EBASCO

REM III PROGRAM

REMEDIAL PLANNING ACTIVITIES AT SELECTED UNCONTROLLED HAZARDOUS SUBSTANCE DISPOSAL SITES

EPA CONTRACT 68-01-7250

EBASCO SERVICES INCORPORATED

FINAL
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY

VOLUME I
REMEDIAL INVESTIGATION REPORT

BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

JULY 1989
W.A. NO. 161-2LD6

EBASCO SERVICES INCORPORATED **EBASCO**

160 Chubb Avenue, Lyndhurst, NJ 07071 · (201) 460-1900

July 28, 1989
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Mr. M Shaheer Alvi, P.E.
Regional Project Officer
Environmental Protection Agency
26 Federal Plaza
New York, NY 10278

Mr. Eduardo Gonzalez
Remedial Project Manager
Environmental Protection Agency
26 Federal Plaza
New York, NY 10278

Subject: REM II PROGRAM - EPA CONTRACT NO. 68-01-7250
FINAL REMEDIAL INVESTIGATION/
FEASIBILITY STUDY REPORT
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Gentlemen:

The REM III Team is pleased to submit twelve (12) copies of the Final Remedial Investigation (RI)/Feasibility Study (FS) Report for the Byron Barrel and Drum Site. The RI and FS Reports have been submitted as Volumes I and II of a stand-alone document since comments on both reports were received in the same time frame. Appendices are submitted as Volumes III and IV. As per your request, ten (10) copies have also been provided to Mr. Jeff Mirarchi of the New York State Department of Environmental Conservation (NYSDEC) in Albany, New York. Furthermore, two (2) copies have been mailed to each of the public repositories at the Byron Town Hall and the Byron-Bergen Public Library.

The Final RI/FS Report reflects comments on the draft reports received from both the EPA and the NYSDEC. Comments on the Draft RI Report were received from the EPA through July 24, 1989. EPA comments on the Draft FS Report were received through July 26, 1989. NYSDEC comments on both reports were received through July 21, 1989. Rapid-turnaround of the comments has been achieved so that the scheduled 4th Quarter FY 1989 Record of Decision (ROD) date can be met. The REM III Team has judiciously allocated resources to accomplish the rapid-turnaround.

In spite of time constraints required to meet the projected ROD date, the REM III Team is confident that the Final RI/FS Report is of high technical quality and will be sufficient for generation of an appropriate ROD. We are looking forward to assisting in Post-RI/FS support activities including review of the Proposed Remedial Action Plan, the public meeting, the Responsiveness Summary, etc. Please do not hesitate to call me at (201) 460-6434, or Mr. Robert Hubbard at (412) 788-1080 should you have any questions, comments, or suggestions.

Very truly yours,

Robert J Hubbard for
Dev R Sachdev, Ph.D., P.E.
Regional Manager - Region II

DRS/RJH/lmd
Enclosures

cc: R Heffernan - EPA, HQ
R Fellman - Ebasco, ZPMO
B Mendez - Ebasco, ZPMO
F Tsang - Ebasco, ZPMO
H Worchel - Ebasco, Region II
G Latulippe - NUS
R Hubbard - NUS

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JULY 28, 1989

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

VOLUME I

REMEDIAL INVESTIGATION REPORT

BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

EPA WORK ASSIGNMENT NUMBER 161-2LD6
UNDER
CONTRACT NUMBER 68-01-7250

PREPARED BY:
NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED BY:
EBASCO SERVICES INCORPORATED
LYNDHURST, NEW JERSEY

PREPARED BY:

Robert J Hubbard
ROBERT J HUBBARD
SITE MANAGER
NUS CORPORATION

APPROVED BY:

Robert J Hubbard for
DEV R SACHDEV, Ph.D., P.E.
REGIONAL MANAGER, REGION II
EBASCO SERVICES INCORPORATED

TABLE OF CONTENTS

VOLUME I OF IV

TABLE OF CONTENTS (Continued)

VOLUME I OF IV

SECTION PAGE

TABLE OF CONTENTS (Continued)

VOLUME I OF IV

SECTION PAGE

TABLE OF CONTENTS (Continued)

VOLUME I OF IV

VOLUME II - FEASIBILITY STUDY

VOLUME III - APPENDICES A-E

VOLUME IV - APPENDICES F-I

TABLES

VOLUME I OF IV

TABLES (Continued)

VOLUME I OF IV

FIGURES

VOLUME I OF IV

FIGURES (Continued)

VOLUME I OF IV

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

REMEDIAL INVESTIGATION

The Byron Barrel and Drum Site was discovered by the New York State Police in 1982 as a result of a report of illegal storage and disposal of approximately 400 55-gallon steel drums. As a result of this report, a police investigation was initiated and a search warrant was issued and executed on July 22, 1982. During execution of the warrant numerous drums were seen at the site in two storage areas. Subsequently, drummed wastes were sampled by the New York State Department of Environmental Conservation (NYSDEC). In March of 1984 the NYSDEC requested that the United States Environmental Protection Agency (EPA) conduct an immediate removal action at the site.

The EPA pursued the possibility of having the property owner conduct the removal operation. When this attempt failed, the EPA initiated the removal action. The removal action included waste compatibility testing; PCB analysis; bulking of compatible materials; analysis of bulked materials for disposal characteristics; and disposal/treatment of drums, wastes, debris, and approximately 40 cubic yards of contaminated soil at offsite locations. Disposal sites consisted of treatment, storage, and disposal facilities approved under the Resource Conservation and Recovery Act.

During the removal action the EPA sampled local domestic wells, soil, and groundwater obtained from and EPA-installed monitoring well. No site-related contamination was detected in residential wells, although volatile organic chemicals were identified in the groundwater sample from the onsite monitoring well. Low levels of residual contamination were detected in soil samples. The residential wells were sampled again in 1986 and no contamination was detected.

A remedial investigation (RI) was conducted at the Byron Barrel and Drum Site in 1988/1989 under EPA Contract Number 68-01-7250. The remedial investigation was conducted to provide a data base sufficient to characterize the nature and extent of contamination at the site, perform a baseline risk assessment, and complete a feasibility study of remedial alternatives.

The remedial investigation included a soil-gas survey, a geophysical (magnetics) investigation, surface and subsurface soil sampling and analysis, a hydrogeologic and groundwater quality investigation, and surface-water and sediment sampling.

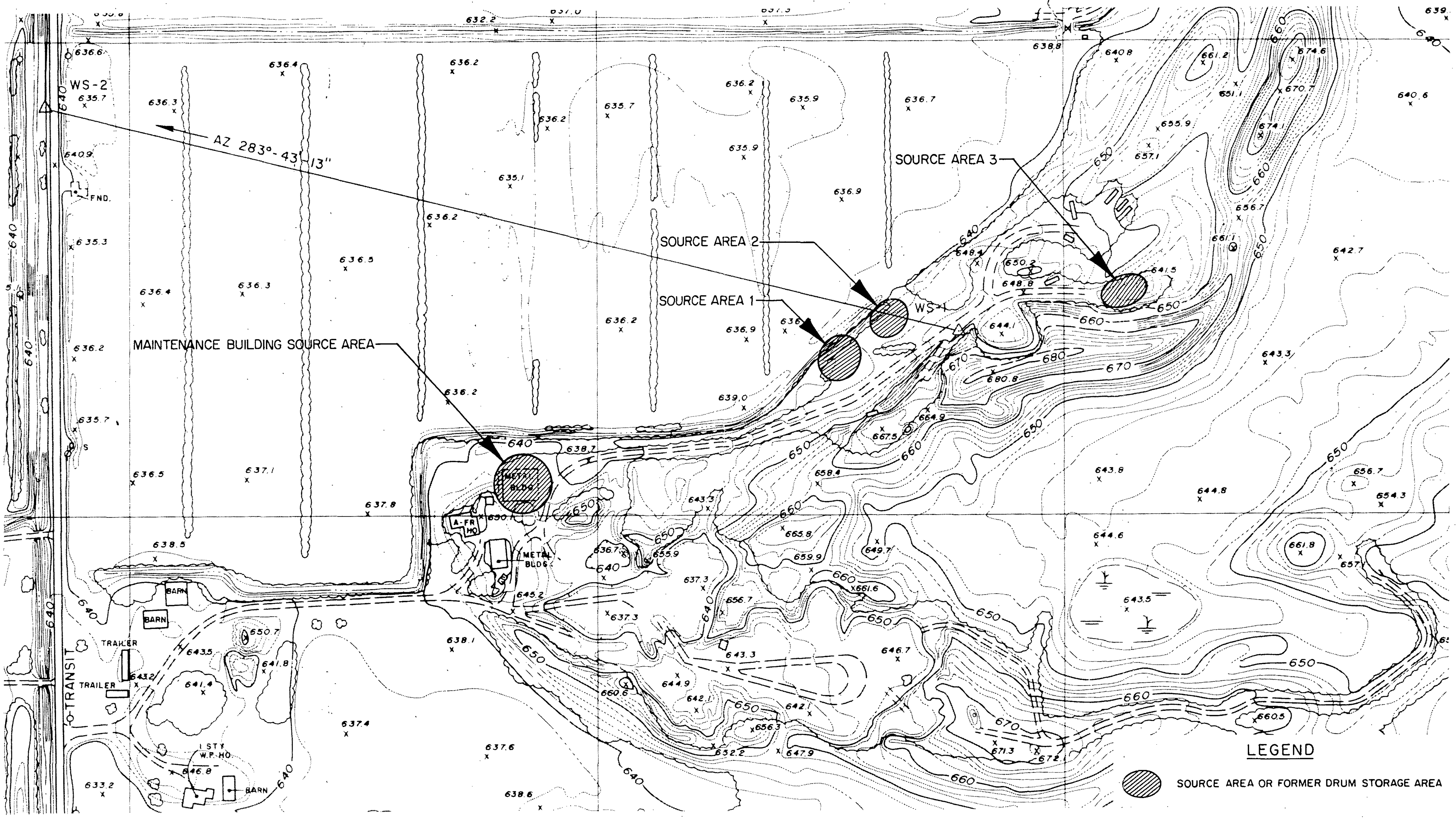
Environmental contamination at the Byron Barrel and Drum Site consists primarily of subsurface soil and groundwater contamination. Chlorinated aliphatic hydrocarbons such as 1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethene, and 1,1-dichloroethene are the primary contaminants. Various monocyclic aromatics such as toluene and xylenes were also detected, although groundwater contamination with these substances is minimal compared to contamination with chlorinated species.

Two major contaminant sources were detected at the site during the remedial investigation (RI) conducted from July 1988 through May 1989. The first of these sources is located in the southwestern portion of a drum storage and waste disposal area (source area 1). The second is located in the vicinity of a large maintenance shed located in the southwest portion of the site property. This secondary source was identified at the close of the field investigation, and a supplemental investigation to characterize contamination in this area was completed in May of 1989. Although magnetic anomalies were identified during the geophysical investigation, test-pitting operations revealed that there are no buried drums at the site.

Based on the results of a subsurface soil sampling and analysis program, it has been estimated that approximately 1,100 cubic yards of contaminated soil are located in source area 1 (Figure ES-1). Concentrations of contaminants in this area are generally relatively low. For example, tetrachloroethene (PCE) was the most concentrated contaminant detected in soil samples from this area. However, PCE concentrations ranged no higher than 4,400 parts per billion. It is believed that a significant amount of site contamination was removed from source area 1 during excavation of contaminated soils during the 1984 EPA removal action.

Based on a soil boring and subsurface soil sampling and analysis program, it is estimated that approximately 3,000 cubic yards of contaminated soil are present in the second source area. This area is located near a large maintenance building in the southwestern corner of the site property (Figure ES-1). Although contamination is distributed over a larger area at this source, concentrations are lower than those encountered in source area 1. For example, volatile organic chemicals were detected at concentrations no greater than 410 parts per billion in this source area (1,1,1-trichloroethane).

Surface soils at the Byron Barrel and Drum Site contained only low levels of volatile organics (less than 50 ppb), phthalate esters (less than 600 ppb), polynuclear aromatic hydrocarbons (less than 300 ppb), and benzoic acid (less than 500 ppb). By contrast, much higher concentrations of various pesticides, such as 4,4'-DDT, 4,4'-DDE, endrin, and dieldrin, were encountered. However, the highest concentrations of these compounds were detected in surface soil samples collected from the adjacent farmland. Onsite samples containing pesticides were obtained in proximity to the agricultural land, and are believed to be present as a result of atmospheric transport of pesticides during application to crops.



LEGEND

▨ SOURCE AREA OR FORMER DRUM STORAGE AREA

FIGURE ES-1

LOCATION OF SOURCES/FORMER DRUM STORAGE AREAS
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

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Inorganic contamination in soils is indistinguishable from background levels with the exception of the detection of concentrations of lead and chromium in excess of background. The maximum concentrations of these analytes were detected in surface soil samples obtained in source area 3 (Figure ES-1). However, review of the analytical results for groundwater samples obtained from monitoring wells in this area indicated that groundwater concentrations of lead and chromium are indistinguishable from background concentrations (i.e., concentrations detected in an upgradient well).

Lead was also detected in surface soil samples from source area 1 at concentrations in excess of background levels. Groundwater samples obtained in the vicinity of this source indicate that lead contamination exists in the aquifer in this area. Subsurface soil samples did not exhibit any substantial contamination with either chromium or lead.

A number of other inorganic chemicals were detected in groundwater samples at concentrations in excess of Maximum Contaminant Levels. However, with the exception of the anomalous detection of relatively high concentrations in one sample obtained from one well, these levels were generally indistinguishable from background concentrations. Another sample obtained from this well during a separate sampling round did not display inorganic concentrations similar to the anomalous sample.

Groundwater samples were not filtered to remove suspended solids prior to acidification. Therefore, the results are indicative of total inorganics rather than dissolved inorganics. Based on the detection of relatively high concentrations of inorganics in an upgradient well, site monitoring wells, and uncontaminated downgradient wells (i.e., wells located beyond the extent of the organic contaminant plumes) it is believed that the detection of these high concentrations is indicative of naturally occurring background levels.

Surface-water and sediment samples obtained in a drainage ditch adjacent to the site property contained relatively low levels of organic chemicals. No evidence of downstream impact on Oak Orchard Creek (the primary receiving surface water body) was identified. Several sediment samples from another drainage ditch that runs east to west just north of the site contained relatively high levels of toluene, acetone, and 2-butanone. However, based upon surface drainage patterns and the absence of potential discharge of contaminated groundwater to this drainage channel, it is not believed that this contamination is site related.

The primary contaminant transport mechanism at the Byron Barrel and Drum Site is associated with groundwater advection of dissolved contaminants. Contaminant plumes originating in the vicinity of source areas 1 and 2 and the maintenance building source were noted to be migrating in the downgradient direction to the north/northwest (Figure ES-2). No evidence of contaminant migration toward residential wells to the southwest was observed during the RI. Based on the analytical results for monitoring well samples, it is apparent that these contaminant plumes are confined to the immediate proximity of the source areas. It is estimated that the contaminant plumes have migrated no further than 400 feet from the sources. This phenomena is a manifestation of the shallow hydraulic gradient and the relatively recent time frame of disposal activities (approximately 1982).

Five potential exposure routes were considered in the baseline risk assessment. Exposure pathways considered include direct dermal contact, accidental ingestion of soils, inhalation of fugitive dust, inhalation of volatile emissions, and groundwater ingestion and inhalation of volatiles during showering. Virtually all of the contaminants detected in site media were included as indicator chemicals with the exception of the pesticides identified in surficial soils. These compounds are considered background contaminants that are unrelated to any disposal activities at the Byron Barrel and Drum Site.

The risk characterization process indicates that those exposure routes associated with surficial contamination (i.e., dermal contact, accidental ingestion, and inhalation of fugitive dust and volatile emissions) constitute noncarcinogenic and carcinogenic risks below those defined as being of concern by EPA. Hazard Indices, which are an indicator of the potential for noncarcinogenic effects, were well below unity (1) for each of these exposure routes. This indicates that estimated doses are below "acceptable" Reference Doses, even using conservative (worst-case) assumptions. Incremental cancer risks were within the EPA target risk range of 10^{-7} to 10^{-4}. A risk of 10^{-7} means that an exposed individual has a 1 in 10 million chance of contracting cancer, whereas a risk of 10^{-4} corresponds to a 1 in 10 thousand chance. Remedial action may be considered for cancer risks in this range. None of the incremental cancer risks associated with these exposure routes exceeded 10^{-6} (a 1 in 1 million chance that an exposed receptor would incur cancer).

The hydrogeologic investigation revealed that there is no existing contaminant migration pathway from the site to the residential wells, although low levels of contaminants were detected in several residential well samples. Incremental cancer risks did not exceed 10^{-6} for exposures associated with use of domestic well water. Hazard Indices for residential wells are well below unity (1), indicating that noncarcinogenic effects, are unlikely through household use of groundwater.

By contrast, the risk assessment indicates that significant carcinogenic and noncarcinogenic risks would be incurred if the aquifer at the Byron Barrel and Drum Site were developed for potable use. The cumulative incremental cancer risk for use of site groundwater exceeds the upper bound of the EPA target risk

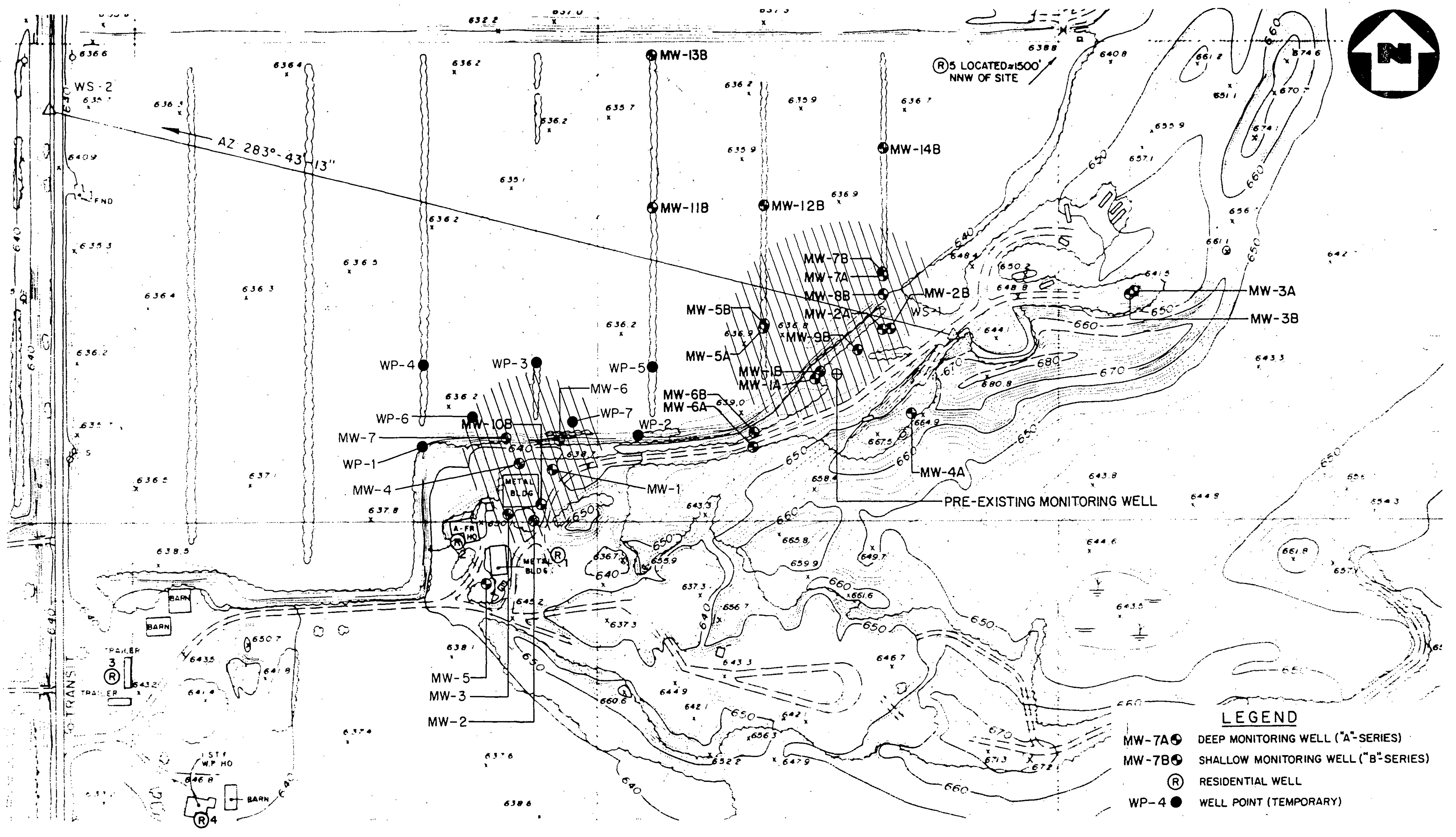

FIGURE ES-2

ESTIMATED EXTENT OF CONTAMINANT PLUMES
BYRON BARREL AND DRUM SITE, BYRON, NY

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range. The fact that hazard Indices exceed unity indicates that noncarcinogenic effects would be likely if this water were developed for drinking water purposes.

FEASIBILITY STUDY

The RI revealed that two sources of contamination exist at the Byron Barrel and Drum Site. The first of these is residual contamination in subsurface soils in the southwestern portion of a former drum storage and waste disposal area (source area 1). The second source is residual subsurface soil contamination located at the extreme southwestern corner of the site property. This source is believed to have originated from solvent spills. This source was identified at the close of the field investigation. Subsurface contamination in both areas occurs in the vadose zone and consists primarily of chlorinated aliphatic hydrocarbons, such as 1,1,1-trichloroethane, tetrachloroethene, and trichloroethene. Contamination with these substances is considered relatively insignificant from both human health and environmental standpoints. Concentrations of chlorinated aliphatics were below five part per million in both source areas. Under existing site conditions, no potential exposure to these source areas is anticipated.

However, two groundwater contaminant plumes were found to be originating from these source areas. The primary groundwater contaminants correspond to residual contamination found in the subsurface soil matrix. The contaminant plumes are currently confined to relatively small areas and have extended no farther than 400 feet from the source areas. The hydraulic gradient at the site is extremely shallow (0.0018 feet/foot), which, in part, accounts for the limited migration of contaminants. In addition, it is believed that disposal of contaminants occurred relatively recently. This also accounts for the limited migration that has been observed.

Although groundwater in the vicinity of the site is used as a drinking water source, the hydrogeologic and groundwater quality investigations revealed that no migration of contaminants to the domestic wells has occurred or is likely to occur in the future. In view of the absence of any existing exposure routes, prevention of aquifer development or aquifer restoration and protection were established as the primary remedial action objectives for the site. Chemical-specific remedial action objectives were developed to meet these general objectives. These specific objectives may be summarized as follows:

Groundwater

- Prevent exposure (ingestion and inhalation) to groundwater having contaminant concentrations in excess of Applicable or Relevant and Appropriate Requirements or other criteria and guidelines "to be considered" (ARARs) and to concentrations corresponding to a cumulative incremental cancer risk in excess of 10^{-4}.

- Restore contaminated groundwater to concentrations attaining ARARs and to concentrations corresponding to a cumulative incremental cancer risk below 10^{-4}.

Soil

- Prevent migration of contaminants from the subsurface soil so that groundwater concentrations will not exceed ARARs or concentrations corresponding to cumulative incremental cancer risk below 10^{-4}.

In general, ARARs are considered protective of the public health since they are developed, in part, based on toxicological properties. However, ARARs generally apply to only one specific chemical compound. The additional requirement that cumulative incremental cancer risks are below 10^{-4} ensures that the potential adverse effects or multiple chemicals (i.e., mixtures) are also addressed. Furthermore, remedial alternatives that would attain a 10^{-6} incremental cancer risk were also considered.

As a result of the limited extent of subsurface soil contamination, the primary emphasis of remedial action, and hence the development of remedial alternatives, was placed on groundwater remedial actions. Although soil remedial alternatives were considered, a limited number of potential technologies and process options were considered for soil remediation. Only those technologies considered to be cost-effective and appropriate to the magnitude of the problem were considered for soil remediation.

As a result of the technology/process option and remedial alternative screening process, the following alternatives were developed for detailed analysis:

- Alternative 1 - No action with monitoring.
- Alternative 2 - Deed and groundwater use restrictions.
- Alternative 3 - Deed restrictions and groundwater pumping, treatment, and discharge to surface water.
- Alternative 4 - Soil capping and groundwater pumping, treatment, and discharge to surface water.
- Alternative 5 - Soil excavation and offsite disposal and groundwater pumping, treatment and discharge to surface water.
- Alternative 6 - Soil excavation and onsite thermal desorption and groundwater pumping, treatment, and discharge to surface water.

- Alternative 7 - In-situ soil vapor extraction and groundwater pumping, treatment, and discharge to surface water.
- Alternative 8 - In-situ soil flushing and groundwater pumping, treatment, and discharge to the subsurface.

A comparative analysis of these remedial alternatives is summarized in Table ES-1. These alternatives are effective in meeting the remedial objectives to various degrees, as outlined in Table ES-1. The cost summaries for Alternatives 3 through 8 presented in Table ES-1 are based on attainment of ARARs and a cumulative incremental cancer risk of 10^{-4}. It was determined that these remedial objectives could be achieved within 20 years (calculations are included in Appendix H). By contrast it was estimated that operation and maintenance would be required for 90 years to meet concentrations corresponding to the lower end of the EPA target risk range (i.e., 10^{-6}). Given the high operation and maintenance costs associated with the various treatment alternatives, it is not considered cost-effective to attain residual risks of 10^{-6}. Furthermore, concentrations attaining ARARs and a cumulative 10^{-4} cancer risk are considered protective of both the environment and the public health. The total present worth of the various alternatives range from $265,000 (Alternative 1) to $7,929,000 (Alternative 5). Capital costs, annual operation and maintenance costs, and the total present worth of each alternative are summarized in Table ES-1 (cost estimates are summarized in Appendix I).

TABLE ES-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Alterative 1 No Further Action with Monitoring	Alternative 2 Deed and Groundwater Restrictions	Alternative 3 Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 4 Capping, Groundwater Pumping, Treatment, and Discharge to Surface Water
DESCRIPTION			
No action. Ongoing monitoring.	Restrict groundwater use and subsurface soil disturbance through institutional controls. Ongoing monitoring.	Collect groundwater; treat using precipitation, sedimentation, filtration, air stripping, and carbon adsorption; and discharge to surface water. Restrict soil disturbance by deed restrictions. Ongoing monitoring.	Place cap over areas of subsurface soil contamination. Collect groundwater; treat using precipitation, sedimentation, filtration air stripping, and carbon adsorption; and discharge to surface water. Ongoing monitoring.
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT			
• Risks to human health and environment not changed.	• Risks to human health reduced by restricting groundwater use and soil disturbance. • Risk to environment not changed.	• Soil - Risks reduced by deed restrictions. Contaminants could still leach to groundwater. • Groundwater - Protection provided by removing groundwater contaminants.	• Soil - Risks reduced by capping, which would reduce potential leaching to groundwater. • Groundwater - Protection provided by removing groundwater contaminants.
COMPLIANCE AND ARARs			
• Would not comply with groundwater ARARs.	• Would not comply with chemical-specific ARARs for ingestion of groundwater. • Would meet all other ARARs.	• All ARARs would be met.	• All ARARs would be met.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Alterative 5 Offsite Disposal, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 6 Thermal Treatment, Groundwater Pumping, Treatment, and Disharge to Surface Water	Alternative 7 In-Situ Vapor Extraction, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 8 In-Situ Soil Flushing Groundwater Pumping, Treatment and Discharge to the Suburface
DESCRIPTION			
Excavate contaminated subsurface soil and dispose at offsite landfill. Collect groundwater; treat using precipitation, sedimentation, filtration air stripping, and carbon adsorption; and discharge to surface water. Ongoing monitoring.	Excavate contaminated subsurface soil and treat on site. Collect groundwater; treat using precipitation, sedimentation, filtration, air stripping, and carbon adsorption; and discharge to surface water. Ongoing monitoring.	Treat soil using in-situ vapor extraction. Collect groundwater; treat using precipitation, sedimentation, filtration, air stripping, and carbon adsorption; and discharge to surface water. Ongoing monitoring.	Collect groundwater; treat using precipitation, sedimentation, filtration, air stripping, and carbon adsorption; and discharge to subsurface. In-situ soil flushing. Ongoing monitoring.
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT			
• Soil - Risks removed through removal and offsite disposal. • Groundwater - Protection provided by removing groundwater contaminants.	• Soil - Risks reduced to treating soil to remove VOCs. • Groundwater - Protection provided by removing groundwater contaminants.	• Soil - Risks reduced by treating soil to remove VOCs. • Groundwater - Protection provided by removing groundwater contaminants.	• Risks reduced by flushing soil contaminants and removing groundwater contaminants.
COMPLIANCE AND ARARs			
• All ARARs would be met.	• All ARARs would be met.	• All ARARs would be met.	• All ARARs would be met.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE THREE

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 No Further Action with Monitoring	Alternative 2 Deed and Groundwater Use Restrictions	Alternative 3 Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 4 Capping, Groundwater Pumping, Treatment, and Discharge to Surface Water
• Not effective in reducing contaminant concentrations. • Aquifer restoration depends on natural flushing and degradation of contaminants. • Long-term monitoring required.	• Not effective in reducing soil or groundwater contaminant concentrations. • Aquifer restoration depends on natural flushing and degradation of contaminants. • Institutional controls would ensure that contaminated soil is not disturbed and groundwater is not used as a potable water supply. • Long-term monitoring required.	• Soil - Not effective in reducing contaminant concentrations or migration to groundwater. Deed restictions would prevent soil disturbance and subsequent exposure. • Groundwater - Reduces risks by reducing contaminant concentrations. Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.	• Soil - Not effective in reducing contaminant concentrations. Capping would reduce infiltration and migration of contaminants to groundwater. • Groundwater - Reduces risks by reducing contaminant concentrations. Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alternative 1 No Further Action with Monitoring	Alternative 2 Deed and Groundwater Use Restrictions	Alternative 3 Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 4 Capping, Groundwater Pumping, Treatment, and Discharge to Surface Water
• No reduction of toxicity, mobility, or volume.	• No reduction of toxicity, mobility, or volume.	• Soil - No reduction of toxicity, mobility, or volume. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.	• Soil - Capping would reduce contaminant mobility. No reduction of toxicity or volume. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE FOUR

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alterative 5 Offsite Disposal, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 6 Thermal Treatment, Groundwater Pumping, Treatment, and Disharge to Surface Water	Alternative 7 In-Situ Vapor Extraction, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 8 In-Situ Soil Flushing, Groundwater Pumping, Treatment and Discharge to Subsurface
• Soil - Risks removed by complete removal of contaminated subsurface soil. • Groundwater - Reduces risks by reducing contaminant concentrations. Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.	• Soil - Risks reduced by treating contaminated soil to reduce VOC concentrations. • Groundwater - Reduces risks by reducing contaminant concentrations. Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.	• Soil - Risks reduced by treating soil to remove VOCs. • Groundwater - Reduces risks by reducing contaminant concentrations. • Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.	• Soil - Risks removed by treating contaminated soil using in-situ soil flushing. • Groundwater - Reduces risks by reducing contaminant concentrations. Excellent long-term reliability based on performance of existing systems. Long-term monitoring and O&M required.

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alterative 5 Offsite Disposal, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 6 Thermal Treatment, Groundwater Pumping, Treatment, and Disharge to Surface Water	Alternative 7 In-Situ Vapor Extraction, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 8 In-Situ Soil Flushing, Groundwater Pumping, Treatment and Discharge to Subsurface
• Soil - No reduction of toxicity, mobility, or volume. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.	• Soil - Toxicity reduced by thermal treatment. No reduction of mobility or volume. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.	• Soil - Toxicity reduced by in-situ vapor extraction. No reduction of mobility or volume. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.	• Soil - Toxicity reduced by in-situ soil flushing. • Groundwater - Pumping would reduce mobility and volume of contaminant plumes. Toxicity reduced by treatment.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE FIVE

Alternative 1 No Further Action with Monitoring	Alternative 2 Deed and Groundwater Use Restrictions	Alternative 3 Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 4 Capping, Groundwater Pumping, Treatment, and Discharge to Surface Water
SHORT-TERM EFFECTIVENESS			
• No risks to public from sampling activities. • Protective equipment required for well sampling personnel.	• No risks to public from sampling activities. • Protective equipment required for well sampling personnel.	• No risks to public during implementation. • Protective equipment required for workers. • Aquifer drawdown during pumping. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels.	• No risks to public during implementation. • Protective equipment required for workers. • Aquifer drawdown during pumping. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels. • Would take 1 to 2 months to construct the cap. • Dust control procedures may be needed.
IMPLEMENTABILITY			
• Groundwater monitoring could be performed using previously-installed wells and residential wells.	• Institutional controls can be implemented by state and local officials. • Groundwater monitoring could be performed using previously-installed wells and residential wells.	• Technologies and process options demonstrated and commercially available. • One SPDES compliance point to be monitored.	• Technologies and process options demonstrated and commercially available. • One SPDES compliance point to be monitored.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE SIX

Alternative 5 Offsite Disposal, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 6 Thermal Treatment, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 7 In-Situ Vapor Extraction, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 8 In-Situ Soil Flushing, Groundwater Pumping, Treatment and Discharge to the Subsurface
SHORT-TERM EFFECTIVENESS			
• Possibility for a spill exists during offsite transport. • Protective equipment required for workers. • Aquifer drawdown during pumping. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels. • Would take 1-2 months to remove contaminated soil. • Measures required to protect public and workers from dust and volatile emissions during excavation and material handling.	• Protective equipment required for workers. • Aquifer drawdown during pumping. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels. • Would take 2 months to treat contaminated soil. • Measures required to protect public and workers from dust and volatile emissions during excavation and material handling.	• No risks to public during implementation. • Protective equipment required for workers. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels. • Aquifer drawdown during pumping. • Would take 3 to 6 months to treat contaminated soil.	• No risks to public during implementation. • Protective equipment required for workers. • Aquifer drawdown during pumping. • Groundwater mounding would occur beneath the recharge basins. This will negate adverse effects of aquifer drawdown in source areas. • Would take 20 years to achieve all ARARs and 10^{-4} risk levels. • Would take 90 years to achieve 10^{-6} risk levels.
IMPLEMENTABILITY			
• Technologies and process options demonstrated and commercially available. • One SPDES compliance point to be monitored.	• Technologies and process options demonstrated and commercially available. • One SPDES compliance point to be monitored.	• Technologies and process options demonstrated and commercially available. • One SPDES compliance point to be monitored.	• Technologies and process options demonstrated and commercially available. • Three SPDES compliance points to be monitored.

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE SEVEN

Alternative 1 No Further Action with Monitoring		Alternative 2 Deed and Groundwater Use Restrictions		Alternative 3 Groundwater Pumping, Treatment, and Discharge to Surface Water		Alternative 4 Capping, Groundwater Pumping, Treatment, and Discharge to Surface Water	
COSTS							
Capital:	$0	Capital:	$15,000	Capital:	$1,506,000	Capital:	$1,716,000
Annual O&M:	$13,600	Annual O&M:	$13,600	Annual O&M:	$232,700(3)	Annual O&M:	$237,400(3)
Present Worth(1):	$265,000	Present Worth(1):	$279,000	Present Worth(1):	$4,874,000	Present Worth(1):	$5,143,000

TABLE ES-1
COMPARATIVE ANALYSIS OF ALTERNATIVES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE EIGHT

Alternative 5 Offsite Disposal, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 6 Thermal Treatment, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 7 In-Situ Vapor Extraction, Groundwater Pumping, Treatment, and Discharge to Surface Water	Alternative 8 In-Situ Soil Flushing, Groundwater Pumping, Treatment and Discharge to the Subsurface
COSTS			
Capital: $3,899,000	Capital: $3,319,000	Capital: $1,761,000	Capital: $1,917,000
Annual O&M: $285,800(3)	Annual O&M: $249,700(3)	Annual O&M: $238,400(3)	Annual O&M: $259,700(3)
Present Worth(1): $7,929,000	Present Worth(1): $6,899,000	Present Worth(1): $5,200,000	Present Worth(1): $5,572,000

(1) Present worth based on 30-year project life, 5 percent discount rate, and zero inflation rate.
(2) To achieve ARAR-based and 10^{-4} risk levels in groundwater.
(3) Annual costs for major portion of operating lifetime (years 3 through 20). Detailed annual costs and other costing information are provided in Appendix I.

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

NUS Corporation (NUS), under contract to Ebasco Services Incorporated (Ebasco), prepared this Remedial Investigation (RI) Report for the U.S. Environmental Protection Agency (EPA). This report presents the results of the RI conducted for the Byron Barrel and Drum Site in Genesee County, New York. Preparation of this RI was accomplished under Work Assignment Number 161-2LD6, Contract Number 68-01-7250.

1.2 SCOPE AND OBJECTIVES

The RI was conducted according to the Work Plan submitted to and approved by EPA in February 1988. The primary goals of this investigation are to determine whether the Byron Barrel and Drum Site presents any current or future public health or environmental risk, and to collect the data necessary to evaluate appropriate remedial actions that are consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986. Specific objectives were developed to meet these goals. The objectives, which were provided in the Final Work Plan (NUS Corporation, February 1988), are summarized as follows:

- Determine the location, quantity, and chemical character of any buried waste materials or drums.
- Characterize the nature and extent of contamination in soils, surface water, sediments, and groundwater.
- Characterize the hydrogeologic regime at the site through the installation, sampling, and hydrogeologic testing of monitoring wells.
- Evaluate contaminant migration routes that are acting at the site to transport contaminants off site, as well as characterize the extent of offsite impacts of contamination.
- Identify current and/or potential receptors of environmental contamination and evaluate the risks associated with these exposures.
- Establish the basic engineering characteristics of site soils and sediments.

1.3 SITE BACKGROUND

This section provides a physical site description, site history, and a summary of previous investigations associated with the site.

1.3.1 Site Location and Description

The Byron Barrel and Drum Site is located in Genesee County, New York, approximately 3.6 miles northwest of the Township of Byron. The site occupies approximately 2 acres of an 8-acre parcel of property off Transit Road. Map coordinates for the site are latitude 43°07'16.5" north, longitude 78°06'28.5" west on the Byron 7.5-minute series quadrangle map, as shown on Figure 1-1.

The Byron Barrel and Drum Site was used as a salvage yard for heavy construction equipment such as graders, bulldozers, cement mixers, and cranes, etc. Numerous pieces of such equipment were seen at the site. In addition, metallic and nonmetallic debris littered the site. The site itself is relatively flat but it is bordered on the east by an esker (a range composed of glacial stream deposits). Gravel was mined in a pit in this esker. The gravel pit is located on the site property.

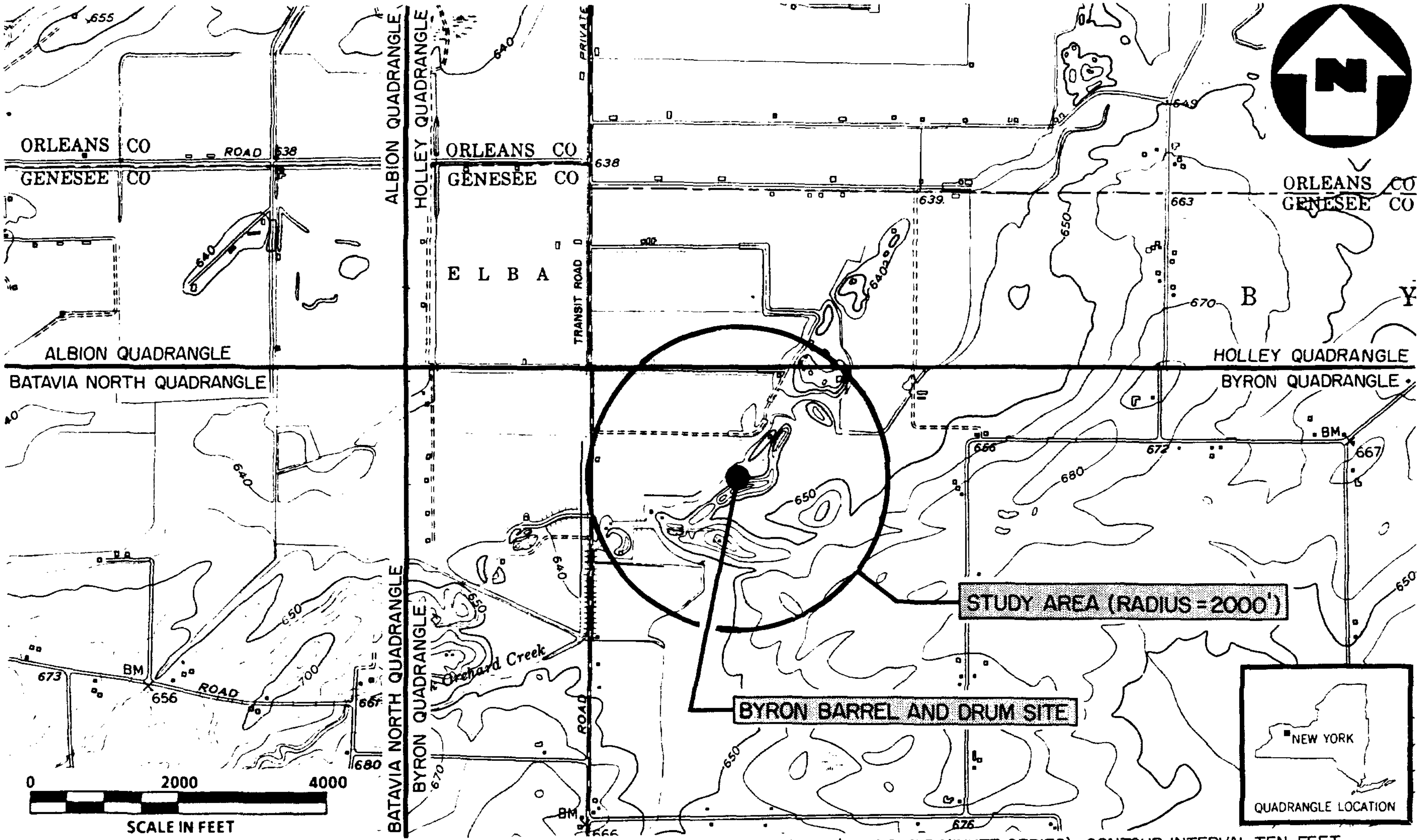
The site is heavily vegetated except in the gravel pit and, to a lesser extent, along the access road. Three known drum storage, or disposal, areas have been identified from file information. Drum removal operations by the EPA were completed at the site in December 1984.

1.3.2 Site History and Previous Investigations

The Byron Barrel and Drum Site was discovered in July 1982, when an unidentified individual reported the disposal of "approximately 400 55-gallon steel barrels that were filled with noxious-smelling chemicals" to John W Anna, a senior investigator with the New York State Police Major Crimes Unit. The source reported that he believed the disposal had occurred in March or April of 1982 on property owned by Mr. Darrell Freeman, Jr.

As a result of this report, a police investigation was initiated. On July 16, 1982, a helicopter flight over the area revealed the presence of a number of drums on the property. Photographs were taken during the flyover. Further investigation by Mr. Anna revealed that Darrell Freeman, Jr., owned the property and did not possess a permit from either the New York State Department of Environmental Conservation (NYSDEC) or the EPA for the storage or disposal of hazardous waste.

As a result of the investigation, a search warrant was issued. Two drum storage areas were quickly located. Mr. Anna reported that the first area contained 121 barrels, whereas the second contained 98 barrels. NYSDEC representatives obtained 11 drum waste samples during the search. Summaries of these analytical results are included with the analytical data base (Appendix E).



BASE MAP IS A PORTION OF THE BYRON, ALBION, HOLLEY, AND BATAVIA NORTH, NY QUADRANGLES (U.S.G.S., 7.5 MINUTE SERIES). CONTOUR INTERVAL TEN FEET.

FIGURE 1-1

LOCATION MAP
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

On July 23, 1982, various persons were interviewed regarding waste disposal activities at the site. A former employee of Mr. Freeman reported that he first noted approximately 80 drums on the Freeman property in the spring of 1978. These drums were located off the east side of the dirt road that runs through the Freeman property. The source further indicated that two more shipments of drums arrived at the site in the summer of 1979. These drums were unloaded and deposited at a site off to the west side of the dirt road behind a small clump of trees. These drum storage locations correspond to those identified during the police search. The source further reported that a fourth load of drums arrived sometime that summer. He did not witness their arrival, but noted that they were piled in front of two cement trucks in an area just south of the second disposal site.

Sometime during the fall of 1980, the source indicated that Mr. Freeman instructed him to go to the site of the fourth load of barrels and bury them in dirt. Apparently, Mr. Freeman instructed this individual to rip the drums open with a backhoe and bury them and mix them in with the dirt. The source indicated that some of the drums contained liquid that smelled like fingernail polish.

The NYSDEC initiated a preliminary investigation of the site. Wehran Engineering (Wehran) and Camp Dresser & McKee (CDM) submitted a preliminary report under the NYSDEC Superfund Program in September 1983. The Phase I data was supplemented to produce final scores under the Hazard Ranking System, and the site was ranked on the Superfund National Priorities List in April 1984 (Rank = 436).

In March 1984, NYSDEC requested that EPA conduct an immediate removal action at the site with funds available under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). On June 5, 1984, EPA issued a notice to Mr. Freeman regarding the intent to conduct the removal operation. Mr. Freeman indicated that he wished to conduct the work on his own. When subsequent contact with Mr. Freeman and his attorneys did not result in progress on the action, EPA commenced removal work at the site on August 11, 1984.

The EPA removal action included waste compatibility testing; PCB analysis; bulking of compatible materials; analysis of bulked materials for disposal characteristics; and proper disposal of drums, wastes, and approximately 40 cubic yards of contaminated soil and debris. Some bulked materials were identified as Resource Conservation and Recovery Act (RCRA) hazardous wastes as a result of the characteristic of ignitability and the presence of spent solvents such as toluene, ethylbenzene, and 1,1,1-trichloroethane. Analytical results for bulked drum waste samples are summarized in Tables 2-1 through 2-3 of the Final Work Plan for the Byron Barrel and Drum Site (Appendix E). Materials from the site were disposed at RCRA-approved treatment, storage, and disposal activities, including: AMO Pollution Services, Cannonsburg, Pennsylvania; Rollins

Environmental Services, Deer Park, Texas; SCA, Model City, New York; Chemical Waste Management, Emelle, Alabama; and Caldwell Systems, Lenoir, North Carolina (EPA, 1985). Soils samples were collected from each of the three identified disposal areas. Although test pits were excavated in an alleged drum burial area (source area 1), no buried drums were found. A monitoring well was installed near the burial area, and a groundwater sample was obtained. Soil and groundwater samples were analyzed for priority pollutants. Sample results were presented in the Final Work Plan (NUS Corporation, February 1988). The EPA removal action was completed by December 28, 1984. Residential well sampling was conducted in the vicinity of the site in June 1986. Three wells (Smith, Freeman, and Ognibene), located southwest of the site, were sampled and analyzed for Target Compound List (TCL) organics and inorganics by an EPA Contract Laboratory Program (CLP) laboratory. No site-related contaminants were detected in the residential well samples.

1.4 REPORT ORGANIZATION

The organization and content of this report (Volume I) are described below. The Feasibility Study Report is included as Volume II. Appendices are provided in Volumes III and IV.

- Section 1.0 - Introduction

  This section summarizes the scope and objectives of the RI. Included are descriptions of the site and relevant background information.

- Section 2.0 - Site Investigation

  This section describes the various tasks of the field investigation activities, including the hydrogeologic investigation and media sampling activities.

- Section 3.0 - Physical Characteristics of the Site

  This section describes the site features, demography and land use, climate, soils, geology, hydrogeology, and surface-water hydrology.

- Section 4.0 - Nature and Extent of Contamination

  This section presents the results of the sampling and analysis program at the site. Included are data on the nature and extent of contamination observed in groundwater, soil, surface water, and sediments.

- Section 5.0 - Contaminant Fate and Transport

  Potential contaminant migration routes, the physical and chemical properties of the contaminants as they relate to environmental fate and transport, and contaminant persistence are included in this section.

- Section 6.0 - Risk Assessment

  This section presents an assessment of the public health and environmental risks associated with chemical contamination currently found at the site. Applicable, relevant, and appropriate requirements (ARARs) are identified for the site contaminants, actual and potential carcinogenic and noncarcinogenic risks are estimated, and an assessment of environmental hazards is presented.

- Section 7.0 - Summary and Conclusions

  This section summarizes the findings of the RI and sets the stage for the Feasibility Study (FS) Report (Volume II).

