any of the commonly used oxidants. When either hydrogen peroxide (H_2O_2) or ozone is catalyzed with ultraviolet light (UV) at wavelengths in the range of 260 to 400 nm, hydroxyl radicals are formed which then react with the organic contaminant. One molecule of H_2O_2 under UV radiation converts to two hydroxyl radicals. One molecule of ozone under UV light converts to one hydroxyl radical. Certain metal ions can yield hydroxyl radical(s); however, they have limitations due to organic complexing of the metal ions and poor oxidation efficiency at low organic concentrations.

Neither H_2O_2 nor ozone contain metals or halogens which can lead to undesirable by-products during the organic oxidation process. H_2O_2 has certain inherent advantages over ozone. H_2O_2 is supplied commercially as an easily handled liquid which has infinite solubility in water. Ozone is a toxic gas with limited water solubility. The water solubility of H_2O_2 simplifies the reactor design, in terms of oxidant addition, mixing of the reactants, and elimination of fugitive toxic gases. Typically, H_2O_2 storage and feed systems are relatively inexpensive compared to ozone generation and feed equipment. For these reasons, only the UV/H_2O_2 process will be considered.

The equipment used in UV/H_2O_2 oxidation consists of two modules; an H_2O_2 storage and feed system and a UV reactor. Materials of construction for tank piping and fittings and an accurate metering pump, must be carefully selected. High purity aluminum, stainless steel and certain plastics such as teflon can be used. A smaller system storage tank could also be constructed from a special stabilized grade of high density polyethylene.

The UV reactor is stainless steel and both gravity and pressurized designs can be used. Recycle of the process water can be provided and adjusted to the desired rate to ensure turbulent flow in the reactor. Mercury vapor UV lamps from 25 to 10,000 watts can be employed. The most common, commercially available UV reactor designs are plug flow and complete mix reactors. Plug flow reactors typically have evenly spaced lamps and are usually operated by gravity or at very low pressures. The absence of turbulence in this design requires that turbidity and suspended solids be removed before the reactor.

Reactors of the complete mix type are usually pressurized but can flow by gravity. The aqueous waste stream surrounds the UV lamps which are placed inside a transparent sleeve, typically made of quartz or special grades of teflon. Moderate levels of turbidity or suspended solids can be tolerated in this type of design due to the turbulent flow pattern.

Effectiveness - UV light catalyzed H_2O_2 process has been demonstrated to be effective for the destruction of many VOCs. There are no toxic by-products of UV/H_2O_2 oxidation. Typically there are no off-gases produced by this process which require further treatment. Due to the low level of chlorinated VOCs detected in site groundwater, concentrations of chlorine in the effluent as chloride and/or hydrochloric acid, would be minimal. Based on the concentrations of 4.040 mg/l cis-1,2-dichloroethylene, 4.433 mg/l trichloroethylene, and 0.206 mg/l vinyl chloride, the chloride concentration would only increase by 7 mg/l. The average chloride concentration in wells MW10-A to MW10-E is 24.9 mg/l, and an additional 7 mg/l will not elevate the concentration over the 250 mg/l 6 NYCRR Part 703 limit. UV/H_2O_2 oxidation can be used in conjunction with other treatment processes, and can be used alone where the water contains only low to moderate levels of toxic organic compounds and little else. The process would be designed for destruction of organics to below detection limits.

The major parameters to consider in designing UV reactors for chemical oxidation are: concentration of pollutants, type of pollutants, UV absorption of waste and treatment objective. The compounds of concern are benzene, cis-1,2-dichloroethylene (DCE), trichloroethylene (TCE), and vinyl chloride (VC). DCE, TCE, and VC are readily oxidized. A bench scale study would be required to determine the specific removal rates achievable for the site's groundwater, any pretreatment requirements, and estimated O&M costs (chemical and electrical requirements).

Implementability - The equipment, chemicals and services needed to implement this process are readily available. ARARs for discharge of treated water would have to be met. The treatment system cannot handle turbid water. As indicated in Table 4-5, the groundwater from the monitoring wells is cloudy. Therefore, pretreatment for metals/solids would be required to prevent fouling of the unit and meet discharge standards. Site features or other related factors should not adversely impact the implementation of this technology.

Cost – The capital costs for installing a chemical oxidation system are moderate. Moderate to high O&M costs are associated with this option.

Screening – This option is potentially applicable for groundwater treatment. However, the capital and O&M costs for this treatment option are significantly higher than for air stripping at this fairly low flow rate. This might not be the case if air emission controls were required for air stripping. However, Section 6.1.7.1 – Polishing Treatment for Off-Gases indicates that such treatment is not anticipated at this time. Therefore, chemical oxidation is not retained for further evaluation.

- ***Chemical Precipitation***

Description – The groundwater sampling results indicate that the metals which are in excess of the ARARs for surface water discharge are aluminum, copper, iron, and zinc. The average concentrations of these metals are 1.81 mg/l (soluble), 0.034 mg/l (solute), and 0.78 mg/l (soluble), respectively. The governing water quality standard for each of the metals is 0.1, .030, 0.3, .03 mg/L, respectively, based on 6 NYCRR Chapter X, Part 703.

Not only is the iron concentration greater than the water quality standards, but the presence of this metal can cause operational problems with the packed tower for air stripping. The majority of the iron present in the groundwater is in the ferrous form (Fe^{2+}). Iron in this form is highly soluble in water making it difficult to remove by sedimentation or filtration. Aeration processes, such as the packed tower air stripper create oxidizing conditions converting iron to the less soluble ferric form (Fe^{3+}). In order to remove iron, prior to the air stripper or chemical oxidation, it can be oxidized and precipitated.

The principle mechanism of precipitation involves the lowering of the solubility of a metallic constituent by the addition of an alkaline reagent. The first unit process in this operation is the pH control system which raises groundwater pH to a level to precipitate the contaminant (approximately 9 to 10). The pH control system includes a precipitation reactor (tank, mixer, and pH control instrumentation) and chemical feed system (storage tanks and metering pumps). Sodium hydroxide will be used rather than lime due to the problems associated with calcium precipitation in the air stripper. Following the precipitation reactor, the groundwater enters a clarifier where solids are allowed to settle out. A polymer is sometimes added to allow the solids to agglomerate and improve the settling characteristics. Because the air stripping system requires suspended total solids concentrations less than 5 to 10 mg/l, the effluent from the settling tanks is passed through a sand filter. The filtered water is neutralized by the addition of sulfuric or hydrochloric acid prior to passing it through the air stripper. The solids in the clarifier underflow are discharged to a sludge holding tank for subsequent de-watering before off-site disposal.

Effectiveness - Chemical precipitation is an effective and reliable conventional technology for metals removal to fractional parts-per-million levels. Chemical precipitation has been successfully used for removing heavy metals and other inorganics from water but is not suitable for organics removal. The process is limited by the fact that not all metals have a common optimum pH at which they precipitate. Chelating and complexing agents can interfere with the precipitation process, but laboratory-scale testing can be used to optimize the full-scale process.

Implementability - The materials and labor needed for proper installation of this process are readily available. Chemical precipitation could meet the remedial action objectives for metals/solids removal in the groundwater, either alone or in combination with a polishing treatment such as filtration. Sludge generated in this process would require proper handling and disposal. When the treatment vessels are covered to prevent volatile emissions, there are no adverse impacts to human health and the environment during remedy implementation.

Cost - The capital cost for implementing this process option is generally moderate. The costs for chemicals, sludge disposal, labor, and maintenance result in moderate O&M costs.

Screening – Chemical precipitation is effective in removing metals and suspended solids from groundwater (pretreatment required for both the air stripper and chemical oxidation systems). Chemical precipitation is retained for further consideration in the overall groundwater treatment train.

Polishing Treatment for Off-Gases

The New York State Air Guide-1 provides a method for determining ambient impact both long- and short-term. It calculates the maximum potential annual impact, using the following equation:

$$Cp\ (ug/m^3) = \frac{4218Q}{h^{2.16}}$$

where Q is the hourly emission rate (lbs/hr) and h is the stack height (ft). The maximum short-term impact, C_{st}, from the point source is determined using the equation below:

$$C_{st}\ (ug/m^3) = 420Cp$$

Table 6-7 provides the maximum potential annual impact, the annual guideline concentration, the maximum short-term impact, and the short-term guideline concentration for each contaminant. The values are based on the average contaminant concentrations determined in Section 6.1.3.1. For the purposes of this calculation, a packed towner height of 30 feet was assumed.

The following observations can be made from the table. The maximum hourly emission for all of the compounds is well below 0.1 lb/hr. This is of primary importance with respect to benzene, chloroform, and vinyl chloride which are the only high toxicity contaminants being discharged to the atmosphere. The emission rates for benzene, carbon tetrachloride and vinyl chloride are 6.7×10^{-6}, 8.3×10^{-6}, and 1.0×10^{-3} lb/hr, respectively. Additionally, it can be seen that for all of the compounds the maximum potential annual impact is lower than the AGC and the maximum short term impact is lower than the SGC for all contaminants. Based on this analysis and present regulations, it is anticipated that vapor phase treatment will not be required for the off-gas from the air stripper. Therefore,

Table 6-7

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS - IRP SITE 10

AIR EMISSIONS ANALYSIS

Compound	Hourly Emisison Rate (lb/hr)	Maximum Annual Impact (ug/m^3)	NYSDEC AGCs (ug/m^3)	Maximum Short-Term Impact (ug/m^3)	NYSDEC SGCs (ug/m^3)
Volatiles					
Benzene	5.7E-06	1.8E-05	1.2E-01	7.7E-03	30.0
Carbon Tetrachloride	8.3E-06	2.3E-05	7.0E-02	9.5E-02	1,300.0
Chloroform	3.6E-05	9.7E-05	23.0	4.1E-01	980.0
1,2 Dichlorethylene (cis)	2.0E-02	5.5E-02	1,900.0	23.1	190,000.0
1,2 Dichloropropane	2.7E-06	7.2E-06	1.5E-01	3.0E-03	83,000.0
Tetrachloroethylene	9.5E-07	2.6E-06	7.5E-02	1.1E-03	81,000.0
Toluene	3.6E-06	9.8E-06	2,000.0	4.1E-03	89,000.0
1,1,1 Trichloroethane	1.5E-06	3.9E-06	1,000.0	1.7E-03	450,000.0
Trichloroethylene	2,2E-02	6.0E-02	4.5E-01	25.3	33,000.0
Vinyl chloride	1.0E-03	2.8E-03	2.0E-02	1.2	1,300.0

vapor phase treatment will not be retained for further evaluation. This is still subject to regulatory review.

6.1.7.2 Soil Technology Process Options

- ***Containment***

Multi-media cap and slurry wall technologies have been evaluated in Section 6.1.7.1.

- ***Removal***
  - ***Excavation***

Description - The excavation of the unconsolidated overburden, including the unsaturated zone, for disposal or treatment.

Effectiveness - The excavation of the contaminated soils would effectively prevent continued degradation of groundwater quality by removing the source. The soils in the saturated zone would be addressed by groundwater recovery and treatment.

Implementability - The major challenge to excavation is controlling the release of contaminated particulates and VOCs into the atmosphere during excavation. Measures to prevent the release of contaminants into the air include covering of the exposed contaminated soils, and suppression of dust through spraying with water and/or a chemical suppressant during dry weather periods. Proper respitory and dermal protection would be required for site workers.

The normal limit of excavation equipment is approximately 15 feet. The excavation of the unsaturated soils is to a depth of 5 feet. Therefore, excavation is implementable.

Cost - The cost of excavation is low to moderate, depending on the depth of excavation.

Screening - Excavation will effectively remove the source of continued groundwater contamination and can be implemented without special methods. Therefore, it is retained for incorporation into the remedial response alternatives.

- ***Treatment***
    - ***Off-Site Incineration***

Description - In high temperature incineration, the organic material in the soil is oxidized into combustion products of carbon dioxide, hydrogen chloride, and water. The most widely used thermal treatment technology is the rotary kiln incinerator.

Effectiveness - Thermal treatment is capable of destroying all of the organic compounds found in the contaminated soil at Site 10. The technology would permanently remove the toxicity of the soil.

Implementability - Soil processing by fixed-based facilities involves only the rotary kiln process option. Off-site rotary kilns are readily available. This project involves only 1,500 cubic yards of contaminated soil, so that the cost, scheduling, and availability of trucks will not be a problem. There are no permitting issues which would limit the implementability of this technology.

Cost - Thermal treatment costs are highly site-specific. Variables affecting cost includes quantities of soil, heat content, debris content, and moisture. Costs for incineration are high.

Screening - Off-site incineration will permanently treat the contaminants in the soil from Site 10 and rotary kiln incinerators which accept contaminated soil are readily available. Therefore, off-site incineration will be retained for incorporation into the remedial response alternatives.

- ***Soil Washing***

Description - Soil washing is a volume reduction method for treating excavated soils. It is based on the principal that the contaminants are associated primarily with soil components finer than 200 mesh, (including fine silts, clays, and soil organic matter). Excavated soils are screened to remove oversize debris greater than one-inch in diameter. Once the debris is removed, the contaminated soil is fed to the soil washing system, where it is slurried with water. It is screened again and fed to froth flotation where hydrophobic components (oil, clay minerals) are removed in the froth phase. The soil slurry then enters a multi-stage, countercurrent, attrition/classification circuit consisting of attrition scrubbing units, hydrocyclones and spiral classifiers. The bulk of the soil is then discharged as the washed product (treated sand). The system has two residuals, process water and contaminated silt/clay.

Effectiveness - A number of bench-scale and full-scale tests of soil washing have been performed on soils contaminated with VOCs, PCBs, oil and grease, phenols, and aromatics. Soil washing fractionates the coarse soils from the fine-grained soils, and the contaminants normally cannot be removed from the fine-grained fraction. Since the majority of the contaminated soils at Site 10 are fine-grained silts and clays, soil washing would not be expected to be an effective means of reducing the volume of contaminated soils. The effectiveness of soil washing for treating the contaminated soils at the burn pit area would have to be determined through a treatability study.

Implementability - A processing area (solvent wash area) would be needed where the soil is treated and the solution containing the contaminants is treated and recycled for reuse (groundwater treatment plant). The treated soil may be used to backfill the excavated area. Since there is the possibility that there may be some residual contamination in the soil following treatment, the Land Disposal Restrictions for certain RCRA hazardous wastes would need to be evaluated.

Cost - The costs associated with soil washing are moderate.

Screening - Although significant volume reduction is not anticipated due to soil conditions at Site 10, soil washing will be retained for incorporation into the remedial response alternatives because it provides a significant cost savings compared to off-site incineration.

6.1.8 Selection of Representative Remedial Technologies

In this step of the FS process, at least one representative process option is selected for each appropriate technology type that has been retained for further evaluation. This is done to simplify the subsequent development and evaluation of alternatives without limiting the flexibility during the remedial design phase.

The selection of representative remedial technologies is based on the evaluations conducted in Section 6.1.7. The technologies retained for further consideration are listed below.

6.1.8.1 Groundwater

No Action - Selected for baseline comparison.

Limited Actions - Deed restrictions, fencing and monitoring.

Containment - Multi-media cap and slurry wall were selected to represent options for reducing/diverting the flow of groundwater into and/or out of the contaminated area.

Collection - Pumping wells and perimeter drains were selected to represent options for removing contaminated groundwater and help contain groundwater contaminants within the site boundaries.

Treatment - Chemical precipitation was selected as the representative treatment for metals/solids removal. Air stripping was selected to represent treatment processes for the organic constituents in the on-site groundwater.

Disposal - Direct discharge to the Cayuga Creek was selected to represent the feasible disposal options for treated groundwater.

6.1.8.2 Soils

No Action - Selected for baseline comparison.

Limited Action - Deed restrictions and fencing were selected to represent the limited actions which reduce exposure to the contaminated soil.

Containment - Multi-media cap and slurry wall were selected to represent options for restricting the migration of contaminants from the soil to the groundwater.

Removal - Excavation is the only method for removing the soils for off-site or on-site treatment.

Treatment - Off-site incineration and soil washing were selected to represent the treatment processes for the organic contaminants in the soil.

Disposal - Off-site landfill was selected to represent the options for disposal of excavated soil.

6.2 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES (PHASE II)

6.2.1 Introduction

6.2.1.1 Development of Remedial Alternatives

In accordance with USEPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies" (October 1988), the general types of remedial alternatives to be considered in the FS process for hazardous waste sites include:

- No action
- Limited actions
- Minimization or elimination of further contamination by source control (e.g., containment, removal, and disposal)
- Management of migration (e.g., containment, collection, treatment, and discharge)

Based on the remedial action objectives and general response actions presented in Section 6.1, seven remedial alternatives were developed using technologies that passed the technical screening process (see Tables 6-4 and 6-5). With the exception of the No Action Alternative (Alternative 1), each remedial alternative includes a group of the technologies and/or other actions identified in Tables 6-4 and 6-5 that were combined in order to best achieve the remedial objectives presented in Section 6.1.2. The seven alternatives are outlined in Table 6-8 and described in more detail in Sections 6.2.2 through 6.2.8. A general description of the alternatives is given below:

Alternative 1 - No Action with Monitoring

Alternative 2 - Limited Action

TABLE 6-8

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS – SITE 10

DEVELOPMENT OF REMEDIAL ALTERNATIVES

NO ACTION LIMITED ACTION CAP ONLY

UNIT DESCRIPTION	TECHNOLOGY	ALTERNATIVES 1	2	3A	3B	4A	4B	5
MONITORING	GROUNDWATER	●	●	●	●	●	●	●
ADMINISTRATIVE	DEED RESTRICTION		●	●	●	●	●	●
	FENCING		●	●	●			
CONTAINMENT CAP	FLEXIBLE MEMBRANE LINER			●	●			
BARRIER	PERIMETER SLURRY WALL				●			
GW COLLECTION	PERIMETER GW COLLECTION			●	●			
	OVERBURDEN GW COLLECTION			●	●	●	●	●
	BEDROCK GW COLLECTION			●	●	●	●	●
GW TREATMENT ON-SITE	AIR STRIPPING			●	●	●	●	●
GW PRE-TREAT ON SITE	CHEMICAL PRECIPITATION			●	●	●	●	●
GW DISPOSAL	ON-SITE SURFACE WATER			●	●	●	●	●
SOIL REMOVAL	EXCAVATION					●	●	●
SOIL TREATMENT	INCINERATION (OFF-SITE)						●	
	SOIL WASHING (ON-SITE)							●
SOIL DISPOSAL	OFF-SITE LANDFILL					●		
BACKFILL	EXISTING SOIL							●
	NEW SOIL					●	●	
HOLD FOR DETAIL ANALYSIS		X		X	X	X		

LEGEND

SELECTED TECHNOLOGY ●

Alternative 3A - Source Containment (Cap Only), Source and Downgradient Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

Alternative 3B - Source Containment (Cap, Circumferential Barrier Wall and Interior Drain), Downgradient Groundwater Collection and On-site Groundwater Treatment with Discharge to Cayuga Creek

Alternative 4A - Source Removal and Off-site Land Disposal, Downgradient Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

Alternative 4B - Source Removal and Off-site Incineration, Downgradient Groundwater Collection and On-site Groundwater Treatment with Discharge to Cayuga Creek

Alternative 5 - Source Removal and On-site Soil Washing with Backfilling of Treated Soils, Downgradient Groundwater Collection, and On-site Treatment of Groundwater with Discharge to Cayuga Creek

6.2.1.2 Screening of Remedial Alternatives

Screening of these seven remedial alternatives was performed using the following criteria:

- Effectiveness (meeting ARARs and being protective of human health and the environment).
- Implementability (ability to construct, operate, and meet permit conditions).
- Order of magnitude cost.

The cost estimate for each remedial alternative was based on the combined sum of the initial capital cost and the net present worth of any ongoing monitoring, operating, or maintenance costs over a 30-year period (using five percent interest). The purpose of the cost estimates developed was to provide a basis for relative cost comparison between the remedial alternatives. Note that these cost estimates may not reflect the actual costs of implementing these alternatives, and therefore should not be used for budgetary purposes.

6.2.2 Alternative 1 – No Action with Monitoring

Description

No remedial action would take place under Alternative 1. Any improvement in groundwater quality would be solely the result of natural processes (e.g., dilution, groundwater flushing, volatilization, microbial degradation, etc.). Semi-annual groundwater sampling and analysis of the on-site monitoring wells would be performed for a period of up to 30 years. Monitoring data would be reviewed every 5 years to determine the need for further monitoring.

Effectiveness

Alternative 1 – No Action with Monitoring, is not effective for remediating the site. There will be no reduction in contaminant concentrations other than that due to natural degradation. The contaminant exposure pathways to groundwater and soil will remain. Furthermore, there is no assurance that the groundwater ARARs will be met within any reasonable or predictable time-frame due to natural attenuation. However, this alternative will be carried through the detailed screening and analysis of alternatives to provide a baseline comparison for the other alternatives.

Implementability

This alternative is easily implementable at the site.

Cost

The costs associated with implementation of Alternative 1 include only those for groundwater sampling, analysis, and reporting. It is assumed that the monitoring will include semi-annual groundwater sampling and analysis at ten existing monitoring wells. The net present worth cost for this alternative has been estimated to be approximately $215,000, based on a 30-year period at five percent interest. The cost breakdown for Alternative 1 is presented in Table 6-9.

TABLE 6-9
ALTERNATIVE 1: NO ACTION/MONITORING
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE CONTROLS	DEED RESTRICTION	LS			
	FENCING	LF			
CONSTRUCTION	MOBILIZATION	LS			
CAP	FLEXIBLE MEMBRANE LINER	LS			
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	SF			
	OVERBURDEN GW COLLECTION	SF			
	BEDROCK GW COLLECTION	LS			
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			
SOIL REMOVAL	EXCAVATION	CY			
SOIL TREATMENT	INCINERATION (OFF-SITE)	CY			
	SOIL WASHING (ON-SITE)	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY			
ENGINEERING - 15% OF CAPITAL COST					$0
CONTINGENCY - 25% OF CAPITAL COST					$0

TOTAL CAPITAL COSTS	$0

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE		
GW TREATMENT SYSTEM O&M/ MONITORING		
FML CAP MAINTENANCE		
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$215,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$215,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

Screening

Because Alternative 1 is required for baseline comparative purposes, it will be retained for further evaluation as a part of the detailed analysis presented in Section 6.3.

6.2.3 Alternative 2 – Limited Action

Description

Alternative 2 is similar to that discussed above and includes the following additional provisions to reduce human exposure to contamination in the Site 10 area:

- Enactment of deed restrictions for the Site 10 property to restrict land use in contaminated areas.

  needed any way
- Enactment of deed restrictions for the site and surrounding properties in order to restrict the use of groundwater in the area.
- Fencing of the area to eliminate future activities at the site which could result in exposure to groundwater.

Effectiveness

Human health would be protected to greater extent under this alternative than with Alternative 1 (above) by minimizing human contact with the contaminated soils and potential groundwater exposures. However, the contaminants in soils and groundwater would remain with potential for off-site migration. There is no assurance that media-specific ARARs would be met for the media of concern within any reasonable or predictable time-frame. Alternative 2 is, therefore, judged not capable of achieving the remedial objectives for the site.

Implementability

There are no limitations associated with implementation of the fencing, monitoring, and deed restrictions for this alternative. In implementing deed restrictions, cooperation from the local zoning board/municipality will be required.

Cost

Cost associated with implementation of Alternative 2 include those for fence construction (approximately 500 feet); 30 years of semi-annual sampling, analysis, and reporting for groundwater; and imposing the deed restrictions. The cost for deed restrictions does not include any litigation cost that may be incurred, e.g., for the right-of-way etc. The net present worth cost for this alternative has been estimated to be approximately $236,000. The cost breakdown for Alternative 2 is presented in Table 6-10.

Screening

Because Alternative 2 is not effective for remediating the site by itself, it will be retained for further evaluation only as a part of other alternatives, as applicable, discussed in this section and in Section 6.3.

6.2.4 Alternative 3A - Source Containment (Cap Only), Source and Downgradient Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

Alternative 3A consists of a combination of the following remedial technologies actions:

- Upper unconfined aquifer groundwater collection by a subsurface perimeter drain and downgradient trench drain.
- Upper fractured bedrock groundwater collection by extraction well.
- On-site treatment of groundwater by air stripping with chemical precipitation pretreatment.
- Installation of a multi-media cap with a flexible membrane liner (FML).
- All actions specified for Alternative 2 (Section 6.2.3) including fencing, deed restrictions, and monitoring.

This alternative would address measures for both source control and management of contaminant migration. The alternative upon implementation will eliminate further migration of contaminants from the source area by isolating soil contaminants from surface infiltration and by intercepting and treating contaminated groundwater in both the overburden and bedrock aquifer.

TABLE 6-10
ALTERNATIVE 2: LIMITED ACTION
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF	$20.00	500	$10,000
CONSTRUCTION	MOBILIZATION	LS			
CAP	FLEXIBLE MEMBRANE LINER	LS			
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	SF			
	OVERBURDEN GW COLLECTION	SF			
	BEDROCK GW COLLECTION	LS			
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			
SOIL REMOVAL	EXCAVATION	CY			
SOIL TREATMENT	INCINERATION (OFF-SITE)	CY			
	SOIL WASHING (ON-SITE)	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY			
ENGINEERING - 15% OF CAPITAL COST					$2,000
CONTINGENCY - 25% OF CAPITAL COST					$4,000

TOTAL CAPITAL COSTS	$21,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE		
GW TREATMENT SYSTEM O&M/ MONITORING		
FML CAP MAINTENANCE		
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$215,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$236,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

For the purposes of this FS, a preliminary estimate of 10 gpm has been established for the complete groundwater recovery system (as outlined in Appendix F). This estimate is conservative, and the actual groundwater recovery rate required to effectively contain and recover the contaminated plume may be significantly less. Due to the relatively minor differences between the estimated groundwater recovery rate for Alternatives 3A, 3B, 4A, 4B, and 5 discussed in this Section, the costing of the groundwater treatment component for each of these alternatives was performed assuming a total of 10 gpm groundwater recovery rate.

The treated groundwater would be discharged to Cayuga Creek. For the purposes of this limited FS, it is assumed that a treated discharge of 10 gpm will not significantly increase the existing flow in the creek. However, a more detailed assessment would be required during the remedial design (RD) phase to evaluate impacts on Cayuga Creek for each alternative which includes groundwater collection, treatment and discharge to the Cayuga Creek.

Based on the assumed extent of soil contamination, it is estimated that the proposed cap would extend over a circular area with a diameter of 100 feet, effectively covering the location of the former burn pit. The layering of the cap would consist of 6 inches of compacted subgrade, a 40 mil very low density polyethylene (VLDPE) geomembrane as an impermeable barrier, 24 inches of protective cover, and 6 inches of soil which would support vegetation. The actual design of any cap to be installed at the site would be finalized in the RD phase.

View of the risk assessment conclusions and even in the absence of soil data for the burn pit area, it is assumed that the contaminated soil in this area will act as a continuing source of groundwater contamination. Installation of a cap will significantly reduce infiltration and consequently the migration of contamination to the groundwater. This could, therefore, significantly reduce the time required for treatment.

The perimeter drain would consist of a trench excavated to bedrock around the perimeter of the capped area (approximately 120 feet square = 480-foot perimeter). Slotted PVC pipe will be installed in the trench sloped to a common collection sump, and the trench would be backfilled with granular material.

Groundwater recovery would consist of a pump to periodically empty the perimeter drain collection sump, and a single groundwater extraction well with a pump installed in

$1.43 / 1000 G

7,516.08/yr

x 30 w

$225,482.80 yr

5,256,000 gal/yr

10 $\frac{g}{M}$, $\frac{60\ m}{hr.}$ · $\frac{24h}{d}$ × 365

bedrock. The groundwater treatment system for Alternatives 3A, 3B, 4A, 4B, and 5 includes chemical precipitation (metals and suspended solid removal) and air stripping (volatile organic removal).

Effectiveness

Alternative 3A would be effective in providing protection of human health through the elimination of the potential for ingestion of contaminated groundwater.

Alternative 3A would also be effective in helping to meet the groundwater ARARs through groundwater recovery and treatment, and source control which would limit contaminant migration by the installation of a cap. The source control would be effective in meeting the ultimate intent of the NYSDEC draft remediation guidance for soil.

The treatment system would be designed to meet New York State Surface Water Discharge Limits for both organics and inorganics, thereby complying with ARARs for surface water discharge. The system would also be designed to comply with New York State Guidelines for control of Toxic Ambient Air Contaminants (Air Guide-1).

Implementability

The cap and groundwater collection and treatment system components are proven remedial technologies, and no significant site-specific implementation difficulties are foreseen.

Cost

Costs components associated with implementation of Alternative 3A include the equipment, material, and installation costs for the cap, perimeter drain, bedrock recovery well, and groundwater treatment system; and the operation and maintenance costs for the groundwater recovery and treatment system; in addition to those costs specified in Section 6.2.3 for Alternative 2. The net present worth cost for this alternative has been estimated to be approximately $3,648,000. The cost breakdown for Alternative 3A is presented in Table 6-11.

TABLE 6-11
ALTERNATIVE 3A: CONTAINMENT – CAP
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF	$20.00	500	$10,000
CONSTRUCTION	MOBILIZATION	LS			$5,000
CAP	FLEXIBLE MEMBRANE LINER	LS			$20,000
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	LF	$15.00	3600	$54,000
	OVERBURDEN GW COLLECTION	LF	$15.00	1500	$23,000
	BEDROCK GW COLLECTION	LS			$30,000
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			$640,000
SOIL REMOVAL	EXCAVATION	CY			
SOIL TREATMENT	INCINERATION (OFF-SITE)	CY			
	SOIL WASHING (ON-SITE)	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY			
ENGINEERING - 15% OF CAPITAL COST					$119,000
CONTINGENCY - 25% OF CAPITAL COST					$198,000

TOTAL CAPITAL COSTS	$1,104,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE	$1,600	$25,000
GW TREATMENT SYSTEM O&M/ MONITORING	$145,000	$2,229,000
FML CAP MAINTENANCE	$5,000	$77,000
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$2,546,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$3,650,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

Screening

Because Alternative 3A is effective and implementable, it will be retained for detailed analysis and further evaluation in Section 6.3.

6.2.5 Alternative 3B - Source Containment (Cap, Perimeter Slurry Wall and Drain) Downgradient Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

Description

Alternative 3B is similar to Alternative 3A with the exception of a perimeter slurry wall around the burn pit area. The gravity drain would be within the containment wall.

Like Alternative 3A, Alternative 3B would address measures for both source control and management of migration. Collection of groundwater at two locations would be necessary with Alternative 3B to both effectively isolate and contain contaminants within the capped area, and prevent migration of contaminants downgradient.

The slurry wall would be constructed by excavating a trench down through the overburden and the water bearing zone of the upper bedrock and would be keyed into the first competent bedrock. The trench is kept open during excavation with a slurry of bentonite and water and as excavation proceeds, the trench is backfilled with a soil/bentonite or plastic/concrete mixture. For the purposes of this FS, it is assumed that the slurry wall construction would extend vertically to a depth of 15 feet into the bedrock to impede groundwater flow through the overburden and upper bedrock water-bearing zone. It is also estimated that the slurry wall would be installed around a circular area with a diameter of approximately 100 feet.

Effectiveness

This alternative would be effective in controlling contaminant migration and helping to meet the groundwater ARARs, through groundwater recovery and treatment and the source control provided by the cap and slurry wall, as discussed in Alternative 3A. In addition, the slurry wall would reduce groundwater flow into the burn pit area and provide a physical barrier to flow from the burn pit area. The source control would be effective in meeting the ultimate intent of the NYSDEC draft remediation guidance for soil. However, without source removal of contaminated soil, actual achievement of the TBCs for soil may not be accomplished.

The treatment system would be designed to meet New York State Surface Water Discharge Limits for both organics and inorganics, thereby complying with ARARs for surface water discharge.

Implementability

The cap, slurry wall, and groundwater collection and treatment system components are proven remedial technologies, and no significant site-specific implementation difficulties are foreseen.

Cost

Costs associated with implementation of Alternative 3B include costs estimated for Alternative 3A with additional mobilization and installation costs for the slurry wall. The net present worth cost for Alternative 3B has been estimated to be approximately $3,756,000. The cost breakdown for Alternative 3B is presented in Table 6-12.

Screening

Because Alternative 3B is effective and implementable, it will be retained for detailed analysis and further evaluation in Section 6.3.

6.2.6 Alternative 4A – Source Removal and Off-site Land Disposal, Downgradient Groundwater Collection, and On-site Groundwater Treatatment with Discharge to Cayuga Creek

Description

Alternative 4A consists of a combination of the following remedial technologies and other actions:

- Excavation and off-site disposal at a non-hazardous waste landfill.
- Upper fractured bedrock groundwater collection by extraction well and downgradient overburden trench drain.
- On-site treatment of groundwater by air stripping with chemical precipitation pretreatment.
- The deed restrictions (groundwater use only) and monitoring actions specified for Alternative 2 (Section 6.2.3).

TABLE 6-12
ALTERNATIVE 3B: CONTAINMENT – CAP & SLURRY WALL
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST [1]
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF	$20.00	500	$10,000
CONSTRUCTION	MOBILIZATION	LS			$10,000
CAP	FLEXIBLE MEMBRANE LINER	LS			$20,000
BARRIER	PERIMETER SLURRY WALL	SF	$15.00	4750	$71,000
GW COLLECTION	PERIMETER GW COLLECTION	SF	$15.00	3600	$54,000
	OVERBURDEN GW COLLECTION	SF	$15.00	1500	$23,000
	BEDROCK GW COLLECTION	LS			$30,000
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			$640,000
SOIL REMOVAL	EXCAVATION	CY			
SOIL TREATMENT	INCINERATION (OFF-SITE)	CY			
	SOIL WASHING (ON-SITE)	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY			
ENGINEERING - 15% OF CAPITAL COST					$131,000
CONTINGENCY - 25% OF CAPITAL COST					$218,000

TOTAL CAPITAL COSTS	$1,212,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST [1]
GW COLLECTION SYSTEM MAINTENANCE	$1,600	$25,000
GW TREATMENT SYSTEM O&M/ MONITORING	$145,000	$2,229,000
FML CAP MAINTENANCE	$5,000	$77,000
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$2,546,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$3,758,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

Alternative 4A is developed to facilitate comparison with off-site treatment of excavated soil which is included in Alternative 4B. Alternative 4A would address both source control and management of contaminant migration at the site. This alternative will eliminate the contaminant source by removing the contaminated soil, and prevent further migration of the existing contaminants in groundwater by intercepting and treating the site groundwater in both the overburden and bedrock aquifers.

For the purposes of this FS, the contaminated soil to be removed is estimated to extend laterally over a circular area in the vicinity of the former burn pit, with a diameter of approximately 100 feet. This contamination is estimated to extend vertically downward to groundwater, which occurs at an average depth of 5 feet in the Site 10 area. These estimated dimensions of the contaminated soil area result in an estimated volume of approximately 1,500 cubic yards of contaminated soil for excavation and off-site land disposal. Confirmatory sampling would be performed to verify that the contaminated burning pit soils have been removed.

Although no data exists at this time to adequately characterize the soils to be excavated for off-site disposal, a non-hazardous, solid waste landfill has been assumed adequate for disposal under Alternative 4A. A Resource Conservation and Recovery Act (RCRA) permitted hazardous waste landfill was not assumed necessary for disposal, because if the soils are classified as RCRA hazardous waste (based on characteristics testing), their disposal would be precluded from landfilling under the RCRA land disposal restrictions (LDR) specified in 40 CFR 266. The LDR may require the contaminated soils to be treated prior to landfilling to achieve contaminant-specific LDR standards. Best Demonstrated Available Technology (BDAT) for soils contaminated with VOCs is incineration. Off-site thermal treatment is included in Alternative 4B, and on-site soil washing is included in Alternative 5.

Effectiveness

Although total removal of the source of contamination could not be achieved for some time due to contamination within the upper bedrock aquifer, removal of the contaminated soil would accelerate the natural recovery of the unconfined aquifer and may eventually allow unrestricted use of the land. Achievement of potential soil TBCs could be expeditiously possible through removal of the contaminated soil. The groundwater recovery and treatment system would be effective in controlling the migration of contaminants and meeting the groundwater ARARs.

Human health would be protected by eliminating the potential for ingestion of contaminated groundwater. The treatment system would be designed to meet New York State Surface Water Discharge Limits for both organics and inorganics, thereby complying with ARARs for surface water discharge.

Implementability

Due to the shallow and homogeneous fine grained nature of the overburden, the limited area of involvement (approximately 100 feet in diameter), and the distance of the area to be excavated from buildings or underground utilities, excavation and on-site handling of soil would not be difficult to implement. As in Alternative 3B (Section 6.2.5), the groundwater recovery and treatment system is likewise implementable.

However, Alternative 4A may not be appropriate if the soil material were determined to be RCRA hazardous waste, due to the associated cost and difficulties discussed above with respect to compliance with RCRA LDR regulations.

Cost

Costs associated with implementation of Alternative 4A include: the labor costs and fees for excavation, transportation, and disposal of the contaminated soil at a solid waste landfill; confirmatory sampling after excavation, equipment, material, and installation costs for the downgradient bedrock recovery well, overburden trench drain and groundwater treatment system; and the operation and maintenance costs for the groundwater recovery and treatment system; in addition to the monitoring cost component specified in Section 6.2.3 for Alternative 2. The net present worth cost for Alternative 4A has been estimated to be approximately $4,020,000. A cost breakdown is presented in Table 6-13.

Screening

Because Alternative 4A is effective and implementable, it will be retained for further evaluation in Section 6.3.

