DESIGN ENGINEERING REPORT

WORK ASSIGNMENT D003825-61

CHEM CORE SITE
CITY OF BUFFALO (C)

SITE NO. 9-15-176
ERIE COUNTY, NY

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Denise M. Sheehan, Acting Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION

URS Corporation
77 Goodell Street
Buffalo, New York 14203

G3799E

August 2005

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SITE #915-176
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AUGUST 2005

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1.0 INTRODUCTION

1.1 Scope

This Design Engineering Report (DER) presents design criteria and supporting data and documentation for the remediation at the Chem Core Site (Site No. 9-15-176). This work is being performed for the New York State Department of Environmental Conservation (NYSDEC) under Work Assignment D003825-61. This DER has been prepared under Subtask 4.3 - Final (100%) Design.

1.2 Record of Decision (ROD) Summary

The approach to remediation at the Chem Core site is stated in the January 2003 ROD (NYSDEC 2003). The remedy for the site, as specified in the ROD, includes the following components:

1. Demolish the building and dispose of demolition debris off-site in a permitted facility.

2. Excavate the contaminated subsurface soil (approximately 7,600 cubic yards) and dispose of the soil in off-site permitted facilities. The goal is to reduce soil contamination to levels consistent with those given in NYSDEC Technical and Administrative Guidance Memorandum (TAGM) No. 4046 to the extent practicable.

3. Install groundwater recovery wells at the site to extract the contaminated groundwater. Install and operate a treatment system at the site to treat the extracted groundwater for disposal into the sanitary sewer system.

4. Evaluate the results from the five-year operation of groundwater extraction and treatment. If concentrations have been reduced sufficiently, implement enhanced

bioremediation or another available technology to achieve groundwater standards to the extent practicable.

5. Design a bioremediation pilot study for off-site groundwater contamination for implementation during construction of the remedy. Based on the results of the pilot study, design a full-scale bioremediation plan of off-site groundwater for implementation, if necessary.

6. Implement a long-term operation, maintenance, and monitoring program for the groundwater extraction and treatment system.

7. A notification will be sent to the county clerk for filing, to notify future owners of the site about the presence of residual contamination remaining in groundwater.

This DER does not address component five (bioremediation pilot study) above. The DER addresses all other components which are part of Task 4 of Work Assignment D003825-61. The bioremediation pilot study will be addressed under Task 3 of Work Assignment D003825-61. Design reports for the bioremediation pilot study will be issued separately. The results of Task 3 will be used in the evaluation of groundwater extraction and treatment after five years as discussed in component 4 above.

2.0 REMEDIAL DESIGN

2.1 Introduction

The remedial design has been developed based on the findings of investigations and studies listed below.

1. Immediate Investigation Work Assignment (IIWA) Report (NYSDEC 1999)
2. Phase I and II Remedial Investigation Report (URS 2002a)
3. Feasibility Study Report (URS 2002b)
4. Remedial Design Investigation Report (URS 2004)

This section describes each remediation component and the technical basis for its design. Additional data such as calculations and support documentation are presented in the appendices to the report.

2.2 Design Basis

2.2.1 Site Demolition

The Chem Core Building No. 1382 will be removed in its entirety, including concrete foundations, to facilitate excavation of contaminated soil beneath the building. Some smaller structures related to the building will also be demolished. These structures include concrete loading docks located to the west adjacent to the railroad property and concrete steps located to the east on the sidewalk adjacent to the building.

All demolition debris except possibly concrete will be disposed of in a C&D landfill. Local concrete crushing operations near the site that process concrete for use as construction materials may accept the concrete debris for little or no charge. If unacceptable to these concrete crushing operations, the concrete will be disposed of at a C&D landfill. Concrete will be brushed and/or power washed, if necessary, to remove any soil that may adhere to the concrete before the concrete is transported off site. Contaminated water resulting from concrete cleaning will be drummed or pumped into a tank on site. It will be sampled and sent off site to an approved facility. Soil that is removed from concrete will be segregated from the other debris and temporarily remain onsite in areas designated as having contaminated soil. The soil removed from concrete will ultimately be shipped off site with other contaminated soil.

2.2.2 <u>Soil Excavation and Disposal</u>

Analytical data for soil samples collected during investigations conducted prior to design are presented on figures included in Appendix 2A. These figures, along with analytical data contained in the reports referenced in Section 2.1, serve as the basis for delineating the soil excavation area.

Soil has been classified based on sampling already performed (Appendix 2A) to simplify remediation and reduce cost. The Department will not require the Contractor to sample, or analyze soil during excavation; however, the Contractor will be required to sample and analyze soil as necessary to meet any requirements of off-site treatment and disposal facilities.

Based on the analytical data, there are three types of contaminated soil on site that will need to be disposed of. These three types are described below.

1. Hazardous Soil: Sample results from this type of soil show consistent exceedances of land disposal criteria for TCLP VOCs - mainly tetrachloroethene (PCE) and trichlorethene (TCE); however, concentrations of VOCs were less than 10 times the UTS for all VOCs detected (see number 3 below). This soil must be disposed of in a permitted facility that can accept hazardous waste.

2. Non-Hazardous Soil: Sample results from this type of soil show exceedances of NYSDEC TAGM 4046 cleanup goals; however, results did not exceed land disposal criteria and were less than ten times the Universal Treatment Standards (UTSs). Treatment is not required because contaminant concentrations were less than ten

times the UTS for each contaminant. Disposal in a permitted hazardous waste facility is not required because the soil does not exhibit the characteristic of a hazardous waste by the toxic characteristic leaching procedure. This contaminated soil must be disposed of in a permitted solid waste facility.

3. Soil to be Treated Off-Site: Sample results from this type of soil show concentrations of some VOCs exceeding NYSDEC TAGM 4046 and concentrations that are greater than 10 times the UTS for some VOCs. Consequently, this type of soil must be sent off-site for treatment. Ultimate disposal will depend on the results of treatment.

4. Soil to be Incinerated: Sample results from this type of soil show concentrations of some VOCs exceeding concentrations acceptable for offsite treatment. This type of soil must be sent offsite for disposal at a permitted incineration facility.

Soil will be excavated to the top of the bedrock surface in all contaminated areas (See Drawing C-2). Based on boring logs, the depth of excavation will range from 12 to 22 feet in the contaminated areas. In addition, soil will be excavated to a depth of 1 foot in all on site areas outside the contaminated areas, i.e. in areas believed to be clean. This surface excavation in clean areas insures that there will be no direct exposure to surface soil contamination if the site is developed.

As requested by NYSDEC, pre-excavation borings will be installed by the Contractor prior to excavation to verify the horizontal limits of contamination and to classify any contaminated soil outside established limits, if analysis shows the soil is contaminated. These borings will be installed to insure that residual contamination left on site is minimized. A total of twenty-two borings will be installed. Twelve borings will be installed approximately five feet from the proposed boundary of excavation and ten borings will be installed about ten feet from the proposed boundary of excavation as shown in Contract Drawing C-2. Soil samples will be collected from the borings based on PID readings (headspace analysis of samples equilibrated in jars) and will be analyzed for VOCs and TCLP VOCs. The boundaries, and consequently the quantity of soil to be excavated, will be re-estimated based on the results of soil sampling.

Up to forty post-excavation samples will also be collected from the sidewalls of excavations and will be analyzed for VOCs and TCLP VOCs. These samples will be used to assess the quantity of residual contamination that will remain. This residual will be onsite contaminated soil that could not be excavated (e.g. for excavations that might undermine foundations of adjacent structures) or off-site soil beyond property boundaries.

The groundwater table is generally below the top of bedrock so significant active dewatering in the excavation will not be required. Some water may be present in the overburden in the northwest corner of the site. The Contractor will need to remove this water prior to excavating. Water can be stored and disposed of offsite or treated (using a temporary treatment system) and discharged to the sewer. Any temporary discharge to the sewer will require that the Contractor obtain a discharge permit from the Buffalo Sewer Authority.

Health and Safety will be a concern for both site workers and off-site residents and workers. The Contractor will be required to develop a health and safety plan that specifies and justifies worker level of protection, and an air monitoring program that protects on-site workers and off-site residents and workers.

Once excavation is complete in an area, the excavated area will be backfilled and graded. A 6-inch top layer of stone will subsequently be placed over the entire site.

2.2.3 Groundwater Extraction and Treatment

The purpose of the groundwater extraction system is to contain groundwater onsite and to prevent, to the extent practicable, further contaminant migration offsite. The treatment system is designed to reduce contaminant levels in groundwater to levels that will permit discharge of the groundwater to the sewer.

Based on groundwater pump test results and analytical methods presented in Appendix 2B, the estimated extraction rate to achieve containment is 2 to 6 gpm. This can be accomplished by using two 6-inch diameter wells that penetrate approximately 20 feet into the water table. To provide a factor of safety, the groundwater treatment system has been designed for a maximum capacity of 10 gpm.

Treatment equipment needs were evaluated based on monitoring well data (Appendix 2C) to represent the system influent and proposed sewer discharge criteria (Appendix 2C). Analysis shows (Appendix 2D) that a shallow tray air stripper with four trays and a blower with a capacity of 150 standard cubic feet per minute will reduce contaminations to concentrations below the discharge criteria.

Analysis of groundwater shows that it contains high levels (300 - 1,900 ppm) of hardness (i.e. calcium and magnesium). The hardness causes formation of a hard scale on the air stripper trays and other components such as pumps. The scale must be removed periodically to keep the equipment operating efficiently. Therefore, the treatment system includes the addition of a deposit control agent to reduce scaling from calcium and magnesium and subsequent maintenance resulting from scaling. The deposit control agent will be pumped from a drum by a metering pump. Iron can also cause a scaling problem; however, groundwater analysis shows that iron concentrations are low (less than 1 ppm). Therefore, no measures have been included in the treatment process to address iron scaling.

Air emissions from the air stripper were also evaluated (Appendix 2E). Using the maximum treatment system capacity (10 gpm) and maximum concentrations of contaminants detected in groundwater, the evaluation showed that air emissions control (treatment) will be required to reduce air emissions to acceptable levels. Using an average capacity (4 gpm) and average concentrations, air emissions control would still be required. To insure compliance with air standards, a catalytic oxidizer for air emissions control is included in groundwater treatment system.

A catalytic oxidizer now located at another New York State Superfund site (Robeson Industries site in Wyoming County), but no longer being used at the Robeson site, will be used for the Chem Core remediation. The catalytic oxidizer will be inspected and repaired as necessary by the manufacturer (Global Technologies) and will be shipped to the site by URS. The Contractor will be responsible for installing and operating the unit.

Performance requirements included in the Contract Documents for the oxidizer will be based on maximum groundwater concentrations and the maximum groundwater extraction rate (10 gpm) except for tetrachloroethene (PCE). Under these worst case conditions, 94% removal of PCE is required. However, the oxidizer manufacturer is only able to guarantee a PCE removal rate of 85 to 90%. For the Contract Documents, a removal rate of 88% will be specified. If average groundwater extraction rates do not exceed 4 gpm, as expected, an 88% removal rate will be more than sufficient to meet air emissions standards even if influent groundwater PCE concentrations are at the maximum concentration detected.

Treated groundwater will be discharged from the air stripper to the sewer by gravity. Analysis shows that gravity discharge is feasible (Appendix 2F). Gravity discharge is employed to reduce the required operator time on site for operation and maintenance. The Contractor will be responsible for coordinating with the Buffalo Sewer Authority (BSA) and installing the discharge line in accordance with BSA requirements.

Other equipment (tanks and pumps) will be used to extract, store, and transfer groundwater for treatment. A groundwater extraction and treatment equipment summary is provided in Table 2-1. Calculations used to specify performance requirements for the pumps are included in Appendix 2G.

The groundwater remediation will be implemented in two phases. The components of the first phase are described above. The first phase will continue for five years. At the end of the first phase, data collected during the initial five year period will be evaluated and the second phase will be implemented. The technology used for the second phase will depend on the findings and success of the first phase. At this time, enhanced bioremediation is being strongly considered for the second phase. A pilot study will be conducted in 2005 to evaluate this technology.

2.2.4 Groundwater Monitoring

During excavation, four wells (MW-01S, MW-01D, MW-14, and EX-01) and one piezometer (PZ-1) will be removed. Three new monitoring wells (MW-20, MW-21, and MW-22) will be installed after excavation and backfilling to replace these wells (see Drawing C-3). The three new wells and an existing well that will not be removed (MW-2) will be used to monitor onsite groundwater levels and contamination.

TABLE 2-1

GROUNDWATER EXTRACTION AND TREATMENT EQUIPMENT

Item	**Capacity**
Submersible Well Pump (2)	5 gpm
Equalization/Storage Tank	1,600 gallons
Transfer Pump (2) [1]	10 gpm
Air Stripper	10 gpm water flow 150 scfm air flow
Metering Pump	variable
Catalytic Oxidizer	600 scfm air flow

gpm = gallons per minute

scfm = standard cubic feet per minute

Notes:

1. Two pumps will be installed - each with a 10 gpm capacity. Only one pump will be used at a time. With this configuration, the system can continue to operate if one of the pumps is not working and needs repair.

3.0 PERMITS AND APPROVALS

The Contractor must obtain a permit to discharge groundwater. The permit must be obtained from the Buffalo Sewer Authority (BSA). Preliminary discharge criteria have been established by the BSA and are presented in Appendix 2C. Permit applications and approvals can be coordinated through Leslie Sedita, Industrial Waste Administrator, for the BSA.

An air discharge permit will not be required. However, the Contractor must meet all the substantive requirements of they NYSDEC's Guidelines For the Control of Toxic Ambient Air Contaminants (DAR-1).

4.0 CONSTRUCTION SEQUENCING PLAN AND SCHEDULE

4.1 Introduction

This section presents a preliminary schedule and description of construction sequencing. The remedial contractor will determine the actual sequence and duration of work segments within the time frame specified in the Contract Documents. The Contractor will be required to submit a work plan with construction schedule to the NYSDEC within 5 days after being notified that he is the apparent low bidder.

4.2 Construction Sequencing

The major work elements, presented in the expected sequence of implementation, for the Chem Core remediation are described below.

1. Mobilization of Equipment, Manpower, and Temporary Facilities: A temporary exclusion zone, air monitoring stations, office space, decontamination trailer, storage and laydown areas, and an equipment decontamination area will be established.

   It is expected that all or most of the temporary facilities will be located on site. However, in the Contract Documents, the Contractor will be given the option to use an offsite location for some elements of work, e.g. storage or laydown areas. The Contractor will be responsible for making all arrangements for and paying for any offsite support locations. The location and activities conducted at these locations must be approved by the Engineer.

2. Demolition of Existing Building: Prior to demolition, asbestos containing material will be removed from the building and will be disposed of off-site. The building, including concrete foundations, will be demolished and demolition debris will be transported offsite to a C&D landfill.

3. Excavation and Backfill: Pre-excavation borings will be installed and sampled to verify the horizontal limits of excavation. Once the final limits have been established, all soil in designated contaminated areas will be excavated down to the bedrock surface while areas outside contaminated areas will be excavated to a depth of one foot. Excavated soil will be transported off-site to a hazardous waste landfill, solid waste landfill, or treatment facility depending on the concentration of VOCs in the soil. All excavated areas will be backfilled with clean fill to within six inches of the proposed final grade.

4. Groundwater Extraction System: The Contractor will install two extraction wells, three monitoring wells, and about 200 feet of below grade pipe.

5. Groundwater Treatment System: Groundwater treatment equipment will be installed in a 20 ft. x 30 ft. pre-engineered metal building. A sanitary sewer connection will be completed, and electrical power, gas, water, and telephone services will be connected to the treatment building.

6. Final Grading: A six-inch layer of stone will be placed over the site.

7. Treatment System Start-up and Testing: Operation of the treatment system will be initiated and treatment efficiency and compliance with discharge criteria will be tested. The estimated duration of the start-up phase is two days, although the actual duration will depend on the Contractor's ability to achieve start-up goals. The required duration for testing is 30 calendar days.

8. Treatment System Operation: The Contractor will continue to operate the treatment system, and be responsible for routine checks, maintenance and monitoring. The required duration for operation is 150 calendar days.

9. Construction Demobilization: The Contractor will demobilize from the site, and the NYSDEC will take over the operation of the treatment system.

4.3 Contractor Schedule

A preliminary general construction schedule is presented in Figure 4-1. The selected Contractor will submit a detailed construction schedule to the NYSDEC as required by Contract.

FIGURE 4-1

PRELIMINARY CONSTRUCTION SCHEDULE

Task Description	2005					2006											
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Bidding	■																
Contract Award		■															
Contractor Submittals			■	■	■												
Mobilization			■														
Demolition				■													
Excavation and Backfill					■	■											
Extraction and Treatment Systems							■										
Final Grading (With Stone)							■										
Start-up and Testing								■									
System Operation									■	■	■	■	■				
Demobilization														■			

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REFERENCES

New York State Department of Environmental Conservation (NYSDEC), 1999. Immediate Investigation Work Assignment (IIWA) Report. Chem-Core site.