2

2.0 FIELD INVESTIGATION ACTIVITIES

2.1 INTRODUCTION

A detailed description of the scope of work for the Byron Barrel and Drum Site investigation is included in the Field Operations Plan (NUS Corporation, March 1988) and the Work Plan (NUS Corporation, February 1988). This section of the RI Report provides a discussion of the data collection activities and describes procedures that were altered as a result of situations encountered in the field. The site study area is shown in Figure 2-1. The site has been divided into three specific source areas of environmental contamination, based on historical chemical-analytical data, as shown in Figure 2-2. Detailed discussions of the source areas are presented in Section 4.0.

2.2 PRELIMINARY ACTIVITIES

Preliminary activities conducted at the Byron Barrel and Drum Site included the following activities:

- Aerial topographic mapping: This activity was designed to produce a higher quality base map for use in project deliverables.
- Relocation activities: An abundance of heavy equipment was removed from the suspected source areas and areas of secondary interest to facilitate the geophysical survey, soil-gas investigation, and monitoring well installation.
- Grubbing: The known source areas were bulldozed of any vegetation to facilitate all field activities.

2.3 SOIL-GAS INVESTIGATION

2.3.1 Soil-Gas Pilot Test

The soil-gas pilot test was performed in six test holes that were bored approximately 2 weeks before the full-scale soil-gas investigation began. The pilot test was conducted to determine if the proposed approach (photoionization detector measurements in soil borings) would be effective prior to mobilizing the full field crew. This test was accomplished as specified in Section 3.2.1 of the Field Operations Plan (NUS Corporation, March 1988). Four samples were taken in suspected source area 1, and two background samples taken outside this area. All sampling points were selected at random.

2.3.2 Soil-Gas Investigation

A soil-gas investigation was determined to be the most cost-effective and timely method of identifying any additional source areas within the site limits. The results were evaluated to determine the locations of potentially contaminated areas and

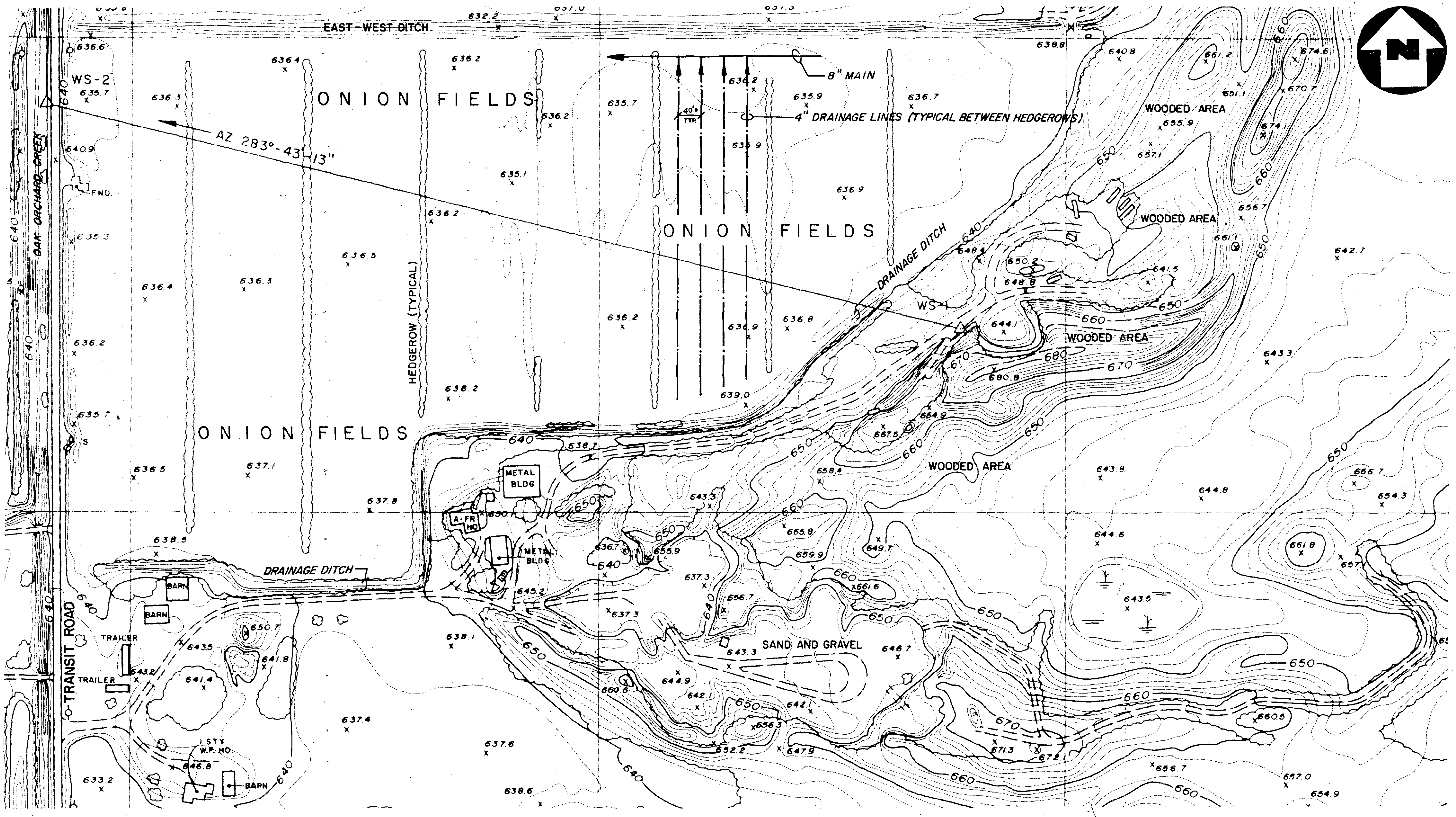


FIGURE 2-1

STUDY AREA

BYRON BARREL AND DRUM SITE, BYRON, NY

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SCALE IN FEET

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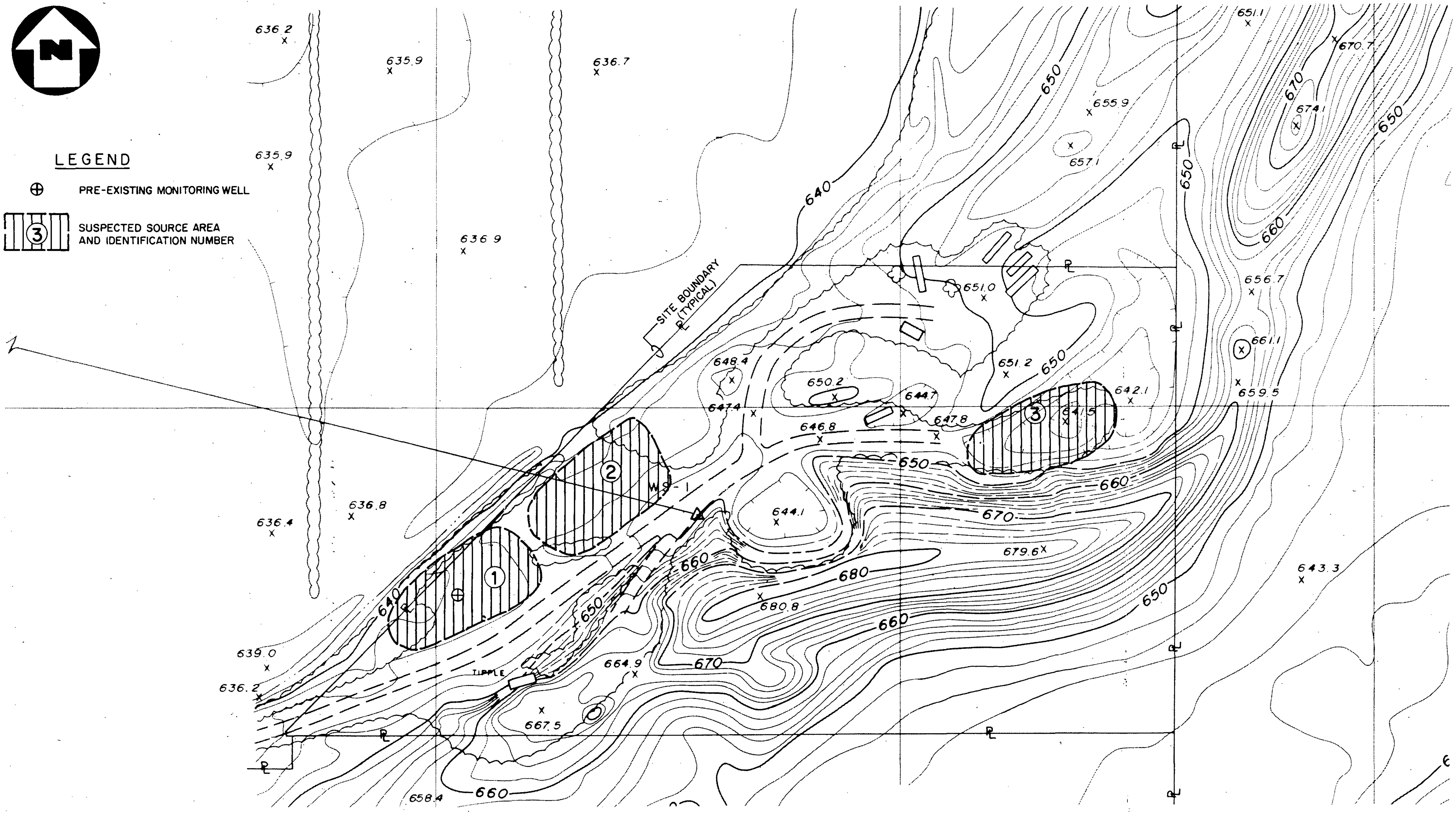

FIGURE 2-2

GENERAL ARRANGEMENT
BYRON BARREL AND DRUM SITE, BYRON, NY

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SCALE IN FEET

NUS CORPORATION

thereby guide the selection of surface soil and subsurface soil sampling points and monitoring well locations.

The soil-gas grid and investigation were conducted as described in Section 3.2.1 of the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.2 of the Final Work Plan (NUS Corporation, February 1988), with the following exceptions:

- Of the 399 boring locations originally proposed, 174 were considered inaccessible because of overgrown vegetation or the presence of equipment and/or scrap. This left 225 borings that were actually bored and tested. Samples were collected on the grid system depicted in Figure 2-3.
- Organic vapor readings were taken immediately after the boring was completed and just before the bag was placed over the hole, as well as 24 hours later, as specified. This change was included because, on two occasions during the pilot test, the bags were torn and pulled from borings by animals during the night.

Samples of soil were mixed with deionized water and were checked for pH and specific conductance for an indication of any contamination by inorganics. The bags of soil were left on site after the examination and testing was complete. All soil slurries were disposed of at the trailer in drums, which were also left on site.

2.4 GEOPHYSICAL INVESTIGATION

A geophysical survey was conducted to locate any buried ferromagnetic materials or drums. This investigation focused on the known or suspected burial area(s) as defined by existing site information and the soil-gas survey. The information acquired from the measured anomalies located during the geophysical survey was used to guide the selection of areas that required caution when the subsurface work was to begin.

The geophysical survey was conducted as described in Section 3.2.3 in the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.3 in the Final Work Plan (NUS Corporation, February 1988) with the following exceptions:

- The grid system was not oriented along true north, as specified by the Field Operations Plan, but rather was oriented northwest-southeast. The soil-gas system grid was used to provide continuity and correlation between the soil-gas and magnetics data. The soil-gas grid was oriented in this fashion for convenience.

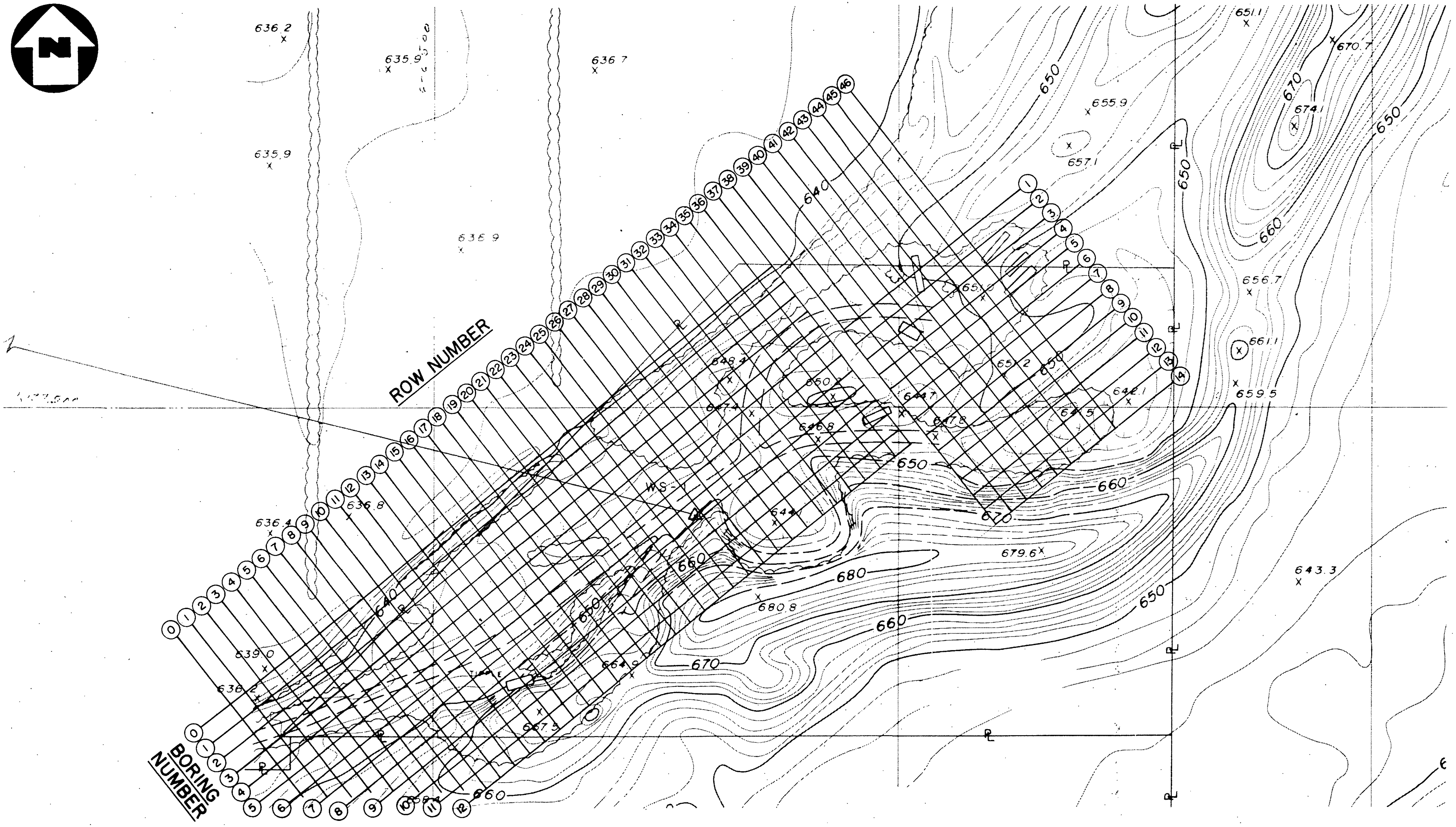


FIGURE 2-3

ORIENTATION OF SOIL-GAS SAMPLING GRID
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

- The grid could not be extended the specified 100 feet past the area of interest because of the massive amounts of scrap and/or equipment that surrounded each of the suspected disposal areas. The grid was extended as far out as possible in each case, generally approximately 50 feet.

Appendix A contains details of the geophysical investigation conducted at the site.

2.5 SURFACE SOIL INVESTIGATION

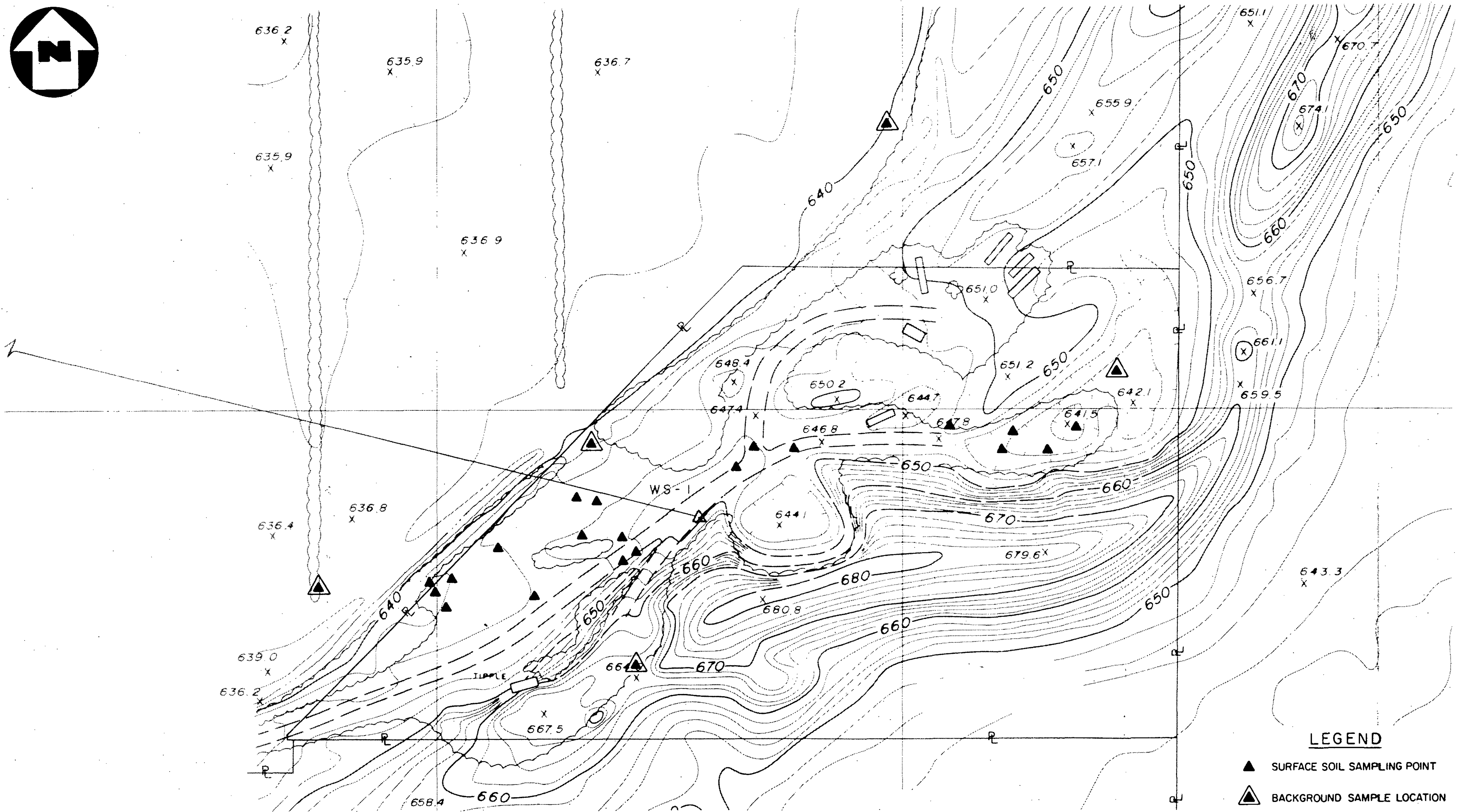
A total of 25 surface soil samples were collected during the field investigation at the locations shown in Figure 2-4. The locations were selected based on the results of the soil-gas investigation and historical information. Of the 25 samples, 21 were collected on site, and 4 were collected off site to provide background information. Surface soil samples were collected to provide the necessary data to assess the risks posed by dermal contact, as well as to provide information on potential contamination migration via surface-water erosion of soil. This task was also designed to augment the soil-gas survey, which is effective for the detection of only volatile organics. These data will be helpful in characterizing surficial contamination by nonvolatile/semivolatile chemicals.

The soil sampling program was conducted as described in Section 3.2.4 of the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.4 of the Final Work Plan (NUS Corporation, February 1988). All sampling procedures were performed as prescribed in Sections 3.2.4.1 and 3.3 of the Final Field Operations Plan.

2.6 SUBSURFACE SOIL INVESTIGATION

As shown in Figure 2-5, test pits and trenches were dug at 46 locations, from which a total of 130 subsurface soil samples were collected for analysis. The subsurface sampling was expected to provide an indication of residual contamination because of potential losses of contaminants from the surface through leaching and volatilization. All samples were analyzed by the onsite analytical laboratory to provide rapid turnaround results. The early results from the initial samples were helpful in directing the ongoing excavation of the test pits. The mobile laboratory analyzed for volatile organics only, as described in Section 3.2.5 of the Final Work Plan (NUS Corporation, February 1988). Twenty samples, picked at random, were sent to a fixed-base laboratory to be analyzed for TCL inorganic and organic parameters using CLP protocols.

The trenching also provided the means to identify any area that might require in-situ or post-excavation treatment. No areas of this type were identified during this activity.



LEGEND

▲ SURFACE SOIL SAMPLING POINT

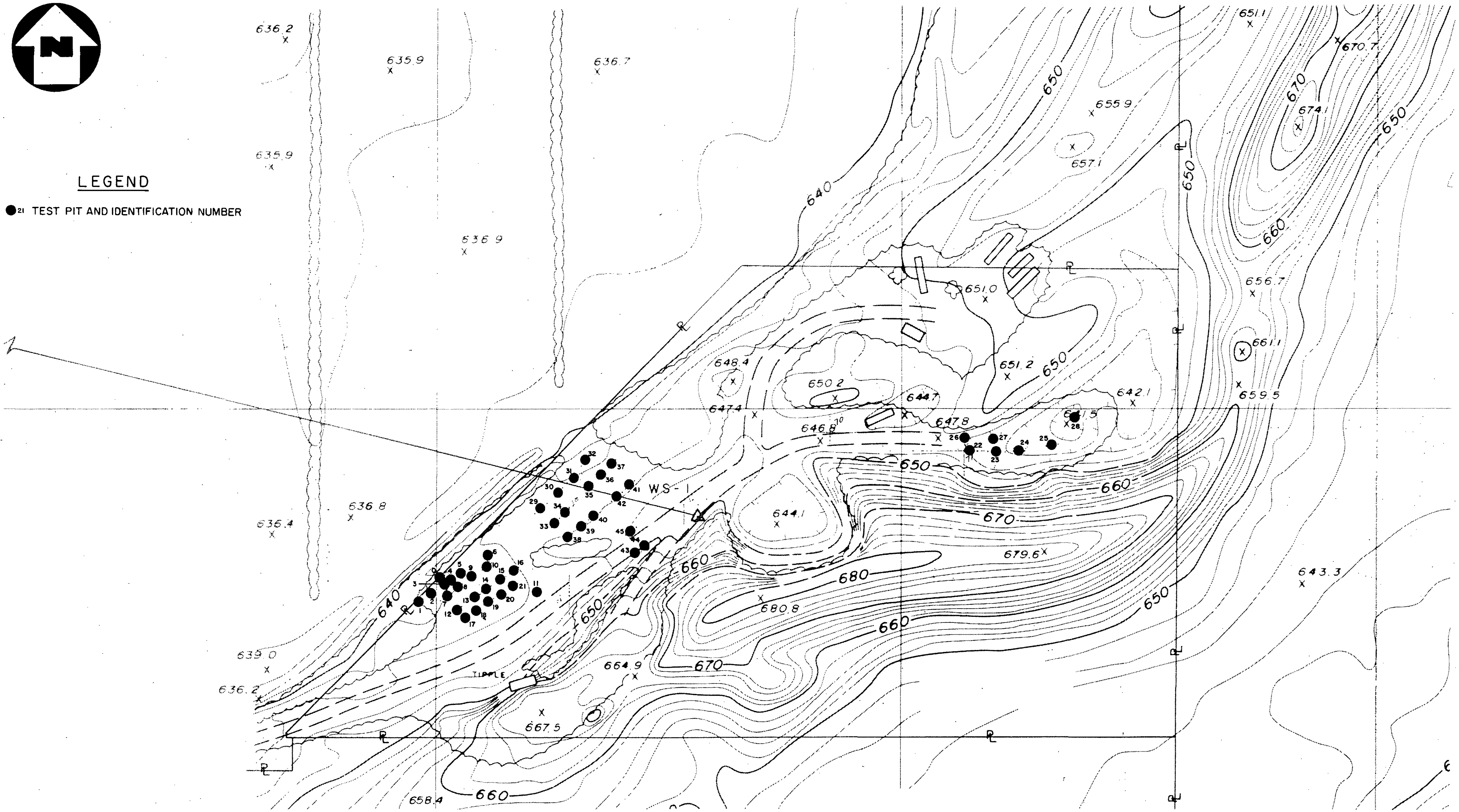
△ BACKGROUND SAMPLE LOCATION

FIGURE 2-4

LOCATION OF SURFACE SOIL SAMPLING POINTS
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

FIGURE 2-5



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LOCATION OF TEST PITS
BYRON BARREL AND DRUM SITE, BYRON, NY

The test pitting and subsurface soil sampling were conducted as described in Section 3.2.5 of the Final Work Plan (NUS Corporation, February 1988) and Sections 3.2.5 and 3.2.5.2 of the Final Field Operations Plan (NUS Corporation, March 1988) with the following exceptions:

- Sampling depths were altered from 4 feet and 8 feet to depths of approximately 2, 4, and 6 feet because of the presence of water at 7 feet in the first pits dug. Deeper samples were obtained where water was not encountered.
- The sample collection point was changed to either the center of the backhoe bucket or the center of the spoils pile from the trench because problems arose in reaching the center of the bucket.
- Trenches were dug in a series of small pits because continuous trenches collapsed.
- Samples were not coned and quartered in an effort to prevent outgassing of volatile organics and to preserve sample integrity.
- The Field Operations Plan originally specified that approximately 200 samples would be taken from the test pits, but 130 samples were considered to be sufficient for the purposes of the investigation. The extent of contamination was adequately defined through volatile organic analysis of these samples. Only one significant source was identified, and this area was well characterized by samples analyzed in both the onsite mobile laboratory and a fixed-base laboratory.

All test pits were backfilled to the original elevation, and the soil was tamped in place with the backhoe bucket.

2.7 HYDROGEOLOGIC INVESTIGATION

The hydrogeologic investigation consisted of the drilling of 20 overburden monitoring wells, the installation of four staff gages, aquifer testing, groundwater sampling of all monitoring wells, and five rounds of water-level measurements. Each of these activities was conducted in accordance with the procedures outlines in the EPA- and NYSDEC-approved Final Work Plan and Final Field Operations Plan for the Byron Barrel and Drum Site (NUS Corporation, February 1988 and March 1988, respectively). Exceptions to the procedures outlined in these plans were sometimes necessitated by field conditions and any modifications are outlined in this section.

2.7.1 Monitoring Well Installation

A total of 20 monitoring wells were installed during the hydrogeologic investigation. These wells were drilled in clusters of two (one deeper well labeled "A" and a shallower well labeled "B") into the overburden containing the aquifer to be examined. The deep well was drilled first, and soil samples were collected for geological description. The shallow well, which was drilled second, was not sampled because logs were kept for the deep wells. Boring logs for all deep wells are presented in Appendix B.

The wells were drilled in 14 separate locations, as shown in Figure 2-6. Of these 14 locations, six have clusters of two wells and eight have only a single well. Well clusters were not installed all locations because the ongoing well analysis revealed that the contaminants were more concentrated in the direction of the onion field located northwest of the site. Once the direction of groundwater flow was established, it was determined that only single wells would be drilled to encounter the upper portion of the water table. These wells would be similar to the "B" wells (shallow) that had been drilled previously. The exception to this was location number four (on top of the esker), where MW-4A was drilled. After the deep well was drilled, a shallow well was deemed unnecessary because the saturated zone was very thin. At the cluster locations, the shallow well was screened in the upper half (approximate) of the aquifer and the deep well was screened in the lower half. Where the aquifer thinned, only one well was deemed necessary for all measurements and sampling.

All monitoring wells were installed as described in Section 3.2.6 of the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.6 of the Final Work Plan (NUS Corporation, February 1988), with the following exceptions:

- Twenty wells were drilled instead of the eighteen originally proposed. As drilling progressed and quick turn-around sample analyses were received from the wells in locations 1 through 7, it became apparent that two more wells would be necessary to complete the desired pattern in the direction of the groundwater flow.

- Wells MW-1A, MW-2A, MW-4A, and MW-7A were cored. Well MW-3A was not cored because of very unstable downhole conditions. MW-5A and MW-6A were not cored because of a combination of weather problems and unstable conditions (abundant gravel and boulders) encountered in the wells.

- The coring that took place in the above-mentioned wells never totaled a full 10 feet in any of the wells because the rig pump did not have the power necessary to pump mud through the core barrel while drilling at that depth. Coring operations continued in a given well until the pump would not continue to work.

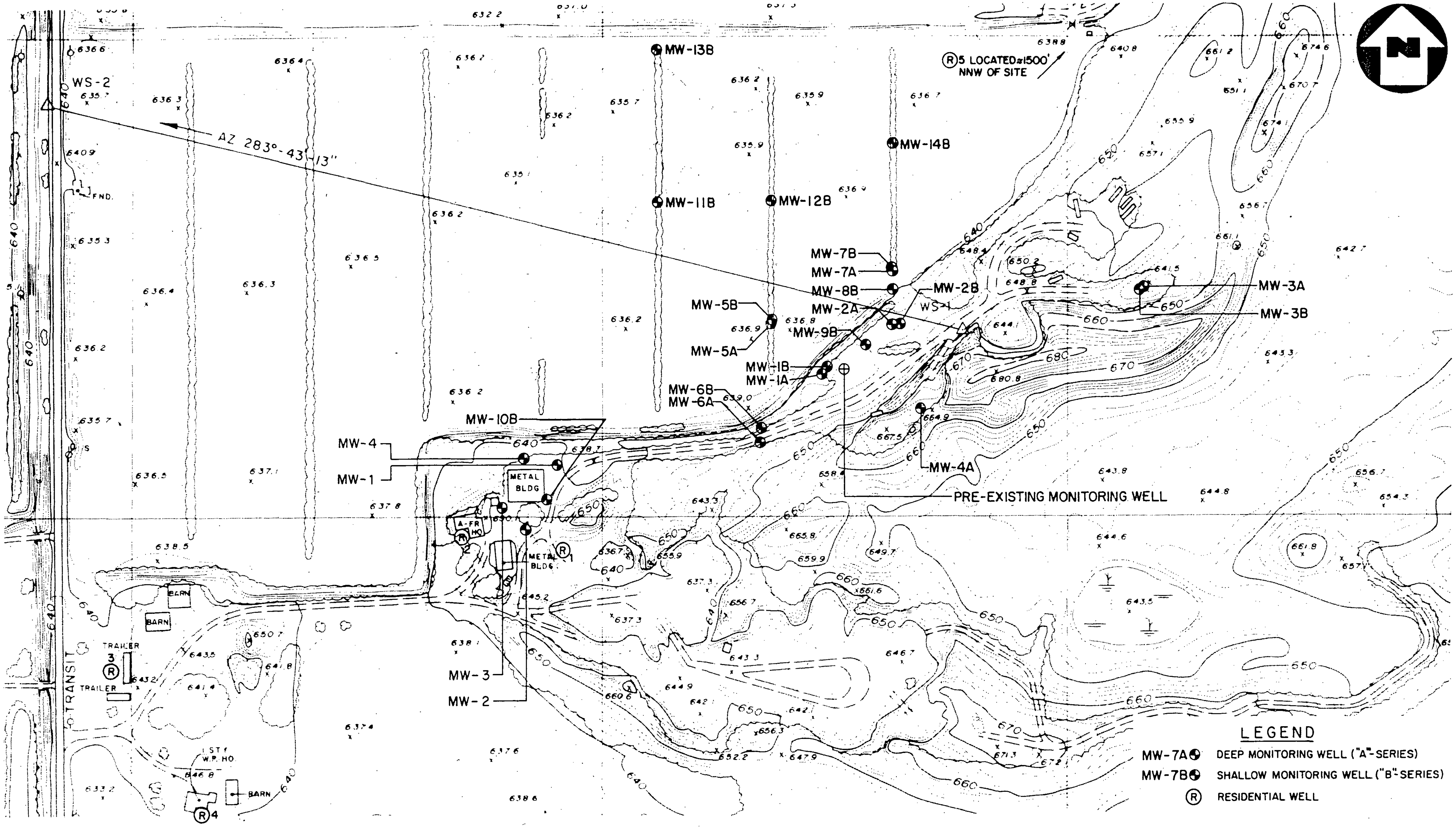


FIGURE 2-6

0 200 400
SCALE IN FEET

LOCATION OF MONITORING AND RESIDENTIAL WELLS
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

2.7.2 Well Construction/Installation

The monitoring wells were installed and developed as described in Section 3.2.6.3 and Section 3.2.6.4 of the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.6 of the Final Work Plan (NUS Corporation, February 1988), with the following exception:

- MW-13B and MW-14B were installed with 5-foot (rather than 10-foot) screens with slot sizes of 0.01 inches, since the addition of two extra wells required additional screen. The drillers had 5-foot screens in stock, which allowed the predetermined guidelines and timetable to be preserved. Well construction details are provided in Appendix C.

2.7.3 Aquifer Testing

The hydraulic conductivity of each newly constructed well was measured by slug-testing techniques. All slug tests were run using a solid slug of predetermined size to effect a measurable rise and fall in the static water level during the course of the test. Data were collected using a 10 PSI pressure transducer and data logger. Both rising-head and falling-head tests were performed on each well. All slug test data and information are included in Appendix D.

One pump test was performed within the study area. MW-2A was chosen as the pumping well because of its proximity to the contaminant source areas and the surrounding wells. MW-2B was chosen as the initial observation well. The test was set up as a drawdown/recovery test. Drawdown and recovery were observed in MW-2A. No change in the water level was noticed in MW-2B. The pump test data are included in Appendix D.

2.7.4 Water-Level Measurements

Five complete rounds of water-level measurements were obtained during the field investigation. Water-level measurements were obtained to define groundwater flow directions, the proximity of the water table to contaminated soils, vertical gradients, and hydrologic connections with local surface water bodies. Water levels were measured in November, December, April, and June, and therefore provide some indication of temporal variations in hydrologic conditions. Water levels were measured as described in Section 3.2.6.7 in the Final Field Operations Plan (NUS Corporation, March 1988).

2.7.5 Staff Gage Installation

Four staff gages were installed at the site to define the hydrologic relationship between groundwater and local surface water bodies. Two gages were located in a drainage ditch running from northeast to southwest along the perimeter of the site. Two gages were located in an east to west trending drainage ditch located directly north of the farmland immediately west of the site. Water-level measurements were obtained in these surface water bodies during two of the groundwater sampling rounds (i.e., those conducted in April and June, 1989). Water levels measurements could not be obtained in the streams during previous water-level measurement rounds as a result of the absence of water or the presence of ice. Staff gage locations are depicted on Figure 2-7.

2.8 RESIDENTIAL WELL SAMPLING

Five residential wells were sampled during the field investigation. Well locations are shown in Figure 2-6. The well samples were obtained as described in Section 3.2.7 of the Final Field Operations Plan with the following exception:

- The purging time required for the residential wells was not specified. These wells were purged for approximately 10 minutes before the sample was taken.

2.9 SURFACE-WATER AND SEDIMENT INVESTIGATION

Surface water and sediment samples were collected to assess possible contaminant migration pathways and to establish the need and direction for a second round of sampling. Sample locations are shown in Figure 2-7.

Surface-water and sediment sampling was conducted as prescribed in Section 3.2.8 of the Final Field Operations Plan (NUS Corporation, March 1988) and Section 3.2.7 of the Final Work Plan (NUS Corporation, February 1988), with the following exception:

- Fewer surface water samples were collected during round 1 than anticipated as a result of dry conditions in the field.

- The surface water and sediment sampling program was expanded to 15 locations during the second round of sampling to assess potential impacts on Oak Orchard Creek.

2.10 SUPPLEMENTAL FIELD INVESTIGATION ACTIVITIES

As a result of the discovery of an additional contaminant source in the southwestern portion of the site property, supplemental field investigation activities were conducted at the Byron Barrel and Drum Site in April and May of 1989. This source was discovered through sampling and analysis of groundwater samples from a monitoring well installed beside a maintenance building located near the southwestern property boundary. Previous samples collected from monitoring wells located between known source areas and residential wells located to the southwest of the site (MW-6A and MW-6B), as well as water level measurements,

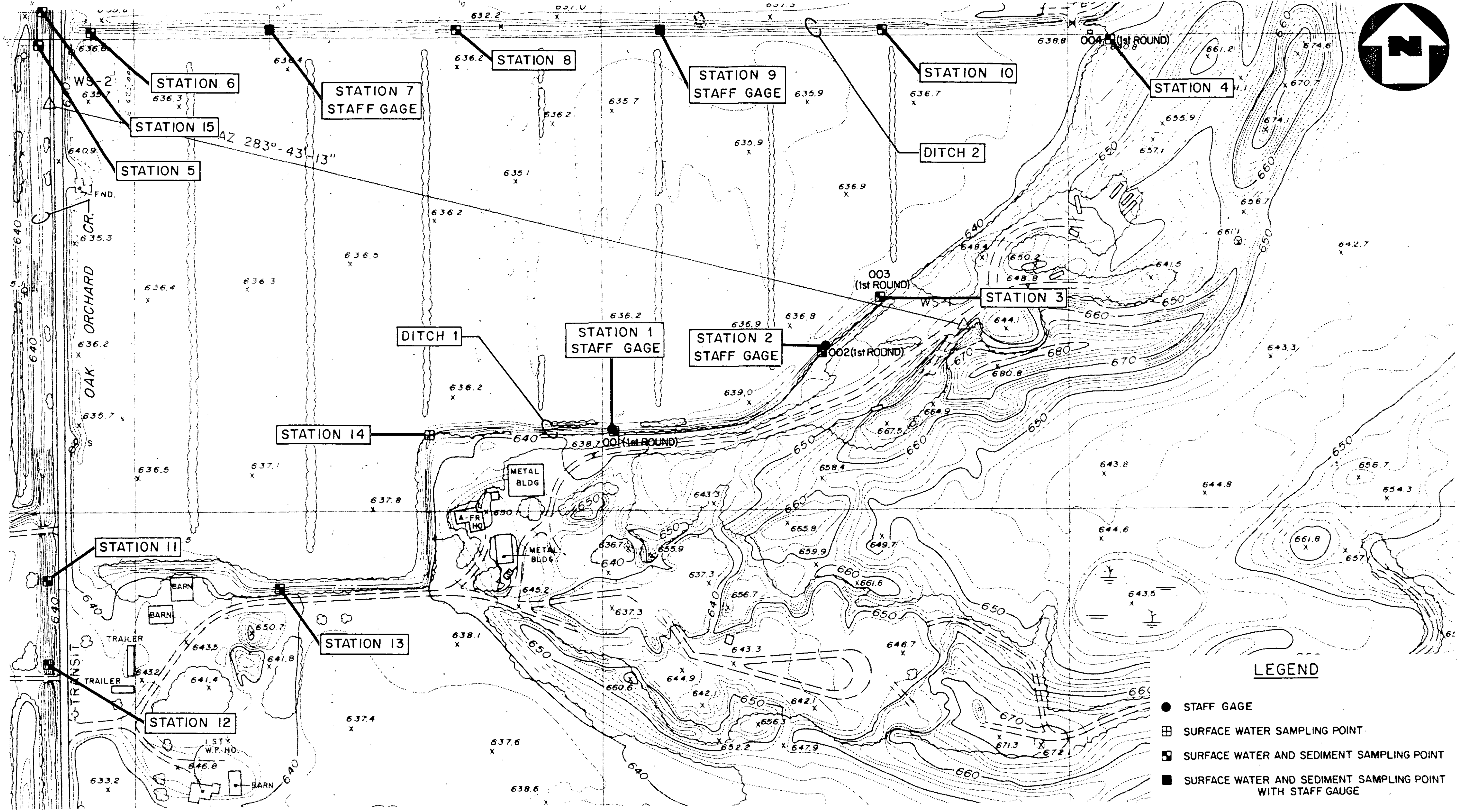


FIGURE 2-7

LOCATION OF SURFACE WATER AND SEDIMENT SAMPLING POINTS, STAFF GAGES
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

indicated that a contaminant migration pathway to the southwest does not exist at the site. However, during the final stage of the phased well installation program, a well was installed near a maintenance building located approximately 650 feet southwest of source area 1 (MW-10B). This well was installed to confirm that no southwestern migration toward the residential wells had occurred and to provide additional information regarding groundwater flow directions. However, samples from this well contained organic contaminants. Based on the nature of this contamination it was determined that an additional source of contamination existed in the vicinity of the maintenance building.

Therefore, supplemental field investigation activities were conducted in this area, including a soil-gas survey, a soil boring and subsurface soil sampling and analysis program, monitoring well and temporary well point installation, and groundwater sampling and analysis. These activities were conducted in accordance with the scope of work outlined in Work Assignment Amendment Number 1, dated April 17, 1989 (Ebasco, April 17, 1989). The data collection activities and minor alterations to the proposed scope of work are summarized in the remainder of this section.

2.10.1 Soil-Gas Investigation

A total of 28 additional soil-gas survey points were investigated in the vicinity of the maintenance building source. The soil-gas survey was conducted in accordance with the scope of work outlined in Work Assignment Amendment Number 1. However, only 28 soil-gas survey points were investigated, whereas the Work Assignment Amendment called for installation of up to thirty soil-gas borings. Twenty-eight borings were considered sufficient for delineation of soil gas anomalies. The supplemental soil-gas survey points are depicted in Figure 2-8.

2.10.2 Soil-Boring Program and Subsurface Soil Sampling

A total of seven soil borings were drilled during the supplemental field investigation. Some deviations from the scope of work outlined in Work Assignment Amendment Number 1 were necessitated by subsurface geologic conditions. Although the Work Assignment Amendment called for subsurface soil sampling during monitoring well installation, sample recovery could not be effected because large amounts of gravel and cobbles were present at monitoring well boring locations. Ultimately, only seven soil borings were completed and sampling depths were constrained by the presence of gravel and cobbles. At most locations, samples could not be recovered from the proposed depths of 4 and 8 feet. Seventeen subsurface soil samples, rather than the twenty-five samples originally proposed, were obtained for volatile organic analysis. Subsurface soil sampling locations are depicted in Figure 2-9.

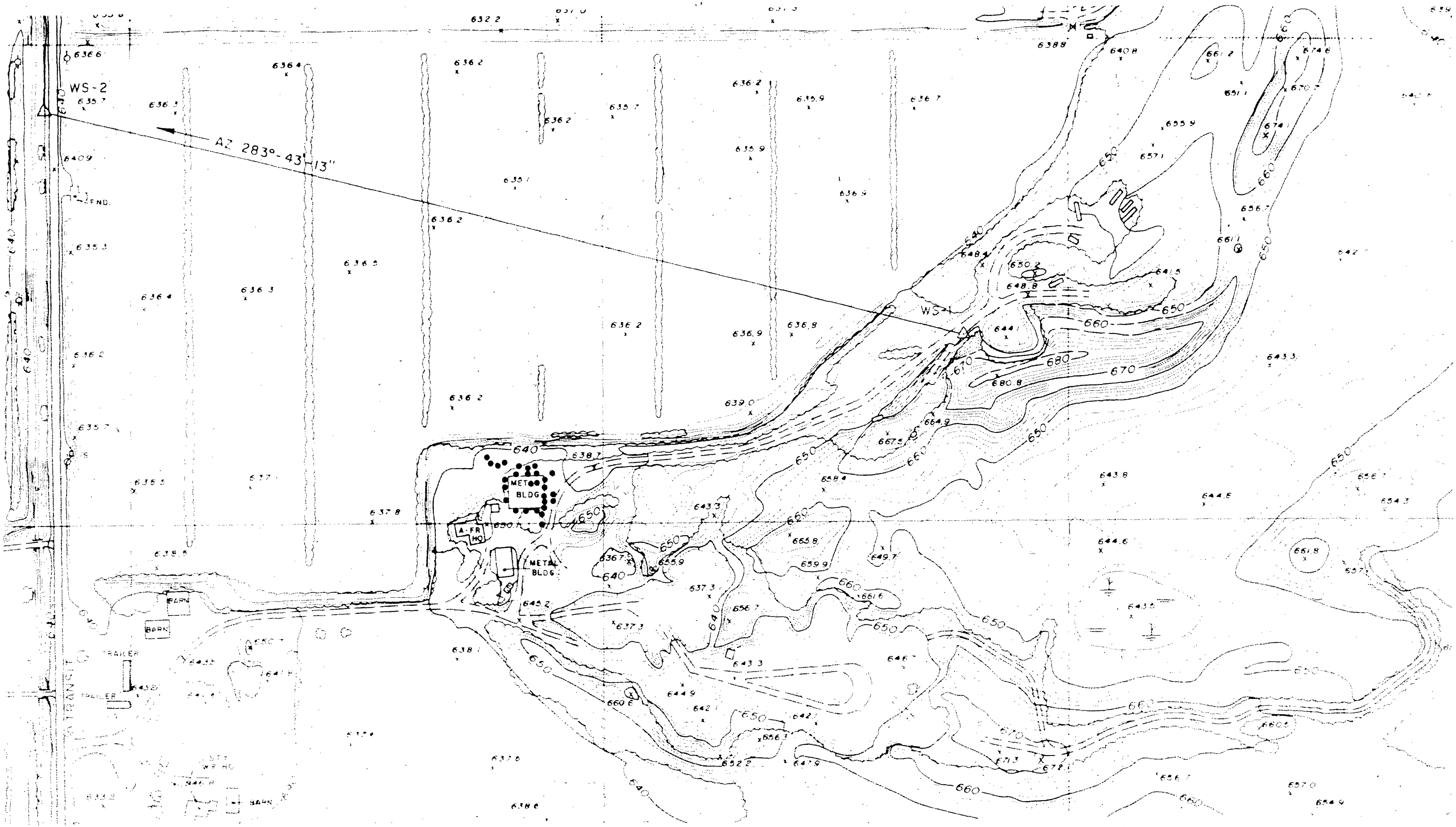


FIGURE 2-8

LOCATION OF SOIL-GAS SURVEY POINTS
SUPPLEMENTAL FIELD INVESTIGATION
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

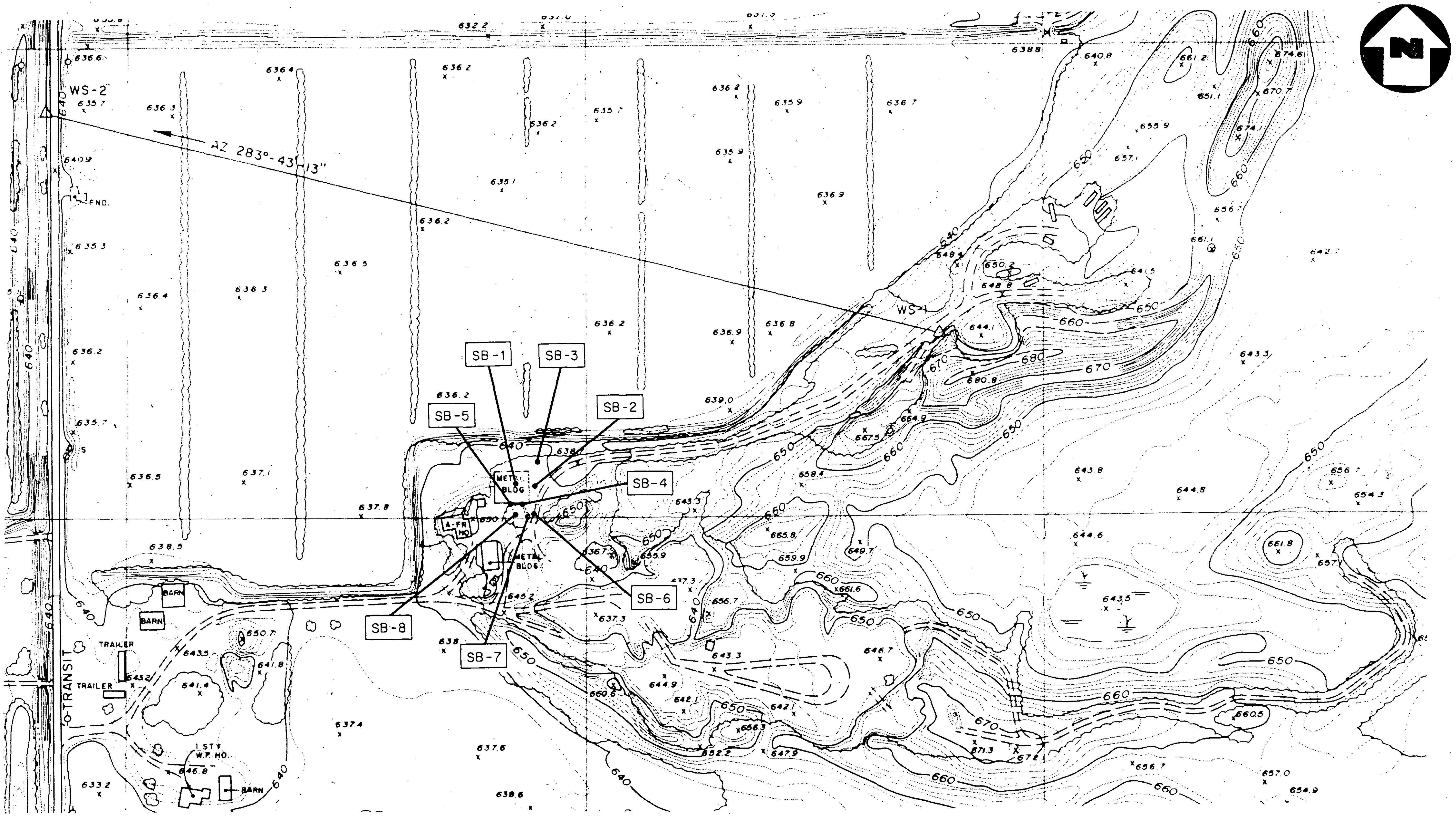


FIGURE 2-9

LOCATION OF SOIL BORINGS
SUPPLEMENTAL FIELD INVESTIGATION
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

2.10.3 Monitoring Well and Temporary Well Point Installation

A total of seven permanent monitoring wells and seven temporary well points were installed during the supplemental field investigation. Wells and well points were installed in accordance with the scope of work outlined in Work Assignment Amendment Number 1 (Ebasco, April 17, 1989). Seven, rather than five, well points were installed to better define the extent of groundwater contamination. Groundwater samples were collected and analyzed for volatile organics. The supplemental permanent monitoring well and temporary well point locations are depicted in Figure 2-10.