TABLE 6-13
ALTERNATIVE 4A: SOIL EXCAVATION & LAND DISPOSAL
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF			
CONSTRUCTION	MOBILIZATION	LS			$10,000
CAP	FLEXIBLE MEMBRANE LINER	LS			
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	SF			
	OVERBURDEN GW COLLECTION	SF	$15.00	1500	$23,000
	BEDROCK GW COLLECTION	LS			$30,000
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			$640,000
SOIL REMOVAL	EXCAVATION	CY	$10.00	1500	$15,000
SOIL TREATMENT	INCINERATION (OFF-SITE)	CY			
	SOIL WASHING (ON-SITE)	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON	$150.00	2430	$365,000
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY	$13.50	1500	$20,000
ENGINEERING - 15% OF CAPITAL COST					$167,000
CONTINGENCY - 25% OF CAPITAL COST					$279,000

TOTAL CAPITAL COSTS	$1,554,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE	$1,600	$25,000
GW TREATMENT SYSTEM O&M/ MONITORING	$145,000	$2,229,000
FML CAP MAINTENANCE		
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$2,469,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$4,023,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

6.2.7 Alternative 4B – Source Removal and Off-site Incineration, Downgriadient Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

Description

Alternative 4B would consist of all of the components of Alternative 4A, with the exception that the excavated soil is assumed to be a RCRA hazardous waste and would be incinerated at an off-site commercial TSDF. It is assumed that incineration is BDAT for the organics of concern at this site. Because only 1,500 cy of soil is to be treated and on-site treatment of less than 8,000 to 10,000 cy is generally not cost-effective, off-site treatment is more appropriate.

Alternative 4B is developed as a contingency alternative to off-site landfilling of excavated soil which is included in Alternative 4A.

Effectiveness

The effectiveness of Alternative 4B in meeting ARARs for groundwater and TBCs for soils, preventing further migration of contaminants, and protecting human health would be identical to that stated in Section 6.2.6 for Alternative 4A. However, the excavated soils would be treated and contaminants permanently destroyed. There will remain a potential of contaminating the clean fill material due to groundwater level fluctuation.

Implementability

The soil excavation and groundwater recovery and treatment system is implementable as noted in Section 6.2.6 for Alternative 4A. The off-site treatment/disposal option of incineration included in Alternative 4B is implementable due to the availability of off-site facilities.

Cost

The cost components for implementing Alternative 4B are identical to those specified in Section 6.2.6 for Alternative 4A, with the exception of the costs for off-site incineration replaces that for off-site landfilling. The net present worth cost for this alternative has been estimated to be approximately $7,288,000. The cost breakdown for Alternative 4B is presented in Table 6-14.

TABLE 6–14
ALTERNATIVE 4B: SOIL EXCAVATION & OFF–SITE INCINERATION
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF			
CONSTRUCTION	MOBILIZATION	LS			$10,000
CAP	FLEXIBLE MEMBRANE LINER	LS			
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	SF			
	OVERBURDEN GW COLLECTION	SF	$15.00	1500	$23,000
	BEDROCK GW COLLECTION	LS			$30,000
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			$640,000
SOIL REMOVAL	EXCAVATION	CY	$10.00	1500	$15,000
SOIL TREATMENT ON-SITE	INCINERATION	CY	$2,000.00	1500	$3,000,000
	SOIL WASHING	CY			
SOIL/ ROCK DISPOSAL	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY			
	NEW SOIL	CY	$13.50	1500	$20,000
ENGINEERING - 15% OF CAPITAL COST					$140,000 *
CONTINGENCY - 25% OF CAPITAL COST					$936,000

TOTAL CAPITAL COSTS	$4,819,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE	$1,600	$25,000
GW TREATMENT SYSTEM O&M/ MONITORING	$145,000	$2,229,000
FML CAP MAINTENANCE		
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$2,469,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$7,288,000

Notes

LS - Lump Sum	SF - Square Feet
LF - Linear Feet	CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

* - Excludes $3,000,000 inceneration cost, however, additional engineering costs for coordination of this item are included.

Screening

Because Alternative 4B is a contingency alternative, it will not be retained for detailed analysis and further evaluation in Section 6.3.

6.2.8 Alternative 5 - Source Removal On-site Soil Washing with Backfilling of Treated Soil, Downgradient Groundwater Collection, and On-site Groundwater Treatment with Discharge to the Cayuga Creek

Description

Alternative 5 consists of a combination of the following remedial technologies and other actions:

- Excavation and on-site treatment by soil washing with backfilling of treated soil.
- Upper fractured bedrock groundwater collection by extraction well and downgradient overburden trench drain.
- On-site treatment of groundwater by air stripping with chemical precipitation pretreatment.
- The deed restrictions (groundwater use only) and monitoring actions specified for Alternative 2 (Section 6.2.3).

This alternative would address measures for both source control and management of migration similar to Alternatives 4A and 4B.

Soil washing is applicable to inorganic and organic waste and can be performed at an on-site processing unit. The process involves the infiltration of a solvent or surfactant solution into the contaminated soil which increases the solubility of the contaminants and leaches them from the soil. The treated soil is then de-watered and the washing solution is treated. If the soil to be excavated is determined to be a RCRA hazardous waste, applicable LDR treatment standards would also have to be met prior to backfilling of the treated material. A treatability variance would be required, in this case, to prove that the LDR treatment standards could be met, i.e., that the treatment is comparable to BDAT.

Effectiveness

The fine-grained nature of the clay and silt comprising the soils to be excavated would complicate the adequate distribution and recovery of washing agents, and could make thorough treatment of these bulk soils difficult. In addition, the effectiveness of soil washing would be dependent upon the types of extractant used and their efficiency at removing the specific contaminants of concern associated with the Site 10 soils. A treatability study would be necessary to make this determination.

If successful, treatment of soil via soil washing will provide the same degree of protection of human health and the environment as Alternatives 4A and 4B, as well as attainment of soil TBCs and groundwater ARARs. However, because of the difficulty in treating the fine-grained soils, this alternative would probably not be effective.

Implementability

The implementability of Alternative 5 may be difficult due to the relatively limited amount of successful applications of soil washing technology on similar soil types and organic contaminants.

Cost

The cost components for implementing Alternative 5 are identical to those specified in Section 6.2.7 for Alternative 4B, with the exception of the costs for the on-site soil washing replaces that for off-site incineration. These costs would include the capital and operating expenses of the soil washing system, and the labor and other fees associated with the additional soil handling, management, and backfilling. The net present worth cost for this alternative has been estimated to be approximately $3,987,000. This cost includes the cost for a treatability study, estimated at $75,000. A cost breakdown for Alternative 5 is presented in Table 6-15.

Because the effectiveness of Alternative 5 is questionable, it will not be retained for further evaluation in Section 6.3.

6.2.9 Summary of Screening Alternatives

A summary of the screening results is presented in Table 6-16. Selection of the remedial alternatives to be further evaluated in the detailed analysis is based on

TABLE 6-15
ALTERNATIVE 5: SOIL EXCAVATION & ON-SITE TREATMENT
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS - SITE 10
PRELIMINARY COST ESTIMATE

CAPITAL COSTS		UNIT	UNIT COST	QUANTITY	PRESENT WORTH COST 1
ADMINISTRATIVE	DEED RESTRICTION	LS			$5,000
CONTROLS	FENCING	LF			
CONSTRUCTION	MOBILIZATION	LS			$10,000
CAP	FLEXIBLE MEMBRANE LINER	LS			
BARRIER	PERIMETER SLURRY WALL	SF			
GW COLLECTION	PERIMETER GW COLLECTION	SF			
	OVERBURDEN GW COLLECTION	SF	$15.00	1500	$23,000
	BEDROCK GW COLLECTION	LS			$30,000
GW TREATMENT ON-SITE	AIR STRIPPING / PRECIP.	LS			$640,000
SOIL REMOVAL	EXCAVATION	CY	$10.00	1500	$15,000
TREATABILITY STUDY		LS			$75,000
SOIL TREATMENT ON-SITE	INCINERATION	CY			
	SOIL WASHING	CY	$185.00	1500	$278,000
SOIL/ ROCK DISPOSAL	OFF-SITE TSDF	LS			
	OFF-SITE LANDFILL	TON			
BACKFILL	EXISTING SOIL	CY	$5.00	1500	$8,000
	NEW SOIL	CY			
ENGINEERING - 15% OF CAPITAL COST					$164,000
CONTINGENCY - 25% OF CAPITAL COST					$273,000

TOTAL CAPITAL COSTS	$1,521,000

OPERATION, MAINTENANCE, AND MONITORING (OMM) COSTS	ANNUAL COST	PRESENT WORTH COST 1
GW COLLECTION SYSTEM MAINTENANCE	$1,600	$25,000
GW TREATMENT SYSTEM O&M/ MONITORING	$145,000	$2,229,000
FML CAP MAINTENANCE		
GROUNDWATER MONITORING	$14,000	$215,000

TOTAL OMM COSTS	$2,469,000

TOTAL PRESENT WORTH CAPITAL AND OMM COSTS	$3,990,000

Notes

LS - Lump Sum
SF - Square Feet
LF - Linear Feet
CY - Cubic Yard

1 - Present worth for OMM costs calculated assuming a period of 30 years at 5% interest.

TABLE 6–16
NIAGARA FALLS INTERNATIONAL AIRPORT
LIMITED RI/FS – SITE 10
Remedial Alternative Screening Summary

ALTERNATIVE	EFFECTIVE	IMPLEMENTABLE	PRELIMINARY PRESENT VALUE COSTS ($000)	CARRY THROUGH DETAILED ANALYSIS
Alternative No.1 - No Action w/ Monitoring - Groundwater Monitoring Program	No	Yes	$215	Yes
Alternative No.2 - Limited Action - Monitoring Well Program - Future Land and GW Use Deed Restrictions - Fencing	Potentially for Human Health, ARARs not met	Yes	$236	Yes, by incorporating with other alternatives
Alternative No.3A - Containment - Cap - FML Cap - GW Collection, (overburden and bedrock) On-Site Total Treatment, and Discharge to On-Site Surface Water or POTW - Groundwater Monitoring Program - Future Land and GW Use Deed Restrictions - Fencing	Yes for Human Health, ARARs for groundwater met	Yes	$3,650	Yes
Alternative No.3B - Containment - Cap & Slurry Wall - FML Cap - Perimeter Slurry Wall - GW Collection (overburden and bedrock), On-Site Treatment, and Discharge to On-Site Surface Water - Groundwater Monitoring Program - Future Land and GW Use Deed Restrictions - Fencing	Yes for Human Health, ARARs for groundwater met	Yes	$3,758	Yes

TABLE 6-16

NIAGARA FALLS INTERNATIONAL AIRPORT

LIMITED RI/FS – SITE 10

Remedial Alternative Screening Summary

ALTERNATIVE	EFFECTIVE	IMPLEMENTABLE	PRELIMINARY PRESENT VALUE COSTS ($000)	CARRY THROUGH DETAILED ANALYSIS
Alternative No.4a - Soil Excavation & Land Disposal - Overburden and Bedrock GW Collection, On-Site Treatment, and Discharge to On-Site Surface Water - Excavation of Soil - Off-site Land Disposal - Backfill with New Soil - Groundwater Monitoring Program - GW Use Deed Restrictions	Yes for Human Health, ARARs for GW and soil met	Yes	$4,023	Yes
Alternative No.4b - Soil Excavation, Off-Site Soil Treatment - Overburden and Bedrock GW Collection, On-Site Treatment, and Discharge to On-Site Surface Water - Excavation of Soil - Off-site Incineration - Backfill with New Soil - Groundwater Monitoring Program - GW Use Deed Restrictions	Yes for Human Health, ARARs for GW and TBCs for soil met	Yes	$7,288	No
Alternative No.5 - Soil Excavation, On-Site Treatment - Overburden and Bedrock GW Collection, On-Site Treatment, and Discharge to On-Site Surface Water - Excavation of Soil - On-site Soil Washing - Backfill with Treated Soil - GW Monitoring Program - GW Use Deed Restrictions	Unknown without Treatability Study	No Fine-grained soils would make implementation difficult	$3,990	No

consideration of the three screening criteria presented in Section 6.2.1 and discussed in Section 6.2.2 through 6.2.8.

After the above screening process, the following four alternatives remain for the detailed analysis (Phase III) to be conducted in Section 6.3:

- Alternative 1, the No Action alternative, included for baseline comparison.
- Alternative 3A which includes a cap over contaminated soils. Overburden and bedrock groundwater collection and treatment, monitoring and deed restrictions.
- Alternative 3B which includes a cap over contaminated soils and perimeter slurry wall for groundwater containment, with overburden and bedrock groundwater collection and treatment, monitoring and deed restrictions.
- Alternative 4A which includes soil removal and off-site disposal, with bedrock overburden and groundwater collection and treatment, monitoring and deed restrictions. It should be noted that upon soil characterization, RCRA Land Disposal Restrictions may become applicable, significantly affecting associated costs.

The above group of alternatives provide a suitable range of technically feasible alternatives covering an appropriate variety of source control (including source removal and multiple containment options for soils and groundwater) and management of migration technologies to be considered for detailed analysis. The remedial technologies included in these alternatives all have a demonstrated track record in similar applications.

The following three alternatives were eliminated from further evaluation in the detailed analysis phase of the FS for the reasons noted below:

- Alternative 2 was eliminated because it is not effective in eliminating migration and exposure pathways. Components of this alternative have been included, where applicable, with other alternatives.
- Alternative 4B was eliminated and would only be considered as a contingency alternative.

- Alternative 5 was eliminated because its implementability and effectiveness are questionable due to the difficulties associated with soil washing for fine-grain, low permeability soils, and the limited field experience of the technology on similar applications. Requirement for treatability study would be evaluated upon further resolution and investigation of soil contamination.

The results of the detailed analysis phase of the FS are presented in Section 6.3 for the four remaining alternatives.

6.3 DETAILED ANALYSIS OF ALTERNATIVES (PHASE III)

6.3.1 Introduction

This section presents a more detailed analysis of each of the remedial action alternatives which passed through the screening process described in Section 6.2. The detailed analysis consists of an evaluation of the following criteria:

1. ***Overall protection of human health and the environment*** - the reduction in risk provided by the alternative.
2. ***Compliance with ARARs*** - the degree to which the alternative is successful in achieving the ARARs specified in Section 6.2.
3. ***Long-term effectiveness and permanence*** - the magnitude of residual risk, and the adequacy and reliability of controls is made for each alternative.
4. ***Reduction of toxicity, mobility, and volume of source through treatment*** - evaluation of this criteria is based on the following:

    - Treatment process used and materials treated
    - Amount of hazardous materials destroyed or treated
    - Degree of expected reductions in toxicity, mobility, and volume
    - Degree to which treatment is irreversible
    - Type and quantity of residual contamination remaining after treatment

5. ***Short-term effectiveness*** - an evaluation of the following criteria is used to determine an alternative's short-term effectiveness:

- Protection of the community during remedial actions
- Protection of workers during remedial actions
- Environmental impacts of the remedial actions
- Time until the remedial action objectives are achieved

6. ***Implementability*** – an evaluation of the following criteria is used to determine an alternative's implementability:

    - Ability to construct and operate the technology
    - Reliability of the technology
    - Ease of undertaking additional remedial actions, if necessary
    - Ability to monitor the effectiveness of the remedy
    - Ability to obtain approvals from other agencies
    - Coordination with other agencies
    - Availability of off-site treatment, storage, and disposal services and capacity
    - Availability of necessary equipment and specialists
    - Availability of prospective technologies

7. ***Cost effectiveness*** – each alternative is assessed for the following criteria:

    - Capital costs
    - Operating and maintenance costs
    - Total present worth cost (based on 30-year operation and maintenance time-frame at five percent interest)

As discussed in Section 6.2.9, the remedial action alternatives to be evaluated in the detailed analysis include Alternatives 1, 3A, 3B, and 4A which are described in Sections 6.2.2, 6.2.4, 6.2.5, and 6.2.6, respectively. A detailed analysis for each of these four alternatives is presented below in Sections 6.3.2 through 6.3.5, in accordance with the evaluation criteria listed above.

6.3.2 Alternative 1 - No Action with Monitoring

The detailed description is provided in Section 6.2.2 and the screening is in accordance with Section 6.3.1. Alternative 1 (no action with monitoring) is presented below.

Overall Protection of Human Health and the Environment

Due to lack of any remedial action under Alternative 1, the current conditions will persist with no favorable impact on overall protection of Human Health and the Environment.

Compliance with ARARs

Because No Remedial Action is being taken, there is no assurance this alternative would meet the ARARs established for groundwater or the TBCs for soil within any reasonable or predictable time-frame.

Long-Term Effectiveness and Permanence

This alternative includes no controls for exposure and no long-term management measures for the two media of concern (i.e., groundwater and contaminated soils). All current and potential future risks would remain under this alternative. Therefore, residual risk will be similar to the potential risk currently associated with the site. This alternative would not provide permanent remediation.

Reduction of Toxicity, Mobility, and Volume

No treatment of soils is proposed in this alternative. Therefore, reduction of toxicity, mobility, and volume is not applicable.

Short-Term Effectiveness

Since no remedial construction would be implemented, protection of the community and workers during remedial action is not an issue. There are no actions included to achieve the remedial action objectives and therefore, the objectives may never be met. This alternative could be implemented immediately.

Implementability

There are no implementability concerns posed by this alternative since no remedial actions would be taken. The groundwater monitoring included in Alternative 1 is easily implementable and reliable. Additional remedial measures can be incorporated with the monitoring components. The equipment and labor for the monitoring are readily available.

Cost Effectiveness

The following costs have been estimated in Table 6-9 for conducting the groundwater monitoring included in Alternative 1:

- Annual operating costs = $14,000
- 30-year present worth cost (at four percent interest) = $215,000

6.3.3 Alternative 3A - Source Containment (Cap Only), Perimeter Drain, Bedrock Groundwater Collection, and On-site Groundwater Treatment with Discharge to Cayuga Creek

A description of Alternative 3A is presented in Section 6.2.4. The primary components of Alternative 3A are presented in Figure 6-1. The detailed analysis for Alternative 3A is presented below.

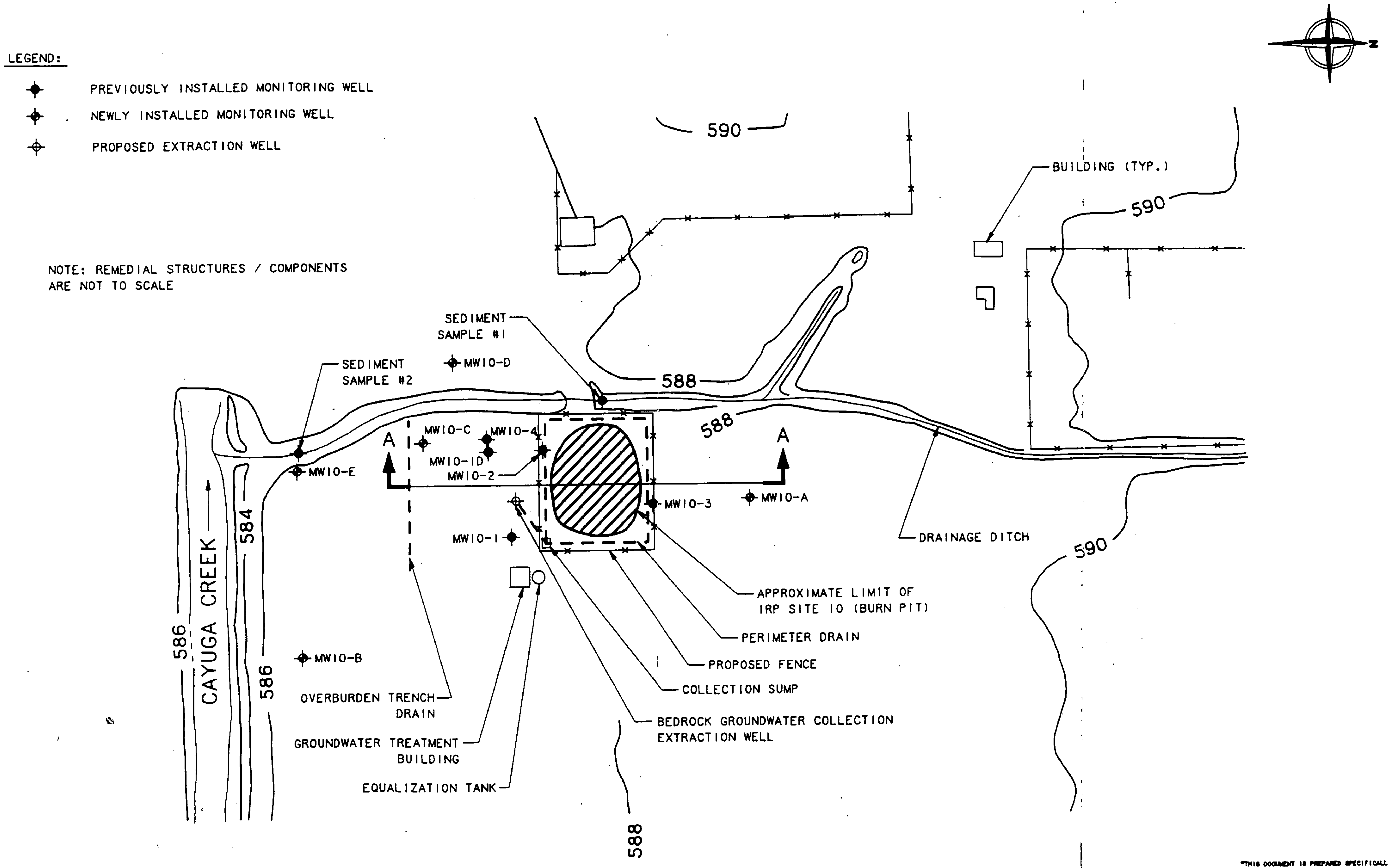
Overall Protection of Human Health and the Environment

Alternative 3A would be effective in providing protection of human health through the elimination of the potential for ingestion of contaminated groundwater (cap, groundwater collection oand treatment, and deed restrictions on groundwater use).

The containment, prevention of further migration, and potential achievement of ARARs and TBCs provided by Alternative 3A would also be protective of environmental receptors exposed to surface water and groundwater.

Compliance with ARARs

This alternative would be effective in controlling contaminant migration and potentially meeting the groundwater ARARs, through groundwater recovery and treatment and the source control preventing migration of contaminants in soils by capping the contaminated soils. Although soil TBCs would not be specifically addressed by this



OCG:(00640.03.LDE)FIG ALT3A SITE PLAN
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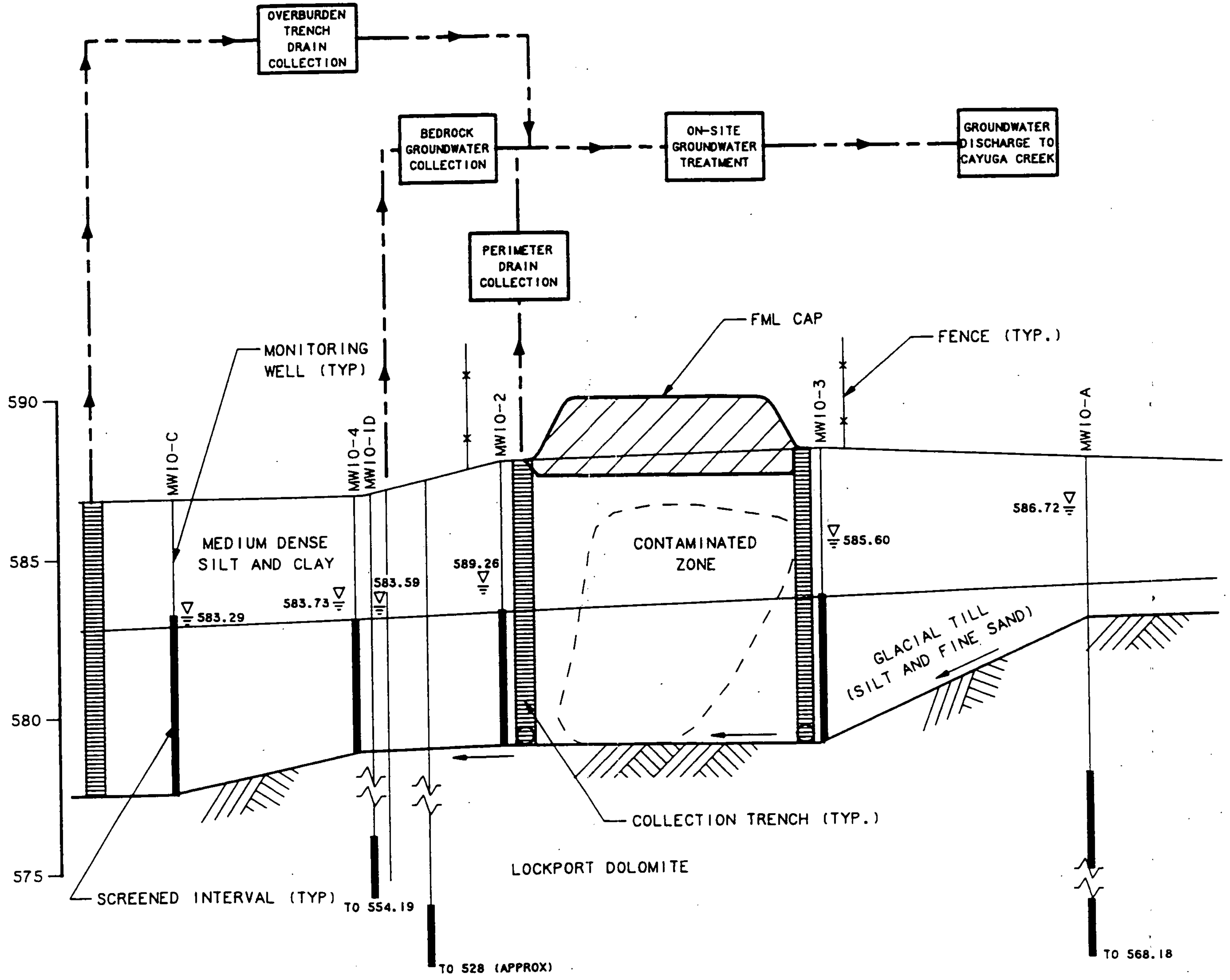
ALTERNATIVE 3A CONCEPTUAL
DESIGN (SHEET 1 - PLAN VIEW)

Figure: 6-1
Project No. 00640



OCG: (00640.03.LDE)FIG ALT3A CONTAIN CAP
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ALTERNATIVE 3A CONCEPTUAL DESIGN (SHEET 2 - SECTION A-A)

Figure: 6-1
Project No. 00640

alternative, the source control would be effective in meeting the ultimate intent of the NYSDEC draft remediation guidance for soil (i.e., elimination of soil exposure pathways and groundwater protection). A waiver from meeting the soil remediation levels may have to be filed. However, without source removal of contaminated soil, actual achievement of the cleanup levels for soil will not be accomplished.

The groundwater treatment system would be designed to meet applicable New York State Surface Water Discharge Limits for pollutants and other parameters (including the contaminants of concern) thereby complying with ARARs for surface water discharge. The emissions from the packed tower would comply with air ARARs.

Any residual management will be conducted in accordance with Federal, State, and Local regulations and is not expected to be a problem.

Long-Term Effectiveness and Permanence

Contaminant migration in soils and groundwater will be effectively controlled by this alternative. Permanent decontamination of the overburden aquifer and the upper water-bearing zones of the bedrock will ultimately be achieved through operation of the groundwater collection and treatment system. Although soil contaminants in the unsaturated zone will be effectively contained, no provision for permanent decontamination of these soils is included in this alternative. To achieve long-term effectiveness, this alternative will rely on a long-term operations and maintenance (O&M) program for the groundwater collection and treatment system, and a long-term maintenance program for the cap.

Reduction of Toxicity, Mobility, and Volume

Since this evaluation criterion applies only to treatment or source areas, this evaluation is not applicable.

Short-Term Effectiveness

This alternative will not impact base activities or personnel during implementation, and worker impacts during construction can be mitigated during construction by establishing appropriate health and safety protocol. There will be minimal impacts to the environment during construction of the cap and perimeter collection drains. Mitigation measures would be required to control run-on, run-off and volatilization of contaminants from soils excavated during installation at the perimeter drain. Deed restrictions on land and groundwater utilization will provide protection to the community and the base personnel during the remedial process.

Because Alternative 3A only provides for containment of the contaminant source, its short-term effectiveness in meeting the remedial objectives for soil is limited to controlling contaminant migration. Achievement of the soil TBCs is not addressed.

Alternative 3A is effective in the short-term in meeting the remedial objective for groundwater by preventing further contaminant migration. However, complete achievement of the remedial objective for groundwater, which includes achievement of groundwater ARARs, will require several years of groundwater recovery and treatment.

It is estimated that to implement this alternative from the issuance of the Record of Decision through construction would be approximatly two years.

Implementability

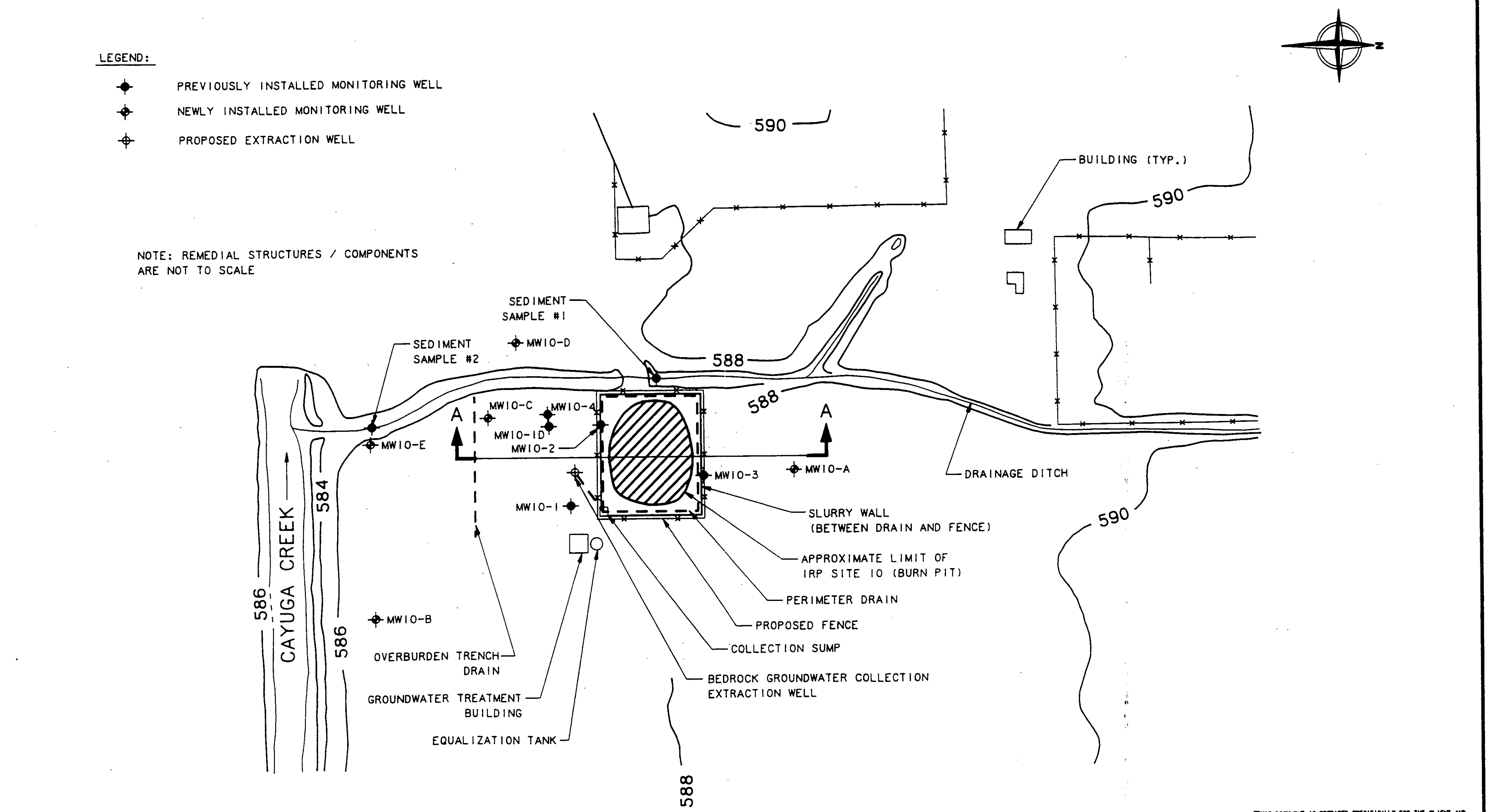
The cap and groundwater collection and treatment system components are proven remedial technologies available from a number of vendors. No significant site-specific implementation difficulties are foreseen. The maintenance of the cap, operation and maintenance of the groundwater collection and treatment system, and groundwater monitoring activities are routine.

The discharge of treated water to Cayuga Creek will require a New York State SPDES Permit; however, the treatment technologies selected will meet the permit requirements. The fencing and deed restrictions are implementable. However, for deed restrictions, cooperation from local authorities will be required.

Cost

The following costs have been estimated in Table 6-11 for implementing Alternative 3A:

- Capital costs = $1,102,000
- Annual operating costs = $164,600
- 30-year present worth cost (at five percent interest) = $3,648,000



OCG:(00640.03.LDE)FIG ALT3B PLAN
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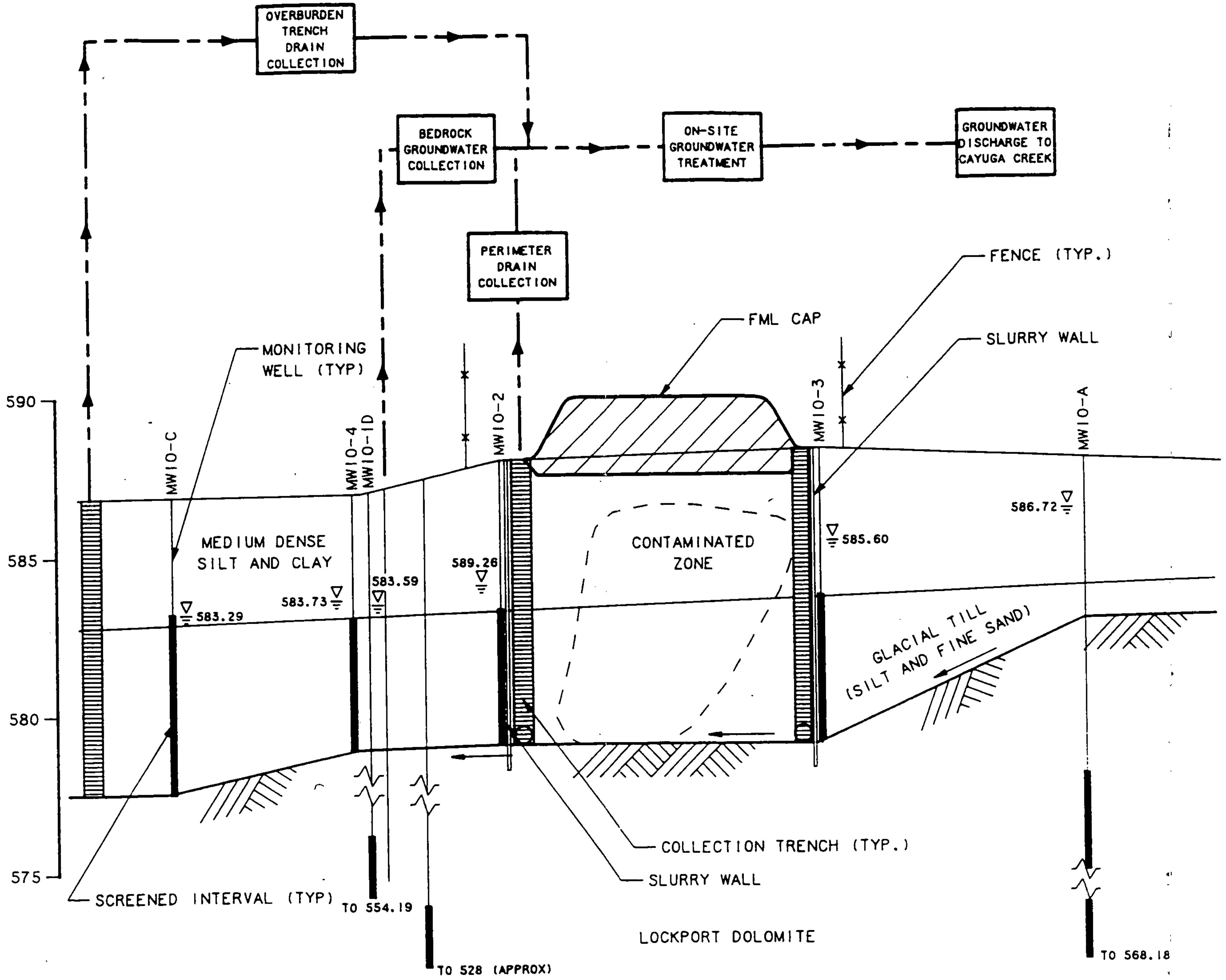
ALTERNATIVE 3B CONCEPTUAL
DESIGN (SHEET 1 - PLAN VIEW)

Figure: 6-2

Project No. 00640



OCG:(00640.03.LDE)FIG ALT3B SLURRY WALL
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ALTERNATIVE 3B CONCEPTUAL DESIGN (SHEET 2 - SECTION A-A)

Figure: 6-2
Project No. 00640

6.3.4 Alternative 3B - Source Containment Cap, Perimeter Slurry Wall and Drain), Downgradient Groundwater Collection, and Groundwater Treatment with Discharge to Cayuga Creek

A description of Alternative 3B is presented in Section 6.2.5. The primary components of Alternative 3B are presented in Figure 6-2. The detailed analysis for Alternative 3B is presented below.

Overall Protection of Human Health and the Environment

Alternative 3B would be effective in providing protection of human health through the elimination of the potential for ingestion of contaminated groundwater (cap, slurry wall, groundwater collection and treatment, and deed restrictions on groundwater use).