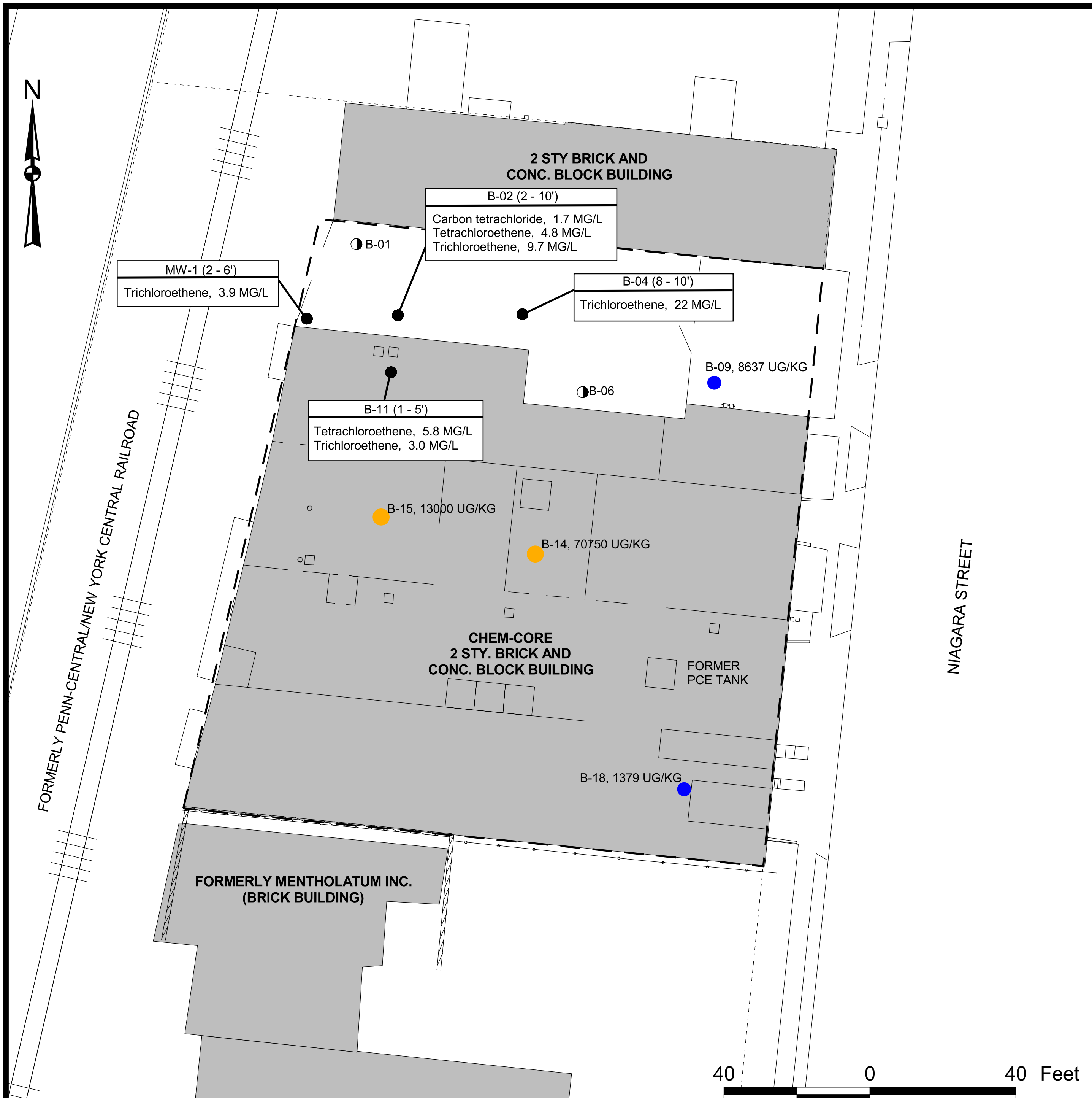
URS Corporation Group Consultants, 2002a. Final Phase I and II Remedial Investigation Report. Chem-Core Site.

URS Corporation Group Consultants, 2002b. Final Feasibility Study Report. Chem-Core Site.

URS Corporation, 2004. Remedial Design Investigation Report. Chem-Core Site.

APPENDIX 2A

SOIL DATA



Legend

- ◑ No Compounds Exceed TCLP Extraction Guidance Values
- ● At Least One Compound Exceeds TCLP Extraction Guidance Values

Depth Interval
B-11 (1 - 5')
Trichloroethene, 3.0 MG/L
Location ID — Compound Exceeding Criteria — Concentration — Units

Total VOC Concentrations in Soil

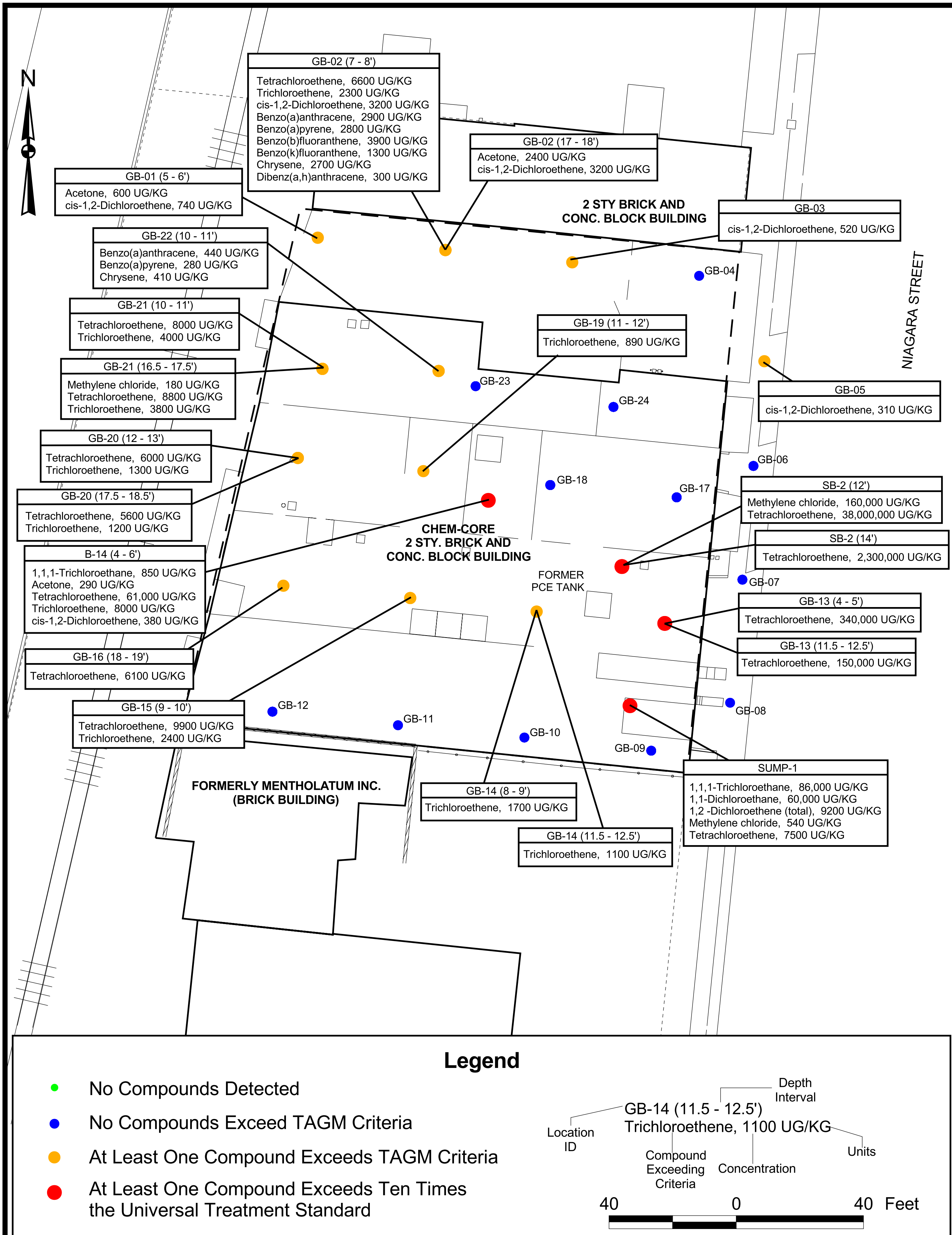
- ND
- 0 - 100 UG/KG
- 100 - 10,000 UG/KG
- 10,000 - 1,000,000 UG/KG
- > 1,000,000 UG/KG

B-18, 1379 UG/KG
Location ID — Concentration — Units

SOURCE: Phase II Limited Site Investigation, Chem Core Facility prepared by Maxim Technologies Inc.

URS	CHEM CORE PREVIOUS INVESTIGATION - PHASE II SOIL SAMPLES (1997)	FIGURE 2A-1

J:\35890.00\GIS\chemical.apr PHASE II SOIL RESULTS (1997)
12/9/2004

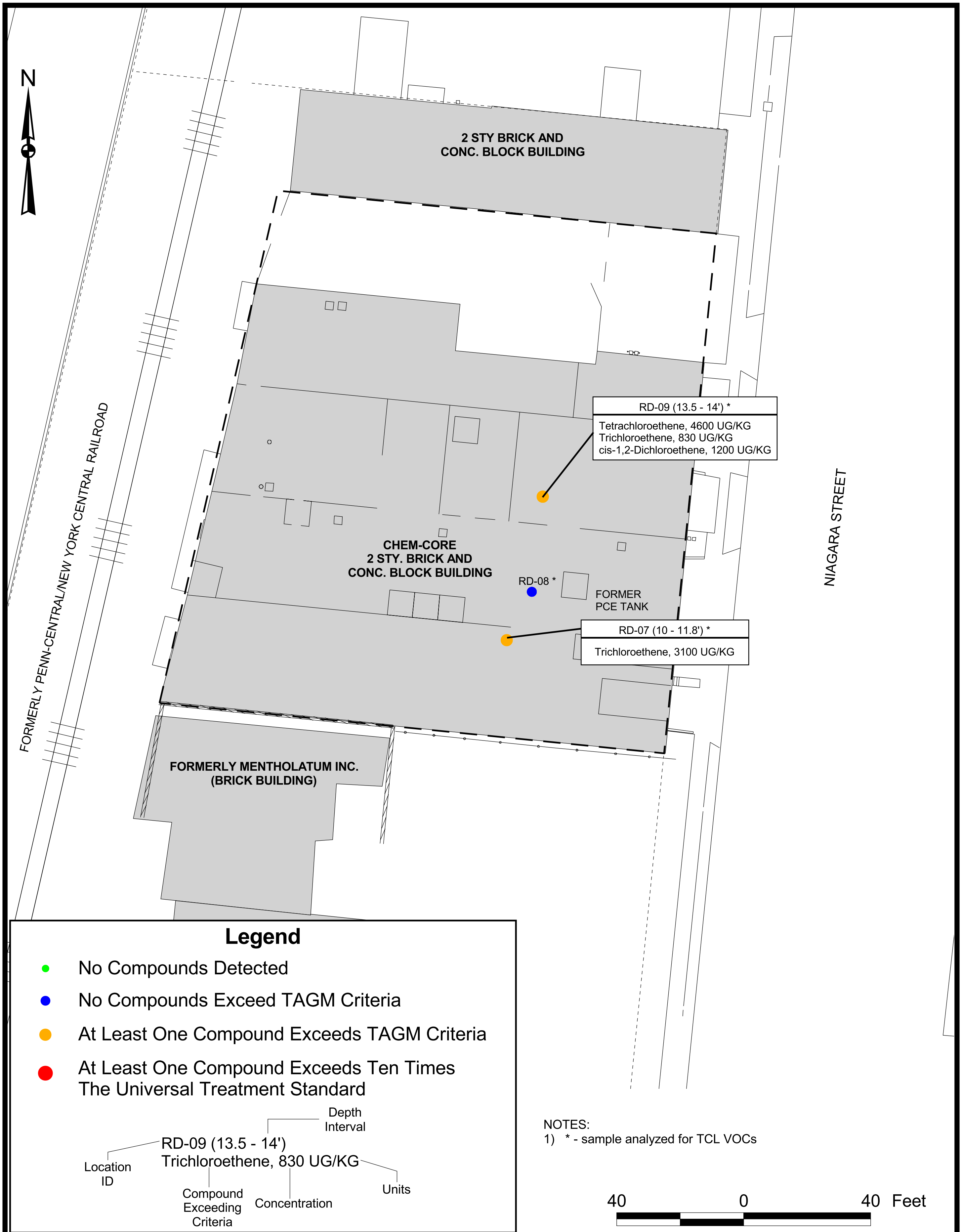


J:\35890.00\GIS\chemical.apr CONTAMINATED SOIL
12/13/2004

URS

CHEM CORE
RI INVESTIGATION (2001)

FIGURE 2A-2

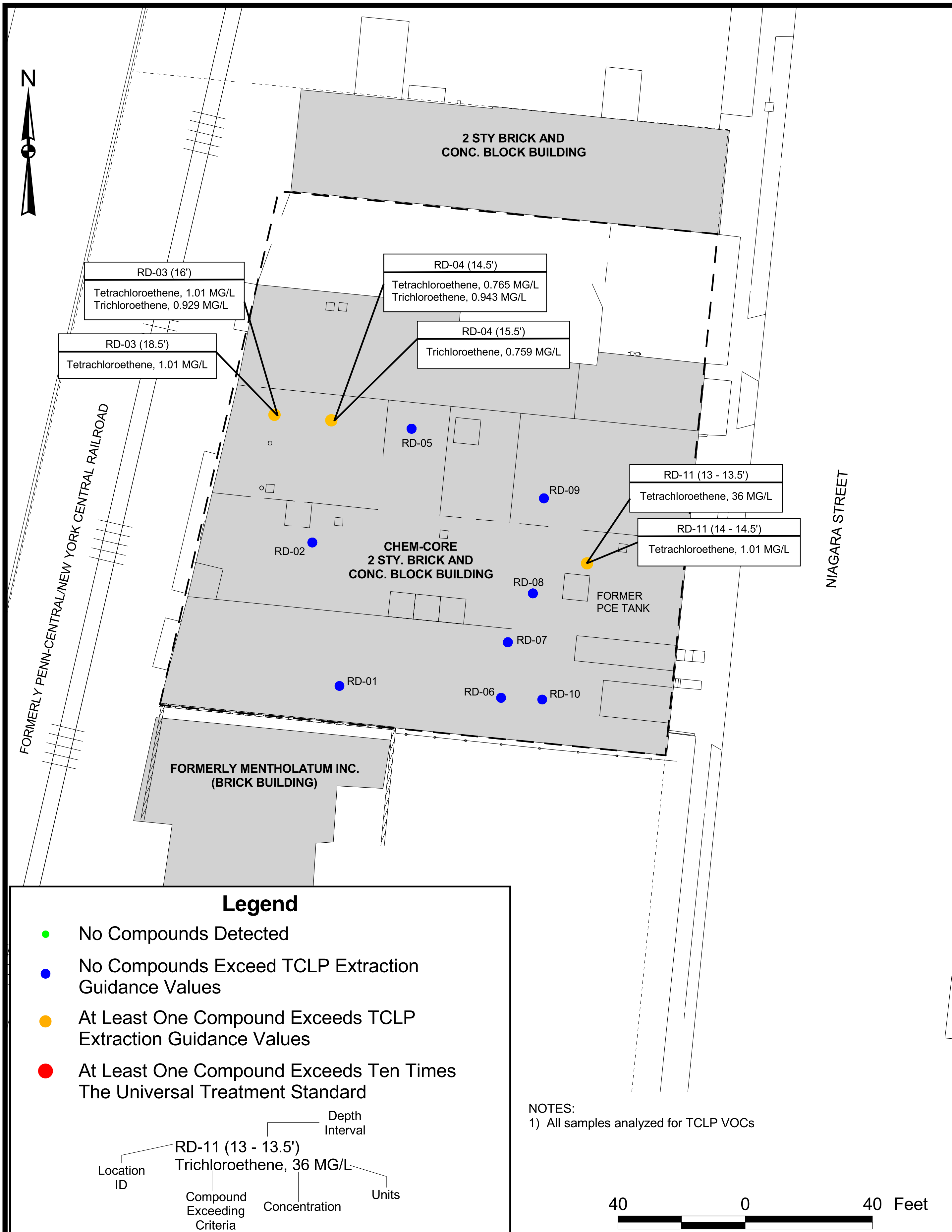


N:\11173519.00000\DB\GIS\chemical.apr VOC SOIL RESULTS
3/3/2005

URS

CHEM CORE
DESIGN INVESTIGATION (2004)
VOC RESULTS

FIGURE 2A-3



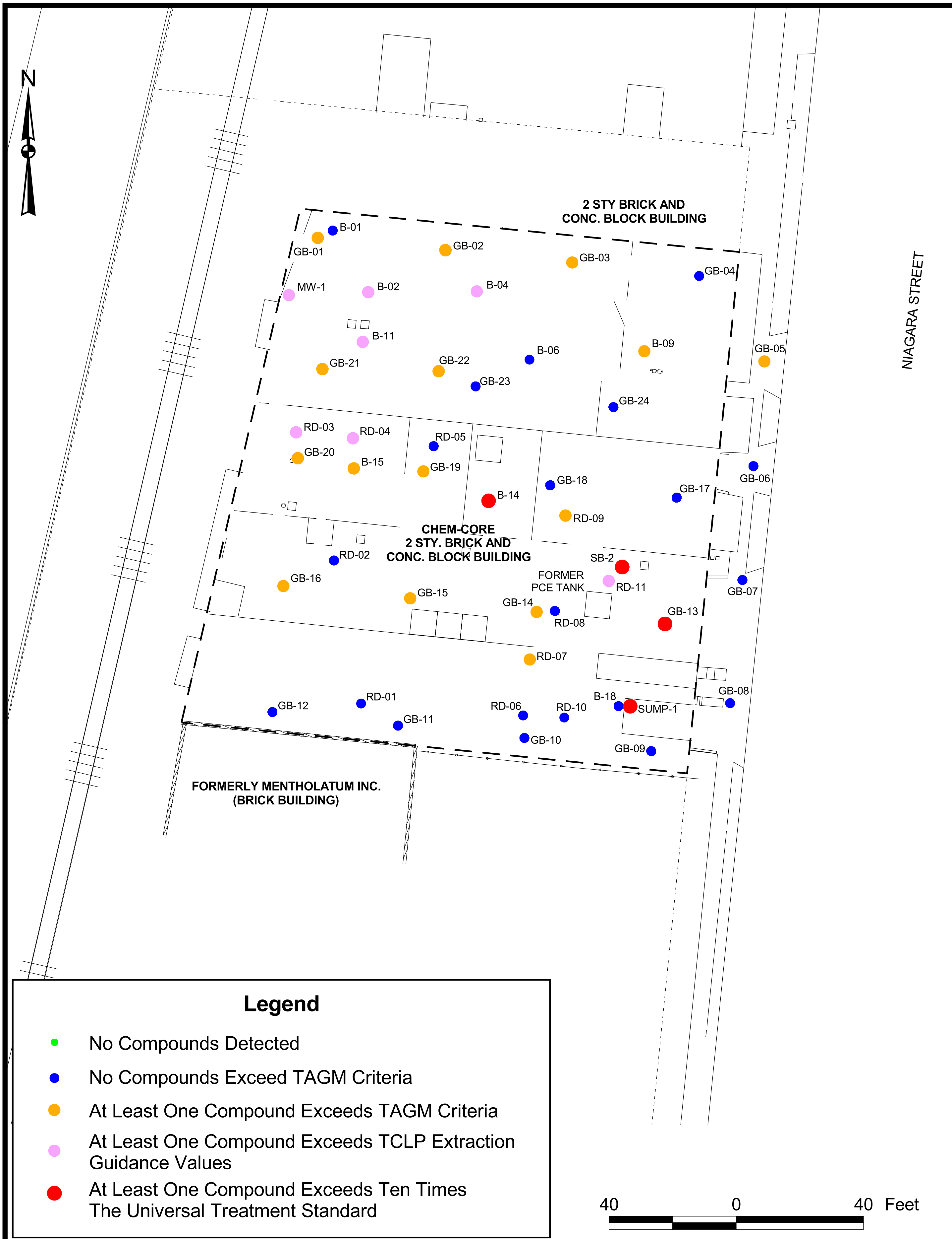
NOTES:
1) All samples analyzed for TCLP VOCs