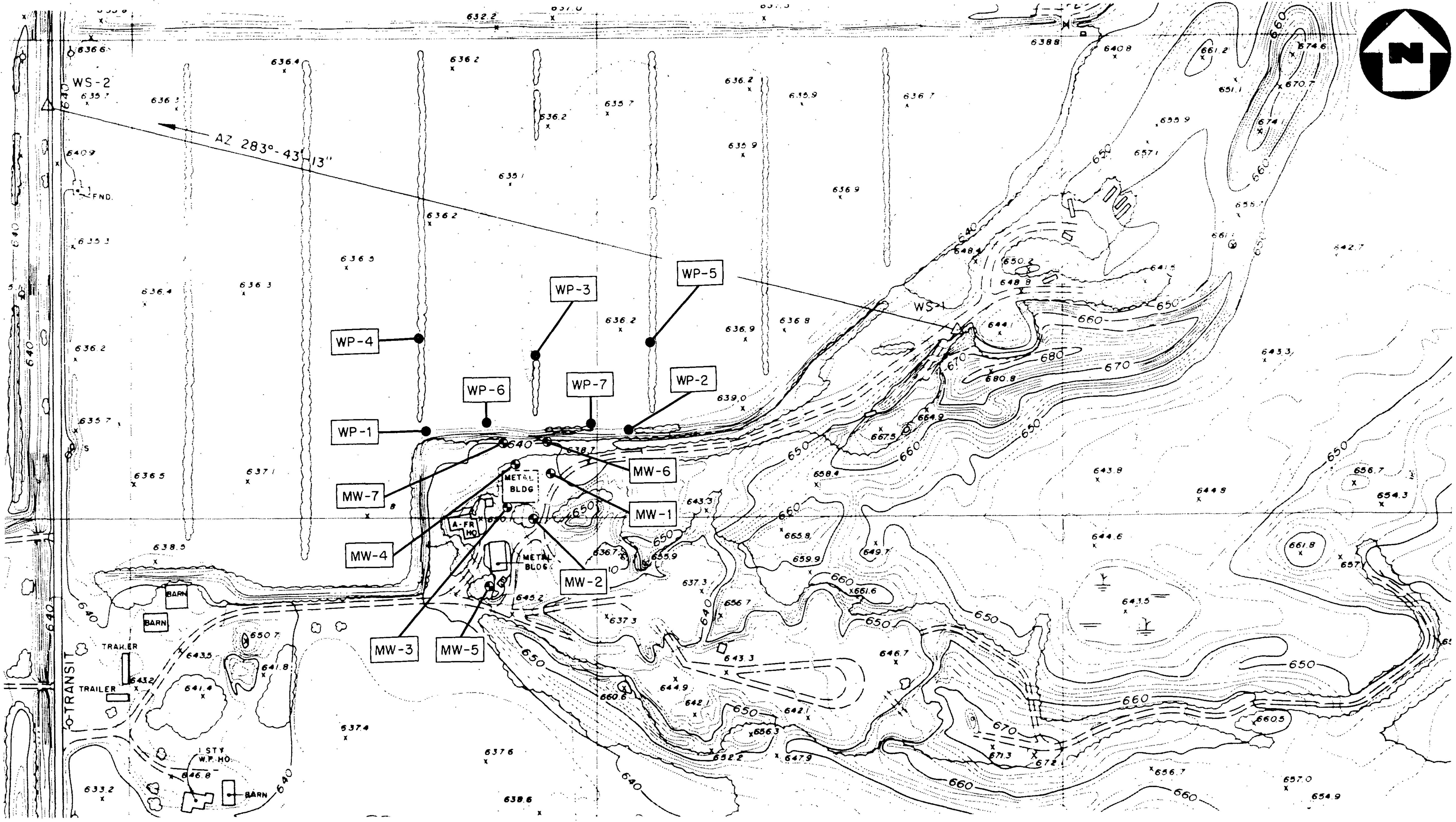


FIGURE 2-10

LOCATION OF MONITORING WELLS AND TEMPORARY WELL POINTS
SUPPLEMENTAL FIELD INVESTIGATION
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

3

3.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

3.1 SURFACE FEATURES AND LAND USE

The study area ranges in elevation from 640 feet to 665 feet above mean sea level (MSL). The study area includes the site and an area bounded on the west and north by an active onion farm and on the southwest by an active sand and gravel pit (see Figure 2-1). Southeast of the site is a heavily wooded area. The farmland originated from low, swampy land and is highly organic in composition. This is referred to as "muckland" and is classified as prime agricultural land by the State of New York.

The site occupies 2.2 acres of an 8-acre parcel off Transit Road. Oak Orchard Creek is the nearest surface-water body. It originates southwest of the site and flows in a generally north-northeasterly direction, approximately 1,000 feet west of the site. The creek collects runoff from the east by way of a drainage tile and ditch system installed throughout the onion fields. A private home is located southwest of the site. Two large vacant buildings are located on site. The site is littered with dozens of large, diverse pieces of construction equipment, including bulldozers and cement trucks that are not in working order.

3.2 CLIMATE AND METEOROLOGY

Western New York has a moderate, continental climate in the summers, whereas the winters can be both long and cold. The average high temperature for the area around Buffalo is 55.0°F and the low averages 39.1°F. The proximity of the Great Lakes moderates swings in the temperature. The annual rainfall averages about 32 inches with an average snowfall of approximately 95 inches. These snows are primarily caused by the effect of lakes Erie and Ontario. Prevailing winds are generally from the west-southwest averaging 8 to 14 miles per hour (Wulforst et al., 1969).

3.3 REGIONAL GEOLOGY

The surficial geology of the region is characterized by glacial debris and drift deposited as part of the Barre Oscillation during the late Wisconsinan Age approximately 12,300 years ago. These deposits consist of eskers, moraines, terraces, coarse gravel and sand, low swampy basins, and muckland. These features were originally associated with the eastern end of ancient Lake Tonawanda. Lake Tonawanda persisted in an enclosed basin after glacial withdrawal. Its boundaries were comprised, in part, by the Barre and Batavia Moraine Systems along with scattered ridges made up of eskers, ridges, and terraces. As the lake dried up, part of its eastern half became the low swampy basin that, today, exists as the Great Bergen Swamp and Alabama Swamp. Much of its level floor was cleared for the farmland that is in use today. This is the muckland that comprises the extensive onion fields located north and west of the site (Muller, 1977).

The repeated advances and retreats of the Wisconsinan glaciers left the boulder clay, locally known as "glacial till," that underlies the surface features described above. Glacial till was transported by and lodged beneath actively flowing continental ice sheets and is considered an example of a ground moraine. This material is found throughout the region in thicknesses as great as 100 feet. Glacial till is characterized by silty clay and silty sand that is sparsely to moderately stony, very compact, and highly impermeable. The glacial till is generally found to be deposited directly on top of the bedrock (Muller, 1977).

The bedrock underlying the glacial till in this region is Silurian in age and consists of massive argillaceous limestones, calcareous shales, and dolostones. This particular group is approximately 20 miles wide (north to south) at the site with older rocks to the north and younger rocks to the south.

3.4 STUDY AREA GEOLOGY

3.4.1 Introduction

This section details the geological findings of the remedial investigation. The raw data obtained during the RI are included in Appendices B, C, and D. A series of cross-sections, two potentiometric surface maps, a bedrock surface contour map, and a glacial till surface contour map were generated with these data.

A total of 20 monitoring wells and 4 staff gages were installed during the field investigation, as shown in Figure 3-1. A summary of well construction details is included in Table 3-1. Well construction diagrams are presented in Appendix C.

3.4.2 Subsurface Geology

The natural overburden at the site consists of organic soil with silty sands that may incorporate finer or coarser material. This material comprises the aquifer of concern. The overburden is underlain by impermeable glacial till that separates the overburden and the underlying bedrock. The bedrock is Silurian-age argillaceous limestone with intermittent dolostone. These three geologic features are common to the entire study area. The relationships between the overburden, till, and bedrock are shown in cross-sections presented as Figures 3-2, 3-3, and 3-4. Cross-section locations are shown on Figure 3-1. Detailed boring logs are presented in Appendix B.

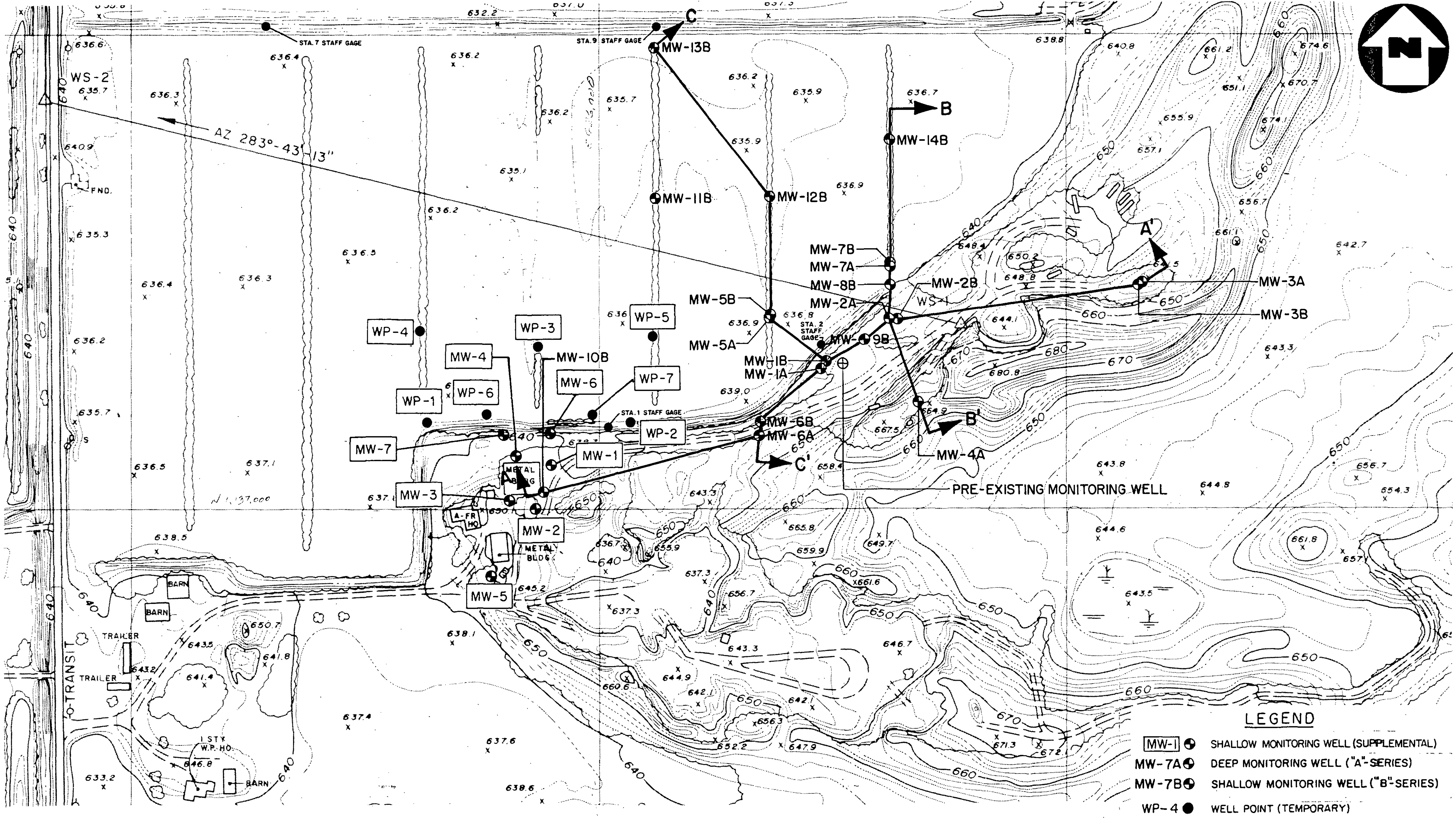


FIGURE 3-1

0 200 400
SCALE IN FEET

LOCATION OF MONITORING WELLS AND HYDROGEOLOGIC CROSS SECTIONS
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

TABLE 3-1

MONITORING WELL CONSTRUCTION DATA
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Well Number	Elevation (feet-MSL)		Bedrock		Open Interval/Screen Setting				Hydraulic Conductivity Values	
					Depth (feet)		Elevation (feet-MSL)			
	Ground Surface	Water-Level Measuring Point	Depth (feet)	Elevation (feet-MSL)	From	To	From	To	Falling Head (cm/sec)	Rising Head (cm/sec)
MW-1A	641.27	643.13	75.0	566.27	17.0	27.0	624.27	614.27	2.42×10^{-4}	8.41×10^{-5}
MW-1B	641.77	643.95	NA	NA	4.0	14.0	637.77	627.77	*	2.61×10^{-2}
MW-2A	645.24	646.86	76.0	569.24	17.5	27.5	627.74	617.74	2.82×10^{-3}	1.13×10^{-3}
MW-2B	644.91	646.87	NA	NA	5.0	15.0	639.91	629.91	2.67×10^{-3}	2.10×10^{-3}
MW-3A	641.50	642.84	74.0	567.50	11.0	21.0	630.50	620.50	4.22×10^{-3}	4.45×10^{-3}
MW-3B	642.14	643.65	NA	NA	4.0	14.0	638.14	628.14	7.04×10^{-3}	7.56×10^{-3}
MW-4A	665.51	667.35	97.5	568.01	34.0	44.0	631.51	621.51	3.38×10^{-3}	5.56×10^{-3}
MW-5A	637.04	638.17	NA	NA	13.0	23.0	624.04	614.04	1.08×10^{-2}	5.30×10^{-3}
MW-5B	636.67	638.32	NA	NA	4.0	14.0	632.67	622.67	4.08×10^{-4}	4.45×10^{-4}
MW-6A	645.33	646.55	NA	NA	18.0	28.0	627.33	617.33	*	*
MW-6B	645.01	647.29	NA	NA	6.5	16.5	638.51	628.51	*	2.86×10^{-2}
MW-7A	638.98	640.92	72.0	566.98	14.0	24.0	624.98	614.98	6.25×10^{-4}	1.06×10^{-3}
MW-7B	638.85	640.45	NA	NA	5.0	15.0	633.85	623.85	2.82×10^{-3}	4.02×10^{-3}
MW-8B	639.76	641.65	NA	NA	5.0	15.0	634.76	624.76	*	8.30×10^{-4}
MW-9B	644.09	646.15	NA	NA	9.5	19.5	634.59	624.59	*	*
MW-10B	641.59	643.89	NA	NA	8.0	18.0	633.59	623.59	8.89×10^{-3}	1.08×10^{-2}
MW-11B	636.26	638.00	NA	NA	5.0	15.0	631.26	621.26	5.21×10^{-4}	4.33×10^{-4}
MW-12B	636.82	638.98	NA	NA	5.0	15.0	631.82	621.82	9.93×10^{-4}	9.93×10^{-4}

TABLE 3-1
MONITORING WELL CONSTRUCTION DATA
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Well Number	Elevation (feet-MSL)		Bedrock		Open Interval/Screen Setting				Hydraulic Conductivity Values	
	Ground Surface	Water-Level Measuring Point	Depth (feet)	Elevation (feet-MSL)	Depth (feet)		Elevation (feet-MSL)		Falling Head (cm/sec)	Rising Head (cm/sec)
					From	To	From	To		
MW-13B	636.28	637.80	NA	NA	7.5	12.5	628.78	623.78	2.12 x 10^{-4}	2.25 x 10^{-4}
MW-14B	637.57	639.19	NA	NA	7.5	12.5	630.07	625.07	5.57 x 10^{-4}	5.34 x 10^{-4}
MW-1	640.09	642.30	NA	NA	7.5	12.5	632.59	627.59	**	**
MW-2	644.61	645.93	NA	NA	8.5	13.5	636.11	631.11	**	**
MW-3	647.81	649.15	NA	NA	11.5	16.5	636.31	631.31	**	**
MW-4	640.78	641.70	NA	NA	6.5	11.5	634.28	629.28	**	**
MW-5	647.22	648.28	NA	NA	12.0	17.0	635.22	630.22	**	**
MW-6	638.68	639.18	NA	NA	6.0	11.0	632.68	627.68	**	**
MW-7	636.67	638.15	NA	NA	5.0	10.0	631.67	626.67	**	**

NA - Borings were not drilled to bedrock.
* - Not calculated (inaccurate data).
** - Not calculated (not tested).

All monitoring well diameters are 2.0 inches I.D. with the exception of MW-1 through MW-7 (1.25 inches I.D.).
All monitoring well screen slot sizes are 0.02 inches, with the exception of MW-13B, MW-14B and MW-1 through MW-7, which are 0.01 inches.

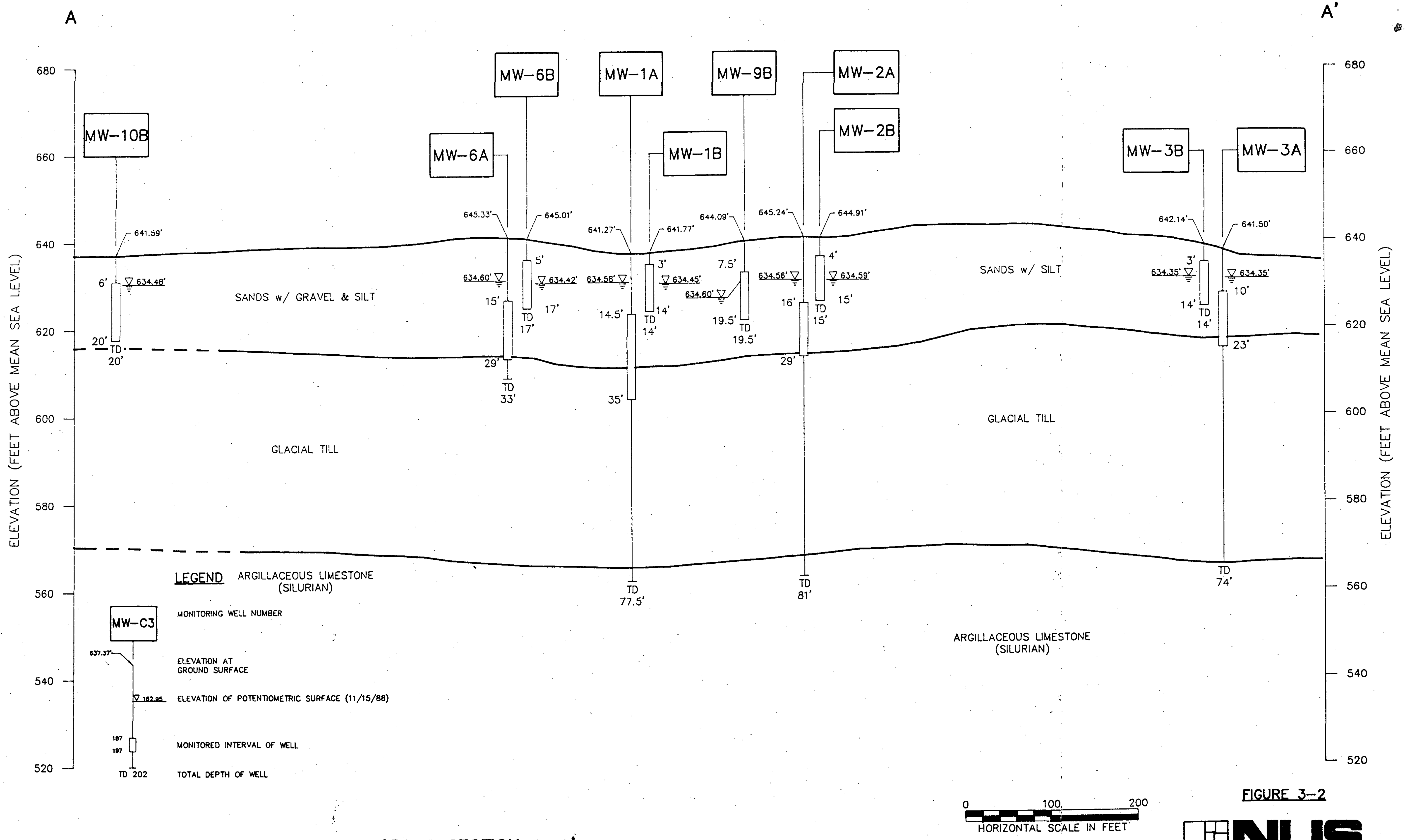


FIGURE 3-2

CROSS SECTION A-A'
BYRON BARREL & DRUM, BYRON, NY

NUS CORPORATION

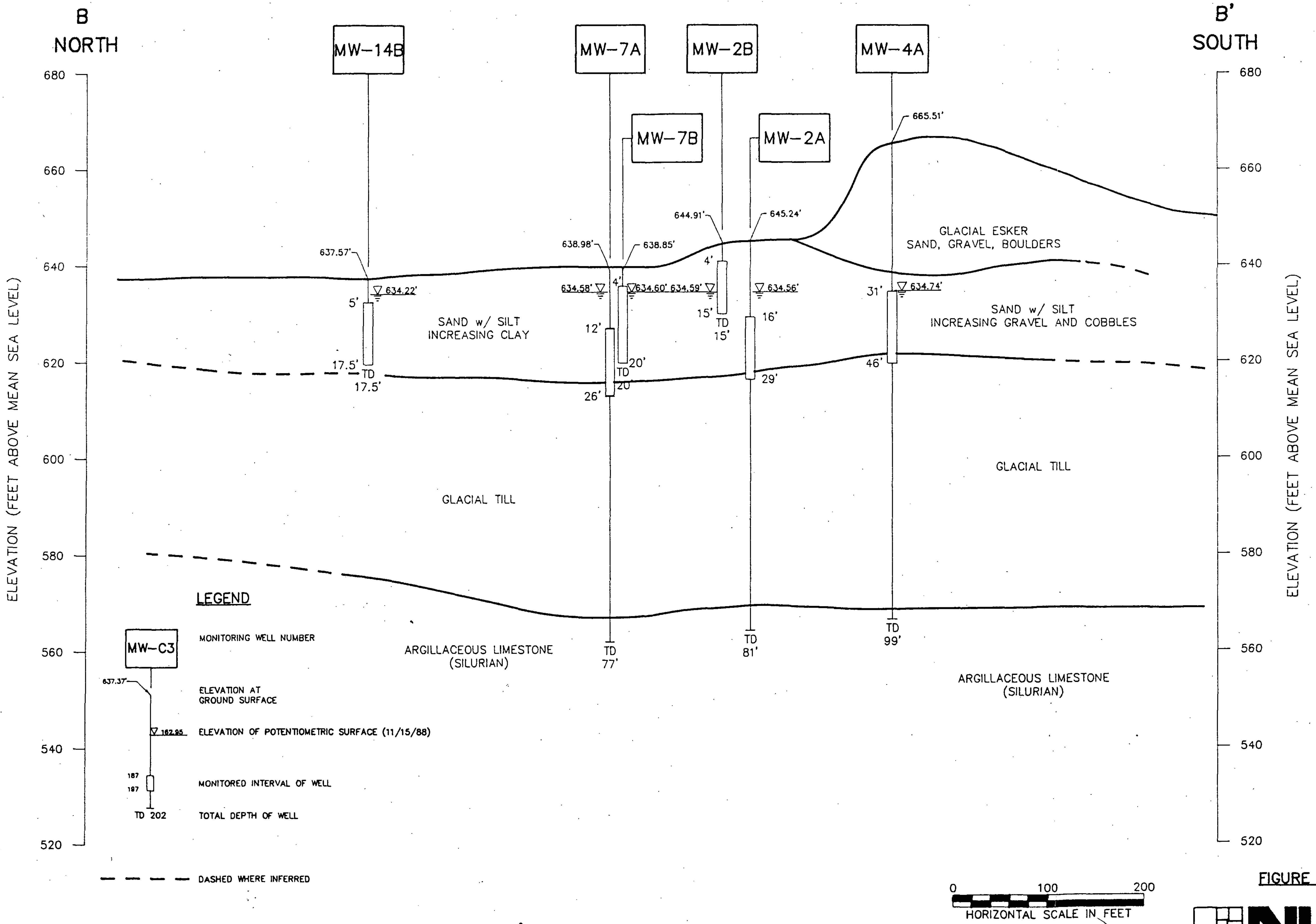


FIGURE 3-3

CROSS-SECTION B-B'
BYRON BARREL & DRUM, BYRON, NY

NUS CORPORATION

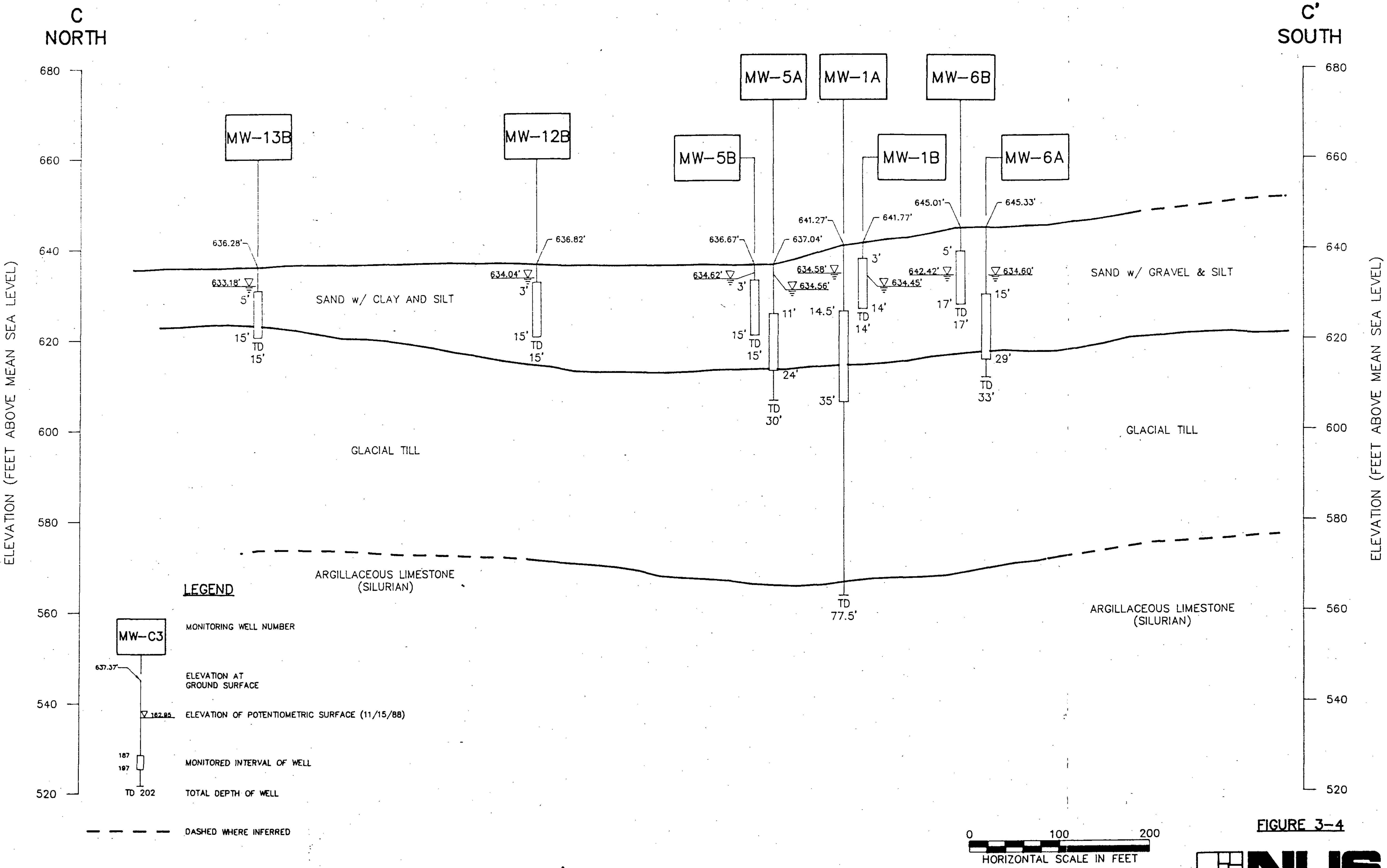


FIGURE 3-4

CROSS SECTION C-C'
BYRON BARREL & DRUM, BYRON, NY

NUS CORPORATION

3.4.2.1 Natural Overburden

The natural overburden in the study area is a Pleistocene-age glacial deposit from the Wisconsinan event. This material extends from the surface to a maximum observed depth of 44 feet at MW-4A, which was drilled at the highest elevation (see cross-section B-B' in Figure 3-3). The overburden thickens south-southeast of the site toward the esker and the gravel pit. The sand with silt becomes more coarse toward the esker, including gravel and small cobbles, although it still remains very poorly sorted. The glacial esker consists of predominantly coarse-grained materials, including sand, gravel, and boulders. The natural overburden thins in the direction of the onion fields to the north and northwest (see Figures 3-3 and 3-4). As the overburden thins, there is a corresponding reduction in grain size of individual grains to fine sands and silt with an increasing amount of clay. Even with this change in grain size, the overburden is still poorly sorted and remains similar to that found in MW-4A. At MW-13B, the overburden was approximately 11 feet thick; whereas, boring MW-1A encountered 27 feet of overburden before reaching the glacial till (see Figure 3-4, cross-section C-C').

3.4.2.2 Glacial Till

Glacial till was encountered in all the borings that were planned to penetrate to the bedrock surface. The glacial till is characterized by a sandy, silty clay that is slightly to moderately stony with no predetermined sorting pattern. The glacial till was completely penetrated in five wells: MW-1A, MW-2A, MW-3A, MW-4A, and MW-7A (see Figures 3-2, 3-3, and 3-4).

The thickest section of glacial till (53 feet) occurred in MW-3A and MW-4A. The other three wells that penetrated through the till show a slight thinning of section. Well MW-13B encountered till at a depth of approximately 12 feet, as opposed to the average of 24.5 feet on wells installed up to that point. The surface of the glacial till slopes toward the north-northwest, as shown in Figure 3-5.

3.4.2.3 Bedrock

The bedrock that underlies the study area was encountered in five borings (MW-1A, MW-2A, MW-3A, MW-4A, MW-7A). The maximum depth at which bedrock was encountered was 99.5 feet in MW-4A, and the minimum depth was 72 feet in MW-7A. The undulating bedrock surface slopes to the north-northwest, as shown on Figure 3-6. The bedrock on site consists of slightly fractured, very hard, argillaceous limestone with no visible porosity. All observed fractures were infilled with calcium carbonate.

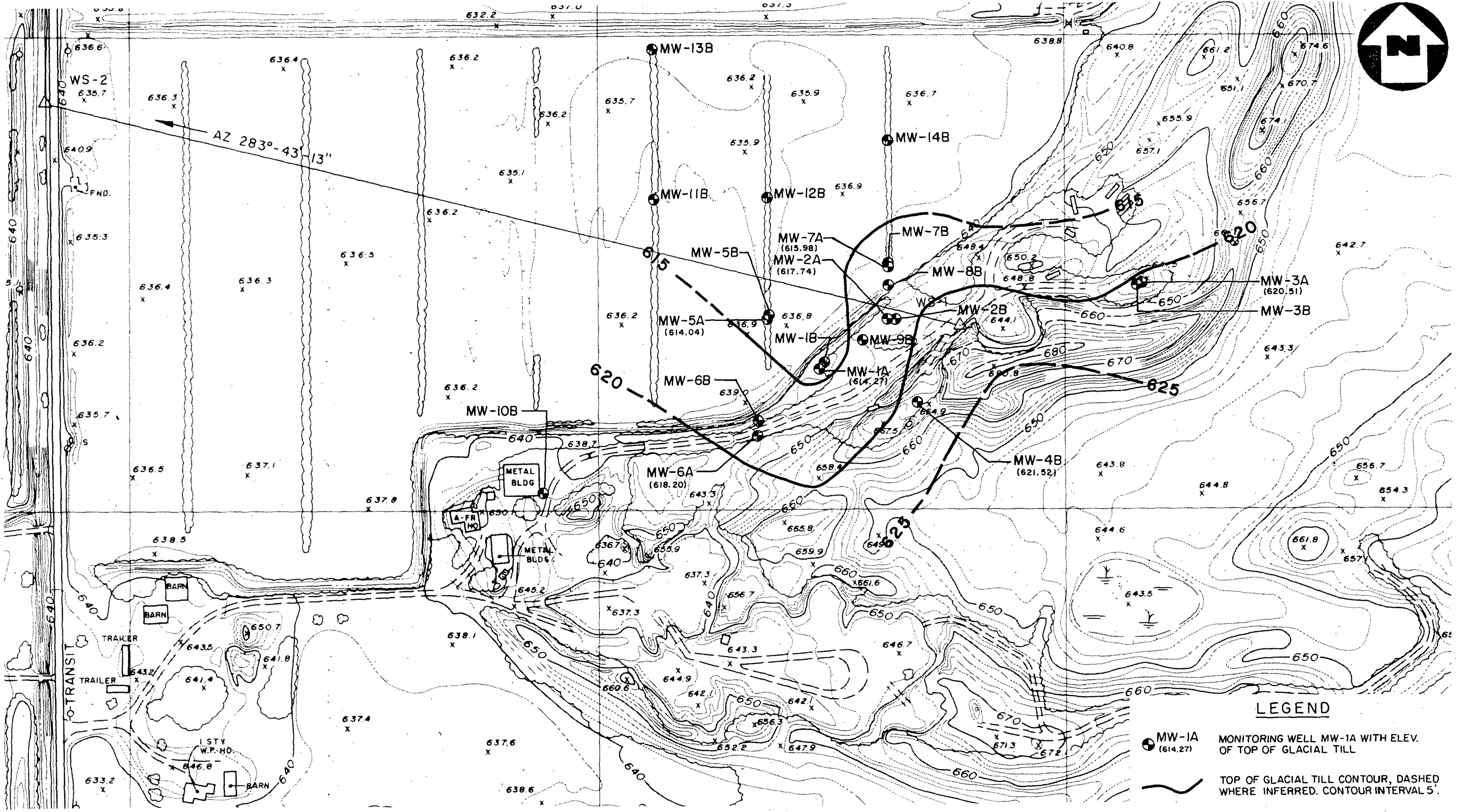


FIGURE 3-5

0 200 400
SCALE IN FEET

GLACIAL TILL SURFACE CONTOUR MAP
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

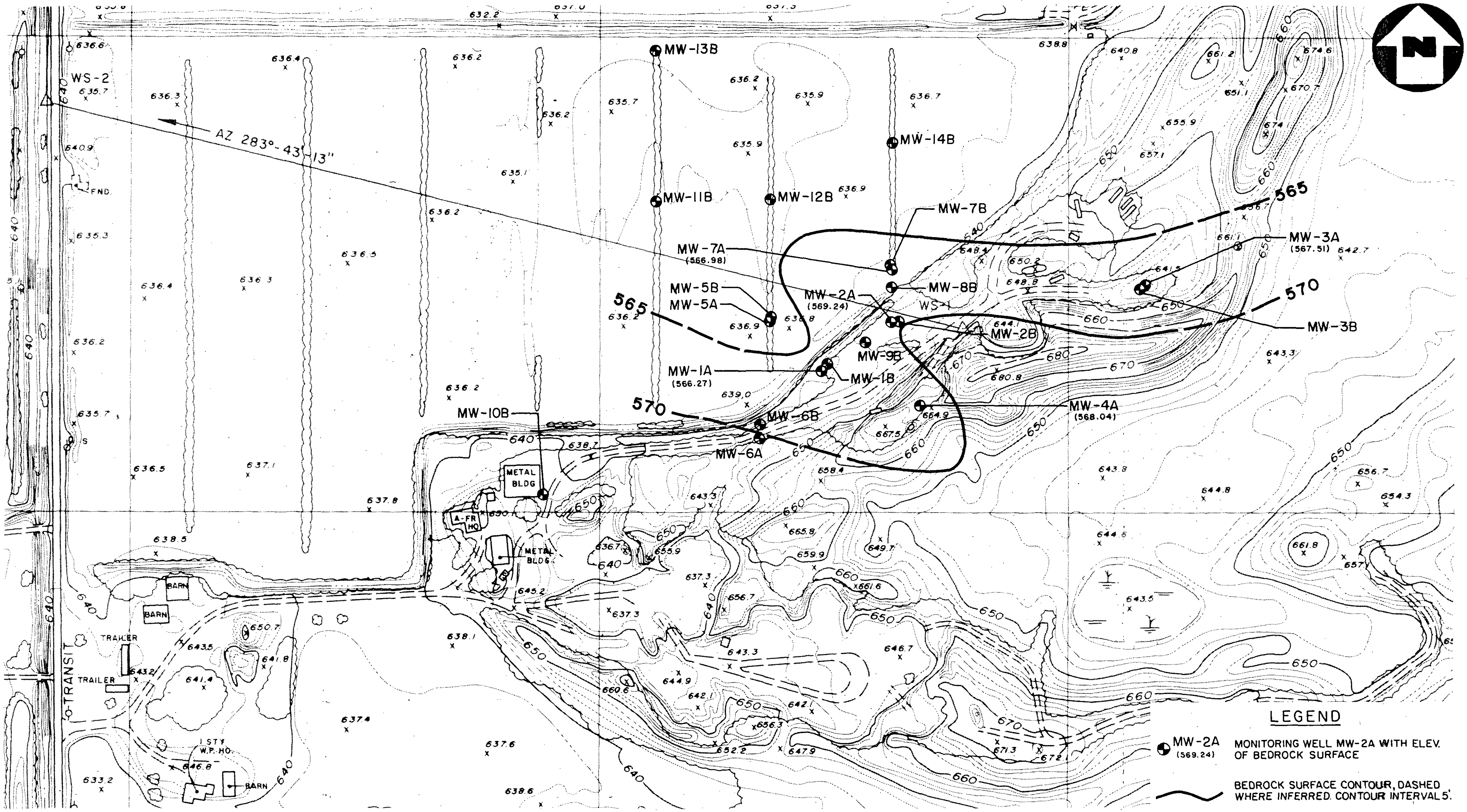


FIGURE 3-6

BEDROCK SURFACE CONTOUR MAP
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

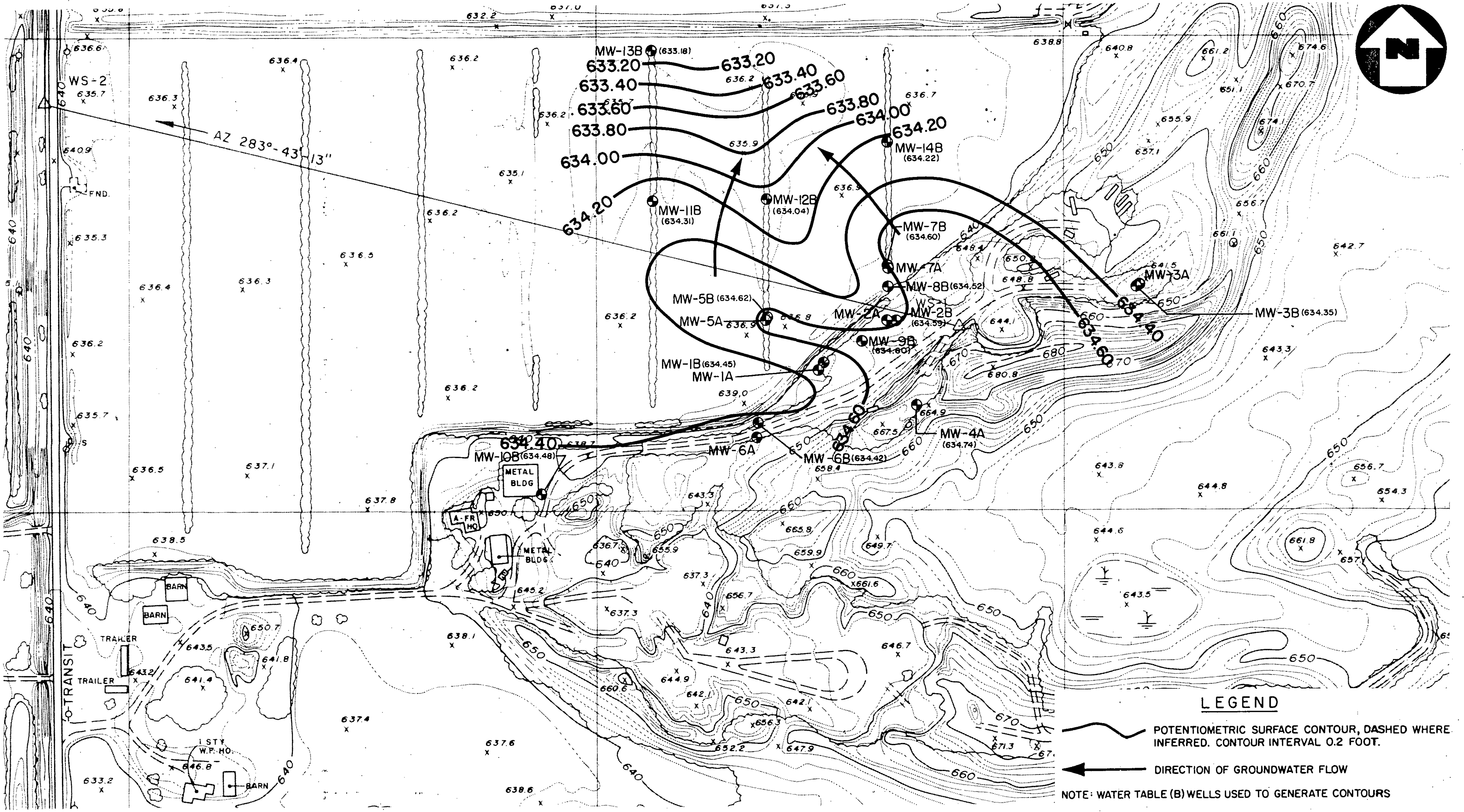
3.4.3 Site Hydrogeology

Groundwater encountered in the natural overburden ranged from less than 4 feet (MW-5A, MW-5B, and MW-11B) to more than 32 feet (MW-4A). There was no evidence of perched water tables in any of the monitoring well borings. The water table was laterally continuous, with consistent water-table measurements obtained throughout the study area (see cross-sections A-A', B-B', and C-C' in Figures 3-2, 3-3, and 3-4). Saturated thicknesses ranged from approximately 18.5 feet in MW-1A to 11.5 feet in MW-4A. This difference is caused by the undulating surface of the glacial till (see Figure 3-7).

Groundwater flows in a north-northwest direction away from the esker, which forms a topographic high. The average hydraulic gradient is 0.0018 ft/ft (see Figures 3-7, 3-8, 3-9, 3-10, and Appendix D for details). The groundwater eventually discharges to Oak Orchard Creek in the western portion of the study area. Table 3-2 presents a summary of water-level measurements made during the field investigation.

Generally, topographic highs represent groundwater recharge points, whereas features such as the drainage ditch to the north of the adjacent farmland serve as groundwater discharge areas. The drainage ditch that borders the site (see Figure 2-7) contains standing water year-round. Silt has dammed the discharge point to Oak Orchard Creek. This ditch appears to be a groundwater discharge area but is not connected to other local surface-water bodies. The onsite surface-water bodies and hydrology will be discussed in greater detail in Section 3.5.

Slug tests were performed to obtain hydraulic conductivity values for all monitoring wells. A pump test was performed on MW-2A. Drawdown data on the observation well (MW-2B) was not conclusive, and the recovery data did not coincide with the previous slug test results. Hydraulic conductivity, calculated from slug tests on monitoring wells screened within the overburden, ranges from 2.25×10^{-4} to 2.86×10^{-2} cm/sec. The calculated groundwater flow velocity ranges from 1.40 to 266.35 feet per year. The minimum velocity of 1.40 feet/year was near MW-13B, which is located in an area where the overburden begins to thin and pinch-out. A noted increase in fine-grained material (silt and clay) in this boring may also be responsible for the slower flow velocity. A maximum velocity of 266.35 feet/year was obtained near MW-6B, which had the fastest measurable recovery of all the monitoring wells. This higher flow velocity is attributed to the coarse gravel and absence of fine material observed in the aquifer during the drilling. Hydraulic conductivities were calculated from data collected in wells were installed along hedgerows where no drainage lines are present and higher groundwater elevations are expected.



LEGEND

POTENTIOMETRIC SURFACE CONTOUR, DASHED WHERE INFERRED. CONTOUR INTERVAL 0.2 FOOT.

