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FEASIBILITY STUDY REPORT
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March 19, 1987
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Attention: Mr. David L. Cummings

FEASIBILITY STUDY REPORT
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

Gentlemen:

Woodward-Clyde Consultants (WCC) is pleased to present the enclosed Feasibility Study Report for the Batrouny Property portion of the Gibson site at Niagara Falls, New York. This report documents the methodology WCC utilized to develop and evaluate various alternatives for remediating the site.

Please contact us with any comments or questions you may have.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

James V. Husted, P.E.
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Enclosure

cc: Blaine Butaud - Olin
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FEASIBILITY STUDY REPORT
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

Submitted to:

OLIN CORPORATION

Charleston, Tennessee

March 1987

Prepared by:

WOODWARD-CLYDE CONSULTANTS

Plymouth Meeting, Pennsylvania

EXECUTIVE SUMMARY

In the fall of 1957, approximately 400 metal drums containing hexachlorobenzene (HCB) and 100 tons of alpha, beta hexachlorocyclohexane cake (BHC) from the Olin Niagara Falls Plant were disposed of on what is now the Batrouny Property portion of the Gibson Site (see Figure 1). These wastes were reportedly covered by Olin with topsoil. Other fill materials, including demolition rubble, flyash, and soil were placed over the wastes by others.

As shown on Figure 2, the Batrouny property portion of the Gibson Site (hereafter referred to as "site") is irregular in shape and occupies slightly more than 1 acre. The site is bounded on the north and east by the Cayuga Creek, a tributary of the Niagara River, on the west by Tuscarora Road, and on the south by a Niagara Mohawk Power Corporation right-of-way. An occupied single-family dwelling and detached garage are located in the western portion of the site.

For purposes of this feasibility study and in order to delineate boundaries of various remedial activity zones, the following are defined:

- Remediation zone - A portion of the site that includes previously documented (through chemical analysis) areas of BHC and/or HCB wastes or contamination on the site, as delineated on Figure 3. The remediation zone also encompasses most portions of the site and contiguous properties that may require encroachment in order to construct certain remedial components discussed in connection with this feasibility study.

- Monitoring zone - An additional area depicted on Figure 3 for possible future monitoring and remediation as may be required.

Reportedly, all wastes deposited at the site are in solid form, including the HCB contained in the drums. These BHC wastes were residues from Olin's manufacturing process which process produced a mixture of isomeric forms, including the alpha, beta, delta, and gamma isomers of BHC. The HCB was a by-product of a Terrachlor (pentachloronitrobenzene) manufacturing process. Production of these compounds was terminated in the mid-1950's.

Under "Plan A" of a Stipulation and Consent Judgement between Olin and the New York Department of Law, Olin engaged a consulting firm to perform a Remedial Investigation (RI) of the Gibson Site. An RI report dated July 31, 1986 summarized the geologic, hydrogeologic, and subsurface contamination conditions at the site. As part of the RI effort, numerous soil borings and monitoring wells (see Figure 2) were placed around the site. Results of the soil boring program revealed that the BHC cake (or soil contaminated with cake) occupies an area of approximately 1/2 acre, varies in thickness up to 6 feet and occupies a volume of approximately 8,500 cubic yards. The boring program also revealed that a stratum of red-brown clay forms a continuous aquiclude beneath the site at a depth of approximately 6 feet. Bedrock was reportedly encountered at a depth at approximately 25 feet.

Results of analytical testing conducted during the RI on 16 soil samples from borings and/or monitoring wells on the site show that only 7 samples had detectable levels of contamination and 3 of these samples were from the same boring (C-3). Samples from boring A-4 showed the greatest levels of BHC contamination (approximately 20 percent alpha-BHC). BHC was the only reported contaminant of concern detected in these samples, as summarized in Table 1.

Chemical analysis of groundwater samples collected from site wells during the RI indicate low concentrations of BHC as summarized in Table 2. The greatest single reported BHC concentration was 18.0 parts per billion (ppb) in a sample collected from well MW-6 on August 22, 1985. Based upon groundwater analyses conducted during the RI, BHC concentrations generally decreased from their initial higher levels during subsequent samplings.

Risk analyses conducted for the site as part of this Feasibility Study indicate that direct contact, airborne transport, and surface water transport represent potentially significant routes of exposure from the standpoint of human health and the environment. In general, the significant exposures are associated with conservative assumptions that assume the presence of highly contaminated material (up to 28 percent total BHCs) over the remediation zone. Much lower risks, within all known state and federal criteria, are associated with the currently understood level of contamination at the site surface, although direct contact still represents a potential concern under present conditions. This concern is because wastes are known to be very close to the surface in certain portions of the site.