J:\35890.00\GIS\chemical.apr TCLP SOIL ANALYTICAL RESULTS
12/9/2004

URS

CHEM CORE
DESIGN INVESTIGATION (2004)
TCLP RESULTS

FIGURE 2A-4



Legend

- No Compounds Detected
- No Compounds Exceed TAGM Criteria
- At Least One Compound Exceeds TAGM Criteria
- At Least One Compound Exceeds TCLP Extraction Guidance Values
- At Least One Compound Exceeds Ten Times The Universal Treatment Standard

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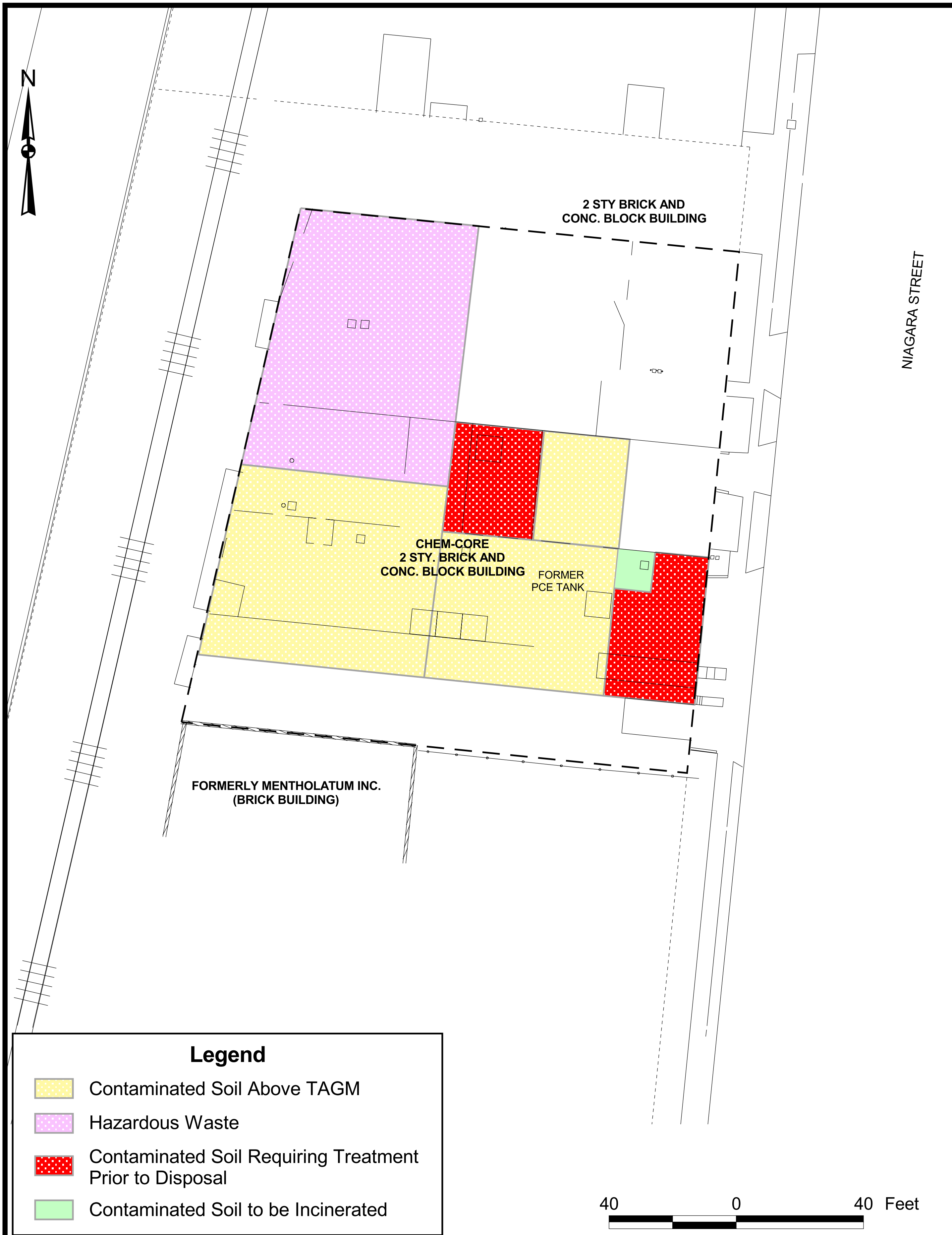
CHEM CORE
SUMMARY OF RESULTS

FIGURE 2A-5

J:\35890.00\GIS\chemical.apr CONTAMINATED SOIL-ALL SAMPLES
12/24/2004



N:\11173519.00000\DB\GIS\chemical.apr AREAS OF CONTAMINATION
7/25/2005

URS

CHEM CORE
AREAS OF CONTAMINATION

FIGURE 2A-6

APPENDIX 2B

GROUNDWATER EXTRACTION CALCULATIONS

CALCULATION COVER SHEET

Client: NYSDEC Project Name: Chem-Core

Project/Calculation Number: 111 73 519

Title: Hydraulic Containment of the Source of Dissolved-Phase Contamination

Total Number of Pages (including cover sheet): ____________

Total Number of Computer Runs: 0

Prepared by: Marek Ostrowski Date: ____________

Checked by: DUANE LENHARDT Date: 12/8/04

Description and Purpose: To design hydraulic containment system for the source of the dissolved-phase contamination.

Design Basis/References/Assumptions

See text.

Remarks/Conclusions/Results: See summary on pg 7. Two wells, pumping total of approximately 2 to 6 gpm.

Calculation Approved by: [signature] 12/8/04

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

MADE BY: M.O. DATE: Oct 11, 2004
CHKD. BY: DL DATE: Dec. 8, 2004

PROJECT: Chem-Core
SUBJECT: Hydraulic Containment of the Source of Dissolved-Phase Contamination

1. PURPOSE

The purpose of this calculation is to design the hydraulic containment system for the source of the dissolved-phase contamination identified at the Chem-Core site. The following elements of the system are specified:

- Number of extraction wells
- Well locations
- Well penetration depth
- Well diameter
- Drawdown to be maintained in the extraction wells and the corresponding expected extraction rate

2. GENERAL

Information about the site is based on Reference 1. The site is located in Buffalo, NY, along the Black Rock canal. Squaw Island, approximately 1,000 feet wide, separates the canal from the Niagara River (see Figure 1-1 of reference 1). The water-bearing formation is the bedrock, composed of dolomite and shale (Figure 3-1 of reference 1). The thickness of the water-bearing formation is not known. Most wells at the site are screened within the top 20 ft of the saturated zone.

The site is located approximately 250 feet from the Black Rock canal. Two concrete retaining walls parallel the canal (Figure 3-1 of reference 1). The general direction of ground water flow is to the west, that is towards the canal and the Niagara River (Figures 3-5 and 3-6 of reference 1).

It is worth noting that the site is situated in the vicinity of a large sewage pump station. Numerous large sewer structures are located in the area. The influence of these features on the flow regime at the site is not known.

The area of the site designated for the hydraulic containment is shown on page 19. The delineation is based on the containment of the area of soil contamination, which is presumed to be the source of the dissolved-phase contamination.

3. METHODOLOGY

Ground water flowing through the designated containment area is to be captured by means of ground water extraction wells. The total extraction rate required to create a capture zone around that area will be calculated using the approximation of a well placed in the uniform flow of ground water. Terms used in this methodology are listed below in alphabetical order:

- d - Downgradient extent of the capture zone, [m]
- H - Saturated thickness, [m]
- i - Hydraulic gradient, [-]
- K - Hydraulic conductivity, [m/s]
- Q - Required total extraction rate, $[m^3/s]$
- Q_w - Extraction rate of a single well, $[m^3/s]$
- R - Well's radius of influence, [m]
- r_w - Radius of the well, [m]
- s_w - Drawdown in the well, [m]
- T - Aquifer's transmissivity, $[m^2/s]$
- W - Width of the capture zone in the direction perpendicular to the flow, at the line passing through the well, [m]

The lateral extent of the capture at the line passing through the wells can be estimated as (reference 2, Figure 12):

$$W = Q / 2 T i$$

Total extraction rate of all wells of the containment system, required to create the capture zone, is:

$$Q = 2 W T i$$

The downgradient extent of the capture zone of a single well, at the line parallel to the flow and passing through the well, can be calculated as (reference 2, Figure 12):

$$d = Q_w / 2\pi T i$$

MADE BY: M.O. DATE: Oct 11, 2004
CHKD. BY: D.L. DATE: Dec 8, 2004

PROJECT: Chem-Core
SUBJECT: Hydraulic Containment of the Source of Dissolved-Phase Contamination

The extraction rate of a given well can be related to the drawdown in that well as (reference 3, Equations 8-4 and 8-12):

$$s_w = (Q_w/2\pi T)\ \ln(R/r_w)$$

$$R = 575 s_w (HK)^{1/2}$$

$$HK = T$$

$$Q_w = s_w\, 2\pi\, T\ /\ \ln(575 s_w T^{1/2}/r_w)$$

The maximum extraction that can be achieved by a well corresponds to the maximum effective drawdown that can be developed in that well.

$$s_w = s_{w\text{-max-eff}}$$

$$Q_{w\text{-max}} = s_{w\text{-max-eff}}\, 2\pi\, T\ /\ \ln(575 s_w T^{1/2}/r_w)$$

The number of extraction wells required to affect full capture is calculated by dividing the total required extraction rate by the maximum extraction rate that can be obtained from a single well:

$$N = Q\ /\ Q_{w\text{-max}}$$

4. PARAMETERS

Aquifer transmissivity - T
Aquifer transmissivity was estimated to be between approximately 60 and 260 ft^2/d (see URS calculation entitled *Analysis of Aquifer Test of August 2004*). Both values are used here to bracket the solution.

$$T_1 = 60\ ft^2/d = 6.5*10^{-5}\ m^2/s$$
$$T_2 = 260\ ft^2/d = 2.8*10^{-4}\ m^2/s$$

Hydraulic gradient - i
Based on Figures 3-5 and 3-6 of reference 1, the average hydraulic is between approximately 0.001 and 0.003. Conservatively, use the highest value:

$$i = 0.003$$

Well radius - r_w
The required extraction rate per well is expected to be low, based on the low hydraulic gradient observed at the site, and rather low transmissivity. Therefore, well diameter does not need to be large. Use 4-inch wells.

$$r_w = 2\ in = 0.05\ m$$

Well drawdown - $s_{w\text{-}max\text{-}eff}$
The thickness of the containment zone is on the order of 10 ft. Assume that the maximum effective drawdown is 2 ft.

$$s_{w\text{-}max\text{-}eff} = 2\ ft = 0.6\ m$$

Width of capture zone - W
The width of the source area in the direction perpendicular to the flow is approximately 200 feet. This is based on the concept of "source containment". The source of the dissolved-phase plume is likely to be created by soil contamination, which has been identified essentially across the entire site. See Figure A-1 of reference 4.
Assume the required width of the capture zone to be 50% greater than the source width.

$$W = 200*1.5 = 300\ ft = 92\ m$$

5. CALCULATIONS

5.1 Estimates for the low value of transmissivity

Summary of parameters:

$T = T_1 = 6.5*10^{-5}\ m^2/s$
$i = 0.003$
$r_w = 0.05\ m$
$s_{w\text{-}max\text{-}eff} = 0.6\ m$
$W = 92\ m$

Calculate:

Required total extraction rate

$$Q = 2\ W\ T_1\ i$$

$$Q = 2*92*(6.5*10^{-5})*0.003 = $$
$$= 3.6*10^{-5}\ m^3/s = 0.6\ gpm$$

Capacity of a single well

$$Q_{w\text{-}max} = s_w\ 2\pi\ T_1\ /\ \ln[575 s_w T^{1/2}/r_w]$$

$$Q_{w\text{-}max} = 0.6*2\pi*(6.5*10^{-5})/\ln[575*0.6*(6.5*10^{-5})^{1/2}/0.05]$$
$$= 2.5*10^{-4}\ /\ \ln(55) = 6.2*10^{-5}\ m^3/s = 1.0\ gpm$$

Number of wells required

$$N = Q\ /\ Q_{w\text{-}max\text{-}eff} = 3.6*10^{-5}\ /\ 6.2*10^{-5} = 0.6$$

One well is sufficient.

Downgradient extent of the capture zone

$$d = Q_w\ /\ 2\pi\ T_1\ i$$

$$d = (6.2*10^{-5})\ /\ 2\pi*(6.5*10^{-5})*0.003 = $$
$$= 51\ m = 166\ ft$$

MADE BY: M.O. DATE: Oct 11, 2004
CHKD. BY: D.L. DATE: Dec 8, 2004

PROJECT: Chem-Core
SUBJECT: Hydraulic Containment of the Source of Dissolved-Phase Contamination

5.2 Estimates for the high value of transmissivity

Summary of parameters:

$T = T_2 = 2.8*10^{-4}\ m^2/s$
$i = 0.003$
$r_w = 0.05\ m$
$s_{w-max-eff} = 0.6\ m$
$W = 92\ m$

Calculate:

Required total extraction rate

$$Q = 2\ W\ T_2\ i$$

$$Q = 2*92*(2.8*10^{-4})*0.003 = \\ = 1.6*10^{-4}\ m^3/s = 2.5\ gpm$$

Capacity of a single well

$$Q_{w-max} = s_w\ 2\pi\ T_2\ /\ \ln[575 s_w (HK)^{1/2}/r_w]$$

$$Q_{w-max} = 0.6*2\pi*(2.8*10^{-4})/\ln[575*0.6*(2.8*10^{-4})^{1/2}/0.05] \\ = 0.0011\ /\ \ln(116) = 2.3*10^{-4}\ m^3/s = 3.7\ gpm$$

Number of wells required

$$N = Q\ /\ Q_{w-max-eff} = 1.6*10^{-4}\ /\ 2.3*10^{-4} = 0.7$$

One well is sufficient

Downgradient extent of the capture zone

$$d = Q_w\ /\ 2\pi\ T_2\ i$$

$$d = (2.3*10^{-4})\ /\ 2\pi*(2.8*10^{-4})*0.003 = \\ = 44\ m = 143\ ft$$

MADE BY: M.O. DATE: Oct 11, 2004
CHKD. BY: D. L. DATE: Dec. 8, 2004

PROJECT: Chem-Core
SUBJECT: Hydraulic Containment of the Source of Dissolved-Phase Contamination

6. SUMMARY

This calculation evaluated the hydraulic containment of the dissolved contamination in the bedrock aquifer at the Chem-Core site at 1382 Niagara Street in Buffalo, NY. The findings are summarized below.

The amount of ground water that has to be intercepted in order to provide the required 300-ft wide capture zone has been estimated to be approximately 1 to 2 gpm. One extraction well is sufficient to provide this extraction rate, at the well drawdown of approximately 2 ft. The downgradient extent of the capture zone of such a well is approximately 150 ft. Therefore, the well should be placed less than 150 ft from the downgradient edge of the source, i.e. the edge of soil contamination.

The well should penetrate approximately 20 ft into the water table, to provide enough vertical distance for the pump, the drawdown and possible water level fluctuations.

In order to provide spare capacity of the system against well fouling, down time for maintenance, etc, two wells are recommended.

In summary, the following system is specified:

- Two extraction wells.
- Well locations as shown on page 12.
- Well penetration depth of 20 ft into the average water table.
- Well diameter of 4 in.
- Two-foot drawdown to be maintained in the wells, resulting in the corresponding expected extraction rate of approximately 1 to 3 gpm per well (total for two wells of approximately 2 to 6 gpm).

7. REFERENCES

1. Phase I & II Remedial Investigation Report
Chem-Core Site
URS Corporation Group Consultants, Final May 2002

2. Groundwater Contamination
Optimal Capture and Containment
S.M. Gorelick, R.A. Freeze, D. Donohue, J.F. Keely
Lewis Publishers, 1993

3. Hydraulics of Groundwater
J. Bear
McGraw-Hill, 1979

4. Feasibility Study Report
Chem-Core Site
URS Corporation Group Consultants, November 2002

pg 9
of —

PHASE I & II REMEDIAL INVESTIGATION REPORT

CHEM-CORE SITE

SITE #9-15-176

BUFFALO, NEW YORK

Reference 1

Prepared For:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

WORK ASSIGNMENT D003825-29

FINAL

Prepared By:

URS CORPORATION GROUP CONSULTANTS

282 DELAWARE AVENUE

BUFFALO, NEW YORK 14202

Draft Copy

MAY 2002

J.