DIRECTION OF GROUNDWATER FLOW

NOTE: WATER TABLE (B) WELLS USED TO GENERATE CONTOURS

FIGURE 3-7

0 200 400
SCALE IN FEET

POTENTIOMETRIC SURFACE MAP OF 11/15/88
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

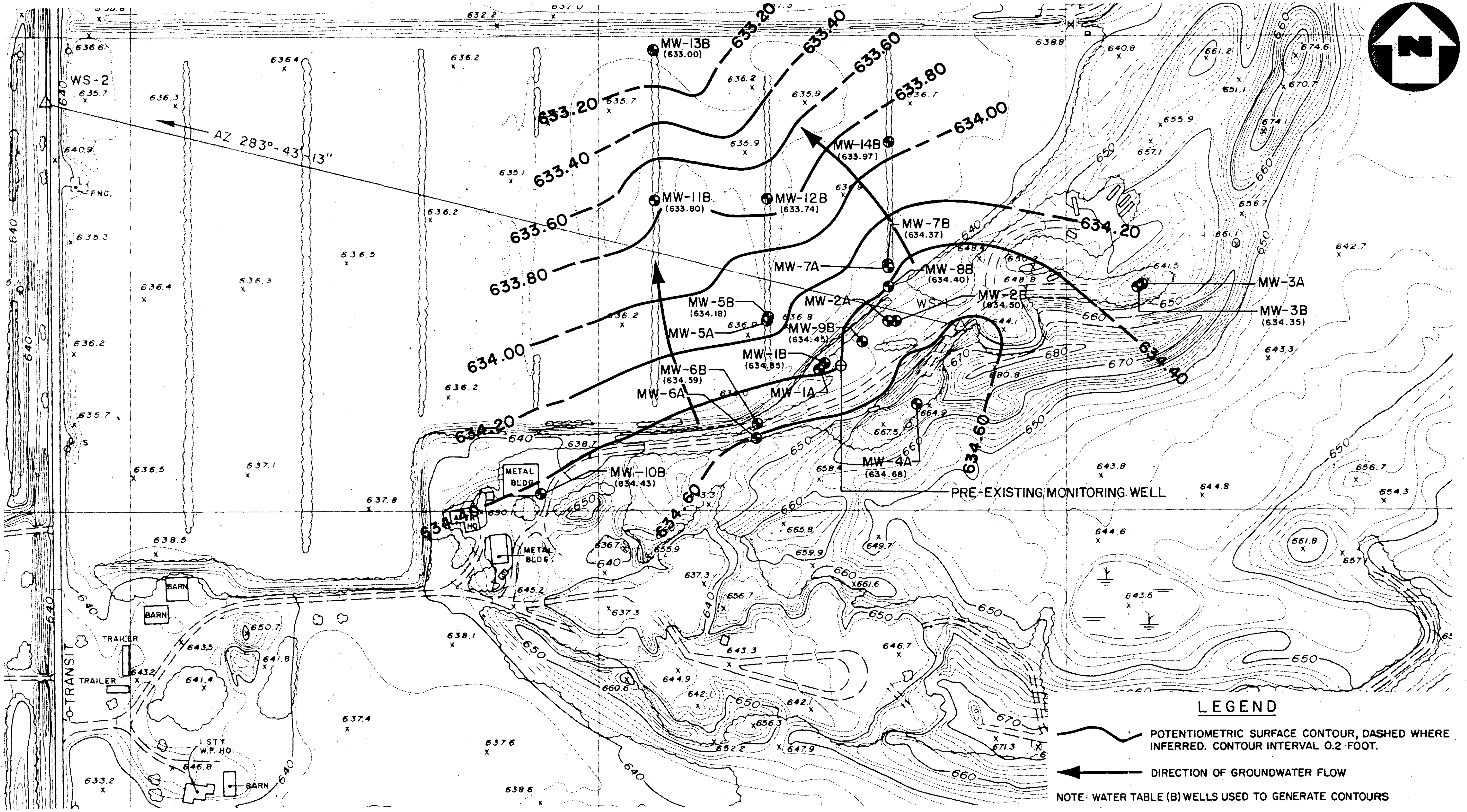


FIGURE 3-8

POTENTIOMETRIC SURFACE MAP OF 12/12/88
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

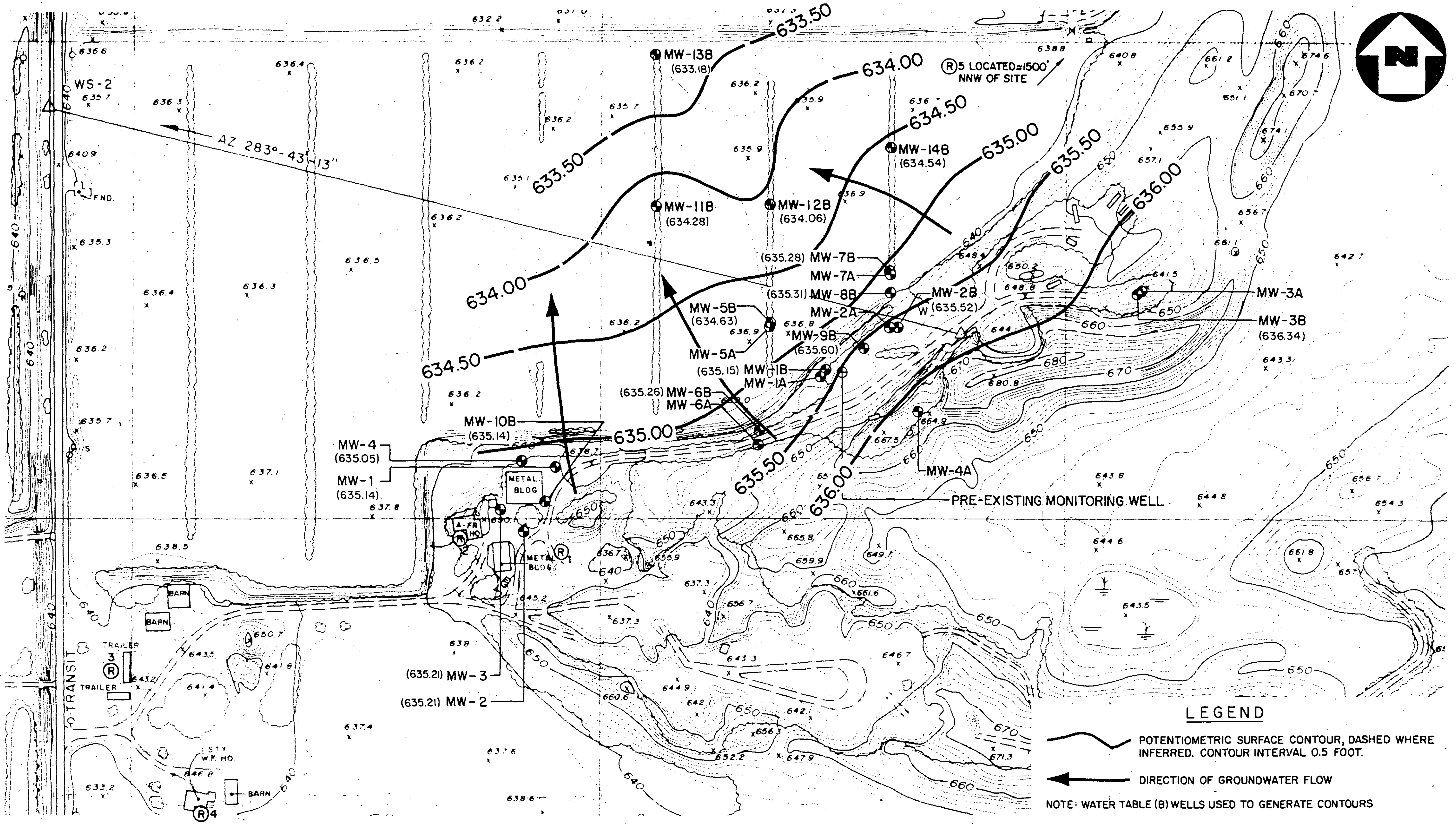
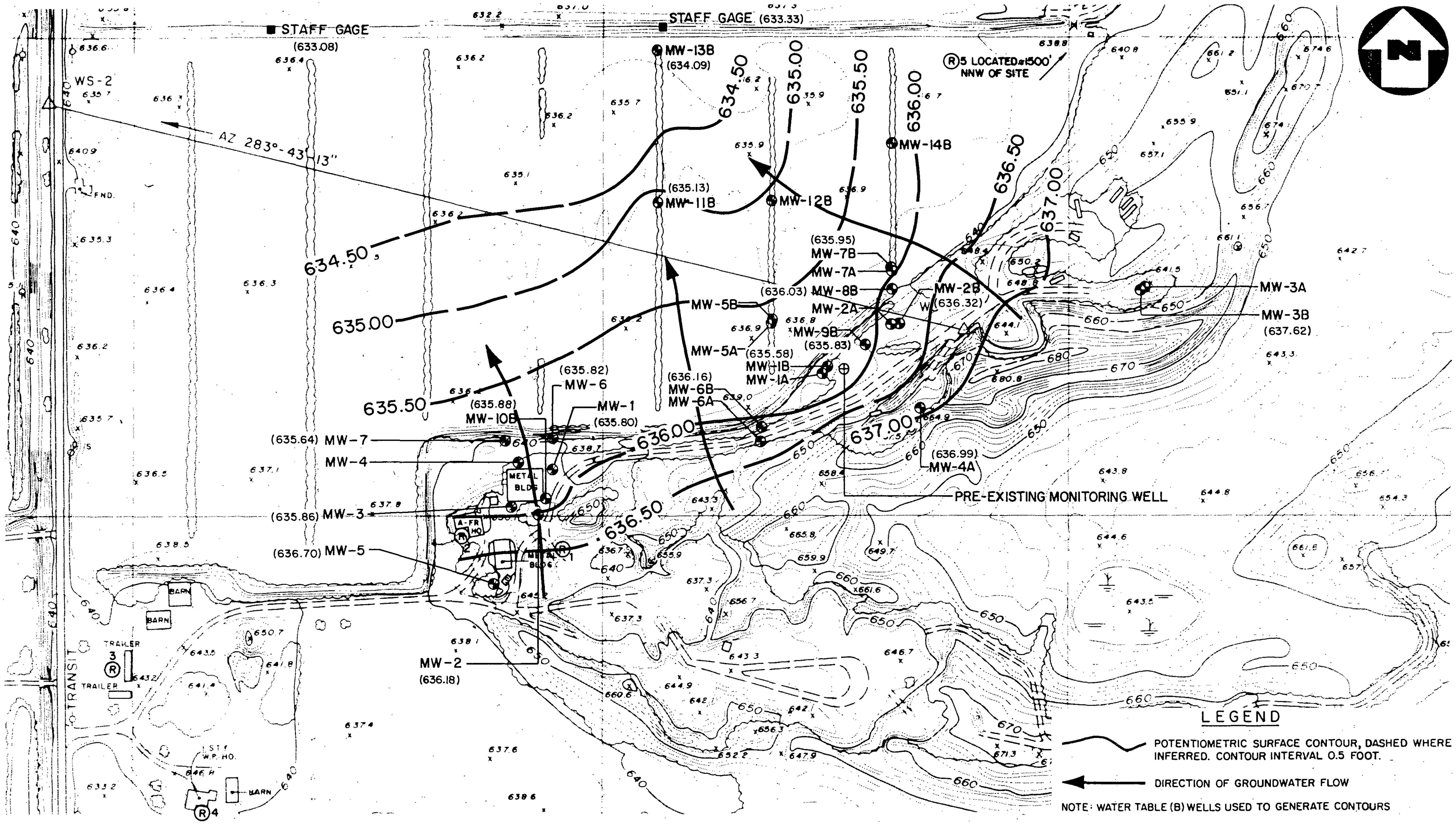


FIGURE 3-9

0 200 400
SCALE IN FEET

POTENTIOMETRIC SURFACE MAP OF 4/25/89
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION



LEGEND

POTENTIOMETRIC SURFACE CONTOUR, DASHED WHERE INFERRED. CONTOUR INTERVAL 0.5 FOOT.

DIRECTION OF GROUNDWATER FLOW

NOTE: WATER TABLE (B) WELLS USED TO GENERATE CONTOURS

FIGURE 3-10

0 200 400
SCALE IN FEET

POTENTIOMETRIC SURFACE MAP OF 6/22/89
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

TABLE 3-2

WATER-LEVEL ELEVATIONS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Well or Staff Gage Number	Elevation Reference Point	November 7, 1988		November 15, 1988		December 12, 1988		April 25, 1989		June 22, 1989	
		Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation
MW-1A	643.13	8.61	634.52	8.55	634.58	8.67	634.46	7.91	635.22	7.37	635.76
MW-1B	643.95	9.64	634.31	9.50	634.45	9.60	634.35	8.80	635.15	8.37	635.58
MW-2A	646.86	12.39	634.47	12.30	634.56	12.41	634.45	11.42	635.44	10.63	636.23
MW-2B	646.87	12.40	634.47	12.28	634.59	12.37	634.50	11.35	635.52	10.55	636.32
MW-3A	642.84	8.53	634.31	8.49	634.35	8.45	634.39	6.33	636.51	4.99	637.85
MW-3B	643.65	9.33	634.32	9.30	634.35	9.30	634.35	7.31	636.34	6.03	637.62
MW-4A	667.35	32.67	634.68	32.61	634.74	32.67	634.68	31.64	635.71	30.36	636.99
MW-5A	638.17	3.64	634.53	3.61	634.56	3.80	634.37	3.10	635.07	2.61	635.56
MW-5B	638.32	3.66	634.66	3.70	634.62	4.14	634.18	3.69	634.63	2.74	635.58
MW-6A	646.55	12.01	634.54	11.95	634.60	12.05	634.50	11.29	635.26	10.76	635.79
MW-6B	647.29	12.95	634.34	12.87	634.42	12.70	634.59	12.03	635.26	11.13	636.16
MW-7A	640.92	6.46	634.46	6.34	634.58	6.53	634.39	5.66	635.26	4.96	635.95
MW-7B	640.45	5.99	634.46	5.85	634.60	6.08	634.37	5.17	635.28	4.50	635.95
MW-8B	641.65	7.20	634.45	7.13	634.52	7.25	634.40	6.34	635.31	5.62	636.03
MW-9B	646.15	11.70	634.45	11.55	634.60	11.70	634.45	10.55	635.60	10.32	635.83
MW-10B	643.89	9.50	634.39	9.41	634.48	9.46	634.43	8.75	635.14	8.01	635.88

TABLE 3-2
WATER-LEVEL ELEVATIONS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Well or Staff Gage Number	Elevation Reference Point	November 7, 1988		November 15, 1988		December 12, 1988		April 25, 1989			
		Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation	Depth to Water (feet)	Elevation
MW-11B	638.00	3.67	634.33	3.69	634.31	4.20	633.80	3.72	634.28	2.87	635.13
MW-12B	638.98	4.94	634.04	4.94	634.04	5.24	633.74	4.92	634.06	-	-
MW-13B	637.80	4.71	633.09	4.62	633.18	4.80	633.00	4.62	633.18	3.71	634.09
MW-14B	639.19	5.10	634.09	4.97	634.22	5.22	633.97	4.65	634.54	-	-
MW-1	642.30	*	*	*	*	*	*	7.16	635.14	6.50	635.80
MW-2	645.93	*	*	*	*	*	*	10.72	635.21	9.75	636.18
MW-3	649.15	*	*	*	*	*	*	13.94	635.21	13.29	635.86
MW-4	641.70	*	*	*	*	*	*	6.65	635.05	8.71	632.99***
MW-5	648.28	*	*	*	*	*	*	*	*	11.58	636.70
MW-6	639.18	*	*	*	*	*	*	*	*	3.36	635.82
MW-7	638.15	*	*	*	*	*	*	*	*	2.51	635.64
SG(NW)	635.33	**	**	**	**	**	**	3.72	631.61	2.25	633.08
SG(NE)	635.35	**	**	**	**	**	**	2.77	632.58	2.02	633.33
SG(SW)	637.91	**	**	**	**	**	**	3.58	634.33	3.49	634.42
SG(SE)	638.66	**	**	**	**	**	**	3.88	634.78	3.81	634.85

* Monitoring wells had not been installed at time of water level measurement.
** Staff gage measurements were not taken on November 7 and 15, 1988 and December 12, 1988 (ice buildup).

3.5 SURFACE-WATER HYDROLOGY

There are several surface-water bodies of interest to this investigation. They include the drainage ditch between the both falling-head and rising-head portions of the slug tests. Calculations are presented in Appendix D. The resulting hydraulic conductivity values were used to calculate a range of groundwater flow velocities by using a minimum value and a maximum value for the effective porosity (0.2 and 0.3).

The glacial till that underlies the overburden is very impermeable and averaged 51.5 feet in thickness in the five wells which completely penetrated that section (see Appendix C, Well Construction Diagrams, for details). Slug tests conducted in the glacial till, during drilling of wells MW-2A and MW-3A, showed hydraulic conductivities of 1.93 x 10^{-6} and 3.91 x 10^{-6} cm/sec, respectively. The values for MW-2A and MW-3A are considered to be representative of the low hydraulic conductivities for the glacial till. The subsurface lithology encountered during drilling did not indicate a route by which groundwater could migrate through the till. Furthermore, water levels in shallow and deep wells at cluster locations were virtually identical, a fact which indicates the absence of downward vertical gradients.

A drainage system which prevents the water table from rising into the root zone of the crops is known to exist beneath the farmland adjacent to the site. The system consists of a series of south to north trending 4-inch laterals that extend from the southern end of the onion field toward a drainage ditch to the north of the onion field. These slotted plastic laterals are located approximately 40 feet on center and are about 3 feet below grade. They slope to the north at a grade of approximately 0.5 percent and tie in to an east to west trending 8-inch main along the drainage ditch. This main conveys excess water to a pumping station located in the northwestern corner of the onion field. Excess water collected via this system is discharged directly to Oak Orchard Creek.

This system is believed to have an impact on groundwater flow conditions in the vicinity of the site. The overall effect of this system will be to cause a series of depressions in the water table along the length of each lateral line. This phenomenon will occur any time precipitation is sufficient to elevate the water table above the base of the drainage lines. Under such conditions, groundwater can be expected to flow toward the laterals.

Although water levels were noted to rise above the drainage lines (approximately 1.5 feet) between December of 1988 and June of 1989, no evidence of localized depression of the water table was obtained during the remedial investigation since monitoring onion fields and the site (Ditch 1), the east-west drainage ditch directly north of the onion fields (Ditch 2), and Oak

Orchard Creek. Figure 2-7 shows the locations of the features in relation to the site.

The ditch separating the site and the onion fields was, at one time, connected and open to Oak Orchard Creek. However, this ditch is dammed with silt; and standing water is present throughout the year in various spots along the ditch. The ditch is best developed along the site directly across from source area 1. The ditch appears to be an exposed expression of the water table based on monitoring well water levels and staff gage measurements.

Two staff gages are located along drainage ditch 1 and two are located along drainage ditch 2. Contrast of water levels in wells located near the staff gages with surface water elevations clearly indicates that groundwater may discharge to both of the surface features. For example, on June 22, 1989 water levels in wells MW-1B and MW-13B were 635.58 feet and 634.09 feet, respectively. Surface water elevations as determined from staff gages located near these wells were 634.85 feet and 633.33 feet, respectively. Therefore it is apparent that groundwater will discharge to these surface water bodies. Drainage ditch 2 flows directly into Oak Orchard Creek. Thus groundwater from the site may ultimately enter Oak Orchard Creek via drainage ditch 2.

Oak Orchard Creek flows northward, passes the study area to the west, and terminates in low, swampy land after it exits the onion fields north of the study area. Oak Orchard Creek acts as a natural receiving channel for runoff from the onion fields. It was observed to contain standing water; the level of which changed with the increase/decrease of precipitation within the region.

4

4.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of environmental contamination at the Byron Barrel and Drum Site is discussed in this section. The validated analytical data generated during the 1988-1989 Remedial Investigation provide the basis for this discussion. The complete analytical data base is included as Appendix E. Tables and figures that summarize the analytical results for samples of various matrices are provided within the body of this report.

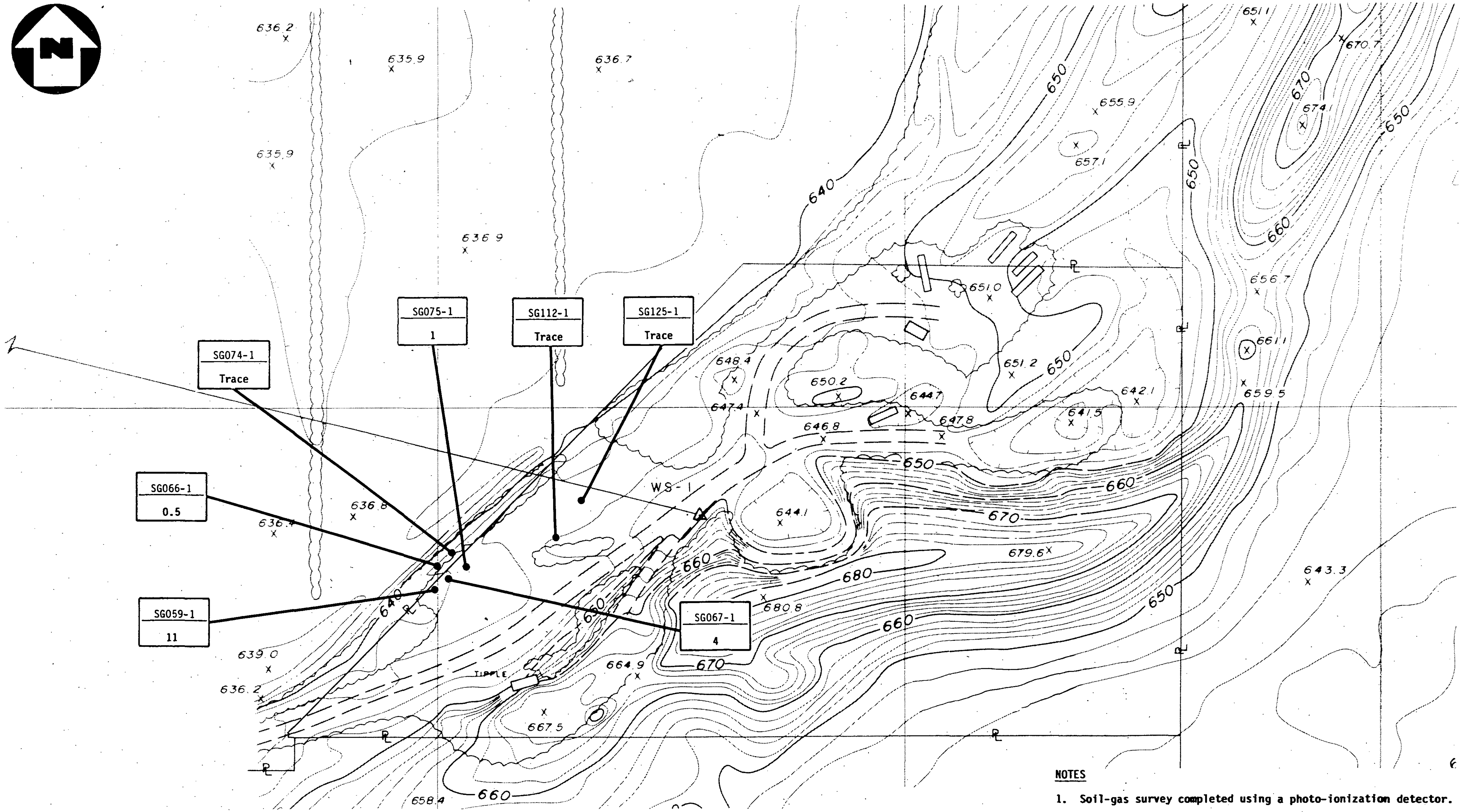
The remainder of this section is structured according to the sequence of investigative activities at the site. Section 4.1 presents the results of the soil-gas investigation. The results of the geophysical investigation are discussed in Section 4.2. The surface soil investigation is summarized in Section 4.3. Section 4.4 presents the results of the subsurface soil investigation. The results of the groundwater sampling and analysis program are summarized in Section 4.5. Residential well results are discussed in Section 4.6. The analytical results for the surface water and sediment sampling program are provided in Section 4.7.

4.1 SOIL-GAS INVESTIGATION

The soil-gas investigation was completed in accordance with the requirements outlined in the Field Operations Plan for the Byron Barrel and Drum Site. A total of 232 soil-gas survey points were monitored during the investigation. The original scope of work called for installation of approximately 400 soil borings to allow access for total volatile organic measurements using a photoionization detector (PID). During the course of the investigation, numerous preassigned sampling points were inaccessible, either as a result of the presence of heavy construction equipment or an extremely heavy understory. All portions of the site deemed accessible for disposal activities were subjected to the soil-gas survey.

The results of the soil-gas survey are provided on Figure 4-1. Only those sampling points where positive detections were encountered on the PID are presented. An area of potential volatile organic contamination was identified in the southwestern portion of source area 1 during the soil-gas survey, as is evident from Figure 4-1.

Organic vapor readings ranging from 0.5 to 11 parts per million (ppm) were encountered in three borings in the southwestern portion of source area 1. Remaining readings in source area 1 and other portions of the site were indistinguishable from background with the exception of four borings located along the access road which ranged from 1 to 4 ppm. These borings were installed in a patch of succulent plants and a large number of roots were encountered during drilling. The results for these



NOTES

1. Soil-gas survey completed using a photo-ionization detector.

FIGURE 4-1

SOIL-GAS SURVEY RESULTS (ppm)
BYRON BARREL AND DRUM SITE, BYRON, NY

0 100 200
SCALE IN FEET

NUS CORPORATION

borings were considered indicative of background levels associated with the plants, based on similar observations at other sites. No historic evidence of disposal of chemicals nor visual evidence of disposal was observed in this area. Based on the results of the soil-gas survey, it was evident that a primary source area exists in the southwestern portion of source area 1.

The results of supplemental soil-gas investigation activities in the vicinity of the maintenance building source are depicted in Figure 4-2. Soil-gas readings ranging from non-detectable to 8 parts per million (ppm) were obtained during the soil-gas survey. Soil-gas concentrations were greatest near the southeastern corner of the maintenance building, as shown on Figure 4-2. Readings of 1 ppm were obtained along the western edge of the building, and based on the results of the subsurface soil and groundwater quality investigations (Sections 4.4 and 4.5), are believed to be a manifestation of outgassing of volatile organics from the groundwater. A reading of 8 ppm was obtained at a soil-gas survey point within the maintenance building. Based on the results of the soil-gas survey it appears that a source of groundwater contamination exists near the southeastern corner of the building and beneath the building itself.

4.2 GEOPHYSICAL INVESTIGATION

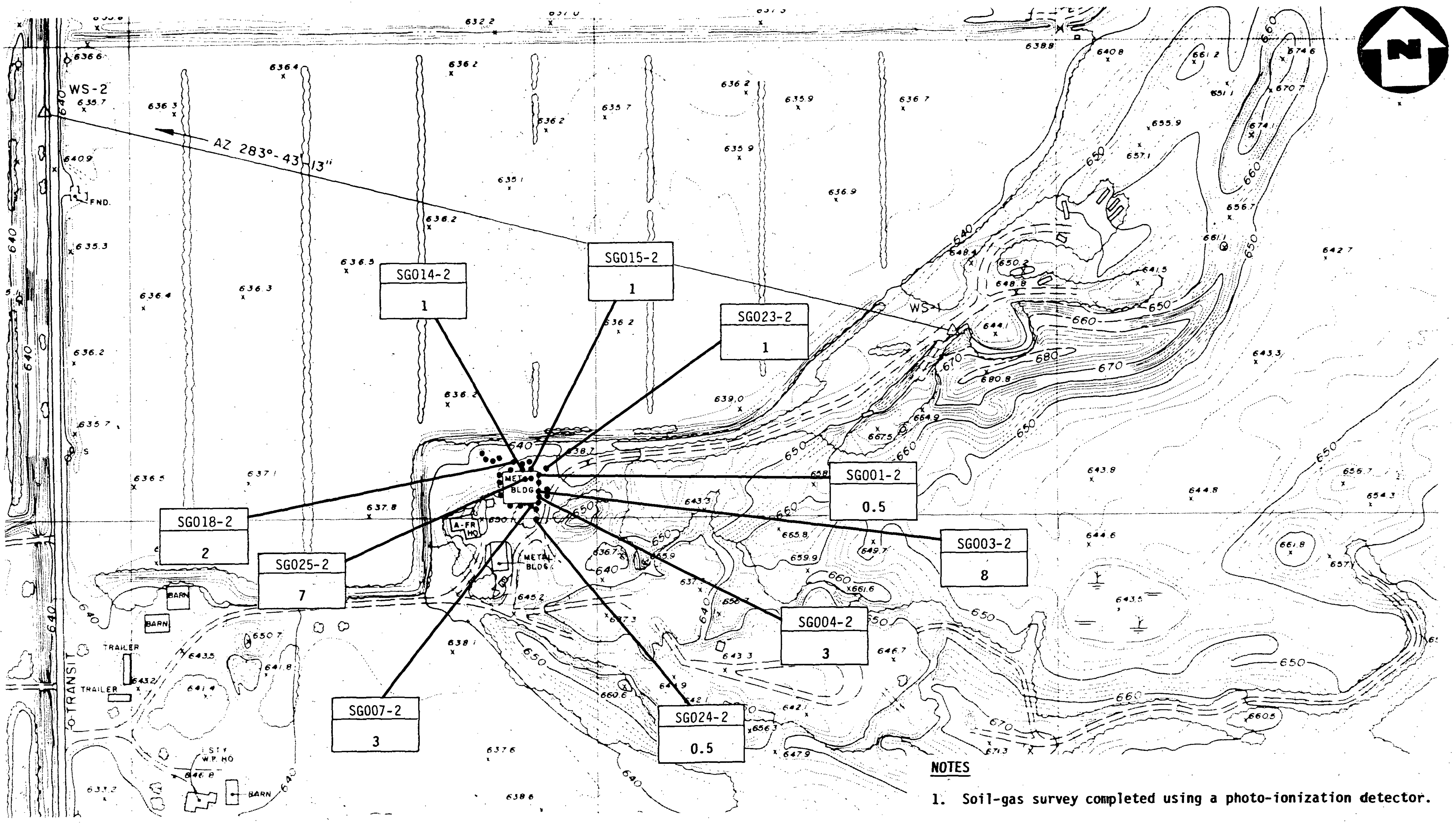
A geophysical survey was conducted to locate buried ferromagnetic materials in three suspected disposal areas. A high resolution land magnetic survey technique was used to locate anomalies in the total magnetic field intensity which would indicate buried ferromagnetic material.

The magnetic surveys were conducted using the grid established for the soil-gas survey. This grid system was oriented northwest-southeast. Although the Work Plan suggested a grid system oriented along true north, the soil-gas grid system was used to provide continuity and correlation between the soil-gas and magnetics data.

4.2.1 Data Acquisition

Total magnetic field intensity and magnetic gradient data were acquired at 10-foot intervals on the grid, using an EDA Instruments OMNI IV proton precession magnetometer/gradiometer. The data were digitally stored in resident memory while the survey was conducted.

Significant amounts of surficial ferromagnetic debris were encountered along the edges of the survey areas, causing substantial interference to the total magnetic field intensity data (which are scalar magnitude measurements). These site conditions prevented accurate delineation of total magnetic field intensity anomalies. However, the magnetic gradient data



NOTES

1. Soil-gas survey completed using a photo-ionization detector.

FIGURE 4-2

SOIL-GAS SURVEY RESULTS (ppm)
MAINTENANCE BUILDING SOURCE
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

(which are vector-vertical measurements) were much less affected by the surficial debris and were selected for further processing to delineate magnetic anomalies.

4.2.2 Data Reduction

The magnetics data were downloaded to a printer for hard copy and were then input to a microcomputer for processing. Golden Software's Surfer program was used to generate contour maps of both the total magnetic field intensity and magnetic gradient data. The contour maps are provided in Appendix A.

4.2.3 Data Interpretation

The magnetics data were interpreted to identify magnetic anomalies in the three survey areas to direct subsequent test-pitting operations. Contour maps of magnetic gradient anomalies greater than 100 gammas/meter were used to locate anomalies not related to surficial ferromagnetic debris. A tabular presentation of the anomalies identified is as follows:

SOURCE AREA 1

Magnitude of Magnetic Decay	Geophysical Survey Grid Coordinates	Corresponding Soil-Gas Survey Grid Coordinates
200+ gammas/meter	Lines 110-120 Position 80	Row 16, Boring 2
500+ gammas/meter	Line 60 Position 80	Row 13, Boring 2
400+ gammas/meter	Line 40 Position 60	Row 12, Boring 3
200+ gammas/meter	Line 40 Position 80	Row 12, Boring 2
500+ gammas/meter	Lines 120-130 Positions 0-10	Rows 16-17, Borings 5-6

SOURCE AREA 2

Magnitude of Magnetic Decay	Geophysical Survey Grid Coordinates	Corresponding Soil-Gas Survey Grid Coordinates
400+ gammas/meter	Line 80 Position 40	Row 22, Boring 6
400+ gammas/meter	Line 80 Position 100	Row 22, Boring 3
300+ gammas/meter	Line 60 Position 100	Row 21, Boring 3
200+ gammas/meter	Line 80 Position 120	Row 21, Boring 2

SOURCE AREA 3

Magnitude of Magnetic Decay	Geophysical Survey Grid Coordinates	Corresponding Soil-Gas Survey Grid Coordinates
200+ gammas/meter	Line 40 Position 80	Row 40, Boring 11
200+ gammas/meter	Line 80 Position 20	Row 42, Boring 14
400+ gammas/meter	Line 100 Position 60	Row 43, Boring 12
500+ gammas/meter	Line 120 Position 20	Row 44, Boring 14
200+ gammas/meter	Line 160 Position 50	Row 46, Borings 12-13

The corresponding soil-gas grid coordinates for these locations are depicted on Figure 2-3. These coordinates were considered potential areas of burial of ferromagnetic material. Magnetic decay readings of 500+ gammas/meter were considered indicative of potential drum burial locations. The results of the geophysical investigation were used to guide subsequent test-pitting operations.

4.3 NATURE AND EXTENT OF SURFACE SOIL CONTAMINATION

A total of 25 surface soil samples were obtained at the site, including 5 samples obtained at background locations. Sampling locations were selected, based on historical information regarding drum storage and waste disposal activities and as a result of the soil-gas survey. Surface soil samples were obtained in each of the suspected source areas and at three locations in the vicinity of the anomalous soil-gas reading along the access road. The analytical results for the surface soil samples are summarized in Table 4-1. Only low levels (from a public health and environmental perspective) of volatile and semi-volatile compounds were detected in surface soil samples. For example, trichloroethene (the most concentrated volatile organic) was detected at concentrations ranging as high as only 47 parts per billion (ppb). Low concentrations of some phthalate esters such as bis(2-ethylhexyl)phthalate (550 ppb) and various polynuclear aromatics such as flouranthene (270 ppb) were also encountered.

The most pronounced contamination detected was identified in background samples collected from the adjacent farmland. Various pesticides were detected in background samples at concentrations ranging as high as 3,500 ppb (dieldrin). Table 4-2 provides a contrast of the pesticide fraction results for site samples versus background levels. It is evident from

TABLE 4-1

OCCURRENCE AND DISTRIBUTION OF SURFACE SOIL CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Contract Required Detection Limit (CRDL) (µg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/kg)(2)	Arithmetic Average Concentration (µg/kg)(3)	Geometric Mean Concentration (µg/kg)(4)
1,1,1-trichloroethane	5	1/27	2.0	0.074	2.5
tetrachloroethene	5	1/27	7.0	0.26	2.6
trichloroethene	5	3/27	3.0 - 47	2.0	2.9
chloroform	5	4/27	1.0 - 2.0	0.26	2.4
bis(2-ethylhexyl)phthalate	330	15/27	37 - 550	85	130
di-n-butylphthalate	330	2/27	42 - 67	4.0	150
butylbenzylphthalate	330	1/27	140	5.2	160
benzo(a)anthracene	330	1/27	110	4.1	160
benzo(b)fluoranthene	330	5/27	40 - 240	16	140
benzo(a)pyrene	330	1/27	100	3.7	160
chrysene	330	2/27	42 - 140	6.7	160
fluoranthene	330	3/27	41 - 270	13	150
phenanthrene	330	2/27	47 - 200	9.1	160
pyrene	330	2/27	53 - 170	8.3	160
benzoic acid	1,600	9/27	40 - 490	57	420
4,4'-DDT	16	13/27	19 - 2,100	260	32
4,4'-DDD	16	2/27	63 - 79	5.3	9.4
4,4'-DDE	16	11/27	18 - 310	43	19
endrin	16	3/27	86 - 250	16	11
endrin ketone	16	1/27	36	1.3	8.5
endosulfan sulfate	16	3/27	60 - 140	9.7	10
dieldrin	16	6/27	25 - 3,500	230	18

TABLE 4-1
OCCURRENCE AND DISTRIBUTION OF SURFACE SOIL CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Contract Required Detection Limit (CRDL) (mg/kg)	No. of Positive Detections/ No. of Samples	*Concentration* Range (mg/kg)(2)	Arithmetic Average Concentration (mg/kg)(3)	*Geometric Mean* Concentration (mg/kg)(4)
aluminum	200	27/27	2,770 - 8,670	5,300	5,100
antimony	60	1/27	10	0.37	1.1
arsenic	10	27/27	1.2 - 49.1	6.2	3.4
beryllium	5	27/27	0.34 - 1.0	0.62	0.59
cadmium	5	19/27	1.2 - 2.8	1.6	1.8
calcium	5,000	27/27	890 - 108,000	21,600	12,100
chromium	10	27/27	4.5 - 804	54	10
cobalt	50	22/27	1.7 - 4.4	2.2	2.2
iron	100	27/27	3,460 - 11,300	7,800	7,600
lead	5	26/27	6 - 2,720	170	30
magnesium	5,000	12/27	1,680 - 28,200	3,400	43
manganese	15	27/27	86.9 - 629	300	270
mercury	0.2	7/27	0.16 - 0.28	0.053	0.66
nickel	40	27/27	4.0 - 9.1	6.3	6.2
potassium	5,000	27/27	200 - 900	450	420
selenium	5	11/27	0.4 - 4.6	0.54	0.96
sodium	5,000	27/27	39.6 - 120	75	71
vanadium	50	27/27	5.4 - 13	8.9	8.6
zinc	20	27/27	44.6 - 308	95	85

(1) Organic analyses conducted using EPA Methods 624 (volatiles), 625 (extractables), and 608 (pesticides/PCBs)
(2) Concentration range for positive detections only.
(3) Calculated using "0" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.

TABLE 4-2

PESTICIDE RESULTS FOR BACKGROUND AND SITE SURFACE SOIL SAMPLES BYRON BARREL AND DRUM SITE BYRON, NEW YORK

Compound	Maximum Concentration (μg/kg)		Average Concentration (μg/kg)(2)	
	Background(1)	Site	Background	Site
4,4'-DDT	2,100	140	1,700	23
4,4'-DDD	79	--(3)	26	--
4,4'-DDE	310	37	227	8.4
endrin	250	--	145	--
endrin ketone	36	--	12	--
endosulfan sulfate	140	--	68	--
dieldrin	3,500	41	1,900	2.1

(1) Background (muckland) samples include BS-SO005-1, BS-SO024-1, and BS-SO025-1D. Background samples obtained in wooded areas (i.e., BS-SO022-1 and BS-SO023-1) not included in the analysis.

(2) Average concentrations determined using only one of any two duplicate samples collected.

(3) -- Not detected above the method detection limit (approximately 16 μg/kg).

the table that background levels of these chemicals are much higher than the levels detected on site. Furthermore, site samples containing pesticides are those obtained in proximity to the adjacent farmland. It is believed that pesticide contamination in these areas resulted from application of pesticides to the crops and not as a result of any releases from the site. Pesticide contamination was not noted on the site during the EPA removal action and overland migration is impeded by a drainage ditch bordering the site. Both aerial application and ground levels spraying could have caused the contamination detected in some site samples. The most contaminated site surface soil sample contained 4,4'-DDT at a concentrations of 140 ppb; whereas 4,4'-DDT was detected in background samples at concentrations ranging to 2,100 ppb.

Inorganic contamination does not appear pronounced in surficial soils at the Byron Barrel and Drum Site. Because inorganic chemicals occur naturally in the environment, it is also useful to contrast the site surface soil results with background levels. Table 4-3 provides a summary of the inorganic analytical results for the site versus background samples. As is evident from the table, only four inorganic constituents are present in site soils at levels significantly above background. Chromium was detected in site samples at concentrations ranging to 804 ppm, whereas background samples contained chromium at concentrations ranging no higher than 7.6 ppm. Lead was detected in site samples at concentrations ranging to 2,720 ppm, whereas background samples contained lead at concentrations ranging no higher than 20.1 ppm. Magnesium and calcium were detected in site samples at concentrations at least twice those in the background samples but these analytes are considered insignificant from both human health and environmental impact standpoints. They are common components of natural soils and are constituents of the human diet.

Based on a review of all site analytical data, particularly the groundwater results (Section 4.6), it was ascertained that five specific chlorinated aliphatic hydrocarbons constitute the predominant site contaminants (i.e., 1,1,1-trichloroethane, 1,1-dichloroethane, tetrachloroethene, trichloroethene, and 1,1-dichloroethene). Figure 4-3 summarizes the results for these analytes in surface soil samples. The results for the primary volatile organic contaminants are consistent with the results of the soil-gas survey. Contamination with chlorinated aliphatics was detected in the western portion of source area 1 in the vicinity of the soil-gas readings. For example, trichloroethene was detected in three samples from this area at concentrations ranging from 3 to 47 ppb. Tetrachloroethene and 1,1,1-trichloroethane were each detected in sample BS-SO007-1 at concentrations of 7 and 2 ppb, respectively. Volatile organics remained undetected above instrument detection limits in remaining surficial soil samples.

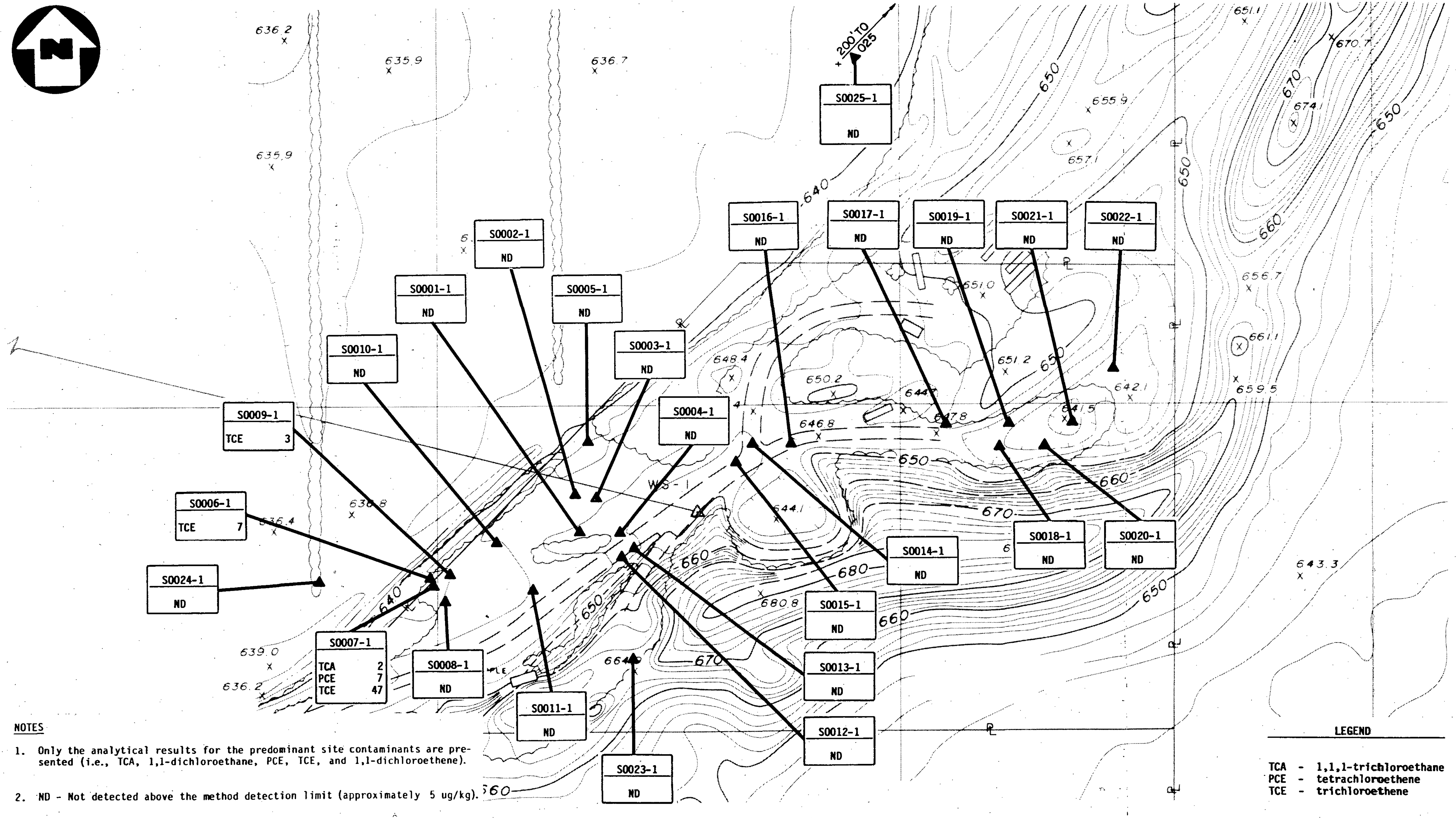
TABLE 4-3

INORGANIC RESULTS FOR BACKGROUND AND SITE SURFACE SOIL SAMPLES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Chemical	Maximum Concentration (mg/kg)		Average Concentration (mg/kg)(2)	
	Background(1)	Site	Background	Site
aluminum	6,650	8,670	4,654	5,531
antimony	-	10	-	0.5
arsenic	49.1	4.4	18.26	2.595
beryllium	0.85	1.0	0.604	0.616
cadmium	2.6	2.8	0.94	1.805
calcium	42,700	108,000	25,498	19,556
chromium	7.6	804	6.38	71.24
cobalt	2.8	4.4	1.08	2.425
iron	9,210	11,300	7,002	8,022
lead	20.1	2,720	15.98	227.41
magnesium	1,740	28,200	348	4,112.5
manganese	360	629	235.38	316.15
mercury	0.28	0.25	0.13	0.0395
nickel	9.1	7.5	7.1	5.875
potassium	900	514	672.8	369.8
selenium	4.6	0.86	1.996	0.1645
sodium	104	120	75.86	73.685
vanadium	13	13	9.94	8.65
zinc	109	308	75.58	102.565

(1) Background samples include BS-SO005-1, BS-SO022-1, BS-SO023-1, BS-SO024-1, and BS-SO025-1.

(2) Average concentrations determined using only one of any two duplicate samples collected.



NOTES

1. Only the analytical results for the predominant site contaminants are presented (i.e., TCA, 1,1-dichloroethane, PCE, TCE, and 1,1-dichloroethene).

2. ND - Not detected above the method detection limit (approximately 5 ug/kg).

LEGEND

TCA - 1,1,1-trichloroethane
PCE - tetrachloroethene
TCE - trichloroethene

FIGURE 4-3

CHLORINATED ALIPHATIC SURFACE SOIL CONTAMINATION (ug/kg)
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

Figure 4-4 presents the analytical results for surface soil samples containing lead and chromium above background levels. As is evident from the figure, chromium and lead contamination is greatest in source area 3. Lower concentrations of lead were detected in several samples from source area 1.

4.4 NATURE AND EXTENT OF SUBSURFACE SOIL CONTAMINATION

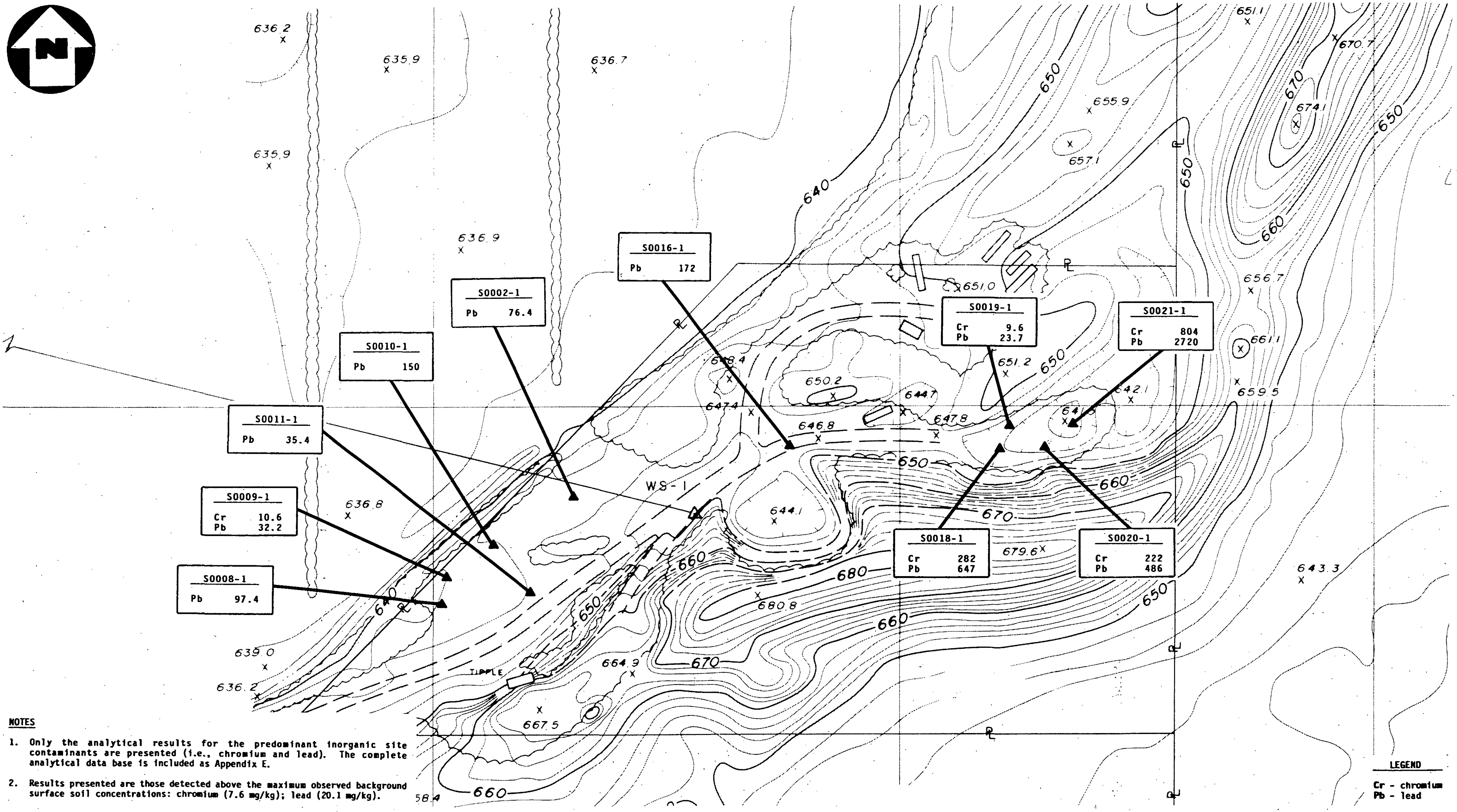
Test-pitting operations were conducted at the site based on the results of the geophysical investigation, soil-gas survey, historic information, and the soil sampling program. A total of 45 test pits were excavated in source areas 1 through 3 to accomplish several objectives, including allowing visual inspection of lithology, visual inspection of evidence of subsurface contamination, visual identification of buried drums in areas of magnetic anomalies, and allowing access for subsurface soil sampling.