The containment, prevention of further migration, and achievement of ARARs provided by Alternative 3B would also be protective of environmental receptors exposed to surface water or groundwater.

Compliance with ARARs

This alternative would be effective in controlling contaminant migration and potentially meeting the groundwater ARARs, through groundwater recovery and treatment and the source control provided by the cap and slurry wall. Although soil TBCswould not be specifically addressed by this alternative, the source control and reduction of exposure would be effective in meeting the ultimate intent of the NYSDEC draft remediation guidance for soil (i.e., elimination of soil exposure pathways and groundwater protection). However, without source removal of contaminated soil, actual achievement of the TBCs for soil will not be accomplished.

The groundwater treatment system would be designed to meet applicable New York State Surface Water Discharge Limits for pollutants and other parameters (including the contaminants of concern), thereby complying with ARARs for surface water discharge. The air emission from the packed tower would comply with air ARARs.

Long-Term Effectiveness and Permanence

Contaminant migration in soils and groundwater will be effectively controlled by this alternative. Permanent decontamination of the overburden aquifer and the upper water-bearing zones of the bedrock will ultimately be achieved through operation of the groundwater collection and treatment system. Although soil contaminants in the unsaturated zone will be effectively contained, no provision for permanent decontamination of these soils is included in this alternative. To achieve long-term effectiveness, this alternative will rely on a long-term operations and maintenance (O&M) program for the groundwater collection and treatment system, and long-term maintenance of the cap and slurry wall.

Reduction of Toxicity, Mobility, and Volume

Since this evaluation criterion applies only to treatment of source areas, this evaluation is not applicable.

Short-Term Effectiveness

This alternative will not impact base activities or personnel during implementation, and worker impacts during construction can be mitigated. The blasting and stockpiling of contaminated bedrock materials will require additional safety and material management procedures to ensure the safety of workers and base personnel, and adequate protection of the environment. Mitigation measures will also be required to control run-on, run-off, and volatilization of contaminants from soils and bedrock excavated during installation of the slurry wall.

There will be no significant impacts to the environment during construction of the cap and slurry wall. Deed restriction on land and groundwater utilization will provide protection to the community and the base personnel during the remedial process.

Because Alternative 3B only provides for containment of the contaminant source, its short-term effectiveness in meeting the remedial objectives for soil is limited to controlling contaminant migration. Achievement of soil cleanup levels is not addressed.

Alternative 3B is effective in the short-term in meeting the remedial objective for groundwater of preventing further contaminant migration. However, complete achievement of the remedial objective for groundwater, which includes achievement of groundwater ARARs, will require groundwater recovery and treatment for a period of years.

It is estimated that the time to implement this alternative from the issuance of the Record of Decision through construction would be approximately two years.

Implementability

The cap and groundwater collection and treatment system components are proven remedial technologies available from a number of vendors. No significant site-specific implementation difficulties are foreseen with these activities. The maintenance of the cap, operation and maintenance of the groundwater collection and treatment system, and groundwater monitoring activities are routine.

Construction of the slurry wall, especially keying into the bedrock to a depth of 15 feet, will include blasting of the bedrock and thus would require significant effort for implementation of this alternative. Additional safety protection for workers and base personnel will be required, including implementation of appropriate construction techniques and controls for blasting. Excavated soil and rock will require transportation and off-site disposal, possibly at a RCRA permitted TSDF.

The discharge of treated water to Cayuga Creek will require a New York State SPDES Permit, however, the technologies selected will meet the permit requirements. The fencing and deed restrictions are clearly implementable.

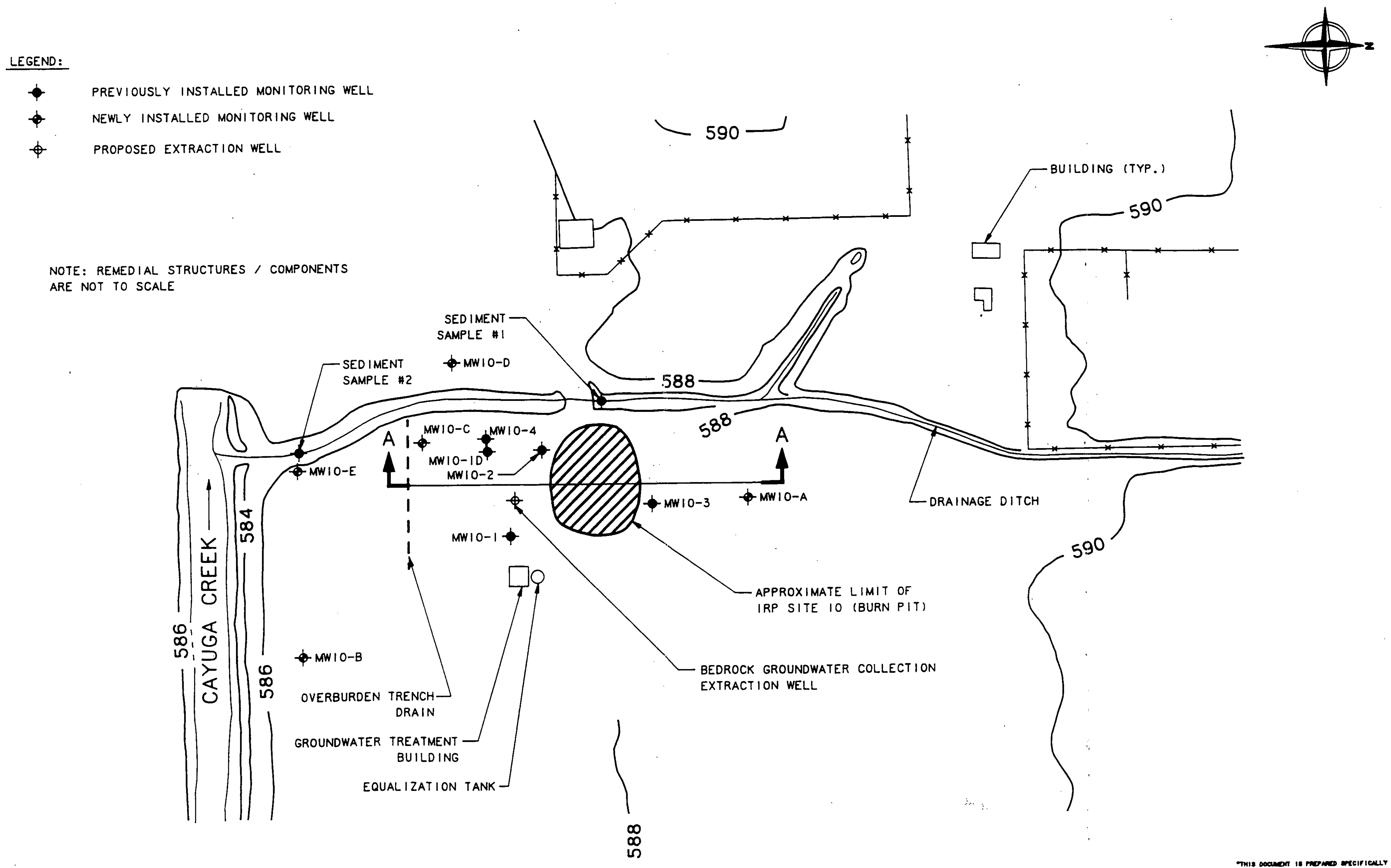
Cost

The following costs have been estimated in Table 6-12 for implementing Alternative 3B:

- Capital costs = $1,210,000
- Annual operating costs = $165,600
- 30-year present worth cost = $3,756,000

6.3.5 Alternative 4A – Source Removal and Off-site Land Disposal, Downgradient Groundwater Collection and Treatment with Discharge to Cayuga Creek

A description of Alternative 4A is presented in Section 6.2.6. The primary components of Alternative 4A are presented in Figure 6-3. The detailed analysis for Alternative 4A is presented below.



OCG:(00640.03.LDE)FIG ALT4A PLAN
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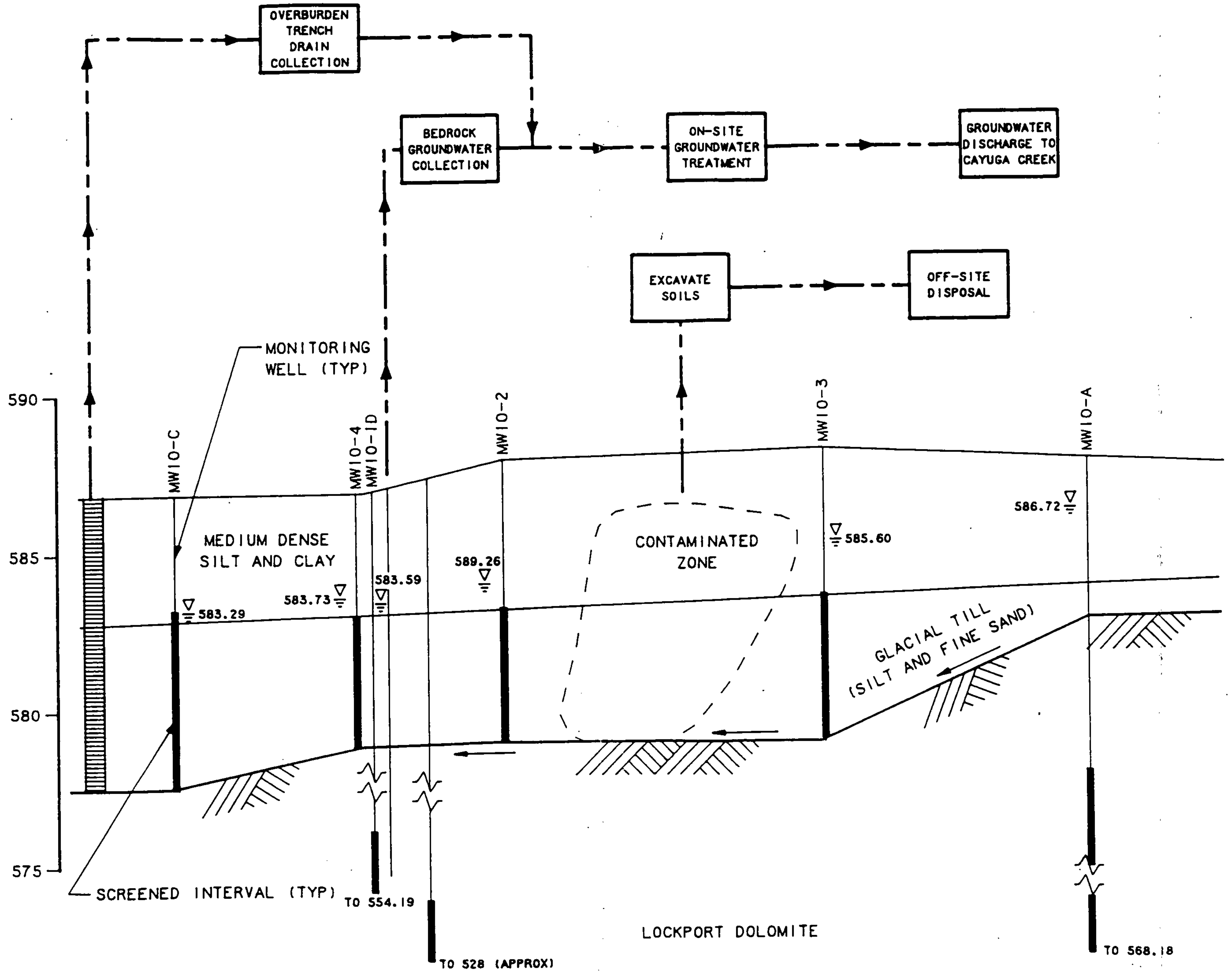
ALTERNATIVE 4A CONCEPTUAL DESIGN (SHEET 1 - PLAN VIEW)

Figure: 6-3
Project No. 00640



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ALTERNATIVE 4A CONCEPTUAL DESIGN (SHEET 2 - SECTION A-A)

Figure: 6-3

Project No. 00640

Overall Protection of Human Health and the Environment

Alternative 4A would be effective in providing protection of human health through the elimination of the potential for ingestion of contaminated groundwater (source removal, groundwater collection and treatment, and deed restrictions on groundwater use).

The source removal (excavation of contaminated soil form the site and properly disposed) and potential achievement of ARARs for groundwater provided by Alternative 4A would be protective of human health and environment and meeting the remedial objectives.

Compliance with ARARs

This alternative would be effective in controlling contaminant migration and potentially meeting the groundwater ARARs, through groundwater recovery and treatment and source removal. Soil TBCs and cleanup levels for contaminants would be met through removal and disposal of contaminated soil.

The groundwater treatment system would be designed to meet applicable New York State Surface Water Discharge Limits for pollutants and other parameters (including the contaminants of concern) thereby complying with ARARs for surface water discharge. The emissions from the packed tower would comply with air ARARs.

Long-Term Effectiveness and Permanence

Contaminant migration from soils will be permanently removed and migration of contaminated groundwater will be effectively controlled by this alternative. Permanent decontamination of the overburden aquifer and the upper water bearing zones of the bedrock will ultimately be achieved through operation of the groundwater collection and treatment system. To achieve long-term effectiveness, this alternative will rely on a long-term operation and maintenance (O&M) program for the groundwater collection and treatment system.

Reduction of Toxicity, Mobility, and Volume

Since this evaluation criterion applies only to treatment of source areas, this evaluation is not applicable.

Short-Term Effectiveness

This alternative will not impact base activities or personnel during implementation, and worker impacts during construction can be mitigated. Environmental impacts during excavation (including volatilization of soil contaminants, run-on, run-off, etc.) can be controlled via implementation of appropriate management practices. These management practices would include lining and covering any accumulated stockpiles of contaminated soils, and lining and covering trucks used to transport the soil off-site. Deed restriction on groundwater utilization will provide protection to the community and the base personnel during the remedial process.

Because Alternative 4A provides for removal of the contaminated soil, it is very effective in the short-term in meeting the remedial objectives for soil. Alternative 4A is also effective in the short-term meeting the remedial objective for groundwater of preventing further contaminant migration. However, complete achievement of the remedial objective for groundwater, which includes achievement of groundwater ARARs, will require groundwater recovery and treatment for a period of years.

It is estimated that the time to implement this alternative from the issuance of the Record of Decision through construction would be approximately two years.

Implementability

Excavation, off-site disposal, and the groundwater collection and treatment system components are proven remedial technologies available from a number of vendors. No significant site-specific implementation difficulties are foreseen. The operation and maintenance of the groundwater collection and treatment system, and groundwater monitoring activities are routine.

The discharge of treated water to Cayuga Creek will require a New York State SPDES Permit; however, the technologies selected will meet the permit requirements. The fencing and deed restrictions are clearly implementable.

The disposal of excavated soils will result in increased trucking activity requiring evaluation of any transportation and traffic volume generated as a result of this alternative.

Cost

The following costs have been estimated in Table 6-13 for implementing Alternative 4A:

- Capital costs = $1,554,000
- Annual operating costs = $160,600
- 30-year present worth cost = $4,023,000

6.3.6 Comparative Analysis of Alternatives

This section presents a comparative analysis of the four remedial alternatives evaluated for Site 10. This comparative analysis is based upon the evaluation criteria presented in Section 6.3.

Overall Protection of Human Health and the Environment

Because Alternative 1 includes no remedial actions to prevent contaminant migration, contain or remove the contaminant source, or treat any of the contaminated media the existing exposure pathways would remain unabated. Therefore, Alternative 1 is clearly not protective of human health and the environment.

Alternative 3A provides a significantly greater level of protection than Alternative 1 by controlling both the source and migration of contaminants, and applying institutional controls to further preclude exposure to soils and groundwater. Alternative 3A therefore, protects all significant human exposure pathways, and protects environmental receptors in contact with surface water, groundwater, and the land surface.

Alternative 3B provides protection of human health and the environment similar to Alternative 3A. However, the slurry wall included in Alternative 3B would provide additional containment to completely isolate the contaminated source area, preventing further contaminant migration.

Alternative 4A would provide a level of protection to human health and the environment similar to Alternatives 3A and 3B. However, through removal of the contaminant source, Alternative 4A would eliminate exposure to environmental receptors in the contaminated soil, and expedite restoration of the site's groundwater while permitting unrestricted land use.

Compliance with ARARs

Alternative 1 will not ensure compliance with any of the ARARs established for the Site 10 area within a reasonable or predictable time frame. Alternatives 3A and 3B achieve all ARARs, with the exception the TBCs currently proposed by the NYSDEC for soil. However, Alternatives 3A and 3B do provide for adequate containment of contaminated soils. Alternative 4A would meet all ARARs, including those for soil.

Long-term Effectiveness and Permanence

The no action alternative is neither effective nor permanent in reducing the magnitude of residual risk associated with Site 10. The long-term effectiveness of Alternatives 3A and 3B rely on a long-term O&M program for the groundwater collection and treatment system, the cap (Alternatives 3A and 3B), and the slurry wall (Alternative 3B). The long-term effectiveness of Alternative 3B is somewhat greater than that of Alternative 3A due to the total isolation of the contaminant source area provided in this alternative. Alternative 4A provides the greatest degree of long-term effectiveness due to the removal of the contaminant source.

Reduction of Toxicity, Mobility, and Volume

Since this evaluation criterion applies only to treatment of source areas, this evaluation is not applicable for the retained alternatives.

Short-Term Effectiveness

Although Alternative 1 will not have any short-term impacts on workers, the public, or the environment; it will also not be effective in the short-term to meet any of the remedial objectives established for the Site 10 area.

Alternatives 3A, 3B, and 4A all provide short-term effectiveness for protection of human health by eliminating the human exposure pathways to soil and groundwater. Exposure to workers, the community, and the environment during implementation of remedial actions for Alternatives 3A, 3B, and 4A would be controlled through mitigation measures, access limitations, and the deed restrictions. However, Alternatives 3B and 4A will require the most significant mitigation measures.

Alternatives 3A, 3B, and 4A will all result in meeting remedial objectives for preventing migration of contaminants in soils and groundwater. However, only Alternative 4A will be effective in the short-term in meeting soil TBCs or remediation levels. Alternatives 3A, 3B, and 4A will each require several years in order to achieve groundwater ARARs.

Implementability

Alternative 1 is highly implementable although it includes no remedial actions and is ineffective in meeting the remedial objectives.

Alternatives 3A, 3B, and 4A all employ proven remedial technologies that are commercially available from a number of vendors, and are therefore implementable. All three of these alternatives include similar groundwater treatment systems which may require treatability studies in the remedial design phase.

Although Alternatives 3A, 3B, and 4A are each implementable, different levels of difficulty are associated with the specific field construction and installation activities associated with each of these alternatives. Alternative 3A includes excavation of contaminated soils to install a perimeter drain. Alternative 4A also includes the excavation of contaminated soil, but involves greater quantities of soil than Alternative 3A. Like Alternatives 3A and 4A, Alternative 3B includes the removal and handling of some contaminated soil and bedrock material. For these reasons, Alternative 3B may be the most difficult to implement.

Costs

A comparison of the total net present worth costs for each alternative are presented in Table 6-16. Alternative 3A (Containment - Cap) is the least expensive and Alternative 4A (Containment - Cap and Slurry Wall) is the most expensive.

6.3.7 Recommended Alternative

Based on the evaluation of alternatives (conducted in Sections 6.3.2 through 6.3.5) and the comparative analysis of alternatives (Section 6.3.6), Alternative 1 is rejected because it would not meet the remedial objectives. As indicated in Section 6.2.6, this FFS has been written based on the assumption that the soil can be disposed at a non-hazardous solid waste landfill. If it can not, the soil would require incineration. Therefore, an evaluation of the soils classification is required. If the soil is indeed non-hazardous, Alternative 4A (Source Removal and Land Disposal) is recommended for Site 10. Alternative 4A provides the greatest degree of long-term effectiveness due to the removal of the contaminant source and the associated cost is in line with Alternatives 3A and 3B.

However, if the soil at Site 10 is classified as hazardous, the recommended alternative is Alternative 3A (Containment, Cap Only). Alternative 3A protects all significant human exposure pathways, and protects environmental receptors in contact with surface water and groundwater. Both Alternatives 3A and 3B achieve ARARs. While Alternative 3B provides greater reduction in contaminant mobility, its significantly higher costs cannot be justified. The groundwater collection system of Alternative 3A will effectively address mobility.

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SELECTED REFERENCES

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Note: Porosity values taken from McWhorter and Sunada, 1977; original reference Morris and Johnson, 1967.

WehranEnviroTech

APPENDICES

APPENDIX A
BORING LOGS

NEW MONITORING WELLS INSTALLED BY WEHRAN – LIMITED RI/FS IRP SITE 10 WELL INSTALLATIONS

BORING/WELL NO. MW10A

SHEET 1 of 1

PROJECT: Limited RI/FS IRP Site 10
PROJECT NO: 00640-02
CLIENT: United States Air Force - AFRES
CONTRACTOR: Parratt - Wolff
RIG: D-50

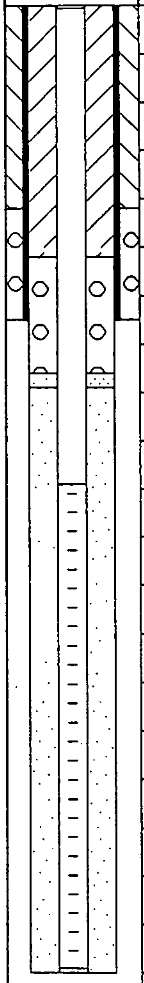
GS ELEV: 588.08 ft.
N-S COORD: 1185.37
E-W COORD: 1100.00
WL REF ELEV: 590.12ft.
DATE STARTED: 11/19/91
DATE FINISHED: 11/20/91
OPERATOR: Doug Richmond
GEOLOGIST: GWH

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	Iron	SS		
DIAM.	6"			
WEIGHT				
FALL				

WELL CONSTRUCT



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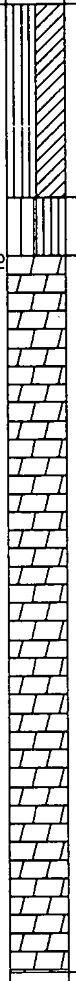


DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (inches)	BLOWS (per 6")	UNIFIED	FIELD DESCRIPTION	REMARKS
	1		10	3, 8 8, 10	ML CL	Dark brown SILT, some (-) fine SAND, trace CLAY, medium dense, damp, roots.	Cuttings and barrel at background HNu.
	2		10	7, 10 17, 21		Red, brown, laminated SILT and CLAY, trace fine SAND, damp, medium dense.	
5	3		12	13, 24 50/0.2	SM ML	Red, brown SILT and fine SAND, trace CLAY, moist dense. At 5.2 feet, weathered Lockport Dolomite.	Slight petroleum odor.
	4		0	50/0		Top of Rock at 5.2 feet. Lockport Dolostone.	Attempt spoon at 6.0 feet. Competent at 6.0 feet. Advanced augers to 6.5 ft. Bentonite seal to 6.5 feet to 4.5 feet. 6-inch casing set at 6.5 feet.
10							
						See next sheet for description.	
15							
20						End of hole at 20.0 feet.	
25							

ROCK BORING/WELL NO. MW10A

SHEET 1 of 1

PROJECT: *Limited RI/FS IRP Site 10*
PROJECT NO: *00640-02*
CLIENT: *United States Air Force - AFRES*
CONTRACTOR: *Parratt - Wolff*
RIG: *D-50*

GS ELEV: *588.08 ft.*
N-S COORD: *1185.37*
E-W COORD: *1100.00*
WL REF ELEV: *590.12ft.*
DATE STARTED: *11/19/91*
DATE FINISHED: *11/20/91*
OPERATOR: *Doug Richmond*
GEOLOGIST: *GWH*

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	*Iron*			
DIAM.	*6"*			*2.5"*
WEIGHT				
FALL				

WELL CONSTRUCT	DEPTH (feet)	RUN NUMBER	SAMPLE & TYPE	RECOVERY %	RQD %	LOG	UNIFIED	FIELD DESCRIPTION	REMARKS
	5							Top of Rock at 5.2 feet.	
								No samples. Start of coring at 6.5 feet.	Augered to 6.5 ft.
	10	1		3.5' 51	63.4			Gray porous, fine textured, vuggy Dolomitic LIMESTONE. Lockport DOLOMITE with gypsum and thin bedding. Fractures at 6.5 to 6.66 ft. (rubble); 6.85 ft., 7.2 ft., 7.27 ft. (at 90°); 7.5 ft. (60°); 7.85 ft. (fracture at 30°); 8.0 ft. (fracture at 45°); 8.8 ft. (fracture at 30°); 9.05 ft. (joint at 0° to 10 ft.); 9.2ft., 9.35 ft. (at 90°).	Return water has petroleum odor. Rate at 5min./ft.
	15	2		5.0' 92	100			Lockport DOLOMITE, fossiliferous limestone with frequent small vugs and gypsum. Fractures at 10.8 ft. (90°); 13.12 ft., 13.46 ft. (at 90° drill breaks on bedding); 13.65 ft., 13.75 ft., 13.90 ft. as drill breaks. Vugs layer at 13.9 to 15 ft.	Barrel stuck in hole.
	20	3		5.0' 100	100			Lockport DOLOMITE, sphalerite. No fractures, all hand breaks and vugs.	
	25							End of hole at 20.0 feet.	

BORING/WELL NO. MW10B

SHEET 1 of 1

PROJECT: *Limited RI/FS IRP Site 10*
PROJECT NO: *00640-02*
CLIENT: *United States Air Force - AFRES*
CONTRACTOR: *Parratt - Wolff*
RIG: *D-50*

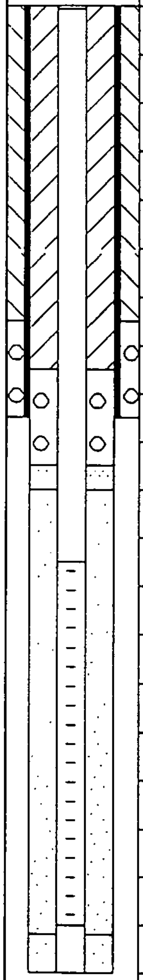
GS ELEV: *586.71 ft.*
N-S COORD: *785.66*
E-W COORD: *1213.00*
WL REF ELEV: *588.84ft.*
DATE STARTED: *11/20/91*
DATE FINISHED: *11/21/91*
OPERATOR: *Doug Richmond*
GEOLOGIST: *GWH*

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	*Iron*	*SS*		
DIAM.	*6"*			
WEIGHT				
FALL				

WELL CONSTRUCT



DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (inches)	BLOWS (per 6")	LOG	UNIFIED	FIELD DESCRIPTION	REMARKS
	1		10	3, 4 8, 10		ML/CL	Dark brown SILT, little (+) CLAY, moist, dense, roots to 0.5 ft. Red brown SILT and CLAY, trace fine SAND, moist, dense.	Cuttings and barrel at background HNu.
	2		12	9, 13 16, 22		ML	Red brown laminated, mottled SILT, trace (+) fine SAND, some (-) CLAY, moist, medium dense.	
5	3		14	4, 8 9, 9		CL	Red brown CLAY, varved, trace (+) SILT, moist, medium stiff.	
	4		12	3, 3 7 50/0.4			Red brown CLAY and SILT to 6.3 feet. 6.3 to 7.7 feet, red brown fine SAND, little SILT, trace fine GRAVEL, moist, medium dense.	Augers advanced to 8.5 feet. Bentonite seal 8.5 to 6.5 feet. Set 6-inch casing to 8.5 feet.
	5		0	50/0.4			No recovery. Top of Rock at 7.7 feet. Lockport Dolostone.	
10								
15							See next sheet for description.	
20							End of hole at 20.0 feet.	
25								

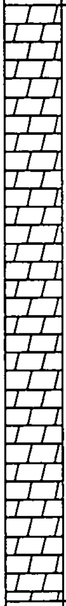
ROCK BORING/WELL NO. MW10B

SHEET 1 of 1

PROJECT: *Limited RI/FS IRP Site 10*	PROJECT NO: *00640-02*	GS ELEV: *586.71 ft.*
CLIENT: *United States Air Force - AFRES*		N-S COORD: *785.66*
CONTRACTOR: *Parratt - Wolff*	RIG: *D-50*	E-W COORD: *1213.00*

GROUNDWATER DATA (feet)		CASING	SAMPLE	TUBE	CORE
DATE / GW DEPTH / GW ELEV / INTAKE	TYPE	*Iron*			
	DIAM.	*6"*			*2.5"*
	WEIGHT				
	FALL				

WL REF ELEV: *588.84ft.*
DATE STARTED: *11/19/91*
DATE FINISHED: *11/20/91*
OPERATOR: *Doug Richmond*
GEOLOGIST: *GWH*

WELL CONSTRUCT	DEPTH (feet)	RUN NUMBER	SAMPLE & TYPE	RECOVERY %	RQD %	LOG	UNIFIED	FIELD DESCRIPTION	REMARKS
	5								
								Top of Rock at 7.7 feet.	
								Start of coring at 8.5 feet.	
	10	1		1.5' 100	100			Lockport DOLOMITE, porous, fossiliferous, lams, no infitted fractures, small vugs. Fractures at 9.68 feet (at 30°).	Petroleum odor on water and rock.
	15	2		5.0' 97	99			Gray Lockport DOLOMITE, fossiliferous. Rod drop at 14.4 feet. Void 0.15 feet thick has rubble. Void at 14.4 feet, fractures at 10.4 ft., 13.6 ft. (at 90°); 14.06 ft. (bedding).	
	20	3		5.0' 100	99			Lockport DOLOMITE, vuggy with fractures. Fracture at 16.45 feet, calcite and CLAY filled (at 90°).	Barrel locked in hole, hard to remove, some sand. Fell to total depth. Taped hole to 19.2 ft.
								End of hole at 20.0 feet.	
	25								

BORING/WELL NO. MW10C

SHEET 1 of 1

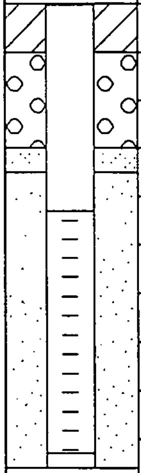
PROJECT: *Limited RI/FS IRP Site 10*
PROJECT NO: *00640-02*
CLIENT: *United States Air Force - AFRES*
CONTRACTOR: *Parratt - Wolff*
RIG: *D-50*

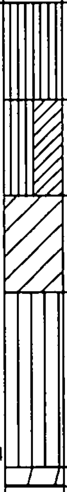
GS ELEV: *586.95 ft.*
N-S COORD: *900.59*
E-W COORD: *1039.45*
WL REF ELEV: *589.11ft.*
DATE STARTED: *11/20/91*
DATE FINISHED: *11/20/91*
OPERATOR: *Doug Richmond*
GEOLOGIST: *GWH*

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	*Iron*	*SS*		
DIAM.	*6"*			
WEIGHT				
FALL				





DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (inches)	BLOWS (per 6")	UNIFIED	FIELD DESCRIPTION	REMARKS
	1	☒	12	3, 6 7, 10	ML	Black brown SILT, some (-) fine SAND, trace CLAY, moist, loose. Red brown CLAY in shoe.	Cuttings and barrel at background HNu.
	2	☒	6	8, 10 14, 11	ML/CL	Red brown mottled CLAY, little (+) SILT, trace (-) fine SAND, stiff, moist.	
5	3	☒	15	17, 16 15, 13	SC	Red brown SILT, some (+) CLAY, trace very fine SAND, trace fine GRAVEL, medium dense, moist. TILL.	▼
	4	☒	18	6, 3 9, 11	SM	Red brown SILT and very fine SAND, little (+) very fine GRAVEL, trace CLAY, moist, wet.	
	5	☒	14	6, 9 50/0.4		Red brown SILT and very fine SAND, trace very fine GRAVEL, trace CLAY, moist to wet. At 9.4 feet, weathered Lockport DOLOMITE.	
10						End of hole at 9.4 feet.	
15							
20							
25							

BORING/WELL NO. MW10D

SHEET 1 of 1

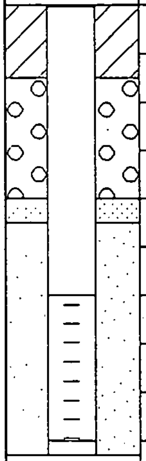
PROJECT: *Limited RI/FS IRP Site 10*	PROJECT NO: *00640-02*	GS ELEV: *587.49 ft.*
CLIENT: *United States Air Force - AFRES*		N-S COORD: *929.60*
CONTRACTOR: *Parratt - Wolff*	RIG: *D-50*	E-W COORD: *972.21*
		WL REF ELEV: *589.49ft.*
		DATE STARTED: *11/21/91*
		DATE FINISHED: *11/21/91*
		OPERATOR: *Doug Richmond*
		GEOLOGIST: *GWH*

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	*Iron*	*SS*		
DIAM.	*6"*			
WEIGHT				
FALL				

WELL CONSTRUCT



DEPTH (feet)	SAMPLE NUMBER	SAMPLE & TYPE	RECOVERY (inches)	BLOWS (per 6")	LOG	UNIFIED	FIELD DESCRIPTION	REMARKS
	1	☒	13	2,5 6,4		ML	Topsoil to 1 ft. Brown black SILT and fine SAND, trace CLAY, moist, roots. Red brown SILT, some (+) CLAY, roots, moist, stiff.	Cuttings and barrel at background HNu.
	2	☒	12	9,8 9,10		CL	Red brown CLAY, little (-) SILT, stiff, damp. Red brown mottled, varved CLAY, little SILT, trace (+) fine SAND, damp, stiff to 5.1 feet.	
5	3	☒	24	6,9 15,11		SM ML	Red brown SILT, little (-) very fine SAND, little CLAY, moist, dense, percent GRAVEL increases to 6.0 feet.	
	4	☒	12	4,5 7,7		ML	Red brown SILT, little (+) CLAY, trace (+) SAND, trace (-) medium to fine GRAVEL, moist.	
	5	☒	8	5,8 50/0.3			Red brown SILT, little (+) CLAY, trace (+) SAND, trace (-) medium to fine GRAVEL, moist, soft. Top of rock at 9.3 feet.	
10							End of hole at 9.3 feet.	
15								
20								
25								

BORING/WELL NO. MW10E

SHEET 1 of 1

PROJECT: Limited RI/FS IRP Site 10
PROJECT NO: 00640-02
CLIENT: United States Air Force - AFRES
CONTRACTOR: Parratt - Wolff
RIG: D-50

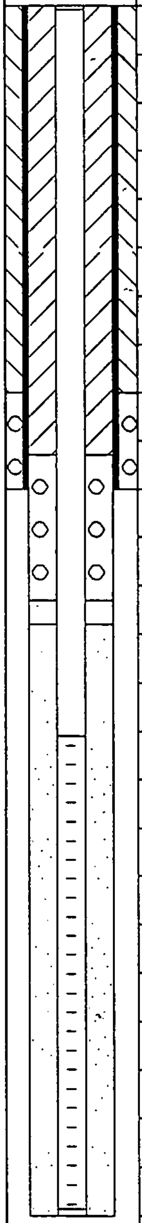
GS ELEV: 586.52 ft.
N-S COORD: 789.17
E-W COORD: 1055.38
WL REF ELEV: 588.24ft.
DATE STARTED: 11/22/91
DATE FINISHED: 11/25/91
OPERATOR: Doug Richmond
GEOLOGIST: GWH/GOC

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	Iron	SS		
DIAM.	6"			
WEIGHT				
FALL				

WELL CONSTRUCT



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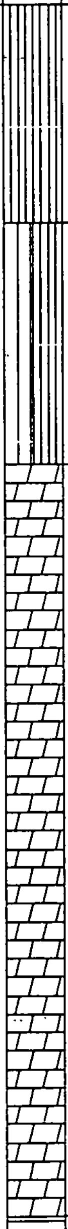


DEPTH (feet)	SAMPLE NUMBER	RECOVERY (inches)	BLOWS (per 6")	UNIFIED	FIELD DESCRIPTION	REMARKS
	1	12	2, 3 5, 10	ML	Black brown SILT, little CLAY, trace fine SAND, roots, moist to 0.66 ft. Red brown SILT and CLAY, stiff, damp to 2.0 ft.	Cuttings and barrel at background HNu.
	2	8	13, 16 16, 17		Red brown SILT and CLAY, damp, stiff, mottled.	
					Red brown SILT and (+) CLAY, stiff, damp, mottled, laminated from 4.0 to 4.5 feet.	
5	3	14	5, 9 14, 14	SM ML	Red brown SILT and (-) very fine SAND, little (-) CLAY, trace (-) fine GRAVEL, moist, dense.	
	4	14	7, 8 9, 10		Red brown SILT and very fine SAND, trace CLAY, trace fine GRAVEL, moist, soft.	
	5	18	5, 5 14 50/0		Red brown SILT and very fine SAND, trace (+) CLAY, trace (+) fine GRAVEL, wet, soft	
10	6	0	50/0		Top of Rock at 9.5 feet. Lockport Dolostone.	6-inch casing set at 10 ft. through bentonite at 8 to 10 ft.
15						
					See next sheet for description.	
20						
25					End of hole at 25.0 feet.	