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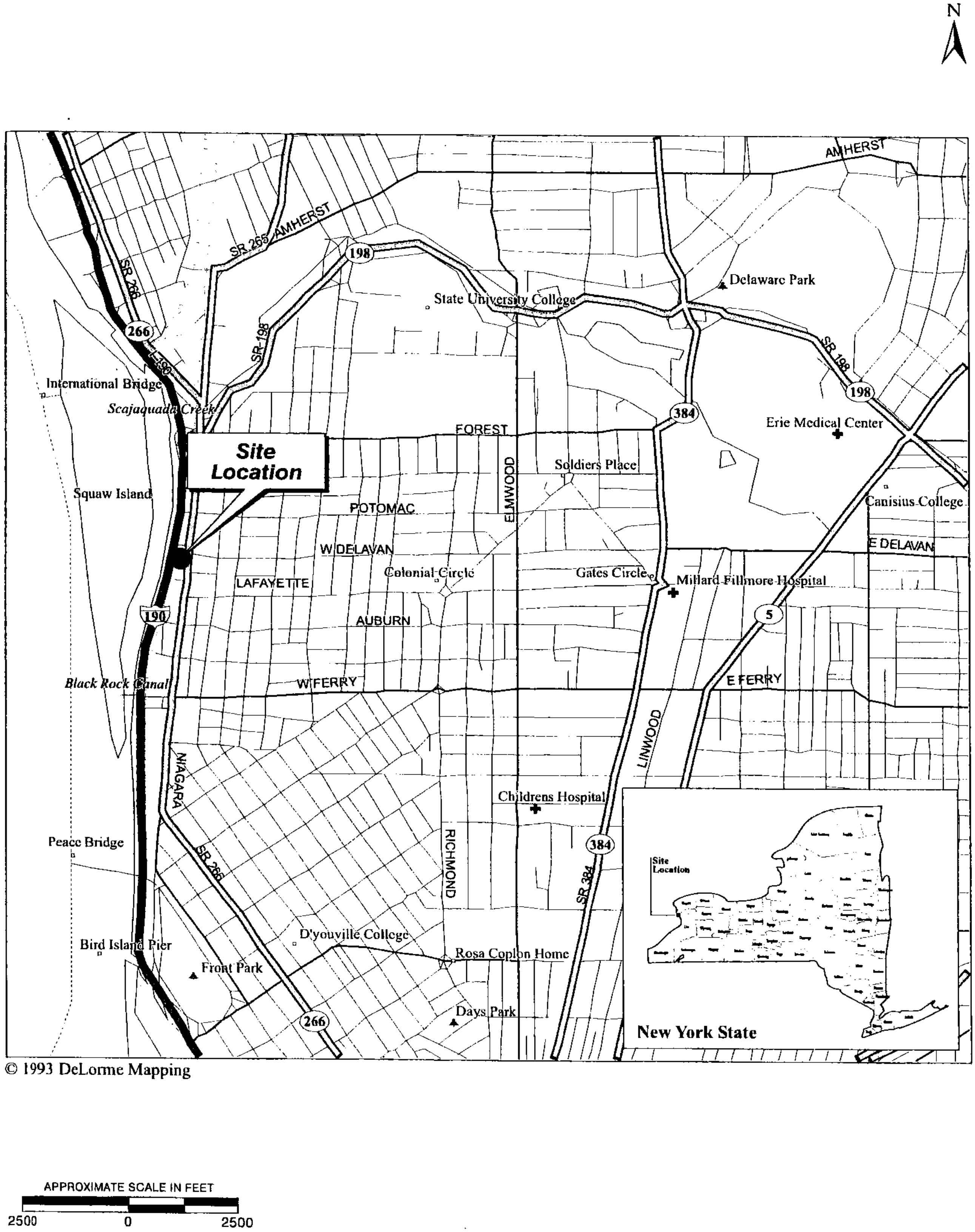
5/8/02 9:00 AM

pg 10 of —



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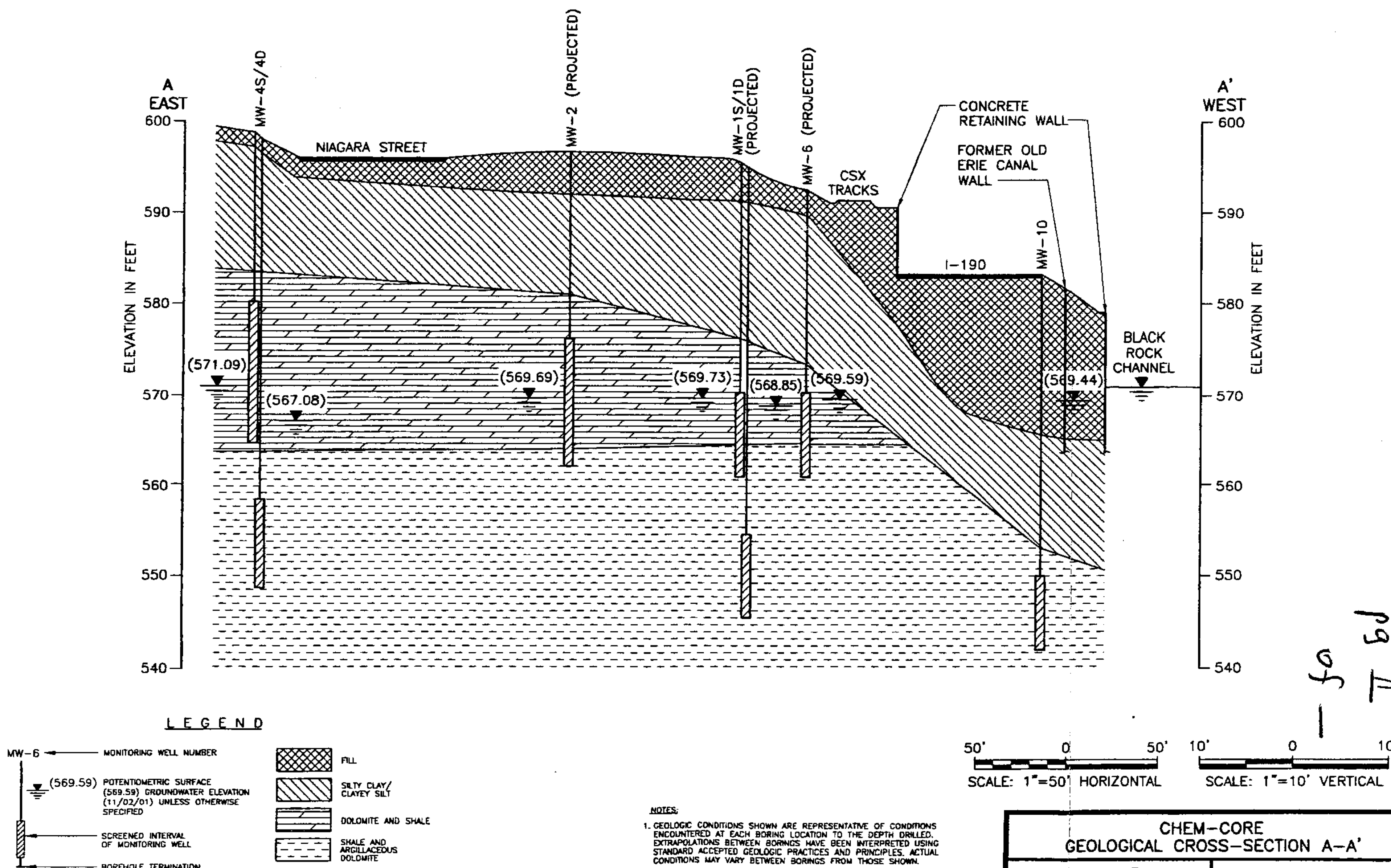
URS

CHEM-CORE FACILITY
SITE LOCATION MAP

FIGURE 1-1



NOTES:

1. GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.
2. ELEVATIONS BASED ON THE NORTH AMERICAN VERTICAL DATUM, 1988.

CHEM-CORE
GEOLOGICAL CROSS-SECTION A-A'

URS

FIGURE 3-1

pg 11 of __

J:\35890.02\CAD\ 1=50 11/13/01-2 ELB

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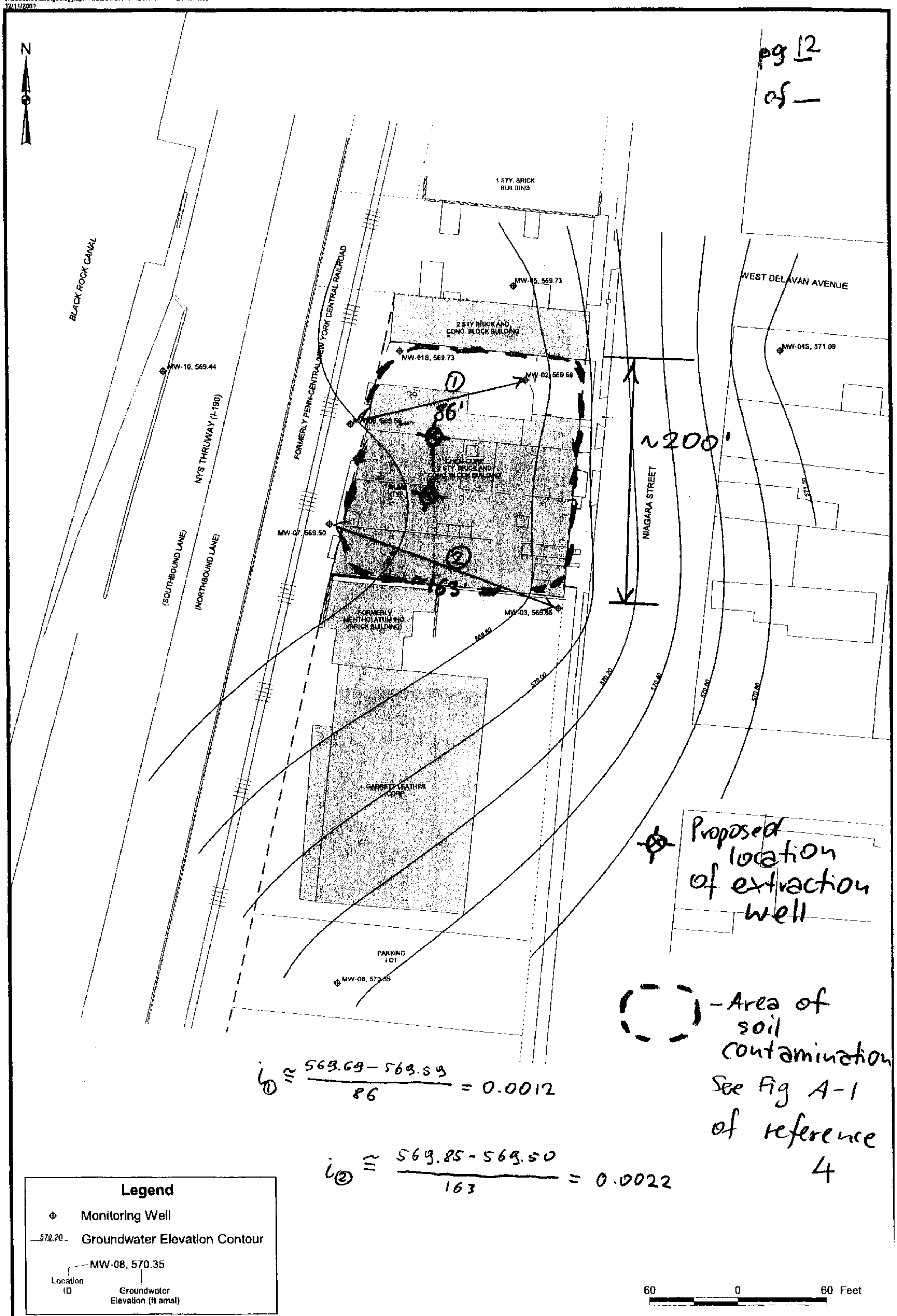
J:\35890.00\GIS\geology.apr 11/02/01 GROUNDWATER ELEVATIONS
12/11/2001



URS

CHEM CORE
GROUNDWATER POTENTIOMETRIC SURFACE MAP (NOVEMBER 2, 2001)

FIGURE 3-5

J:\35690.00\GIS\geology.apr 11/16/01 GROUNDWATER ELEVATIONS
12/11/2001

$$i_{①} \cong \frac{569.43 - 569.23}{86} = 0.0023$$

$$i_{②} \cong \frac{569.58 - 569.15}{163} = 0.0026$$

Legend

- ⌖ Monitoring Well
- _570.20_ Groundwater Elevation Contour
- MW-08, 569.85 — Location ID / Groundwater Elevation (ft amsl)

60 0 60 Feet

URS	CHEM CORE GROUNDWATER POTENTIOMETRIC SURFACE MAP (NOVEMBER 15, 2001)	FIGURE 3-6

pg 14
of —

Groundwater Contamination

Optimal Capture and Containment

Steven M. Gorelick
R. Allan Freeze
David Donohue
Joseph F. Keely

Reference 2

LEWIS PUBLISHERS
Boca Raton Ann Arbor London Tokyo

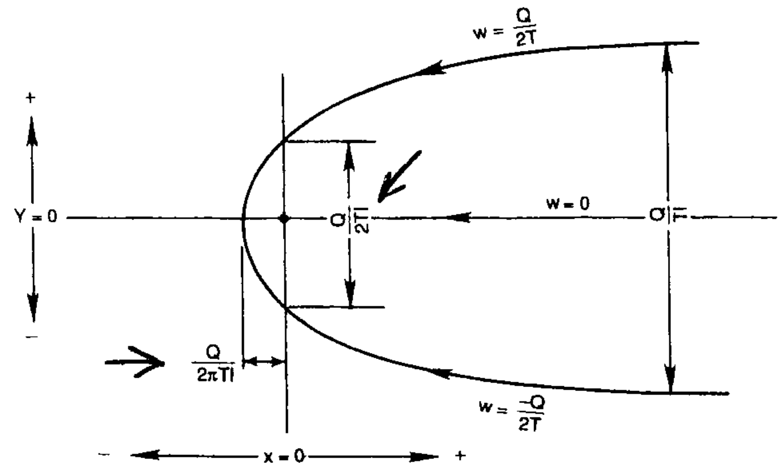


Figure 12. Equation for the dividing streamlines separating the capture zone of a single well from the rest of an aquifer.

and no flow tubes (or contaminants) can slip between the extraction wells. For two or three equally spaced wells, located along a line perpendicular to the regional gradient, and all pumping at the same rate, Javandel and Tsang provide the recommended spacings listed in the right-hand column of Table 5.

The design methodology for a one-, two-, or three-well extraction system using Table 5 involves a trial-and-error procedure with a set of alternative well networks. One tries to identify the lowest cost network that will meet the following specifications, given measured values for aquifer transmissivity, T, and regional hydraulic gradient, I:

1. The capture-zone geometry, as indicated by the values given in Table 5 for the distance between dividing streamlines, must be adequate to encompass the known boundaries of the contaminant plume.
2. The pumping rate, Q, to be applied at each of the wells, must not create drawdowns in excess of any constraints on the available drawdown at the wells.
3. The distances between the wells must be equal to or less than the recommended distances given in Table 5.

It must be emphasized that use of Table 5 to design remedial well networks will *not* lead to an optimal design. The limitations on the analytical solutions on which the table is based are too severe. It will provide a design that works for a pre-specified number of wells, all on a

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pg 16
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McGRAW-HILL BOOK COMPANY

New York
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Mexico
Montreal
New Delhi
Panama
Paris
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Singapore
Sydney
Tokyo
Toronto

Reference 3

JACOB BEAR

Department of Civil Engineering
Technion—Israel Institute of Technology
Haifa
Israel

Hydraulics of Groundwater

By integrating (8-1) from r_w to R, we obtain

$$s_w = H - h_w = \phi(R) - \phi(r_w) = (Q_w/2\pi T)\ln(R/r_w) \tag{8-4}$$

Between any two distances r_1 and $r_2(>r_1)$, we obtain

$$\phi(r_2) - \phi(r_1) = s(r_1) - s(r_2) = (Q_w/2\pi T)\ln(r_2/r_1) \tag{8-5}$$

Equation (8-5) is called the Thiem equation (Thiem, 1906).

Between any two distances r and R, we obtain

$$s(r) = \phi(R) - \phi(r) = (Q_w/2\pi T)\ln(R/r) \tag{8-6}$$

By dividing (8-3) by (8-4), we obtain

$$\phi(r) - h_w = (H - h_w)\frac{\ln(r/r_w)}{\ln(R/r_w)} \tag{8-7}$$

showing that the shape of the curve $\phi = \phi(r)$, given h_w and H at r_w and R, respectively, is independent of Q_w and T.

The distance R in (8-4), (8-6), and (8-7), where the drawdown is zero, is called the *radius of influence of the well*. Since we have established above that steady flow cannot prevail in an infinite aquifer, the distance R should be interpreted as a parameter which indicates the distance beyond which the drawdown is negligible, or unobservable. In general, this parameter has to be estimated from past experience. Fortunately, R appears in (8-6) in the form of $\ln R$ so that even a large error in estimating R does not appreciably affect the drawdown determined by (8-6). The same observation is true also for another parameter—the radius of the well r_w (Sec. 8-1).

Various attempts have been made to relate the radius of influence, R, to well, aquifer, and flow parameters in both steady and unsteady flow in confined and phreatic aquifers. Some relationships are purely empirical, others are semi-empirical. For example (Bear, Zaslavsky, and Irmay, 1968).

Semi-empirical formulas are

Lembke (1886, 1887): $R = H(K/2N)^{1/2}$, (8-8)

Weber (Schultze, 1924): $R = 2.45\,(HKt/n_e)^{1/2}$, (8-9)

Kusakin (Aravin and Numerov, 1953): $R = 1.9\,(HKt/n_e)^{1/2}$ (8-10)

Empirical formulas are

Siechardt (Chertousov, 1962): $R = 3000 s_w K^{1/2}$, (8-11)

Kusakin (Chertousov, 1949): $R = 575 s_w (HK)^{1/2}$ (8-12)

where R, s_w (= drawdown in pumping well), and H are in meters and K in meters per second.