Although conflicting historic information indicated that drum burial may have occurred at the site, the test-pitting operation does not support this assertion. Those areas in which magnetic anomalies were detected contained buried ferromagnetic materials such as sheet metal, reinforcement bars, pipes, wires, fittings, I-beams, etc. No drums were encountered in any of the test pits.

Source area 3 was considered the most likely location for any drum burial to have occurred. Source area 3 is located in a shallow ravine. A large amount of construction debris and other fill material had been backfilled in this area. Although some magnetic anomalies were detected in source area 3 during the geophysical investigation, these appeared to be associated with metallic debris. No drums were detected during test-pit operations in this area.

During preliminary site activities (clearing of scrap metal, abandoned vehicles, etc.), the bulk of this material was moved aside with a bulldozer. Test pitting operations in source area 3 were, therefore, conducted in the natural soil and no drums were encountered.

No visual evidence of contamination (i.e., stained soils) was detected in any of the test pits, with the exception of a solidified mass of a rubber-like material encountered in test pit number 2 (southwest corner of source area 1). Real-time health and safety monitoring using a photoionization detector (PID) was consistent with the results of the soil-gas survey and the surface soil sampling and analysis program. High PID readings (approximately 50 ppm) were encountered in test pits located in the southwestern portion of source area 1.



NOTES

1. Only the analytical results for the predominant inorganic site contaminants are presented (i.e., chromium and lead). The complete analytical data base is included as Appendix E.

2. Results presented are those detected above the maximum observed background surface soil concentrations: chromium (7.6 mg/kg); lead (20.1 mg/kg).

LEGEND

Cr - chromium
Pb - lead

FIGURE 4-4

INORGANIC SURFACE SOIL CONTAMINATION (mg/kg)
BYRON BARREL AND DRUM SITE, BYRON, NY

0 100 200
SCALE IN FEET

NUS CORPORATION

Subsurface soil samples were collected at various depths from each of the test pits. One hundred and twenty-nine samples were analyzed in an onsite mobile laboratory. Target compounds for mobile laboratory analysis were selected, based on historical information and included benzene, toluene, 1,1,1-trichloroethane (TCA), 1,2-dichloroethane, trichloroethene (TCE), and 1,2-dichloroethene. The analytical results for the mobile laboratory samples are summarized in Table 4-4.

As shown in Table 4-4, volatile organics were detected in subsurface soil samples at concentrations ranging from 5 ppb to 2,669 ppb. The most pronounced contaminants based on the mobile laboratory results are toluene, TCA, and TCE. Concentrations of these analytes ranged as high as 865, 551, and 2,669 ppb, respectively. The mobile laboratory results for the predominant site contaminants (i.e., TCA and TCE) are summarized in Figure 4-5. Only the results for test pits containing at least one positive detection are presented on the figure (all of the test pit locations are identified on Figure 2-6).

It is evident that the bulk of the subsurface contamination at the Byron Barrel and Drum Site is located in the southwestern portion of source area 1. The lateral extent of contamination in this area is relatively well-defined by the results for test pit 0 (the northwestern-most test pit), test pit 1 (the southwestern-most test pit), test pits 6, 10, and 15 (which are not shown, but form a line of uncontaminated test pits just northeast of test pit 9), and test pits 17 through 21 (which are not shown, but form a line just to the southeast of test pits 12 and 13). Based on the detection of the various analytes in the mobile laboratory samples, an estimate of the total volume of contaminated soil may be made. It is estimated that a roughly rectangular area with dimensions 50 feet by 75 feet is contaminated with volatile organics. The average depth to the water table in this area is approximately 8 feet. Therefore, it is estimated that source area 1 contains 30,000 cubic feet (1,100 cubic yards) of contaminated soil. No significant contamination was noted in any of the remaining subsurface soil samples.

Twenty subsurface soil samples were also obtained for full Target Compound List (TCL) analysis under the auspices of the EPA's Contract Laboratory Program. The analytical results for the CLP samples are summarized in Table 4-5. The results for the CLP samples are generally consistent with the mobile laboratory results. Volatile organics are the primary contaminants and toluene and trichloroethene were detected at relatively high concentrations (i.e., 2,700 ppb and 2,800 ppb, respectively). In addition, several other volatile organics, notably xylenes and tetrachloroethene (PCE), were detected at high concentrations. Xylene concentrations ranged as high as 1,700 ppb, while PCE concentrations ranged as high as 4,400 ppb. All of these detections occurred in the southwestern portion of

TABLE 4-4

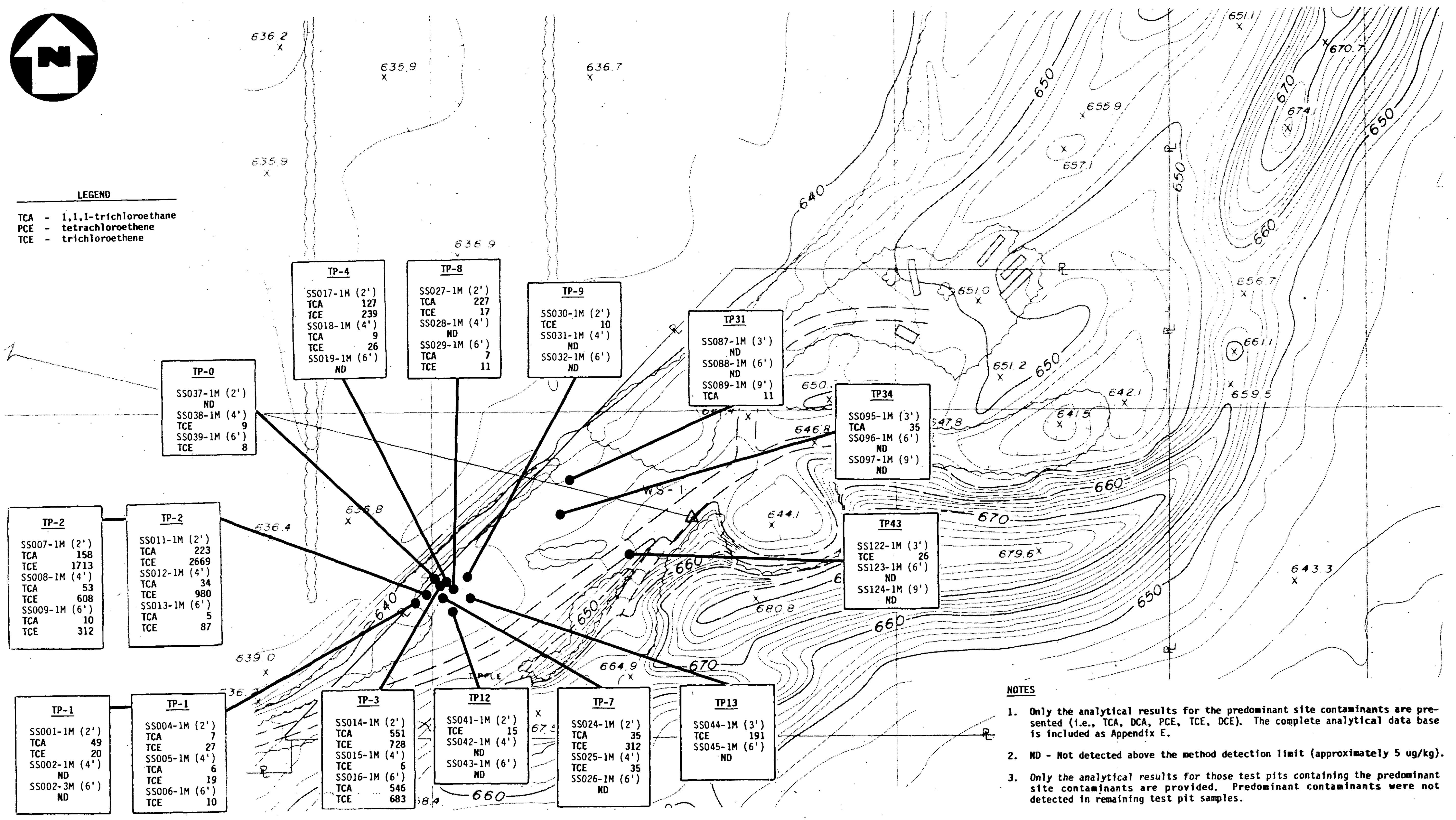
OCCURRENCE AND DISTRIBUTION OF SUBSURFACE SOIL CONTAMINANTS
MOBILE LABORATORY SAMPLES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Contract Required Detection Limit (CRDL) (µg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/kg)(1)	Arithmetic Average Concentration (µg/kg)(2)	Geometric Mean Concentration (µg/kg)(3)
benzene	5	3/129	5-19	0.26	2.6
toluene	5	8/129	9-865	11	3.1
ethylbenzene	5	3/129	14-17	0.36	2.6
1,1,1-trichloroethane	5	18/129	5-551	16	3.7
1,2-dichloroethane	5	1/129	5.1	0.04	2.5
trichloroethene	5	25/129	6-2669	68	4.8
1,2-dichloroethene	5	5/129	6-22	0.60	2.7

(1) Concentration range for positive detections only.
(2) Calculated using "ϕ" for nondetections.
(3) Calculated using 1/2 the CLP CRDL for nondetections.

LEGEND

TCA - 1,1,1-trichloroethane
PCE - tetrachloroethene
TCE - trichloroethene



TP-0
SS037-1M (2')
ND
SS038-1M (4')
TCE 9
SS039-1M (6')
TCE 8

TP-4
SS017-1M (2')
TCA 127
TCE 239
SS018-1M (4')
TCA 9
TCE 26
SS019-1M (6')
ND

TP-8
SS027-1M (2')
TCA 227
TCE 17
SS028-1M (4')
ND
SS029-1M (6')
TCA 7
TCE 11

TP-9
SS030-1M (2')
TCE 10
SS031-1M (4')
ND
SS032-1M (6')
ND

TP31
SS087-1M (3')
ND
SS088-1M (6')
ND
SS089-1M (9')
TCA 11

TP34
SS095-1M (3')
TCA 35
SS096-1M (6')
ND
SS097-1M (9')
ND

TP43
SS122-1M (3')
TCE 26
SS123-1M (6')
ND
SS124-1M (9')
ND

TP-2
SS007-1M (2')
TCA 158
TCE 1713
SS008-1M (4')
TCA 53
TCE 608
SS009-1M (6')
TCA 10
TCE 312

TP-2
SS011-1M (2')
TCA 223
TCE 2669
SS012-1M (4')
TCA 34
TCE 980
SS013-1M (6')
TCA 5
TCE 87

TP-1
SS001-1M (2')
TCA 49
TCE 20
SS002-1M (4')
ND
SS002-3M (6')
ND

TP-1
SS004-1M (2')
TCA 7
TCE 27
SS005-1M (4')
TCA 6
TCE 19
SS006-1M (6')
TCE 10

TP-3
SS014-1M (2')
TCA 551
TCE 728
SS015-1M (4')
TCE 6
SS016-1M (6')
TCA 546
TCE 683

TP12
SS041-1M (2')
TCE 15
SS042-1M (4')
ND
SS043-1M (6')
ND

TP-7
SS024-1M (2')
TCA 35
TCE 312
SS025-1M (4')
TCE 35
SS026-1M (6')
ND

TP13
SS044-1M (3')
TCE 191
SS045-1M (6')
ND

NOTES

1. Only the analytical results for the predominant site contaminants are presented (i.e., TCA, DCA, PCE, TCE, DCE). The complete analytical data base is included as Appendix E.
2. ND - Not detected above the method detection limit (approximately 5 ug/kg).
3. Only the analytical results for those test pits containing the predominant site contaminants are provided. Predominant contaminants were not detected in remaining test pit samples.

FIGURE 4-5

CHLORINATED ALIPHATIC SUBSURFACE SOIL CONTAMINATION (ug/kg)
- MOBILE LABORATORY RESULTS -
BYRON BARREL AND DRUM SITE, BYRON, NY

0 100 200
SCALE IN FEET

NUS CORPORATION

TABLE 4-5

OCCURRENCE AND DISTRIBUTION OF SUBSURFACE SOIL CONTAMINANTS
CONTRACT LABORATORY PROGRAM SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Contract Required Detection Limit (CRDL) (μg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (μg/kg)(2)	Arithmetic Average Concentration (μg/kg)(3)	Geometric Mean Concentration (μg/kg)(4)
acetone	10	1/20	270	14	6.1
toluene	5	9/20	6.0-2,700	240	13
ethylbenzene	5	2/20	33-51	4.2	3.3
xylenes	5	3/20	7.0-1,700	89	4.3
1,1,1-trichloroethane	5	4/20	17-150	16.1	4.8
1,1,2-trichloroethane	5	1/20	12	0.6	2.7
tetrachloroethene	5	10/20	3.0-4,400	280	11
trichloroethene	5	10/20	13-2,800	220	18
1,1-dichloroethene	5	2/20	2.0-10	0.6	2.6
methylene chloride	5	5/20	25-190	24	5.8
1,3-dichloropropene	5	1/20	7	0.35	2.6
bis(2-ethylhexyl)phthalate	330	4/20	80-1,700	100	180
di-n-butylphthalate	330	8/20	1,200-2,000	700	420
naphthalene	330	1/20	95	4.8	160
pyrene	330	1/20	79	4.0	160
4,4'-DDT	16	1/20	12	0.6	8.2
4,4'-DDE	16	1/20	7	0.35	7.9
PCB 1254	160	1/20	690	35	89
aluminum	200	20/20	1,370-5,640	3,300	3,100
antimony	60	1/20	10.4	0.52	1.1
arsenic	10	17/20	1.3-2.9	1.7	1.8

TABLE 4-5
OCCURRENCE AND DISTRIBUTION OF SUBSURFACE SOIL CONTAMINANTS
CONTRACT LABORATORY PROGRAM SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Contract Required Detection Limit (CRDL) (μg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (μg/kg)(2)	Arithmetic Average Concentration (μg/kg)(3)	Geometric Mean Concentration (μg/kg)(4)
barium	200	20/20	6.8-69	36	31
cadmium	5	1/20	1.2	0.06	1.0
calcium	5,000	20/20	1,670-91,600	39,000	26,000
chromium	10	9/20	1.7-15.5	2.7	2.1
cobalt	50	19/20	1.7-8.2	3.8	3.5
copper	25	17/20	3.2-12.8	6.7	5.5
iron	100	20/20	3,210-12,300	7,200	6,900
lead	5	10/20	4.7-22.6	4.6	2.8
magnesium	5,000	20/20	1,970-26,500	11,000	9,100
manganese	15	20/20	137-536	310	290
nickel	40	9/20	3.7-8.8	2.9	2.2
potassium	5,000	16/20	240-699	380	130
silver	10	2/20	57.7-144	10	1.6
sodium	5,000	11/20	61.4-756	77	12
vanadium	50	20/20	4.0-14.4	8.5	8.1
zinc	20	20/20	17.4-122	57	50

(1) Organic analyses conducted using EPA Methods 624 (volatiles), 625 (extractables), and 608 (pesticides/PCBs).

(2) Concentration range for positive detections only.

(3) Calculated using "ϕ" for nondetections.

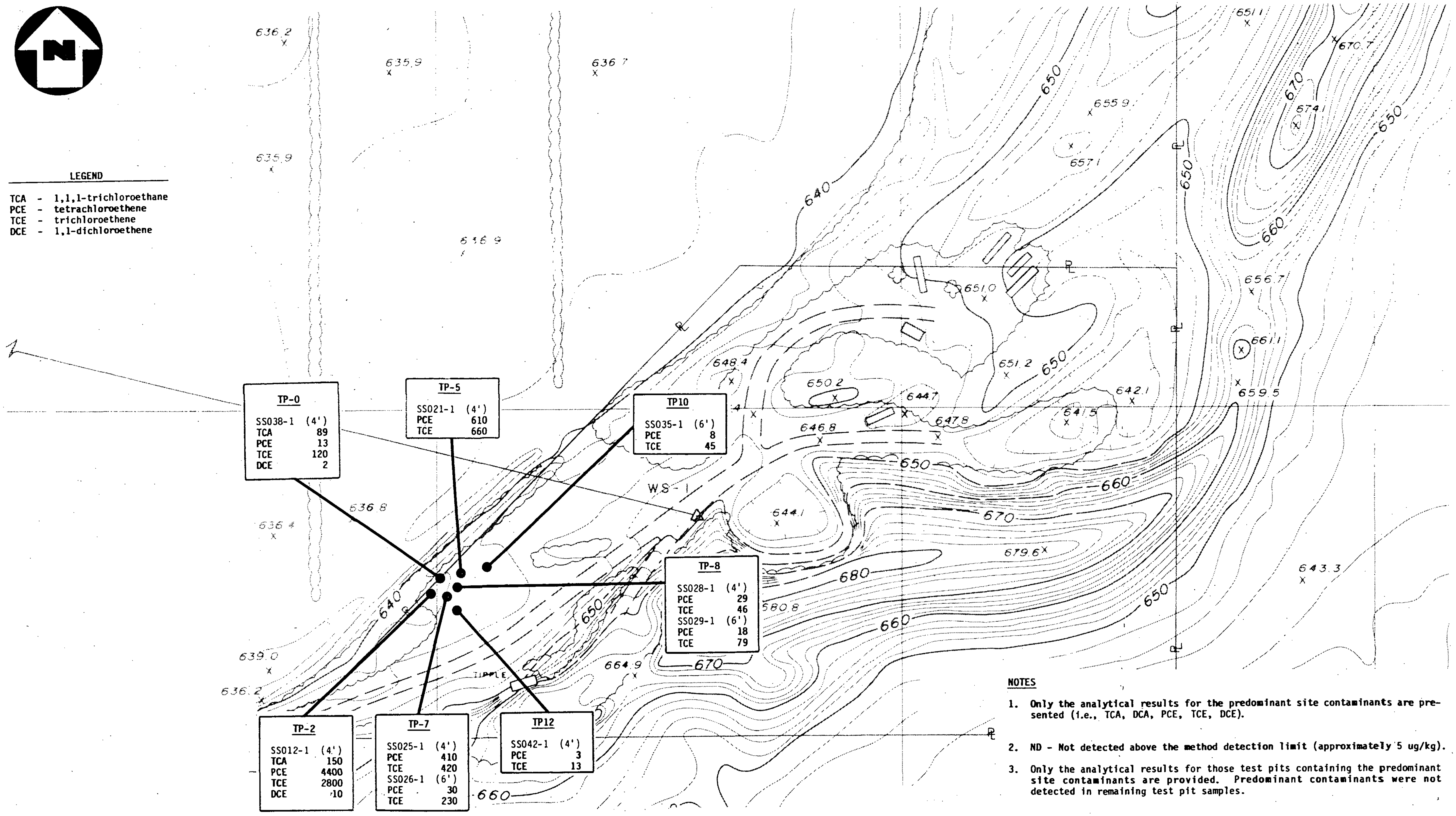
(4) Calculated using 1/2 the CLP CRDL for nondetections.

source area 1. In addition, phthalate esters were detected in several samples at concentrations ranging as high as 2,000 ppb (di-n-butylphthalate). PCB 1254 was detected in one sample from test pit 2 at a depth of 4 feet. PCBs were detected in drum samples collected by the NYSDEC prior to the EPA removal action. The detection of PCB 1254 at a concentration of 690 µg/kg indicates that some release of PCBs occurred at the site. However, only one sample from source area 1 contained a PCB compound and the available data indicate that PCB contamination is not extensive. PCBs were not identified in any of the other matrices sampled at the site (i.e., surface soil, sediment, groundwater, or surface water).

Figure 4-6 summarizes the analytical results for the subsurface CLP samples. Once again, the predominant groundwater contaminants have been used to form the basis of the predominant contaminants for this figure. The analytical results for TCA, PCE, TCE, and 1,1-dichloroethene (DCE) are presented on the figure. Only the results for those test pits containing positive detections of these analytes are provided on Figure 4-6. The results for the CLP samples are generally consistent with the mobile laboratory samples. These results delineate an area of contamination extending from test pit 2 northeast to test pit 10, and from test pit 0 southeast to test pit 12. Once again, these results delineate an area of approximately 50 feet by 75 feet, resulting in a volume estimate of 1,100 cubic yards of contaminated soil. No significant contamination was identified in any of the remaining CLP subsurface soil samples.

During the course of the test pit operations, it was noted that the subsurface consists of sand and gravel deposits. Based on the appearance of the overburden and on the absence of any visual evidence of contamination, it was anticipated that only low levels of organic materials would be encountered in the soil matrix. It was not expected that the soils would exhibit a marked capacity for adsorption of organic chemicals. The analytical results appear to confirm this suspicion. No organic analyte was detected in subsurface soils above 4.4 ppm, in spite of the fact that historical information indicates that direct dumping of liquid wastes into an open pit occurred in source area 1.

The analytical results for subsurface soil samples obtained in the vicinity of the maintenance building source are depicted in Figure 4-7. Subsurface soil samples contained several chlorinated aliphatic hydrocarbons, including 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, 1,1-dichloroethene, and methylene chloride. Concentrations of these analytes are generally greatest in samples obtained from borings around the southern edge of the maintenance building (i.e., samples from soil borings 7 and 8). TCA concentrations ranged as high as 410 parts per billion in these samples.



LEGEND

TCA - 1,1,1-trichloroethane
PCE - tetrachloroethene
TCE - trichloroethene
DCE - 1,1-dichloroethene

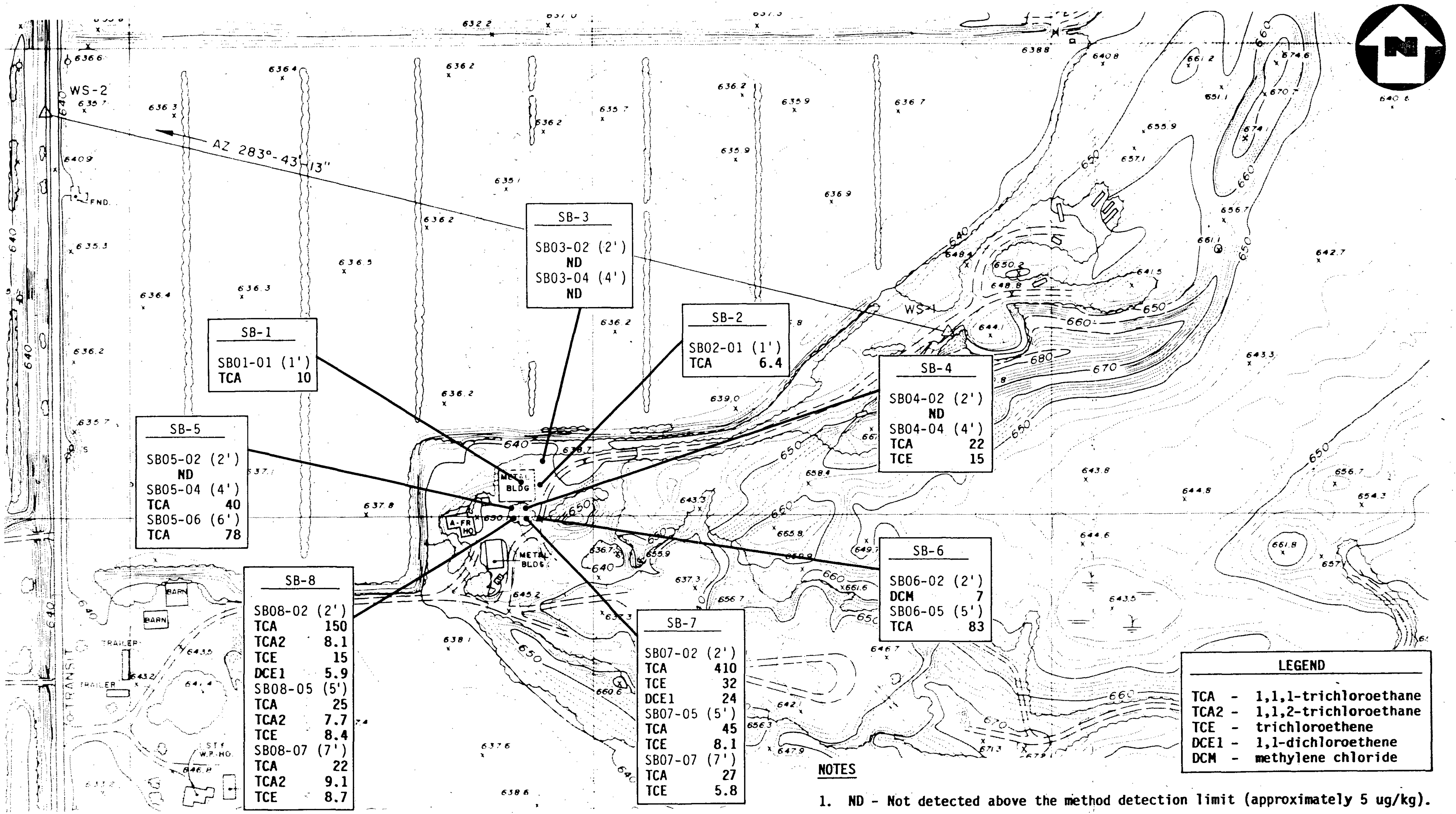
NOTES

1. Only the analytical results for the predominant site contaminants are presented (i.e., TCA, DCA, PCE, TCE, DCE).
2. ND - Not detected above the method detection limit (approximately 5 ug/kg).
3. Only the analytical results for those test pits containing the predominant site contaminants are provided. Predominant contaminants were not detected in remaining test pit samples.

FIGURE 4-6

CHLORINATED ALIPHATIC SUBSURFACE SOIL CONTAMINATION (ug/kg)
-CLP RESULTS-
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION



LEGEND

TCA - 1,1,1-trichloroethane
TCA2 - 1,1,2-trichloroethane
TCE - trichloroethene
DCE1 - 1,1-dichloroethene
DCM - methylene chloride

NOTES

1. ND - Not detected above the method detection limit (approximately 5 ug/kg).

FIGURE 4-7

CHLORINATED ALIPHATIC SUBSURFACE SOIL CONTAMINATION (μg/kg)
MAINTENANCE BUILDING SOURCE
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION

Concentrations at this location decrease with depth as is evident from Figure 4-7. It is believed that this is a manifestation of the increasing quantity of gravel present with increasing depth at these locations. Numerous borings were drilled in this area before sites suitable for recovery of samples were obtained. These borings were installed approximately 25 feet from the southern edge of the maintenance building and were sited as a result of the detection of organic contaminants in a sample from monitoring well MW-2 (Section 4.5). Low levels of contamination were detected in this groundwater sample (i.e., less than 1 ppm total volatile organics) and soil borings 7 and 8 were drilled to investigate contamination in this area.

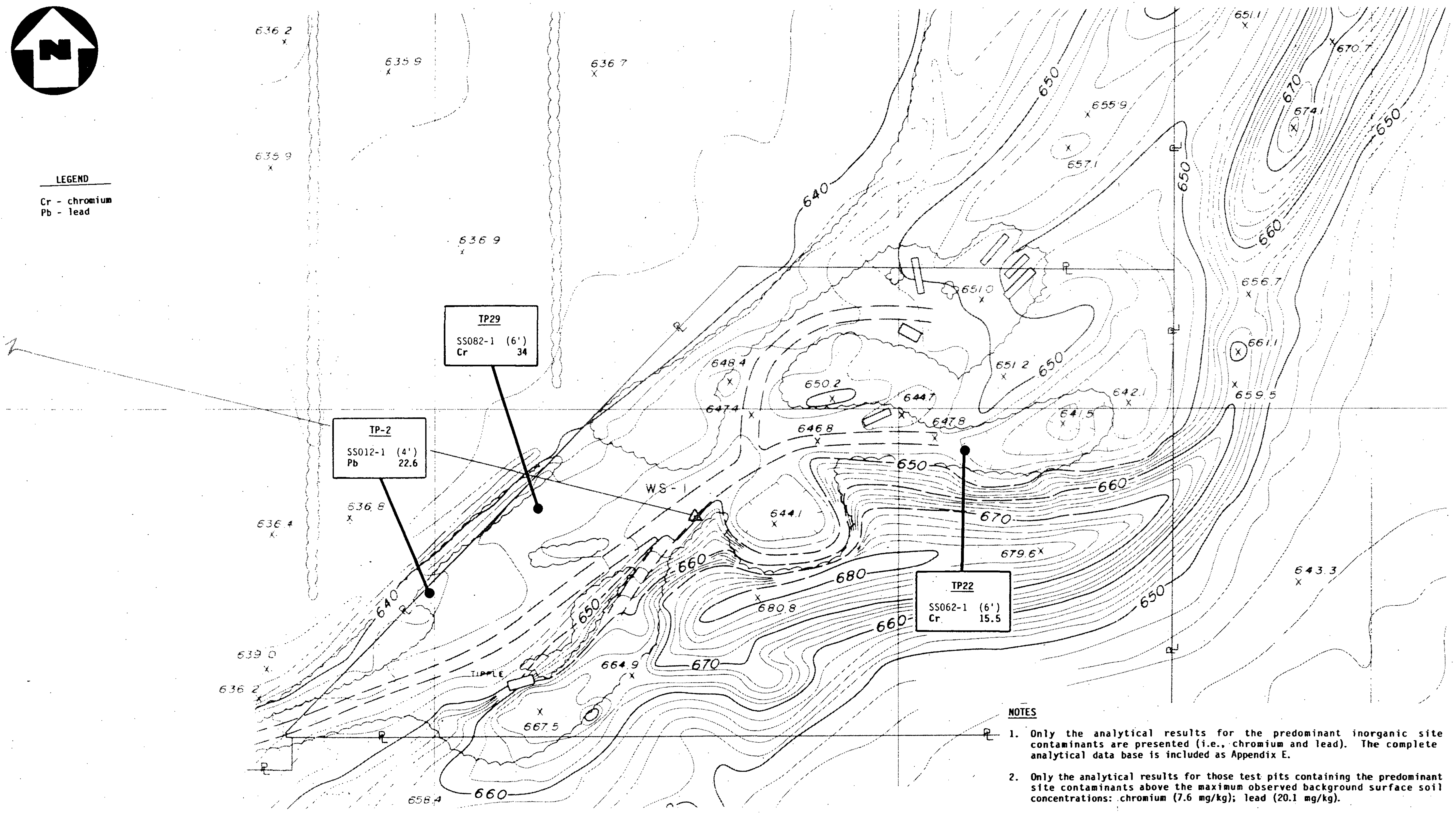
Based on the results of the soil-gas survey and the subsurface soil sampling and analysis program, it is estimated that the maintenance building source is approximately 100 feet by 100 feet in area. Assuming that contamination extends to the water table, it is estimated that approximately 3,000 cubic yards of contaminated unsaturated zone soil exist in this area.

Figure 4-8 depicts detections of chromium and lead above background soil concentrations. From the figure it is apparent that subsurface contamination with these substances is not extensive in any of the source areas.

4.5 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

Four distinct rounds of groundwater sampling were conducted at the Byron Barrel and Drum Site. The first two rounds were conducted during the course of the monitoring well installation program to aid in locating downgradient wells. Two complete rounds of monitoring well sampling were completed, once all of the wells were installed. One of these sampling rounds included analysis for the full complement of Target Compound List analytes. The second sampling round included analysis only for volatile organics and metals, since no pesticides or semi-volatile organics were detected in the first complete sampling round. The first complete round of groundwater samples included analysis of volatile organics using EPA Method 624 (detection limits ranging from 5 to 10 ppb). The second complete sampling round included analysis for volatile organics, using EPA Methods 601 and 602 (detection limits below 1 ppb).

The complete analytical data base for the groundwater sampling and analysis program is included in Appendix E. Only the complete rounds of sampling (rounds 3 and 4) are discussed in the body of this report, since they are most indicative of the nature and extent of contamination. The analytical results for groundwater sampling rounds 3 and 4 are summarized in Tables 4-6 and 4-7, respectively.



LEGEND

Cr - chromium
Pb - lead

NOTES

1. Only the analytical results for the predominant inorganic site contaminants are presented (i.e., chromium and lead). The complete analytical data base is included as Appendix E.

2. Only the analytical results for those test pits containing the predominant site contaminants above the maximum observed background surface soil concentrations: chromium (7.6 mg/kg); lead (20.1 mg/kg).

FIGURE 4-8

0 100 200
SCALE IN FEET

NUS CORPORATION

INORGANIC SUBSURFACE SOIL CONTAMINATION (mg/kg)
BYRON BARREL AND DRUM SITE, BYRON, NY

TABLE 4-6

OCCURRENCE AND DISTRIBUTION OF GROUNDWATER CONTAMINANTS
ROUND 3 MONITORING WELL SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Contract Required Detection Limit (CRDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
toluene	5	2/20	1.0	0.10	2.3
xylenes	5	3/20	2.0-3.0	0.35	2.5
1,3-dichlorobenzene	5	4/20	2.0-3.0	0.45	4.2
1,4-dichloroebenze	5	1/20	2.0	0.10	4.8
1,1,1-trichloroethane	5	11/20	9.0-4,400	380	33
1,1-dichloroethane	5	10/20	1.0-290	18	4.5
tetrachloroethene	5	1/20	82	4.1	3.0
trichloethene	5	4/20	5.0-3,300	170	4.3
1,2-dichloroethene	5	1/20	110	5.5	3.0
1,1-dichloroethene	5	9/20	2.0-41	5.3	4.4
N-nitrosodiphenylamine	10	2/20	2.0	0.20	4.6
arsenic	10	20/20	2.0-26	9.6	7.8
barium	200	20/20	84-2,870	840	610
beryllium	5	5/20	3.0-5.0	0.90	2.7
cadmium	5	20/20	3.0-24	11	9.2
calcium	5,000	20/20	125,000-549,000	420,000	390,000

TABLE 4-6
OCCURRENCE AND DISTRIBUTION OF GROUNDWATER CONTAMINANTS
ROUND 3 MONITORING WELL SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Contract Required Detection Limit (CRDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
chromium	10	19/20	13-89	40	33
cobalt	50	20/20	5.0-105	31	23
copper	25	20/20	31-618	160	110
iron	100	20/20	5,794-44,300	28,000	25,000
lead	5	20/20	13-260	97	73
magnesium	5,000	20/20	34,200-151,000	91,000	83,000
manganese	15	20/20	552-9,460	3,900	3,000
mercury	0.2	5/20	0.2-0.5	0.07	0.13
nickel	40	20/20	30-144	71	64
potassium	5,000	20/20	2,580-8,920	4,400	4,100
silver	10	1/20	6	0.30	5.0
sodium	5,000	20/20	3,300-37,900	11,000	7,900
vanadium	50	18/20	12-54	27	27
zinc	20	20/20	62-2,020	570	380

(1) Organic analyses conducted using EPA Methods 624 (volatiles), 625 (extractables), and 608 (pesticides/PCBs).
(2) Concentration range for positive detections only.
(3) Calculated using "ϕ" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.

TABLE 4-7

OCCURRENCE AND DISTRIBUTION OF GROUNDWATER CONTAMINANTS
ROUND 4 MONITORING WELL SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Method Detection Limit (MDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
benzene	0.2	1/20	0.50	0.025	2.3
toluene	0.2	5/20	0.3-1.0	0.14	1.7
chlorobenzene	0.2	2/20	0.046-0.22	0.013	1.8
1,2-dichlorobenzene	0.4	1/20	0.026	0.0013	2.0
1,3-dichlorobenzene	0.4	2/20	0.02-0.041	0.003	1.6
1,4-dichlorobenzene	0.3	8/20	0.016-0.91	0.054	0.46
1,1,1-trichloroethane	0.03	11/20	15-760	150	26
1,1,2-trichloroethane	0.02	8/20	0.013-3.7	0.19	0.49
1,1-dichloroethane	0.07	11/20	0.12-16	3.5	2.7
tetrachloroethene	0.03	1/20	51	2.6	2.9
trichloroethene	0.12	4/20	5.9-2,800	140	4.2
1,2-dichloroethene	0.10	1/20	0.93	0.047	2.4
1,1-dichloroethene	0.13	11/20	0.46-6.1	1.6	2.4
vinyl chloride	0.18	1/20	0.06	0.003	4.0
chloroform	0.05	3/20	0.026-0.13	0.0095	1.4
bromodichloromethane	0.10	2/20	0.021-0.024	0.0022	1.6
2-chloroethylether	0.13	1/20	60	3.0	5.7
aluminum	200	20/20	1,460-279,000	51,000	24,000
arsenic	10	1/20	41.3	2.1	5.6
barium	200	20/20	120-5,230	870	480

TABLE 4-7
OCCURRENCE AND DISTRIBUTION OF GROUNDWATER CONTAMINANTS
ROUND 4 MONITORING WELL SAMPLES(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Method Detection Limit (MDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
beryllium	5	20/20	1.1-22.6	4.3	2.8
cadmium	5	3/20	4.7-21.4	1.8	3.1
calcium	5,000	20/20	71,4000- 2,070,000	460,000	290,000
chromium	10	20/20	37.8-479	130	100
cobalt	50	18/20	7.5-377	57	33
copper	25	20/20	9.5-2,110	350	120
iron	100	20/20	2,530-666,000	110,000	50,000
lead	5	18/20	4.5-631	110	35
magnesium	5,000	20/20	10,900-500,000	120,000	78,000
manganese	15	20/20	132-19,800	3,300	1,600
mercury	0.2	3/20	0.40-0.70	0.085	0.13
nickel	40	20/20	8.9-606	120	75
potassium	5,000	20/20	1,710-35,300	11,000	8,100
silver	10	11/20	4.1-8.9	2.7	4.9
sodium	5,000	19/20	2,110-50,800	11,000	7,700
vanadium	50	20/20	4.5-574	110	51
zinc	20	20/20	24.6-7,580	1,300	370

(1) Organic analyses conducted using EPA Methods 601/602 (volatiles).
(2) Concentration range for positive detections only.
(3) Calculated using "0" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.

As shown in Tables 4-6 and 4-7, a number of volatile organic chemicals were detected in site groundwater samples during the third and fourth sampling rounds. Volatile organics detected frequently and/or at high concentrations include 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (DCE), and 1,2-dichloroethene. Concentrations of these compounds ranged as high as 4,400 ppb, 290 ppb, 82 ppb, 3,300 ppb, 41 ppb, and 110 ppb, respectively. Of these compounds, all but 1,2-dichloroethene are considered major site contaminants. Only one sample was found to contain 1,2-dichloroethene at a concentration above 1 ppb, which is the sample mentioned above.

In addition, numerous other volatile organic compounds were detected in site groundwater samples. For example, benzene, toluene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, vinyl chloride, chloroform, and bromodichloromethane were detected at concentrations ranging as high as 0.5 ppb, 1.0 ppb, 0.026 ppb, 0.041 ppb, 2 ppb, 3.7 ppb, 0.06 ppb, 0.13 ppb, and 0.024 ppb, respectively. In addition, N-nitrosodiphenylamine was detected at concentrations ranging to 2 ppb.

For the most part, all of the organic contaminants were detected in groundwater samples obtained from wells located in the vicinity of or immediately downgradient of source areas 1 and 2. One notable exception to this general trend is the detection of high levels of contamination in monitoring well MW-10B, which is the southwestern-most well installed on the site property.

During the course of the phased well installation program, it was ascertained that groundwater flows northwest of the site. Once the various source area wells were installed, a well cluster (MW-6A and MW-6B) was installed between the sources and the residential wells to the southwest. These wells were sampled (round 2). Both the analytical results and the hydraulic gradient indicated that contaminants were not migrating from the source areas to the residential wells. However, MW-10B was installed to provide additional information regarding groundwater flow directions and to confirm that no contaminant migration toward the residential wells had occurred. The detection of high concentrations of chlorinated aliphatics in this well was unanticipated. These results indicate the presence of an additional source in the vicinity of MW-10B.

This conclusion is based on several aspects of site-specific hydrogeology and the chemical-analytical results. The hydraulic gradient is to the northwest, away from the residential wells; MW-10B is located cross-gradient to the contaminant source areas. No major site contaminants have been detected in three rounds of groundwater samples obtained from MW-6A and MW-6B, which is located between the source areas and MW-10B. The primary contaminant in MW-10B is 1,1,1-trichloroethane, whereas the predominant contaminant in the nearest source area (source area 1) is trichloroethene. These contaminants are very similar with respect to their environmental mobility (See Section 5.0: Contaminant Fate and Transport) and trichloroethene would be more likely to affect MW-10B than 1,1,1-trichloroethane. Based on this information it has been concluded that the major site source areas are not responsible for the contamination detected in MW-10B. An additional phase of the field investigation is currently under way to ascertain the nature and extent of contamination in the vicinity of MW-10B. This information will be incorporated in either the final remedial investigation report or in an addendum to the report.

Low levels of volatile organic contamination were noted in several wells that are not associated with source areas 1 and 2. For example, toluene was detected in the upgradient well (MW-4A) in two of three samples at concentrations ranging to 2 ppb. Methylene chloride was detected in one of three samples from this well at a concentration of 2.8 ppb. Contamination has not been detected consistently in this well and concentrations are on the order of instrument detection limits. These results are not considered indicative of an extensive upgradient contamination.

Low concentrations of some chemicals were also detected in the source area 3 monitoring wells. For example, TCA was detected in one of three samples from MW-3A at a concentration of 0.03 ppb. Chloroform was detected in one of three samples from this well at a concentration of 0.026 ppb. TCA was detected in one of three samples from MW-3B at a concentration of 0.05 ppb, while chloroform was detected in two of three samples at concentrations ranging to 0.1 ppb. One sample from this well also contained 1,4-dichlorobenzene at a concentration of 0.02 ppb. Once again, the sporadic detection of low levels of contamination in these samples is not considered indicative of widespread contamination in source area 3. Based on the results of the soil-gas survey, the surface and subsurface soil sampling activities, and the groundwater results, it is concluded that suspected source area 3 is an insignificant source of contamination at the Byron Barrel and Drum Site.

Low concentrations of some analytes were also detected in samples obtained from well cluster number 6. TCA (0.28 ppb), PCE (0.06), chloroform (0.13 ppb), vinyl chloride (0.06 ppb), and 1,4-dichlorobenzene (0.027 ppb) were each detected in one of three samples from MW-6A. Samples from MW-6B contained low levels of similar compounds in some samples but not others. Once again, it has been concluded that no significant source of contamination exists in the vicinity of this well.

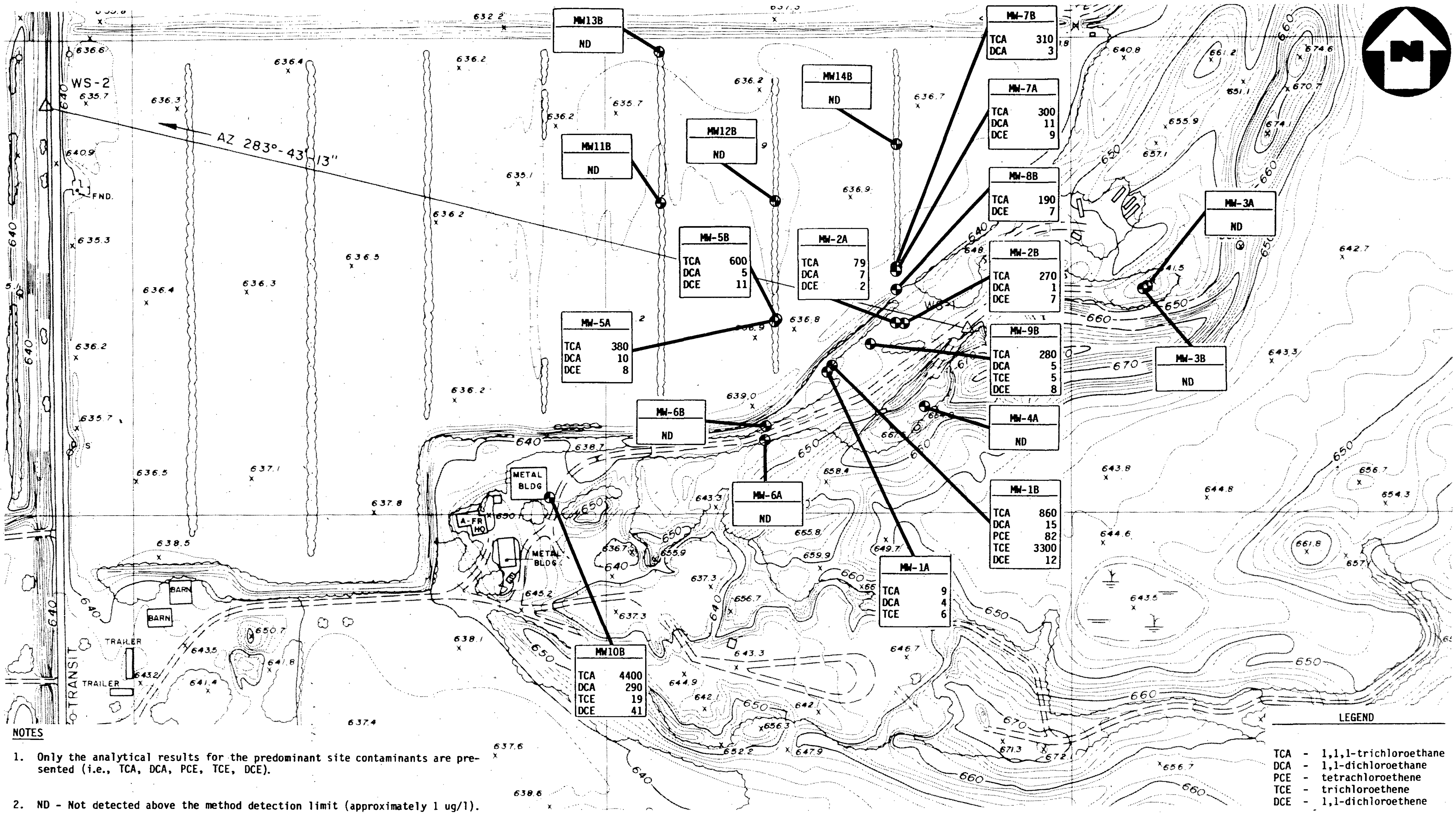
The detection of low levels of contamination in wells MW-4A, MW-3A, MW-3B, MW-6A, and MW-6B may be a result of either inadequate decontamination procedures or bottle contamination. Most of the analytes detected in these wells were also detected in bottle, trip, and field blanks at similar levels.

Figures 4-9 and 4-10 summarize the results for the predominant site groundwater contaminants for the third and fourth sampling rounds, respectively. The results for these sampling results are relatively consistent and indicate that contamination has originated in source areas 1 and 2 and is migrating to the northwest of the site at least as far as monitoring well clusters 5 and 7 (approximately 200 feet from the source areas). Once these clusters were installed and an additional round of water levels and analytical results were obtained, downgradient monitoring wells MW-11B, MW-12B, MW-13B, and MW-14B were installed to ascertain the distance the plume had traveled. These wells were sampled on two occasions and no contamination was detected. Thus it is concluded that the plume has migrated less than 400 feet from the source areas.

The southwestern and northeastern extent of the contamination originating from source areas 1 and 2 are currently ill-defined by actual groundwater sample results. However, based on groundwater flow directions and interpolation between various wells, it is anticipated that the contaminant plume associated with source areas 1 and 2 is contained to an area within 400 feet of the source areas. Extensive contaminant migration is not anticipated, since the results of hydraulic conductivity testing indicate that permeability decreases away from the site.