ROCK BORING/WELL NO. MW10E

SHEET 1 of 1

PROJECT: *Limited RI/FS IRP Site 10*
PROJECT NO: *00640-02*
CLIENT: *United States Air Force - AFRES*
CONTRACTOR: *Parratt - Wolff*
RIG: *D-50*

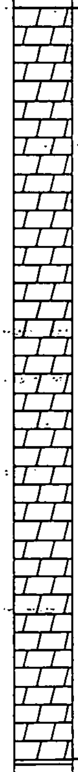
GS ELEV: *586.52 ft.*
N-S COORD: *789.17*
E-W COORD: *1055.38*
WL REF ELEV: *588.24ft.*
DATE STARTED: *11/22/91*
DATE FINISHED: *11/25/91*
OPERATOR: *Doug Richmond*
GEOLOGIST: *GWH/GOC*

GROUNDWATER DATA (feet)

DATE	GW DEPTH	GW ELEV	INTAKE

	CASING	SAMPLE	TUBE	CORE
TYPE	Iron			
DIAM.	6"			2.5"
WEIGHT				
FALL				

WELL CONSTRUCT	DEPTH (feet)	RUN NUMBER	SAMPLE & TYPE	RECOVERY %	RQD %	LOG	UNIFIED	FIELD DESCRIPTION	REMARKS
	9.5							Top of Rock at 9.5 feet.	
	10							No samples. Start of coring at 10.0 feet.	Augered to 10.0 ft.
	10–15	1		5.0' 100	50			Dark gray vuggy, somewhat fossiliferous Lockport DOLOSTONE. 10.3 ft. (irregular at 30°); 10.8 ft. (irregular angle at horizontal); 11.9 ft. (irregular, angle varied with clay infill); 12.3 ft. (smooth at 30°); 12.85 ft. (irregular, angle at sub horizontal); 12.85 to 13.2 ft. (smooth at 70°); 13.5 to 14.4 ft. (drill breaks).	
	15–20	2		5.0' 90	75			Dark gray vuggy, somewhat fossiliferous Lockport DOLOSTONE. 15.3 ft. (rough, angle at sub horizontal); 15.5 ft. (smooth, angle at horizontal); 16.05 to 16.2 ft. (irregular, sub horizontal, infilled with clay and fine gravel); 16.7 ft. (smooth, angle at horizontal); 16.95 to 17.5 ft. (irregular, some clay and fine gravel infill - zone of possible core loss).	
	20–25	3		5.0' 100	76			Dark gray vuggy, somewhat fossiliferous Lockport DOLOSTONE. 20.1 to 20.3 ft. (rubble); 20.8 to 21.1 ft. (drill break in vuggy zone); 21.5 to 21.8 ft. (broken up in vuggy area); 22.6 ft. (smooth, angle at sub horizontal - possible drill break).	
	25							End of hole at 25.0 feet.	



EXISTING MONITORING WELLS INSTALLED BY OTHERS – STAGE 1 AND IRP RI/FS WELL INSTALLATIONS (IRB ASSOCIATIES AND SAIC, RESPECTIVELY)

JRB ASSOCIATES
A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

DRILLING LOG

Project: Niagara Falls AFRF
Owner: USAF
Well No.: 10-1

Site Sketch

Location: Abandoned Fire Training Area E of Bldg. 722
Reference Point:
Reference Point Elevation:

Field Book No.: 2 pp5-6
Log By: C. Kruger
Driller: J.Genovese/Empire
Rig Type: CME-45
Total Depth: 8.8' BLS

	Date	Time
Drilling Started:	10/23/84	1502
Drilling Completed:	10/23/84	1552

Water Level: 6.35' BTC

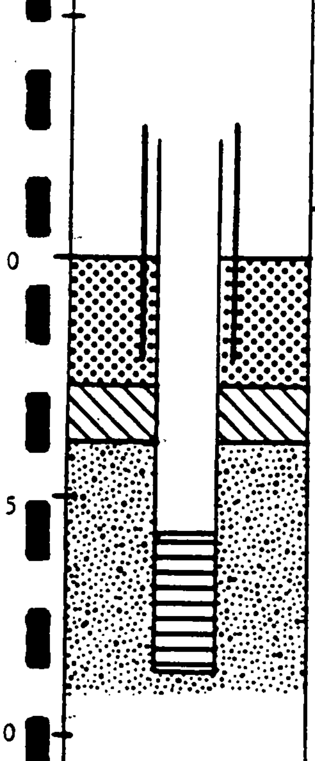
Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less DESCRIPTION
0				
				S.I. 2.0-3.5' BLS Rec. 0.8'
2.5		SS#1	27	silt and clay, trace gravel:dark grey(10YR 4/1) to dark brown
	▨			(7.5YR 4/2):firm:dense:compact:dry:pervasive pungent petroleum
	▨			odor on sample and downhole
5.0				
				S.I. 6.0-7.5' BLS Rec. 1.4'
	▨	SS#2	28	0.8' silt and clay, some sand near interval base;reddish brown
	▨			(2.5YR 4/4) with some grey(2.5YR 5/0) to dark brown (10YR
7.5	▨			4/3) mottles;firm;very dense;compact;dry;finely laminated
				0.4' silt and fine sand, trace clay, trace fine gravel:dark
				reddish brown(5YR 3/4) with greenish grey (5GY 6/1) mottles;
	▨			firm:medium dense:moist:slight petroleum odor
	▨			0.2' silt and clay, trace fine sand:reddish brown(5YR 4/4):firm:
10.0				dense:compact:dry

≈8.8' BLS bedrock

JRB ASSOCIATES
A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

WELL CONSTRUCTION SUMMARY

Project: Niagara Falls AFRF Owner: USAF Well No.: 10-1



Drilling Summary:

Total Depth: 8.8' BLS
Drillers: J.Genovese/Empire
Borehole Diameter(s): 6.0"
Rig Type: CME-45
Elevation: Land Surface: 587.43'
Bit(s): Auger
Top of Casing: 589.88'
Drilling Fluid Type: none
Supervisory Geologist: A.Wickline,C.Kruger
Amount Use: -
Log Book No. 2 pp. 5-6
Water Level: 6.35' BTC

Well Design:

Casing: Material: PVC
Screen: Material: PVC
Diameter: 2.0" ID 2.5" OD
Diameter: 2.0" ID
Length: 11.3'
Slot: 10/inch
Filter: Material: 40 sand
Setting: 5.8-8.8' BLS
Setting: 3.8-8.8' BLS
Seals: Type: Bentonite Pellets
Grout: Type: #1 Portland Cement:Bentonite 19:1
Setting: 2.8-3.8' BLS
Setting: LS-2.8' BLS
Surface Casing: 4.0" ID steel w/lock
Other:

Time Log:

	Started		Completed	
Drilling:	10/23/84	1502	10/23/84	1522
Installation:	10/23/84	1529	10/23/84	1552
Water Level Reading:	11/05/84	1450	11/09/84	1419
Development:	11/05/84	1450	11/09/84	1454

Well Development:

Method/Equipment: Bailer, CME-45 pump
Static Depth to Water:
Pumping Depth to Water:
Pumping Rate:
Volume Pumped: 6.6 gal

JRB ASSOCIATES
A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

DRILLING LOG

Project: Niagara Falls AFRF
Owner: USAF
Well No.: 10-2

Location: Abandoned Fire Training Area E of Bldg. 722
Field Book No.: 2 pp 3-4
Log By: C.Kruger
Driller: J.Genonvese/Empire
Rig Type: CME-45
Reference Point:
Total Depth: 9.0' BLS
Reference Point Elevation:

	Date	Time
Drilling Started:	10/23/84	1413
Drilling Completed:	10/23/84	1428

Water Level: 6.92' BTC

Site Sketch

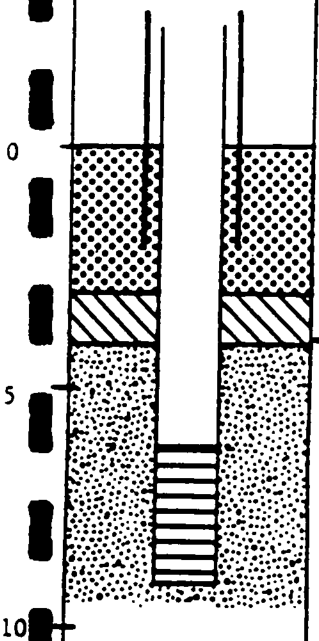
Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	Legend S.I. Sampling Interval Rec. Recovery Grain Size and 50 to 40% some 40 to 10% trace 10% or less **DESCRIPTION**
0				
2.5				
				S.I. 3.0-4.5' BLS Rec. 1.2'
		SS#1	18	silt and clay:brown(10YR 5/3) with common grey(2.5Y 5/0) to
				reddish brown(5YR 4/4) mottles:firm:dense:compact:slightly damp:
				laminated
5.0				
7.5				S.I. 7.5-9.0' BLS Rec. 0.25'
		SS#2	32	0.2' silt and clay, some gravel, some fine sand:dark red(2.5YR
				3/6) with common reddish brown(5YR 4/4) to light yellowish
				brown(2.5Y 6/4) mottles;dense;compact;moist
				0.05' dolomitic bedrock:light grey(5Y 7/1) mottled light grey
10.0				(N 6/0);equigranular;phaneritic

±9.0' BLS bedrock

JRB ASSOCIATES
A Company of Science Applications, Inc.
400 Westpark Drive, McLean, Virginia 22102

WELL CONSTRUCTION SUMMARY

Project: Niagara Falls AFRF Owner: USAF Well No.: 10-2



Drilling Summary:

Total Depth: 9.0' BLS Drillers: J.Genovese/Empire

Borehole Diameter(s): 6.0"

Rig Type: CME-45

Elevation: Land Surface: 588.00' Bit(s): Auger

Top of Casing: 590.40' Drilling Fluid Type: none

Supervisory Geologist: A.Wickline,C.Kruger Amount Use: -

Log Book No. 2 pp. 3-4 Water Level: 6.92' BLS

Well Design:

Casing: Material: PVC Screen: Material: PVC

Diameter: 2.0" ID 2.5" OD Diameter: 2.0"ID

Length: 11.5' Slot: 10/inch

Filter: Material: 40 sand Setting: 6.0-9.0' BLS

Setting: 4.0-9.0' BLS Seals: Type: Bentonite Pellets

Grout: Type: #1 Portland Cement:Bentonite 19:1 Setting: 3.0-4.0' BLS

Setting: LS-3.0' BLS Surface Casing: 4.0"ID steel w/lock

Other:

Time Log:

	Started		Completed	
Drilling:	10/23/84	1413	10/23/84	1428
Installation:	10/23/84	1437	10/23/84	1600
Water Level Reading:	11/05/84	1409	11/09/84	1413
Development :	11/05/84	1409	11/09/84	1435

Well Development:

Method/Equipment: Bailer

Static Depth to Water:

Pumping Depth to Water:

Pumping Rate:

Volume Pumped: 5.4 gal

JRB ASSOCIATES
A Company of Science Applications, Inc.
8400 Westpark Drive, McLean, Virginia 22102

DRILLING LOG

Project: Niagara Falls AFRF **Owner:** USAF **Well No.:** 10-3

Site Sketch

Location: Abandoned Fire Training Area E of Bldg. 722

Reference Point:

Reference Point Elevation:

Field Book No.: 2 pp 1-2

Log By: A.Wickline, C.Kruger

Driller: J.Genovese/Empire

Rig Type: CME-45

Total Depth: 9.9' BLS

	Date	Time
Drilling Started:	10/23/84	1317
Drilling Completed:	10/23/84	1330
Water Level:	6.36' BTC	

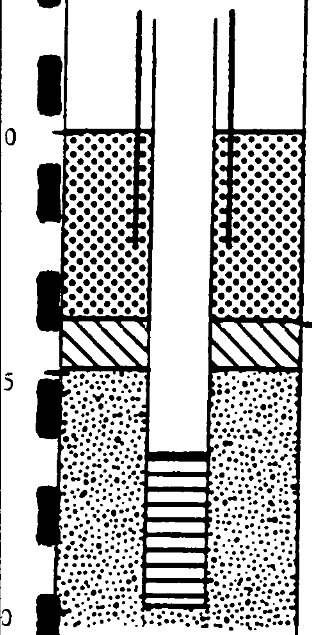
Legend
S.I. Sampling Interval
Rec. Recovery
Grain Size
and 50 to 40%
some 40 to 10%
trace 10% or less

Depth (feet)	Graphic Log	Sample Type and Number	Blow Count (N)	DESCRIPTION
0				
				S.I. 4.5-6.0' BLS Rec. 1.4'
5	▨	SS#1	48	silt and clay, trace fine sand, trace gravel:dark red(2.5YR 3/6)
	▨			with some reddish brown(5YR 4/4) to light yellowish brown(2.5Y
				6/4) mottles:friable:dense:compact:dry
		SS#2	86	S.I. 9.5-9.9' BLS Rec. 0.2'
10	▨			dolomitic bedrock;very dark grey(10YR 3/1);equigranular
	▨			
				≈9.9' BLS bedrock

JRB ASSOCIATES
A Company of Science Applications, Inc.
8[illegible]0 Westpark Drive, McLean, Virginia 22102

WELL CONSTRUCTION SUMMARY

Project: Niagara Falls AFRF Owner: USAF Well No.: 10-3



Drilling Summary:

Total Depth: 9.9' BLS Drillers: J.Genovese/Empire
Borehole Diameter(s): 6.0"
Rig Type: CME-45
Elevation: Land Surface: 588.37' Bit(s): Auger
Top of Casing: 590.67' Drilling Fluid Type: none
Supervisory Geologist: A.Wickline,C.Kruger Amount Use: -
Log Book No. 2 pp. 1-2 Water Level: 6.36' BTC

Well Design:

Casing: Material: PVC Screen: Material: PVC
Diameter: 2.0" ID 2.5" OD Diameter: 2.0"ID
Length: 12.4' Slot: 10/inch
Filter: Material: 40 sand Setting: 6.9-9.9' BLS
Setting: 4.9-9.9' BLS Seals: Type: Bentonite Pellets
Grout: Type: #1 Portland Cement:Bentonite 19:1 Setting: 3.9-4.9' BLS
Setting: LS-3.9' BLS Surface Casing: 4.0" ID steel w/lock
Other:

Time Log:

	Started		Completed	
Drilling:	10/23/84	1317	10/23/84	1330
Installation:	10/23/84	1340	10/23/84	1610
Water Level Reading:	11/05/84	1517	11/09/84	1404
Development :	11/05/84	1517	11/05/84	1600

Well Development:

Method/Equipment: CME-45 pump
Static Depth to Water:
Pumping Depth to Water:
Pumping Rate:
Volume Pumped: 15.2 gal

MONITORING WELL CONSTRUCTION SUMMARY

Well No. : MW 10-4
Location (NY. Coord.
Northings : 1,133,8.0.635
Eastings : 406,563.118
Reference Point : TOP OF PVC CASING
Reference Point Elev. : 589.39 MSL
Type of Security : STEEL CASING WITH
: LOCKING CAP
Supervisory Geologist : S. KELLER
Log Book/Page No. : 3/98-105
Drilling Company : EMPIRE SOILS INVESTIGATION
Rig Type : CME 45; HOLLOW-STEM AUGER
Driller : K. FULLER
Drilling Started : 0825 HR/7-21-89
Drilling Completed : 1325 HR/7-21-89

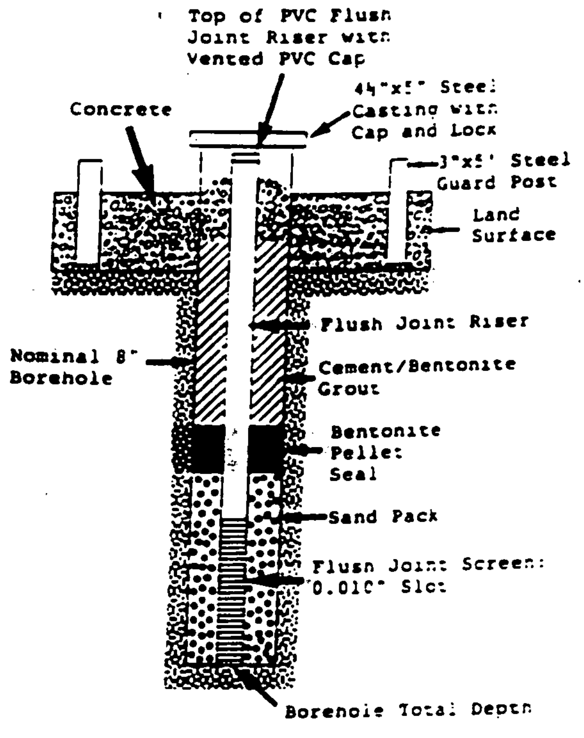
Development
Date : 7/25/89
Type : BAILER
Volume Purged : 17 GAL
(bailed well dry twice)

Water Level/Date: 7.44 BTOC/10-04-89
581.95 MSL

Hydraulic Conductivity: NA

MONITORING WELL AS-BUILT

		BLS	MSL
Land Surface		0.00	586.96
Top of PVC Flush Joint Riser Measured at Reference Point		+ 2.43	589.39
Cement/Bentonite Grout	Top	1.50	588.46
	Bottom	2.50	584.46
2" I.D. Schedule 40 PVC Flush Joint Riser	Top	+ 2.43	589.39
	Bottom	4.50	582.46
Bentonite 1/4" Pellet Seal	Top	2.50	584.46
	Bottom	3.50	583.46
2" I.D. Schedule 40 PVC Flush Joint Screen 0.010" Slot	Top	4.50	582.46
	Bottom	7.90	579.06
4Q Sand Pack	Top	3.50	583.46
	Bottom	7.90	579.06
8" Borehole Total Depth		7.90	579.06



NOT TO SCALE

All measurements in feet unless otherwise noted
- Above Land Surface
BLS - Below Land Surface
MSL - Mean Sea Level Datum
BTOC- Below Top of Casing

MONITORING WELL BORING LOG

WB-10-4

DEPTH (ft.BLS)	LITHOLOGIC SYMBOLS	SAMPLE NUMBER	BLOW COUNT	SAMPLE INTERVAL (ft.BLS)	RECOVERY (ft.)	SOIL TYPE (USCS)	LITHOLOGIC DESCRIPTION	OVA (PPM)	LEL (%)
0.0	-	WB-10-4-1	3,6,8	0.0-1.5	1.0	CL	CLAY TO SILTY CLAY; fissile; low to med-plastic; firm; moist; strong brown(7.5YR4/6).	bkgd	0
	-								
1.0	-								
	-	WB-10-4-2	8,8,13	1.5-3.0	1.5	CL	CLAY TO SILTY CLAY; fissile; low to med-plastic; firm; moist; brown(7.5YR4/2).	bkgd	0
2.0	-								
	-								
3.0	-	WB-10-4-3	9,5,12	3.0-4.5	1.5	CL	CLAY TO SILTY CLAY; fissile; med-plastic; firm; moist; reddish brown(5YR5/3).	bkgd	0
	-								
4.0	-								
	-	WB-10-4-4	6,9,11	4.5-6.0	1.5	CL	CLAYEY SILT; subr pebbles; low-plastic; soft; moist; yellowish red(5YR4/6).	bkgd	0
5.0	-								
	-								
6.0	-	WB-10-4-5	9,12,15	6.0-7.5	1.5	CL	CLAYEY SILT; some pebbles; mottles; low to med-plastic; soft; wet; yellowish red(5YR4/6).	bkgd	0
	-								
7.0	-								
	-	WB-10-4-6	9,100/.35'	7.5-9.5	0.85	CL	CLAYEY SILT; subang pebbles; low-plastic; soft; wet; yellowish red(5YR4/6).	bkgd	0
8.0	-								
			BEDROCK 7.9'BLS						

MONITORING WELL CONSTRUCTION SUMMARY

Well No. : MW 10-1D
Location (NY. Coord.)
Northings : 1,133,805.763
Eastings : 406,571.706
Reference Point : TOP OF PVC CASING
Reference Point Elev. : 589.64 MSL
Type of Security : STEEL CASING WITH
: LOCKING CAP
Supervisory Geologist : S. KELLER
Log Book/Page No. : 8/46-48,65-68
Drilling Company : EMPIRE SOILS INVESTIGATION
Rig Type : FAILING F-6; HOLLOW-STEM AUGER & AIR ROTARY
Driller : P. BENCE
Drilling Started : 1340-1745 HR/8-1-89
Drilling Completed : 0900-1610 HR/8-4-89

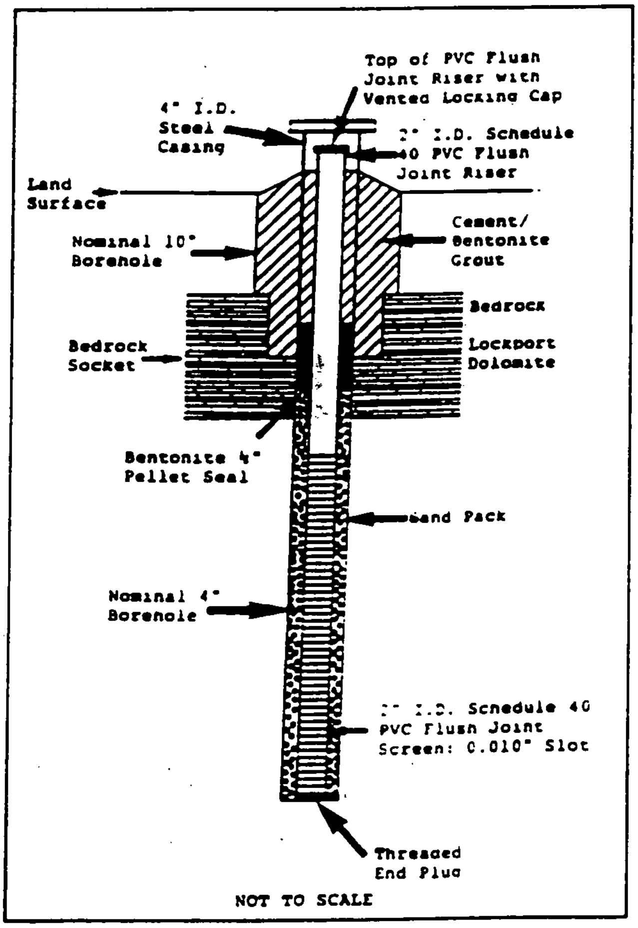
Development
Date : 8/8/89
Type : HAND PUMP
Volume Purged : 100 GAL

Water Level/Date: 7.48 BTOC/ 10-04-89
582.16 MSL

Hydraulic Conductivity: NA

MONITORING WELL AS-BUILT

			BLS	MSL
Land Surface			0.00	587.09
Top of PVC Flush Joint Riser Measured at Reference Point		+	2.55	589.64
4" I.D. Steel casing	Top	+	3.00	590.09
	Bottom		10.50	576.59
Cement/Bentonite Grout	Top		0.00	587.09
	Bottom		6.70	580.39
2" I.D. Schedule 40 PVC Flush Joint Riser	Top	+	2.55	589.64
	Bottom		12.66	574.43
Bentonite 1/4" Pellet Seal	Top		6.70	580.39
	Bottom		11.70	575.39
Bedrock Socket	Top		8.10	578.99
	Bottom		10.50	576.59
2" I.D. Schedule 40 PVC Flush Joint Screen 0.010" Slot	Top		12.66	574.43
	Bottom		32.90	554.19
4Q Sand Pack	Top		11.70	575.39
	Bottom		32.90	554.19
Borehole Total Depth			32.90	554.19



All measurements in feet unless otherwise noted
\+ - Above Land Surface
BLS - Below Land Surface
MSL - Mean Sea Level Datum
BTOC- Below Top of Casing

MONITORING WELL BORING LOG

WB-10-1D

DEPTH (ft.BLS)	LITHOLOGIC SYMBOLS	SAMPLE NUMBER	BLOW COUNT	SAMPLE INTERVAL (ft.BLS)	RECOVERY (ft.)	SOIL TYPE (USCS)	LITHOLOGIC DESCRIPTION	OVA (PPM)	LEL (%)
0.0	-								
	-								
1.0	-								
	-								
2.0	-								
	-								
3.0	-								
	-								
4.0	-								
	-								
5.0	-								
	-	WB-10-1D-1	6,8,11	5.4-6.9	1.5	CL	CLAY TO SILTY CLAY; rock fragments; med-plastic; firm; moist; reddish brown(5YR5/3).	70	0
6.0	-								
	-								
7.0	-	WB-10-1D-2	18,15,100/.2'	6.9-8.1	1.2	GM	GRAVELLY SILT TO FINE SAND; abundant dolomite fragments; low to med-plastic; soft; wet; reddish brown(5YR4/4).	80	0
	-								
8.0	-								
			BEDROCK 8.1'BLS						

SAND PACK GRAIN-SIZE DISTRIBUTION AND UNIFORMITY COEFFICIENT

MORIE SCREENINGS

Typical Physical Analysis
#1 Well Gravel

MM.	Sieve No.	Cum. Grame	% Ret.	% Pass.
1.680	12	.4	.4	99.6
1.410	14	16.2	15.8	83.8
1.190	16	38.0	21.8	62.0
1.000	18	72.2	34.2	27.8
.840	20	92.6	20.4	7.4
.710	25	98.5	5.9	1.5
.590	30	99.2	.7	.8
.500	35	99.8	.6	.2
.420	40	100.0	.2	

Typical Chemical Analysis

SiO_2	99.390
Fe_2O_3	.240
Al_2O_3	.190
TiO_2	.120
CaO	.010
MgO	.004
L.O.I.	.046

Acid solubility (1:1 HCL) .08 to .11%
Sp. Gr. - 2.64 to 2.66

UNIFORMITY COEFFICIENT $C_U = \frac{D_{60}}{D_{10}} = \frac{1.17}{0.88} = 1.33$

$C_U < 2.0$ CONSIDERED UNIFORM.

THE MORIE COMPANY, INC.
MINERS OF INDUSTRIAL SAND AND GRAVEL
Main Office: 1201 N. High St., Millville, NJ 08332
Phone: Area Code 609/327-4500

GEORGIA SILICA DIVISION
Junction City, GA 31812
404/269-3294

ALABAMA SILICA DIVISION
Tuscaloosa, AL 35401
205/758-8353

MONITORING WELL SURVEY DATA

AIRBASE CONVERSION TO NY STATE PLANE [illegible]

ob ID : ABW \SORDATAC\
ob name : AIR BASE
Description : MONITORING WELL LOCATIONS
eference : SITE 10
ield surveyor : ODG DWM
omputer operator : ODG
Date printed : 31 DEC 1991 10:07am

t No.	Easting	Northing	Elev(MS)	Code	Description
10	406584.86	1133637.00	588.24	MW 10EPVC	
15	406742.51	1133638.81	588.84	MW 10BPVC	
9	406565.18	1133747.81	589.11	MW 10CPVC	
7	406497.00	1133774.54	589.49	MW 10DPVC	
5	406563.12	1133804.63	589.65	MW 10-4PVC	
4	406571.71	1133805.76	589.69	MW 10-1DPVC	
16	406643.81	1133823.79	589.92	MW 10-1PVC	
3	406571.93	1133853.05	590.46	MW 10-2PVC	
03	406618.96	1133949.16	590.76	MW 10-3 PVC	
101	406616.08	1134034.48	590.12	MW 10 APVC	

PLOT O:\SORDATAC\

APPENDIX B
WELL DEVELOPMENT DATA

TABLE B1

NIAGARA FALLS AIRBASE

WELL DEVELOPMENT DATA SUMMARY

Well	Amount Bailed (Gallons)	pH	Specific Conductance (umhos/m)	Description
MW10-A	25	7.37	1100	Turbid, brown with oily sheen
	45	7.28	1100	Turbid brown with oily sheen
	55	7.31	1110	Less turbid, brown with oily sheen still present
	75	7.32	1100	Less turbid, brown, still >100 NTU
MW10-B	25	6.87	2050	Turbid, brown sweet odor
	50	6.91	2050	Turbid brown still has odor
	70	6.89	2070	Turbid, brown
	90	6.85	2020	Turbid, brown
MW10-C	2	6.2	1520	Slightly turbid
	3 (to Dry)	6.98	1610	Increase of turbidity
MW10-D	3 (to Dry)	7.07	2500	Turbid, brown
MW10-E	20	7.32	2420	Turbid gray strong sulphur odor
	45	7.41	2400	Same
	75	7.38	2420	Same – less turbidity

APPENDIX C
ANALYTICAL RESULTS

General
Testing
Corporation

A Full Service Environmental Laboratory

January 17, 1992

Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Re: Niagara Falls Air Force Base

Dear Mr. Combes:

Enclosed please find the data package for the above referenced site. Ten monitoring wells, 2 surface waters, one equipment blank, one field blank and one trip blank were sampled by our field crew on December 10, 1991.

Analytical data can be found in Section A and the corresponding Quality Control Data is in Section B. Sections C and D contain the Analytical Chronology and Field Documentation. All data has been reviewed prior to report submittal. Should you have any questions, please contact me at 454-3760.

Thank you for your continued use of our services.

Sincerely,

GENERAL TESTING CORP.

Janice M Jaeger

Janice M Jaeger
Client Representative

Enc.
SL:sm

710 Exchange Street • Rochester, New York 14608 • (716) 454-3760 • Fax (716) 454-1245
85 Trinity Place • Hackensack, NJ 07601 • (201) 488-5242 • Fax (201) 488-6386
435 Lawrence Bell Drive • Amherst, NY 14221 • (716) 634-0454 • Fax (716) 634-9019

General
Testing
Corporation

COMPANY: WEHRAN ENVIROTECH - NIAGARA FALLS
AIR FORCE BASE
JOB #: R91/5639

VOLATILE ORGANICS

Wehran-water samples were analyzed for priority pollutant volatiles by method 8021 from SW-846.

The initial calibration criteria of 20% RSD was met for all analytes.

All surrogate standard recoveries were within acceptance limits for all samples.

All matrix spike, matrix spike duplicate, reference check standard recoveries, and % RPD data were within QC acceptance limits.

The equipment and field trip blanks were free of any contamination.

The trip and laboratory blanks were free of any contamination.

All required analysis holding times were met.

Sample R91/5639-002 was analyzed at a 1/10 dilution to bring target analytes within the linear range of the system.

No analytical problems were encountered.

INORGANIC ANALYSIS

Wehran-water samples were analyzed for site specific inorganic analytes using approved EPA methodologies.

The precision analysis performed on sample R91/5639-001 for TDS and nitrite showed the % relative error to be outside QC acceptance limits. All results have been flagged with "*" accordingly.

The matrix spike recovery for the lead analysis was outside QC limits for sample R91/5639-001. The data has been flagged "N".

No other analytical or QC problems were encountered with these analysis.

COMPANY: WEHRAN ENVIROTECH-NIAGARA FALLS
AIR FORCE BASE
JOB #: R91/5640

VOLATILE ORGANICS

Wehran-water samples were analyzed for target compound list volatiles by method 8021 from SW-846.

The initial calibration criteria of 20% RSD was met for all analytes.

The continuing calibration criteria of 15% D was met for all analytes in all daily calibration check standards.

All surrogate standard recoveries were within acceptance limits for all samples.

All matrix spike, matrix spike duplicate, reference check standard recoveries, and % RPD data were within QC acceptance limits.

Both laboratory blanks were free of any contamination.

All required analysis holding times were met.

Sample R91/5640-002, 003 and 004 were analyzed at dilutions to bring target analytes within the linear range of the system.

No analytical problems were encountered.

General
Testing
Corporation

CASE NARRATIVE

JOB #: R91/5641
COMPANY: WEHRAN NIAGARA FALLS AIR FORCE BASE

Soil samples were analyzed for target compound list semivolatile organics by EPA method 8270. The recovery of pyrene in the matrix spike duplicate of sample 1 was outside QC limits, however the reference check recovery was within limits for this compound. The recovery of 4-Nitrophenol was outside QC limits in the reference check sample, but was within limits in the MS and MSD for this sample group. The data has been accepted.

General
Testing
Corporation

Effective 10/1/91

GTC LIST OF QUALIFIERS

U - Indicates compound was analyzed for but was not detected. The sample quantitation limit must be corrected for dilution and for percent moisture.

J - Indicates an estimated value. For further explanation see case narrative / cover letter.

B - This flag is used when the analyte is found in the associated blank as well as in the sample.

E - This flag identifies compounds whose concentrations exceed the calibration range and reanalysis could not be performed.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

N - Spiked sample recovery not within control limits. (Flag the entire batch - Inorganic analytes only)

* - Duplicate analysis not within control limits. (Flag the entire batch - Inorganic analysis only)

\- Also used to qualify Organics QC data outside limits. (Only used on the QC summary sheets)

M - Duplication injection precision not met (GFA only).

S - Reported value determined by Method of Standard Additions. (MSA)

X - As specified in the case narrative.

General Testing Corporation

GTC REPORT # WEHRAN ENVIROTECH
NIAGARA FALLS AIR FORCE BASE

REPORT INDEX

GTC REPORT # WEHRAN ENVIROTECH
NIAGARA FALLS AIR FORCE BASE

SECTION A

ANALYTICAL DATA

Presented in this section is analytical data for the parameters requested. The following references concerning units and analytical methodology apply to the data herein

Units: see report

Analytical Methodology Obtained From:

( ) Federal Register, 40 CFR Part 136, Guidelines Establishing Test Procedures for the analyses of Pollutants under the Clean Water Act, 10/26/84.

(X) SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, 9/86.