In phreatic aquifers (Sec. 8-3) N, H, and n_e represent accretion from precipitation, the initial thickness of the saturated layer, and the specific yield (or effective porosity) of the aquifer, respectively. In confined aquifers, H and n_e have to be pg 18 of —

Reference 4

FEASIBILITY STUDY REPORT

CHEM-CORE SITE

SITE #9-15-176

BUFFALO, NEW YORK

Prepared for:

NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

WORK ASSIGNMENT D003825-29

FINAL

Prepared by:

URS CORPORATION GROUP CONSULTANTS

282 DELAWARE AVENUE

BUFFALO, NEW YORK 14202

NOVEMBER 2002

STATE OF NEW
JAMES A. LANZO
No. 65478
LICENSED PROFESSIONAL

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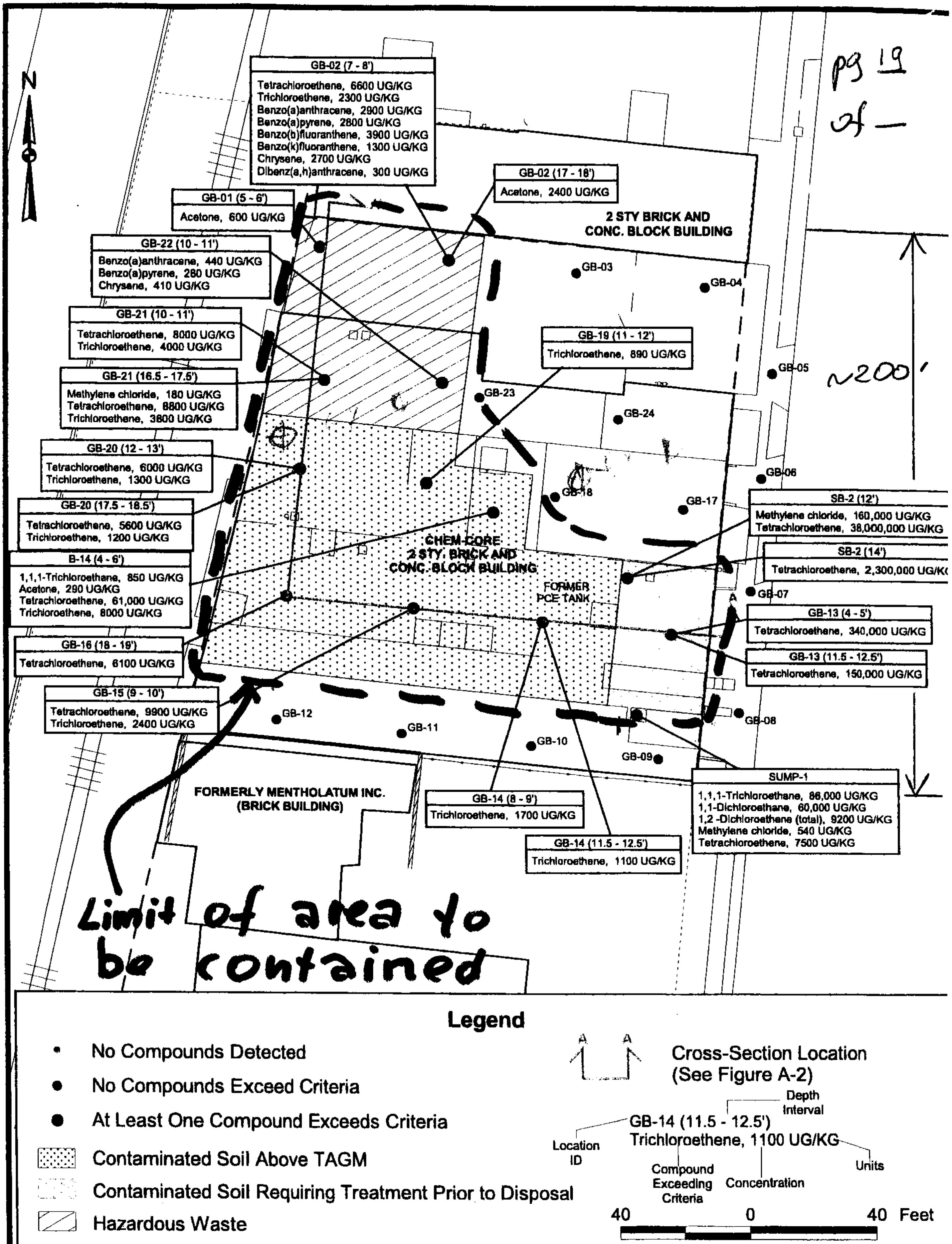


J:\35690.00\GIS\chemical.apr CONTAMINATED SOIL
10/17/2002

URS	CHEM CORE CONTAMINATED SOIL	FIGURE A-1

APPENDIX 2C

GROUNDWATER CONCENTRATIONS AND DISCHARGE CRITERIA

BUFFALO SEWER AUTHORITY

WASTEWATER TREATMENT PLANT

BUFFALO SEWER AUTHORITY CORPORATE SEAL 1935

Anthony A. Hazzan
General Manager

Salvatore J. LoTempio
Treatment Plant Superintendent

Anthony J. Barone
Director of Sewer Maintenance

December 9, 2004

RECEIVED URS
DEC 13 2004
JOB # __________

Mr. James Caruso
URS Corporation
77 Goodell Street
Buffalo, New York 14203

Re: Discharge request

Dear Mr. Caruso:

Based on information and analytical data provided by URS, the Buffalo Sewer Authority will accept the anticipated discharge of approximately 14,400 gallons of wastewater daily from a remediation project at the former Chemcore site on Niagara Street. This discharge will be accepted after pretreatment by air stripping. If air stripping does not meet BSA discharge limits, then carbon filter treatment must be included.

Please fill out a BPDES permit application and return in a timely manner to insure the permit is issued before the start of discharge.

On another matter, a BPDES permit will be issued for the continued discharge of wastewater from the Sovereign facility upon completion of a BPDES permit application.

Should you have any questions, you may contact James Overholt at extension 255.

Very truly yours,

BUFFALO SEWER AUTHORITY

Anthony A. Hazzan
General Manager

By: Leslie Sedita
Leslie Sedita
Industrial Waste Administrator
Industrial Waste Section

cc: S. LoTempio
wp\jo\chemcoredisc.ltr

Foot of West Ferry • 90 West Ferry Street
Buffalo, New York 14213-1799
Phone: 716-883-1820

Jim Caruso
12/13/2004 10:30 AM

To: Craig Pawlewski/Buffalo/URSCorp@URSCORP
cc:
Subject: Re: Chemcore Discharge

JIM CARUSO
PROJECT MANAGER
URS CORP.
77 GOODELL ST.
BUFFALO NY 14203
TEL: (716) 856-5636
DIRECT: (716) 923-1107
FAX: (716) 856-2545
jim_caruso@urscorp.com
----- Forwarded by Jim Caruso/Buffalo/URSCorp on 12/13/2004 10:31 AM -----

Jim Caruso
11/23/2004 03:02 PM

To: lsedita@sa.ci.buffalo.ny.us
cc: overholt@sa.ci.buffalo.ny.us
Subject: Re: Chemcore Discharge

Leslie and Jim,
The updated spreadsheet for the proposed air stripped treated wastewater discharge from the Chemcore site located at Niagara St. and W. Delavan is attached.
We have developed a spreadsheet listing the pollutants that were detected with their respective concentrations and the proposed pretreated limits.
You will note that the acetone concentration is the only change.
The limits are based on 14400 gallons per day.
Please call if you have any concerns or questions.

ChemcoreWater discharge jc.

JIM CARUSO
PROJECT MANAGER
URS CORP.
77 GOODELL ST.
BUFFALO NY 14203
TEL: (716) 856-5636
DIRECT: (716) 923-1107
FAX: (716) 856-2545
jim_caruso@urscorp.com
----- Forwarded by Jim Caruso/Buffalo/URSCorp on 11/02/2004 02:57 PM -----

NYSDEC Chem-Core Site

Summary of Groundwater Analytical Results and Proposed Discharge Limits

Maximum Discharge Rate: 10 gpm 14400 gallons/day
Average Discharge Rate: 2 - 6 gpm

Parameter	Units	Minimum	Maximum	Average	Proposed Concentration Based Discharge Limits (ug/L)	Proposed Mass Based Discharge Limits (lbs/day)
Volatiles						
1,1,1-Trichloroethane	UG/L	15	9000	1882	155	0.0186
1,1,2-Trichloroethane	UG/L	3	3	3	155	0.0186
1,1-Dichloroethane	UG/L	10	5300	1376	50	0.0060
1,1-Dichloroethene	UG/L	1	1000	261	30	0.0036
1,2-Dichlorobenzene	UG/L	2	2	2	50	0.0060
1,2-Dichloroethane	UG/L	14	160	70.2	30	0.0036
1,2-Dichloropropane	UG/L	7	10	8.5	50	0.0060
4-Methyl-2-pentanone	UG/L	2	3	2.5	50	0.0060
Acetone	UG/L	11	100	55.5	100	0.0120
Benzene	UG/L	3	52	24.29	50	0.0060
Carbon disulfide	UG/L	2	2	2	none	
Chloroform	UG/L	6	180	71.33	40	0.0048
cis-1,2-Dichloroethene	UG/L	49	30000	9142	30	0.0036
Ethylbenzene	UG/L	0.51	8	5.17	150	0.0180
Methyl tert-butyl ether	UG/L	1	1	1	20	0.0024
Methylene chloride	UG/L	5	350	127.5	200	0.0240
Tetrachloroethene	UG/L	2	21000	3041	40	0.0048
Toluene	UG/L	1	2200	653	70	0.0084
trans-1,2-Dichloroethene	UG/L	2	250	51.55	30	0.0036
Trichloroethene	UG/L	5	14000	2148	140	0.0168
Vinyl chloride	UG/L	7	10000	2643	100	0.0120
Xylene (Total)	UG/L	6.3	180	67.83	40	0.0048
Semivolatiles						
2-Methylphenol	UG/L	3	3	3	80	0.0096
4-Methylphenol	UG/L	3	3	3	80	0.0096
bis(2-Ethylhexyl)phthalate	UG/L	3	14	8.5	30	0.0036
Caprolactam	UG/L	3	3	3	none	

NYSDEC Chem-Core Site

Summary of Groundwater Analytical Results and Proposed Discharge Limits

Maximum Discharge Rate: 10 gpm 14400 gallons/day
Average Discharge Rate: 2 - 6 gpm

Parameter	Units	Minimum	Maximum	Average	Proposed Concentration Based Discharge Limits (ug/L)	Proposed Mass Based Discharge Limits (lbs/day)
Filtered Metals						
Iron	UG/L	67.5	916	271.4	none	
Metals						
Aluminum	UG/L	91.5	2180	670.5	none	
Arsenic	UG/L	2.1	6.8	4.45	14	0.0017
Barium	UG/L	54.3	124	98.56	250	0.0300
Beryllium	UG/L	0.3	0.3	0.3	none	
Calcium	UG/L	128000	171000	152000	none	
Chromium	UG/L	1.5	16.4	7.53	33	0.0040
Cobalt	UG/L	1.3	3.7	2.2	none	
Copper	UG/L	1	10.9	4.55	20	0.0024
Iron	UG/L	336	6480	2598	none	
Magnesium	UG/L	17200	126000	66400	none	
Manganese	UG/L	35.3	131	83.3	none	
Nickel	UG/L	2.8	61.3	20	125	0.0150
Potassium	UG/L	5660	12700	8456	none	
Silver	UG/L	1.6	3	2.3	6	0.0007
Sodium	UG/L	159000	228000	188000	none	
Thallium	UG/L	6.6	11.4	9	none	
Vanadium	UG/L	0.72	23.7	8.13	none	
Zinc	UG/L	4.7	49.1	20.66	100	0.0120
Miscellaneous Parameters						
Cyanide	UG/L	3.2	3.2	3.2	6	0.0007
Hardness	MG/L	550	730	635	none	

APPENDIX 2D

AIR STRIPPER MODEL

ShallowTray®
low profile air strippers

System Performance Estimate

Client and Proposal Information:

Chem-Core
Buffalo, NY
Sheet 1

Series chosen:	1300-P	
Water Flow Rate:	10 gpm	2.3 m3/hr
Air Flow Rate:	150 scfm	260 m3/hr
Water Temp:	50 °F	10 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	113 :1	
Safety Factor:	20%	

Contaminant	Untreated Influent Effluent Target	SELECTED MODEL Model P 1311 Effluent lbs/hr ppmv %removal	Model P 1321 Effluent lbs/hr ppmv %removal	Model P 1331 Effluent lbs/hr ppmv %removal	Model P 1341 Effluent lbs/hr ppmv %removal	Model P 1351 Effluent lbs/hr ppmv %removal
1,1,1-Trichloroethane	9000 ppb	579 ppb	37 ppb	2 ppb	<1 ppb	<1 ppb
Solubility 4,400 ppm	ppb	0.04 13.34	0.04 14.20	0.05 14.25	0.05 14.26	0.05 14.26
Mwt 133.41		93.57%	99.59%	99.97%	100.00%	100.00%
1,1,2-Trichloroethane	3 ppb	2 ppb	1 ppb	1 ppb	<1 ppb	<1 ppb
Solubility 4,500 ppm	ppb	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Mwt 133.41		29.85%	50.78%	65.47%	75.78%	83.01%
1,1- Dichloroethane	5300 ppb	408 ppb	31 ppb	2 ppb	<1 ppb	<1 ppb
Solubility 5,500 ppm	ppb	0.02 10.45	0.03 11.25	0.03 11.31	0.03 11.32	0.03 11.32
Mwt 98.96		92.29%	99.41%	99.95%	100.00%	100.00%
1,1-Dichloroethylene	1000 ppb	38 ppb	1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 500 ppm	ppb	0.00 2.10	0.01 2.18	0.01 2.18	0.01 2.18	0.01 2.18
Mwt 96.94		96.17%	99.85%	99.99%	100.00%	100.00%
1,2-Dichlorobenzene	2 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 100 ppm	ppb	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Mwt 147		74.21%	93.35%	98.28%	99.56%	99.89%
1,2-Dichloroethane	160 ppb	87 ppb	47 ppb	25 ppb	14 ppb	7 ppb
Solubility 550 ppm	ppb	0.00 0.16	0.00 0.24	0.00 0.29	0.00 0.31	0.00 0.33
Mwt 98.96		45.80%	70.63%	84.08%	91.37%	95.32%
1,2-Dichloropropane	10 ppb	2 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 2,700 ppm	ppb	0.00 0.01	0.00 0.02	0.00 0.02	0.00 0.02	0.00 0.02
Mwt 113		77.37%	94.88%	98.84%	99.74%	99.94%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
MIBK	3 ppb	3 ppb	3 ppb	3 ppb	3 ppb	3 ppb
Solubility 17,000 ppm	ppb	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Mwt 100.2		2.13%	4.21%	6.24%	8.23%	10.19%
Due to its high solubility, MIBK removal is difficult to predict. Call your NEEP representative for more information						
Acetone	100 ppb	100 ppb	100 ppb	100 ppb	100 ppb	100 ppb
Solubility 50,000 ppm	ppb	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Mwt 58.08		0.00%	0.00%	0.00%	0.00%	0.00%
Due to its miscibility with water, acetone removal is difficult to predict. Call your NEEP representative for more information						
Benzene	52 ppb	7 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 1,780 ppm	ppb	0.00 0.12	0.00 0.14	0.00 0.14	0.00 0.14	0.00 0.14
Mwt 78.12		86.59%	98.20%	99.76%	99.97%	100.00%
Chloroform	180 ppb	19 ppb	2 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 8,000 ppm	ppb	0.00 0.29	0.00 0.32	0.00 0.32	0.00 0.32	0.00 0.32
MW 119.38		89.57%	98.91%	99.89%	99.99%	100.00%
cis-1,2-DCE	30000 ppb	5084 ppb	862 ppb	146 ppb	25 ppb	4 ppb
Solubility 8,690 ppm	ppb	0.13 54.32	0.15 63.53	0.15 65.09	0.15 65.35	0.15 65.40
Mwt 96.94		83.05%	97.13%	99.51%	99.92%	99.99%
Total ppb	45810 ppb	6330 ppb	1087 ppb	281 ppb	142 ppb	115 ppb
Total VOC lbs/hr - ppmv		0.20 80.79	0.22 91.87	0.23 93.61	0.23 93.91	0.23 93.97
Total		86.18%	97.63%	99.39%	99.69%	99.75%

This report has been generated by ShallowTray Modeler software version 6.12e. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. North East Environmental Products, Inc. (NEEP Systems) is not responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment.