The only known potential route of exposure to groundwater is via seepage of shallow groundwater to the Cayuga Creek. Based upon results of geotechnical testing performed during the RI, the clay layer aquitard beneath the site that prevents migration of contaminants to deeper water-bearing zones.

In considering potential risks associated with various remedial alternatives for the site, these risks were subdivided into short-term exposure risks and long-term exposures. In general, any remedial activity that disturbs the site surface or wastes within the site increases the potential short-term risk. However, if the waste materials are removed from the site, long-term risks associated with these waste materials would be reduced. These long-term risks would also be reduced to acceptable levels through application of appropriate site containment technologies.

Remedial actions that are considered appropriate for this site include placement of an impermeable cap over the remediation zone, a physical barrier circumscribing the remediation zone, and limited groundwater pumping and removal with off-site treatment. Remedial actions which involve excavation and removal of the waste materials from the site are not cost-effective and may cause significant short-term adverse environmental impacts at the site.

It is recommended that the site be remediated by rerouting the Cayuga Creek around and away from the existing site, installing a fully circumscribing soil-bentonite slurry wall barrier, installing a double flexible membrane liner cap with a perimeter collection drain system and develop an appropriate monitoring program. This recommended alternative (Alternative 3C) is estimated to have a total capital cost of $534,000, an annual operation and maintenance cost of $35,000 for the first five years after completion and $12,000 per year thereafter, and a total present worth cost of

$734,000. A major factor in determining the annual O&M cost will be the extent of monitoring requirements.

Implementation of Alternative 3C should effectively contain contaminants within the remediation zone and prevent their migration from the site into the environment. WCC believes remediation of the site can be accomplished in a most cost-effective and environmentally sound manner through implementation of Alternative 3C.

A Draft Feasibility Study Report was submitted by Olin for review by the New York State Department of Environmental Conservation (NYDEC) in November 1986. Comments on the Draft Feasibility Study Report were provided by the NYDEC in a letter dated January 16, 1987. These comments have been addressed and incorporated, where appropriate, into the Feasibility Study Report.

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1.0 INTRODUCTION

Various alternatives for managing subsurface contamination at the Batrouny property portion of the Gibson Site, located off Tuscarora Road near Niagara Falls Boulevard in Niagara Falls, New York are presented and evaluated in this Feasibility Study Report. The methodology to develop and evaluate various remedial alternatives is patterned after guidance documents provided by the United States Environmental Protection Agency (USEPA) on feasibility studies under CERCLA (USEPA, April 1985). The Feasibility Study Report has been prepared in accordance with "Plan A" (as modified) of the Stipulation and Consent Judgement between the State of New York and Olin Corporation, et al.

Woodward-Clyde Consultants (WCC) was authorized by Olin-Chemicals, a division of Olin Corporation (Olin), to prepare this Feasibility Study Report. WCC reviewed various reports and data generated by others and corresponded with Olin representatives during this study. The general format of this Feasibility Study Report is summarized as follows:

- Describe the site and define site problems and remedial objectives.
- Present, discuss, and screen potentially applicable technologies which could remediate the site problems.
- Develop remedial alternatives and evaluate their cost-effectiveness.
- Recommend a remedial alternative or alternatives.

1.1 SITE BACKGROUND INFORMATION

It is reported that a single disposal of approximately 400 metal drums containing hexachlorobenzene (HCB) and 100 truckloads of hexachlorocyclohexane cake (BHC) took place on what is now the Batrouny property portion of the Gibson site in the fall of 1957. The regional location plan is depicted on Figure 1.

As shown on Figure 2, the Batrouny property portion of the Gibson site (hereafter referred to as "site") is irregular in shape and occupies slightly more than 1 acre. The site is bounded on the north and east by the Cayuga Creek, a tributary of the Niagara River, on the west by Tuscarora Road, and on the south by a Niagara Mohawk Power Corporation right-of-way. An occupied single-family dwelling and detached garage are located in the western portion of the site.

Based upon available information, the BHC and HCB wastes, together with other fill material and demolition rubble, were utilized to fill a former swamp area that occupied approximately the eastern two-thirds of the Batrouny property. Wastes were apparently placed in close proximity to the Cayuga Creek and then covered with various amounts of soil. The south and west embankments of Cayuga Creek are protected to some degree with rip-rap consisting of random-sized pieces of broken concrete.