In addition to the organic contaminants detected in site groundwater samples, a number of inorganic constituents were detected above background levels. Table 4-8 provides a summary of the inorganic sample results for the upgradient well (MW-4A) versus the site well samples. As shown in the table, numerous inorganic chemicals were detected at levels in excess of background concentrations. Chemicals detected at concentrations significantly above background include aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, sodium, vanadium, and zinc. It should be noted that groundwater samples were not filtered prior to acidification. Hence, these results are indicative of total inorganics in the water samples, including those present in suspended solids. Groundwater samples from the site were generally turbid and the inorganic results are certainly overestimates of the actual dissolved inorganic concentrations. It should be noted that the average concentrations presented in Table 4-8 indicate that there is little difference between the overall site concentrations and background levels. With the exception of sodium, mercury, and zinc, the average background concentrations exceed the site average values.

Furthermore, it is interesting to note that virtually all of the maximum concentrations of inorganics in site monitoring wells were found in the fourth round sample from monitoring well MW-6B. By contrast, the results for the third round sample are



NOTES

1. Only the analytical results for the predominant site contaminants are presented (i.e., TCA, DCA, PCE, TCE, DCE).

2. ND - Not detected above the method detection limit (approximately 1 ug/l).

LEGEND

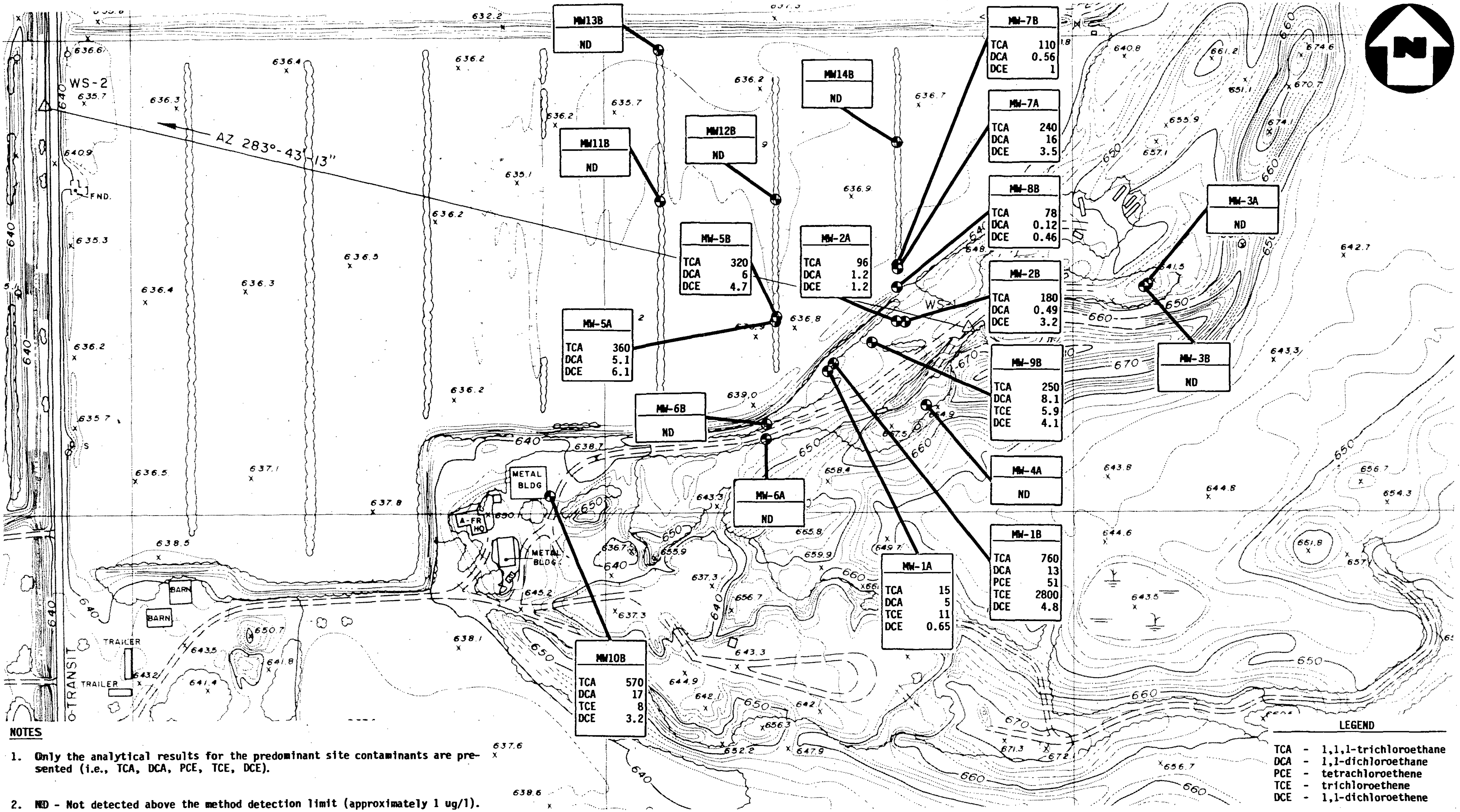
TCA - 1,1,1-trichloroethane
DCA - 1,1-dichloroethane
PCE - tetrachloroethene
TCE - trichloroethene
DCE - 1,1-dichloroethene

0 200 400
SCALE IN FEET

FIGURE 4-9

CHLORINATED ALIPHATICS DETECTED IN MONITORING WELL SAMPLES (ug/l) - 11/7-9/88
BYRON BARREL AND DRUM SITE, BYRON, NY

NUS CORPORATION



NOTES

1. Only the analytical results for the predominant site contaminants are presented (i.e., TCA, DCA, PCE, TCE, DCE).
2. ND - Not detected above the method detection limit (approximately 1 ug/l).

LEGEND

TCA - 1,1,1-trichloroethane
DCA - 1,1-dichloroethane
PCE - tetrachloroethene
TCE - trichloroethene
DCE - 1,1-dichloroethene

FIGURE 4-10

CHLORINATED ALIPHATICS DETECTED IN MONITORING WELL SAMPLES (ug/l) - 12/13-14/88
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

TABLE 4-8

INORGANIC RESULTS FOR UPGRADIENT AND SITE GROUNDWATER SAMPLES BYRON BARREL AND DRUM SITE BYRON, NEW YORK

Chemical	Maximum Concentration (µg/l)		Average Concentration (µg/l)(3)	
	Upgradient(1)	Site(2)	Upgradient(1)	Site(2)
aluminum	58,900	279,000	29,450	28,072
arsenic	8.0	24	4.0	3.967
barium	1,490	5,230	1,159.5	1,003.3
beryllium	4.6	22.6	4.3	2.8
cadmium	20	24	10	6.8
calcium	549,000	2,070,000	494,000	449,160
chromium	171	479	130	87.8
cobalt	65	377	64.05	48.8
copper	406	2,110	395	295.4
iron	159,000	666,000	96,300	77,575
lead	170	631	147.5	117.96
magnesium	151,000	500,000	147,000	102,932
manganese	8,340	19,800	5,755	3,939
mercury	-	0.7	-	0.0933
nickel	143	606	141.5	97.38
potassium	12,900	35,300	9,500	7,475
silver	6.0	8.9	5.6	1.3
sodium	9,370	50,800	9,190	10,769
vanadium	129	574.0	87	72.2
zinc	917	7,580	835	1,116

(1) Upgradient samples from MW-4A.
(2) Site samples do not include wells 4A, 11B, 12B, 13B, or 14B.
(3) Average concentrations determined using only one of any two duplicate samples collected.

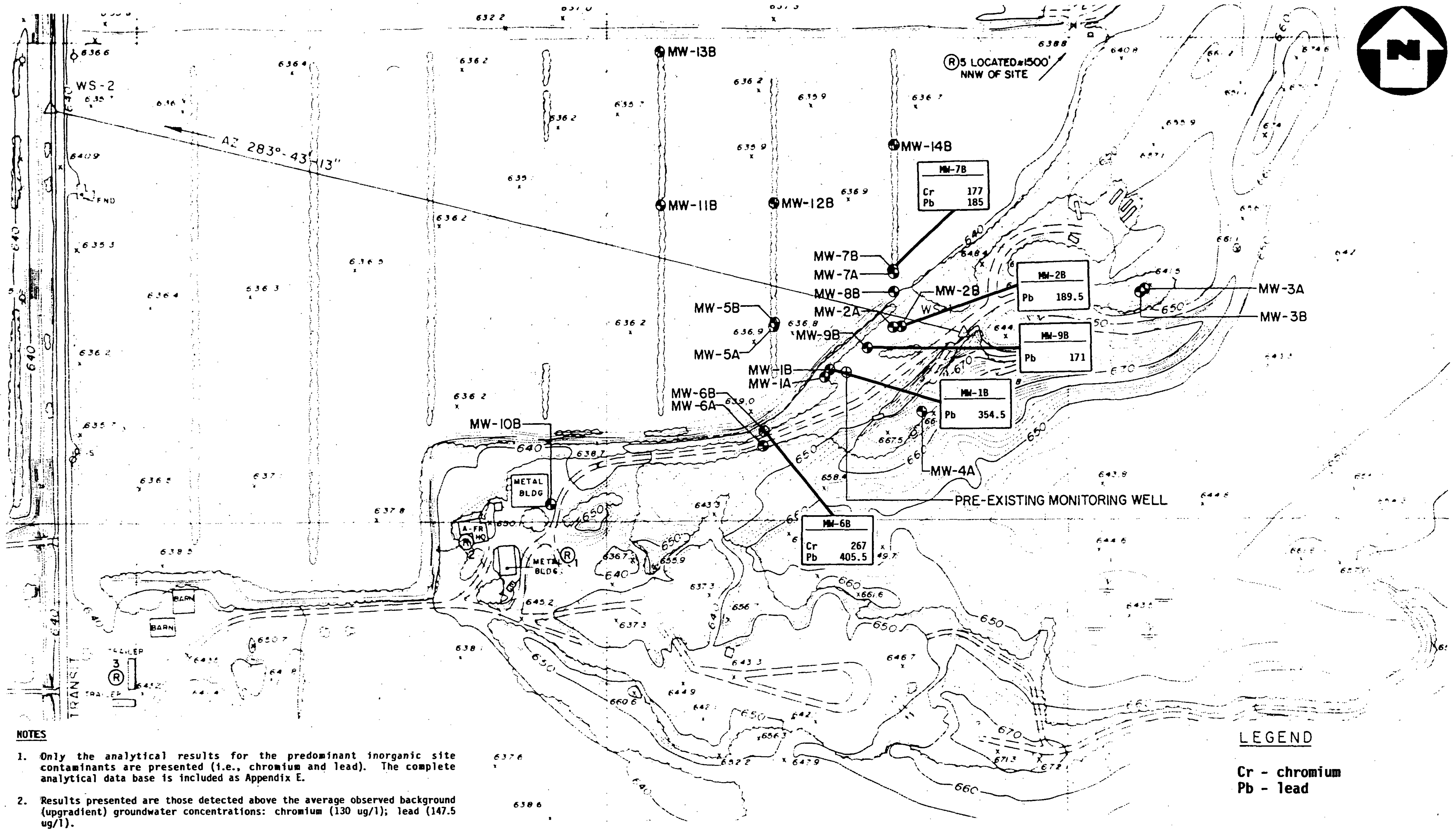
virtually indistinguishable from the upgradient well results, as may be seen by comparison of sample numbers BS-MW04A-3/ BS-MW04A-4 and BS-MW06B-3 (Appendix E). The anomalous occurrence of high concentrations of inorganics in this one sample is inexplicable, although it is possible that this sample contained an unusually high silt load. The results for the other well at this cluster location (MW-6A) are also quite similar to the upgradient concentrations, suggesting that the data for sample number BS-MW06B-4 are outliers. Figure 4-11 displays the results for chromium and lead detected above background (upgradient) levels. Based on these results, it appears that lead contamination exists in source areas 1 and 2.

Based on the available inorganic results, it has been concluded that no significant anthropogenic inorganic contamination is originating from the Byron Barrel and Drum Site.

The analytical results for groundwater samples collected during the supplemental activities are summarized in Figure 4-12. Groundwater contamination consists of chlorinated aliphatics and ketones. Organic contamination with 1,1,1-trichloroethane (TCA) and 2-butanone (methyl ethyl ketone or MEK) is most pronounced. Concentrations of TCA ranged as high as 2,500 parts per billion (ppb) while concentrations of MEK ranged as high as 3,000 ppb.

The detection of MEK in two wells in this area (i.e., monitoring wells MW-1 and MW-6) is considered somewhat anomalous. This substance is exceedingly soluble in water, and it is unusual that it is confined to such a small area. Although no basis for rejection of these results was identified during data validation activities, it should be noted that this substance was also identified in quality assurance samples for the site (blanks). Although the concentrations in the blanks were much lower than those in the samples, the possibility that this substance is a laboratory artifact cannot be conclusively rejected.

The extent of groundwater contamination in the vicinity of the maintenance building source is relatively well defined by the analytical results for samples from monitoring wells MW-3 and MW-5, and the temporary well points WP-1, WP-2, WP-3, WP-4, and WP-5. These results delineate a contaminant plume extending from the maintenance building source to the north of the site. It is estimated that the plume has extended no farther than 300 feet from the source area at the southern edge of the maintenance building. No evidence of contaminant migration to the southwest of the source is apparent. This is consistent with the groundwater flow directions depicted in Figure 3-9 (Potentiometric Surface Map of 4/25/89) and Figure 3-10 (Potentiometric Surface Map of 6/22/89).



NOTES

1. Only the analytical results for the predominant inorganic site contaminants are presented (i.e., chromium and lead). The complete analytical data base is included as Appendix E.
2. Results presented are those detected above the average observed background (upgradient) groundwater concentrations: chromium (130 ug/l); lead (147.5 ug/l).

LEGEND

Cr - chromium
Pb - lead

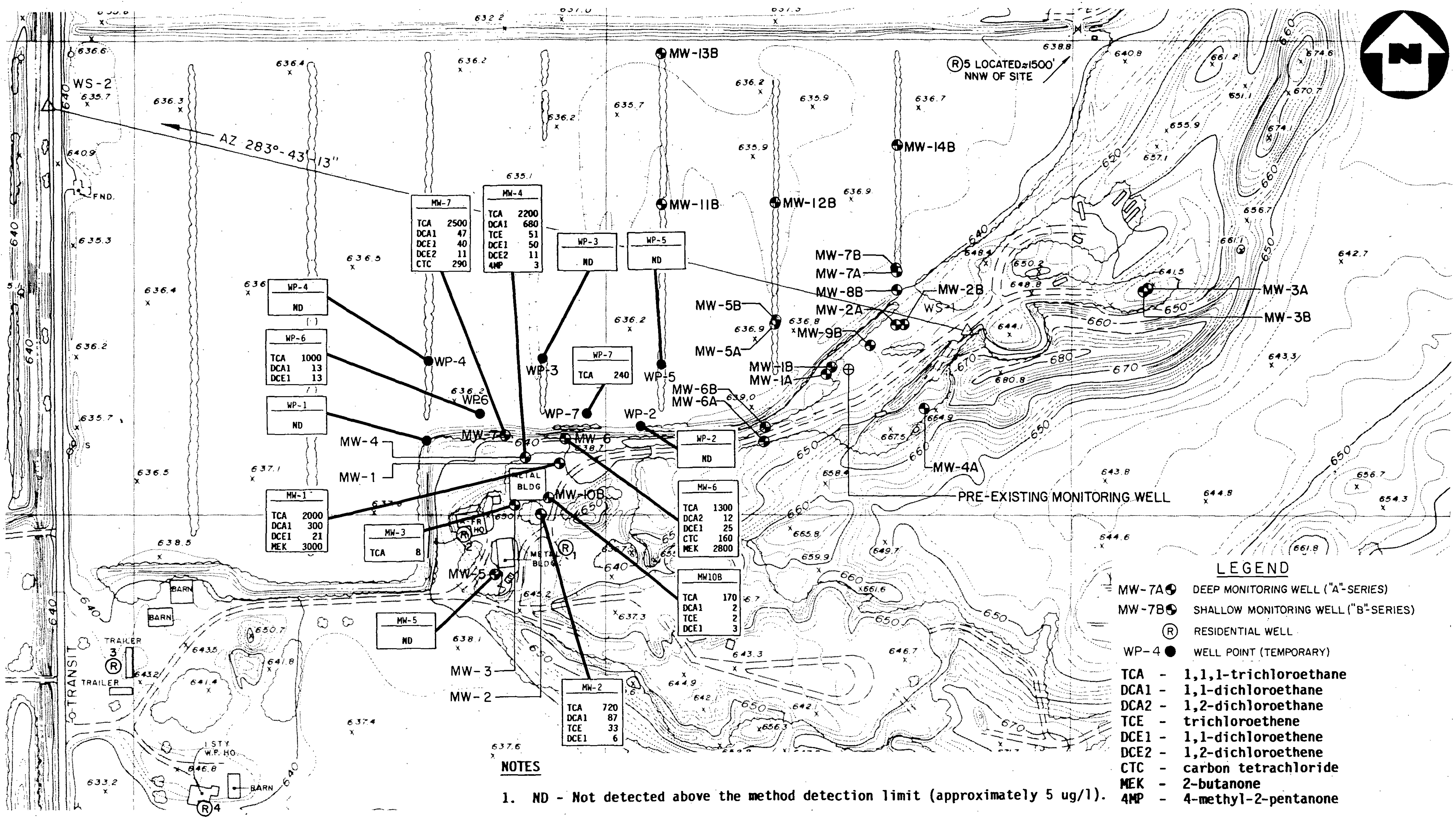
FIGURE 4-11

INORGANIC CONTAMINANTS DETECTED IN MONITORING WELL SAMPLES (ug/l)

BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION



MW-7	
TCA	2500
DCA1	47
DCE1	40
DCE2	11
CTC	290

MW-4	
TCA	2200
DCA1	680
TCE	51
DCE1	50
DCE2	11
4MP	3

WP-3
ND

WP-5
ND

WP-4
ND

WP-6	
TCA	1000
DCA1	13
DCE1	13

WP-7	
TCA	240

WP-1
ND

WP-2
ND

MW-1	
TCA	2000
DCA1	300
DCE1	21
MEK	3000

MW-3	
TCA	8

MW-6	
TCA	1300
DCA2	12
DCE1	25
CTC	160
MEK	2800

MW10B	
TCA	170
DCA1	2
TCE	2
DCE1	3

MW-5
ND

MW-2	
TCA	720
DCA1	87
TCE	33
DCE1	6

NOTES

1. ND - Not detected above the method detection limit (approximately 5 ug/l).

LEGEND

MW-7A ◒	DEEP MONITORING WELL ("A"-SERIES)
MW-7B ◓	SHALLOW MONITORING WELL ("B"-SERIES)
Ⓡ	RESIDENTIAL WELL
WP-4 ●	WELL POINT (TEMPORARY)

TCA	1,1,1-trichloroethane
DCA1	1,1-dichloroethane
DCA2	1,2-dichloroethane
TCE	trichloroethene
DCE1	1,1-dichloroethene
DCE2	1,2-dichloroethene
CTC	carbon tetrachloride
MEK	2-butanone
4MP	4-methyl-2-pentanone

FIGURE 4-12

CHLORINATED ALIPHATICS AND KETONES DETECTED
IN MONITORING WELL AND WELL POINT SAMPLES (ug/l) - 4/21/89 TO 5/11/89
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

Although a well was not installed due east of the maintenance building source area, the eastern extent of the contaminant plume can be inferred from the analytical results for the monitoring wells and well points. For example, the concentrations detected in MW-10B indicate that the contaminant plume does not originate at a location to the east of the maintenance building source. If this were the case, the contaminant concentrations in MW-10B would be expected to be similar to, or greater than, the concentrations in the downgradient monitoring wells (i.e., MW-1, MW-4, MW-6, and MW-7). However, this condition was not observed.

Furthermore, based on the concentrations detected in wells MW-1, MW-4, MW-6, and MW-7 and well point WP-6, it is apparent that the majority of the contamination is migrating to the northwest. If the contaminant plume were more extensive in the eastern direction, it would be expected that higher concentrations would be detected in samples from WP-7. The analytical results for WP-2 also provide an indication of the eastern extent of the plume. No contamination was detected in this well. If extensive contamination exited in groundwater to the east, this well would be expected to be contaminated based on the general groundwater flow direction.

The estimated extent of the contaminant plumes originating from source areas 1 and 2, as well as the maintenance building source is depicted in Figure 4-13.

4.6 NATURE AND EXTENT OF RESIDENTIAL WELL CONTAMINATION

Residential wells in the vicinity of the Byron Barrel and Drum Site have been sampled on four separate occasions since 1984. No contamination was detected in the residential wells during previous sampling efforts conducted by the EPA and its contractors. During the 1988-1989 RI, five residential wells in the vicinity of the site were sampled during two distinct sampling rounds.

The analytical results for the residential well samples are summarized in Table 4-9. As shown in the table, three chlorinated aliphatic hydrocarbons were detected in various residential well samples. Carbon tetrachloride was detected in one of two samples obtained from the residential well on the site property (R-1) at a concentration of 0.0094 ppb. Tetrachloroethene was detected in one of two samples obtained from well R-5 at a concentration of 0.25 ppb. Trichloroethene was detected in one of two samples obtained from well R-4 at a concentration of 0.32 ppb.

The available information from the site does not indicate that these contaminants originated from source areas 1 and 2. Nor is it likely that this contamination originated from the recently

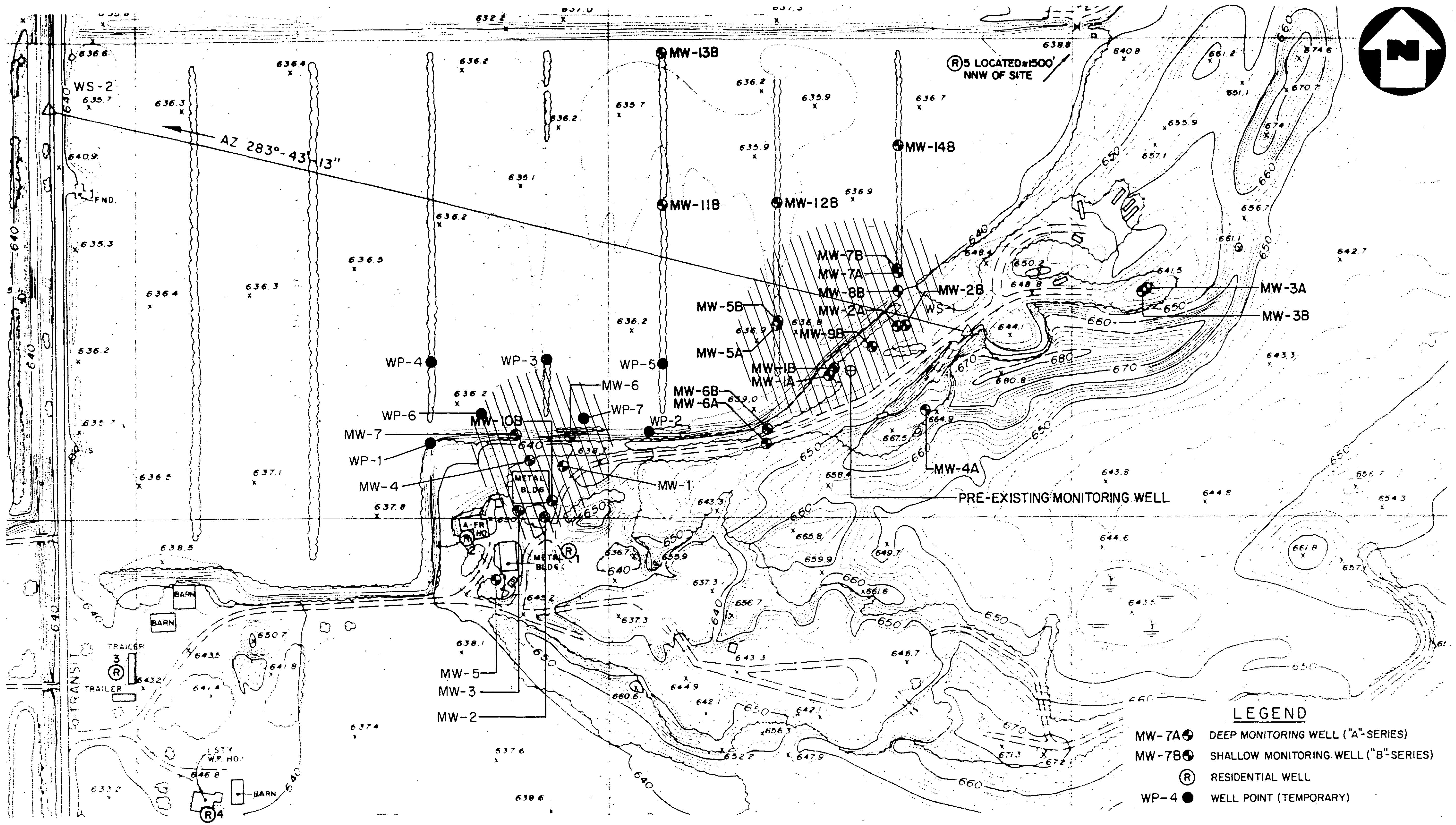


FIGURE 4-13

ESTIMATED EXTENT OF CONTAMINANT PLUMES
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

TABLE 4-9

OCCURRENCE AND DISTRIBUTION OF RESIDENTIAL WELL CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Method Detection Limit (MDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
tetrachloroethene	0.03	1/10	0.25	0.025	2
trichloroethene	0.12	1/10	0.32	0.032	2
carbon tetrachloride	0.12	1/10	0.0094	0.0009	1.4
aluminum	200	2/10	67.2 - 219	29	100
antimony	60	3/10	40.6 - 54.2	14	34
arsenic	10	1/10	5	0.5	5
barium	200	5/10	28 - 241	58	96
calcium	5,000	5/10	62,600 - 302,000	61,000	16,000
cobalt	50	1/10	18.8	1.9	24
iron	100	5/10	63.8 - 5,180	970	170
lead	5	2/10	1.6 - 4.0	0.56	2.5
magnesium	5,000	5/10	19,100 - 52,200	15,000	8,300
manganese	15	4/10	9.6 - 309	38	14
potassium	5,000	2/10	1,110 - 1,420	250	2,200
sodium	5,000	5/10	2,750 - 15,800	5,000	4,600
zinc	20	2/10	21.8 - 25	4.7	12

(1) Organic analyses conducted using EPA Methods 601/602.
(2) Concentration range for positive detections only.
(3) Calculated using "0" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.

identified source area near MW-10B. As previously discussed, groundwater does not flow toward the residential wells to the southwest. In addition, given the high concentrations of 1,1,1-trichloroethane detected in MW-10B, this contaminant would be the first to arrive at the wells southwest of the site if a contaminant plume would migrate in that direction. Given the groundwater flow direction and the shallow hydraulic gradient, it is also considered virtually impossible for the contaminants in well R-5 (1,500 feet north/northeast) to have originated at the Byron Barrel and Drum Site.

Furthermore, the majority of the monitoring wells at the Byron Barrel and Drum Site are low-yielding wells. During purging, these wells could be bailed dry relatively rapidly. Given the fact that the overburden material over most of the site is not highly transmissive and since domestic pumping wells such as those in the vicinity of the site will not place an excessive demand on an aquifer, it is extremely unlikely that a cone of depression could extend from the residential well locations to the site.

In addition to these low levels of organic contamination, a number of inorganic constituents were also detected in the residential well samples although the concentrations are lower than those detected in the upgradient monitoring well and uncontaminated downgradient monitoring wells. It is believed that at least one of the residential wells is equipped with a filtration system which helps to remove suspended solids. In addition, residential wells are generally equipped with storage tanks, which serve as settling tanks. Thus, most of the suspended solids do not reach the tap. The levels present in the tapwater are well below the background levels encountered in the monitoring wells. Inorganic constituents were not detected in residential well samples above the National Interim Primary or Secondary Drinking Water Regulations or the Maximum Contaminant Levels promulgated under the Safe Drinking Water Act.

4.7 NATURE AND EXTENT OF SURFACE WATER AND SEDIMENT CONTAMINATION

Two distinct rounds of surface water and sediment sampling and analysis were conducted during the 1988-1989 RI. The first sampling round was conducted during the early phases of the field investigation and included sampling along a drainage ditch running northeast to southwest immediately adjacent to the site property. A second round of sampling and analysis was conducted at a later date, to determine if any impact on Oak Orchard Creek occurred as a result of contamination at the site. The first round of surface water/sediment samples were analyzed for the full complement of Target Compound List organic and inorganic analytes. Based on the observed nature of site contamination, the second round of samples were analyzed for volatile organics only.

Based on groundwater and surface water elevations, it was ascertained that the drainage ditches circumscribing the adjacent farmland are discharge points for groundwater. Since volatile organics were detected in groundwater samples, it was concluded that surface water and sediments could be contaminated with organic chemicals. Contaminated groundwater would be expected to pass through the sediment column, leaving some residual levels bound in the organic matter in the bottom of the drainage ditches. The analytical results for sediment samples are summarized in Table 4-10.

As shown in Table 4-10, two of the major site contaminants (TCA and DCA) were detected in sediment samples at concentrations ranging to 32 and 19 ppb, respectively. In addition, several other organic chemicals were also detected, including acetone, 2-butanone, 4-methyl-2-pentanone, toluene, and styrene. As was evident with background surface soil samples, sediment samples contained various pesticides. The highest concentrations of pesticides were detected at a sampling location in a ditch running alongside the site at a point 700 feet north of the contaminant source areas. Once again, this contamination is considered indicative of the agricultural use of pesticides in the area.

Figure 4-14 presents the organic analytical results for sediment samples collected from the drainage ditches and Oak Orchard Creek. The analytical results for the primary site contaminants (TCA and DCA) are provided on the figure as well as several other contaminants not believed to be site-related.

As shown on the figure, sample SD002-1 contained relatively low levels of TCA (32 ppb), DCA (19 ppb), and toluene (2 ppb). This sample was obtained immediately adjacent to the primary source area in the southwestern portion of source area 1. The sample is considered indicative of the discharge of contaminated groundwater at this location. A sediment sample collected near MW-10B (SD001-1) contained acetone (250 ppb), 2-butanone (34 ppb), and toluene (0.7 ppb). It is presently unclear if this contamination is associated with the groundwater contamination detected around MW-10B, although none of the major contaminants detected in that well (i.e., the chlorinated aliphatics) were detected in the sediments. In addition, a surface water sample was also obtained at this location. Neither acetone or 2-butanone were detected in the sample, despite the fact that these compounds are extremely water-soluble. No volatile organic contaminants were detected in any of the second round sediment samples collected along the course of this drainage ditch.

By contrast, a number of contaminants were detected in samples obtained from a drainage ditch running east to west along the northern edge of the adjacent muckland. Toluene was the most concentrated contaminant. This compound was detected in two samples at concentrations of 900 and 1,600 ppb. Acetone and 2-butanone were also detected, but at much lower concentrations.

TABLE 4-10

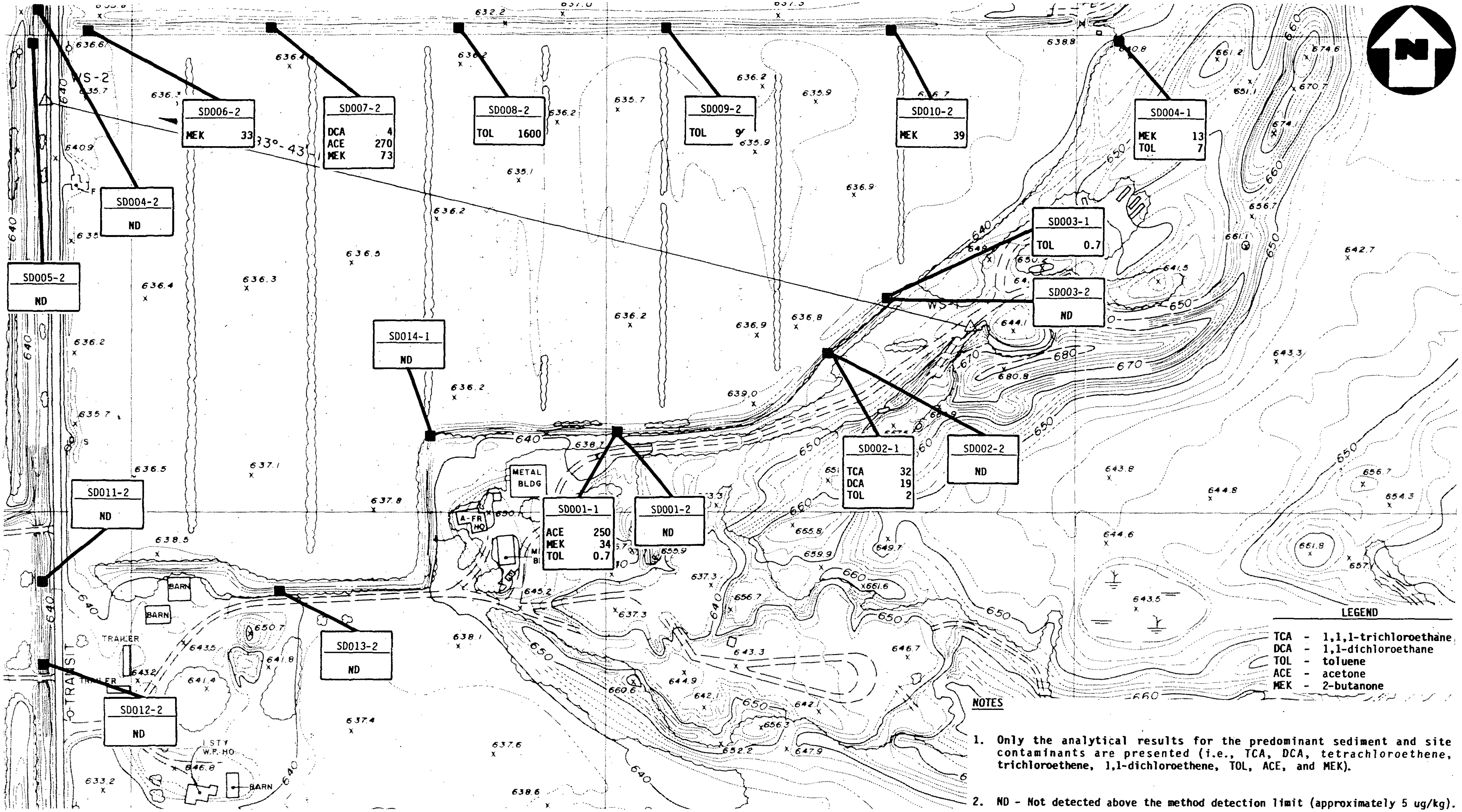
OCCURRENCE AND DISTRIBUTION OF SEDIMENT CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Contaminant	Contract Required Detection Limit (CRDL) (µg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/kg)(2)	Arithmetic Average Concentration (µg/kg)(3)	Geometric Mean Concentration (µg/kg)(4)
acetone	10	2/18	250 - 270	29	7.8
2-butanone	10	5/18	13 - 73	11	8.5
4-methyl-2-pentanone	10	1/18	10	0.56	5.2
toluene	5	5/18	0.7 - 1,600	140	4.8
styrene	5	1/18	1.0	0.056	2.4
1,1,1-trichloroethane	5	1/18	32	1.8	2.9
1,1-dichloroethane	5	2/18	4 - 19	1.3	2.9
4,4'-DDT	16	2/4	28 - 1,000	260	37
4,4'-DDD	16	2/4	19 - 220	60	23
endrin	16	1/4	110	28	15
endosulfan sulfate	16	1/4	84	21	14
dieldrin	16	3/4	34 - 530	170	66

TABLE 4-10
OCCURRENCE AND DISTRIBUTION OF SEDIMENT CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Contract Required Detection Limit (CRDL) (mg/kg)	No. of Positive Detections/ No. of Samples	Concentration Range (mg/kg)(2)	Arithmetic Average Concentration (mg/kg)(3)	Geometric Mean Concentration (mg/kg)(4)
aluminum	200	3/4	1,410 - 2,680	1,600	310
arsenic	10	4/4	2.3 - 12.1	6.3	4.8
barium	200	4/4	30 - 157.7	75	62
beryllium	5	3/4	0.4 - 0.6	0.35	0.56
calcium	5,000	4/4	21,702 - 44,815	30,000	29,000
chromium	10	4/4	4.5 - 51.5	17	9.3
copper	25	4/4	12.6 - 40	21	19
iron	100	4/4	3,180 - 6,000	4,800	4,600
lead	5	4/4	5.3 -13.7	9.1	8.6
magnesium	5,000	4/4	1,745 - 10,259	6,200	5,200
manganese	15	4/4	1.7 - 227.7	130	52
nickel	40	2/4	6.3 - 8.1	3.6	2.7
potassium	5,000	1/4	430	110	4.6
selenium	5	1/4	1.7	0.43	1.1
vanadium	50	3/4	4.5 - 9.4	5.3	4.2
zinc	20	4/4	56.6 - 75.2	66	66

(1) Organic analyses conducted using EPA Methods 624 (volatiles), 625 (extractables), and 608 (pesticides/PCBs)
(2) Concentration range for positive detections only.
(3) Calculated using "0" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.



LEGEND

TCA - 1,1,1-trichloroethane
DCA - 1,1-dichloroethane
TOL - toluene
ACE - acetone
MEK - 2-butanone

NOTES

1. Only the analytical results for the predominant sediment and site contaminants are presented (i.e., TCA, DCA, tetrachloroethene, trichloroethene, 1,1-dichloroethene, TOL, ACE, and MEK).
2. ND - Not detected above the method detection limit (approximately 5 ug/kg).

FIGURE 4-14

SELECTED SEDIMENT CONTAMINATION (μg/kg)
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

It is unclear exactly where this contamination originated. There is no overland connection between the site and this drainage ditch. Furthermore, the analytical results for groundwater samples do not indicate that contaminants are migrating from the site to these locations via a subsurface pathway. In spite of the observations of contamination in sediments in the drainage ditches, no evidence of sediment contamination is evident in Oak Orchard Creek, which is the primary receiving surface water body.

As discussed in Section 3.4, a drainage system exists in the adjacent farmland. This system drains excess water from the field and discharges it directly to Oak Orchard Creek. It was considered possible that this system could act as a migration pathway for contaminants in groundwater. However, no evidence of this was detected during the surface water and sediment investigation. Samples obtained both upstream and downstream of the outfall from the drainage system pumping station displayed no contamination.

It is believed that several factors account for the absence of any contamination at these locations. Since the drainage system drains the entire field, a great deal of dilution of any potential contamination will occur in the main drainage line. Furthermore, groundwater will flow to the system under high water table conditions, which are not expected to occur with any great frequency. Under such conditions, contaminant attenuation via sorption to soils will continue to act and will impede migration of contaminants to the drainage lines. Finally, volatilization of contaminants directly from the outfall will be enhanced by the turbulence induced by pumping.

The analytical results for surface water samples are summarized in Table 4-11. Several of the major site contaminants were detected in surface water samples, including TCA (7 ppb) and DCA (30 ppb). In addition, several contaminants that were not detected anywhere else at the site were also identified at low levels, including phenol, 4-methylphenol, di-n-octylphthalate, and carbon disulfide. A surface water sample obtained adjacent to source area 1 contained TCA, DCA, toluene, phenol, and 4-methylphenol, as shown in Figure 4-15. The presence of TCA and DCA is considered indicative of the discharge of contaminated groundwater. The presence of the phenolics is inexplicable, but does not appear related to the site contamination. The analytical results for samples obtained downstream of the site, in the northern drainage ditch, and in Oak Orchard Creek indicate that although some contaminants are discharging to the adjacent surface water body, no far reaching impact is discernible. No evidence of inorganic contamination was identified in the drainage ditch adjacent to the site.

TABLE 4-11

OCCURRENCE AND DISTRIBUTION OF SURFACE WATER CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

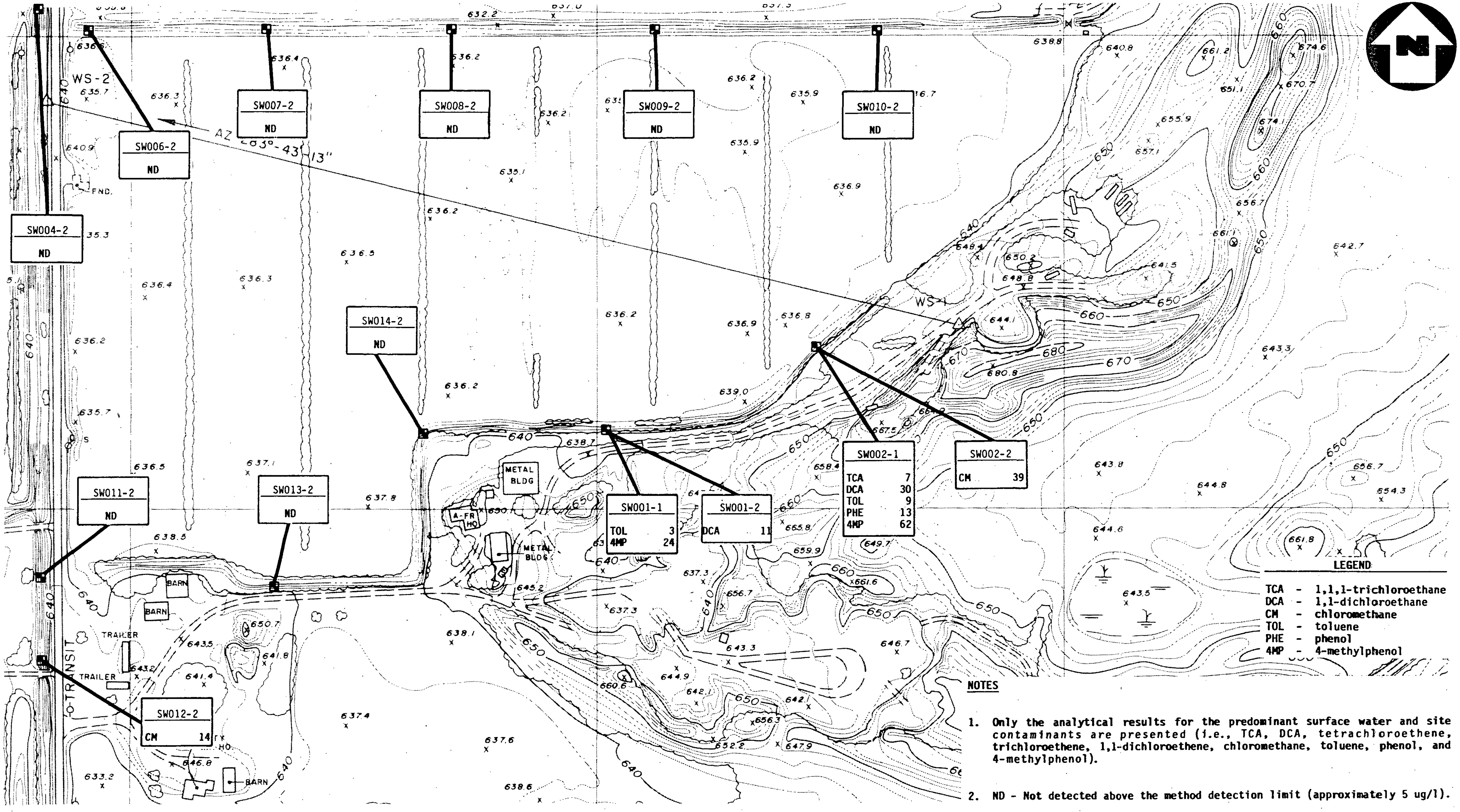
Contaminant	Contract Required Detection Limit (CRDL) (μg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (μg/L)(2)	Arithmetic Average Concentration (μg/L)(3)	Geometric Mean Concentration (μg/L)(4)
toluene	5	2/15	3 - 9	0.80	2.8
1,1,1-trichloroethane	5	1/15	7	0.47	2.7
1,1-dichloroethane	5	2/15	11 - 30	2.7	3.3
1,2-dichloroethene	5	1/15	2	0.13	2.5
chloromethane	5	2/15	14 - 39	3.5	6.1
carbon disulfide	5	3/15	4 - 13	1.7	3.1
di-n-octylphthalate	10	2/2	3 - 4	3.5	3.5
phenol	10	1/2	13	6.5	8.1
4-methylphenol	10	2/2	8 - 62	35	22
aluminum	200	1/2	4,826	2,400	690
arsenic	10	2/2	9.8 - 31.9	21	18
barium	200	1/2	818	410	290
calcium	5,000	2/2	98,600 - 397,000	250,000	200,000
cobalt	50	1/2	1,540	770	200
copper	25	1/2	97	49	35
iron	100	1/2	29,100	15,000	1,200
lead	5	1/2	28.2	14	8.4
magnesium	5,000	2/2	28,500 - 41,600	35,000	34,000
manganese	15	2/2	677 - 899	790	780
nickel	40	1/2	17	8.5	18

TABLE 4-11
OCCURRENCE AND DISTRIBUTION OF SURFACE WATER CONTAMINANTS(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Contaminant	Contract Required Detection Limit (CRDL) (µg/L)	No. of Positive Detections/ No. of Samples	Concentration Range (µg/L)(2)	Arithmetic Average Concentration (µg/L)(3)	Geometric Mean Concentration (µg/L)(4)
potassium	5,000	1/2	3,950	2,000	3,100
sodium	5,000	2/2	3,080 - 4,750	3,900	3,800
vanadium	50	2/2	23 - 51	37	34
zinc	20	1/2	391	200	63

(1) Organic analyses conducted using EPA Methods 624 (volatiles), 625 (extractables), and 608 (pesticides/PCBs)
(2) Concentration range for positive detections only.
(3) Calculated using "0" for nondetections.
(4) Calculated using 1/2 the CLP CRDL for nondetections.

FIGURE 4-15



LEGEND

TCA - 1,1,1-trichloroethane
DCA - 1,1-dichloroethane
CM - chloromethane
TOL - toluene
PHE - phenol
4MP - 4-methylphenol

NOTES

1. Only the analytical results for the predominant surface water and site contaminants are presented (i.e., TCA, DCA, tetrachloroethene, trichloroethene, 1,1-dichloroethene, chloromethane, toluene, phenol, and 4-methylphenol).
2. ND - Not detected above the method detection limit (approximately 5 ug/l).

SELECTED SURFACE WATER CONTAMINATION ($\mu g/L$)
BYRON BARREL AND DRUM SITE, BYRON, NY

0 200 400
SCALE IN FEET

NUS CORPORATION

4.8 SUMMARY

The majority of contamination at the Byron Barrel and Drum Site is confined to subsurface soils and groundwater. The predominant site contaminants are volatile organics, particularly chlorinated aliphatic hydrocarbons. A major source area was detected in the southwestern portion of source area 1. It is estimated that 1,100 cubic yards of contaminated soil are present in this area. A second minor source was detected in the vicinity of the maintenance building. It is estimated that 3,000 cubic yards of soil contaminated with low concentrations of volatile organics are present in this area.

Two distinct groundwater contaminant plumes were noted at the site. The first originates in the vicinity of source area 1 and extends northwest into the adjacent farmland to a distance between 200 and 400 feet. A second plume originating at the maintenance building source was identified. This plume extends no farther than 300 feet from the source in a northerly direction.

Pesticide contamination was noted in background surface soil samples. Limited pesticide contamination on site is not considered to be related to storage or disposal activities. With the exception of the detection of relatively high concentrations of chromium and lead in selected surface soil samples, inorganic contamination is indistinguishable from background levels.

Low concentrations of phthalate esters and polynuclear aromatic hydrocarbons were detected in soil samples. Concentrations of these analytes ranged no higher than 600 ppb. One detection of a polychlorinated biphenyl (PCB 1254) occurred in a subsurface soil sample. None of these water-insoluble constituents were detected in groundwater, surface water, or sediment samples.

5

5.0 CONTAMINANT FATE AND TRANSPORT

Various aspects of contaminant fate and transport at the Byron Barrel and Drum Site are discussed in this section. Potential contaminant migration routes are identified and discussed in Section 5.1. Section 5.2 presents a brief discussion of contaminant persistence. Various chemical and physical properties affecting contaminant migration are discussed in Section 5.3.

5.1 POTENTIAL MIGRATION ROUTES

In general, numerous potential contaminant migration routes exist in areas contaminated with hazardous materials. Such migration routes include, but are not limited to, atmospheric migration via particulate or volatile/semivolatile emissions, overland migration of dissolved or adsorbed contaminants, lateral migration of gases through the subsurface, and migration via groundwater transport.

As a result of the nature of contamination at the Byron Barrel and Drum Site and various site-specific conditions, only groundwater transport is considered the major contaminant migration route. The major portion of contamination is contained in saturated subsurface soils and groundwater, as discussed in Section 4.0 (Nature and Extent of Contamination).