Report Generated: 12/9/2004 Modeler V6.12e 5/24/2001

☐ = BELOW DISCHARGE LIMIT

ShallowTray®

low profile air strippers

System Performance Estimate

Client and Proposal Information:

Chem-Core
Buffalo, NY
Sheet 2

Series chosen:	1300-P	
Water Flow Rate:	10 gpm	2.3 m3/hr
Air Flow Rate:	150 scfm	260 m3/hr
Water Temp:	50 °F	10 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	113 :1	
Safety Factor:	20%	

Contaminant	Untreated Influent Effluent Target	SELECTED MODEL Model P 1311 Effluent lbs/hr ppmv %removal	Model P 1321 Effluent lbs/hr ppmv %removal	Model P 1331 Effluent lbs/hr ppmv %removal	Model P 1341 Effluent lbs/hr ppmv %removal	Model P 1351 Effluent lbs/hr ppmv %removal
Ethyl Benzene Solubility 152 ppm Mwt 106.16	8 ppb ppb	<1 ppb 0.00 0.01 87.88%	<1 ppb 0.00 0.02 98.53%	<1 ppb 0.00 0.02 99.82%	<1 ppb 0.00 0.02 99.98%	<1 ppb 0.00 0.02 100.00%
MTBE Solubility 43,000 ppm Mwt 88.15	1 ppb ppb	<1 ppb 0.00 0.00 35.22%	<1 ppb 0.00 0.00 58.03%	<1 ppb 0.00 0.00 72.81%	<1 ppb 0.00 0.00 82.39%	<1 ppb 0.00 0.00 88.59%
Methylene Chloride Solubility 20,000 ppm Mwt 84.9	350 ppb ppb	86 ppb 0.00 0.66 75.37%	21 ppb 0.00 0.82 93.93%	5 ppb 0.00 0.86 98.51%	1 ppb 0.00 0.87 99.63%	<1 ppb 0.00 0.87 99.91%
Tetrachloroethylene Solubility 150 ppm Mwt 165.83	21000 ppb ppb	809 ppb 0.10 25.73 96.15%	31 ppb 0.11 26.72 99.85%	1 ppb 0.11 26.76 99.99%	<1 ppb 0.11 26.76 100.00%	<1 ppb 0.11 26.76 100.00%
Toluene Solubility 515 ppm Mwt 92.13	2200 ppb ppb	333 ppb 0.01 4.28 84.88%	50 ppb 0.01 4.93 97.71%	8 ppb 0.01 5.03 99.65%	1 ppb 0.01 5.04 99.95%	<1 ppb 0.01 5.05 99.99%
t-1,2-Dichloroethylene Solubility 600 ppm Mwt 96.94	250 ppb ppb	20 ppb 0.00 0.50 91.98%	2 ppb 0.00 0.54 99.36%	<1 ppb 0.00 0.54 99.95%	<1 ppb 0.00 0.55 100.00%	<1 ppb 0.00 0.55 100.00%
Trichloroethylene Solubility 1100 ppm Mwt 131.5	14000 ppb ppb	680 ppb 0.07 21.41 95.14%	33 ppb 0.07 22.45 99.76%	2 ppb 0.07 22.50 99.99%	<1 ppb 0.07 22.50 100.00%	<1 ppb 0.07 22.50 100.00%
Vinyl Chloride Solubility 1100 ppm Mwt 62.5	10000 ppb ppb	85 ppb [illegible] 33.53 99.15%	<1 ppb 0.05 33.81 99.99%	<1 ppb 0.05 33.82 100.00%	<1 ppb 0.05 33.82 100.00%	<1 ppb 0.05 33.82 100.00%
Xylenes Solubility 175 ppm Mwt 106	180 ppb ppb	23 ppb 0.00 0.31 86.94%	3 ppb 0.00 0.35 98.30%	<1 ppb 0.00 0.36 99.78%	<1 ppb 0.00 0.36 99.97%	<1 ppb 0.00 0.36 100.00%
Total ppb	47989 ppb	2038 ppb	142 ppb	16 ppb	3 ppb	1 ppb
Total VOC lbs/hr - ppmv		0.23 86.44	0.24 89.65	0.24 89.89	0.24 89.92	0.24 89.92
Total		95.75%	99.70%	99.97%	99.99%	100.00%

Report Generated: 12/9/2004 Modeler V6.12e 5/24/2001

☐ = BELOW DISCHARGE LIMIT

APPENDIX 2E

AIR EMISSIONS CALCULATIONS

CALCULATION COVER SHEET

Client: NYSDEC Project Name: Chem-Core

Project/Calculation Number: 11173519

Title: Air Discharge and Treatment

Total Number of Pages (including cover sheet): 7

Total Number of Computer Runs: 0

Prepared by: Donald A. McCall Date: 12.7.04

Checked by: Craig W. Pawlewski Date: 12/9/04

Description and Purpose:

Determine Air Discharge and Treatment requirements.

Design Basis/References/Assumptions

See Attached

Remarks/Conclusions/Results:

See Attached

Calculation Approved by: [signature] 12/9/04

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

JOB NO.: 11173519

MADE BY: D. McCall DM DATE: 12-22-04

CHECKED BY: CWP DATE: 12/22/04

PROJECT: NYSDEC Chem-Core Site

SUBJECT: Air Discharge and Treatment

Problem: Estimate the contaminant emissions in the air discharge from the proposed groundwater treatment system, compare the emissions to the appropriate standards, and determine the treatment needed for air discharge to meet the standards.

References:

1. *Guidelines for the Control of Toxic Ambient Air Contaminants*, New York State Department of Environmental Conservation, DAR-1, Air Guide 1, Issued November 12, 1997.

2. *NIOSH Pocket Guide to Chemical Hazards*, URS on-line health and safety website, November 9, 2004.

3. *2004 TLVs and BEIs*, ACGIH, 2004.

Assumptions:

1. The only source of emissions evaluated will be the off-gas from the air stripper. Other minor sources of air emissions (leakage, tank vents, etc. are assumed to be minimal).

2. As a worst case, calculations are based on the maximum contaminant concentration detected in any of the groundwater monitoring wells. Average contaminant concentrations also are shown. Actual contaminant concentrations are expected to fall somewhere between the two numbers.

3. Contaminant emissions are calculated based on a groundwater collection and treatment rate of 10 gpm. The actual rate may be less, which will lead to a corresponding decrease in the contaminant emissions to the air.

4. The effectiveness of air stripping varies for all contaminants. As a conservative assumption for these calculations, it is assumed that 100% of the contaminants in the influent groundwater are removed and discharged to the air.

5. The height of the discharge stack from the treatment system is assumed to be a minimum of 1.5 times the height of the building. Thus, in accordance with Ref. 1, II.A.2, building cavity impacts will not be considered. However, based on this stack height, it as also assumed that there will be no dilution due to plume rise or momentum flux.

6. The calculations below are for 1,1,1-trichloroethane, and generally follow the order of the information presented on the attached spreadsheet, Table 1. Table 1 includes the same calculations for all detected contaminants.

---

1. **Determine Contaminant Emissions**

The major source of contaminant emissions from the groundwater treatment system will be the off-gas from the air stripper. Table 1 shows the Minimum, Maximum, and Average contaminant concentrations detected in the groundwater from recent onsite sampling.

2. **Maximum / Average Discharge**

Assuming that 100% of contaminants are stripped from the groundwater, and based on a flow rate of 10 gpm, the contaminant loading to the atmosphere is calculated:

(9000 μg/L) x (3.785 L / gal) x (1 g / $10^6 \mu$g) x (1 lb / 454 g) x (10 gal/min) x (60 min/hr) = 0.045 lb/hr of 1,1,1-TCA.

Total volatile emissions were calculated to be 0.47 lb/hr based on maximum numbers. The total based on average concentrations is only 0.04 lb/hr.

3. **Methodology**

Knowing the contaminant emission rate, the maximum annual impacts (i.e., the ambient concentration) for each contaminant is calculated. The annual impact is then compared to the ambient Annual-average-based Guideline Concentration (AGC) for each contaminant.

Likewise, short-term impacts (1-hour) are determined and compared to Short-term ambient Guideline Concentrations (SGCs).

4. **Calculate the Actual Annual Impact (C_a)**

The discharge stack is considered to be a standard point source. Reference 1, Section III.A, offers the following equation to calculate the annual concentration:

$$C_a = (6.0)(Q_a)/(h_e^{2.25})$$

Where:

C_a = the maximum actual Annual Impact (μg/m^3)
Q_a = source emission rate (lb/yr),
h_e = effective stack height, which in this case is assumed to be 15 feet (ft)

Now, substituting into the equation:

$$C_a = (6)(0.045 \text{ lb/hr} \times 8760 \text{ hr/yr})/(15^{2.25})$$

$$C_a = 5.34 \ \mu g/m^3 \text{ for 1,1,1-TCA}$$

Since the system is assumed to operate 365 days, 24 hours per day, the actual impact is the same as the potential impact.

5. **Compare the Annual Impact to the AGC**

Ref. 1 gives an Annual Guideline Concentration (AGC) for 1,1,1-TCA of 1,000 μg/m^3.

Comparing the calculated ambient concentration (C_a) to the guideline concentration shows that the even based on maximum concentrations, the emissions of 1,1,1-TCA are expected to meet the guidelines, and no additional treatment is required.

Table 1 shows the calculations for the other organic parameters detected in the groundwater. Vinyl chloride requires approximately 98% removal in order to meet the guidelines for ambient concentrations. Table 1 also shows the calculations based on the average contaminant concentrations.

6. **Calculate the Maximum Short-term Impact from the Source Area**

Reference 1, Section III.A.5, offers the following equation to calculate the maximum short-term impact:

$$C_{ST} = C_p * 65$$

Where:

C_{ST} = the maximum Short-term Impact ($\mu g/m^3$)

C_p = maximum potential Annual Impact ($\mu g/m^3$); in this case, C_p is equal to the C_a calculated earlier.

Substituting into the equation:

$$C_{ST} = 5.34\ \mu g/m^3 * 65$$

$$C_{ST} = 347.1\ \mu g/m^3 \text{ for 1,1,1-TCA}$$

7. **Compare the Maximum Short-term Impact to the SGC**

Ref. 1 gives a Short-term Guideline Concentration (SGC) of 68,000 $\mu g/m^3$ for 1,1,1-TCA.

JOB NO.: 11173519

MADE BY: D. McCall DATE: 12-22-04
CHECKED BY: CWP DATE: 12/22/04

PROJECT: **NYSDEC Chem-Core Site**
SUBJECT: **Air Discharge and Treatment**

Comparing the calculated short-term concentration to the guideline concentration shows that the calculated short-term 1,1,1-TCA concentration is lower than the guideline concentration.

Table 1 shows the calculations for the other organic parameters detected in the groundwater. As shown on the table, none of the contaminants are expected to exceed any short-term guideline concentrations.

Several of the contaminants detected at the Chem-core site do not have SGC values published in Ref. 1. In those cases, in accordance with the procedures outlined in Ref. 1, IV.A.2.b.1. the SGC was taken to be the smaller of the TLV (Ref. 3) or the REL (Ref. 2) divided by 4.2.

8. HCl Emissions

The method typically used for the treatment of chlorinated organic compounds is incineration, whether by thermal or catalytic oxidation. A concern of this treatment is the end product of hydrochloric acid that is formed during incineration:

$$C_2H_3Cl_3 + O_2 = H_2O + CO_2 + HCl$$

For every mole of 1,1,1-TCA incinerated, 3 moles of HCl are produced. Converting to lb/hr:

(0.045 lb/hr 1,1,1-TCA) x (1 lb-mol / 133.4 lb) x (3 mol HCl / mol 1,1,1-TCA) x (36.5 lb HCl / lb-mol) = 0.037 lb/hr of HCl produced.

As shown on Table 1, the total HCl from all chlorinated compounds is estimated to be 0.357 lb/hr, based on maximum concentrations. Based on previous evaluations at other site, an HCl limit of 4 lb/hr has been provided by the DEC. Therefore, the quantity of HCl emissions at this site should be acceptable and not require any further treatment.

NYSDEC Chem-Core Site

Summary of Air Discharge and Treatment Requirements

Maximum Water Discharge Rate (gpm): 10 or 5004 lb/hr
Average Water Discharge Rate (gpm): 4 or 2001.6 lb/hr
Assumed Stack Height (ft): 15 minimum

Parameter	Units	Minimum	Maximum	Average	Maximum Discharge (lb/h)	Average Discharge (lb/h)	AGC ($\mu g/m^3$)	Maximum C_a ($\mu g/m^3$)	Removal to Attain AGC - Maximum	Average C_a ($\mu g/m^3$)	Removal to Attain AGC - Average	SGC ($\mu g/m^3$)	Maximum C_{ST} ($\mu g/m^3$)	Removal to Attain SGC - Maximum	Average C_{ST} ($\mu g/m^3$)	Removal to Attain SGC - Average	Maximum HCl Emissions (lb/h)	Average HCl Emissions (lb/h)
Volatiles																		
1,1,1-Trichloroethane	UG/L	15	9000	1882	4.50E-02	3.77E-03	1,000	5.34E+00	0.00%	4.47E-01	0.00%	68,000	3.47E+02	0.00%	2.91E+01	0.00%	3.70E-02	3.09E-03
1,1,2-Trichloroethane	UG/L	3	3	3	1.50E-05	6.00E-06	1.4	1.78E-03	0.00%	7.13E-04	0.00%	10,714	1.16E-01	0.00%	4.63E-02	0.00%	1.23E-05	4.93E-06
1,1-Dichloroethane	UG/L	10	5300	1376	2.65E-02	2.75E-03	0.63	3.15E+00	79.98%	3.27E-01	0.00%	95,238	2.05E+02	0.00%	2.12E+01	0.00%	1.96E-02	2.03E-03
1,1-Dichloroethene	UG/L	1	1000	261	5.00E-03	5.22E-04	70	5.94E-01	0.00%	6.20E-02	0.00%	4,721	3.86E+01	0.00%	4.03E+00	0.00%	3.77E-03	3.93E-04
1,2-Dichlorobenzene	UG/L	2	2	2	1.00E-05	4.00E-06	360	1.19E-03	0.00%	4.75E-04	0.00%	30,000	7.72E-02	0.00%	3.09E-02	0.00%	4.97E-06	1.99E-06
1,2-Dichloroethane	UG/L	14	160	70.2	8.00E-04	1.40E-04	0.038	9.50E-02	60.00%	1.67E-02	0.00%	952	6.18E+00	0.00%	1.08E+00	0.00%	5.90E-04	1.04E-04
1,2-Dichloropropane	UG/L	7	10	8.5	5.00E-05	1.70E-05	4	5.94E-03	0.00%	2.02E-03	0.00%	51,000	3.86E-01	0.00%	1.31E-01	0.00%	3.23E-05	1.10E-05
4-Methyl-2-pentanone	UG/L	2	3	2.5	1.50E-05	5.00E-06	3,000	1.78E-03	0.00%	5.94E-04	0.00%	31,000	1.16E-01	0.00%	3.86E-02	0.00%	0.00E+00	0.00E+00
Acetone	UG/L	11	100	55.5	5.00E-04	1.11E-04	28,000	5.94E-02	0.00%	1.32E-02	0.00%	180,000	3.86E+00	0.00%	8.57E-01	0.00%	0.00E+00	0.00E+00
Benzene	UG/L	3	52	24.29	2.60E-04	4.86E-05	0.13	3.09E-02	0.00%	5.77E-03	0.00%	1,300	2.01E+00	0.00%	3.75E-01	0.00%	0.00E+00	0.00E+00
Carbon disulfide	UG/L	2	2	2	1.00E-05	4.00E-06	700	1.19E-03	0.00%	4.75E-04	0.00%	6,200	7.72E-02	0.00%	3.09E-02	0.00%	0.00E+00	0.00E+00
Chloroform	UG/L	6	180	71.33	9.00E-04	1.43E-04	0.043	1.07E-01	59.77%	1.69E-02	0.00%	150	6.95E+00	0.00%	1.10E+00	0.00%	8.26E-04	1.31E-04
cis-1,2-Dichloroethene	UG/L	49	30000	9142	1.50E-01	1.83E-02	1,900	1.78E+01	0.00%	2.17E+00	0.00%	188,821	1.16E+03	0.00%	1.41E+02	0.00%	1.13E-01	1.38E-02
Ethylbenzene	UG/L	0.51	8	5.17	4.00E-05	1.03E-05	1,000	4.75E-03	0.00%	1.23E-03	0.00%	54,000	3.09E-01	0.00%	7.98E-02	0.00%	0.00E+00	0.00E+00
Methyl tert-butyl ether	UG/L	1	1	1	5.00E-06	2.00E-06	3,000	5.94E-04	0.00%	2.38E-04	0.00%	42,930	3.86E-02	0.00%	1.54E-02	0.00%	0.00E+00	0.00E+00
Methylene chloride	UG/L	5	350	127.5	1.75E-03	2.55E-04	2.1	2.08E-01	0.00%	3.03E-02	0.00%	14,000	1.35E+01	0.00%	1.97E+00	0.00%	1.51E-03	2.19E-04
Tetrachloroethene	UG/L	2	21000	3041	1.05E-01	6.08E-03	1	1.25E+01	91.98%	7.22E-01	0.00%	1,000	8.10E+02	0.00%	4.69E+01	0.00%	9.25E-02	5.36E-03
Toluene	UG/L	1	2200	653	1.10E-02	1.31E-03	400	1.31E+00	0.00%	1.55E-01	0.00%	37,000	8.49E+01	0.00%	1.01E+01	0.00%	0.00E+00	0.00E+00
trans-1,2-Dichloroethene	UG/L	2	250	51.55	1.25E-03	1.03E-04	1,900	1.48E-01	0.00%	1.22E-02	0.00%	188,821	9.65E+00	0.00%	7.96E-01	0.00%	9.42E-04	7.77E-05
Trichloroethene	UG/L	5	14000	2148	7.00E-02	4.30E-03	0.5	8.31E+00	93.99%	5.10E-01	1.99%	54,000	5.40E+02	0.00%	3.32E+01	0.00%	5.84E-02	3.58E-03
Vinyl chloride	UG/L	7	10000	2643	5.00E-02	5.29E-03	0.11	5.94E+00	98.15%	6.28E-01	82.48%	180,000	3.86E+02	0.00%	4.08E+01	0.00%	2.92E-02	3.09E-03
Xylene (Total)	UG/L	6.3	180	67.83	9.00E-04	1.36E-04	100	1.07E-01	0.00%	1.61E-02	0.00%	4,300	6.95E+00	0.00%	1.05E+00	0.00%	0.00E+00	0.00E+00
Subtotal Volatiles					0.47	0.04											3.57E-01	3.19E-02
Semivolatiles																		
2-Methylphenol	UG/L	3	3	3	1.50E-05	6.00E-06	52	1.78E-03	0.00%	7.13E-04	0.00%	2,381	1.16E-01	0.00%	4.63E-02	0.00%	0.00E+00	0.00E+00
4-Methylphenol	UG/L	3	3	3	1.50E-05	6.00E-06	52	1.78E-03	0.00%	7.13E-04	0.00%	2,381	1.16E-01	0.00%	4.63E-02	0.00%	0.00E+00	0.00E+00
bis(2-Ethylhexyl)phthalate	UG/L	3	14	8.5	7.00E-05	1.70E-05	0.42	8.31E-03	0.00%	2.02E-03	0.00%	1,190	5.40E-01	0.00%	1.31E-01	0.00%	0.00E+00	0.00E+00
Caprolactam	UG/L	3	3	3	1.50E-05	6.00E-06	12	1.78E-03	0.00%	7.13E-04	0.00%	238	1.16E-01	0.00%	4.63E-02	0.00%	0.00E+00	0.00E+00
Subtotal Semivolatiles					0.0001	0.0000											0.00E+00	0.00E+00

N:\11173519.00000\EXCEL\Design\[air discharge.xls]Sheet1

APPENDIX 2F

GRAVITY DISCHARGE

URS **EXHIBIT 4.7-2**

CALCULATION COVER SHEET

Client: ____________________ Project Name: Chem Core

Project/Calculation Number: 111 73 756. 93000

Title: Gravity Discharge from Treatment Plant

Total Number of Pages (including cover sheet): 6 (5 + cover)

Total Number of Computer Runs: 0

Prepared by: Marek Ostrowski Date: Feb 24, 05

Checked by: CRAIG PAWLEWSKI Date: 2/24/05

Description and Purpose: To verify feasibility of discharging treated water by gravity

---

Design Basis/References/Assumptions See text.