( ) Other: NYS Part 360

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls
Air Force Base

Collected : 12/10/91 P.O. #:

ANALYTICAL RESULTS - mg/l

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	MW-10-A	MW-10-C	MW-10-E	MW-10-E Duplicate	MW-10-B	MW-10-D	Equipment Blank	Field Blank
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91
Time Collected:	09:25	10:45	11:10	11:25	11:58	12:15	13:00	11:10
pH	7.67	7.66	7.83	7.78	8.16	7.75	8.06	8.06
Spec. Cond. (umhos/cm)	926	997	1750	1540	1580	1670	55.0	54.5
Temperature °C -Field	9.0	9.5	9.0	9.0	10.0	10.0	11.5	9.0
Alkalinity, Total	332	429	260	267	257	327	2.0 U	2.0 U
Chloride	21.3	50.6	16.9	15.0	18.7	26.7	1.0 U	1.0 U
Fluoride	0.515	0.455	1.17	1.32	0.844	1.08	0.10 U	0.10 U
Nitrogen, Nitrate	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.50 U	0.050 U
Nitrogen, Nitrite	0.047*	0.016*	0.010 U*	0.011*	0.020*	0.029*	0.010 U*	0.010 U*
Nitrogen,Nitrate/Nitrite	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.050 U	0.50 U	0.050 U
Pet. Hydrocarbons, IR	0.10 U	0.10 U	0.10 U	0.10 U	1.68	0.40	0.10 U	0.10 U
Phosphorous, Ortho as P	0.0362	0.0180	0.010 U	0.010 U	0.010 U	0.0180	0.010 U	0.010 U
Silica, Total	4.78	5.76	4.78	5.12	5.17	7.08	0.004 U	0.004 U
Solids, Dissolved @180 C	773*	1020*	2180*	2200*	1880*	2130*	10.0 U*	10.0 U*
Sulfate	256	361	259	1350	1040	1220	10.0 U	10.0 U
Aluminum	35.2	6.81	3.51	15.6	20.3	8.23	0.10 U	0.10
Barium	0.42	0.21	0.27	0.33	0.38	0.24	0.10 U	0.10 U
Boron, Total	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U	0.250 U
Calcium, Total	337	228	543	833	480	415	0.50 U	0.50 U
Chromium, Total	0.0484	0.017	0.0108	0.0342	0.0279	0.0185	0.010 U	0.010 U
Copper, Total	0.107	0.010 U	0.010 U	0.0954	0.0308	0.010 U	0.010 U	0.010 U
Iron, Total	41.5	5.68	3.09	15.1	18.2	7.25	0.050 U	0.050 U
Lead, Furnace	0.0099 N	0.0086 N	0.0076 N	0.0169 N	0.0529 N	0.0096 N	0.0050 UN	0.0050 UN
Magnesium, Total	170	90.2	121	242	158	164	0.50 U	0.50 U
Manganese, Total	0.783	0.544	0.193	0.854	0.606	0.409	0.0050 U	0.0050 U
Nickel, Total	0.0563	0.020 U	0.020 U	0.0329	0.020 U	0.020 U	0.020 U	0.020 U
Potassium, Total	12.1	3.11	1.74	3.92	59.6	4.10	0.250 U	0.250 U
Sodium, Total	9.69	18.2	8.88	5.74	25.8	26.7	0.156	0.216
Zinc, Total	3.75	0.180	0.188	0.745	1.14	0.412	0.010 U	0.0153

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145 NJ ID# in Hackensack: 02317

NJ ID# in Rochester: 73331 NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls

Collected : 12/10/91 P.O. #:

ANALYSIS * BY GC METHOD *8021 ANALYTICAL RESULTS - ug/l

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	MW-10-A	MW-10-C	MW-10-E	MW-10-E Duplicate	MW-10-B	MW-10-D	Equipment Blank	Field Blank
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91
Time Collected:	09:25	10:45	11:10	11:25	11:58	12:15	13:00	11:10
Date Analyzed:	12/17/91	12/18/91	12/18/91	12/18/91	12/18/91	12/17/91	12/17/91	12/18/91
Dilution:	1/1	1/10	1/1	1/1	1/1	1/1	1/1	1/1
Chloromethane	5 U	50 U	5 U	5 U	5 U	5 U	5 U	5 U
Bromomethane	5 U	50 U	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Chloride	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Chloroethane	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Methylene Chloride	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	121	6.81	11.1	1 U	1 U	1 U	1 U
Chloroform	1 U	10 U	1 U	1.76	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	1 U	10 U	1 U	1.97	1 U	1 U	1 U	1 U
Carbon Tetrachloride	1 U	10 U	1 U	1.15	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichloropropene-Trans	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	1 U	497	1 U	1.36	1 U	1 U	1 U	1 U
1,3-Dichloropropene (Cis)	1 U	10 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
1,1,2-Trichloroethane	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
2-Chloroethylvinyl Ether	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Bromoform	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
1,1,2,2-Tetrachloroethane	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Tetrachloroethene	1 U	20 U	1 U	1.78	1 U	1 U	1 U	1 U
Chlorobenzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
1,3-Dichlorobenzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichlorobenzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
1,4-Dichlorobenzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Benzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Toluene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethylbenzene	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Total Xylene (o,m,p)	2 U	20 U	2 U	2 U	2 U	2 U	2 U	2 U
Total Volatiles	ND	517.01	6.81	19.12	ND	ND	ND	ND

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:

Niagara Falls
Air Force Base

Collected : 12/10/91

P.O. #:

ANALYSIS * BY GC METHOD 8021 ANALYTICAL RESULTS - %

Sample:	-001	-002	-003	-004	-005	-006	-007	-008
Location:	MW-10-A	MW-10-C	MW-10-E	MW-10-E Duplicate	MW-10-B	MW-10-D	Equipment Blank	Field Blank
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91
Time Collected:	09:25	10:45	11:10	11:25	11:58	12:15	13:00	11:10
SURROGATE STANDARD RECOVERIES								
% Recovery								
Bromochloromethane (Acceptance Limits: 60-138%)	118%	96%	107%	106%	106%	91%	117%	98%
2-Bromo-1-chloropropane (Acceptance Limits: 60-134%)	122%	99%	99%	105%	98%	103%	105%	88%
a,a,a-Trifluorotoluene (Acceptance Limits: 60-134%)	111%	84%	82%	85%	91%	100%	97%	85%

*Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls
Air Force Base

Collected : 12/10/91 P.O. #:

ANALYTICAL RESULTS - mg/l

Sample:	-017							
Location:	Trip Blank							
Date Collected:	12/10/91							
Time Collected:	--							
pH								
Spec. Cond. (umhos/cm)								
Temperature °C -Field								
Alkalinity, Total								
Chloride								
Fluoride								
Nitrogen, Nitrate								
Nitrogen, Nitrite								
Nitrogen,Nitrate/Nitrite								
Pet. Hydrocarbons, IR								
Phosphorous, Ortho as P								
Silica, Total								
Solids, Dissolved @180 C								
Sulfate								
Aluminum								
Barium								
Boron, Total								
Calcium, Total								
Chromium, Total								
Copper, Total								
Iron, Total								
Lead, Furnace								
Magnesium, Total								
Manganese, Total								
Nickel, Total								
Potassium, Total								
Sodium, Total								
Zinc, Total								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145 NJ ID# in Hackensack: 02317
NJ ID# in Rochester: 73331 NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls

Collected : 12/10/91

P.O. #:

ANALYSIS * BY GC METHOD *8021

ANALYTICAL RESULTS - ug/l

Sample:	-017							
Location:	Trip Blank							
Date Collected:	12/10/91							
Time Collected:	--							
Date Analyzed:	12/18/91							
Dilution:	1/1							
Chloromethane	5 U							
Bromomethane	5 U							
Vinyl Chloride	2 U							
Chloroethane	2 U							
Methylene Chloride	1 U							
Trichlorofluoromethane	1 U							
1,1-Dichloroethene	1 U							
1,1-Dichloroethane	1 U							
trans-1,2-Dichloroethene	1 U							
cis-1,2-Dichloroethene	1 U							
Chloroform	1 U							
1,2-Dichloroethane	1 U							
1,1,1-Trichloroethane	1 U							
Carbon Tetrachloride	1 U							
Bromodichloromethane	1 U							
1,2-Dichloropropane	1 U							
1,3-Dichloropropene-Trans	2 U							
Trichloroethene	1 U							
1,3-Dichloropropene (Cis)	1 U							
Dibromochloromethane	2 U							
1,1,2-Trichloroethane	2 U							
2-Chloroethylvinyl Ether	2 U							
Bromoform	2 U							
1,1,2,2-Tetrachloroethane	2 U							
Tetrachloroethene	1 U							
Chlorobenzene	2 U							
1,3-Dichlorobenzene	2 U							
1,2-Dichlorobenzene	2 U							
1,4-Dichlorobenzene	2 U							
Benzene	2 U							
Toluene	2 U							
Ethylbenzene	2 U							
Total Xylene (o,m,p)	2 U							
Total Volatiles	ND							

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:

Niagara Falls
Air Force Base

Collected : 12/10/91

P.O. #:

ANALYSIS * BY GC METHOD 8021 **ANALYTICAL RESULTS - %**

Sample:	-017						
Location:	Trip Blank						
Date Collected:	12/10/91						
Time Collected:	--						
SURROGATE STANDARD RECOVERIES							
% Recovery							
Bromochloromethane (Acceptance Limits: 60-138%)	79%						
2-Bromo-1-chloropropane (Acceptance Limits: 60-134%)	83%						
a,a,a-Trifluorotoluene (Acceptance Limits: 60-134%)	77%						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05640　　Date: 30 DEC., 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

NIAGARA FALLS
AIR FORCE BASE

Collected : 12/10/91　　P.O. #:

ANALYSIS * BY GC METHOD 8021　　ANALYTICAL RESULTS - ug/1

Sample:	-001	-002	-003	-004	-005			
Location:	10-3	10-2	10-1D	10-4	10-1			
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91			
Time Collected:	09:45	09:55	10:10	10:25	12:00			
Date Analyzed:	12/18/91	12/19/91	12/19/91	12/19/91	12/19/91			
Dilution :	1/1	1/200	1/100	1/25	1/2			
Chloromethane	5 U	1000 U	500 U	125 U	10 U			
Bromomethane	5 U	1000 U	500 U	125 U	10 U			
Vinyl Chloride	2 U	400 U	1160	50 U	76.3			
Chloroethane	2 U	400 U	200 U	50 U	4 U			
Methylene Chloride	1 U	200 U	100 U	25 U	2 U			
Trichlorofluoromethane	1 U	200 U	100 U	25 U	2 U			
1,1-Dichloroethene	1 U	200 U	100 U	25 U	2 U			
1,1-Dichloroethane	1 U	200 U	100 U	25 U	2 U			
Chloroform	42.6	200 U	100 U	25 U	2 U			
1,2-Dichloroethane	1 U	200 U	100 U	25 U	2 U			
1,1,1-Trichloroethane	1.73	200 U	100 U	25 U	2 U			
Carbon Tetrachloride	9.96	200 U	100 U	25 U	2 U			
Bromodichloromethane	1 U	200 U	100 U	25 U	2 U			
1,2-Dichloropropane	3.17	200 U	100 U	25 U	2 U			
1,3-Dichloropropene-Trans	2 U	400 U	200 U	50 U	4 U			
Trichloroethene	124	20,800	1720	3450	6.95			
1,3-Dichloropropene (Cis)	1 U	200 U	100 U	25 U	2 U			
Dibromochloromethane	2 U	400 U	200 U	50 U	4 U			
1,1,2-Trichloroethane	2 U	400 U	200 U	50 U	4 U			
2-Chloroethylvinyl Ether	2 U	400 U	200 U	50 U	4 U			
Bromoform	2 U	400 U	200 U	50 U	4 U			
1,1,2,2-Tetrachloroethane	2 U	400 U	200 U	50 U	4 U			
Tetrachloroethene	1.14	200 U	100 U	25 U	2 U			
Chlorobenzene	2 U	400 U	200 U	50 U	4 U			
1,3-Dichlorobenzene	2 U	400 U	200 U	50 U	4 U			
1,2-Dichlorobenzene	2 U	400 U	200 U	50 U	4 U			
1,4-Dichlorobenzene	2 U	400 U	200 U	50 U	4 U			
Benzene	2 U	400 U	200 U	50 U	8.04			
Toluene	2 U	400 U	200 U	50 U	4.32			
Ethylbenzene	2 U	400 U	200 U	50 U	4 U			
Total Xylene (o,m,p)	2 U	400 U	200 U	50 U	4 U			
cis-1,2-Dichloroethene	73.3	7530	13,100	3210	202			
trans-1,2-Dichloroethene	1 U	200 U	100 U	25 U	2 U			

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05640 Date: DEC. 24 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:

NIAGARA FALLS
AIR FORCE BASE

Collected : 12/10/91 P.O. #:

ANALYSIS * BY GC METHOD 8021 ANALYTICAL RESULTS - %

Sample:	-001	-002	-003	-004	-005			
Location:	10-3	10-2	10-1D	10-4	10-1			
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91			
Time Collected:	09:45	09:55	10:10	10:25	12:00			
SURROGATE STANDARD RECOVERIES								
% Recovery								
Bromochloromethane (Acceptance Limits: 60-138%)	123%	92%	106%	108%	100%			
2-Bromo-1-chloropropane (Acceptance Limits: 60-134%)	112%	78%	88%	96%	91%			
a,a,a-Trifluorotoluene (Acceptance Limits: 60-134%)	106%	114%	127%	134%	116%			

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:

Niagara Falls Air Force Base
CORRECTED COPY

Collected : 12/10/91

P.O. #:

ANALYTICAL UNITS - ug/g Wet Wt.

Sample:	-001	-002						
Location:	Sediment Sample 1	Sediment Sample 2						
Date Collected:	12/10/91	12/10/91						
Time Collected:	13:15	13:45						
Pet. Hydrocarbons, IR	192	50.9						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base
CORRECTED COPY

Collected : 12/10/91 P.O. #:

HSL VOLATILES BY EPA METHOD 8240* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-001	-002						
Location:	Sediment Sample 1	Sediment Sample 2						
Date Collected:	12/10/91	12/10/91						
Time Collected:	13:15	13:45						
Date Analyzed:	12/20/91	12/20/91						
Dilution:	1/1	1/1						
Chloromethane	5 U	5 U						
Bromomethane	5 U	5 U						
Vinyl Chloride	5 U	5 U						
Chloroethane	5 U	5 U						
Methylene Chloride	5 U	5 U						
Acetone	20 U	20 U						
Carbon Disulfide	10 U	10 U						
Trichlorofluoromethane	5 U	5 U						
Vinyl Acetate	10 U	10 U						
1,1-Dichloroethene	5 U	5 U						
1,1-Dichloroethane	5 U	5 U						
trans-1,2-Dichloroethene	5 U	5 U						
cis-1,2-Dichloroethene	5 U	5 U						
Chloroform	5 U	5 U						
2-Butanone (MEK)	10 U	10 U						
1,2-Dichloroethane	5 U	5 U						
1,1,1-Trichloroethane	5 U	5 U						
Carbon Tetrachloride	5 U	5 U						
Bromodichloromethane	5 U	5 U						
1,2-Dichloropropane	5 U	5 U						
1,3-Dichloropropene (Trans)	5 U	5 U						
Trichloroethene	5 U	5 U						
Dibromochloromethane	5 U	5 U						
1,1,2-Trichloroethane	5 U	5 U						
Benzene	5 U	5 U						
1,3-Dichloropropene(Cis)	5 U	5 U						
Bromoform	5 U	5 U						
4-Methyl-2-pentanone(MIBK)	10 U	10 U						
2-Hexanone	10 U	10 U						
Tetrachloroethene	5 U	5 U						
1,1,2,2-Tetrachloroethane	5 U	5 U						
Toluene	5 U	5 U						
Chlorobenzene	5 U	5 U						

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force
Base
CORRECTED COPY

Collected : 12/10/91

P.O. #:

HSL VOLATILES BY EPA METHOD 8240* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-001	-002
Location:	Sediment Sample 1	Sediment Sample 2
Date Collected:	12/10/91	12/10/91
Time Collected:	13:15	13:45
Date Analyzed:	12/20/91	12/20/91
Dilution:	1/1	1/1
Ethylbenzene	5 U	5 U
Styrene	5 U	5 U
Total Xylene (o,m,p)	5 U	5 U
Surrogate Standard Recoveries		
1,2-Dichloroethane-d4	106%	111%
(Acceptance limits: 73-116%)		
Toluene d8	102%	106%
(Acceptance limits 80-114%)		
4-Bromofluorobenzene	95%	91%
(Acceptance limits 78-116%)		

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force
Base
CORRECTED COPY

Collected : 12/10/91

P.O. #:

HSL ACID EXTRACTABLES BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-001	-002
Location:	Sediment Sample 1	Sediment Sample 2
Date Collected:	12/10/91	12/10/91
Time Collected:	13:15	13:45
Date Extracted:	12/12/91	12/12/91
Date Analyzed:	12/13/91	12/16/91
Dilution:	1/2	1/2
Phenol	660 U	660 U
2-Chlorophenol	660 U	660 U
2-Nitrophenol	660 U	660 U
2,4-Dimethylphenol	660 U	660 U
2,4-Dichlorophenol	660 U	660 U
4-Chloro-3-methylphenol	660 U	660 U
2,4,6-Trichlorophenol	660 U	660 U
2,4-Dinitrophenol	1320 U	1320 U
4-Nitrophenol	1320 U	1320 U
2-Methyl-4,6-dinitrophenol	1320 U	1320 U
Pentachlorophenol	1320 U	1320 U
2-Methylphenol	660 U	660 U
4-Methylphenol	660 U	660 U
Benzoic Acid	3300 U	3300 U
2,4,5-Trichlorophenol	660 U	660 U
SURROGATE STANDARD RECOVERIES		
2-Fluorophenol (Acceptance Limits: 16-122%)	65%	80%
Phenol-d6 (Acceptance Limits: 30-100%)	62%	80%
2,4,6-TriBromophenol (Acceptance Limits: 24-143%)	59%	80%

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base
CORRECTED COPY

Collected : 12/10/91 P.O. #:

HSL BASE NEUTRALS BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-001	-002						
Location:	Sediment Sample 1	Sediment Sample 2						
Date Collected:	12/10/91	12/10/91						
Time Collected:	13:15	13:45						
Date Extracted:	12/12/91	12/12/91						
Date Analyzed:	12/13/91	12/16/91						
Dilution:	1/2	1/2						
N-Nitrosodimethylamine	330 U	330 U						
Bis(2-chloroethyl) ether	330 U	330 U						
1,3 Dichlorobenzene	330 U	330 U						
1,4 Dichlorobenzene	330 U	330 U						
1,2 Dichlorobenzene	330 U	330 U						
bis(-2-chloroisopropyl)ether	330 U	330 U						
N-Nitroso-Di-n-propylamine	330 U	330 U						
Hexachloroethane	330 U	330 U						
Nitrobenzene	330 U	330 U						
Isophorone	330 U	330 U						
bis(-2-chloroethoxy)methane	330 U	330 U						
1,2,4-Trichlorobenzene	330 U	330 U						
Naphthalene	330 U	330 U						
Hexachlorobutadiene	330 U	330 U						
Hexachlorocyclopentadiene	330 U	330 U						
2-Chloronaphthalene	330 U	330 U						
Dimethyl phthalate	330 U	330 U						
Acenaphthylene	330 U	330 U						
Acenaphthene	330 U	330 U						
2,4-Dinitrotoluene	330 U	330 U						
2,6-Dinitrotoluene	330 U	330 U						
Diethyl phthalate	330 U	330 U						
4-Chlorophenyl-phenyl-ether	330 U	330 U						
Fluorene	330 U	330 U						
1,2-Diphenylhydrazine	330 U	330 U						
N-Nitrosodiphenylamine	330 U	330 U						
4-Bromophenyl-phenylether	330 U	330 U						
Hexachlorobenzene	330 U	330 U						
Phenanthrene	330 U	330 U						
Anthracene	330 U	330 U						
Di-n-butyl phthalate	330 U	330 U						
Benzidine	3300 U	3300 U						
Fluoranthene	330 U	330 U						
Pyrene	330 U	340						

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job Number: R91/05641 Date: JAN. 22 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base
CORRECTED COPY

Collected : 12/10/91 P.O. #:

HSL BASE NEUTRALS BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-001	-002						
Location:	Sediment Sample 1	Sediment Sample 2						
Date Collected:	12/10/91	12/10/91						
Time Collected:	13:15	13:45						
Date Extracted:	12/12/91	12/12/91						
Date Analyzed:	12/13/91	12/16/91						
Dilution:	1/2	1/2						
Butyl benzyl phthalate	330 U	330 U						
3,3'-Dichlorobenzidine	330 U	330 U						
Benzo(a)anthracene	330 U	330 U						
Bis(2-ethylhexyl)phthalate	330 U	330 U						
Chrysene	330 U	330 U						
Di-n-octyl phthalate	330 U	330 U						
Benzo(b)Fluoranthene	330 U	330 U						
Benzo(k)fluoranthene	330 U	330 U						
Benzo(a)pyrene	330 U	330 U						
Indeno(1,2,3-cd)pyrene	330 U	330 U						
Dibenzo(a,h)anthracene	330 U	330 U						
Benzo(g,h,i)perylene	330 U	330 U						
Benzyl Alcohol	1320 U	1320 U						
4-Chloroaniline	660 U	660 U						
2-Methyl Naphthalene	660 U	660 U						
2-Nitroaniline	1320 U	1320 U						
3-Nitroaniline	1320 U	1320 U						
Dibenzofuran	660 U	660 U						
4-Nitroaniline	3300 U	3300 U						
SURROGATE STANDARD RECOVERIES								
Nitrobenzene-d5	61%	76%						
(Acceptance Limits: 19-103%)								
2-Fluorobiphenyl	64%	82%						
(Acceptance Limits: 26-119%)								
Terphenyl-d14	76%	118%						
(Acceptance Limits: 18-142%)								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145 NY ID# in Hackensack: 10801
NJ ID# in Rochester: 73331 NJ ID# in Hackensack: 02317

Michael K Perry

Laboratory Director

General Testing Corporation

GTC REPORT # WEHRAN ENVIROTECH
NIAGARA FALLS AIR FORCE BASE

SECTION B

LABORATORY QUALITY CONTROL DATA

Presented in this section is Quality Control Associated with the data provided in Section A of this report.

Quality Control Explanations:

(1) RUN QUALITY CONTROL - Selected QC data from the analytical run in which your sample(s) were involved.

(2) JOB SPECIFIC QUALITY CONTROL - QC data specific to your set of samples.

(3) DUPLICATES - Replicate analyses of a given sample used to monitor precision. Relative Percent Difference is calculated as the difference divided by the average, times 100.

(4) MATRIX SPIKES - Addition of a known amount of analyte to a sample. Recovery is calculated by subtracting original value attributable to the sample from the combined value. The difference is then divided by the amount added to calculate percent recovery. Poor recoveries may indicate analytical interference due to the matrix of the sample. Any other samples of this matrix may also have been affected, high or low as indicated by the percent recovery.

(5) LABORATORY CONTAMINANTS - Laboratory de-ionized water used to monitor for contamination during analysis.

(6) BLANK SPIKES - Same as item #4 but analyte is added to laboratory de-ionized water. This indicates the accuracy of analysis.

(7) REFERENCE CHECK SAMPLES - Samples from an outside source having a known concentration of analyte. Used as a measure of analytical accuracy.

When possible, all components of the above listed QC protocol are performed during an analytical run. The resulting data is compared to historical records when evaluating the quality of analytical runs. The data provided in your report has passed our Quality Assurance review.

Quality Control Notes:

GTC LABORATORY QUALITY CONTROL REPORT

CUSTOMER: Wehran Envirotech JOB # : R91/05639 UNITS: mg/l REPORT TYPE: Job Specific

PARAMETER	SAMPLE	ORIGINAL RESULT	DUPLICATE RESULT	% REL. ERROR	ACCEPT. LIMIT %	ORIGINAL RESULT	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMIT %	METHOD BLANK	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMITS %	REFERENCE #	KNOWN PMVAL	PERCENT RECOVERY	ACCEPT. LIMITS %
//////////////////		* PRECISION				* MATRIX SPIKING				BLANK SPIKES				REFERENCE STANDARD			
PH	-001	7.67	7.67	0.0%	*+	7.67	NA			NA				NA			
Spec.Cond.	-001	926	935	1.0%	*+	926	NA			NA				NA			
Temperature	-001	9.0	9.0	0.0%	*+	9.0	NA			NA				NA			
Alkalinity	-001	332	335	0.9%	10	332	100	102%	82-126	2.0 U	20.0	100%	88-123	REF STD	196	100%	90-115
Chloride	-001	21.3	21.4	0.5%	10	21.3	25.0	107%	68-132	1.0 U	5.0	95%	82-121	REF STD	65.0	101%	90-110
Fluoride	-001	0.515	0.494	4.1%	10	0.515	0.500	104%	67-133	0.10 U	0.500	107%	85-115	REF STD	1.81	106%	85-115
NO2	-001	0.0470	0.0530	12.0%*	10	0.0470	0.500	102%	84-126	0.010 U	0.050	102%	85-115	REF STD	0.900	102%	90-110
NO3/NO2	-001	0.050 U	0.050 U	NC	10	0.050 U	0.500	101%	75-131	0.050 U	0.250	100%	85-115	REF STD	1.80	101%	90-111
Pet. Hydro	-002	124	131	5.5	36.6	NA				0.010 U	4.238	62.3	61.1-113	REF STD	124.5	124	99.6
Phos. Ortho	-001	0.0362	0.0362	0.0%	10	0.0362	0.100	94%	70-130	0.010 U	0.050	106%	70-130	REF STD	0.900	101%	80-120
Silica	-001	0.0478	0.0469	1.9%	10	0.0478	0.040	100%	81-124	0.0040 U	0.020	104%	88-121	REF STD	0.0500	99%	88-110
Solids, Dis	-001	773	665	15.0%*	10	773	NA			NA				REF STD	1240	98%	90-110
Sulfate	-001	25.6	26.0	1.6%	10	25.6	20.0	101%	69-130	10.0 U	20.0	98%	79-116	REF STD	236	97%	77-114
Aluminum	-001	35.2	34.9	0.9%	30	35.2	0.50	V	60-140	0.10 U	0.50	102%	70-130	REF STD	4.00	99%	80-120

**Reference Check samples are not available for all analyses.

*+Currently no limits established.

GTC LABORATORY QUALITY CONTROL REPORT

CUSTOMER: Wehran Envirotech JOB # : R91/05639 UNITS: mg/l REPORT TYPE: Job Specific

PARAMETER	SAMPLE	ORIGINAL RESULT	DUPLICATE RESULT	% REL. ERROR	ACCEPT. LIMIT %	ORIGINAL RESULT	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMIT %	METHOD BLANK	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMITS %	REFERENCE #	KNOWN PMVAL	PERCENT RECOVERY	ACCEPT. LIMITS %
//////////////////////		* PRECISION				* MATRIX SPIKING				BLANK SPIKES				REFERENCE STANDARD			
Barium	-001	0.42	0.47	11.2%	30	0.42	0.50	104%	60-135	0.10 U	0.50	98%	70-123	REF STD	4.00	101%	80-120
Boron	-001	0.250 U	0.250 U	NC	30	0.250 U	50.0	96%	80-120	0.250 U	5.0	98%	80-120	REF STD	5.00	100%	90-110
Calcium	-001	337	336	0.3%	20	337	10.0	V	80-120	0.50 U	2.00	103%	80-120	REF STD	50.0	103%	90-110
Chromium	-001	0.0484	0.0426	12.7%	30	0.0484	0.250	92%	80-120	0.010 U	0.250	106%	80-120	REF STD	5.00	100%	90-110
Copper	-001	0.107	0.104	2.8%	20	0.107	0.100	100%	80-120	0.010 U	0.100	103%	80-120	REF STD	5.00	101%	90-110
Iron	-001	41.5	39.6	4.7%	20	41.5	0.250	V	80-120	0.050 U	0.250	108%	80-120	REF STD	5.00	100%	90-110
Lead, Furn	-001	0.0099	0.0094	5.2%	30	0.0099	0.020	164%*	50-150	0.0050 U	0.020	109%	70-130	REF STD	0.030	102%	80-120
Magnesium	-001	170	169	0.6%	20	170	10.0	V	80-120	0.50 U	2.00	100%	80-120	REF STD	50.0	99%	90-110
Manganese	-001	0.783	0.762	2.7%	20	0.783	0.0500	V	80-120	0.0050 U	0.050	100%	80-120	REF STD	5.00	100%	90-110
Nickel	-001	0.0563	0.0482	15.5%	30	0.0563	0.200	93%	80-120	0.020 U	0.200	102%	80-120	REF STD	5.00	100%	90-110
Potassium	-001	12.1	12.1	0.0%	20	12.1	10.0	72%	60-140	0.250 U	2.00	96%	80-128	REF STD	4.00	99%	80-120
Sodium	-001	9.69	9.90	2.1%	20	9.69	10.0	79%	60-140	0.10 U	2.00	100%	83-119	REF STD	4.00	99%	80-117
Zinc	-001	3.75	3.60	4.1%	20	3.75	0.0500	V	80-120	0.010 U	0.050	99%	80-120	REF STD	1.00	102%	90-110

**Reference Check samples are not available for all analyses.

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls

Collected : 12/10/91

P.O. #:

ANALYSIS * BY GC METHOD *8021 ANALYTICAL RESULTS - ug/l

Sample:	-018	-019
Location:	Lab Meth. Blank	Lab Meth. Blank
Date Collected:	--	--
Time Collected:	--	--
Date Analyzed:	12/16/91	12/17/91
Dilution:	1/1	1/1
Chloromethane	5 U	5 U
Bromomethane	5 U	5 U
Vinyl Chloride	2 U	2 U
Chloroethane	2 U	2 U
Methylene Chloride	1 U	1 U
Trichlorofluoromethane	1 U	1 U
1,1-Dichloroethene	1 U	1 U
1,1-Dichloroethane	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U
Chloroform	1 U	1 U
1,2-Dichloroethane	1 U	1 U
1,1,1-Trichloroethane	1 U	1 U
Carbon Tetrachloride	1 U	1 U
Bromodichloromethane	1 U	1 U
1,2-Dichloropropane	1 U	1 U
1,3-Dichloropropene-Trans	2 U	2 U
Trichloroethene	1 U	1 U
1,3-Dichloropropene (Cis)	1 U	1 U
Dibromochloromethane	2 U	2 U
1,1,2-Trichloroethane	2 U	2 U
2-Chloroethylvinyl Ether	2 U	2 U
Bromoform	2 U	2 U
1,1,2,2-Tetrachloroethane	2 U	2 U
Tetrachloroethene	1 U	1 U
Chlorobenzene	2 U	2 U
1,3-Dichlorobenzene	2 U	2 U
1,2-Dichlorobenzene	2 U	2 U
1,4-Dichlorobenzene	2 U	2 U
Benzene	2 U	2 U
Toluene	2 U	2 U
Ethylbenzene	2 U	2 U
Total Xylene (o,m,p)	2 U	2 U
Total Volatiles	ND	ND

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05639 Date: JAN. 8 1992

Client:
Mr.Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:
Niagara Falls
Air Force Base

Collected : 12/10/91

P.O. #:

ANALYSIS * BY GC METHOD 8021 ANALYTICAL RESULTS - %

Sample:	-018	-019						
Location:	Lab Meth. Blank	Lab Meth. Blank						
Date Collected:	--	--						
Time Collected:	--	--						
SURROGATE STANDARD RECOVERIES								
% Recovery								
Bromochloromethane (Acceptance Limits: 60-138%)	76%	96%						
2-Bromo-1-chloropropane (Acceptance Limits: 60-134%)	70%	89%						
a,a,a-Trifluorotoluene (Acceptance Limits: 60-134%)	92%	79%						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

3A - WATER VOLATILE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: General Testing Corp. Contract: ____________

Lab Code: ________ Case No.: _______ SAS No.: _________ SDG No.: _____

Matrix Spike - EPA Sample No. : R91/05639 -001

COMPOUND	SPIKE ADDED (ug/l)	SAMPLE CONCENTRATION (ug/l)	MS CONCENT. (ug/l)	MS % REC #	QC LIMITS REC.
1,1-Dichloroethene	19.8	0.00	24.1	122%	28-167
Trichloroethene	21.4	0.00	27.7	130%	35-146
Benzene	20.0	0.00	23.5	118%	39-150
Toluene	19.7	0.00	24.9	127%	46-148
Chlorobenzene	20.2	0.00	24.7	122%	55-135

COMPOUND	SPIKE ADDED (ug/l)	MSD CONCENT. (ug/l)	MSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
1,1-Dichloroethene	19.8	25.5	129%	5.8%	30	28-167
Trichloroethene	21.4	29.4	137%	5.7%	30	35-146
Benzene	20.0	23.7	119%	0.9%	30	39-150
Toluene	19.7	25.1	128%	0.7%	30	46-148
Chlorobenzene	20.2	24.9	123%	1.0%	30	55-135

Columns to be used to flag recovery and RPD values with an asterik

* Values outside of QC limits

RPD:___0____ out of ___5____ outside limits
Spike Recovery:__0___ out of __10___ outside limits

COMMENTS: ____

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05640 Date: 30 DEC., 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

NIAGARA FALLS
AIR FORCE BASE

Collected : 12/10/91 P.O. #:

ANALYSIS * BY GC METHOD 8021 ANALYTICAL RESULTS - ug/l

Sample:	-006	-007						
Location:	Lab Meth. Blank	Lab Meth. Blank						
Date Collected:	--	--						
Time Collected:	--	--						
Date Analyzed:	12/17/91	12/18/91						
Dilution :	1/1	1/1						
Chloromethane	5 U	5 U						
Bromomethane	5 U	5 U						
Vinyl Chloride	2 U	2 U						
Chloroethane	2 U	2 U						
Methylene Chloride	1 U	1 U						
Trichlorofluoromethane	1 U	1 U						
1,1-Dichloroethene	1 U	1 U						
1,1-Dichloroethane	1 U	1 U						
Chloroform	1 U	1 U						
1,2-Dichloroethane	1 U	1 U						
1,1,1-Trichloroethane	1 U	1 U						
Carbon Tetrachloride	1 U	1 U						
Bromodichloromethane	1 U	1 U						
1,2-Dichloropropane	1 U	1 U						
1,3-Dichloropropene-Trans	2 U	2 U						
Trichloroethene	1 U	1 U						
1,3-Dichloropropene (Cis)	1 U	1 U						
Dibromochloromethane	2 U	2 U						
1,1,2-Trichloroethane	2 U	2 U						
2-Chloroethylvinyl Ether	2 U	2 U						
Bromoform	2 U	2 U						
1,1,2,2-Tetrachloroethane	2 U	2 U						
Tetrachloroethene	1 U	1 U						
Chlorobenzene	2 U	2 U						
1,3-Dichlorobenzene	2 U	2 U						
1,2-Dichlorobenzene	2 U	2 U						
1,4-Dichlorobenzene	2 U	2 U						
Benzene	2 U	2 U						
Toluene	2 U	2 U						
Ethylbenzene	2 U	2 U						
Total Xylene (o,m,p)	2 U	2 U						
cis-1,2-Dichloroethene	1 U	1 U						
trans-1,2-Dichloroethene	1 U	1 U						

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05640 Date: DEC. 24 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:
NIAGARA FALLS
AIR FORCE BASE

Collected : 12/10/91 P.O. #:

ANALYSIS * BY GC METHOD 8021 ANALYTICAL RESULTS - %

Sample:	-006	-007					
Location:	Lab Meth. Blank	Lab Meth. Blank					
Date Collected:	--	--					
Time Collected:	--	--					
SURROGATE STANDARD RECOVERIES							
% Recovery							
Bromochloromethane (Acceptance Limits: 60-138%)	96%	98%					
2-Bromo-1-chloropropane (Acceptance Limits: 60-134%)	89%	112%					
a,a,a-Trifluorotoluene (Acceptance Limits: 60-134%)	79%	104%					

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry
Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

3A - WATER VOLATILE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: General Testing Corp. Contract: -

Lab Code: - Case No.: - SAS No.: - SDG No.: -

Matrix Spike - EPA Sample No. : R91/05640 -001

COMPOUND	SPIKE ADDED (ug/l)	SAMPLE CONCENTRATION (ug/l)	MS CONCENT. (ug/l)	MS % REC #	QC LIMITS REC.
1,1-Dichloroethene	19.8	0.0	20.1	101%	28-167
Trichloroethene	21.4	124	131	V	35-146
Benzene	20.0	0.0	15.5	78%	39-150
Toluene	19.6	0.0	15.6	80%	46-148
Chlorobenzene	20.2	0.0	18.8	93%	55-135

COMPOUND	SPIKE ADDED (ug/l)	MSD CONCENT. (ug/l)	MSD % REC #	% RPD #	QC LIMITS	
					RPD	REC.
1,1-Dichloroethene	19.8	21.8	110%	8.4%	30	28-167
Trichloroethene	21.4	125	V	4.1%	30	35-146
Benzene	20.0	16.8	84%	7.9%	30	39-150
Toluene	19.6	16.2	82%	3.5%	30	46-148
Chlorobenzene	20.2	20.1	99%	6.4%	30	55-135

Columns to be used to flag recovery and RPD values with an asterik

* Values outside of QC limits

RPD:___0____ out of ___5____ outside limits
Spike Recovery:__0___ out of __10___ outside limits

COMMENTS:

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Job No: R91/05640

Date: 24 DEC., 1991

	REFERENCE CHECK		
EPA METHOD 8010/8020	TRUE VALUE	% RECOVERY	ACCEPTANCE LIMITS (%)
Date Analyzed: 12/18/91			
Chloromethane	40.0	131%	D - 193
Bromomethane	40.0	102%	D - 144
Vinyl Chloride	20.0	136%	28 - 163
Chloroethane	--	--	46 - 137
Methylene Chloride	20.0	121%	25 - 162
Trichlorofluoromethane	20.0	80%	21 - 156
1,1-Dichloroethene	20.0	120%	28 - 167
1,1-Dichloroethane	20.0	112%	47 - 132
Total 1,2-Dichloroethene	20.0	119%	38 - 155
Chloroform	20.0	117%	49 - 133
1,2-Dichloroethane	20.0	118%	51 - 147
1,1,1-Trichloroethane	20.0	109%	41 - 138
Carbon Tetrachloride	20.0	118%	43 - 143
Bromodichloromethane	20.0	108%	42 - 172
1,2-Dichloropropane	20.0	105%	44 - 156
1,3-Dichloropropene-Trans	20.0	123%	22 - 178
Trichloroethene	20.0	104%	35 - 146
1,3-Dichloropropene(Cis)	20.0	106%	22 - 178
Dibromochloromethane	20.0	112%	24 - 191
1,1,2-Trichloroethane	20.0	93%	39 - 136
2-Chloroethylvinyl Ether	--	--	14 - 186
Bromoform	20.0	114%	13 - 159
1,1,2,2-Tetrachloroethane	20.0	119%	8 - 184
Tetrachloroethene	20.0	102%	26 - 162
Chlorobenzene	40.0	101%	38 - 150
1,3-Dichlorobenzene	40.0	75%	7 - 187
1,2-Dichlorobenzene	40.0	67%	D - 208
1,4-Dichlorobenzene	40.0	81%	42 - 143
Benzene	20.0	86%	39 - 150
Toluene	20.0	90%	46 - 148
Ethylbenzene	20.0	80%	32 - 160
Total Xylene (o,m,p)	60.0	78%	59 - 127

GTC LABORATORY QUALITY CONTROL REPORT

CUSTOMER: Wehran Envirotech   JOB # : R91/05641   UNITS: ug/g Wet Wt.   REPORT TYPE: Job Specific

PARAMETER	SAMPLE	MAT SPK	MAT SPK DUP	% REL. ERROR	ACCEPT. LIMIT %	ORIGINAL RESULT	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMIT %	METHOD BLANK	SPIKE ADDED	PERCENT RECOVERY	ACCEPT. LIMITS %	REFERENCE #	KNOWN PMVAL	PERCENT RECOVERY	ACCEPT. LIMITS %
////////////////////		* PRECISION				* MATRIX SPIKING				BLANK SPIKES				REFERENCE STANDARD			
Pet. Hydro.	-001	708	670	5.52	18.11	192	4238	94.4	55.9-130	10.0 U	4238	96.6	61.1-123	REF STD	124.5	102	*+

* Analytical results previous to accounting for dilutions.   ** Reference Check samples are not available for all analyses.   ++ Outside of Quality Control Limits.

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: DEC. 26 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference
Niagara Falls Air Force Base

Collected : 12/10/91 P.O. #:

HSL VOLATILES BY EPA METHOD 8240* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-003							
Location:	Lab Meth. Blank							
Date Collected:	--							
Time Collected:	--							
Date Analyzed:	12/20/91							
Dilution:	1/1							
Chloromethane	5 U							
Bromomethane	5 U							
Vinyl Chloride	5 U							
Chloroethane	5 U							
Methylene Chloride	5 U							
Acetone	20 U							
Carbon Disulfide	10 U							
Trichlorofluoromethane	5 U							
Vinyl Acetate	10 U							
1,1-Dichloroethene	5 U							
1,1-Dichloroethane	5 U							
trans-1,2-Dichloroethene	5 U							
cis-1,2-Dichloroethene	5 U							
Chloroform	5 U							
2-Butanone (MEK)	10 U							
1,2-Dichloroethane	5 U							
1,1,1-Trichloroethane	5 U							
Carbon Tetrachloride	5 U							
Bromodichloromethane	5 U							
1,2-Dichloropropane	5 U							
1,3-Dichloropropene (Trans)	5 U							
Trichloroethene	5 U							
Dibromochloromethane	5 U							
1,1,2-Trichloroethane	5 U							
Benzene	5 U							
1,3-Dichloropropene(Cis)	5 U							
Bromoform	5 U							
4-Methyl-2-pentanone(MIBK)	10 U							
2-Hexanone	10 U							
Tetrachloroethene	5 U							
1,1,2,2-Tetrachloroethane	5 U							
Toluene	5 U							
Chlorobenzene	5 U							

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: DEC. 26 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Collected : 12/10/91 P.O. #:

HSL VOLATILES BY EPA METHOD 8240* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-003						
Location:	Lab Meth... Blank						
Date Collected:	--						
Time Collected:	--						
Date Analyzed:	12/20/91						
Dilution:	1/1						
Ethylbenzene	5 U						
Styrene	5 U						
Total Xylene (o,m,p)	5 U						
Surrogate Standard Recoveries							
1,2-Dichloroethane-d4 (Acceptance limits: 75-119%)	106%						
Toluene d8 (Acceptance limits 85-110%)	101%						
4-Bromofluorobenzene (Acceptance limits 84-116%)	97%						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

VOLATILE ORGANICS - SOIL SAMPLE
SOIL VOLATILE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: General Testing Corp.
Matrix Spike - Sample No. : R91/05641 -001

COMPOUND	SPIKE ADDED (ug/kg)	SAMPLE CONCENTRATION (ug/kg)	MS CONCENT. (ug/kg)	MS % REC #	QC LIMITS REC.
1,1-Dichloroethene	50	0.0	46.8	94%	D-234
Trichloroethene	50	0.0	37.4	75%	71-157
Benzene	50	0.0	40.4	81%	37-151
Toluene	50	0.0	43.2	86%	47-150
Chlorobenzene	50	0.0	42.4	85%	37-160

COMPOUND	SPIKE ADDED (ug/kg)	MSD CONCENT. (ug/kg)	MSD % REC #	% RPD #	QC LIMITS	
					RPD	REC.
1,1-Dichloroethene	50	48.1	96%	2.7%	30	D-234
Trichloroethene	50	39.6	79%	5.7%	30	71-157
Benzene	50	42.6	85%	5.3%	30	37-151
Toluene	50	45.7	91%	5.6%	30	47-150
Chlorobenzene	50	44.7	89%	5.3%	30	37-160

Columns to be used to flag recovery and RPD values with ++.
++ = Values outside of QC limits
MS QC Limits = EPA Acceptance Criteria
RPD Limits = Internal Acceptance Criteria

RPD: 0 out of 5 outside limits
Spike Recovery: 0 out of 10 outside limits

COMMENTS: ______________________________

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: DEC. 31 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Collected : 12/10/91 P.O. #:

HSL ACID EXTRACTABLES BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-003							
Location:	Lab Meth. Blank							
Date Collected:	--							
Time Collected:	--							
Date Extracted:	12/12/91							
Date Analyzed:	12/13/91							
Dilution:	1/2							
Phenol	660 U							
2-Chlorophenol	660 U							
2-Nitrophenol	660 U							
2,4-Dimethylphenol	660 U							
2,4-Dichlorophenol	660 U							
4-Chloro-3-methylphenol	660 U							
2,4,6-Trichlorophenol	660 U							
2,4-Dinitrophenol	1320 U							
4-Nitrophenol	1320 U							
2-Methyl-4,6-dinitrophenol	1320 U							
Pentachlorophenol	1320 U							
2-Methylphenol	660 U							
4-Methylphenol	660 U							
Benzoic Acid	3300 U							
2,4,5-Trichlorophenol	660 U							
SURROGATE STANDARD RECOVERIES								
2-Fluorophenol	72%							
(Acceptance Limits: 16-122%)								
Phenol-d6	71%							
(Acceptance Limits: 30-100%)								
2,4,6-TriBromophenol	67%							
(Acceptance Limits: 24-143%)								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

SEMI-VOLATILE - SOIL SAMPLE

SOIL ACID EXTRACTABLE SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: General Testing Corp.