Fugitive dust and volatile emissions, coupled with subsequent airborne transport, are considered minor contaminant transport mechanisms as a result of the absence of substantial surficial contamination at the site, but will be considered in support of the risk assessment. Similarly, the absence of extensive surficial contamination precludes overland migration of contaminants via erosion.

By contrast, substantial evidence indicates that groundwater transport of dissolved organic species is a significant contaminant migration route. Substantial groundwater contamination has been detected in groundwater samples from overburden monitoring wells at the site. For example, 1,1,1-trichloroethane (TCA) and trichloroethene (TCE) were detected in monitoring wells at concentrations ranging as high as 4,400 ppb and 3,300 ppb, respectively. Based on the results of the hydrogeologic and chemical/analytical investigations, it is apparent that the primary source contaminants (chlorinated aliphatics) are migrating through the subsurface via transport in the porous overburden. The configuration of the contaminant plume originating from source areas 1 and 2 is shown in Figure 4-7. The plume is slowly migrating to the northwest of the source areas.

The porous overburden at the site is underlain by approximately 50 feet of dense glacial till. This impermeable material acts as a confining layer and precludes downward migration of contaminants. Furthermore, no significant vertical hydraulic gradients were identified via water level measurements in the various cluster well locations at the site. Based on the relatively low concentrations of chlorinated aliphatics detected in site monitoring wells, it is considered unlikely that a dense non-aqueous phase liquid exists at the site.

This conclusion is based on the concentrations encountered in groundwater samples and a comparison of the relative concentrations in shallow versus deep wells in well clusters located in the source areas. The concentrations of chlorinated aliphatics are well below their water solubility limits. For example, TCA was detected at a maximum concentration of 4,400 ppb, whereas its solubility in water is 720,000 ppb. TCE was detected at a maximum concentration of 3,300 ppb, whereas its solubility in water is 1,100,000 ppb. Contrast of the analytical results for shallow versus deep wells at the source well clusters (MW-1A/MW-1B and MW-2A/MW-2B) indicates that contaminant concentrations are greater in the shallow (B) wells, as shown on Figures 4-5 and 4-6. This provides additional evidence that the contaminants exist as dissolved species, rather than as a separate phase.

5.2 CONTAMINANT PERSISTENCE

Several transformation processes are believed to affect the persistence of organic chemicals in the environment. The primary processes affecting contaminant fate in the environment include microbial, photolytic, and chemical degradation. However, based on existing data and site-specific conditions, it does not appear that any of these fate processes are significant at the Byron Barrel and Drum Site.

As discussed in Section 4.0 (Nature and Extent of Contamination), contamination at the primary source areas and in downgradient locations includes chlorinated aliphatic and monocyclic aromatic contamination in groundwater as well as saturated and unsaturated subsurface soils. The primary contaminants include 1,1,1-trichloroethane (TCA); 1,1-dichloroethane (DCA); tetrachloroethene (PCE); trichloroethene (TCE); 1,1-dichloroethene (DCE); toluene; and xylenes.

As a result of the nature of chemical contamination at the site, the remainder of the persistence discussion will focus primarily on TCA and TCE, although brief discussions of the persistence of other soil and groundwater contaminants are also included.

In general, photolytic degradation is not considered to be a relevant degradation mechanism for either chlorinated aliphatic compounds such as TCA, DCA, PCE, TCE, or DCE, or for monocyclic aromatic compounds, such as toluene (EPA, December 1982). Furthermore, even if such compounds were subject to photolytic degradation, they must be present in media exposed to sunlight for such degradation to occur (i.e., the atmosphere, surface soils, or surface-water bodies). Although some contaminants have been noted to discharge to an adjacent drainage ditch, it appears that the bulk of the contamination has migrated beneath this ditch into the subsoils of the adjacent muckland. Therefore, photolytic degradation is not expected to be a significant degradation mechanism.

Generally, organic molecules are subject to several chemical reactions under environmental conditions. Such reaction mechanisms include hydration, acid:base reactions, addition, elimination, and hydrolysis. However, chlorinated alkanes and alkenes and monocyclic aromatics are not particularly amenable to the majority of these degradation mechanisms. Hydration may be a significant degradation mechanism for molecules containing a carbonyl group (e.g., aldehydes and ketones), but is of very little importance for the major contaminants detected at the Byron Barrel and Drum Site. In addition, such reactions are reversible and, therefore, do not result in the permanent transformation of organic chemicals. Similarly, acid:base reactions are significant only for organic acids and bases and do not play a role in the degradation of chlorinated aliphatic compounds or the majority of monocyclic aromatic compounds. Addition reactions can convert alkenes to alkanes, while elimination reactions can effect the reverse reaction. However, addition and elimination reactions generally require reaction conditions that are unlikely to occur in the natural environment (e.g., high temperatures, strongly basic or acidic conditions, or the presence of specific reagents or catalysts). Hydrolysis is the only chemical fate process that may have any impact on the transformation of site-specific contaminants.

Hydrolysis reactions can occur under acidic, basic, or neutral conditions. Because the groundwater pH is near neutral, neutral hydrolysis is more likely to occur than acid- or base-catalyzed hydrolysis at the Byron Barrel and Drum Site. A literature survey has revealed that hydrolytic degradation is a significant degradation mechanism for halogenated alkanes (EPA, December 1982). The chlorinated alkenes and monocyclic aromatics detected in site groundwater are not subject to degradation via hydrolysis.

The reported first-order, neutral hydrolysis rate constants for the primary chlorinated alkanes detected in site groundwater may be used to estimate the half-lives of these species in groundwater (i.e., half-lives may be determined as $\ln[2]/K_n$, where K_n is the neutral hydrolysis rate constant $[hr^{-1}]$). Literature values of K_n and estimated half-lives are as follows (EPA, December 1982):

Chlorinated Alkane	K_n (hr^{-1})	$t_{1/2}$ (years)
1,1,1-trichloroethane	1.70×10^{-4}	0.5
1,1-dichloroethane	1.15×10^{-7}	700

It is apparent from the estimated half-lives that hydrolytic degradation may be a significant degradation mechanism for TCA. Chlorinated aliphatic hydrocarbons such as TCA, PCE, and TCE are subject to reductive dehalogenation via the action of anaerobic bacteria. Research indicates that degradation of highly chlorinated ethanes may be quite slow, while degradation of chlorinated ethenes may occur at a significant rate under appropriate conditions (Cline and Viste, 1984). Reductive dehalogenation of PCE and TCE reportedly results in the formation of vinyl chloride, which appears resistant to further degradation. The degradation of chlorinated aliphatics is dependent upon numerous site-specific environmental conditions, including the concentration of dissolved oxygen, pH, the abundance of microorganisms, and macronutrient availability (i.e., the abundance of phosphorus and nitrogen). However, based on the observed nature of contamination at the Byron Barrel and Drum Site, it does not appear that biodegradation is a significant attenuation mechanism. Although PCE and TCE degradation is reportedly quite rapid under the appropriate conditions, vinyl chloride (the primary metabolic byproduct) has been detected only once in groundwater samples obtained at the site. Although substantial quantities of TCE are present in groundwater beneath source area 1, no vinyl chloride has been detected in any of the samples obtained from monitoring wells located in the vicinity of this source. Vinyl chloride was detected in one groundwater sample collected during the RI, but the concentration was only 0.06 ppb. Generally, at sites where anaerobic bacteria are active, downgradient monitoring wells display markedly greater ratios of the end product (vinyl chloride) to the parent compounds (PCE and TCE). This is not the case at the Byron Barrel and Drum Site. Although vinyl chloride has been detected, it is present in a different area that does not reveal a trend of possible anaerobic degradation. This could be a result of the absence of sufficient nutrients, although it is considered likely that the absence of anaerobic conditions in the groundwater regime is also a limiting factor.

In conclusion, although it is possible that some environmental degradation mechanisms may function at the site (particularly hydrolysis and anaerobic degradation), it is considered unlikely that transformation will have a significant impact on the attenuation of site contaminants. It is much more likely that physical attenuation mechanisms such as adsorption, molecular diffusion, and hydrodynamic dispersion will serve to reduce contaminant concentrations as a function of distance and time. Various chemico-physical properties affecting the fate and transport of site contaminants are discussed in the following section.

5.3 CONTAMINANT MIGRATION

This section provides a qualitative discussion of the potential migration of the contaminants found at the Byron Barrel and Drum Site. The physical and chemical properties of the chemicals found at the site are presented in Table 5-1. These parameters may be used to assess the behavior of a chemical in the environment.

Empirically determined literature values of water solubility, octanol/water partition coefficient, soil/sediment adsorption coefficient, vapor pressure, Henry's Law constant, bioconcentration factor, and specific gravity are presented, as available. Calculated values, which were obtained using approximation methods, are presented when literature values are unavailable. A discussion of the environmental significance of each of these parameters follows.

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is proportional to its water solubility. More soluble chemicals are expected to enter water much more readily and rapidly than less soluble chemicals. The water solubilities presented in Table 5-1 indicate that the volatile organic chemicals, such as those detected in site media, are several orders of magnitude more water-soluble than base/neutral-extractable compounds (phthalate esters and polynuclear aromatics) and pesticides.

Although isolated occurrences of phthalate esters, polynuclear aromatics, one polychlorinated biphenyl, and pesticides were identified in soil samples, such compounds have not been detected in groundwater samples. This is a manifestation of their limited water solubility, the low concentration detected in the soil matrix, and their sporadic distribution in the unsaturated zone.

The octanol/water partition coefficient is a measure of the equilibrium partitioning of a chemical between octanol and water. The octanol/water partition coefficient is also used to estimate bioconcentration factors in aquatic organisms. A linear relationship between the octanol/water partition coefficient and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has been determined (Lyman, et al., 1982). Polynuclear aromatics, phthalate esters, and pesticides are several orders of magnitude more likely to partition to fatty tissues than the more water-soluble volatile organics. The octanol/water partition coefficient is also useful in characterizing the sorption of compounds by organic soils when experimental values are not available.

TABLE 5-1

MOBILITY PARAMETERS FOR ORGANIC CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

CAS #	Chemical	Molecular Weight(1)	Water Solubility(1) (mg/l @ 20°C)	Octanol/Water Partition Coefficient(1)	Soil/Sediment Adsorption Coefficient(1)	Vapor Pressure(1) (mm Hg @ 20°C)	Henry's Law Constant(1) (atm-m^3/mol)	Bioconc. Factor(1) (μg/kg) $(\mu g/l)^{-1}$	Specific Gravity(2) (20°C/4°C)
KETONES									
67-64-1	acetone	58.08(2)	600,000(4)	0.58(2)	0.35/18(5)	270(30°C)(2)	$3.43x10^{-5}$(13)	0.39(16)	0.791
78-93-3	2-butanone	72.1(2)	353,000(10°C)(2)	1.82(2)	1.1/33(5)	77.5(2)	$2.08x10^{-5}$(13)	0.93(16)	0.805
MONOCYCLIC AROMATICS									
71-43-2	benzene	78.12	1,780(25°C)	135	65	95.2(25°C)	$5.5x10^{-3}$	37	0.879
108-88-3	toluene	92.13	535(25°C)	620	300	28.7	$6.66x10^{-3}$	148	0.867
100-41-4	ethylbenzene	106.16	152	2,200	1,100	7	$6.6x10^{-3}$	470	0.867
	xylenes(17)	106.17	187	1,195	248	5.8	$4.33x10^{-3}$	128	0.868
108-90-7	chlorobenzene	112.56	488(25°C)	690	330	11.7	$3.58x10^{-3}$	164	1.107
108-95-2	phenol	94.11	93,000(25°C)	30	14.2	0.341(25°C)	$4.54x10^{-7}$	9.4	1.07
108-39-4	4-methylphenol	108.13(2)	24,000(40°C)(2)	83(2)	263(8)	0.04(2)	$2.37x10^{-7}$(13)	17(16)	1.035
95-50-1	1,2-dichlorobenzene	147.01	100	3,600	1,700	1.0	$1.93x10^{-3}$	730	1.305
541-73-1	1,3-dichlorobenzene	147.01	123(25°C)	3,600	1,700	2.28(25°C)	$3.61x10^{-3}$	730	1.288
106-46-7	1,4-dichlorobenzene	147.01	79(25°C)	3,600	1,700	1.18(25°C)	$3.1x10^{-3}$	730	1.458
CHLORINATED ALIPHATICS									
79-34-5	1,1,2,2-tetrachloroethane	167.85	2,900	245	118	5	$3.8x10^{-4}$	91	1.60
71-55-6	1,1,1-trichloroethane	133.41	720(25°C)	320	152	123(25°C)	$3.0x10^{-2}$	81	1.35
79-00-5	1,1,2-trichloroethane	133.41	4,500	117	56	19	$7.42x10^{-4}$	33	1.44
75-34-3	1,1-dichloroethane	98.96	5,500	63	30	180	$4.26x10^{-3}$	19	1.174
107-06-2	1,2-dichloroethane	98.96	8,690	30	14	61	$9.14x10^{-4}$	9	1.25

TABLE 5-1
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

CAS #	Chemical	Molecular Weight(1)	Water Solubility(1) (mg/l @ 20°C)	Octanol/Water Partition Coefficient(1)	Soil/Sediment Adsorption Coefficient(1)	Vapor Pressure(1) (mm Hg @ 20°C)	Henry's Law Constant(1) (atm-m^3/mol)	Bioconc. Factor(1) (μg/kg) $(\mu g/l)^{-1}$	Specific Gravity(2) (20°C/4°C)
CHLORINATED ALIPHATICS - CONTINUED									
127-18-4	tetrachloroethene	165.83	200	759	364	14	1.53×10^{-2}	252	1.626
79-01-6	trichloroethene	131.39	1,100	263	126	57.9	9.1×10^{-3}	97	1.46
540-59-0	1,2-dichloroethene	96.94	600	123	59	326	6.7×10^{-2}	48	1.26
75-35-4	1,1-dichloroethene	96.94	400	135	65	591(25°C)	1.9×10^{-1}	53	1.218
75-01-4	vinyl chloride	62.5	2,700(25°C)	17	8.2	2,660(25°C)	8.14×10^{-2}	5.7	0.912
67-66-3	chloroform	119.38	8,200	91	44	150.5	2.88×10^{-3}	26	1.489
75-09-2	methylene chloride	84.94	20,000	18.2	8.8	362.4	2.03×10^{-3}	6.0	1.327(19)
75-27-4	bromodichloromethane	163.83	4,500	126	61	50	2.41×10^{-3}	35	1.971(25/25°C)
124-48-1	dibromochloromethane	208.3	4,000	174	84	76	9.9×10^{-4}	47	2.38
PHTHALATE ESTERS									
117-81-7	bis(2-ethylhexyl) phthalate	391	0.4(25°C)	4.1×10^{9}	2.0×10^{9}	2×10^{-7}	3.0×10^{-7}	2.3×10^{8}	0.99(20/20°C)
117-84-0	di-n-octylphthalate	391	3.0(25°C)	7.4×10^{9}	3.6×10^{9}	1.4×10^{-4}(25°C)	1.7×10^{-5}	3.9×10^{8}	0.99(20/20°C)
84-74-2	di-n-butylphthalate	278.3	13(25°C)	360,000	170,000	1×10^{-5}(25°C)	2.8×10^{-7}	47,000	1.0465
84-66-2	diethylphthalate	222.2	896(25°C)	295	142	3.5×10^{-3}(25°C)	1.2×10^{-6}	107	1.120(25/25°C)
85-68-7	butylbenzylphthalate	312	2.9	360,000	170,000	6×10^{-5}	8.3×10^{-6}	47,000	1.1(25/25°)
131-11-3	dimethylphthalate	194.2	5,000	36.3	17.4	4.19×10^{-3}	2.15×10^{-6}	16	

TABLE 5-1
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE THREE

CAS #	Chemical	Molecular Weight$^{(1)}$	Water Solubility$^{(1)}$ (mg/l @ 20°C)	Octanol/Water Partition Coefficient$^{(1)}$	Soil/Sediment Adsorption Coefficient$^{(1)}$	Vapor Pressure$^{(1)}$ (mm Hg @ 20°C)	Henry's Law Constant$^{(1)}$ (atm-m^3/mol)	Bioconc. Factor$^{(1)}$ (µg/kg) (µg/l)$^{-1}$	Specific Gravity$^{(2)}$ (20°C/4°C)
POLYNUCLEAR AROMATICS									
56-55-3	benzo(a)anthracene	228.3	0.0057	410,000	200,000	2.2x10^{-8}	1x10^{-6}	53,000	
205-99-2	benzo(b)fluoranthene	252.3	0.014(25°C)	1.15x10^{6}	550,000	5x10^{-7}	1.22x10^{-5}	140,000	
50-32-8	benzo(a)pyrene	252	0.0038(25°C)	1.15x10^{6}	550,000	5.6x10^{-9}(25°C)	4.9x10^{-7}	140,000	
218-01-9	chrysene	228.3	0.0018(25°C)	410,000	200,000	6.3x10^{-9}(25°C)	1.05x10^{-6}	53,000	1.274
206-44-0	fluoranthene	202.3	0.26(25°C)	79,000	38,000	5x10^{-6}(25°C)	6.5x10^{-6}	12,000	
85-01-8	phenanthrene	178.2	1.00(25°C)	28,000	14,000	9.6x10^{-4}(25°C)	2.26x10^{-4}	4,700	1.025
129-00-0	pyrene	202.3	0.13(25°C)	80,000	38,000	2.5x10^{-6}(25°C)	5.1x10^{-6}	12,000	
PESTICIDES/PCBs									
50-29-3	4,4'-DDT	354.5	0.0055(25°C)	8.1x10^{6}	3.9x10^{6}	1.9x10^{-7}(25°C)	1.58x10^{-5}	8.0x10^{6}	
72-54-8	4,4'-DDD	320	0.09(25°C)	1.6x10^{6}	770,000	10.2x10^{-7}(30°C)	2.2x10^{-8}	180,000	
72-55-9	4,4'-DDE	318	0.04	9.1x10^{6}	4.4x10^{6}	6.5x10^{-6}	6.8x10^{-5}	890,000	
72-20-8	endrin	381	0.25	3,500	1,700	2.0x10^{-7}	4.0x10^{-7}	710	
1031-07-8	endosulfan sulfate	422.9	0.22	0.05	0.024	1x10^{-5}(25°C)	2.6x10^{-5}	0.029	
60-57-1	dieldrin	381	0.195(25°C)	3,500	1,700	1.78x10^{-7}	4.57x10^{-10}	710	1.75

TABLE 5-1
MOBILITY PARAMETERS FOR ORGANIC CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK -
PAGE FOUR

CAS #	Chemical	Molecular Weight(1)	Water Solubility(1) (mg/l @ 20°C)	Octanol/Water Partition Coefficient(1)	Soil/Sediment Adsorption Coefficient(1)	Vapor Pressure(1) (mm Hg @ 20°C)	Henry's Law Constant(1) (atm-m^3/mol)	Bioconc. Factor(1) (µg/kg) (µg/l)$^{-1}$	Specific Gravity(2) (20°C/4°C)
MISCELLANEOUS COMPOUNDS									
75-15-0	carbon disulfide	76.14(2)	2,300(22°C)(2)	69/145(2)	150/210(12)	260(2)	1.13x10^{-1}(13)	15/26(16)	1.263
86-30-6	N-nitrosodiphenylamine	198.2	40(25°C)	1,349	648	0.1(25°C)	6.6x10^{-4}	426	
65-85-0	benzoic acid	122.1(2)	2,900(2)	74(2)	150(12)	0.00704(19)		16(16)	1.27

(1) EPA, December 1982 except as otherwise noted.
(2) Verschueren, 1983.
(4) Lyman; et al., 1982 Eq 2-6.
(5) Lyman; Eq 4-10 and 4-8, respectively.
(8) Lyman; Eq 4-8.
(12) Lyman; Eq 4-5 and 4-8, average value.
(13) Lyman; Eq 15-8.
(16) Lyman; Eq 5-2.
(17) Average values for ortho, meta, and para-xylene.
(18) Value provided for trans isomer.
(19) EPA, December 1987.
NA Not available.

The soil/sediment adsorption coefficient is related to the water solubility and the octanol/water partition coefficient. This parameter indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high soil/sediment adsorption coefficients generally have low water solubilities and vice versa. Chemicals such as phthalate esters and polynuclear aromatic hydrocarbons (PAHs) are relatively immobile in the subsurface environment and are preferentially bound to the soil phase. These compounds are not subject to groundwater transport to the same extent as compounds with high water solubilities.

The soil/sediment adsorption coefficient may be used to infer the relative rates at which the more mobile chemicals (volatiles) are transported in the groundwater. The soil/sediment adsorption coefficient and the fractional organic carbon content of the soil (f_{oc}) may be used to determine an equilibrium distribution coefficient (K_d) for the solid and aqueous matrices:

$$K_d = f_{oc} \times K_{oc}$$

where: K_d is the distribution coefficient (µg/kg/µg/l)
f_{oc} is the soil organic carbon content (kg/kg)
K_{oc} is the soil/sediment adsorption coefficient (µg/kg organic carbon/µg/l)

Total organic carbon (TOC) results may be used to estimate f_{oc} for soils. Five subsurface soil samples were analyzed for TOC. The average TOC value for site subsurface soils is 9,600 mg/kg. Thus:

$$f_{oc} = (9{,}600 \text{ mg/kg})(1 \times 10^{-6} \text{ kg/mg})$$

$$= 9.6 \times 10^{-3} \text{ Kg organic carbon/Kg soil}$$

The distribution coefficient can, in turn, be used to estimate the potential for attenuation of a contaminant as a result of adsorption. The following dimensionless parameter is commonly encountered in solute transport modeling (Javandel et al., 1984):

$$R = 1 + \frac{\rho}{n} K_d$$

where: R is the retardation factor (dimensionless)
ρ is the soil bulk density (Kg/l)
n is the effective porosity of the soil (decimal fraction)

The retardation factor can be interpreted as the velocity of a contaminant relative to the velocity of the groundwater. A retardation factor close to 1.0 indicates that the contaminant has little tendency to bind to soils and, hence, moves freely in the groundwater. By contrast, the larger the value of R, the greater the tendency for a contaminant to bind to the soil matrix and the slower it will move in groundwater. Assuming a soil bulk density of 2 kg/l and an effective porosity of 0.3, values of R can be calculated for selected contaminants as follows:

Contaminant	K_{oc}	K_d	R
1,1,1-trichlorethane	152	1.5	10
1,1-dichloroethane	30	0.29	2.9
trichloroethene	126	1.2	9.1
benzo(a)pyrene	55,000	530	3,500

It is apparent from the above values, that site soils have some adsorptive capacity for the primary contaminants. By contrast, a representative polynuclear aromatic hydrocarbon (benzo(a)pyrene) displays a much greater tendency to bind to the soil matrix. Pesticides and polychlorinated biphenyls are similar to the representative polynuclear aromatic. It is readily apparent why these compounds remain bound in the soil matrix.

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance where environmental interfaces such as surface soil/air and surface water/air are important, rather than in evaluation of groundwater and subsurface soils. Vapor pressures for volatiles are generally many times higher than vapor pressures for phthalate esters and PAHs. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. The primary contaminants detected at the Byron Barrel and Drum Site are volatile in nature. Therefore, although it is apparent that contaminants are discharging to the adjacent surface water body, no extensive contamination has been found and no downstream impacts are evident.

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface-water bodies. The ratio of these two parameters provides an estimate of the Henry's Law constant and may be used to calculate the equilibrium contaminant concentrations in the vapor (air) versus the liquid (water) phases for dilute solutions commonly encountered in environmental settings. The Henry's Law constant is also useful for mass transfer applications for air-stripping column design.

Bioconcentration factors represent the ratio of aquatic-animal-tissue concentration to water concentration. The ratio is both contaminant- and species-specific. When site-specific values are not measured, literature values may be used; or the BCF may be derived from the octanol/water partition coefficient. Phthalate esters, PAHs, and pesticides will bioconcentrate at levels three to six orders of magnitude greater than those concentrations found in the water where the exposed species resides. Volatile organics are not as readily bioconcentrated.

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether pure compounds or very high concentrations of the contaminant will float or sink in water. As shown in Table 5-1, chlorinated aliphatic compounds (e.g., TCE, TCA, PCE) are generally denser than water. Based on site groundwater results, it appears that contaminant movement has not been affected by density. As discussed in Section 5.1, contaminant concentrations do not increase with depth at well clusters near the sources, thus suggesting that no free product reached the surface of the glacial till.

6

6.0 BASELINE RISK ASSESSMENT

6.1 INTRODUCTION

This section discusses the risks to human and environmental receptors posed by chemical contaminants at the Byron Barrel and Drum Site. To assess these risks, three major aspects of the chemical contamination must be considered, as well as environmental fate and transport of site chemicals.

1. The potential for human or environmental exposure to site chemicals and the concentrations to which the receptors may be exposed.
2. The carcinogenic and noncarcinogenic health hazards associated with the organic chemicals detected at the site.
3. The risks associated with exposure to chemicals at the concentrations identified above, as compared with applicable regulatory enforceable standards or guidelines for the protection of human or environmental receptors.

The basis for this risk assessment is the validated Contract Laboratory Program chemical-analytical data base for environmental samples collected during the Remedial Investigation (1987/1988). Section 6.2 presents the Public Health Evaluation, whereas Section 6.3 presents the Environmental Assessment.

6.2 PUBLIC HEALTH EVALUATION

This section addresses the human health risks attributable to the Byron Barrel and Drum Site and is based on an assessment approach suggested in the Superfund Public Health Evaluation Manual (EPA, October 1986). The approach consists of the four components listed below.

- Hazard Identification
- Dose-Response Evaluation
- Exposure Assessment
- Risk Characterization

Hazard identification (Section 6.2.1) is primarily concerned with the selection of site contaminants ("indicator chemicals") that represent the human health and/or environmental impacts associated with wastes at the site. Contaminant concentrations, contaminant release mechanisms, environmental fate and transport, exposure rates, and toxicity are considered to reduce the complete list of site contaminants to a list of chemicals that will adequately define the associated risks. Qualitative discussions of acute, chronic, and nonthreshold (carcinogenic) effects on humans and animals are presented for each of the selected indicator chemicals.

The dose-response evaluation (Section 6.2.2) presents available human health and environmental impact information for the indicator chemicals. Reference Doses (RfDs) or other equivalent criteria are used to evaluate potential noncarcinogenic effects. An RfD is the dose at which potential noncarcinogenic effects are not expected to occur. Cancer potency factors are used to estimate the risks associated with carcinogenic substances present in site media. Enforceable standards such as Maximum Contaminant Levels (MCLs) or regulatory guidelines such as Ambient Water Quality Criteria (AWQC) and EPA Drinking Water Health Advisories (DWHA) are also presented for comparison to the contaminant concentrations observed at the site.

The exposure assessment (Section 6.2.3) is based on source contaminant concentrations, contaminant release mechanisms, and other pertinent information such as land and water use or demographic information. Potential human exposures to contaminants are identified in this section.

In the context of this report, "exposure assessment" includes not only receptor exposure mechanisms such as inhalation, ingestion, and dermal contact, but also migration of chemicals via environmental transport routes. The environmental fate and transport of indicator chemicals is discussed in this section, relying on information such as environmental "mobility parameters," degradation mechanisms, and site-specific chemical analytical results. The nature and extent of contamination as well as contaminant fate and transport discussions (Sections 4.0 and 5.0) have been reviewed as necessary, since this information is of paramount importance to the exposure assessment. Quantitative, semiquantitative, or qualitative estimates of exposure duration and concentrations are made in this section.

Risk characterization (Section 6.2.4) compares the exposure concentrations predicted in Section 6.2.3 to MCLs, AWQC, or other relevant regulatory standards or guidelines (Section 6.2.2) to qualitatively define the risks associated with noncarcinogenic effects of chemicals identified in various site media. Predicted doses of chemicals having noncarcinogenic effects are divided by Reference Doses to generate Hazard Indices as indicators of potential noncarcinogenic effects. The Hazard Indices provide an indication of the likelihood of threshold effects. Estimates of carcinogenic risks associated with individual chemicals and mixtures of site chemicals will also be presented in this section.

6.2.1 Hazard Identification

Indicator chemicals will be identified in this section, based on various aspects of their occurrence and distribution, mobility, persistence, and toxicity. These indicator chemicals will be selected to represent site contamination and will provide the framework for the quantitative risk assessment presented in Section 6.2.4.1.

The occurrence and distribution of site contaminants was discussed in detail in Section 4.0 (Nature and Extent of Contamination). Volatile organics are the primary contaminants at the site, although some semivolatile constituents, pesticides, and inorganics were also detected. The reader is advised to review Section 4.0 as necessary.

Because chemicals having nonthreshold effects can cause adverse effects even at low concentrations, all of the organic carcinogenic substances detected in groundwater were included as indicator compounds, regardless of their frequency of occurrence or concentrations. In addition, those carcinogenic or potentially carcinogenic compounds detected in other site media were also included as indicator compounds. Several substances displaying only noncarcinogenic effects were detected in groundwater samples. These compounds (e.g., toluene, ethylbenzene, 1,1,1-trichloroethane, chlorobenzene, and 1,2-dichlorobenzene) were also included as indicator chemicals.

With the exception of various pesticides, virtually all of the organic chemicals detected at the site and in the study area were included as indicator chemicals. As discussed in Section 4.0 (Nature and Extent of Contamination), background levels of pesticides are substantially greater than any levels detected on site (i.e., approximately one order of magnitude). Several of the pesticides were detected only in background locations. Site samples containing pesticides were generally from locations near the adjacent farmland, suggesting that aerial application or spray application of pesticides on windy days resulted in the low-level pesticide contamination on site. In view of the presence of background contamination, the various pesticides were not included as indicator chemicals (see Table 4-4).

Chromium and lead were included as indicator chemicals as a result of their detection in surface soils above background. In addition, polynuclear aromatic hydrocarbons and phthalate esters were included as a result of their presence in surface soils.

Table 6-1 summarizes the indicator chemicals selected to represent contamination Byron Barrel and Drum Site. The table includes a compilation of those compounds used for quantitative risk assessment purposes. Appendix F summarizes the toxic effects for selected indicator compounds. The summaries are presented in the form of toxicity profiles. Adverse effects on both human and environmental receptors are discussed.

6.2.2 Dose-Response Evaluation

6.2.2.1 Dose-Response Parameters

An important component of the risk assessment process is the relationship between the dose of a compound (amount to which an

TABLE 6-1

INDICATOR CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Carcinogens	Noncarcinogens
benzene	acetone
1,4-dichlorobenzene	2-butanone
1,1,2-trichloroethane	4-methyl-2-pentanone
1,1-dichloroethane	toluene
1,2-dichloroethane	xylenes
tetrachloroethene	chlorobenzene
trichloroethene	1,2-dichlorobenzene
1,1-dichloroethene	1,3-dichlorobenzene
carbon tetrachloride	phenol
chloroform	4-methylphenol
methylene chloride	di-n-butyl phthalate
chloromethane	1,1,1-trichloroethane
bromodichloromethane	1,2-dichloroethene
chlorodibromomethane	benzoic acid
benzo(a)pyrene	chromium
benzo(a)anthracene	lead
benzo(b)fluoranthene	
bis(2-ethylhexyl)phthalate	
N-nitrosodiphenylamine	

individual or population is exposed) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. Noncarcinogenic risks may be quantitatively assessed by comparing estimated doses with Reference Doses. Carcinogenic risks may be quantitatively assessed using the Carcinogenic Potency Factor. Each of these parameters, as well as the weight of evidence for carcinogenicity, is discussed below.

Reference Dose (RfD) - Applies to prolonged human exposure to hazardous chemicals (i.e., chronic exposure) and is based solely on the noncarcinogenic effects of chemical substances. The RfD is usually expressed as an acceptable dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOAEL or NOEL) or a lowest-observed-adverse-effect-level (LOAEL) by an appropriate "uncertainty factor." NOAELs, etc., are determined from laboratory or epidemiological toxicity studies. The uncertainty factor (10, 100, or 1,000) is based on the availability of toxicity data: 10 is used if appropriate chronic human data are available; 100 is used if sufficient chronic animal data are available; and 1,000 is used if only subchronic animal data can be obtained. An additional uncertainty factor, ranging from 1 to 10, may also be included, depending on the severity of the observed effect if a LOAEL is used to develop the Reference Dose. Even if applicable human data exist, the RfD (as diminished by the uncertainty factor) still maintains a margin of safety so that chronic human health effects are not underestimated. Thus, the RfD is an acceptable guideline for the qualitative evaluation of noncarcinogenic risk, although the associated uncertainties preclude its use for precise risk quantitation.

Carcinogenic Potency Factor (CPF) - Is developed by the EPA's Carcinogen Assessment Group and is applicable for estimating the lifetime probability (assumed 70-year lifespan) of human receptors contracting cancer as a result of exposure to known or suspected carcinogens. This factor is generally reported in units of $(mg/kg/day)^{-1}$ and is derived through an assumed low-dosage linear relationship and an extrapolation from high to low dose-responses determined from animal studies. The value used in reporting the slope factor is the upper 95 percent confidence limit.

The carcinogenic potency of polynuclear aromatic hydrocarbons (PAHs) is currently under EPA review. In the past, the CPF for benzo(a)pyrene (B(a)P) has been used as a representative CPF for all carcinogenic PAHs. However, the method used in this document differs somewhat from this approach. The EPA's Carcinogen Assessment Group has developed relative carcinogenic potencies for dibenzo(a,h)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, and benzo(a) anthracene. The relative potencies are based on B(a)P and may be used to estimate CPFs. For example, the potency of benzo(b) fluoranthene, relative to B(a)P, is 0.08 (Chu and Chen, 1984). Therefore, the CPF for benzo(b)fluoranthene (BBF) was determined as follows:

$$CPF_{BBF} = 0.08\ CPF_{B(a)P}$$

EPA Weight-of-Evidence - Describes the preponderance of evidence regarding carcinogenic effects in humans and animals. The categories are defined as follows (EPA, October 1986):

EPA Category	Description of Group	Description of Evidence
Group A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.
Group B1	Probable human carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies.
Group B2	Probable human carcinogen	Sufficient evidence of carcinogenicity in animals; inadequate evidence of carcinogenicity in humans.
Group C	Possible human carcinogen	Limited evidence of carcinogenicity in animals.
Group D	Not classified	Inadequate evidence of carcinogenicity in animals.
Group E	No evidence of carcinogenicity in humans	No evidence for carcinogenicity in at least two adequate animal tests or in both epidemiologic and animal studies.

6.2.2.2 Applicable or Relevant and Appropriate Requirements

This section presents available regulatory standards or guidelines for the indicator chemicals selected in the preceding section. Currently, the only enforceable regulatory standards are the Maximum Contaminant Levels (MCLs). However, MCLs have not been specified for the majority of the indicator chemicals. Therefore, only regulatory guidelines may be used for comparative purposes to infer health risks and environmental impacts. Relevant regulatory guidelines include Ambient Water Quality Criteria, Maximum Contaminant Level Goals, and EPA Drinking Water Health Advisories. The methodology used to establish these environmental criteria is summarized briefly below.

Maximum Contaminant Levels (MCLs) - MCLs are enforceable standards promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are applicable for water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with lifetime exposure (70 year lifetime) of an average adult (70 kg) consuming 2 liters of water per day, but reflect the detection limits of laboratories servicing public water suppliers.

Maximum Contaminant Level Goals (MCLGs) - Are specified as zero for carcinogenic substances, based on the assumption of nonthreshold toxicity, and do not consider the technical or economic feasibility of achieving these goals. MCLGs are nonenforceable guidelines based entirely on health effects and consider the relative contribution of the contaminant from drinking water sources. The MCLs have been set as close to the MCLGs as is considered technically and economically feasible.

Ambient Water Quality Criteria (AWQC) - Are not enforceable regulatory guidelines but are of utility in assessing acute and chronic toxic effects in aquatic organisms as well as human receptors. AWQCs consider acute and chronic effects in both freshwater and salt water aquatic life as well as adverse carcinogenic and noncarcinogenic health effects in humans from ingestion of both water (2 liters/day) and aquatic organisms (6.5 grams/day) and from the ingestion of aquatic organisms alone. The AWQC may also be adjusted to consider ingestion of water alone (2 liters/day).

Health Advisories - Are guidelines developed by the EPA Office of Drinking Water for nonregulated contaminants in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (assumed body weight of 10 kg) who consume 1 liter of water per day or for adults (assumed body weight of 70 kg) who consume 2 liters of water per day. Health Advisories are generally available for acute (1 day), subchronic (10 days), and longer-term (up to 7 years) exposure scenarios. Health advisories may also be developed for lifetime exposures if appropriate data are available. These guidelines are designed to consider only threshold effects and, as such, do not consider carcinogenicity.

Values of the available regulatory standards and guidelines are presented in Table 6-2. Table 6-2 presents values for the indicator chemicals that are human, suspected human, or possible human carcinogens; for chemicals having only noncarcinogenic effects; and for chemicals having both carcinogenic and noncarcinogenic effects.

6.2.3 Exposure Assessment

Estimated human doses of site contaminants are generated in this section. Several potential exposure mechanisms are considered, and these involve both exposure at the source and exposure to chemicals released to the surrounding environment. Specifically, the following human exposure routes are considered:

- Direct dermal contact at the source
- Accidental ingestion of contaminated soil at the source
- Inhalation of contaminated fugitive dust
- Inhalation of volatile emissions
- Household use of groundwater

TABLE 6-2

STANDARDS, GUIDELINES, AND DOSE-RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Compound	CPF(1)(5)(8) (mg/kg/day)$^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
acetone			Oral: 1.0×10^{-1}						
2-butanone			Oral: 5.0×10^{-2} Inhal: 9.0×10^{-2}		1-day (child): 75,000 10-day (child): 7,500 Longer-term (child): 2,500 Longer-term (adult): 8,600 Lifetime: 172				
4-methyl-2-pentanone			Oral: 5.0×10^{-2} Inhal: 2.0×10^{-2}						
benzene	Oral: 2.9×10^{-2} Inhal: 2.9×10^{-2}	A		0(a) 5	1-day (child): 200 10-day (child): 200	0(0.67)(c)	0(0.66)(c)	5,300	
ethylbenzene			Oral: 1.0×10^{-1}	700(h) 700(b)	1-day (child): 30,000 10-day (child): 3,000 Longer-term (child): 1,000 Longer-term (adult): 3,000 Lifetime: 700	2,400	1,400	32,000	
toluene			Oral: 3.0×10^{-1} Inhal: 1.0×10^{0}	2,000(h) 2,000(b)	1-day (child): 20,000 10-day (child) 3,000 Longer-term (child) 3,000 Longer-term (adult) 10,000 Lifetime: 2,000	15,000	14,300	17,500	
xylenes			Oral: 2.0×10^{0} Inhal: 4.0×10^{-1}	10,000(b) 10,000(h)	1-day (child): 40,000 10-day (child): 40,000 Longer-term (child): 40,000 Longer-term (adult): 100,000 Lifetime: 10,000				
chlorobenzene			Oral: 3.0×10^{-2} Inhal: 5.0×10^{-3}		1-day (child): 4,300 10-day (child): 4,300 Longer-term (child): 4,300 Longer-term (adult): 15,000 Lifetime: 300	488	488	250	50

TABLE 6-2
STANDARDS, GUIDELINES, AND DOSE-RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM
BYRON, NEW YORK
PAGE TWO

Compound	CPF(1)(5)(8) $(mg/kg/day)^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
1,2-dichlorobenzene			Oral: $4.0x10^{-1}$ Inhal: $4.0x10^{-1}$	600(b) 600(h)	1-day (child): 9,000 10-day (child): 9,000 Longer-term (child): 9,000 Longer-term (adult): 30,000 Lifetime: 620	400	470	1,120	763
1,3-dichlorobenzene				600(b) 600(h)	1-day (child): 9,000 10-day (child): 9,000 Longer-term (child): 9,000 Longer-term (adult): 30,000 Lifetime: 620	400	470	1,120	763
1,4-dichlorobenzene	Oral: $2.4x10^{-2}$	B2		75(a) 75	1-day (child): 10,000 10-day (child): 10,000 Longer-term (child): 10,000 Longer-term (adult): 40,000 Lifetime: 75	400	470	1,120	763
1,1,2-trichloroethane	Oral: $5.7x10^{-2}$ Inhal: $5.7x10^{-2}$	B2	Oral: $4.0x10^{-1}$	3(i)		0(0.6)(c)	0(0.6)(c)	18,000	9,400
1,1,1-trichloroethane			Oral: $9.0x10^{-2}$ Inhal: $3.0x10^{-1}$	200(a) 200	1-day (child): 100,000 10-day (child): 40,000 Longer-term (child): 40,000 Longer-term(adult): 100,000 Lifetime: 200	19,000	18,400	18,000	
1,1-dichloroethane	Oral: $9.1x10^{-2}$	C	Oral: $1.0x10^{-1}$ Inhal: $1.0x10^{-1}$						
1,2-dichloroethane	Oral: $9.1x10^{-2}$ Inhal: $9.1x10^{-2}$	B2		0(a) 5	1-day (child): 700 10-day (child): 700 Longer-term (child): 700 Long-term (adult): 2,600	0(0.94)(c)	0(0.94)(c)	118,000	20,000

TABLE 6-2
STANDARDS, GUIDELINES, AND DOSE-RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM
BYRON, NEW YORK
PAGE THREE

Compound	CPF(1)(5)(8) (mg/kg/day)$^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
tetrachloroethene	Oral: 5.1×10^{-2} Inhal: 3.3×10^{-3}	B2	Oral: 1.0×10^{-2}	0(b) 5(h)	1-day (child): 2,000 10-day (child): 2,000 Longer-term (child): 1,000 Longer-term (adult): 5,000	0(0.88)(c)	0(0.8)(c)	5,280	840
trichloroethene	Oral: 1.1×10^{-2} Inhal: 1.3×10^{-2}	B2		0(a) 5		0(2.8)	0(2.7)(c)	45,000	21,900
1,1-dichloroethene	Oral: 6.0×10^{-1} Inhal: 1.2×10^{0}	C	Oral: 9.0×10^{-3}	7(a) 7	1-day (child): 2,000 10-day (child): 1,000 Longer-term (child): 1,000 Longer-term (adult): 4,000 Lifetime: 7	0(0.033) (c)	0(0.033) (c)	11,600	
1,2-dichloroethene				70(b)	1-day (child): 20,000 10-day (child): 1,430 Longer-term (child): 1,430 Longer-term(adult): 5,000 lifetime: 70			11,600	
vinyl chloride	Oral: 2.30×10^{0} Inhal: 2.95×10^{-1}	A		0(a) 2	1-day (child): 3,000 10-day (child): 3,000 Longer-term (child): 10 Longer-term(adult): 50	0(2.0) (c)	0(2.0)(c)		
carbon tetrachloride	Oral: 1.3×10^{-1} Inhal: 1.3×10^{-1}	B2	Oral: 7.0×10^{-4}	0(a) 5	1-day (child): 4,000 10-day (child): 200 Longer-term (child): 70 Longer-term (adult): 300	0(0.42)(c)	0(0.4)(c)	35,200	
chloroform	Oral: 6.1×10^{-3} Inhal: 8.1×10^{-2}	B2	Oral: 1.0×10^{-2}	100(f)		0(0.19) (c)(g)	0(0.19)(c)(g)	28,900	1,240
methylene chloride	Oral: 7.5×10^{-3} Inhal: 1.4×10^{-2}	B2	Oral: 6.0×10^{-2}		1-day (child): 13,300 10-day (child): 1,500	0(0.19) (c)(g)	0(0.19)(c)(g)	11,000(g)	

TABLE 6-2
STANDARDS, GUIDELINES, AND DOSE-RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM
BYRON, NEW YORK
PAGE FOUR

Compound	CPF(1)(5)(8) (mg/kg/day)$^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
chloromethane	Oral: 1.3x10^{-2} Inhal: 6.3x10^{-3}	C				0(0.19) (c)(g)	0(0.19)(c)(g)	11,000(g)	
bromodichloromethane	Oral: 1.3x10^{-1}	B2		100(f)		0(0.19) (c)(g)	0(0.19)(c)(g)	11,000(g)	
chlorodibromomethane	Oral: 8.4x10^{-2}	B2	Oral: 2.0x10^{-1}	100(f)		0(0.19) (c)(g)	0(0.19)(c)(g)	11,000(g)	
benzoic acid			Oral: 4.0x10^{0}						
carbon disulfide			Oral: 1.0x10^{-1}						
phenol			Oral: 6.0x10^{-1}			3,500	3,500	10,200	2,560
bis(2-ethylhexyl) phthalate	Oral: 6.84x10^{-4}	B2	Oral: 2.0x10^{-2}			21,000	15,000	940	3
polynuclear aromatic hydrocarbons						0(0.0031) (c)	0(0.0028)(c)		
benzo(a)anthracene	Oral: 1.54x10^{-1} Inhal: 8.17x10^{-2}	B2							
benzo(b)fluoranthene	Oral: 9.2x10^{-1} Inhal: 4.9x10^{-1}	B2							
benzo(a)pyrene	Oral: 1.15x10^{1} Inhal: 6.1x10^{0}	B2							
polychlorinated biphenyls	Oral: 7.7x10^{0}	B2		0(b)		0(0.0126) (c)	0(7.9x10^{-5})(c)	2.0	0.014
N-nitrosodiphenylamine	Oral: 4.9x10^{-3}	B2				0(4.9)(c)	0(7.0)(c)	5,850	

TABLE 6-2
STANDARDS, GUIDELINES, AND DOSE RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM
BYRON, NEW YORK
PAGE FIVE

Compound	CPF(1)(5)(8) (mg/kg/day)$^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
arsenic	Inhal: 5.0×10^{1}	A	Oral: 1.0×10^{-1}	50(b) 50	1-day (child): 50 10-day (child): 50 Longer-term (child): 50 Longer-term (adult): 50 Lifetime: 50	0(0.025) (c)	0(0.0022)(c)	360(III)	190(III)
barium			Oral: 5.0×10^{-2} Inhal: 1.0×10^{-4}	1,000 1,500(b)	1-day (child): 510 10-day (child): 510 Longer-term (child): 510 Longer-term (adult): 1,800 Lifetime: 1,500				
cadmium	Inhal: 6.10×10^{0}	B1	Oral: 5.0×10^{-4}	5(b) 10	1-day (child): 43 10-day (child): 8 Longer-term (child): 5 Longer-term (adult): 18 Lifetime: 5	10	10	39(d)	5.6(d)
chromium	Inhal: 4.1×10^{1} (+6)	A	Oral: 5.0×10^{-3} (+6) Oral: 1.0×10^{0} (+3)	120(b) 50	1-day (child): 1,400 10-day (child): 1,400 Longer-term (child): 240 Longer-term (adult): 840 Lifetime: 120	50(+6) 179(+3)	50(+6) 170(+3)	16(+6) 1,700(+3)	11(+6) 210(+3)
copper			Oral: 3.7×10^{-2} Inhal: 1.0×10^{-2}	1,300(b)		1,000(e)	1,000(e)	120(d)	67(d)
lead			Oral: 1.4×10^{-3}	20(b) 50	Long-term (child): 20 Long-term (adult): 10 Lifetime: 20	50	50	1082(d)	48(d)

TABLE 6-2
STANDARDS, GUIDELINES, AND DOSE RESPONSE PARAMETERS FOR INDICATOR CHEMICALS
BYRON BARREL AND DRUM
BYRON, NEW YORK
PAGE SIX

Compound	CPF(1)(5)(8) $(mg/kg/day)^{-1}$	EPA Weight of Evidence (1)(5)(8)	Chronic RfD(1)(8) (mg/kg/day)	MCL(1) (µg/l)	Health Advisory(1)(9) (µg/l)	Ambient Water Quality Criteria			
						Human Health		Aquatic Life(3)(4)	
						Drinking Water Only (µg/l)(2)	Biota and Drinking Water (µg/l)(2)	Acute Toxicity (µg/l)	Chronic Toxicity (µg/l)
mercury			Oral: 3.0×10^{-4}	3(b) 2	1-day (child): 1.6 10-day (child): 1.6 Longer-term (child): 1.6 Lifetime: 1.0	10	0.144	2.4	0.012
nickel	Inhal: 8.4×10^{-1}	A	Oral: 2.0×10^{-2}		1-day (child): 1,000 10-day (child): 1,000 Longer-term (child): 100 Lifetime: 150	15.4	13.4	7,913(d)	880(d)
vanadium			Oral: 7.0×10^{-3}						
zinc			Oral: 2.0×10^{-1}			5,000(e)	5,000(e)	654(d)	592(d)

Sources:

(1) EPA, November 16, 1987.
(2) EPA, October 1986.
(3) EPA, November 28, 1980.
(4) EPA, February 7, 1984; EPA, July 29, 1985; EPA, March 11, 1986; and EPA, March 2, 1987.
(5) Chu and Chen, 1984.
(6) EPA, July 29, 1985.
(7) EPA, March 11, 1986.
(8) EPA, January 1989.
(9) EPA, February 23, 1989.