Remarks/Conclusions/Results:

- A 4-inch PVC pipe would be sufficient
- A manhole would be needed at the 90° bend.

Calculation Approved by: [signature] 12/9/04

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

MADE BY: M.O. DATE: Feb 24, 2005
CHKD. BY: CWP DATE: 2/24/2005

PROJECT: Chem-Core
SUBJECT: Gravity Discharge from Treatment Plant

1. PURPOSE

The purpose of this calculation is to verify the feasibility of discharging water by gravity from the proposed ground water treatment plant to the sanitary manholes located near the northeast corner of the two-story building.

2. CALCULATIONS

See attached drawing C-6 of the 50% Design package. Ground elevation at the location of the treatment building is approximately 597 feet. Assume 5 feet minimum cover for frost protection. From that, the elevation of the upgradient pipe invert is 597 - 5 = 592 feet. Elevations of pipe inverts of the sanitary manholes are between 585 and 586 feet. Use 586 feet. The distance between the plant and the manholes is approximately 130 feet. From this, the pipe slope is:

$$S = (592 - 586) / 130 = 0.046$$

Assume PVC pipe. Use roughness coefficient of 0.013 (see attached).

$$n = 0.013$$

Use pipe flowing half-full. Assume the minimum pipe diameter of 4 inches to provide for ease of maintenance.

$$D = 4 \text{ in} = 0.33 \text{ ft}$$

Manning's equation:

$$Q = (1.49 / n)\ A\ R_H^{2/3}\ S^{1/2}$$

For half-full pipe:

$$Q = (1.49/n)\ (\pi D^2/8)\ [(\pi D^2/8)/(\pi D/2)]^{2/3}\ S^{1/2}$$

$$Q = (1.49/n)\ (\pi D^2/8)\ (D/4)^{2/3}\ S^{1/2}$$

$$Q = (1.49/0.013)\ (\pi*0.33^2/8)\ (0.33/4)^{2/3}\ (0.046)^{1/2}$$

$$Q = 115*0.043*0.19*0.21 = 0.20\ ft^3/s = 90\ gpm$$

JOB NO. 111 73 756

MADE BY: M.O. DATE: Feb 24, 2005
CHKD. BY: CWP DATE: 2/24/2005

PROJECT: Chem-Core
SUBJECT: Gravity Discharge from Treatment Plant

Extraction rate from the treatment system has been estimated to be on the order of 1 to 10 gpm. The pump conveying water from the tank to the air stripper is anticipated to operate intermittently, with the flow rate of 10 gpm. Therefore, a 4-inch diameter PVC pipe flowing half full should be sufficient to provide required discharge capacity from the air stripper.

Note: the discharge pipe would make a 90 degree bend at the northwest corner of the two-story building. A manhole would be required at that location.

REMEDIAL DESIGN

CONTRACT DRAWINGS
CONTRACT NO.

FOR THE
CHEM CORE SITE REMEDIAL CONSTRUCTION
NYSDEC SITE 9-15-176
CITY OF BUFFALO, ERIE COUNTY, NEW YORK

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
NEW YORK STATE

Prepared for:

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Erin Crotty, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION

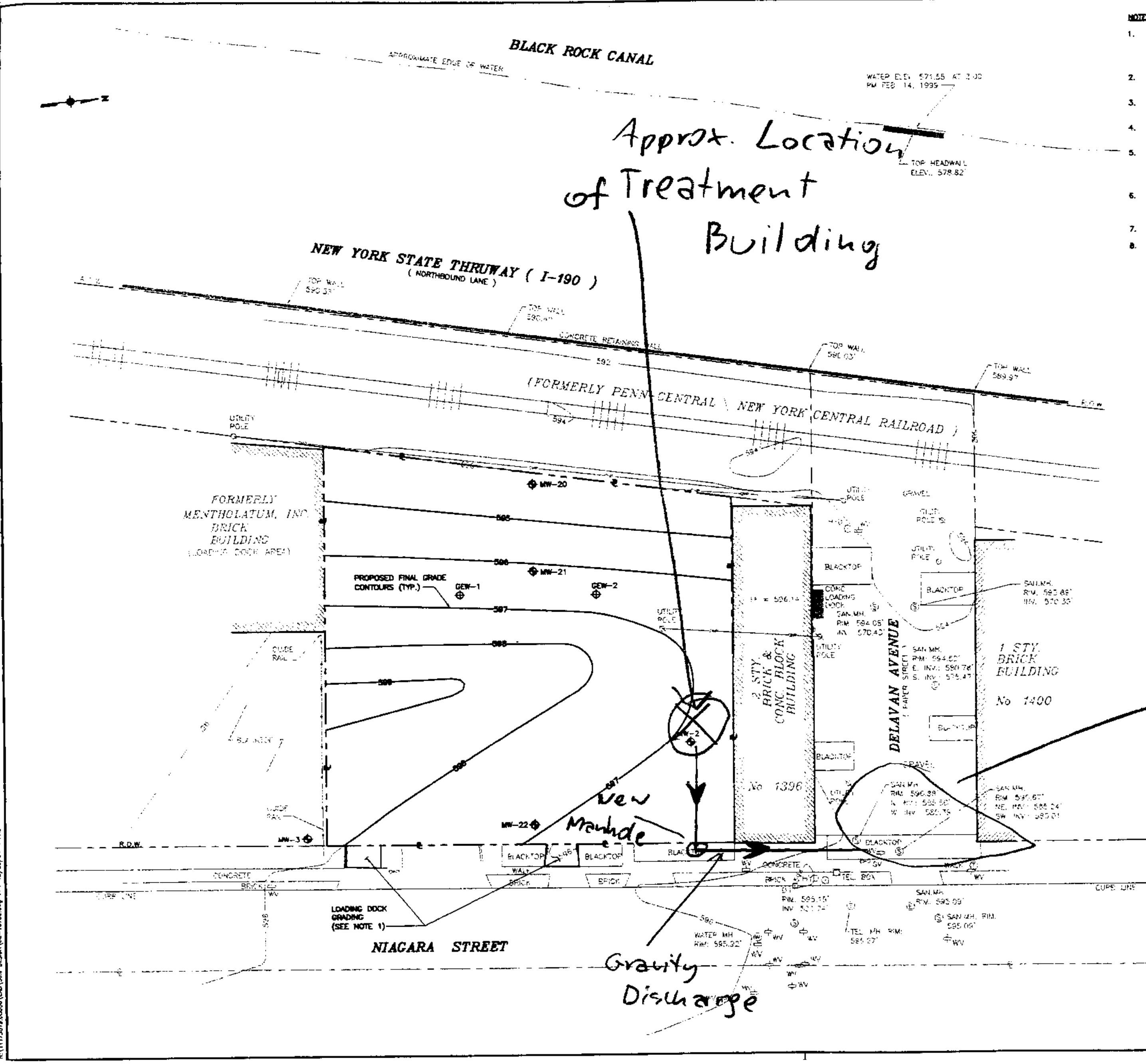
DECEMBER 2004

URS Corporation
New York
77 Goodell Street
Buffalo, New York 14203
(716)856-5636 phone - (716)856-2545 fax

50% DESIGN

3/5

N:\11173559.00000\CAD\50% DESIGN\CC-10669.DWG 1:1 12/6/04-2 PAL



NOTES:

1. LOADING DOCK GRADING: REMOVE CONCRETE SLAB, FILL WITH GENERAL FILL AND COVER WITH THREE (3) INCHES OF COMPACTED GRAVEL PLUS THREE (3) INCHES OF DENSE BINDER MEETING CURRENT NYSDOTSS. MATCH ADJACENT GRADES AND SLOPE 0.5% TOWARD STREET.
2. MINIMUM FINAL GRADE SLOPE SHALL BE 1%. MAXIMUM FINAL GRADE SLOPE SHALL BE 10%.
3. THE CONTRACTOR SHALL SURVEY THE LOCATIONS OF ALL UNDERGROUND UTILITIES AND PROVIDE A RECORD DRAWING THEREOF.
4. ALL UNDERGROUND UTILITIES SHALL BE PROTECTED AND PRESERVED FOR POSSIBLE FUTURE USE.
5. THE SHOWN PROPOSED FINAL GRADE CONTOURS SHALL BE CONSIDERED AS A GENERAL GRADING CONCEPT. ACTUAL FINAL GRADES MAY VARY, PENDING ENGINEER'S APPROVAL AND TRANSITION TO ACTUAL SURROUNDING GRADES.
6. PROPOSED FINAL GRADES SHALL TRANSITION SMOOTHLY WITH SURROUNDING GRADES WITH NO ABRUPT GRADE CHANGES AND NO RESULTING SURFACE WATER CONCENTRATIONS.
7. SHOWN FINAL GRADE CONTOURS REFLECT TOP OF VEGETATIVE LAYER.
8. THERE SHALL BE NO NET RESULTING FILL INCREASE AGAINST SURROUNDING STRUCTURES UNLESS APPROVED BY THE ENGINEER.

4/5

SCALE: 1" = 20'

50% DESIGN

REVISIONS

URS Corporation

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

CHEM CORE SITE
CITY OF BUFFALO
ERIE COUNTY
SITE NO. 9-15-176

REMEDIAL CONSTRUCTION

FINAL GRADING PLAN

C-6

GO WITH THE FLOW! THE HISTORY OF RESEARCH ON MANNING'S *n* VALUES

Adapted from ACPA's Design Data 10 by Matt Childs, P.E., and Zach Gerich, ACPA Intern
American Concrete Pipe Association
Irving, Texas
(972) 506-7216

INTRODUCTION

Selection of the proper value for the coefficient of roughness of a pipe is essential in evaluating the flow through culverts and sewers. An excessive value is uneconomical and results in oversizing of pipe, while equally, a low value can result in hydraulically inadequate pipe.

Proper values for the coefficient of roughness of commercially available pipe has been the objective of periodic investigations and, as a result, extensive knowledge and data are available on this often-controversial subject.

DESIGN VALUES

The difference between laboratory test values of Manning's *n* and accepted design values is significant. Numerous tests by public agencies and others have established Manning's *n* laboratory values. These laboratory results, however, were obtained utilizing clean water and straight pipe sections without bends, manholes, debris, or other obstructions. The laboratory results indicated the only differences were between smooth wall and rough wall pipes. Rough wall, such as unlined corrugated metal pipe have relatively high *n* values, which are approximately 2.5 to 3 times those of smooth wall pipe.

Smooth wall pipes were found to have *n* values ranging between 0.009 and 0.010 but, historically, engineers familiar with sewers have used 0.012 or 0.013. This "design factor" of 20-30 percent takes into account the difference between laboratory testing and actual installed conditions. The use of such design factors is good engineering practice and, to be consistent for all pipe materials, the applicable Manning's *n* laboratory value should be increased a similar amount in order to arrive at comparative design values. Recommended design values are shown in Table 1.

FLOW FORMULAS

Manning's formula, in terms of flow, is expressed as follows:

$$Q = \frac{1.486}{n} AR^{2/3}S^{1/2} \quad \text{where:}$$

Q = flow in pipe, cubic feet per second

A = cross-sectional area of flow, square feet

R = hydraulic radius, equal to the cross-sectional area of flow divided by the wetted perimeter of pipe, feet

S = slope of pipe, foot per foot

n = coefficient of roughness appropriate to the type of pipe

Table 1: Recommended Values of Manning's *n*

Pipe Material	Values of Manning's *n*		
	Lab Values	Promoted Values	ACPA Recommended Values
Concrete	0.009-0.010[1]	0.011-0.013[1]	storm sewer - 0.011-0.012[1] sanitary sewer - 0.012-0.013[1]
HDPE lined	0.009-0.015[2]	0.009-0.013[3]	storm sewer - 0.012-0.020[2]
PVC solid wall	0.009-0.011[4]	0.009[4]	storm & sanitary sewer - 0.011-[redacted]
Corrugated Pipe	0.012-0.030[5]	0.012-0.026[6]	0.021-0.029[7]

0.013

1 American Concrete Pipe Association's "Concrete Pipe Design Manual" - 2000
2 Tullis and Barfuss Study - 1989
3 CPPA Specifications
4 Uni-Bell's "Handbook of PVC Pipe" - 2001
5 University of Minnesota test on Culvert Pipes - 1950
6 NCSPA'S "Modern Sewer Design" - 1999
7 U.S. Department of Transportation Federal Highway Administration's "Hydraulic Design of Highway Culverts" - 2001

MANNING *n* VALUE RESEARCH

HDPE PIPE

Research by Tullis and Barfuss in 1989, presented to the American Society of Civil Engineers showed that tests on corrugated HDPE pipe with a liner has a laboratory Manning's *n* value in the

APPENDIX 2G

PUMP CALCULATIONS

CALCULATION COVER SHEET

Client: NYSDEC Project Name: Chem Core

Project/Calculation Number: 11173519

Title: Pump Sizing Calculations

Total Number of Pages (including cover sheet): 12

Total Number of Computer Runs: 0

Prepared by: Donald A. M'Call [signature] Date: 2-25-05

Checked by: Craig W. Pawlewski CWP Date: 2/28/05

Description and Purpose:

Calculations for pumps P-100, 101 and GEW-1 and 2

Design Basis/References/Assumptions

See Attached

Remarks/Conclusions/Results:

See Attached

Calculation Approved by: [signature] 2/28/05

Project Manager/Date

Revision No.:	Description of Revision:	Approved by:

Project Manager/Date

URS

JOB NO.: 11173519

MADE BY: D. McCall DATE: 2-25-05
CHECKED BY: CWP DATE: 2/28/05

PROJECT: **NYSDEC Chem Core Site**

SUBJECT: **Pump Sizing Calculations**

Problem: Determine the design parameters and specifications for the pumps located in the groundwater treatment facility.

References:

1. *Cameron Hydraulic Data*, 17th Edition, C. C. Heald, Ingersoll-Rand, Woodcliff Lake, NJ, 1988.

2. *Perry's Chemical Engineers' Handbook*, Sixth Edition, Robert Perry & Don Green, McGraw-Hill, Inc., 1984.

3. *Ryan Herco* Product Catalog, ryanherco.com.

General Assumptions:

1. Friction Loss calculations are based on the Hazen-Williams equation. All equations are provided on the attached pages for each calculation. A "C" value of 120 has been assumed for all applications. The actual C value is more likely on the order of 130 - 140. The lower value is used to be conservative and to include a factor of safety for design.

2. For most applications, the actual quantities of valves and fittings will be determined during the installation and construction of the systems. For the purpose of these calculations, a conservative estimate of the type and quantities of fittings has been made.

3. For applications where pumps have the option to pump to multiple locations, the worst-case application (based on longest distance and/or highest static head) was used in the calculation.

The following pages summarize the calculations for each pump. A sketch of the pump application is included at the end of each section.