Matrix Spike - Sample No. : R91/05641 -001

COMPOUND	SPIKE ADDED (ug/kg)	SAMPLE CONCENT. (ug/kg)	MS CONCENT. (ug/kg)	MS % REC #	QC LIMITS REC.
Phenol	13,500	0.00	9580	71%	5-112
2-Chlorophenol	13,400	0.00	10,700	80%	23-134
4-Chloro-3-methylphenol	13,400	0.00	11,800	88%	22-147
4-Nitrophenol	13,300	0.00	15,400	116%	D-132
Pentachlorophenol	13,300	0.00	14,400	108%	14-176

COMPOUND	SPIKE ADDED (ug/kg)	MSD CONCENT. (ug/kg)	MSD % REC #	% RPD #	QC LIMITS RPD	QC LIMITS REC.
Phenol	13,500	9660	72%	1.4%	30	5-112
2-Chlorophenol	13,400	11,300	84%	4.9%	30	23-134
4-Chloro-3-methylphenol	13,400	12,600	94%	6.6%	30	22-147
4-Nitrophenol	13,300	17,500	132%	13%	30	D-132
Pentachlorophenol	13,300	16,800	126%	15%	30	14-176

\# - Columns to be used to flag recovery and RPD values with ++.
++ - Values outside of QC limits
MS QC Limits = EPA Acceptance Criteria
RPD Limits = Internal Acceptance Criteria

RPD: 0 out of 5 outside limits
Spike Recovery: 0 out of 10 outside limits

COMMENTS:

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Job No: R91/05641

Date: 26 DEC., 1991

Acid Extractables By EPA Method 8270	REFERENCE CHECK TRUE VALUE	% RECOVERY	ACCEPTANCE LIMITS (%)
Date Extracted: 12/12/91			
Date Analyzed: 12/13/91			
Phenol	13,500	64%	5 - 112
2-Chlorophenol	13,400	63%	23 - 134
4-Chloro-3-methylphenol	13,400	70%	22 - 147
4-Nitrophenol	13,300	220%*	D - 132
Pentachlorophenol	13,330	97%	14 - 176

Michael K. Perry

Lab Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05641 Date: DEC. 31 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force
Base

Collected : 12/10/91 P.O. #:

HSL BASE NEUTRALS BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-003							
Location:	Lab Meth. Blank							
Date Collected:	--							
Time Collected:	--							
Date Extracted:	12/12/91							
Date Analyzed:	12/13/91							
Dilution:	1/2							
N-Nitrosodimethylamine	330 U							
Bis(2-chloroethyl) ether	330 U							
1,3 Dichlorobenzene	330 U							
1,4 Dichlorobenzene	330 U							
1,2 Dichlorobenzene	330 U							
bis(-2-chloroisopropyl)ether	330 U							
N-Nitroso-Di-n-propylamine	330 U							
Hexachloroethane	330 U							
Nitrobenzene	330 U							
Isophorone	330 U							
bis(-2-chloroethoxy)methane	330 U							
1,2,4-Trichlorobenzene	330 U							
Naphthalene	330 U							
Hexachlorobutadiene	330 U							
Hexachlorocyclopentadiene	330 U							
2-Chloronaphthalene	330 U							
Dimethyl phthalate	330 U							
Acenaphthylene	330 U							
Acenaphthene	330 U							
2,4-Dinitrotoluene	330 U							
2,6-Dinitrotoluene	330 U							
Diethyl phthalate	330 U							
4-Chlorophenyl-phenyl-ether	330 U							
Fluorene	330 U							
1,2-Diphenylhydrazine	330 U							
N-Nitrosodiphenylamine	330 U							
4-Bromophenyl-phenylether	330 U							
Hexachlorobenzene	330 U							
Phenanthrene	330 U							
Anthracene	330 U							
Di-n-butyl phthalate	330 U							
Benzidine	3300 U							
Fluoranthene	330 U							
Pyrene	330 U							

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job Number: R91/05641

Date: DEC. 31 1991

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Collected : 12/10/91

P.O. #:

HSL BASE NEUTRALS BY EPA METHOD 8270* ANALYTICAL RESULTS - ug/kg Wet Wt.

Sample:	-003							
Location:	Lab Meth. Blank							
Date Collected:	--							
Time Collected:	--							
Date Extracted:	12/12/91							
Date Analyzed:	12/13/91							
Dilution:	1/2							
Butyl benzyl phthalate	330 U							
3,3'-Dichlorobenzidine	330 U							
Benzo(a)anthracene	330 U							
Bis(2-ethylhexyl)phthalate	330 U							
Chrysene	330 U							
Di-n-octyl phthalate	330 U							
Benzo(b)Fluoranthene	330 U							
Benzo(k)fluoranthene	330 U							
Benzo(a)pyrene	330 U							
Indeno(1,2,3-cd)pyrene	330 U							
Dibenzo(a,h)anthracene	330 U							
Benzo(g,h,i)perylene	330 U							
Benzyl Alcohol	1320 U							
4-Chloroaniline	660 U							
2-Methyl Naphthalene	660 U							
2-Nitroaniline	1320 U							
3-Nitroaniline	1320 U							
Dibenzofuran	660 U							
4-Nitroaniline	3300 U							
SURROGATE STANDARD RECOVERIES								
Nitrobenzene-d5	65%							
(Acceptance Limits: 19-103%)								
2-Fluorobiphenyl	71%							
(Acceptance Limits: 26-119%)								
Terphenyl-d14	86%							
(Acceptance Limits: 18-142%)								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145 NY ID# in Hackensack: 10801
NJ ID# in Rochester: 73331 NJ ID# in Hackensack: 02317

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

SEMI-VOLATILE - SOIL SAMPLE

SOIL BASE/NEUTRAL MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

Lab Name: General Testing Corp.

Matrix Spike - Sample No. : R91/05641 -001

COMPOUND	SPIKE ADDED (ug/kg)	SAMPLE CONCENT. (ug/kg)	MS CONCENT. (ug/kg)	MS % REC #	QC LIMITS REC.
1,4 Dichlorobenzene	6730	0.00	5030	75%	20-124
N-Nitroso-Di-n-propylamine	6410	0.00	5260	82%	D-230
1,2,4-Trichlorobenzene	6730	0.00	5190	77%	44-142
Acenaphthene	5790	0.00	5094	88%	47-145
2,4-Dinitrotoluene	6660	0.00	5190	78%	39-139
Pyrene	6330	0.00	7060	112%	52-115

COMPOUND	SPIKE ADDED (ug/kg)	MSD CONCENT. (ug/kg)	MSD % REC #	% RPD #	QC LIMITS	
					RPD	REC.
1,4 Dichlorobenzene	6730	5150	77%	2.6%	30	20-124
N-Nitrsodi-n-propylamine	6410	5510	86%	4.8%	30	D-230
1,2,4-Trichlorobenzene	6730	5380	80%	3.8%	30	44-142
Acenaphthene	5790	5430	94%	6.6%	30	47-145
2,4-Dinitrotoluene	6660	5910	89%	13%	30	39-139
Pyrene	6330	7990	126%*	12%	30	52-115

- Columns to be used to flag recovery and RPD values with ++.
++ - Values outside of QC limits
MS QC Limits = EPA Acceptance Criteria
RPD Limits = Internal Acceptance Criteria

RPD: 0 out of 6 outside limits
Spike Recovery: 1 out of 12 outside limits

COMMENTS: ______

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Job No: R91/05641

Date: 26 DEC., 1991

	REFERENCE CHECK		
BASE NEUTRALS BY EPA METHOD 8270	TRUE VALUE	% RECOVERY	ACCEPTANCE LIMITS (%)
Date Extracted: 12/12/91			
Date Analyzed: 12/13/91			
1,4 Dichlorobenzene	6730	62%	20 - 124
N-Nitroso-Di-n-propylamine	6410	64%	D - 230
1,2,4-Trichlorobenzene	6730	67%	44 - 142
Acenaphthene	5790	83%	47 - 145
2,4-Dinitrotoluene	6660	76%	39 - 139
Pyrene	6330	63%	

GTC REPORT # WEHRAN ENVIROTECH
NIAGARA FALLS AIR FORCE BASE

SECTION C

ANALYTICAL CHRONOLOGY

Presented in this section is a Laboratory Chronology listing the dates of all preparations and analyses performed on the samples covered in this report. Holding times (maximum times in which to analyze a sample) are derived from the referenced methodology.

Chronology Notes:

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No. R91/05639 Date JAN. 8 1992

Client:

Wehran Envirotech

Sample(s) Reference

Niagara Falls
Air Force Base

Date Received: 12/11/91

Date Sample Taken: 12/10/91

LABORATORY CHRONICLE
DATE ANALYZED

Sample: Location:	-001 MW-10-A	-002 MW-10-C	-003 MW-10-E	-004 MW-10-E Duplicate	-005 MW-10-B	-006 MW-10-D	-007 Equipment Blank	-008 Field Blank	-017 Trip Blank
pH - Field Measured	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91		12/10/91	
Spec. Cond. (umhos/cm)	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91		12/10/91	
Temperature °C -Field	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91		12/10/91	
Alkalinity, Total	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	
Chloride	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	
Fluoride	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	
Nitrogen, Nitrate	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	
Nitrogen, Nitrite	12/11/91	12/11/91	12/11/91	12/11/91	12/11/91	12/11/91	12/11/91	12/11/91	
Nitrogen,Nitrate/Nitrite	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	12/13/91	
Pet. Hydrocarbons, IR	12/31/91	12/31/91	12/31/91	12/31/91	12/31/91	12/31/91	12/31/91	12/31/91	
Phosphorous, Ortho as P	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	
Silica, Total	12/31/91	12/23/91	12/23/91	12/23/91	12/23/91	12/23/91	12/23/91	12/23/91	

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No. R91/05639 Date JAN. 2 1992

Client:

Wehran Envirotech

Sample(s) Reference

Niagara Falls
Air Force Base

Date Received: 12/11/91

Date Sample Taken: 12/10/91

LABORATORY CHRONICLE
DATE ANALYZED

Sample: Location:	-001 MW-10-A	-002 MW-10-C	-003 MW-10-E	-004 MW-10-E Duplicate	-005 MW-10-B	-006 MW-10-D	-007 Equipment Blank	-008 Field Blank	-017 Trip Blank
Solids, Dissolved @180 C	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	
Sulfate	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	12/12/91	
Aluminum	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	
Barium	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	
Boron, Total	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	
Calcium, Total	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	
Chromium, Total	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	
Copper, Total	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	
Iron, Total	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	12/19/91	
Lead, Furnace	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	12/20/91	
Magnesium, Total	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	12/24/91	
Manganese, Total	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No. R91/05639 Date JAN. 2 1992

Client:

Wehran Envirotech

Sample(s) Reference

Niagara Falls
Air Force Base

Date Received: 12/11/91

Date Sample Taken: 12/10/91

LABORATORY CHRONICLE
DATE ANALYZED

Sample: Location:	-001 MW-10-A	-002 MW-10-C	-003 MW-10-E	-004 MW-10-E Duplicate	-005 MW-10-B	-006 MW-10-D	-007 Equipment Blank	-008 Field Blank	-017 Trip Blank
Nickel, Total	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	
Potassium, Total	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	12/17/91	
Sodium, Total	12/16/91	12/16/91	12/16/91	12/16/91	12/16/91	12/16/91	12/16/91	12/16/91	
Zinc, Total	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	12/18/91	

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job. No: R91/05640 Date: DEC. 26 1991

Client:

Wehran Envirotech

Sample(s) Reference

NIAGARA FALLS
AIR FORCE BASE

Date Received: 12/11/91

Date Sample Taken: 12/10/91

LABORATORY CHRONICLE
DATE ANALYZED

Sample: Location:	-001 10-3	-002 10-2	-003 10-1D	-004 10-4	-005 10-1				
8021 Scan	12/18/91	12/19/91	12/19/91	12/19/91	12/19/91				

General Testing Corporation

GTC REPORT # WEHRAN ENVIROTECH
NIAGARA FALLS AIR FORCE BASE

SECTION D

FIELD DOCUMENTATION

Presented in this section is all support documentation requested.

Documentation Provided:

(X) Chain of Custody Forms
( ) Analytical Request Forms
( ) Shipping Receipts
( ) Laboratory Receipt Log
(X) Other: FIELD FORMS

39

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

710 Exchange Street
Rochester, NY 14608

85 Trinity Place
Hackensack, NJ 07601

435 Lawrence Bell Drive
Amherst, NY 14221-7077

GTC Job No. R91/56~~40~~9
Client Project No. /

Sample Origination & Shipping Information

Collection Site Niag. Falls Airbase

Address (Street, City, State, Zip)

Collector C. Thompson (Print) Clinton Thompson (Signature)

Bottles Prepared by GTC
Bottles Shipped to Client via GTC
Samples Shipped via GTC

Rec'd by
Seal/Shipping #
Seal/Shipping #

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign	1. Sign	/ /
for	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by 12/11/91 @ 09:00

	Client I.D.# Lab#	Sample Location Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	Preserved N	Filtered Y	Filtered N	Bottle Set(s) (see below)
1	#1 QC R91/5639 -001 -009	mw 10-A 12/10/91 9:25		See Analitical request	✓		✓		1,1,10,4,8,8,4
2	#2 R91/5639 -002 -010	MW 10-C 12/10/91 10:45		" "					1,3,4,5,7,8
3	#3 R91/5639 -003 -011	MW 10-E 12/10/91 11:10		" "					1,3,4,5,7,8
4	#4 R91/5639 -004 -012	MW 10-E 12/10/91 11:25		" "					1,3,4,5,7,8
5	#5 R91/5639 -005 -013	MW 10-13 12/10/91 11:58		" "					1,3,4,5,7,8

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. Plastic	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.	Gallon Glass	
# of each	34		2	3	2		2	2		1	

Additional Analytes

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H)
River or Stream (R), Pond (P), Industrial Discharge (I), ____(X), ____ (Y)

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

39

710 Exchange Street
Rochester, NY 14608

85 Trinity Place
Hackensack, NJ 07601

435 Lawrence Bell Drive
Amherst, NY 14221-7077

GTC Job No. R91/5639
Client Project No. ______

Sample Origination & Shipping Information

Collection Site NIAG. FALLS Airbase
Address ______ Street ______ City ______ State ______ Zip ______
Collector C. Thompson (Print) Clinton Thompson (Signature)

Bottles Prepared by GTC
Bottles Shipped to Client via GTC
Samples Shipped via GTC

Rec'd by ______
Seal/Shipping # ______
Seal/Shipping # ______

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign	1. Sign	/ /
for	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by ______ 12/11/91 @ 09:00

	Client I.D.# Lab#	Sample Location Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	Sample Prep Preserved N	Sample Prep Filtered Y	Sample Prep Filtered N	Bottle Set(s) (see below)
1	# 6	MW 10-D		See Analitical	✓		✓		1,3,4,5,7,8
	R91/5639 -006 -014	12/10/91 12 15		request					
2	# 7	Equipt. BlAnk		" "	✓		✓		1,3,4,5,7,8
	R91/5639 -007 -015	12/10/91 13 00							
3	#8	field BlANK MW10-E		" "	✓		✓		1,3,4,5,7,8
	R91/5639 -008 -016	12/10/91 11 10							
4		TripBlank		8020/8021					1
	R91/5639-017	12/10/91							
5									
		/ / :							

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. Plastic	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.		
# of each	~~3~~4		2	3	2		2	1			

Additional Analytes ______

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H). River or Stream (R), Pond (P), Industrial Discharge (I), ______(X), ______ (Y).

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

710 Exchange Street Rochester, NY 14608	85 Trinity Place Hackensack, NJ 07601	435 Lawrence Bell Drive Amherst, NY 14221-7077	GTC Job No. R91/5640 Client Project No.

Sample Origination & Shipping Information

Collection Site NIAG.FALLS Airbase

Address
Street City State Zip

Collector C. Thompson (Print) Clinton Thompson (Signature)

Bottles Prepared by GTC

Bottles Shipped to Client via GTC

Samples Shipped via GTC

Rec'd by

Seal/Shipping #

Seal/Shipping #

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign	1. Sign	/ /
for	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by 12/11/91 @ 09:00

	Client I.D.# Lab#	Sample Location Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	Preserved N	Filtered Y	Filtered N	Bottle Set(s) (see below)	
1	#1 QC	10-3		See Analitical	✓			✓	1	
	R91/5640-001	12/10/91 9:45		request						
2	#2	10-2		" "					1	
	R91/5640-002	12/10/91 9:55								
3	#3	10-1D		" "					1	
	R91/5640-003	12/10/91 10:10								
4	#4	10-4		" "					1	
	R91/5640-004	12/10/91 10:25								
5	#5	10-1		" "					1	
	R91/5640-005	12/10/91 12:00								

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. Plastic	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.		
# of each	4										

Additional Analytes

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H) River or Stream (R), Pond (P), Industrial Discharge (I), ______(X), ______(Y)

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

710 Exchange Street
Rochester, NY 14608

85 Trinity Place
Hackensack, NJ 07601

435 Lawrence Bell Drive
Amherst, NY 14221-7077

GTC Job No. R91/5641
Client Project No. ______

Sample Origination & Shipping Information
Collection Site Niag. Falls Airbase
Address ______ Street ______ City ______ State ______ Zip ______
Collector C. Thompson (Print) Clinton Thompson (Signature)

Bottles Prepared by GTC
Bottles Shipped to Client via GTC
Samples Shipped via GTC
Rec'd by ______
Seal/Shipping # ______
Seal/Shipping # ______

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign	1. Sign	/ /
for	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by Tom Hastings 12/11/91 @ 14:55

	Client I.D.# Lab#	Sample Location Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	N	Filtered Y	N	Bottle Set(s) (see below)	
1	#1QC	Sediment Pond		See Analitical				✓	4	
	R91/5641-001	12/10/91 13:15		request						
2	#2	Creek		" "				✓	4	
	R91/5641-002	12/10/91 13:45								
3										
		/ / :								
4										
		/ / :								
5										
		/ / :								

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. ~~Plastic~~ Glass	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.		
# of each				4							

Additional Analytes ______

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H). River or Stream (R), Pond (P), Industrial Discharge (I), ______(X), ______(Y).

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niag. Falls Airbase

Job Number R91/~~5439f~~ 5639

Well I.D. MW 10A (New)

Lab Number #1 QC

PURGE INFORMATION

Purge Method stainless steel bailer

Well Depth (ft) 21.75

Static Water Level (ft)— 4.06

Depth of Water Column (gal/ft)x 17.69

Well Constant (gal/ft)x .16

Volume standing in well 2.83 gallons x 5 vols = 14.15

Start of Purge: Date 12 / 9 / 91 Time 9 : 35 - 9:59

Purge Observations Muddy red good recharge

Total Volume Purged 15 gallons

# of Volume Casings Purged 5+ Vols

SAMPLING INFORMATION

Sample Method stainless steel bailer

Sample Date: 12 / 10 / 91 Time: 9 : 25 Sample Depth: 5.96 ft.

Sample Appearance: muddy reddish tint

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	7.67	7.67
4.00	Spec. Cond.	umhos/cm	926	935
10.00	Temp	°Celsius	9.0	9.0
1,413	Spec. Grav.		1.001	1.001

Field Filtered Y [✓ N] Date/Time 12 / 10 / 91 10 : 15

Meter Calibration: Date/Time 12 / 10 / 91 9 : 20

FIELD OBSERVATIONS: Weather 35°, overcast, west breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12 / 10 / 91 Signature

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niagara Fall Airbase Job Number P91/5639

Well I.D. MW - 10c Lab Number #2

PURGE INFORMATION Purge Method Stainless steel bailer

Well Depth (ft) 11.05

Static Water Level (ft)— 7.95

Depth of Water Column (gal/ft)x 3.10

Well Constant (gal/ft)x .16

Volume standing in well .49 gallons x 5 vols = 2.48

Start of Purge: Date 12 / 9 / 91 Time 12 : 30 - 12:45

Purge Observations muddy red good recharge

Total Volume Purged 3 gallons # of Volume Casings Purged 5+ vols

SAMPLING INFORMATION Sample Method Stainless steel bailer

Sample Date: 12 / 10 / 91 Time: 10 : 45 Sample Depth: 7.99 ft.

Sample Appearance: Muddy, reddish tint

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	2
7.00	pH	stnd	7.66	7.64
4.00	Spec. Cond.	umhos/cm	997	985
10.00	Temp	°Celsius	9.5	9.5
1413	Spec. Grav.		1.000	1.000

Field Filtered [✓ Y]N Date/Time 12 / 10 / 91 11 : 35

Meter Calibration: Date/Time 12 / 10 / 91 10 : 40

FIELD OBSERVATIONS: Weather 35°, overcast, west breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/ 10/ 91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niagara FALLS Airbase Job Number P91/5639

Well I.D. MW ~~8~~ Cr.-10E (New) Lab Number #344

PURGE INFORMATION Purge Method stainless steel bailer

Well Depth (ft) 26.59

Static Water Level (ft)— 5.12

Depth of Water Column (gal/ft)x 21.47

Well Constant (gal/ft)x .16

Volume standing in well 3.43 gallons x 5 vols = 17.17

Start of Purge: Date 12/9/91 Time 12:50 - 13:15

Purge Observations greyish to red good recharge

Total Volume Purged 18 gallons # of Volume Casings Purged 5+ vols

SAMPLING INFORMATION Sample Method stainless steel bailer

Sample Date: 12/10/91 Time: 11:00 Sample Depth: 5.30 ft.

Sample Appearance: muddy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 3	3	4	4
7.00	pH	stnd	7.83	7.83	7.78	7.7
4.00	Spec. Cond.	umhos/cm	1,752	1,725	1,543	1,54
10.00	Temp	°Celsius	9.0	9.0	9.0	9.0
1,413	Spec. Grav.		1.001	1.001	1.001	1.001

Field Filtered [✓ Y]/N Date/Time 12/10/91 12:05

Meter Calibration: Date/Time 12/10/91 11:05

FIELD OBSERVATIONS: Weather 35°, overcast, west breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niagara Falls Airbase Job Number R91/5639

Well I.D. MW-10[illegible] CT B (New) Lab Number # 5

PURGE INFORMATION Purge Method Stainless steel bailer

Well Depth (ft) 21.15

Static Water Level (ft)— 9.75

Depth of Water Column (gal/ft)x 11.4

Well Constant (gal/ft)x .16

Volume standing in well 1.82 gallons x 5 vols = 9.12

Start of Purge: Date 12 / 9 / 91 Time 13 : 28 - 13:43

Purge Observations greyish to red good recharge

Total Volume Purged 10 gallons # of Volume Casings Purged 5+ vols

SAMPLING INFORMATION Sample Method Stainless steel bailer

Sample Date: 12 / 10 / 91 Time: 11 : CT [illegible] 58 Sample Depth: 10.99 ft.

Sample Appearance: Moddy, with greyish tint

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	8.16	8.14
4.00	Spec. Cond.	umhos/cm	1,585	1,595
10.00	Temp	°Celsius	10.0	10.0
1,413	Spec. Grav.		1.001	1.001

Field Filtered [✓ Y]/N Date/Time 12 / 10 / 91 12 : 36

Meter Calibration: Date/Time 12 / 10 / 91 11 : 45

FIELD OBSERVATIONS: Weather 35°, overcast, slight breeze

C. Thompson, S. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12 / 10 / 91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niag. Falls Airbase Job Number R91/5639

Well I.D. MW-10D (NEW) Lab Number #6

PURGE INFORMATION Purge Method stainless steel bailer

Well Depth (ft) 11.96

Static Water Level (ft)— 7.58

Depth of Water Column (gal/ft)x 4.38

Well Constant (gal/ft)x .16

Volume standing in well .70 gallons x 5 vols = 3.50

Start of Purge: Date 12 / 9 / 91 Time 14 : 15 - 14:20

Purge Observations redish slow recharge

Total Volume Purged 1½ gallons # of Volume Casings Purged 1T to DRY

SAMPLING INFORMATION Sample Method Stainless Steel bailer

Sample Date: 12 / 10 / 91 Time: 12 : 15 Sample Depth: 8.96 ft.

Sample Appearance: Moddy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	7.75	7.76
4.00	Spec. Cond.	umhos/cm	1,676	1,665
10.00	Temp	°Celsius	10.0	10.0
1,413	Spec. Grav.		1.001	1.001

Field Filtered [✓ Y] N Date/Time 12/ 10 / 91 12 : 55

Meter Calibration: Date/Time 12 / 10 / 91 12 : 10

FIELD OBSERVATIONS: Weather 35°, Slight breeze, overcast

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): Clark Thompson

Date: 12 / 10 / 91 Signature Clark Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location NIAGARA FALLS AIR BASE Job Number R91/5639

Well I.D. EQUIPMENT BLANK Lab Number ~~128~~ #7

PURGE INFORMATION Purge Method N/A

Well Depth (ft)

Static Water Level (ft)—

Depth of Water Column (gal/ft)x

Well Constant (gal/ft)x

Volume standing in well N/A gallons

Start of Purge: Date ___/___/___ Time ___:___

Purge Observations

Total Volume Purged ___ gallons # of Volume Casings Purged N/A

SAMPLING INFORMATION Sample Method DI RINSE STAINLESS BAILER

Sample Date: 12/10/91 Time: 13:00 Sample Depth: N/A ft.

Sample Appearance: CLEAR NO ODOR

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	2
7.00	pH	stnd	8.06	8.06
4.00	Spec. Cond.	umhos/cm	54.50	55.25
10.00	Temp	°Celsius	11.5	11.5
1.413	Spec. Grav.		.999	.999

Field Filtered Y/N Date/Time ___/___/___ ___:___

Meter Calibration: Date/Time 12/10/91 12:55

FIELD OBSERVATIONS: Weather

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niagara FALLS AirBASE Job Number R91/5639

Well I.D. Field blank done AT well # MW10-E Lab Number #8

PURGE INFORMATION Purge Method N/A

Well Depth (ft)

Static Water Level (ft)—

Depth of Water Column (gal/ft)x

Well Constant (gal/ft)x

Volume standing in well gallons

Start of Purge: Date / / Time :

Purge Observations

Total Volume Purged gallons # of Volume Casings Purged

SAMPLING INFORMATION Sample Method

Sample Date: 12/10/91 Time: 11:10 Sample Depth: N/A ft.

Sample Appearance: D.I. Water

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	8.06	8.05
4.00	Spec. Cond.	umhos/cm	54.50	54.75
10.00	Temp	°Celsius	9.0	9.0
1413	Spec. Grav.		.999	.999

Field Filtered Y [✓ N] Date/Time / / :

Meter Calibration: Date/Time 12/10/91 11:05

FIELD OBSERVATIONS: Weather 35°, overcast, slight breeze

C. Thompson, S. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niag. FALLS Airbase Job Number R91/5840
Well I.D. 10-3 (OLD) Lab Number # 2 QC

PURGE INFORMATION Purge Method stainless Steel bailer

Well Depth (ft) 11.90
Static Water Level (ft)— 6.09
Depth of Water Column (gal/ft)x 5.81
Well Constant (gal/ft)x .16
Volume standing in well .92 gallons x 5 vols = 4.64
Start of Purge: Date 12 / 9 / 91 Time 10 : 10 - 10:31
Purge Observations Muddy red good recharge
Total Volume Purged 5 gallons # of Volume Casings Purged 5+ vols

SAMPLING INFORMATION Sample Method stainless steel bailer
Sample Date: 12 / 10 / 91 Time: 9 : 45 Sample Depth: 6.86 ft.
Sample Appearance: clear but cloudy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	2
7.00	pH	stnd	7.74	7.74
4.00	Spec. Cond.	umhos/cm	1,150	1,165
10.00	Temp	°Celsius	9.0	9.0
1,413	Spec. Grav.		1.000	1.000

Field Filtered [✓ Y] N Date/Time 12 / 10 / 91 10 : 35
Meter Calibration: Date/Time 12 / 10 / 91 9 : 40

FIELD OBSERVATIONS: Weather 35°, overcast, West breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.
Sampler (Print): C. Thompson

Date: 12 / 10 / 91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niag. FALLS Airbase Job Number R91/5640

Well I.D. 10-2 Lab Number #2

PURGE INFORMATION Purge Method Stainless steel/bailer

Well Depth (ft) 10.93

Static Water Level (ft)— 7.03

Depth of Water Column (gal/ft)x 3.90

Well Constant (gal/ft)x .16

Volume standing in well .62 gallons x 5vols = 3.12

Start of Purge: Date 12/9/91 Time 10:41 - 10:51

Purge Observations Muddy red slow recharge

Total Volume Purged 2 gallons # of Volume Casings Purged 1+vol to dry

SAMPLING INFORMATION Sample Method Stainless steel bailer

Sample Date: 12/10/91 Time: 9:55 Sample Depth: 8.02 ft.

Sample Appearance:

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	7.67	7.65
4.00	Spec. Cond.	umhos/cm	1,233	1,245
10.00	Temp	°Celsius	9.5	9.5
1,413	Spec. Grav.		1,000	1,000

Field Filtered Y [✓ N] Date/Time __/__/__ __:__

Meter Calibration: Date/Time 12/10/91 9:50

FIELD OBSERVATIONS: Weather 35°, overcast, slight breeze

C. Thompson

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

R91/5640

Site Location NiAg. FAlls Airbase Job Number ~~R91/5840~~ CT

Well I.D. 10-1D Lab Number #3

PURGE INFORMATION Purge Method stainless steel/bailer

Well Depth (ft) 34.65

Static Water Level (ft)— 7.86

Depth of Water Column (gal/ft)x 26.79

Well Constant (gal/ft)x .16

Volume standing in well 4.28 gallons x 5 vols = 21.43

Start of Purge: Date 12/9/91 Time 11:00 - 11:50

Purge Observations black to red good recharge

Total Volume Purged 22 gallons # of Volume Casings Purged 5

SAMPLING INFORMATION Sample Method Stainless steel bailer

Sample Date: 12/10/91 Time: 10:10 Sample Depth: 7.94 ft.

Sample Appearance: Muddy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	2
7.00	pH	stnd	7.60	7.58
4.00	Spec. Cond.	umhos/cm	1,233	1,225
10.00	Temp	°Celsius	9.5	9.5
1413	Spec. Grav.		1,000	1.000

Field Filtered Y [✓ N] Date/Time 12/10/91 1:

Meter Calibration: Date/Time 12/10/91 10:05

FIELD OBSERVATIONS: Weather 35°, overcast, slight breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location Niag. Falls Airbase Job Number R91/5640

Well I.D. MW 10-4 Lab Number #4

PURGE INFORMATION Purge Method Stainless steel bailer

Well Depth (ft) 10.06

Static Water Level (ft)— 7.25

Depth of Water Column (gal/ft)x 2.81

Well Constant (gal/ft)x .16

Volume standing in well .44 gallons x5 vols = 2.24

Start of Purge: Date 12/9/91 Time 12:00 - 12:05

Purge Observations rusty red to muddy red slow recharge

Total Volume Purged 1 gallons # of Volume Casings Purged 1+ To Dry

SAMPLING INFORMATION Sample Method Stainless steel bailer

Sample Date: 12/10/91 Time: 10:25 Sample Depth: 7.86 ft.

Sample Appearance: Cloudy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	7.81	7.82
4.00	Spec. Cond.	umhos/cm	925	930
10.00	Temp	°Celsius	9.0	9.0
1,413	Spec. Grav.		1.000	1.000

Field Filtered [✓ Y]/N Date/Time 12/10/91 :

Meter Calibration: Date/Time 12/10/91 10:20

FIELD OBSERVATIONS: Weather 35°, overcast, west breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature Clinton Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location: NiAg. FALLS Airbase Job Number: R91/5640

Well I.D.: 10-1 OLD Lab Number: #5

PURGE INFORMATION

Purge Method: stainless steel bailer

Well Depth (ft): 10.95

Static Water Level (ft)—: 5.39

Depth of Water Column (gal/ft)x: 5.56

Well Constant (gal/ft)x: .16

Volume standing in well: .88 gallons x 5 vols = 4.44

Start of Purge: Date 12/9/91 Time 13:55 - 13:59

Purge Observations: Muddy red slow recharge

Total Volume Purged: 1 gallons

# of Volume Casings Purged: 1+ vol TO DRY

SAMPLING INFORMATION

Sample Method: Stainless steel bailer

Sample Date: 12/10/91 Time: 12:00 Sample Depth: 6.98 ft.

Sample Appearance: Muddy

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
7.00	pH	stnd	7.34	7.35
4.00	Spec. Cond.	umhos/cm	1,447	1,435
10.00	Temp	°Celsius	10.0	10.0
1,413	Spec. Grav.		1.001	1.001

Field Filtered Y [✓ N] Date/Time ___/___/___ ___:___

Meter Calibration: Date/Time 12/10/91 11:55

FIELD OBSERVATIONS: Weather 35°, overcast, slignt breeze

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location NIAGFALLS Airbase Job Number R91/5641

Well I.D. ~~Sediment pond~~ Lab Number #1 QC

Sediment sample 1 [illegible] 1/21

PURGE INFORMATION Purge Method N/A

Well Depth (ft) ____

Static Water Level (ft)— ____

Depth of Water Column (gal/ft)x ____

Well Constant (gal/ft)x ____

Volume standing in well ____ gallons

Start of Purge: Date ___/___/___ Time ___:___

Purge Observations ____

Total Volume Purged ____ gallons # of Volume Casings Purged ____

SAMPLING INFORMATION Sample Method Grabbed dirt

Sample Date: 12/10/91 Time: 13:15 Sample Depth: N/A ft.

Sample Appearance: N/A

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	2
	pH	stnd		
	Spec. Cond.	umhos/cm	N/A	
	Temp	°Celsius		
	Spec. Grav.			

Field Filtered Y/N Date/Time ___/ N/A ___:___

Meter Calibration: Date/Time ___/___/ N/A ___:___

FIELD OBSERVATIONS: Weather 40, slight breeze, overcast

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature [illegible] Thompson

GENERAL TESTING CORPORATION
GROUNDWATER MONITORING FIELD FORM

Site Location: Niag. Falls Airbase Job Number: R91/5641

Well I.D.: ~~Creek~~ Sediment sample 2 Lab Number: #2
JMD 1/21

PURGE INFORMATION Purge Method: N/A

Well Depth (ft):

Static Water Level (ft)—

Depth of Water Column (gal/ft)x

Well Constant (gal/ft)x

Volume standing in well ______ gallons

Start of Purge: Date ___/___/___ Time ___:___

Purge Observations:

Total Volume Purged ______ gallons # of Volume Casings Purged:

SAMPLING INFORMATION Sample Method: GRABBED DIRT

Sample Date: 12/10/91 Time: 13:45 Sample Depth: N/A ft.

Sample Appearance: N/A

FIELD MEASUREMENTS

Meter Number	Parameter	Unit Stnd.	Replicates 1	Replicates 2
	pH	stnd		
	Spec. Cond.	umhos/cm	N/A	
	Temp	°Celsius		
	Spec. Grav.			

Field Filtered Y/N Date/Time ___/___/ N/A ___:___

Meter Calibration: Date/Time ___/___/ N/A ___:___

FIELD OBSERVATIONS: Weather: 40°, slight breeze, overcast

C. Thompson, J. Williams

I certify that sampling procedures were in accordance with all applicable EPA, state and corporate protocols.