CPF Carcinogenic Potency Factor
RfD Reference Dose
MCL Maximum Contaminant Level

EPA Weight of Evidence:
- A - Human carcinogen
- B1/B2 - Probable human carcinogen
- C - Possible human carcinogen
- D - Not classified

Notes

(a) Maximum Contaminant Level Goal (MCLG)
(b) Proposed MCLG
(c) The AWQC for the maximum protection of human health is zero. The value in parentheses corresponds to a 10^{-6} estimated lifetime cancer risk.
(d) Criterion varies with hardness. Reported value is for a hardness of 763 mg/l.
(e) Organoleptic concerns.
(f) Interim MCL for total trihalomethanes.
(g) Reported value is for halomethanes in general.
(h) Proposed MCL.
(i) Tentative MCLG.

Several other exposure routes were also considered for inclusion but were dismissed based on site-specific conditions. During development of the Work Plan, root uptake of contaminants by the adjacent crops was considered possible. However, through direct visual inspection it was determined that the crops grown in the adjacent field have shallow root zones (i.e., less than six inches). The drainage system in the field appears to be effective in preventing groundwater from reaching the root zone. For example, even after very heavy rains in the spring of 1989, it not noted that the water table in the onion field was still approximately 1.5 feet below the ground surface. Hence, this potential exposure route was discounted. Furthermore, exposures through contact and noncontact recreation in the surface water bodies were also discounted based on the size of the drainage ditches and Oak Orchard Creek.

Each of the exposure routes, as well as the methods of estimating the human doses, are discussed in detail in the remainder of this section. In general, two cases are considered for each pathway; the first is a maximum-case scenario and the second is an average case scenario.

6.2.3.1 Direct Dermal Contact

The site is presently unfenced. Therefore, human receptors may come in direct contact with contaminated soil or waste. Trespassing adolescents and adult hunters are considered the most likely receptors via direct dermal contact. The site is located in a rural area, and no young children reside in the vicinity of the site. The following expression was used to estimate the doses incurred in this manner (Schaum, November 1984):

$$\text{Dose} = \frac{C \times SA \times AD \times RAF \times EF}{BW}$$

Where:

Dose = the incurred daily intake per unit body weight (mg/kg/day)
C = the soil/waste concentration (mg/kg)
SA = the exposed skin surface area (cm^2)
AD = the quantity of soil that adheres to exposed skin ($mg/cm^2/day$)
RAF = the relative absorption fraction of the contaminant (decimal fraction)
EF = the frequency of exposure (days/year)
BW = the body weight of the receptor (kg)

Two separate sets of dose estimates were generated for this potential exposure route. The first was based on the maximum observed surface soil concentrations of the indicator chemicals. This is considered a conservative estimate, since the maximum concentrations occur at distinct and separate locations.

Therefore, it is unlikely that a receptor will come into contact with the maximum concentrations on a routine basis. The second scenario employed the average observed surface soil concentrations. This average-case scenario is considered a realistic estimate.

The surface area of exposed skin that may come into contact with contaminated soils was set as 2,950 cm^2 and 2,330 cm^2 for adult and adolescent receptors, respectively. This value is the approximate area of exposed hands and forearms for adult and adolescent receptors (15 years of age). The adherence factor (AD) was set as 1 mg/cm^2 for both adult and adolescent receptors. This is the amount of soil that will adhere to the skin.

The relative absorption fraction was set as 10 percent (0.1), 5 percent (0.005), and 5 percent (0.005) for volatile organics, semivolatile organics, and inorganics, respectively. This factor accounts for resistance to mass transfer from the soil to the skin surface, as well as to transport through the skin. These are considered reasonable estimates since studies have shown that only about 10 percent of most substances will be absorbed by the skin, even upon topical administration (Feldmann and Mailbach, 1970).

The frequency of exposure was set as 30 days per year. This is considered a conservative value, since receptors are not likely to frequent the site area. The population is relatively sparse in the vicinity of the site, and the presence of a large amount of scrap metal and debris make it an unattractive location. The exposure frequency has been included in the dose calculation for two reasons: (1) lifetime average doses were used to determine carcinogenic risks, and (2) chronic Reference Doses were used to determine noncarcinogenic risk estimates. The use of dose-response parameters based on chronic exposures (i.e., Cancer Potency Factors and chronic Reference Doses) dictates that chronic exposure levels be used. Body weights were set as 70 kg and 45 kg for adult and adolescent receptors, respectively.

6.2.3.2 Accidental Ingestion of Soil

Because the site is unfenced, it is considered possible that receptors may be exposed through accidental ingestion of contaminated soil. Pica ingestion is generally a tendency exhibited only by children of ages between 6 months and 6 years, and it is improbable that such receptors would come in contact with most of the sources at the site. However, adult and adolescent receptors could be exposed in an incidental manner through hand-to-mouth contact (e.g., smoking, eating, etc). Exposures through accidental ingestion were estimated using the following expression:

$$\text{Dose} = \frac{C \times IR \times EF}{BW}$$

Where:

Dose = the daily dose incurred per unit body weight (mg/kg/day)
C = the arithmetic average concentration of contaminant in soil for each source area (mg/kg)
IR = the soil ingestion rate (kg/day)
EF = the frequency of exposure (days/year)
BW = the body weight of the receptor (kg)

Both maximum-case and average-case exposure estimates were generated in the same manner as for dermal contact. A soil ingestion rate of 100 mg/day was used for both scenarios. Exposure frequencies were specified as 30 days/year for both cases. Body weights were specified as 70 kg for adult and 45 kg for adolescent receptors, respectively.

6.2.3.3 Inhalation of Fugitive Dust

Human receptors reside in the vicinity of the Byron Barrel and Drum Site. Although site vegetation will impede the emission of particulates via wind erosion, several sources may be susceptible to fugitive dust emission. Therefore, the potential for inhalation of fugitive dust exists in the vicinity of the site, and this contaminant release mechanism and subsequent exposure route was considered. The following expression was used to estimate doses incurred through inhalation of fugitive dust:

$$\text{Dose} = \frac{X \times BR \times AF}{BW}$$

Where:

Dose = the daily dose incurred per unit body weight (mg/kg/day)
X = the downwind contaminant concentration (mg/m^3)
BR = the ventilation (breathing) rate of a human receptor (m^3/day)
AF = the absorption fraction of inhaled contaminants (decimal fraction)
BW = the body weight of the receptor (kg)

A particulate emission model suggested in the Superfund Exposure Assessment Manual was used to generate the downwind contaminant concentrations (EPA, April 1988). The model, its applicability, limitations, and relevant assumptions, are discussed in Appendix G.

Both maximum-case and average-case exposure estimates were generated for this exposure route. Breathing rates of 20 m^3/day and 10 m^3/day were used for adult and child receptors, respectively. Body weights of 10 kg and 70 kg were used for child and adult receptors, respectively. An absorption fraction of 1.0 was used for both scenarios. This absorption fraction is conservative, since it does not account for expectoration of particulates.

In addition, other inputs to the particulate emission model were specified to generate a conservative dose estimate. A disturbance frequency of 30 wind events/month was used. A vegetative cover factor of 0 was used in both scenarios.

6.2.3.4 Inhalation of Volatile Emissions

Doses resulting from the inhalation of volatilized soil contaminants can be significant for downwind receptors. Although surface soil contamination appears negligible at the Byron Barrel and Drum Site, this exposure route has also been considered. A model presented in the Superfund Exposure Assessment Manual was used (EPA, April 1988). The models used to estimate exposure assume that no source depletion occurs. A calculated emission rate is then modeled to a downwind receptor. (See Appendix G for relevant equations and input parameters.)

Inhalation of the calculated air concentrations will result in a dose that can be estimated as follows:

$$\text{Dose} = \frac{C_{air} \times IR \times AF}{BW}$$

Where:

Dose = Daily contaminant intake per unit body weight (mg/kg/day)
C_{air} = Air concentration of contaminant of concern (g/m^3)
IR = Inhalation rate (m^3/day)
AF = Absorption fraction (decimal fraction)
BW = Body weight of the receptor (µg)

For this exposure route, average and maximum surface soil concentrations were used to generate two exposure scenarios. Inhalation rates of 20 m^3/day and 10 m^3/day were used for adult and child receptors, respectively. The absorption fraction was specified as 100 percent. Body weights were set as 70 kg and 10 kg for adult and child receptors, respectively.

6.2.3.5 Household Use of Groundwater

Groundwater in the vicinity of the Byron Barrel and Drum Site is used as a potable water source. The hydrogeologic and analytical investigation has demonstrated that residential wells are not currently affected by contamination in site groundwater. Although low levels (i.e., less than 0.4 µg/l) of some contaminants were detected in selected residential wells, it does not appear that this contamination originated at the site.

Nonetheless, it is appropriate to assess the potential health impacts in the event that the aquifer beneath the Byron Barrel and Drum Site is developed for potable use. Such an assessment will provide an indication of the condition of the aquifer and may define the need for groundwater remediation or institutional controls to prevent future development.

Several contaminants were detected in domestic well samples, including tetrachloroethene, trichloroethane, and carbon tetrachloride. At this time there is no reason to believe that these contaminants originated at the Byron Barrel and Drum Site, as discussed in Section 4.0 (Nature and Extent of Contamination). However, exposures to these chemicals will also be considered.

There are numerous routes of exposure associated with household use of contaminated water. Receptors may be exposed via ingestion and inhalation of volatiles emitted from showers, dishwashers, washing machines, and other turbulent sources, as well as through dermal contact during bathing, dishwashing, car washing, etc. However, previous experience has shown that ingestion and inhalation of volatiles during showering are the predominant exposure mechanisms in the home. Dermal uptake is essentially negligible; similarly, doses incurred through inhalation from all other sources (i.e., dishwashers, washing machines, etc.) generally amount to less than 10 percent of the dose incurred through ingestion and shower inhalation. Therefore, only ingestion and inhalation of volatiles during showering are assessed quantitatively for this exposure route.

Ingestional exposures are estimated using the following expression (EPA, October 1986):

$$\text{Dose} = \frac{\text{C x IR x AF}}{\text{BW}}$$

Where:

Dose = the daily dose incurred per unit body weight (mg/kg/day)
C = the water concentration (mg/L)
IR = the water ingestion rate (L/day)
AF = absorption fraction (decimal fraction)
BW = the body weight of the receptor (kg)

Ingestion rates were set as 1 l/day and 2 l/day for a 10 kg (child) and 70 kg (adult) receptor, respectively. Absorption fractions were specified as 100 percent (1.0) for all groundwater contaminants.

The following model was used to estimate inhalational exposures from volatile and semivolatile chemicals in groundwater during showering (Foster and Chrostowski, 1987):

$$\text{Dose} = \frac{\text{S x IR}}{\text{BW x Ra x }10^6}\left[\text{Ds} + \exp[-\text{Ra Dt}]/\text{Ra} - \exp[\text{Ra (Ds} - \text{Dt)}]/\text{Ra}\right]$$

Where:

Dose = daily dose incurred (mg/kg/shower) per unit body weight
S = volatile organic chemical generation rate ($\mu g/m^3/min$)
IR = inhalation rate (liters/min)
BW = receptor body weight (kg)
Ra = air exchange rate (min^{-1})
Dt = total duration in shower room (min)
Ds = shower duration (min)

This model accounts for inhalation during a shower and after showering (while the receptor remains in the shower room). Additional aspects of the model are discussed in Appendix G. The inhalation rate used was 20 l/min. A body weight of 70 kg was used. The air exchange rate used was 8.3×10^{-3} min^{-1}. The shower duration (D_s) and total exposure duration (D_t) were set as 15 minutes and 20 minutes, respectively.

Three distinct groundwater use scenarios were considered: (1) doses based on maximum observed monitoring well concentrations; (2) doses based on average monitoring well concentrations; (3) doses based on concentrations detected in distinct residential wells.

Table 6-3 provides a summary of the various exposure routes and input parameters considered. Dose calculations and other relevant assumptions are included in Appendix G.

6.2.4 Risk Characterization

Human health risks are characterized on both a quantitative and qualitative basis in this section. Risks are discussed qualitatively through comparison of concentrations and/or doses with the standards/guidelines presented in Table 6-2 (Dose-Response Parameters for Indicator Chemicals). Quantitative risk estimates are generated through the use of Carcinogenic Potency Factors and Reference Doses. Noncarcinogenic risk is assessed using the Hazard Index (summation of the ratios of the estimated doses to the Reference Doses):

$$\text{Hazard Index (HI)} = \sum \left\{ \frac{Dose}{Reference\,Dose} \right\}$$

If the value of the Hazard Index exceeds unity (1.0), there is a potential health risk associated with exposure to that particular chemical mixture (EPA, September 1986). This approach assumes that the endpoints (threshold effects) are the same for each of the contaminants, and is therefore an overestimate of actual risks (EPA, October 1986). The Hazard Index is not a mathematical prediction of the severity of toxic

TABLE 6-3

EXPOSURE ROUTES AND INPUT PARAMETERS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Matrix	Exposure Route	Input Parameters
Soil	Dermal Contact	Maximum Surface Soil Concentrations Average Surface Soil Concentrations Soil Adherence Factor: 1 mg/cm^2 Exposed Surface Area of Skin: Adult - 2,950 cm^2 Adolescent - 2,330 cm^2 Relative Absorption Fraction: Volatiles - 10% Semivolatiles - 5% Inorganics - 5% Body weight: Adult - 70 kg Adolescent - 45 kg Exposure Frequency: 30 days/year
Soil	Accidental Ingestion	Maximum Surface Soil Concentrations Average Surface Soil Concentrations Soil Ingestion Rate: 100 mg/day Body Weight: Adult - 70 kg Adolescent - 45 kg Exposure Frequency: 30 days/year
Air	Dust Inhalation	Maximum Surface Soil Concentrations Average Surface Soil Concentrations Breathing Rate: Adult - 20 m^3/day Child - 10 m^3/day Disturbance Frequency: 30 events/month Vegetative Cover Factor: 0 Source Surface Area: 400 m^2 Body Weight: Adult - 70 kg Child - 10 kg Exposure Frequency: 365 days/year

TABLE 6-3
EXPOSURE ROUTES AND INPUT PARAMETERS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Matrix	Exposure Route	Input Parameters	
Air	Volatile Inhalation	Maximum Surface Soil Concentrations	
		Average Surface Soil Concentrations	
		Breathing Rate:	
		Adult -	20 m^3/day
		Child -	10 m^3/day
		Source Surface Area:	2,000 m^2
		Body Weight:	
		Adult -	70 kg
		Child -	10 kg
		Exposure Frequency:	365 days/year
Water	Ingestion/Inhalation	Maximum Monitoring Well Concentrations	
		Average Monitoring Well Concentrations	
		Maximum Residential Well Concentrations	
		Ingestion Rate:	
		Adult -	2 L/day
		Child -	1 L/day
		Inhalation Rate:	
		Adult -	20 m^3/day
		Child -	10 m^3/day
		Body Weight:	
		Adult -	70 kg
		Child -	10 kg
		Exposure Frequency:	365 days/year

effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic effects. If the ratio of the dose and Reference Dose exceeds unity for an individual chemical, it is likely that noncarcinogenic effects would occur upon exposure to that indicator chemical.

Carcinogenic risk estimates are provided in the form of incremental cancer risks, and are determined as follows:

$$\text{Risk} = \frac{\text{CPF x Dose x ED}}{\text{LT}}$$

Where: CPF = Cancer Potency Factor $(\text{mg/kg/day})^{-1}$
Dose = The estimated dose incurred by the receptor during the exposure period (mg/kg/day)
ED = The time that an individual is exposed (years)
LT = The receptor's anticipated lifetime (years)

The resulting number (risk) is a unitless expression of an individual's incremental likelihood of developing cancer as a result of exposure to the carcinogenic indicator chemicals. An incremental cancer risk of 1×10^{-6} indicates that an exposed individual has a $1/1 \times 10^{6}$ (or 1 in 1 million) chance of contracting cancer.

Total risks for multiple compounds can be presented as the summation of the risks for individual contaminants. Calculating risks in this manner assumes that individual intakes are small, that there are no antagonistic/synergistic effects between chemicals, and that all chemicals produce the same result (i.e., cancer). Cancer risks from various exposure routes are also additive, if the exposed populations are the same.

Incremental cancer risk estimates are a probability statement, but the linear form of the cancer risk expression can yield values in excess of unity. For this reason, the nonlinear form of the dose-response equation is used when intakes (doses) are large. This relationship was used for any risks that exceeded 1×10^{-1} and is expressed as follows:

$$\text{Risk} = 1 - \exp\left[\frac{-\text{CPF x Dose x ED}}{\text{LT}}\right]$$

As shown in Table 6-2, not all of the site contaminants are known or suspected human carcinogens. Therefore, when appropriate, two cancer-risk estimates are presented under each scenario. The first of these is the cumulative risk from all Group A, B1, B2, and C carcinogens. The second estimate is based on the risk from Group A, B1, and B2 carcinogens only.

6.2.4.1 Quantitative Risk Assessment

The noncarcinogenic and carcinogenic risks for each of the exposure routes discussed in Section 6.2.3 (Exposure Assessment) are presented in this section. Both maximum-case and average-case risk estimates are provided. Since a given receptor may be exposed through multiple routes, cumulative risks for multiple exposure routes are also summarized.

Hazard Indices for direct dermal contact, accidental ingestion, fugitive dust inhalation, volatile emission inhalation, and groundwater use were determined using the dose estimates generated as outlined in Section 6.2.3 (Exposure Assessment) and the Reference Doses provided in Table 6-2. These doses were also used to generate incremental cancer risk estimates for adult receptors. An exposure duration of 40 years and a lifetime of 70 years were used to characterize carcinogenic risks.

Table 6-4 summarizes the noncarcinogenic risk estimates associated with the various soil and air exposure routes. The noncarcinogenic risk estimates summarized in Table 6-4 indicate that noncarcinogenic effects are unlikely under both the maximum-case and average-case exposure scenarios. The Hazard Indices for the various exposure routes range no higher than 4.3×10^{-3} (maximum-case dermal contact exposure route), which is well below unity (1.0). The cumulative Hazard Index for all four exposure routes is 4.9×10^{-3} for the maximum-case exposure routes.

Table 6-5 summarizes the carcinogenic risk estimates associated with the soil and air exposure routes. The incremental cancer risks provided in Table 6-5 indicate that the carcinogenic risks associated with these exposure routes are very low and fall well within the EPA target risk range of 10^{-7} to 10^{-4}. For example, the maximum incremental cancer risk is 3.0×10^{-7}, which corresponds to a 1 in 3.3 million chance ($1/3.0 \times 10^{-7}$) that an individual would contract cancer after 40 years of exposure under the conditions specified in Section 6.2.3 (Exposure Assessment). The cumulative incremental cancer risk for all of the soil and air exposure routes (maximum-case) is 6.5×10^{-7}, which corresponds to a 1 in 1.5 million chance that an individual would contract cancer after 40 years of exposure.

The results of the noncarcinogenic and carcinogenic risk characterization indicate that the risks associated with residual surficial contamination at the Byron Barrel and Drum Site are in the lower end of the EPA target risk range. These results confirm intuitive expectations regarding the surficial contamination at the site. Only extremely low levels of contamination were detected during the remedial investigation, and it was not anticipated that this contamination would pose inordinate risks.

By contrast, the results of the risk characterization for the various groundwater use scenarios indicate that the risks would be significant if the aquifer at the Byron Barrel and Drum Site

TABLE 6-4

NONCARCINOGENIC RISK ESTIMATES
SOIL AND AIR EXPOSURE ROUTES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Indicator Chemical	Dose/Reference Dose							
	Dermal Contact(1)		Accidental Ingestion(1)		Dust Inhalation(2)		Volatile Inhalation(2)	
	Maximum-Case	Average-Case	Maximum-Case	Average-Case	Maximum-Case	Average-Case	Maximum-Case	Average-Case
1,1,1-trichloroethane	9.5x10^{-9}	3.5x10^{-10}	4.1x10^{-9}	1.5x10^{-10}	4.9x10^{-12}	1.8x10^{-13}	2.4x10^{-5}	8.8x10^{-7}
tetrachloroethene	3.0x10^{-7}	1.1x10^{-8}	1.3x10^{-7}	4.7x10^{-9}	5.1x10^{-11}	1.9x10^{-12}	2.6x10^{-5}	9.7x10^{-7}
trichloroethene	-(3)	-	-	-	-	-	-	-
chloroform	8.5x10^{-8}	1.1x10^{-8}	3.7x10^{-8}	4.7x10^{-7}	-	-	-	-
benzoic acid	2.6x10^{-8}	3.0x10^{-9}	2.2x10^{-8}	2.6x10^{-9}	-	-	-	-
benzo(a)anthracene	-	-	-	-	-	-	-	-
benzo(b)fluoranthene	-	-	-	-	-	-	-	-
benzo(a)pyrene	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate	5.9x10^{-6}	9.0x10^{-7}	5.0x10^{-6}	7.7x10^{-7}	-	-	-	-
di-n-butyl phthalate	1.4x10^{-7}	3.6x10^{-8}	1.2x10^{-7}	7.4x10^{-9}	-	-	-	-
chromium (III)	1.7x10^{-4}	1.5x10^{-5}	1.5x10^{-4}	1.3x10^{-5}	-	-	-	-
lead	4.1x10^{-3}	2.6x10^{-4}	3.5x10^{-4}	2.3x10^{-4}	-	-	-	-
Total (Hazard Index)	4.3x10^{-3}	2.8x10^{-4}	5.1x10^{-4}	2.4x10^{-4}	5.6x10^{-11}	2.1x10^{-12}	5.0x10^{-5}	1.9x10^{-6}

(1) Risk estimates based on adolescent receptors exposed at the source.
(2) Risk estimates based on child receptors exposed at downwind locations.
(3) - Not applicable: Reference Dose unavailable for ingestional and/or inhalational exposure.

TABLE 6-5

CARCINOGENIC RISK ESTIMATES
SOIL AND AIR EXPOSURE ROUTES
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Indicator Chemical	Incremental Cancer Risk							
	Dermal Contact(1)		Accidental Ingestion(1)		Dust Inhalation(2)		Volatile Inhalation(2)	
	Maximum-Case	Average-Case	Maximum-Case	Average-Case	Maximum-Case	Average-Case	Maximum-Case	Average-Case
1,1,1-trichloroethane	-	-	-	-	-	-	-	-
tetrachloroethene	$7.1x10^{-11}$	$2.6x10^{-12}$	$2.4x10^{-11}$	$8.9x10^{-13}$	$2.8x10^{-15}$	$1.0x10^{-16}$	$1.4x10^{-9}$	$5.3x10^{-11}$
trichloroethene	$1.0x10^{-10}$	$4.4x10^{-12}$	$3.5x10^{-11}$	$1.5x10^{-12}$	$7.3x10^{-14}$	$3.1x10^{-15}$	$1.7x10^{-7}$	$7.2x10^{-9}$
chloroform	$2.4x10^{-12}$	$3.1x10^{-13}$	$8.2x10^{-13}$	$1.1x10^{-13}$	$1.9x10^{-14}$	$2.5x10^{-15}$	$1.3x10^{-7}$	$1.7x10^{-8}$
benzoic acid	-	-	-	-	-	-	-	-
benzo(a)anthracene	$1.7x10^{-9}$	$6.2x10^{-11}$	$1.1x10^{-9}$	$4.2x10^{-11}$	$1.1x10^{-12}$	$4.0x10^{-14}$	$5.3x10^{-16}$	$2.0x10^{-17}$
benzo(b)fluoranthene	$2.2x10^{-8}$	$1.5x10^{-9}$	$1.5x10^{-8}$	$9.9x10^{-10}$	$1.4x10^{-11}$	$9.4x10^{-13}$	$1.5x10^{-13}$	$9.9x10^{-15}$
benzo(a)pyrene	$1.1x10^{-8}$	$4.2x10^{-10}$	$7.7x10^{-9}$	$2.9x10^{-10}$	$7.3x10^{-11}$	$2.7x10^{-12}$	$8.6x10^{-15}$	$3.2x10^{-16}$
bis(2-ethylhexyl)phthalate	$7.6x10^{-10}$	$1.2x10^{-10}$	$5.2x10^{-10}$	$8.0x10^{-11}$	-	-	-	-
di-n-butyl phthalate	-	-	-	-	-	-	-	-
chromium (III)	-	-	-	-	-	-	-	-
lead	-	-	-	-	-	-	-	-
Total	$3.6x10^{-8}$	$2.1x10^{-9}$	$2.4x10^{-8}$	$1.4x10^{-9}$	$2.9x10^{-7}$	$3.7x10^{-8}$	$3.0x10^{-7}$	$2.4x10^{-8}$

(1) Risk estimates based on adult receptors exposed at the site.
(2) Risk estimates based on adult receptors exposed at downwind locations.
(3) - Not applicable: Surface soil indicator chemical has no known carcinogenic effects or will not be subject to volatile

were developed for potable purposes. Although minor contamination was detected in residential wells during the second sampling round, it does not appear that this contamination originated at the Byron Barrel and Drum Site (see Section 4.0). Under present site conditions, it does not appear that the residential wells are threatened by site contamination. Two distinct contaminant plumes were identified at the site, and both are migrating to the northwest (downgradient), away from the residential wells.

Table 6-6 summarizes the noncarcinogenic risk estimates associated with the various groundwater use scenarios, including those based on maximum monitoring well concentrations, arithmetic average monitoring well concentrations, and maximum residential well concentrations. Under the maximum monitoring well concentration scenario, the Hazard Index is 38, whereas the Hazard Index under the average monitoring well concentration scenario is 5.8. The fact that both Hazard Indices exceed unity indicates that noncarcinogenic effects would be likely if a drinking water well were installed in the contaminant plumes. The primary contributors to this noncarcinogenic risk are 1,1,1-trichloro-ethane, barium, copper, lead, vanadium, and zinc. It should be recalled that groundwater samples were not filtered prior to preservation (acidification). Hence, any insoluble inorganic species present in suspended solids appeared in analytical results for these samples. Thus, the risks associated with the various metals may be overestimated. However, the Hazard Index exceeds unity (1.0) even without the inclusion of the inorganic results.

By contrast, the noncarcinogenic risk estimates based on the analytical results for residential wells do not exceed unity. The Hazard Index based on residential well results is 2.2×10^{-1}. The primary contributors to this Hazard Index are the various metals detected in the residential wells, and since high concentrations of inorganics were detected in both the site monitoring wells and the upgradient and uncontaminated downgradient monitoring wells, it appears that high background levels of inorganics exist in the vicinity of the Byron Barrel and Drum Site.

Table 6-7 summarizes the carcinogenic risk estimates for the maximum monitoring well, average monitoring well, and maximum residential well concentration scenarios. Under the maximum and average monitoring well concentration scenarios, the incremental cancer risks are 2.4×10^{-3} and 2.0×10^{-4}, respectively. These scenarios exceed the EPA target risk range of 10^{-7} to 10^{-4} and correspond to a 1 in 420 and a 1 in 5,000 chance than an individual would develop cancer after a lifetime of exposure.

By contrast, the cumulative incremental cancer risk estimate, based on observed residential well concentrations, is 3.4×10^{-7}, which corresponds to a 1 in 2.9 million chance that an individual would contract cancer upon a lifetime of exposure. The three carcinogenic chemicals detected in the residential

TABLE 6-6

NONCARCINOGENIC RISK ESTIMATES
GROUNDWATER USE
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Indicator Chemical	Dose/Reference Dose		
	Maximum Monitoring Well Concentrations(1)	Average Monitoring Well Concentrations(2)	Residential Well Concentrations
benzene	-(3)	-	-
toluene	1.1×10^{-4}	1.6×10^{-5}	-
xylenes	1.7×10^{-4}	2.0×10^{-5}	-
chlorobenzene	1.1×10^{-3}	1.8×10^{-4}	-
1,2-dichlorobenzene	2.8×10^{-6}	1.4×10^{-7}	-
1,4-dichlorobenzene	-	-	-
1,1,2-trichloroethane	2.6×10^{-3}	1.4×10^{-4}	-
1,1,1-trichloroethane	1.6×10^{0}	1.5×10^{-1}	-
1,2-dichloroethane	-	-	-
1,1-dichloroethane	8.3×10^{-2}	5.0×10^{-3}	-
tetrachloroethene	2.5×10^{-1}	1.2×10^{-2}	7.5×10^{-4}
trichloroethene	-	-	-
1,1-dichloroethene	1.3×10^{-1}	1.7×10^{-2}	-
vinyl chloride	-	-	-
carbon tetrachloride	-	-	3.8×10^{-4}

TABLE 6-6
NONCARCINOGENIC RISK ESTIMATES
GROUNDWATER USE
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Indicator Chemical	Dose/Reference Dose		
	Maximum Monitoring Well Concentrations(1)	Average Monitoring Well Concentrations(2)	Residential Well Concentrations
chloroform	1.5×10^{-3}	2.7×10^{-5}	-
methylene chloride	1.3×10^{-3}	-	-
bromodichloromethane	-	-	-
dibromochloromethane	2.0×10^{-5}	-	-
N-nitrosodiphenylamine	-	-	-
chromium	1.4×10^{-2}	2.5×10^{-3}	-
lead	1.3×10^{1}	2.4×10^{0}	8.2×10^{-2}
Total (Hazard Index)	1.5×10^{1}	2.6×10^{0}	8.3×10^{-2}

(1) Based on four rounds of monitoring well sampling and analysis.
(2) Based on round 3 and round 4 monitoring well sampling and analysis.
(3) - Not applicable: No Reference Dose available or contaminant not detected.

TABLE 6-7

CARCINOGENIC RISK ESTIMATES
GROUNDWATER USE
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Indicator Chemical	Incremental Cancer Risk		
	Maximum Monitoring Well Concentrations(1)	Average Monitoring Well Concentrations(2)	Residential Well Concentrations
benzene	4.0×10^{-7}	2.0×10^{-8}	–
toluene	–(3)	–	–
xylenes	–	–	–
chlorobenzene	–	–	–
1,2-dichlorobenzene	–	–	–
1,4-dichlorobenzene	7.8×10^{-7}	3.9×10^{-9}	–
1,1,2-trichloroethane	5.0×10^{-6}	2.6×10^{-7}	–
1,1,1-trichloroethane	–	–	–
1,2-dichloroethane	9.4×10^{-7}	–	–
1,1-dichloroethane	4.3×10^{-4}	2.6×10^{-5}	–
tetrachloroethene	7.1×10^{-5}	3.5×10^{-6}	2.2×10^{-7}
trichloroethene	1.0×10^{-3}	5.0×10^{-5}	9.7×10^{-8}
1,1-dichloroethene	9.3×10^{-4}	1.2×10^{-4}	–
vinyl chloride	2.5×10^{-6}	1.2×10^{-7}	–
carbon tetrachloride	–	–	3.1×10^{-8}

TABLE 6-7
CARCINOGENIC RISK ESTIMATES
GROUNDWATER USE
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Indicator Chemical	Incremental Cancer Risk		
	Maximum Monitoring Well Concentrations(1)	Average Monitoring Well Concentrations(2)	Residential Well Concentrations
chloroform	4.4 x 10^{-7}	8.1 x 10^{-9}	-
methylene chloride	7.5 x 10^{-7}	-	-
bromodichloromethane	4.9 x 10^{-7}	4.7 x 10^{-9}	-
dibromochloromethane	1.9 x 10^{-7}	-	-
N-nitrosodiphenylamine	1.6 x 10^{-7}	1.6 x 10^{-8}	-
chromium	-	-	-
lead	-	-	-
Total	2.4 x 10^{-3}	2.0 x 10^{-4}	3.4 x 10^{-7}

(1) Based on four rounds of monitoring well sampling and analysis.
(2) Based on round 3 and round 4 monitoring well sampling and analysis.
(3) - Not applicable: Contaminant not detected or noncarcinogenic.

wells (tetrachloroethene, trichloroethene, and carbon tetrachloride) were found in three separate wells. The individual risks for each of these wells are 2.2×10^{-7}, 9.7×10^{-8}, and 3.1×10^{-8}. These estimates correspond to 1 in 4.5 million, 1 in 10 million, and 1 in 32 million chance that an individual would contract cancer over a lifetime of exposure.

In conclusion, surficial contamination at the Byron Barrel and Drum Site poses minimal risks to human receptors. The cumulative Hazard Index from dermal contact, accidental ingestion, and inhalation of volatiles and dust is 4.9×10^{-3}, which is well below 1.0. The cumulative incremental cancer risk through these exposure routes is 6.5×10^{-7} (1 in 1.5 million), which falls well within the EPA target risk range of 10^{-7} to 10^{-4}.

The Hazard Index for groundwater use based on residential well concentrations is 2.2×10^{-1}, which is below unity. The incremental cancer risk for groundwater use based on residential well concentration is 3.4×10^{-7} (1 in 2.9 million), which falls well within the target risk range.

However, the Hazard Index for groundwater use based on maximum monitoring well concentrations exceeds 1.0 (38). Therefore noncarcinogenic effects would be likely if the aquifer at the Byron Barrel and Drum Site were developed for potable use. Similarly, the incremental cancer risk based on maximum monitoring well concentrations exceeds the upper ground of the target risk range (2.4×10^{-3}). An incremental cancer risk of 1 in 420 would be incurred if the aquifer is developed for potable purposes under future conditions.

6.2.4.2 Qualitative Risk Assessment

As a supplement to the quantitative risk assessment presented in Section 6.2.4.1, this section presents a comparison of site-specific data to Applicable or Relevant and Appropriate Requirements (ARARs). This information is particularly useful in the Feasibility Study when setting cleanup standards based on regulatory requirements.

Table 6-8 compares the maximum contaminant concentrations in the groundwater to Federal MCLs, MCLGs, and Drinking Water Health Advisories. Benzene, vinyl chloride, and carbon tetrachloride were detected at maximum concentrations of less than 1 µg/l. The MCLGs for these chemicals are zero, but the MCLs are not exceeded. The maximum concentrations of 1,1,1-trichlorothane, tetrachloroethene, trichloroethene, 1,2-dichloroethene, and 1,1-dichloroethene exceed the MCLGs. MCLs have been set for only three of these chemicals, and these, too, have been exceeded in onsite groundwater samples. The Health Advisories, which protect against toxic effects, are not exceeded for any organic chemical on site.

TABLE 6-8

COMPARISON OF MAXIMUM OBSERVED GROUNDWATER CONTAMINANT CONCENTRATIONS WITH MCLs AND DWHAs(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Chemical	Maximum Groundwater Concentration (µg/l)	Maximum Contaminant Level (µg/l)	Maximum Contaminant Level Goal (µg/l)	EPA Drinking Water Health Advisory (µg/l)
benzene+	0.5	5	0	200
toluene	1.0	2,000 (3)	2,000 (2)	20,000
xylenes	3.0		440 (2)	40,000
chlorobenzene	0.25			4,300
1,2-dichlorobenzene	0.026		620 (2)	9,000
1,3-dichlorobenzene	3.0			9,000
1,4-dichlorobenzene	2.0		75	10,000
1,1,1-trichloroethane*+	4,400	200	200	100,000
tetrachloroethene+	82		0 (2)	2,000
trichlorothene*	3,300	5	0	
1,2-dichlorothene+	110		70 (2)	20,000
1,1-dichloroethene*	41	7	7	2,000
vinyl chloride+	0.06	2	0	3,000
carbon tetrachloride+	0.0094	5	0	4,000

TABLE 6-8
COMPARISON OF MAXIMUM OBSERVED GROUNDWATER CONTAMINANT CONCENTRATIONS WITH MCLs AND DWHAs(1)
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK
PAGE TWO

Chemical	Maximum Groundwater Concentration (µg/l)	Maximum Contaminant Level (µg/l)	Maximum Contaminant Level Goal (µg/l)	EPA Drinking Water Health Advisory (µg/l)
chloroform	0.51	100		
methylene chloride	2.8			13,300
bromodichloromethane	0.23	100		
dibromochloromethane	0.14	100		
arsenic	41.3	50	50 (2)	50
barium*+	5,230	1,000	1,500 (2)	510
cadmium*+	24	10	5 (2)	43
chromium*+	479	50	120 (2)	1,400
copper+	2,110		1,300 (2)	
lead*+	631	50	20 (2)	20
mercury	0.7	2	3 (2)	1.6
nickel	606			1.000

(1) DWHA - EPA Drinking Water Health Advisory (1-day health advisory for a child).
(2) Proposed Maximum Contaminant Level Goal.
(3) Proposed Maximum Contaminant Level.
* Chemical exceeds MCL.
\+ Chemical exceeds MCLG.
No standards are available for other contaminants detected in groundwater.

Barium, cadmium, chromium (III), and lead are present in onsite groundwater at concentrations in excess of the MCLs. The maximum concentrations of barium and lead also exceed the EPA Health Advisories. These results indicate that adverse health effects could be expected if this water were ingested regularly.

In Table 6-9, the maximum contaminant concentrations in groundwater are compared to New York State requirements. New York has adopted MCLs for a number of inorganics and has also set standards for inorganics in raw water supplies. The maximum concentrations of barium, cadmium, copper, lead, and zinc in onsite groundwater exceed the state standards. The groundwater quality regulations for arsenic and lead are one-half the state MCLs, which means that arsenic is also in exceedance of state standards.

NYSDEC has promulgated groundwater quality regulations for waters that can be used as potable water supply. Standards have been set for inorganics and only a few volatile organics. The standard that applies to any chemical is the most stringent of the three standards presented in Table 6-9. The groundwater standard for trichloroethene is 10 µg/l, and the maximum concentration found in onsite groundwater is 3,300 µg/l. The state standards also require that benzene not be detected using EPA Method 602 with a detection limit of 0.2 µg/l. The maximum concentrations of carbon tetrachloride and chloroform were well below the state groundwater quality regulations.

6.3 ENVIRONMENTAL ASSESSMENT

Table 6-10 presents a comparison of the maximum contaminant concentrations in surface waters to the Federal Ambient Water Quality Criteria for the protection of aquatic life and to the state surface water standards. Oak Orchard Creek is currently a Class D stream but may be upgraded to Class C. Class D surface waters are suitable for contact recreation and allow for survival of aquatic life. Class C surface waters are suitable for fishing, contact recreation, and fish propagation. None of the organics were found at concentrations that exceed the AWQC. Of the inorganics in the site surface waters, only copper exceeds the Federal and state standards for chronic toxicity, based on a calculated hardness of 763 mg/l. No acute standards are exceeded. In addition, the maximum concentrations of zinc and vanadium exceed the state standards for chronic toxicity to aquatic life. However, the stream is very small and receives runoff from a large area of agriculture It is likely that aquatic life is more susceptible to the presence of pesticides.

During the course of the remedial investigation, it was noted that the aquatic ecosystem appears healthy (based on visual observations). No stressed flora or fauna were noted in either the drainage ditches or in Oak Orchard Creek. The site itself also appears to support a healthy population of mammals and reptiles. Species observed in the vicinity of the site included garter snakes, rabbits, white tail deer, and muskrats.

TABLE 6-9

COMPARISON OF MAXIMUM OBSERVED GROUNDWATER CONTAMINANT CONCENTRATIONS WITH NEW YORK STATE MCLs AND GROUNDWATER STANDARDS
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Chemical	Maximum Groundwater Concentration (µg/L)	NYSDOH Maximum Contaminant Levels (µg/L)	NYSDOH Standards-Sources of Water Supply (µg/L)	NYSDEC Groundwater Quality Regulations (µg/L)
benzene	0.5			ND
trichloroethene *	3,300			10
carbon tetrachloride	0.0094			5
chloroform	0.51			100
arsenic *	41.3	50	50	25
barium *+	5,230	1,000	1,000	1,000
cadmium *+	24	10	10	10
copper *+	2,110	1,000	200	1,000
lead *+	631	50	50	25
mercury	0.7	2	5	2
zinc *+	7,580	5,000	300	5,000

*	Chemical exceeds groundwater quality regulations. Quality standards for potable groundwater are the most stringent of those listed.
+	Chemical exceeds NYSDOH MCLs.
ND	Not detectable using common analytical methods.

No standards are available for other contaminants detected in groundwater. However, it has been reported that a recent revision to Part V of the New York State Sanitary Code calls for water concentrations below 5 ppb (µg/l) for all volatile organic chemicals with the exception of vinyl chloride (<2 ppb).

TABLE 6-10

COMPARISON OF MAXIMUM SURFACE WATER CONTAMINANT CONCENTRATIONS AND AMBIENT WATER QUALITY CRITERIA
BYRON BARREL AND DRUM SITE
BYRON, NEW YORK

Chemical	Maximum Surface Water Concentration (µg/L)	Ambient Water Quality Criteria[1] (µg/L)		NY State Surface Water Standard (µg/L)	
		Acute	Chronic	Class D	Class C
toluene	9	17,500	--		
1,1,1,-trichloroethane	7	18,000	--		
1,2-dichloroethene	0	11,600	--		
chloromethane	39	11,000	--		
phenol	13	10,200	2,560	5.0	5.0
4-methylphenol	62	--	--		
arsenic	31.9	360	190	360	190
copper	97	120	67	120	67
lead	28.2	1,082	48	1,082	48
nickel	17	7,913	880	8,641	448
vanadium	51			190	14
zinc	391	654	592	1,735	30

(1) Ambient water quality criteria for the protection of freshwater aquatic life. Inorganics are based on a calculated hardness of 763 mg/L.

7

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY

7.1.1 Nature and Extent of Contamination

Environmental contamination at the Byron Barrel and Drum Site primarily consists of subsurface soil and groundwater contamination. Based on the absence of substantial soil contamination, it appears that the EPA removal action conducted in 1984 was partially effective in reducing contaminant releases. Chlorinated aliphatic hydrocarbons such as 1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethene, and 1,1-dichloroethene are the primary contaminants. Various monocyclic aromatics such as toluene and xylenes were also detected, although groundwater contamination with these substances is minimal when compared to the contamination with chlorinated species.

Two major contaminant sources were detected at the site during the 1988-1989 remedial investigation (RI). The first of these sources is located in the southwestern portion of a drum storage and waste disposal area (source area 1). The second source is located in the vicinity of a large maintenance shed located in the southwest portion of the site property (maintenance building source).

Based on the results of a subsurface soil sampling and analysis program, it has been estimated that approximately 1,100 cubic yards of contaminated soil are located in source area 1. Concentrations of contaminants in this area are generally relatively low, probably as a result of the sandy nature of the soil in the vicinity of the source and as a result of the EPA removal action. For example, tetrachloroethene (PCE) was the most concentrated contaminant detected in soil samples from this area. However, PCE concentrations ranged no higher than 4,400 ppb. Based on the supplemental soil boring program, it is estimated that approximately 3,000 cubic yards of contaminated soil exist in the maintenance building source area. Concentrations of volatile organics are even lower than those detected in source area 1.

Surface soils at the Byron Barrel and Drum Site contained only low levels of volatile organics (less than 50 ppb), phthalate esters (less than 600 ppb), polynuclear aromatic hydrocarbons (less than 300 ppb), and benzoic acid (less than 500 ppb). By contrast, much higher concentrations of various pesticides, such as 4,4'-DDT, 4,4'-DDE, endrin, and dieldrin were encountered. However, the highest concentrations of these compounds were detected in surface soil samples which were collected from the adjacent farmland. Onsite samples containing pesticides were obtained in proximity to the agricultural land and are believed to be present as a result of atmospheric transport of pesticides during their application to crops.

Inorganic contamination in both soils and water appears to be indistinguishable from background levels. Although chromium and lead were detected in site surface soils above background, contamination with these substances is not pronounced. Groundwater samples were not filtered prior to preservation and, consequently, they contained relatively high levels of inorganic species. However, only one site monitoring well sample contained levels markedly different from upgradient results and a previous sample from this well did not display similar contamination.

Surface water and sediment samples obtained in a drainage ditch adjacent to the site property contained relatively low levels of organic chemicals. No evidence of downstream impact on Oak Orchard Creek (the primary receiving surface water body) was identified. Several sediment samples from another drainage ditch that runs east to west, just north of the site, contained relatively high levels of toluene, acetone, and 2-butanone. However, based upon surface drainage patterns and the absence of potential discharge of contaminated groundwater to this drainage channel, it is not believed that this contamination is site-related.

7.1.2 Contaminant Fate and Transport

The primary contaminant transport mechanism at the Byron Barrel and Drum Site is associated with groundwater advection of dissolved contaminants. A contaminant plume originating in the vicinity of source areas 1 and 2 was noted to be migrating in the downgradient direction to the northwest. No evidence of contaminant migration toward residential wells to the southwest was observed during the RI. Based on the analytical results for monitoring well samples, it is apparent that this contaminant plume is confined to the immediate proximity of the source areas. It is estimated that the contaminant plume has migrated no further than 400 feet from the sources. This phenomenon is a manifestation of the shallow hydraulic gradient and the relatively recent time frame of disposal activities (as late as 1982).

As a result of the supplemental field investigation, a second plume originating at the maintenance building source was delineated. This plume is also migrating in a northerly direction and has extended no farther than 300 feet from the source area.

7.1.3 Risk Assessment

Five potential exposure routes were considered during the course of the risk assessment. The exposure pathways included direct dermal contact, accidental ingestion of soils, inhalation of fugitive dust, inhalation of volatile emissions, and groundwater ingestion as well as inhalation of volatiles during showering. Virtually all of the contaminants detected in site media were included as indicator chemicals, with the exception of the pesticides identified in surficial soils. These compounds are considered background contaminants that are unrelated to any disposal activities at the Byron Barrel and Drum Site.

The risk characterization process indicates that those exposure routes associated with surficial contamination (i.e., dermal contact, accidental ingestion, and inhalation of fugitive dust and volatile emissions) constitute minimal noncarcinogenic and carcinogenic risks to the surrounding population. Hazard Indices were well below unity for each of these exposure routes. Incremental cancer risks were well within the EPA target risk range of 10^{-7} to 10^{-4}. None of the incremental cancer risks associated with these exposure routes exceeded 10^{-6} (a 1 in 1 million chance that an exposed receptor would incur cancer).

Low levels of contaminants were detected in several residential well samples, but risks posed by these contaminants are in the lower end of the EPA target risk range. Incremental cancer risks did not exceed 10^{-6} for exposures associated with use of domestic well water. Hazard Indices for residential wells are well below unity.

By contrast, the risk assessment indicates that significant carcinogenic and noncarcinogenic risks would be incurred if the aquifer at the Byron Barrel and Drum Site were developed for potable use. The cumulative incremental cancer risk for use of site groundwater exceeds the upper bound of the EPA target risk range. Hazard Indices exceed unity, indicating that noncarcinogenic effects would be likely if this water were developed for drinking water purposes.

7.2 CONCLUSIONS

7.2.1 Data Limitations and Recommendations for Future Work

The results of the remedial investigation are considered sufficient to define the nature and extent of contamination, provide the basis for the baseline risk assessment, and complete the feasibility study of alternatives. However, assuming that remedial action may be implemented at the site, several additional data requirements have been identified that should be satisfied during the remedial design phase, if groundwater treatment is pursued. These data requirements focus on installation of the groundwater recovery system and the removal of inorganic constituents from groundwater.

It is recommended that a long-term pumping test be conducted to optimize pumping rates, well diameters, etc., before installation of the groundwater recovery system. Furthermore, it is recommended that thorough characterization of inorganic contamination in source area wells be completed. It is recommended that source area wells be sampled for both total and dissolved metals, total suspended solids, and total dissolved solids. This information will allow for design of an optimum inorganics treatment system.

In addition, it is also recommended that resampling of monitoring wells MW-1 and MW-6 be conducted to verify the presence of 2-butanone (MEK) prior to completion of the remedial design. This contaminant is extremely difficult to remove via treatment methods such as air stripping. If groundwater remediation is anticipated, significant cost savings could be realized if this contaminant is not truly present in site groundwater at the concentrations detected during the supplemental field investigation.

7.2.2 Remedial Action Objectives

The remedial investigation and risk assessment process demonstrated that the site does not pose a threat to potential receptors under existing site conditions. Therefore, the primary objective of any remedial action will be the restoration of the aquifer so that it will be suitable for development or the implementation of controls to prevent such development in the future. In addition, subsurface soils may also require remediation to levels sufficient to ensure that no further degradation of the aquifer occurs. Contaminant-specific cleanup goals which are necessary to attain these objectives will be presented in the Feasibility Study Report (Volume II).

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