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N:\11173519.00000\EXCEL\Design\[Pump sizing calcs.xls]GEW-1,2

PROJECT: **NYSDEC Chem Core Site**

SUBJECT: **Pump Sizing Calculations**

02/28/05

Submersible Pumps GEW-1, -2

Configuration: 2 identical pumps
Type of Pump: Submersible
Liquid Being Pumped: water

Made By: Donald A. McCall [initials] **Date:** 2-25-05
Checked By: CWP **Date:** 2/28/05

Input Data

Design Flow Rate (per pump)	Q	5	gal/min
Liquid Density	ρ	62.43	lb/ft^3
Absolute Viscosity	μ	1	centipoise
Average Liquid Temperature	T	50-90	^{o}F
Pipe Diameter - Inlet Side (Sch. 80 PVC)	D_I	0.935	inch
Pipe Diameter - Discharge, Prior to Tee (Sch. 80 PVC)	D_{DPT}	0.935	inch
Pipe Diameter - Discharge, After Tee (Sch. 80 PVC)	D_{DAT}	0.935	inch
Pipe Length - Inlet	L_I	0	feet
Pipe Length - Discharge, Prior to Tee	L_{DPT}		feet
Pipe Length - Discharge, After Tee	L_{DAT}	140	feet
C Value for Pipe (Sch. 80 PVC)	C	120	unitless
Static Head - Inlet Side (See Note 3)	H_I	0	feet
Static Head - Discharge Side	H_D	60	feet
Atmospheric Pressure (absolute)	H_a	33.96	feet
Liquid Vapor Pressure at Pumping Temperature (Average)	H_{vpa}	0.783	feet

Pipe Fittings - Inlet Side

	Quantity	K Value	Total K
Entrance Loss		0.5	0
Exit Loss		1	0
Flow Meter		1	0
Gate Valve		0.18	0
Globe Valve		7.8	0
Angle Valve		1.27	0
Ball Valve		0.07	0
Butterfly Valve			0
Swing Check Valve		2.3	0
90 Deg. Elbow		0.69	0
45 Deg. Elbow		0.37	0
Tee (Thru Branch)		1.38	0
Tee (Thru Run)		0.46	0
Total K_I			0

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02/28/05

PROJECT: **NYSDEC Chem Core Site**

SUBJECT: **Pump Sizing Calculations**

Submersible Pumps GEW-1, -2

Configuration: 2 identical pumps
Type of Pump: Submersible
Liquid Being Pumped: water

Made By: Donald A. McCall [signature] **Date:** 2-25-05
Checked By: CWR **Date:** 2/28/05

Pipe Fittings - Discharge, Prior to Tee

	Quantity	K Value	Total K
Entrance Loss			0
Exit Loss			0
Flow Meter			0
Gate Valve			0
Globe Valve			0
Angle Valve			0
Ball Valve			0
Butterfly Valve			0
Swing Check Valve			0
90 Deg. Elbow			0
45 Deg. Elbow			0
Tee (Thru Branch)			0
Tee (Thru Run)			0
Total K_{DPT}			0

Pipe Fittings - Discharge, After Tee

	Quantity	K Value	Total K
Entrance Loss	1	0.5	0.5
Exit Loss	1	1	1
Flow Meter	1	1	1
Gate Valve	2	0.18	0.36
Globe Valve		7.8	0
Angle Valve		1.27	0
Ball Valve		0.07	0
Butterfly Valve			0
Swing Check Valve	1	2.3	2.3
90 Deg. Elbow	6	0.69	4.14
45 Deg. Elbow		0.37	0
Tee (Thru Branch)	1	1.38	1.38
Tee (Thru Run)		0.46	0
Total K_{DAT}			10.68

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PROJECT: **NYSDEC Chem Core Site**
SUBJECT: **Pump Sizing Calculations**

Submersible Pumps GEW-1, -2

Configuration: 2 identical pumps
Type of Pump: Submersible
Liquid Being Pumped: water

Made By: Donald A. McCall **Date:** 2-28-05
Checked By: CWP **Date:** 2/28/05

Calculations

Suction Side

1. Determine Pipe Friction Loss - H_f

$H_{Pipe} = 0.002083\ L_I\ (100/C)^{1.85}[(Q^{1.85})/(D_I^{4.8655})]$ — H_{Pipe} 0.00 feet

2. Determine Friction Loss Through Fittings

$H_{Valves} = (K_I)(0.00259)(Q^2)/D_I^4$ — H_{Valves} 0.00 feet

3. Static Lift — H_I 0.00 feet

4. Total Suction Losses — $H_{Suction}$ 0.00 feet

Discharge Side - Prior to Tee (If Applicable)

5. Determine Pipe Frictin Loss - H_f

$H_{Pipe} = 0.002083\ L_{DPT}\ (100/C)^{1.85}[(Q^{1.85})/(D_{DPT}^{4.8655})]$ — H_{Pipe} 0.00 feet

6. Determine Friction Loss Through Fittings

$H_{Valves} = (K_{DPT})(0.00259)(Q^2)/D_{DPT}^4$ — H_{Valves} 0.00 feet

7. Static Lift (Assume 0) — 0.00 feet

8. Total Discharge Loss - Prior to Tee — H_{DPT} 0.00 feet

N:\11173519.00000\EXCEL\Design\[Pump sizing calcs.xls]GEW-1,2

PROJECT: NYSDEC Chem Core Site

02/28/05

SUBJECT: Pump Sizing Calculations

Submersible Pumps GEW-1, -2

Configuration: 2 identical pumps
Type of Pump: Submersible
Liquid Being Pumped: water

Made By: Donald A. McCall **Date:** 2-28-05
Checked By: CWP **Date:** 2/28/05

Discharge Side - After Tee

9. Determine Pipe Frictin Loss - H_f

$H_{Pipe} = 0.002083\ L_{DAT}\ (100/C)^{1.85}[(Q^{1.85})/(D_{DAT}{}^{4.8655})]$	H_{Pipe}	5.67	feet

10. Determine Friction Loss Through Fittings

$H_{Valves} = (K_{DAT})(0.00259)(Q^2)/D_{DAT}{}^4$	H_{Valves}	0.90	feet
11. Static Lift	H_D	60.00	feet
12. Total Discharge Loss - After Tee	H_{DAT}	66.57	feet

Pump Design Criteria

Total Head

$H = H_{Suction} + H_{DPT} + H_{DAT}$	H	66.57	feet

Design Flow Rate

Q	Q	5	gpm

Hydraulic Horsepower (100% efficiency)

Hp = (gpm)(H)(sp. gr.) / [(3960)(eff.)]	Hp	0.08	Hp

NPSHA

$NPSHA = H_a - H_{vpa} - H_{suction}$	NPSHA	33.18	feet

NOTE:
1. C value of 120 includes a conservative factor of safety for design.
2. Quantities of valves and fittings are a reasonable estimate of the actual quantities.
3. Although there will ususally be some static head on the inlet side, a conservative value of "0" is assumed.

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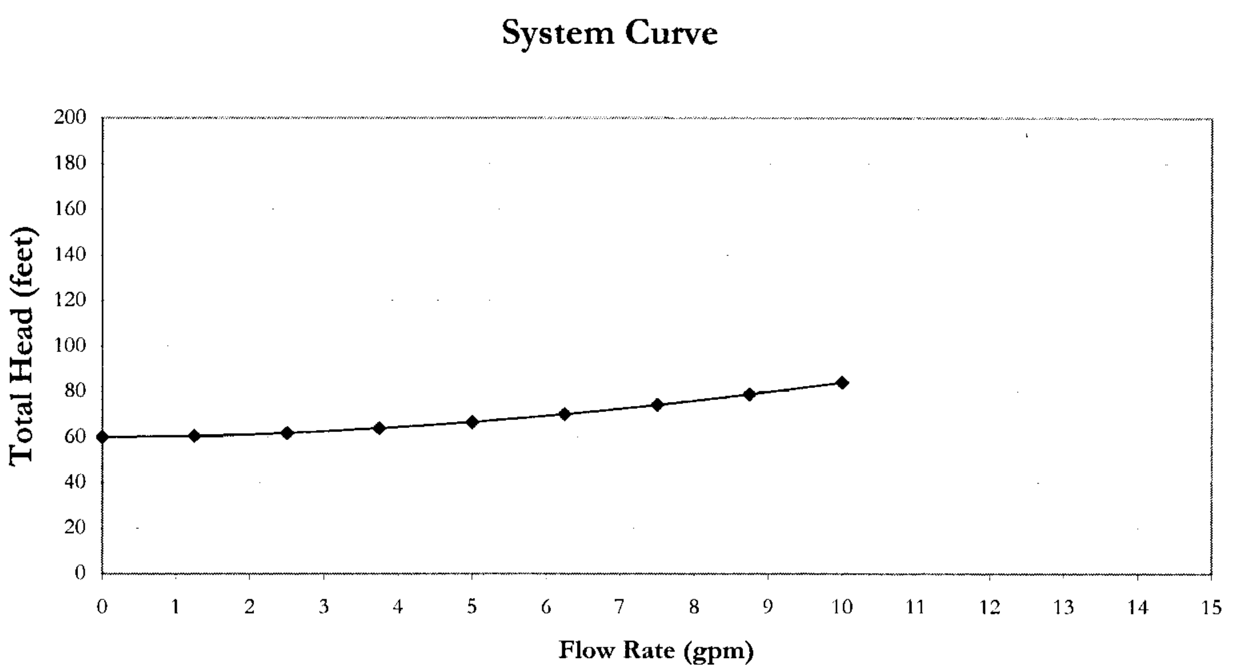
PROJECT: NYSDEC Chem Core Site 02/28/05

SUBJECT: Pump Sizing Calculations

Submersible Pumps GEW-1, -2

Configuration: 2 identical pumps
Type of Pump: Submersible
Liquid Being Pumped: water

Made By: Donald A. McCall **Date:** 2-25-05
Checked By: CWP **Date:** 2/28/05



Q (One Pump) =	5	H =	66.57

PROJECT: **NYSDEC Chem Core Site**
SUBJECT: **Pump Sizing Calculations**

Transfer Pumps P-100, 101

Configuration: 1 pump with a spare
Type of Pump: Centrifugal
Liquid Being Pumped: water

Made By: Donald A. McCall DAM **Date:** 2-25-05
Checked By: C.WP **Date:** 2/28/05

Input Data

Design Flow Rate (per pump)	Q	10	gal/min
Liquid Density	ρ	62.43	lb/ft^3
Absolute Viscosity	μ	1	centipoise
Average Liquid Temperature	T	50-90	°F
Pipe Diameter - Inlet Side (Sch. 40 PVC)	D_I	1.59	inch
Pipe Diameter - Discharge, Prior to Tee (Sch. 40 PVC)	D_{DPT}	1.59	inch
Pipe Diameter - Discharge, After Tee (Sch. 40 PVC)	D_{DAT}	1.59	inch
Pipe Length - Inlet	L_I	6	feet
Pipe Length - Discharge, Prior to Tee	L_{DPT}		feet
Pipe Length - Discharge, After Tee	L_{DAT}	25	feet
C Value for Pipe (Sch. 40 PVC)	C	120	unitless
Static Head - Inlet Side (See Note 3)	H_I	0	feet
Static Head - Discharge Side (incl. filter pressure drop)	H_D	15	feet
Atmospheric Pressure (absolute)	H_a	33.96	feet
Liquid Vapor Pressure at Pumping Temperature (Average)	H_{vpa}	0.783	feet

Pipe Fittings - Inlet Side

	Quantity	K Value	Total K
Entrance Loss	1	0.5	0.5
Exit Loss		1	0
Flow Meter		1	0
Gate Valve	1	0.15	0.15
Globe Valve		7.1	0
Angle Valve		1.16	0
Ball Valve		0.06	0
Butterfly Valve			0
Swing Check Valve		2.1	0
90 Deg. Elbow	2	0.63	1.26
45 Deg. Elbow		0.34	0
Tee (Thru Branch)	1	1.26	1.26
Tee (Thru Run)		0.42	0
		Total K_I	3.17

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PROJECT: **NYSDEC Chem Core Site**

02/28/05

SUBJECT: **Pump Sizing Calculations**

Transfer Pumps P-100, 101

Configuration: 1 pump with a spare
Type of Pump: Centrifugal
Liquid Being Pumped: water

Made By: Donald A. McCall **Date:** 2-25-05
Checked By: CWP **Date:** 2/28/05

Pipe Fittings - Discharge, Prior to Tee

	Quantity	K Value	Total K
Entrance Loss			0
Exit Loss			0
Flow Meter			0
Gate Valve			0
Globe Valve			0
Angle Valve			0
Ball Valve			0
Butterfly Valve			0
Swing Check Valve			0
90 Deg. Elbow			0
45 Deg. Elbow			0
Tee (Thru Branch)			0
Tee (Thru Run)			0
		Total K_{DPT}	0

Pipe Fittings - Discharge, After Tee

	Quantity	K Value	Total K
Entrance Loss	1	0.5	0.5
Exit Loss	1	1	1
Flow Meter		1	0
Gate Valve	4	0.15	0.6
Globe Valve		7.1	0
Angle Valve		1.16	0
Ball Valve		0.06	0
Butterfly Valve			0
Swing Check Valve	1	2.1	2.1
90 Deg. Elbow	6	0.63	3.78
45 Deg. Elbow	1	0.34	0.34
Tee (Thru Branch)	3	1.26	3.78
Tee (Thru Run)		0.42	0
		Total K_{DAT}	12.1

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PROJECT: **NYSDEC Chem Core Site**

SUBJECT: **Pump Sizing Calculations**

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02/28/05

Transfer Pumps P-100, 101

Configuration: 1 pump with a spare
Type of Pump: Centrifugal
Liquid Being Pumped: water

Made By: Donald A. McCall DAM **Date:** 2-25-05
Checked By: CWP **Date:** 2/28/05

Calculations

Suction Side

1. Determine Pipe Friction Loss - H_f

$H_{Pipe} = 0.002083\ L_I\ (100/C)^{1.85}[(Q^{1.85})/(D_I^{4.8655})]$ — H_{Pipe} 0.07 feet

2. Determine Friction Loss Through Fittings

$H_{Valves} = (K_I)(0.00259)(Q^2)/D_I^4$ — H_{Valves} 0.13 feet

3. Static Lift — H_I 0.00 feet

4. Total Suction Losses — $H_{Suction}$ 0.19 feet

Discharge Side - Prior to Tee (If Applicable)

5. Determine Pipe Frictin Loss - H_f

$H_{Pipe} = 0.002083\ L_{DPT}\ (100/C)^{1.85}[(Q^{1.85})/(D_{DPT}^{4.8655})]$ — H_{Pipe} 0.00 feet

6. Determine Friction Loss Through Fittings

$H_{Valves} = (K_{DPT})(0.00259)(Q^2)/D_{DPT}^4$ — H_{Valves} 0.00 feet

7. Static Lift (Assume 0) — 0.00 feet

8. Total Discharge Loss - Prior to Tee — H_{DPT} 0.00 feet

Transfer Pumps P-100, 101

Configuration: 1 pump with a spare
Type of Pump: Centrifugal
Liquid Being Pumped: water

Made By: Donald A. McCall DW **Date:** 2-25-05
Checked By: CWF **Date:** 2/28/05

Discharge Side - After Tee

9. Determine Pipe Frictin Loss - H_f

$H_{Pipe} = 0.002083\ L_{DAT}\ (100/C)^{1.85}[(Q^{1.85})/(D_{DAT}^{4.8655})]$	H_{Pipe}	0.28	feet

10. Determine Friction Loss Through Fittings

$H_{Valves} = (K_{DAT})(0.00259)(Q^2)/D_{DAT}^4$	H_{Valves}	0.49	feet
11. Static Lift (incl. 5 ft. ΔP for the filter)	H_D	15.00	feet
12. Total Discharge Loss - After Tee	H_{DAT}	15.77	feet

Pump Design Criteria

Total Head

$H = H_{Suction} + H_{DPT} + H_{DAT}$	H	15.96	feet

Design Flow Rate

Q	Q	10	gpm

Hydraulic Horsepower (100% efficiency)

Hp = (gpm)(H)(sp. gr.) / [(3960)(eff.)]	Hp	0.04	Hp

NPSHA

$NPSHA = H_a - H_{vpa} - H_{suction}$	NPSHA	32.98	feet

NOTE:
1. C value of 120 includes a conservative factor of safety for design.
2. Quantities of valves and fittings are a reasonable estimate of the actual quantities.
3. Although there will ususally be some static head on the inlet side, a conservative value of "0" is assumed.

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N:\11173519.00000\EXCEL\Design\[Pump sizing calcs.xls]GEW-1,2

PROJECT: **NYSDEC Chem Core Site**

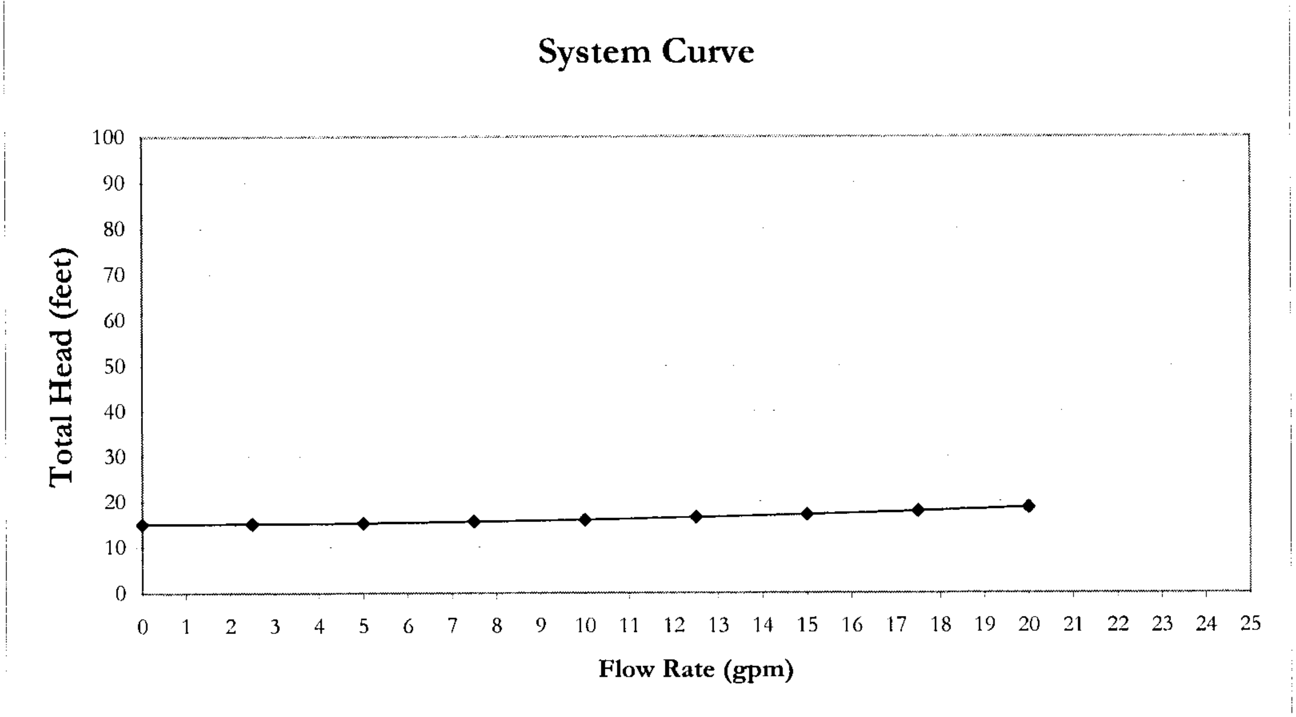
02/28/05

SUBJECT: **Pump Sizing Calculations**

Transfer Pumps P-100, 101

Configuration: 1 pump with a spare
Type of Pump: Centrifugal
Liquid Being Pumped: water

Made By: Donald A. McCall **Date:** 2-25-05
Checked By: **Date:**



Q (One Pump) = 10 H = 15.96