Sampler (Print): C. Thompson

Date: 12/10/91 Signature: Clinton Thompson

ANALYTICAL RESULTS - GROUNDWATER SOLUBLE METALS

RECEIVED FEB 11 1992

General Testing Corporation

A Full Service Environmental Laboratory

FEB. 4 1992

Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Re: Niagara Falls Air Force
Base R91/5639

Dear Mr. Glen Combes

Enclosed are the results of the analysis requested. All data has been reviewed prior to report submission. Should you have any questions please contact me at 454-3760.

Thank you for letting us provide this service.

Sincerely,

GENERAL TESTING CORPORATION

Janice M Jaeger

Janice Jaeger
Customer Service Representative

aa

Enc.

710 Exchange Street • Rochester, New York 14608 • (716) 454-3760 • Fax (716) 454-1245
85 Trinity Place • Hackensack, NJ 07601 • (201) 488-5242 • Fax (201) 488-6386
435 Lawrence Bell Drive • Amherst, NY 14221 • (716) 634-0454 • Fax (716) 634-9019

General
Testing
Corporation

Effective 10/1/91

GTC LIST OF QUALIFIERS

U - Indicates compound was analyzed for but was not detected. The sample quantitation limit must be corrected for dilution and for percent moisture.

J - Indicates an estimated value. For further explanation see case narrative / cover letter.

B - This flag is used when the analyte is found in the associated blank as well as in the sample.

E - This flag identifies compounds whose concentrations exceed the calibration range and reanalysis could not be performed.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

N - Spiked sample recovery not within control limits. (Flag the entire batch - Inorganic analytes only)

* - Duplicate analysis not within control limits. (Flag the entire batch - Inorganic analysis only)

- Also used to qualify Organics QC data outside limits. (Only used on the QC summary sheets)

M - Duplication injection precision not met (GFA only).

S - Reported value determined by Method of Standard Additions. (MSA)

X - As specified in the case narrative.

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R92/00216 Date: FEB. 4 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference
Niagara Falls Air Force
Base R91/5639

Received : 01/14/92 P.O. #:

ANALYTICAL RESULTS - mg/l

Sample:	-001	-002	-003	-004	-005			
Location:	MW-10A R91/5636-1	MW-10E R91/5639-3	MW-10B R91/5639-5	MW-10C R91/5639-2	MW-10D R91/5639-6			
Date Collected:	12/10/91	12/10/91	12/10/91	12/10/91	12/10/91			
Time Collected:	09:25	11:10	11:58	10:45	12:15			
Aluminum, Soluble	5.05	0.137	3.12	0.112	0.608			
Iron, Soluble	3.40	0.389	2.17	0.0631	0.382			
Lead, Sol. (Furnace)			0.0282					
Magnesium, Soluble	59.5	104	76.2	74.0	142			
Manganese, Soluble	0.101	0.0831	0.104	0.361	0.189			
Sodium, Soluble			8.37		27.8			
Zinc, Soluble	0.400	0.0277	0.175		0.147			

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

Michael K. Perry

Laboratory Director

ANALYTICAL RESULTS - DRILL CUTTINGS
TCLP ANALYSIS

General Testing Corporation

A Full Service Environmental Laboratory

RECEIVED JAN 29 1992

JAN. 16 1992

Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Re: Niagara Falls Air Force
Base

Dear Mr. Glen Combes

Enclosed are the results of the analysis requested. All data has been reviewed prior to report submission. Should you have any questions please contact me at 454-3760.

Thank you for letting us provide this service.

Sincerely,

GENERAL TESTING CORPORATION

Janice M Jaeger

Janice Jaeger
Customer Service Representative

aa

Enc.

710 Exchange Street • Rochester, New York 14608 • (716) 454-3760 • Fax (716) 454-1245
85 Trinity Place • Hackensack, NJ 07601 • (201) 488-5242 • Fax (201) 488-6386
435 Lawrence Bell Drive • Amherst, NY 14221 • (716) 634-0454 • Fax (716) 634-9019

General
Testing
Corporation

Effective 10/1/91

GTC LIST OF QUALIFIERS

U - Indicates compound was analyzed for but was not detected. The sample quantitation limit must be corrected for dilution and for percent moisture.

J - Indicates an estimated value. For further explanation see case narrative / cover letter.

B - This flag is used when the analyte is found in the associated blank as well as in the sample.

E - This flag identifies compounds whose concentrations exceed the calibration range and reanalysis could not be performed.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

N - Spiked sample recovery not within control limits. (Flag the entire batch - Inorganic analytes only)

* - Duplicate analysis not within control limits. (Flag the entire batch - Inorganic analysis only)

  - Also used to qualify Organics QC data outside limits. (Only used on the QC summary sheets)

M - Duplication injection precision not met (GFA only).

S - Reported value determined by Method of Standard Additions. (MSA)

X - As specified in the case narrative.

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Received : 12/24/91

P.O. #:

ANALYTICAL RESULTS - mg/l

Sample:	-001						
Location:	Drum Composite						
Date Collected:	12/23/91						
Time Collected:	10:30						
	BIASED	UNBIASED	% RECOVERY				
TCLP Extraction Metals ***							
Arsenic	0.50 U	0.50 U	86%				
Barium	0.551	0.471	85%				
Cadmium	0.10 U	0.10 U	74%				
Chromium	0.10 U	0.10 U	82%				
Lead	0.10 U	0.10 U	71%				
Mercury	0.0020 U	0.0020 U	99%				
Selenium	0.50 U	0.50 U	90%				
Silver	0.10 U	0.10 U	87%				

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.

NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

***TCLP Toxicity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol. 55, No. 126,
June 29, 1990.

Data reported is biased on the above regulation.

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Received : 12/24/91

P.O. #:

TCLP VOLATILES BY EPA METHOD 8240*** ANALYTICAL RESULTS - ug/l

Sample:	-001		
Location:	Drum Composite		
Date Collected:	12/23/91		
Time Collected:	10:30		
	BIASED	UNBIASED	% RECOVERY
Date Analyzed:	01/07/92		
Dilution:	1/10		
Benzene	50 U	50 U	106%
Carbon Tetrachloride	50 U	50 U	105%
Chlorobenzene	50 U	50 U	107%
Chloroform	50 U	50 U	108%
1,2-Dichloroethane	50 U	50 U	104%
1,1-Dichloroethene	50 U	50 U	102%
Methyl Ethyl Ketone	100 U	100 U	78%
Tetrachloroethene	50 U	50 U	106%
Trichloroethene	50 U	50 U	112%
Vinyl Chloride	50 U	50 U	106%
SURROGATE STANDARD RECOVERIES			
1,2-Dichloroethane-d4	100%		
(Acceptance Limits: 75-119%)			
Toluene d8	100%		
(Acceptance Limits: 85-110%)			
Bromofluorobenzene	98%		
(Acceptance Limits: 84-116%)			

nless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
Y ID# in Rochester: 10145
J ID# in Rochester: 73331
J ID# in Hackensack: 02317
Y ID# in Hackensack: 10801

**TCLP Toxicity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol. 55, No. 126,
June 29, 1990.

Data reported is biased on the above regulation.

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force
Base

Received : 12/24/91 P.O. #:

TCLP ACID EXTRACTABLES BY EPA METHOD 8270*** ANALYTICAL RESULTS - ug/l

Sample:	-001							
Location:	Drum Composite							
Date Collected:	12/23/91							
Time Collected:	10:30							
	BIASED	UNBIASED	% RECOVERY					
Date Extracted:	01/07/92							
Date Analyzed:	01/09/92							
Dilution:								
m+p-cresol	100 U	100 U	52%					
o-cresol	100 U	100 U	20%					
Pentachlorophenol	200 U	200 U	50%					
2,4,5-Trichlorophenol	100 U	100 U	52%					
2,4,6-Trichlorophenol	100 U	100 U	55%					
Surrogate Standard Recoveries:								
2-Fluorophenol	1.7%*							
(Acceptance Limits: 10-109%)								
Phenol-d6	0.6%*							
(Acceptance Limits: 10-73%)								
2,4,6-TriBromophenol	41%							
(Acceptance Limits: 10-141%)								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

***TCLP Toxicity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol. 55, No. 126,
June 29, 1990.

Data reported is biased on the above regulation.

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force Base

Received : 12/24/91 P.O. #:

TCLP BASE NEUTRALS BY EPA METHOD 8270*** ANALYTICAL RESULTS - ug/1

Sample:	-001						
Location:	Drum Composite						
Date Collected:	12/23/91						
Time Collected:	10:30						
	BIASED	UNBIASED	% RECOVERY				
Date Extracted:	01/07/92						
Date Analyzed:	01/09/92						
Dilution:	1/10						
1,4 Dichlorobenzene	50 U	50 U	59%				
2,4-Dinitrotoluene	50 U	50 U	81%				
Hexachlorobenzene	50 U	50 U	67%				
Hexachloroethane	50 U	50 U	15%				
Nitrobenzene	50 U	50 U	72%				
Pyridine	100 U	100 U	32%				
Hexachloro-1,3-butadiene	50 U	50 U	66%				
Surrogate Standard Recoveries:							

Nitrobenzene-d5	57%						
(Acceptance Limits: 26-111%)							
2-Fluorobiphenyl	80%						
(Acceptance Limits: 23-131%)							
Terphenyl-d14	80%						
(Acceptance Limits: 20-151%)							

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

***TCLP Toxicity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol. 55, No. 126,
June 29, 1990.

Data reported is biased on the above regulation.

Michael K. Perry

Laboratory Director

General Testing Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference

Niagara Falls Air Force
Base

Received : 12/24/91 P.O. #:

TCLP PESTICIDES-BY GC METHOD 8080 *** ANALYTICAL RESULTS - ug/l

Sample:	-001						
Location:	Drum Composite						
Date Collected:	12/23/91						
Time Collected:	10:30						
	BIASED	UNBIASED	% RECOVERY				
Date Extracted:	01/08/92						
Date Analyzed:	01/10/92						
Dilution:	1/10						
Chlordane	20 U	20 U	76%				
Endrin	5.0 U	5.0 U	89%				
Heptachlor	5.0 U	5.0 U	87%				
Heptachlor epoxide	5.0 U	5.0 U	75%				
gamma-BHC (Lindane)	5.0 U	5.0 U	90%				
Methoxychlor	20 U	20 U	65%				
Toxaphene	100 U	--	--				
Surrogate Standard Recovery							
% Recovery							
Dibutylchlorendate (Acceptance Limits: 24-154)	92%						
Tetrachloro-meta-xylene (Acceptance Limits: 27-119)	80%						

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145 NY ID# in Hackensack: 10801
NJ ID# in Rochester: 73331 NJ ID# in Hackensack: 02317

***TCLP Toxicity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol. 55, No. 126,
June 29, 1990.

Data reported is biased on the above regulation

Michael K. Perry

Laboratory Director

General
Testing
Corporation

A Full Service Environmental Laboratory

LABORATORY REPORT

Job No: R91/05981 Date: JAN. 16 1992

Client:
Mr. Glen Combes
Wehran Envirotech
345 Lang Blvd.
Grand Island, NY 14072

Sample(s) Reference:

Niagara Falls Air Force Base

Received : 12/24/91 P.O. #:

TCLP HERBICIDES-ANALYSIS BY GC METHOD 8150 *** ANALYTICAL RESULTS - ug/1

Sample:	-001							
Location:	Drum Composite							
Date Collected:	12/23/91							
Time Collected:	10:30							
	BIASED	UNBIASED	% RECOVERY					
Date Extracted:	01/07/92							
Date Analyzed:	01/10/92							
Dilution:	1/100							
2,4-D	50 U	50 U	86%					
2,4,5-TP (Silvex)	50 U	50 U	78%					
SURROGATE STANDARD RECOVERIES								
% Recovery								
2,4-DB	58%							
(Acceptance Limits 18-152)								

Unless otherwise noted, analytical methodology has been obtained from references as cited in 40 CFR, parts #136 & #261.
NY ID# in Rochester: 10145
NJ ID# in Rochester: 73331
NJ ID# in Hackensack: 02317
NY ID# in Hackensack: 10801

*** TCLP Toxcity Characteristic Leaching Procedure.
Federal Register, Part 261, Vol.55, No. 126,
June 29, 1990

Data reported is biased on the above regulation.

Michael K. Perry
Laboratory Director

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

710 Exchange Street
Rochester, NY 14608

85 Trinity Place
Hackensack, NJ 07601

435 Lawrence Bell Drive
Amherst, NY 14221-7077

GTC Job No. R91/5981
Client Project No. 00640-02

Sample Origination & Shipping Information

Collection Site Niagara Falls AB
Address ______ Street City State Zip
Collector GEORGE HORMANCE (Print) George Hormance (Signature)

Bottles Prepared by GTC
Bottles Shipped to Client via Courier
Samples Shipped via Fed Ex

Rec'd by Client
Seal/Shipping # ______
Seal/Shipping # ______

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign George Hormance	1. Sign	/ /
for Weber	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by Tom Hastings 12/24/91 @ 09:30

	Client I.D.# Lab #	Sample Location Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	Preserved N	Filtered Y	Filtered N	Bottle Set(s) (see below)
1	1	Drum Composite 12/23/91 10:30		FULL TCLP 8240, 8270, metals Pest/PCB/Herb					
2		/ / :							
3		/ / :							
4		/ / :							
5		/ / :							

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. Plastic	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.		
# of each											

Additional Analytes ______

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H), River or Stream (R), Pond (P), Industrial Discharge (I), ______(X), ______(Y).

APPENDIX D
RISK ASSESSMENT TABLES
TAKEN FROM SAIC IRP RI/FS REPORT

TABLE 4-58. RISK CHARACTERIZATION FOR SITE 10: EXPOSURE TO GROUNDWATER

Chemical	Mean (a) Concentration in Groundwater (ug/L)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	11600.00			
Barium	187.00	3.67E-02	Hypertension	
Chromium	20.00	3.92E-02	Skin	
Cobalt	9.00		Thyroid, Heart	
Copper	40.00	1.06E-02	GI Tract, Blood	
Lead	72.00	5.05E-01	CNS, Kidney	
Manganese	1460.00	7.16E-02	CNS, Reproductive	
Molybdenum	7.00			
Nickel	30.00	1.47E-02	Skin, Lung	
Vanadium	25.00	3.50E-02	Respiratory Effects	
Zinc	905.00	4.44E-02	GI Tract	
ORGANICS				
Benzene	80.00	2.18E+00	Hematopoietic Sys.	6.50E-06
Ethylbenzene	1.10	1.08E-04	Skin, Liver, Kidney	
Methylene Chloride	1544.00	2.52E-01	Liver, Kidney, CNS	3.25E-05
Toluene	1.40	4.58E-05	CNS	
Trichloroethylene	6430.00	6.31E+00	Liver, Kidney, CNS	1.98E-04
Vinyl Chloride	36.00	2.72E-01	Blood, Liver, CNS	2.32E-04
Xylenes	1.80	8.83E-06	CNS	
Hazard Index: Combined Exposure		9.77E+00		
Excess Lifetime Cancer Risk: Combined Exposure				5E-04

a. Arithmetic mean of groundwater sampling set. "Not detected" results were treated as one half the limit of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of Base personnel to contaminated groundwater. Exposure assumptions: consumption of 1 liter of water per day, by a 70 kg adult, 5 days per week, 50 weeks per year, for 20 years of a 70 year lifetime.

TABLE 4-59. RISK CHARACTERIZATION FOR SITE 10: EXPOSURE TO SOILS

Chemical	Mean (a) Concentration in Soil (mg/Kg)	Hazard Quotient Noncarcinogenic Effects (b) (Dose/RfD)	Noncarcinogenic Effects: Target Organ System	Excess Lifetime Carcinogenic Risk (b) (Dose x q1*)
INORGANICS				
Aluminum	6303.00			
Barium	521.00	1.64E-03	Hypertension	
Beryllium	0.26	8.23E-06	Lung, Skin, Heart	5.05E-08
Boron	76.20	1.33E-04	CNS, GI Tract, Skin	
Cadmium	0.71	2.23E-04	Kidney	
Chromium	225.20	7.07E-03	Skin	
Cobalt	6.15		Thyroid, Heart	
Copper	14.58	6.19E-05	GI Tract, Blood	
Lead	26.10	2.93E-03	CNS, Kidney	
Manganese	608.00	4.77E-04	CNS, Reproductive	
Nickel	13.60	1.07E-04	Skin, Lung	
Vanadium	17.30	3.88E-04	Respiratory Effects	
Zinc	391.00	3.07E-04	GI Tract	
ORGANICS				
Acetone	0.02	3.45E-08	Liver, Kidney	
Trichloroethylene	0.09	1.40E-06	Liver, Kidney, CNS	4.39E-11
Hazard Index: Combined Exposure		1.33E-02		
Excess Lifetime Cancer Risk: Combined Exposure				5E-08

a. Arithmetic mean of samples for full soil column. "Not detected" results were treated as one half the l
of detection and included in the calculation of the mean.

b. Dose calculated assuming hypothetical ingestion exposure of Base personnel to contaminated surface soil
Exposure assumptions: inadvertent ingestion of 0.1 grams of soil per day, by a 70 kg adult, 2 days per
20 weeks per year, for 20 years of a 70 year lifetime.

TABLE G-4. TOXICITY MEASURES FOR WASTE SITE EVALUATION: INGESTION AND INHALATION PATHWAYS

COMPOUND	Noncarcinogenic Effects Oral Route (mg/kg/day)		Source (Oral)	Noncarcinogenic Effects Inhalation Route (mg/kg/day)		Source (Inhal.)	Noncarcinogenic Effect of Concern	Carcinogenic Potency Factor (q1*): Oral Exposure (mg/kg/day)-1	Source (Oral)	Carcinogenic Potency Factor (q1*): Inhalation Exposure (mg/kg/day)-1	Source (Inhal.)
	RfD-S(a)	RfD-C(b)		RfD-S(a)	RfD-C(b)						
INORGANICS											
Antimony	4.00E-04	4.00E-04	d	--	--		Heart, Lung				
Arsenic	1.00E-03	1.00E-03	d	--	1.00E-03	d,m	Skin, Lung	1.75E+00 [A] f	c,d	5.00E+01 [A]	d
Barium	5.00E-02	5.00E-02	d	1.00E-03	1.00E-04	d	Fetotoxicity				
Beryllium	5.00E-03	5.00E-03	d	5.00E-03	5.00E-03	d,n	Lung, Skin, Heart	4.30E+00 [B2]	c	8.40E+00 [B2]	d
Boron	9.00E-02	9.00E-02	d.	--	--		CNS, GI Tract, Skin				
Cadmium	--	5.00E-04	d	--	5.00E-04	d,m	Kidney			6.10E+00 [B1]	d
Chromium	2.00E-02	5.00E-03	d,m,n	2.00E-02	5.00E-03	d,m,n	Skin				
Cobalt	--	--		--	--		Thyroid, Heart				
Copper	3.70E-02	3.70E-02	d,e	--	3.70E-02	d,e,m	GI Tract, Blood				
Lead	--	1.40E-03	d,u	--	1.40E-03	d,m	CNS, Kidney				
Manganese	5.00E-01	2.00E-01	d	3.00E-04	3.00E-04	d	CNS, Reproductive				
Mercury	3.00E-04	3.00E-04	d	3.00E-04	3.00E-04	d,m	CNS				
Nickel	2.00E-02	2.00E-02	c,d	--	2.00E-02	c,d,m	Skin, Lung				
Silver	--	3.00E-03	c	--	--		Liver, Kidney, CNS				
Thallium	7.00E-04	7.00E-05	d	--	--		Liver, Kidney, CNS				
Vanadium	7.00E-03	7.00E-03	d	--	--		Respiratory Effects				
Zinc	2.00E-01	2.00E-01	d	--	2.00E-01	d,m	Anemia				
ORGANICS											
Acetone	--	1.00E-01	d	--	--		Liver, Kidney				
Benzene	--	3.60E-04	y	--	--		Hematopoietic Sys.	2.90E-02 [A]	d	2.90E-02 [A]	d
Bis(2-ethylhexyl)phthalate	2.00E-02	2.00E-02	d	2.00E-02	2.00E-02	d,m	Liver	1.40E-02 [B2]	d,v	1.40E-02 [B2]	d,m
2-Butanone	5.00E-01	5.00E-02	d	9.00E-01	9.00E-02	d	CNS, Fetotoxicity				
Chlorobenzene	2.00E-01	2.00E-02	d	5.00E-02	5.00E-03	d	Liver, Kidney				
1,2-Dichlorobenzene	9.00E-01	9.00E-02	d	4.00E-01	4.00E-02	d	Liver, Kidney, CNS				
1,3-Dichlorobenzene	9.00E-01	9.00E-02	d,h	4.00E-01	4.00E-02	d,u	Liver, Kidney, CNS				
1,4-Dichlorobenzene	9.00E-01	9.00E-02	d,h	4.00E-01	4.00E-02	d,u	Liver, Kidney, CNS	2.40E-02 [B2]	d	2.40E-02 [B2]	d,m
Dichlorodifluoromethane	9.00E-01	2.00E-01	d	--	--		Liver, Lung				
1,1-Dichloroethane	1.00E+00	1.00E-01	d	1.00E+00	1.00E-01	d	Liver, Kidney, CNS	9.10E-02 [B2]	d	9.10E-02 [B2]	d,m
1,2-Dichloroethane	1.00E+00	1.00E-01	d,k	1.00E+00	1.00E-01	d,p	Liver, Kidney, CNS	9.10E-02 [B2]	d	9.10E-02 [B2]	d
1,2-Dichloroethylene	9.00E-03	9.00E-03	d,g	--	--		Liver, Kidney, CNS				
Ethylbenzene	1.00E+00	1.00E-01	d	--	--		Skin, Liver, Kidney				
Methylene Chloride	6.00E-02	6.00E-02	d	6.00E-02	6.00E-02	d,m	Liver, Kidney, CNS	7.50E-03 [B2]		4.70E-07 [B2]	d
2-Methylnaphthalene	4.00E-03	4.00E-03	d,x	--	--		Skin				
Naphthalene	4.00E-03	4.00E-03	d	--	--		Eye, Blood				
Phenanthrene	4.00E-03	4.00E-03	d,x	--	--		Skin				
Pyrene	4.00E-03	4.00E-03	d,x	--	--		Skin				
Toluene	4.00E-01	3.00E-01	d	2.00E+00	2.00E+00	d	CNS				
1,1,1-Trichloroethane	9.00E-01	9.00E-02	d	3.00E+00	3.00E-01	d	CNS, Lung, Kidney				
Trichloroethylene	1.00E-01	1.00E-02	d,j	1.00E-01	1.00E-02	c,s,m	Liver, Kidney, CNS	1.10E-02 [B2]	d	1.70E-02 [B2]	d
Vinyl Chloride	--	1.30E-03	w	--	--		Blood, Liver, CNS	2.30E+00 [A]	d	2.95E-01 [A]	d
Xylenes	4.00E+00	2.00E+00	d	7.00E-01	4.00E-01	d,t	CNS				

a. RfD—Reference dose for subchronic (short-term) exposure.
b. RfD—Reference dose for chronic (long-term) exposure.
c. IRIS DATA BASE
d. USEPA ORD Health Effects Assessment Summary Tables (HEAST) FY 1989.
e. RfD derived from the USEPA drinking water standard as listed in USEPA 1989 HEAST 2nd Quarter report.
f. Carcinogenic Potency Factor currently under review by EPA (IRIS Data Base). However, a unit risk factor is provided in IRIS: 5E-05 per ug/l. Potency Factor used was derived from this unit risk factor assuming ingestion of 2 liters of water per day by a 70 kg adult.
g. In the absence of toxicity data, the RfDs for 1,1-Dichloroethylene have been adopted for 1,2-Dichloroethylene.
h. In the absence of toxicity data, the RfDs for 1,2-Dichlorobenzene have been adopted for this compound.
j. In the absence of toxicity data, the RfDs for PCE have been adopted for TCE.
k. In the absence of toxicity data, the RfDs for 1,1-Dichloroethane have been adopted for 1,2-Dichloroethane.
m. RfDs or potency factors for the oral exposure route have been used in the absence of toxicity data for the inhalation route.
n. References doses for hexavalent chromium, oral route.
p. In the absence of toxicity data, the reference dose for 1,1-dichloroethane is used for 1,2-dichloroethane.
s. In the absence of toxicity data, the reference dose for tetrachloroethylene is used for trichloroethylene.
t. Toxicity measures presented are for mixed xylenes.
u. In the absence of toxicity data, the reference dose for 1,2-dichlorobenzene is used for this compound.
v. In the absence of toxicity data, the potency factor for benzo(a)pyrene has been adopted for this compound.
w. Reference dose for vinyl chloride was derived from the EPA ODW longer-term drinking water health advisory.
x. In the absence of toxicity data, the RfDs for naphthalene have been adopted for this compound.
y RfD for chronic exposure to 70 kg adult derived from EPA ADI of 0.025 mg/day. Drinking Water Criteria Document for Benzene (USEPA 1985, EPA Office of Drinking Water).

APPENDIX E
ADDITIONAL TOXICOLOGICAL PROFILES

CARBON TETRACHLORIDE

CAS No. 56-23-5

Chemical Formula: CCl_4

Synonyms: Tetrachloromethane
Carbona
Carbon chloride
Perchloromethane

Physico-chemical Characteristics

Molecular Weight:	153.8
Melting Point:	-23°C
Boiling Point:	76.5°C
Density:	1.594
Solubility in Water:	785 mg/l at 20°C

Criteria and Standards:

Safe Drinking Water Act (EPA)

Maximum Contaminant Level Goal (MCLG)	0 mg/l (Final)
Maximum Contaminant Level (MCL)	0.005 mg/l (Final)

Environmental Transport and Fate

Carbon tetrachloride tends to be adsorbed to organic matter, since the octanol;water partition coefficient is about 110;1. Carbon tetrachloride dissolved in water does not photodegrade or oxidize in any measurable amounts. Although the compound is lipophilic, there is little tendency for this compound to bioaccumulate in aquatic or marine organisms.

General Toxicity and Metabolism

Results from several studies indicate that carbon tetrachloride is rapidly and extensively absorbed from the gastrointestinal tract of experimental animals. It is also absorbed through the skin and lungs.

The oral reference dose (RfD) is 0.0007 mg/kg/day, based upon liver lesions detected in rats during a subchronic gavage study. Male Sprague-Dawley rats were given 1, 10 or 33 mg carbon tetrachloride by corn oil gavage, 5 days per week for 12 weeks. Liver lesions, as evidenced by mild centrilobular vacuolization and statistically significant increases in serum sorbitol dehydrogenase activity, were observed at the 10 and 33 mg/kg/day and the NOAEL was 1 mg/kg/day. Medium overall confidence in the oral RfD was noted.

Evidence of Carcinogenicity

There is convincing evidence from animal studies that oral exposure to carbon tetrachloride leads to hepatic tumors and this is supported by a number of studies employing parenteral routes of exposure. Carbon tetrachloride has been classified by the USEPA as a group B2 probable human carcinogen.

References

Agency for Toxic Substances and Disease Registry, December, 1989. Toxicological Profile for Carbon Tetrachloride. Prepared by Life Systems, Inc.

US Environmental Protection Agency, May 26, 1992. Integrated Risk Information System (IRIS) Online Database Search.

CHLOROFORM

CAS No. 67-66-3

Chemical Formula: $CHCl_3$

Synonyms: Methane trichloride
Formyl trichloride
Methenyl chloride
Methane trichloride

Physico-chemical Characteristics

Molecular Weight: 119.38
Melting Point: -63.2°C
Boiling Point: 61.3°C
Density: 1.485 g/cm^3
Solubility in Water: 8.22 g/l at 20°C
Log Octanol/Water Partition Coefficient: 1.97

Criteria and Standards

Clean Water Act

Aquatic Organisms
Fresh Water
a. Acute 28,900 ug/l
b. Chronic 1,240 ug/l

Ambient Water Quality Criteria

Water and Fish Consumption 0.19 ug/l
Fish Consumption Only 15.7 ug/l

Environmental Transport and Fate

When released to the soil, chloroform will volatilize rapidly from the surface or leach readily through soil, with likely entry into the groundwater and persisting for long periods of time. When released into the atmosphere, chloroform may be transported long distances before being degraded by reaction with photochemically generated hydroxyl radicals.

General Toxicity and Metabolism

Chloroform is absorbed extensively through the lungs and gastrointestinal tract. The liver is assumed to be the principle site of chloroform metabolism. Chloroform elimination is believed to occur predominantly by the pulmonary route, although small amounts of chloroform metabolites were detected in the urine of dosed experimental animals.

The oral reference dose (RfD) for chloroform is 0.01 mg/kg/day. The principle study reported was fatty cyst formation in the liver. The study was a chronic oral bioassay conducted on dogs. The critical study was of chronic duration, used an appropriate number of dogs, and measured multiple endpoints; however, only two treatment doses were used and no NOAEL was determined. Therefore, confidence in the study is rated medium. Confidence in the database is considered medium to low; several studies support the choice of a LOAEL, but a NOAEL was not found. Confidence in the RfD is also considered medium to low.

Evidence of Carcinogenicity

Many epidemiologic studies support an association of increased risk of bladder, colon, and rectal cancer in humans exposed to chloroform in drinking water; however, many of these studies are hampered by the fact that exposure occurs to other trihalomethanes. In a NCI bioassay, 50 B6C3F1 mice per sex were administered time weighted average doses of 138 and 277 mg/kg bw/day for males and 238 and 477 mg/kg by/day for females, by gavage for 78 weeks. All treated groups for each sex exhibited dose-related and significantly increased incidences of hepatocellular carcinomas. A similar NCI bioassay administered 50 Osborne-Mendel rats per sex per dose to time weighted average doses of 90 and 180 mg/kg bw/day for males, and 100 and 200 mg/kg bw/day for females, for 78 weeks by gavage. A treatment related increase in renal carcinomas and adenomas (combined) was observed in male rats, reaching statistical significance at the highest dose. The USEPA has classified chloroform as a group B2 probable human carcinogen.

References

Agency for Toxic Substances and Disease Registry, January, 1989. Toxicological Profile for Chloroform. Prepared by Syracuse Research Corporation.

US Environmental Protection Agency, May 26, 1992. Integrated Risk Information System (IRIS) Online Database Search.

cis-1,2-DICHLOROETHYLENE

CAS No. 156-60-5

Chemical Formula: $C_2H_2Cl_2$

Synonyms: trans-1,2-Dichloroethylene

Physico-chemical Characteristics:

Molecular Weight: 96.94
Melting Point: -80.5°C
Boiling Point: 60.3°C
Specific Gravity: 1.2837 (20/4°C)
Solubility in Water: 6,250 mg/l at 25°C
Log octanol/water
Partition coefficient: 2.09

Criteria and Standards

Safe Drinking Water Act

Maximum Contaminant Level Goal (MCLG) 0.07 mg/l (Final, 1/91)
Maximum Contaminant Level (MCL) 0.07 mg/l (Final, 1/91)

Environmental Transport and Fate

1,2-Dichloroethylene evaporates rapidly. When released to soil surfaces or to rivers, lakes, streams, etc., almost all of the compound will evaporate into the air. 1,2-Dichloroethylene will leach from the soil into the groundwater. Once in the groundwater, it takes about 13 to 48 weeks for half of the given amount of compound to break down.

General Toxicity and Metabolism

Based upon 1,2-dichloroethylene's physical properties, it is expected to be absorbed quickly by any route of exposure (oral, inhalation and dermal). 1,2-Dichloroethylene is expected to be distributed to the liver and kidney with rapid excretion by both biliary and renal routes based on its' structural similarity to related chlorinated compounds.

The oral reference dose for cis-1,2-dichloroethylene is 0.01 mg/kg/day, based upon a rat chronic gavage assay in which a decreased hematocrit and hemoglobin were the effects of concern noted.

Evidence of Carcinogenicity

Currently there are no data in humans or animals regarding the carcinogenic potential of 1,2-dichloroethylene, and has therefore been classified as a group D, inadequate evidence of carcinogenicity.

References

Agency for Toxic Substances and Disease Registry, October, 1989. Draft Toxicological Profile for cis-1,2-Dichloroethene, trans-1,2-Dichloroethene and 1,2-Dichloroethene. Prepared by: Syracuse Research Corporation.

US Environmental Protection Agency, 1991. Health Effects Assessment Tables (HEAST, FY-1991).

1,2-DICHLOROPROPANE

CAS No. 78-87-5

Chemical Formula: $C_3H_6Cl_2$

Synonyms: Propylene dichloride
Propylene chloride
2,3-Dichloropropane

Physico-chemical Characteristics

Molecular Weight:	112.99
Freezing Point:	-100.44°C
Boiling Point:	96.37°C
Density:	1.15597 at 20°C
Solubility in Water:	2,700 mg/l at 20°C
Log Octanol/Water Partition Coefficient:	1.99

Criteria and Standards

Safe Drinking Water Act (EPA)

Maximum Contaminant Level Goal (MCLG)	0 mg/l (Final, 1/91)
Maximum Contaminant Level (MCL)	0.005 mg/l (Final, 1/91)

Environmental Transport and Fate

1,2-Dichloropropane is not expected to be adsorbed appreciably to soil, sediment or suspended solids in water, due to its low k_{oc} value. The compound is also resistant to hydrolysis and biotransformation. The major removal process for 1,2-dichloropropane from surface waters is expected to be volatilization.

General Toxicity and Metabolism

Based upon studies in laboratory animals, 1,2-dichloropropane is absorbed by the gastrointestinal tract, lungs and skin. The liver is one of the main target organs for the toxic effects of 1,2-dichloropropane. A National Toxicology Program study (1986) found liver necrosis in female rats given 250 mg/kg/day of the compound for 103 weeks, but not in females at less than 125 mg/kg/day or in males at any of the doses. This study also found necrosis of the liver in male mice; but not females that were administered 125 or 250 mg/kg/day of the compound by gavage for 103 weeks (5 days per week). Lower doses were not tested.

Evidence of Carcinogenicity

The US EPA has classified 1,2-dichloropropane as a group B2 carcinogen. Mice gavage studies reported an increase in liver adenomas.

References

Agency for Toxic Substances and Disease Registry, December, 1989. Toxicological Profile for 1,2-Dichloropropane. Prepared by: Syracuse Research Corporation.

National Toxicology Program (NTP), 1986. Toxicology and Carcinogenesis Studies of 1,2-Dichloropropane in F344N/N Rats and B6C3F1 Mice (Gavage Studies). Technical Report No. 263.

US Environmental Protection Agency, May 26, 1992. Integrated Risk Information System Online Database Search.

TETRACHLOROETHYLENE

CAS No. 127-18-4

Chemical Formula: C_2Cl_4

Synonyms: 1,1,2,2-Tetrachloroethylene
Perchloroethylene
ethylene tetrachloride

Physico-chemical Characteristics

Molecular Weight:	165.83
Freezing Point:	-22.7°C
Boiling Point:	121.2°C
Solubility in Water:	150 mg/l at 25°C
Specific Gravity:	1.62 (20/4°C)
Log Octanol Water/ Partition Coefficient:	

Criteria and Standards

Safe Drinking Water Act (EPA)

Maximum Contaminant Level Goal (MCLG) 0 mg/l (Final 1/91)
Maximum Contaminant Level (MCL) 0.005 mg/l (Final, 1/91)

Environmental Transport and Fate

Laboratory studies have demonstrated that tetrachloroethylene volatilizes rapidly from water. The relatively high vapor pressure of the compound indicates that it is expected to exist entirely in the vapor phase in the ambient atmosphere and not partition to atmospheric particulates. Tetrachloroethylene also has a medium to high soil mobility.

General Toxicity and Metabolism

Tetrachloroethylene is known to be absorbed in humans by inhalation and has been shown to be completely absorbed in rats after oral ingestion. Data from both human and animal exposure indicate liver and kidney damage may occur as well as depression of the central nervous system resulting in effects such as lethargy, decreased ability to concentrate, and loss of coordination, based upon chronic exposure.

The oral reference dose (RfD) for chronic oral exposure of tetrachloroethylene is 0.01 mg/kg/day. Hepatotoxicity in mice, and liver weight gain in rats were reported as the principal effect in the supporting study. Confidence in the principal studies is low mainly because of the lack of complete histopathological examination at the NOAEL in the study. The database is relatively complete but lacks studies of reproductive and teratology endpoints subsequent to oral exposure; thus it receives a medium confidence rating. Medium confidence in the RfD is reported.

Evidence of Carcinogenicity

Tetrachloroethylene has been shown to be carcinogenic in laboratory rats and mice. Epidemiologic studies on carcinogenicity in humans are inconclusive. The US EPA has classified tetrachloroethylene as a group B2 probable human carcinogen.

References

Agency for Toxic Substances and Disease Registry, January 1990. Toxicological Profile for Tetrachloroethylene. Prepared by: Syracuse Research Corporation.

US Environmental Protection Agency, May 26, 1992. Integrated Risk Information System Online Database Search.

APPENDIX F
BEDROCK EXTRACTION WELL PUMPING RATE CALCULATIONS

APPENDIX F

GROUNDWATER PUMPING RATE ESTIMATES

Analytical groundwater modeling techniques were utilized to estimate groundwater withdrawal rates for the collection and treatment of contaminated groundwater found to occur beneath the IRP Site 10 study area. More specifically, preliminary computer modeling was used to simulate the effectiveness of a single bedrock pumping well system to control groundwater flow and, therefore, contaminant migration within the upper bedrock hydrostratigraphic unit. Simulations were based on the hydrogeologic information and conceptual model of groundwater flow presented in Section 4.0 of the Limited RI/FS draft report. Analytical groundwater modeling was performed using the WELFLO micro-computer program designed by Walton (1989) for simulation of two dimensional flow.