Wastes disposed at the site are reportedly all in solid form, including the HCB contained in the drums. The BHC cake is a white, fine-grained organic solid, generally appearing in a powder-like form.

The BHC manufacturing process produced a mixture of isomeric forms, including the alpha, beta, delta, and gamma isomers of BHC. This mixture (termed "alpha-beta cake") was processed further in order to upgrade the gamma isomer content and resulted in a waste material predominated by the other isomers. Olin ceased production of these compounds in the mid-1950s.

Reportedly, total waste quantities disposed at the site have been estimated at 90 tons of HCB (in the buried drums) and 100 tons of BHC (alpha-beta cake). Generalized locations of the buried materials are depicted on Figure 3. The extent of waste deposits at the site, as depicted on Figure 3, was generated through data reported in the Remedial Investigation Report (HLA, July 1986). Figure 3 shows that, based upon geophysical investigations conducted during the Remedial Investigation (RI), buried metal (reportedly the drums) is concentrated in the eastern portion of the site adjacent to the existing top-of-stream bank. Also from Figure 3, the extent of BHC cake waste is present in the site embankment along Cayuga Creek (primarily in the northeastern portion of the site) and, by visual observation during the field investigation of alleged cake material in the "Y" series borings that are located along the southern boundary of the site, just inside the Niagara Mohawk Power Corporation right-of-way. However, results of chemical analyses of samples collected from the 2- to 4-foot depth range in borings Y1, Y3, and Y4 indicated no detectable levels of BHC (HLA, July 1986).

For purposes of this Feasibility Study and in order to delineate boundaries of various remedial activity zones, the following are defined:

- REMEDIATION ZONE - A portion of the site that includes previously documented (through chemical analysis) areas of BHC and/or HCB wastes or contamination on the site. The remediation zone, as shown on Figure 3, encompasses most portions of the site and contiguous properties that may require encroachment in order to construct certain remedial components discussed in connection with this Feasibility Study.

- MONITORING ZONE - An additional area depicted on Figure 3 for possible future monitoring and remediation as may be required.

In accordance with the Stipulation and Consent Judgement (as modified), this Feasibility Study has been prepared to address remediation of the Batrouny property portion of the Gibson Site. In accordance with provisions of the Stipulation and Consent Judgement (as modified), the southern portion of the Gibson Site will be the subject of a supplemental investigation of contamination and an independent feasibility study. The investigation, and possible future remediation of off-site contamination will be the subject of subsequent "Plans" under the Consent Judgement.

1.2 SITE CONDITIONS

Site conditions and the nature and extent of contamination are described in the following sections.

1.2.1 PREVIOUS INVESTIGATIONS

On July 23, 1981, the New York State Department of Environmental Conservation (NYDEC) collected samples of soil from the site and samples of sediment and water from the adjacent Cayuga Creek. Chemical analyses performed on these samples indicated BHC contamination up to approximately 7.7 percent by weight in some soil samples collected from the Batrouny property. Approximately 12.6 parts per million (ppm) alpha-BHC were reported in a sediment sample collected from the site side (i.e., west side) of the Cayuga Creek about 50 feet upstream of the northern most Niagara Mohawk Power Corporation high-tension line. No detectable levels of alpha-BHC or any other BHC isomers were detected in the creek water samples.

The New York Department of Law (NYDOL) brought suit against Olin and the other Gibson Site property owners (New York v. Olin, Et Al., CIV 83-1400) in December 1983, in order to have the site investigated and remediated. In March 1985, Olin and the State of New York entered into a Stipulation and Consent Judgement that set forth a program for site specific study and remedial action.

Under "Plan A" of the Consent Judgement, Olin contracted with Harding Lawson Associates (HLA) in May 1985 to perform a Remedial Investigation (RI) of the Gibson Site. An RI Report dated July 31, 1986 was prepared by HLA for Olin Corporation pertaining to the Gibson Site. This report presented data and analyses resulting from a four-phase investigative program conducted between May 1985 and June 1986. Major conclusions drawn by the RI report include:

- Geophysical survey results indicated an area of approximately 2600 square feet where the majority of the buried drums are reportedly located (see Figure 3). From the soil boring program, the BHC cake (alpha-beta cake) was identified only to the north of the power line right-of-way (i.e., Batrouny Property) and was concentrated in the northeastern portion of the site. This alpha-beta cake (or soil contaminated with cake) occupies an area of approximately 27,400 square feet, varies in thickness from 0 to 6 feet and occupies a volume (including the associated overburden) estimated at 8500 cubic yards. The boring program also indicated that a stratum of red-brown clay forms a continuous aquiclude across the site which was generally encountered at a depth of about 6 feet. Bedrock was encountered during the soil boring program at a depth of approximately 25 feet.