The area modeled extends beyond the zone of contamination delineated in the Limited RI and was divided into 200 grid cells (nodes) using a 10 x 20 grid having a uniform grid spacing of 20 feet. Values of drawdown were calculated at individual node locations during each simulation. Average values of transmissivity, storativity, aquitard thickness and aquitard vertical hydraulic conductivity were used during initial simulations. The following aquifer properties were held constant during initial simulations:

Bedrock Aquifer Transmissivity = 2,500 gpd/ft
Bedrock Aquifer Storativity = 0.0003
Overburden Aquitard Thickness = 10 feet
Overburden Aquitard Vertical Hydraulic Conductivity = 0.0212 gpd/ft^2

Following initial simulations, aquifer transmissivity was increased to 5,000 gpd/ft in order to provide conservatively high or worst case estimates of groundwater flow in the bedrock.

A single fully penetrating pumping well screening the upper fractured zone of the bedrock was simulated under non-leaky artesian conditions (refer to Figure 6-1). Pumping rates were held constant during simulations run for a 1-year (365-day) period. The single pumping well scenario was simulated using pumping rates of 5 gpm, 10 gpm, 15 gpm, 25 gpm, and 50 gpm. Analytical model output from each simulation are included in this Appendix. The results of the groundwater analytical modeling efforts are summarized below.

Simulations of a single bedrock pumping well suggest that this simple groundwater extraction system will effectively control groundwater flow and contain contaminant migration within the upper bedrock aquifer beneath IRP Site 10. The drawdown effect of the pumping well produces a cone of depression, or lateral zone of influence, that extends radially from the pumping well across the entire zone of contamination identified for the bedrock in the Limited RI. The cone of depression represents a lowering of the potentiometric surface across the shallow bedrock unit which will induce horizontal flow towards the pumping center, as well as downward flow from the overburden to the bedrock.

As little as a 5 gpm pumping rate provided a sufficient cone of depression to control horizontal groundwater flow. For example, using an average transmissivity for the Lockport Dolomite of 2,500 gpd/ft, approximately 1 foot of drawdown is created at the model grid boundaries. Using the conservative estimate of transmissivity for the bedrock of 5,000 gpd/ft, a similar drawdown effect is realized under a constant pumping rate of 10 gpm.

Due to the fine-grained restrictive properties of the unconsolidated deposits, it is assumed that groundwater yields from the overburden unit will be low. It is further assumed that under steady-state conditions, the rate of groundwater collection from the overburden will be minimal such that a conservative estimate of the bedrock pumping rate would be inclusive of groundwater extracted from both the overburden and upper bedrock units. Based on the above-stated assumptions and analytical modeling results, a groundwater pumping rate of 10 gpm is recommended for development of remedial alternatives that include the groundwater extraction and treatment component. This recommended groundwater withdrawal rate would sufficiently control or contain contaminant migration as well as minimize the amount of pumped water that would require treatment.

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days=  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft=     0.00
Y-coordinate of upper-left grid node in ft=     0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=    5.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    2500.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                         I-COLUMN
        1      2      3      4      5      6      7      8      9     10


 1    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
 2    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
 3    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
 4    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
 5    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
 6    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
 7    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
 8    1.15   1.25   1.38   1.57   1.88   3.58   1.88   1.57   1.38   1.25
 9    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
10    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
11    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
12    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
13    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
14    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
15    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
16    0.87   0.89   0.91   0.93   0.94   0.94   0.94   0.93   0.91   0.89
17    0.83   0.85   0.86   0.88   0.88   0.89   0.88   0.88   0.86   0.85
18    0.79   0.81   0.82   0.83   0.84   0.84   0.84   0.83   0.82   0.81
19    0.76   0.77   0.78   0.79   0.80   0.80   0.80   0.79   0.78   0.77
20    0.73   0.74   0.75   0.75   0.76   0.76   0.76   0.75   0.75   0.74
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 3
Simulation period number= 1
Duration of simulation period in days=  100.000
Simulation period number= 2
Duration of simulation period in days=  365.000
Simulation period number= 3
Duration of simulation period in days= 1095.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft=     0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=    5.00
Duration of pump operation during simulation period
in days=  100.000
Well radius in ft=  0.50
Simulation period number= 2
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=    5.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Simulation period number= 3
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=    5.00
Duration of pump operation during simulation period
in days= 1095.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    2500.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  100.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                               I-COLUMN
          1     2     3     4     5     6     7     8     9    10

   1    0.91  0.94  0.96  0.98  0.99  1.00  0.99  0.98  0.96  0.94
```

```
  4    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
  5    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
  6    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
  7    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
  8    1.15   1.25   1.38   1.57   1.88   3.58   1.88   1.57   1.38   1.25
  9    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
 10    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
 11    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
 12    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
 13    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
 14    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
 15    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
 16    0.87   0.89   0.91   0.93   0.94   0.94   0.94   0.93   0.91   0.89
 17    0.83   0.85   0.86   0.88   0.88   0.89   0.88   0.88   0.86   0.85
 18    0.79   0.81   0.82   0.83   0.84   0.84   0.84   0.83   0.82   0.81
 19    0.76   0.77   0.78   0.79   0.80   0.80   0.80   0.79   0.78   0.77
 20    0.73   0.74   0.75   0.75   0.76   0.76   0.76   0.75   0.75   0.74


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                            I-COLUMN
         1      2      3      4      5      6      7      8      9     10


  1    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
  2    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
  3    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
  4    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
  5    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
  6    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
  7    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
  8    1.15   1.25   1.38   1.57   1.88   3.58   1.88   1.57   1.38   1.25
  9    1.14   1.24   1.36   1.52   1.73   1.88   1.73   1.52   1.36   1.24
 10    1.12   1.20   1.30   1.41   1.52   1.57   1.52   1.41   1.30   1.20
 11    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
 12    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
 13    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
 14    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
 15    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
 16    0.87   0.89   0.91   0.93   0.94   0.94   0.94   0.93   0.91   0.89
 17    0.83   0.85   0.86   0.88   0.88   0.89   0.88   0.88   0.86   0.85
 18    0.79   0.81   0.82   0.83   0.84   0.84   0.84   0.83   0.82   0.81
 19    0.76   0.77   0.78   0.79   0.80   0.80   0.80   0.79   0.78   0.77
 20    0.73   0.74   0.75   0.75   0.76   0.76   0.76   0.75   0.75   0.74


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS: 1095.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                            I-COLUMN
         1      2      3      4      5      6      7      8      9     10


  1    0.91   0.94   0.96   0.98   0.99   1.00   0.99   0.98   0.96   0.94
  2    0.95   0.98   1.02   1.04   1.06   1.07   1.06   1.04   1.02   0.98
  3    0.99   1.04   1.08   1.12   1.14   1.15   1.14   1.12   1.08   1.04
  4    1.04   1.09   1.15   1.20   1.24   1.25   1.24   1.20   1.15   1.09
  5    1.08   1.15   1.22   1.30   1.36   1.38   1.36   1.30   1.22   1.15
```

7	1.14	1.24	1.36	1.52	1.73	1.88	1.73	1.52	1.36	1.24
8	1.15	1.25	1.38	1.57	1.88	3.58	1.88	1.57	1.33	1.25
9	1.14	1.24	1.36	1.52	1.73	1.88	1.73	1.52	1.36	1.24
10	1.12	1.20	1.30	1.41	1.52	1.57	1.52	1.41	1.30	1.20
11	1.08	1.15	1.22	1.30	1.36	1.38	1.36	1.30	1.22	1.15
12	1.04	1.09	1.15	1.20	1.24	1.25	1.24	1.20	1.15	1.09
13	0.99	1.04	1.08	1.12	1.14	1.15	1.14	1.12	1.08	1.04
14	0.95	0.98	1.02	1.04	1.06	1.07	1.06	1.04	1.02	0.98
15	0.91	0.94	0.96	0.98	0.99	1.00	0.99	0.98	0.96	0.94
16	0.87	0.89	0.91	0.93	0.94	0.94	0.94	0.93	0.91	0.89
17	0.83	0.85	0.86	0.88	0.88	0.89	0.88	0.88	0.86	0.85
18	0.79	0.81	0.82	0.83	0.84	0.84	0.84	0.83	0.82	0.81
19	0.76	0.77	0.78	0.79	0.80	0.80	0.80	0.79	0.78	0.77
20	0.73	0.74	0.75	0.75	0.76	0.76	0.76	0.75	0.75	0.74

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 3
Simulation period number: 1
Duration of simulation period in days:    0.500
Simulation period number: 2
Duration of simulation period in days:    1.000
Simulation period number: 3
Duration of simulation period in days:    3.000
Number of grid columns: 10
Number of grid rows: 20
Grid spacing in ft:    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:    5.00
Duration of pump operation during simulation period
in days:    0.500
Well radius in ft:  0.50
Simulation period number: 2
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:    5.00
Duration of pump operation during simulation period
in days:    1.000
Well radius in ft:  0.50
Simulation period number: 3
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:    5.00
Duration of pump operation during simulation period
in days:    3.000
Well radius in ft:  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft:    2500.00
Aquifer storativity as a decimal: 0.000300
Aquitard thickness in ft:  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft:     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:    0.500

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:
```

```
   1    0.77   0.80   0.82   0.84   0.86   0.86   0.86   0.84   0.82   0.80
   2    0.81   0.85   0.88   0.91   0.92   0.93   0.92   0.91   0.88   0.85
   3    0.86   0.90   0.94   0.98   1.00   1.01   1.00   0.98   0.94   0.90
   4    0.90   0.96   1.01   1.06   1.10   1.11   1.10   1.06   1.01   0.96
   5    0.94   1.01   1.09   1.16   1.22   1.25   1.22   1.16   1.09   1.01
   6    0.98   1.06   1.16   1.27   1.38   1.43   1.38   1.27   1.16   1.06
   7    1.00   1.10   1.22   1.38   1.59   1.75   1.59   1.38   1.22   1.10
   8    1.01   1.11   1.25   1.43   1.75   3.44   1.75   1.43   1.25   1.11
   9    1.00   1.10   1.22   1.38   1.59   1.75   1.59   1.38   1.22   1.10
  10    0.98   1.06   1.16   1.27   1.38   1.43   1.38   1.27   1.16   1.06
  11    0.94   1.01   1.09   1.16   1.22   1.25   1.22   1.16   1.09   1.01
  12    0.90   0.96   1.01   1.06   1.10   1.11   1.10   1.06   1.01   0.96
  13    0.86   0.90   0.94   0.98   1.00   1.01   1.00   0.98   0.94   0.90
  14    0.81   0.85   0.88   0.91   0.92   0.93   0.92   0.91   0.88   0.85
  15    0.77   0.80   0.82   0.84   0.86   0.86   0.86   0.84   0.82   0.80
  16    0.73   0.75   0.77   0.79   0.80   0.80   0.80   0.79   0.77   0.75
  17    0.69   0.71   0.73   0.74   0.75   0.75   0.75   0.74   0.73   0.71
  18    0.65   0.67   0.68   0.69   0.70   0.70   0.70   0.69   0.68   0.67
  19    0.62   0.63   0.64   0.65   0.66   0.66   0.66   0.65   0.64   0.63
  20    0.59   0.60   0.61   0.62   0.62   0.62   0.62   0.62   0.61   0.60


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:    1.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
          1      2      3      4      5      6      7      8      9     10

   1    0.85   0.88   0.91   0.93   0.94   0.94   0.94   0.93   0.91   0.88
   2    0.89   0.93   0.96   0.99   1.01   1.01   1.01   0.99   0.96   0.93
   3    0.94   0.98   1.03   1.06   1.09   1.09   1.09   1.06   1.03   0.98
   4    0.98   1.04   1.09   1.15   1.18   1.20   1.18   1.15   1.09   1.04
   5    1.03   1.09   1.17   1.24   1.30   1.33   1.30   1.24   1.17   1.09
   6    1.06   1.15   1.24   1.35   1.46   1.51   1.46   1.35   1.24   1.15
   7    1.09   1.18   1.30   1.46   1.67   1.83   1.67   1.46   1.30   1.18
   8    1.09   1.20   1.33   1.51   1.83   3.52   1.83   1.51   1.33   1.20
   9    1.09   1.18   1.30   1.46   1.67   1.83   1.67   1.46   1.30   1.18
  10    1.06   1.15   1.24   1.35   1.46   1.51   1.46   1.35   1.24   1.15
  11    1.03   1.09   1.17   1.24   1.30   1.33   1.30   1.24   1.17   1.09
  12    0.98   1.04   1.09   1.15   1.18   1.20   1.18   1.15   1.09   1.04
  13    0.94   0.98   1.03   1.06   1.09   1.09   1.09   1.06   1.03   0.98
  14    0.89   0.93   0.96   0.99   1.01   1.01   1.01   0.99   0.96   0.93
  15    0.85   0.88   0.91   0.93   0.94   0.94   0.94   0.93   0.91   0.88
  16    0.81   0.83   0.85   0.87   0.88   0.88   0.88   0.87   0.85   0.83
  17    0.77   0.79   0.81   0.82   0.83   0.83   0.83   0.82   0.81   0.79
  18    0.73   0.75   0.76   0.78   0.78   0.78   0.78   0.78   0.76   0.75
  19    0.70   0.71   0.73   0.73   0.74   0.74   0.74   0.73   0.73   0.71
  20    0.67   0.68   0.69   0.70   0.70   0.70   0.70   0.70   0.69   0.68


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:    3.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
          1      2      3      4      5      6      7      8      9     10

   1    0.90   0.93   0.96   0.98   0.99   0.99   0.99   0.98   0.96   0.93
```

3	0.99	1.03	1.08	1.11	1.14	1.15	1.14	1.11	1.08	1.03
4	1.03	1.09	1.15	1.20	1.23	1.25	1.23	1.20	1.15	1.09
5	1.08	1.15	1.22	1.29	1.35	1.38	1.35	1.29	1.22	1.15
6	1.11	1.20	1.29	1.41	1.51	1.56	1.51	1.41	1.29	1.20
7	1.14	1.23	1.35	1.51	1.72	1.88	1.72	1.51	1.35	1.23
8	1.15	1.25	1.38	1.56	1.88	3.57	1.88	1.56	1.38	1.25
9	1.14	1.23	1.35	1.51	1.72	1.88	1.72	1.51	1.35	1.23
10	1.11	1.20	1.29	1.41	1.51	1.56	1.51	1.41	1.29	1.20
11	1.08	1.15	1.22	1.29	1.35	1.38	1.35	1.29	1.22	1.15
12	1.03	1.09	1.15	1.20	1.23	1.25	1.23	1.20	1.15	1.09
13	0.99	1.03	1.08	1.11	1.14	1.15	1.14	1.11	1.08	1.03
14	0.95	0.98	1.01	1.04	1.06	1.06	1.06	1.04	1.01	0.98
15	0.90	0.93	0.96	0.98	0.99	0.99	0.99	0.98	0.96	0.93
16	0.86	0.89	0.91	0.92	0.93	0.93	0.93	0.92	0.91	0.89
17	0.82	0.84	0.86	0.87	0.88	0.88	0.88	0.87	0.86	0.84
18	0.79	0.80	0.82	0.83	0.83	0.84	0.83	0.83	0.82	0.80
19	0.75	0.77	0.78	0.79	0.79	0.79	0.79	0.79	0.78	0.77
20	0.72	0.73	0.74	0.75	0.75	0.76	0.75	0.75	0.74	0.73

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number: 1
Duration of simulation period in days:  365.000
Number of grid columns: 10
Number of grid rows: 20
Grid spacing in ft:    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:   10.00
Duration of pump operation during simulation period
in days:  365.000
Well radius in ft:  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft:    2500.00
Aquifer storativity as a decimal: 0.000300
Aquitard thickness in ft:  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft:     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
         1      2      3      4      5      6      7      8      9     10

  1    1.81   1.87   1.92   1.96   1.99   2.00   1.99   1.96   1.92   1.87
  2    1.90   1.97   2.03   2.09   2.12   2.14   2.12   2.09   2.03   1.97
  3    1.99   2.08   2.16   2.23   2.28   2.30   2.28   2.23   2.16   2.08
  4    2.08   2.19   2.30   2.40   2.47   2.50   2.47   2.40   2.30   2.19
  5    2.16   2.30   2.45   2.60   2.72   2.76   2.72   2.60   2.45   2.30
  6    2.23   2.40   2.60   2.82   3.03   3.13   3.03   2.82   2.60   2.40
  7    2.28   2.47   2.72   3.03   3.45   3.77   3.45   3.03   2.72   2.47
  8    2.30   2.50   2.76   3.13   3.77   7.15   3.77   3.13   2.76   2.50
  9    2.28   2.47   2.72   3.03   3.45   3.77   3.45   3.03   2.72   2.47
 10    2.23   2.40   2.60   2.82   3.03   3.13   3.03   2.82   2.60   2.40
 11    2.16   2.30   2.45   2.60   2.72   2.76   2.72   2.60   2.45   2.30
 12    2.08   2.19   2.30   2.40   2.47   2.50   2.47   2.40   2.30   2.19
 13    1.99   2.08   2.16   2.23   2.28   2.30   2.28   2.23   2.16   2.08
 14    1.90   1.97   2.03   2.09   2.12   2.14   2.12   2.09   2.03   1.97
 15    1.81   1.87   1.92   1.96   1.99   2.00   1.99   1.96   1.92   1.87
 16    1.73   1.78   1.82   1.85   1.87   1.88   1.87   1.85   1.82   1.78
 17    1.65   1.69   1.73   1.75   1.77   1.77   1.77   1.75   1.73   1.69
 18    1.58   1.61   1.64   1.66   1.67   1.68   1.67   1.66   1.64   1.61
 19    1.51   1.54   1.56   1.58   1.59   1.60   1.59   1.58   1.56   1.54
 20    1.45   1.47   1.49   1.51   1.52   1.52   1.52   1.51   1.49   1.47
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days=  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft=      0.00
Y-coordinate of upper-left grid node in ft=      0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=   15.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    2500.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=      0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
          1      2      3      4      5      6      7      8      9     10

  1     2.72   2.81   2.88   2.94   2.98   2.99   2.98   2.94   2.88   2.81
  2     2.85   2.95   3.05   3.13   3.18   3.20   3.18   3.13   3.05   2.95
  3     2.98   3.11   3.24   3.35   3.42   3.45   3.42   3.35   3.24   3.11
  4     3.11   3.28   3.45   3.60   3.71   3.75   3.71   3.60   3.45   3.28
  5     3.24   3.45   3.67   3.89   4.07   4.15   4.07   3.89   3.67   3.45
  6     3.35   3.60   3.89   4.23   4.55   4.70   4.55   4.23   3.89   3.60
  7     3.42   3.71   4.07   4.55   5.18   5.65   5.18   4.55   4.07   3.71
  8     3.45   3.75   4.15   4.70   5.65  10.73   5.65   4.70   4.15   3.75
  9     3.42   3.71   4.07   4.55   5.18   5.65   5.18   4.55   4.07   3.71
 10     3.35   3.60   3.89   4.23   4.55   4.70   4.55   4.23   3.89   3.60
 11     3.24   3.45   3.67   3.89   4.07   4.15   4.07   3.89   3.67   3.45
 12     3.11   3.28   3.45   3.60   3.71   3.75   3.71   3.60   3.45   3.28
 13     2.98   3.11   3.24   3.35   3.42   3.45   3.42   3.35   3.24   3.11
 14     2.85   2.95   3.05   3.13   3.18   3.20   3.18   3.13   3.05   2.95
 15     2.72   2.81   2.88   2.94   2.98   2.99   2.98   2.94   2.88   2.81
 16     2.60   2.67   2.73   2.78   2.81   2.82   2.81   2.78   2.73   2.67
 17     2.48   2.54   2.59   2.63   2.65   2.66   2.65   2.63   2.59   2.54
 18     2.37   2.42   2.46   2.49   2.51   2.52   2.51   2.49   2.46   2.42
 19     2.27   2.31   2.35   2.37   2.39   2.39   2.39   2.37   2.35   2.31
 20     2.18   2.21   2.24   2.26   2.28   2.28   2.28   2.26   2.24   2.21
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days=  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft=     0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=   100.00
Y-coordinate of well in ft=   140.00
Well discharge in gpm=   25.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    2500.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                         I-COLUMN
         1      2      3      4      5      6      7      8      9     10

  1    4.53   4.68   4.80   4.90   4.97   4.99   4.97   4.90   4.80   4.68
  2    4.75   4.92   5.09   5.22   5.31   5.34   5.31   5.22   5.09   4.92
  3    4.97   5.19   5.40   5.58   5.70   5.75   5.70   5.58   5.40   5.19
  4    5.19   5.47   5.75   6.00   6.19   6.26   6.19   6.00   5.75   5.47
  5    5.40   5.75   6.12   6.49   6.79   6.91   6.79   6.49   6.12   5.75
  6    5.58   6.00   6.49   7.04   7.58   7.84   7.58   7.04   6.49   6.00
  7    5.70   6.19   6.79   7.58   8.63   9.42   8.63   7.58   6.79   6.19
  8    5.75   6.26   6.91   7.84   9.42  17.88   9.42   7.84   6.91   6.26
  9    5.70   6.19   6.79   7.58   8.63   9.42   8.63   7.58   6.79   6.19
 10    5.58   6.00   6.49   7.04   7.58   7.84   7.58   7.04   6.49   6.00
 11    5.40   5.75   6.12   6.49   6.79   6.91   6.79   6.49   6.12   5.75
 12    5.19   5.47   5.75   6.00   6.19   6.26   6.19   6.00   5.75   5.47
 13    4.97   5.19   5.40   5.58   5.70   5.75   5.70   5.58   5.40   5.19
 14    4.75   4.92   5.09   5.22   5.31   5.34   5.31   5.22   5.09   4.92
 15    4.53   4.68   4.80   4.90   4.97   4.99   4.97   4.90   4.80   4.68
 16    4.33   4.44   4.55   4.63   4.68   4.69   4.68   4.63   4.55   4.44
 17    4.13   4.23   4.31   4.38   4.42   4.43   4.42   4.38   4.31   4.23
 18    3.95   4.04   4.10   4.16   4.19   4.20   4.19   4.16   4.10   4.04
 19    3.78   3.85   3.91   3.95   3.98   3.99   3.98   3.95   3.91   3.85
 20    3.63   3.69   3.73   3.77   3.79   3.80   3.79   3.77   3.73   3.69
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days:  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period= 1
Well number: 1
X-coordinate of well in ft=  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:  50.00
Duration of pump operation during simulation period
in days:  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    2500.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                         I-COLUMN
          1      2      3      4      5      6      7      8      9     10

  1     9.06   9.35   9.61   9.81   9.94   9.98   9.94   9.81   9.61   9.35
  2     9.49   9.85  10.17  10.44  10.61  10.68  10.61  10.44  10.17   9.85
  3     9.94  10.38  10.80  11.16  11.41  11.50  11.41  11.16  10.80  10.38
  4    10.38  10.94  11.50  12.00  12.37  12.51  12.37  12.00  11.50  10.94
  5    10.80  11.50  12.24  12.98  13.58  13.82  13.58  12.98  12.24  11.50
  6    11.16  12.00  12.98  14.09  15.16  15.67  15.16  14.09  12.98  12.00
  7    11.41  12.37  13.58  15.16  17.26  18.84  17.26  15.16  13.58  12.37
  8    11.50  12.51  13.82  15.67  18.84  35.75  18.84  15.67  13.82  12.51
  9    11.41  12.37  13.58  15.16  17.26  18.84  17.26  15.16  13.58  12.37
 10    11.16  12.00  12.98  14.09  15.16  15.67  15.16  14.09  12.98  12.00
 11    10.80  11.50  12.24  12.98  13.58  13.82  13.58  12.98  12.24  11.50
 12    10.38  10.94  11.50  12.00  12.37  12.51  12.37  12.00  11.50  10.94
 13     9.94  10.38  10.80  11.16  11.41  11.50  11.41  11.16  10.80  10.38
 14     9.49   9.85  10.17  10.44  10.61  10.68  10.61  10.44  10.17   9.85
 15     9.06   9.35   9.61   9.81   9.94   9.98   9.94   9.81   9.61   9.35
 16     8.65   8.89   9.09   9.25   9.35   9.39   9.35   9.25   9.09   8.89
 17     8.27   8.46   8.63   8.76   8.83   8.86   8.83   8.76   8.63   8.46
 18     7.91   8.07   8.21   8.31   8.37   8.40   8.37   8.31   8.21   8.07
 19     7.57   7.71   7.82   7.91   7.96   7.98   7.96   7.91   7.82   7.71
 20     7.25   7.37   7.47   7.54   7.58   7.60   7.58   7.54   7.47   7.37
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number: 1
Duration of simulation period in days:  365.000
Number of grid columns: 10
Number of grid rows: 20
Grid spacing in ft:    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:    5.00
Duration of pump operation during simulation period
in days:  365.000
Well radius in ft:  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft:    5000.00
Aquifer storativity as a decimal: 0.000300
Aquitard thickness in ft:  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft:     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                           I-COLUMN
         1      2      3      4      5      6      7      8      9     10

  1    0.53   0.55   0.56   0.57   0.57   0.58   0.57   0.57   0.56   0.55
  2    0.55   0.57   0.59   0.60   0.61   0.61   0.61   0.60   0.59   0.57
  3    0.57   0.60   0.62   0.64   0.65   0.65   0.65   0.64   0.62   0.60
  4    0.60   0.63   0.65   0.68   0.70   0.70   0.70   0.68   0.65   0.63
  5    0.62   0.65   0.69   0.73   0.76   0.77   0.76   0.73   0.69   0.65
  6    0.64   0.68   0.73   0.78   0.84   0.86   0.84   0.78   0.73   0.68
  7    0.65   0.70   0.76   0.84   0.94   1.02   0.94   0.84   0.76   0.70
  8    0.65   0.70   0.77   0.86   1.02   1.87   1.02   0.86   0.77   0.70
  9    0.65   0.70   0.76   0.84   0.94   1.02   0.94   0.84   0.76   0.70
 10    0.64   0.68   0.73   0.78   0.84   0.86   0.84   0.78   0.73   0.68
 11    0.62   0.65   0.69   0.73   0.76   0.77   0.76   0.73   0.69   0.65
 12    0.60   0.63   0.65   0.68   0.70   0.70   0.70   0.68   0.65   0.63
 13    0.57   0.60   0.62   0.64   0.65   0.65   0.65   0.64   0.62   0.60
 14    0.55   0.57   0.59   0.60   0.61   0.61   0.61   0.60   0.59   0.57
 15    0.53   0.55   0.56   0.57   0.57   0.58   0.57   0.57   0.56   0.55
 16    0.51   0.52   0.53   0.54   0.55   0.55   0.55   0.54   0.53   0.52
 17    0.49   0.50   0.51   0.52   0.52   0.52   0.52   0.52   0.51   0.50
 18    0.47   0.48   0.49   0.49   0.50   0.50   0.50   0.49   0.49   0.48
 19    0.45   0.46   0.47   0.47   0.47   0.48   0.47   0.47   0.47   0.46
 20    0.44   0.44   0.45   0.45   0.46   0.46   0.46   0.45   0.45   0.44
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days=  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft=     0.00
Y-coordinate of upper-left grid node in ft=     0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=  100.00
Y-coordinate of well in ft=  140.00
Well discharge in gpm=  10.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    5000.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
         1      2      3      4      5      6      7      8      9     10

  1    1.06   1.09   1.12   1.14   1.15   1.15   1.15   1.14   1.12   1.09
  2    1.10   1.14   1.17   1.20   1.22   1.22   1.22   1.20   1.17   1.14
  3    1.15   1.19   1.24   1.27   1.30   1.31   1.30   1.27   1.24   1.19
  4    1.19   1.25   1.31   1.36   1.40   1.41   1.40   1.36   1.31   1.25
  5    1.24   1.31   1.38   1.46   1.52   1.54   1.52   1.46   1.38   1.31
  6    1.27   1.36   1.46   1.57   1.67   1.73   1.67   1.57   1.46   1.36
  7    1.30   1.40   1.52   1.67   1.88   2.04   1.88   1.67   1.52   1.40
  8    1.31   1.41   1.54   1.73   2.04   3.73   2.04   1.73   1.54   1.41
  9    1.30   1.40   1.52   1.67   1.88   2.04   1.88   1.67   1.52   1.40
 10    1.27   1.36   1.46   1.57   1.67   1.73   1.67   1.57   1.46   1.36
 11    1.24   1.31   1.38   1.46   1.52   1.54   1.52   1.46   1.38   1.31
 12    1.19   1.25   1.31   1.36   1.40   1.41   1.40   1.36   1.31   1.25
 13    1.15   1.19   1.24   1.27   1.30   1.31   1.30   1.27   1.24   1.19
 14    1.10   1.14   1.17   1.20   1.22   1.22   1.22   1.20   1.17   1.14
 15    1.06   1.09   1.12   1.14   1.15   1.15   1.15   1.14   1.12   1.09
 16    1.02   1.04   1.06   1.08   1.09   1.09   1.09   1.08   1.06   1.04
 17    0.98   1.00   1.02   1.03   1.04   1.04   1.04   1.03   1.02   1.00
 18    0.94   0.96   0.97   0.98   0.99   0.99   0.99   0.98   0.97   0.96
 19    0.91   0.92   0.94   0.94   0.95   0.95   0.95   0.94   0.94   0.92
 20    0.88   0.89   0.90   0.91   0.91   0.91   0.91   0.91   0.90   0.89
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number: 1
Duration of simulation period in days:  365.000
Number of grid columns: 10
Number of grid rows: 20
Grid spacing in ft:    20.00
X-coordinate of upper-left grid node in ft:     0.00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:   100.00
Y-coordinate of well in ft:   140.00
Well discharge in gpm:   15.00
Duration of pump operation during simulation period
in days:  365.000
Well radius in ft:  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft:    5000.00
Aquifer storativity as a decimal: 0.000300
Aquitard thickness in ft:  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft:     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
         1     2     3     4     5     6     7     8     9    10

  1    1.59  1.64  1.67  1.70  1.72  1.73  1.72  1.70  1.67  1.64
  2    1.66  1.71  1.76  1.80  1.83  1.84  1.83  1.80  1.76  1.71
  3    1.72  1.79  1.86  1.91  1.95  1.96  1.95  1.91  1.86  1.79
  4    1.79  1.88  1.96  2.04  2.09  2.11  2.09  2.04  1.96  1.88
  5    1.86  1.96  2.07  2.18  2.27  2.31  2.27  2.18  2.07  1.96
  6    1.91  2.04  2.18  2.35  2.51  2.59  2.51  2.35  2.18  2.04
  7    1.95  2.09  2.27  2.51  2.83  3.06  2.83  2.51  2.27  2.09
  8    1.96  2.11  2.31  2.59  3.06  5.60  3.06  2.59  2.31  2.11
  9    1.95  2.09  2.27  2.51  2.83  3.06  2.83  2.51  2.27  2.09
 10    1.91  2.04  2.18  2.35  2.51  2.59  2.51  2.35  2.18  2.04
 11    1.86  1.96  2.07  2.18  2.27  2.31  2.27  2.18  2.07  1.96
 12    1.79  1.88  1.96  2.04  2.09  2.11  2.09  2.04  1.96  1.88
 13    1.72  1.79  1.86  1.91  1.95  1.96  1.95  1.91  1.86  1.79
 14    1.66  1.71  1.76  1.80  1.83  1.84  1.83  1.80  1.76  1.71
 15    1.59  1.64  1.67  1.70  1.72  1.73  1.72  1.70  1.67  1.64
 16    1.53  1.57  1.60  1.62  1.64  1.64  1.64  1.62  1.60  1.57
 17    1.47  1.50  1.53  1.55  1.56  1.56  1.56  1.55  1.53  1.50
 18    1.42  1.44  1.46  1.48  1.49  1.49  1.49  1.48  1.46  1.44
 19    1.36  1.39  1.40  1.42  1.42  1.43  1.42  1.42  1.40  1.39
 20    1.32  1.33  1.35  1.36  1.37  1.37  1.37  1.36  1.35  1.33
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number: 1
Duration of simulation period in days: 365.000
Number of grid columns: 10
Number of grid rows: 20
Grid spacing in ft:    20.00
X-coordinate of upper-left grid node in ft:      .00
Y-coordinate of upper-left grid node in ft:     0.00
Simulation period number: 1
Number of production, injection, and image wells
active during simulation period: 1
Well number: 1
X-coordinate of well in ft:  100.00
Y-coordinate of well in ft:  140.00
Well discharge in gpm:   50.00
Duration of pump operation during simulation period
in days:  365.000
Well radius in ft:  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft:    5000.00
Aquifer storativity as a decimal: 0.000300
Aquitard thickness in ft:  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft:      0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                         I-COLUMN
         1     2     3     4     5     6     7     8     9    10

  1    5.31  5.45  5.58  5.68  5.75  5.77  5.75  5.68  5.58  5.45
  2    5.52  5.70  5.87  6.00  6.09  6.12  6.09  6.00  5.87  5.70
  3    5.75  5.97  6.19  6.37  6.49  6.54  6.49  6.37  6.19  5.97
  4    5.97  6.26  6.54  6.79  6.98  7.04  6.98  6.79  6.54  6.26
  5    6.19  6.54  6.91  7.28  7.58  7.70  7.58  7.28  6.91  6.54
  6    6.37  6.79  7.28  7.84  8.37  8.63  8.37  7.84  7.28  6.79
  7    6.49  6.98  7.58  8.37  9.42 10.22  9.42  8.37  7.58  6.98
  8    6.54  7.04  7.70  8.63 10.22 18.67 10.22  8.63  7.70  7.04
  9    6.49  6.98  7.58  8.37  9.42 10.22  9.42  8.37  7.58  6.98
 10    6.37  6.79  7.28  7.84  8.37  8.63  8.37  7.84  7.28  6.79
 11    6.19  6.54  6.91  7.28  7.58  7.70  7.58  7.28  6.91  6.54
 12    5.97  6.26  6.54  6.79  6.98  7.04  6.98  6.79  6.54  6.26
 13    5.75  5.97  6.19  6.37  6.49  6.54  6.49  6.37  6.19  5.97
 14    5.52  5.70  5.87  6.00  6.09  6.12  6.09  6.00  5.87  5.70
 15    5.31  5.45  5.58  5.68  5.75  5.77  5.75  5.68  5.58  5.45
 16    5.10  5.22  5.32  5.40  5.45  5.47  5.45  5.40  5.32  5.22
 17    4.90  5.00  5.09  5.15  5.19  5.21  5.19  5.15  5.09  5.00
 18    4.72  4.80  4.87  4.92  4.96  4.97  4.96  4.92  4.87  4.80
 19    4.55  4.62  4.68  4.72  4.75  4.76  4.75  4.72  4.68  4.62
 20    4.38  4.44  4.49  4.53  4.55  4.56  4.55  4.53  4.49  4.44
```

```
GENERAL DATA BASE:

Number of simulation periods for which drawdown
or recovery is to be calculated 1
Simulation period number= 1
Duration of simulation period in days:  365.000
Number of grid columns= 10
Number of grid rows= 20
Grid spacing in ft=    20.00
X-coordinate of upper-left grid node in ft=     0.00
Y-coordinate of upper-left grid node in ft=     0.00
Simulation period number= 1
Number of production, injection, and image wells
active during simulation period= 1
Well number= 1
X-coordinate of well in ft=  100.00
Y-coordinate of well in ft=  140.00
Well discharge in gpm=   25.00
Duration of pump operation during simulation period
in days=  365.000
Well radius in ft=  0.50
Number of observation wells for which time-
drawdown tables are desired 0
Aquifer transmissivity in gpd/ft=    5000.00
Aquifer storativity as a decimal= 0.000300
Aquitard thickness in ft=  10.00
Aquitard vert. hydr. conduct. in gpd/sq ft=     0.021


NODAL COMPUTATION RESULTS:

SIMULATION PERIOD DURATION IN DAYS:  365.000

VALUES OF DRAWDOWN OR RECOVERY (FT) AT NODES:

J-ROW                          I-COLUMN
         1      2      3      4      5      6      7      8      9     10

  1    2.65   2.73   2.79   2.84   2.87   2.89   2.87   2.84   2.79   2.73
  2    2.76   2.85   2.93   3.00   3.05   3.06   3.05   3.00   2.93   2.85
  3    2.87   2.99   3.09   3.18   3.25   3.27   3.25   3.18   3.09   2.99
  4    2.99   3.13   3.27   3.39   3.49   3.52   3.49   3.39   3.27   3.13
  5    3.09   3.27   3.46   3.64   3.79   3.85   3.79   3.64   3.46   3.27
  6    3.18   3.39   3.64   3.92   4.19   4.31   4.19   3.92   3.64   3.39
  7    3.25   3.49   3.79   4.19   4.71   5.11   4.71   4.19   3.79   3.49
  8    3.27   3.52   3.85   4.31   5.11   9.34   5.11   4.31   3.85   3.52
  9    3.25   3.49   3.79   4.19   4.71   5.11   4.71   4.19   3.79   3.49
 10    3.18   3.39   3.64   3.92   4.19   4.31   4.19   3.92   3.64   3.39
 11    3.09   3.27   3.46   3.64   3.79   3.85   3.79   3.64   3.46   3.27
 12    2.99   3.13   3.27   3.39   3.49   3.52   3.49   3.39   3.27   3.13
 13    2.87   2.99   3.09   3.18   3.25   3.27   3.25   3.18   3.09   2.99
 14    2.76   2.85   2.93   3.00   3.05   3.06   3.05   3.00   2.93   2.85
 15    2.65   2.73   2.79   2.84   2.87   2.89   2.87   2.84   2.79   2.73
 16    2.55   2.61   2.66   2.70   2.73   2.74   2.73   2.70   2.66   2.61
 17    2.45   2.50   2.54   2.58   2.60   2.60   2.60   2.58   2.54   2.50
 18    2.36   2.40   2.44   2.46   2.48   2.48   2.48   2.46   2.44   2.40
 19    2.27   2.31   2.34   2.36   2.37   2.38   2.37   2:36   2.34   2.31
 20    2.19   2.22   2.25   2.27   2.28   2.28   2.28   2.27   2.25   2.22
```