- A groundwater table perched on the aquiclude was encountered at depths generally less than 5 feet across the site. The water table, as determined during the RI groundwater evaluation program, slopes towards the east and northeast toward Cayuga Creek.

- Air samples collected during RI drilling operations (HLA, July 1986) and analyzed chemically for BHC and HCB showed no detectable levels of these compounds. Similarly, organic vapor monitoring conducted during these drilling operations indicated vapor levels generally less than 2 ppm.

- Of the 16 soil samples selected for chemical analysis from borings and/or monitoring wells on the site, only 7 showed detectable levels of contamination and 3 of these samples were from the same boring (C-3). Boring A-4 samples showed the greatest levels of BHC contamination (20 percent alpha BHC). BHC was the only reported contaminant of concern detected in these samples, as summarized in Table 1.

- Chemical analysis of groundwater samples collected from site wells (MW-1, MW-5, MW-6, and MW-7) indicate low concentrations of BHC, as shown in Table 2. The greatest reported BHC concentration was 18.0 parts per billion (ppb) in a sample collected from MW-6 on August 22, 1985. Reported BHC concentrations generally decreased with time from their initial levels.

In order to evaluate the reported site conditions for the purpose of developing and evaluating remedial actions, WCC utilized data from selected borings (see Appendix A) to develop the site cross-section plan depicted on Figure 4. The indicated cross-sections are shown on Figures 5A through 5F.

In general, WCC agrees with the findings of these previous investigations. Conclusions developed in the RI report (HLA, July 1986) have been utilized by WCC in developing the remedial alternatives presented and evaluated in this Feasibility Study Report.

1.2.2 PHYSIOGRAPHY/LAND USE

The site is situated immediately adjacent to the Cayuga Creek and in the lower portion of the drainage basin, approximately 3000 feet upstream from the confluence of the Cayuga Creek with the Niagara River. The lower portion of the basin, known as the Huron Plain, exhibits very low gradients of less than 4 feet per mile. These gradients are attributable to the geologic history of the basin which at various times was inundated by glacial lakes. Reportedly, massive deposits of red-brown stiff to hard lacustrine clays blanket the area. The Cayuga Creek adjacent to the site flows through a channel cut into the regional clay deposits.

Topographic relief across the site is approximately 4 feet, from a maximum elevation of 574 feet in the extreme western portion of the site adjacent to Tuscarora Road to elevation 570 in the northeastern corner of the site (Top of stream bank adjacent to the Cayuga Creek). Overall site relief generally slopes slightly to the northeast.

The Cayuga Creek adjacent to the site is subject to daily fluctuations in water level caused by local power authorities. The reported average difference between the daily high and low levels at the creek mouth is about 0.94 feet (Erie and Niagara Counties Planning Board, 1975). Backwater effects of the Niagara River level variations reportedly affect stream levels approximately 1000 feet upstream of the Niagara Falls Boulevard bridge, which corresponds to the upstream corner of the site.

Adjacent land use consists primarily of commercial/residential development with small commercial businesses concentrated along Niagara Falls Boulevard. Single-family residences border Tuscarora Road to the west. To the south of the Niagara Mohawk Power Corporation right-of-way, is a used car business with access off Niagara Falls Boulevard.

Within the Niagara Mohawk Power Corporation right-of-way are aboveground, high-tension electric transmission lines. In addition to these utilities, there are four reported underground pipelines consisting of a 10-inch diameter brine line located along the approximate alignment indicated on Figure 2, a 20-inch water line situated to the south of the Niagara Mohawk Power Corporation right-of-way and two parallel, recently installed brine lines situated to the south of the 20-inch water line.

1.2.3 GEOLOGY/HYDROGEOLOGY

Fill at the site consists of industrial wastes (primarily BHC and HCB), demolition materials and miscellaneous debris. Fill thickness ranges between 6 and 9 feet, as reported by the boring logs of Appendix A.

The fill materials at the site were emplaced upon natural sediments, consisting of clays, sands, and silts. Alluvial deposits, mostly sand and silt, are generally poorly sorted, occur in isolated pockets, and range up to 2 feet thick across the site.

Beneath the fill and alluvial sediments is a stiff clay layer. This layer has been shown to be generally continuous throughout the site. The clay is apparently of glaciolacustrine origin, in which case, it would correlate with an extensive clay unit, locally varved, that overlies bedrock throughout the Niagara Falls area. Although most on-site borings did not penetrate through the clay, the few that did indicate the clay to be 10 to 14 feet thick beneath the Gibson Site. Beneath the glaciolacustrine clay are varied lenses of silty, gravelly sand, and/or clayey sandy silt ranging in thickness from about 3 to 7 feet. Beneath these lenses is bedrock, consisting of the Lockport Formation, a fractured dolomite underlain by shales and siltstones.

The shallowest water-bearing zone beneath the site consists of the fill and alluvial sediments above the clay. As an aquiclude impeding downward migration of groundwater, the clay is inferred to be effective, based on reported laboratory permeability measurements (approximately 10^{-8} cm/sec).

Groundwater in the fill zone is largely the result of infiltration and percolation of precipitation through the fill and immediately surrounding areas. Permeabilities in the fill area are moderate to low, reportedly averaging approximately 10^{-5} cm/sec. Lateral groundwater flow in the fill zone is towards Cayuga Creek, the local discharge point. The top of the clay unit, which supports the uppermost groundwater, crops out in places above the creek level. Accordingly, groundwater flowing along the clay surface either seeps out in the stream bank or otherwise migrates downgradient to contribute base flow to the creek. However, based on the limited saturated thickness and permeability data for the fill zone and the overall hydraulic gradient across the site, base flow contributions to Cayuga Creek from the fill are not significant (on the order of 20 gallons per day).

Beneath the clay, the second water-bearing zone is found in the bedrock. Groundwater occurs along vertical and horizontal fractures in the Lockport dolomite. At the Gibson Site, the top of the Lockport dolomite is reported to be 23 to 26 feet below grade. No site-specific data exist on the permeabilities, flow directions, or flow rates in the Lockport.

1.2.4 SOIL AND WATER CONTAMINATION

Previous studies have shown that the BHC contamination from wastes disposed at the Batrouny property portion of the Gibson Site have generally been limited to the unsaturated zone and the shallow water-bearing zone that overly the clay aquitard throughout the site. Analytical data generated from sampling and analyzing numerous soil borings (Table 1) situated in and around the site have indicated the following:

1. The major apparent contaminant associated with the wastes present in the fill at the site are isomeric forms of BHC.

2. These isomeric BHC forms (including alpha, beta, delta, and gamma) are present in varying concentrations ranging from less than detectable limit to a maximum reported value of 200,000 ppm (20 percent). HCB was not detected in any of the soil samples collected on the site.

3. Of the BHC isomers detected, alpha appears in the greatest concentration, while the others (beta, gamma, delta) appear in order of decreasing concentration.

4. Inorganic contaminants of concern (primarily mercury) in soil and groundwater samples from the site do not appear in concentrations significant enough to influence selection of remedial technologies or alternatives.

Four shallow groundwater monitoring wells situated in and around the site indicate the following, as summarized in Table 2:

1. Concentrations of BHC ranged from less than the detection limit to a maximum reported value of 18.0 parts per billion (ppb) of beta-BHC in MW-6 reported during the August 1985 sampling.

2. Concentrations of all isomeric forms of BHC reported have generally decreased with time during the evaluation period (August 1985 to June 1986).

3. Detectable levels of both alpha- and beta-BHC are reported in samples from monitoring well No. 1 which, according to the hydrogeologic data developed during the RI report, is located upgradient of the primary disposal area.

1.2.5 RISK ASSOCIATED WITH EXISTING SITE CONDITIONS

1.2.5.1 GENERAL

The assessment of risk for the existing site conditions considers the potential pathways of site contaminants in the environment, as well as the physical/chemical and toxicological properties of the contaminants. Contaminants considered in this assessment are hexachlorobenzene (HCB) and the various isomers of benzene hexachloride (BHC), also known as hexachlorocyclohexane, which represent the major contaminants known to be present at the site. Only BHC has been detected in environmental samples collected from the site to date. The HCB wastes are suspected to be contained in drums in the eastern portion of the site. No HCB contamination was detected in any soil samples; therefore, quantitative assessment of risk is limited to BHC.

1.2.5.2 CONTAMINANT PATHWAYS

Figure 6 illustrates the major potential pathways for contaminants at the site, including the sources, pathways, and potential receptors. The primary sources of contaminants are wastes deposited at the site and the contaminated soils. Four general exposure routes are considered:

- Direct contact
- Airborne
- Surface water
- Groundwater

Details of the assessment of risk for the no-action alternative (i.e., existing conditions) are presented in Appendix B. Analyses of risk were performed for both lower limit and upper limit conditions. The lower limit case assumed a total BHC concentration of 18 ppm across the surface of the site based on available analytical results of surface samples. The upper limit case assumed surface soils were contaminated to 28 percent total BHCs, the highest level of contamination observed in BHC cake at the site. For purposes of this Feasibility Study, the risks associated with existing site conditions were evaluated under the conservative assumption that the lower limit and/or upper limit BHC concentrations are uniform across the entire remediation zone. This range of values was used to bracket the potential risks posed by the site.

Both BHC and HCB have low aqueous solubilities and vapor pressures, and thus have relatively low mobility in the environment. Toxicity of these compounds has only been studied for the oral exposure route. Inhalation and dermal contact toxicity have not been studied, although BHC is known to be absorbed through the skin. Both compounds are considered potential carcinogens by USEPA, based primarily on animal data rather than human exposures.

Direct contact with soils is expected to be limited to residents or visitors to the site. Although the risk associated with dermal exposure cannot be quantified, significant potential exposures to BHC via dermal contact were estimated for both lower limit and upper limit conditions. These possible dermal exposures are only significant when compared to equivalent oral exposures at a 10^{-5} risk of cancer.

Airborne exposure may occur through volatilization of contaminants, or by airborne transport of contaminated soil or waste particulates (fugitive dust). Potential airborne exposures could impact nearby residents. Because there are no airborne toxicity data for site contaminants, the risks associated with the airborne route cannot be accurately quantified. All projected airborne BHC concentrations were below the TLV for gamma-BHC (lindane-500mg/m^3 for skin exposure). Lindane is currently the only isomer of BHC for which a TLV value has been established. Projected lower limit concentrations do not appear to be significant (less than 0.001 mg/m^3). However, projected long-term upper limit exposures are significant when compared to oral exposures associated with a 10^{-5} lifetime cancer risk.

Surface water exposures may occur from transport of contaminated particulates in surface runoff from the site into Cayuga Creek. Seepage of groundwater may also carry contaminants to the creek. Because Cayuga Creek discharges to the

Niagara River, affected populations could potentially include aquatic resources in Cayuga Creek or the Niagara River and any people contacting these water bodies. Contact could occur by skin contact and/or ingesting water or aquatic biota. Projected lower limit concentrations of BHC in Cayuga Creek were below applicable criteria for protection of human health and aquatic effects. Projected upper limit concentrations exceed criteria for protection of human health, which assume ingestion of water. Cayuga Creek, however, is not currently used as or classified for drinking water supply. Projected upper limit concentrations of BHC also exceed the NYDEC criterion for protection of aquatic life, although they do not exceed USEPA criteria.

The only known potential route of exposure to groundwater contaminants is via seepage of shallow groundwater to Cayuga Creek. It is currently assumed that the clay aquitard beneath the site prevents migration of contaminants to deeper water-bearing zones.

1.2.6 SUMMARY OF RISKS AND SITE PROBLEMS

In summary, direct contact, airborne transport, and surface water transport represent potential significant routes of exposures from the standpoint of human health and the environment. In general, the significant exposures are associated with the upper limit projections, which assume the presence of highly contaminated material (i.e., 28 percent total BHCs) at the site. Much lower risks are associated with low-level contamination at the surface, although direct contact represents a potential concern even under the lower limit (18 ppm) assumptions.

Based upon results of reported previous site investigations and WCC's evaluation of data presented in the RI Report (HLA July 1986), the following site problems have been identified:

1. Groundwater possibly contaminated with various isomeric forms of BHC seeps into Cayuga Creek.

2. A seasonal high water table results in direct contact between wastes and the shallow perched groundwater table in the site.

3. Precipitation infiltrates and percolates through the site to generate the majority of the shallow perched groundwater table, subsequently forming the seepage which enters Cayuga Creek.

4. The shallow perched groundwater beneath the site is contaminated with low levels of BHC (alpha, beta, gamma, and delta isomers).

5. Soil and wastes contained within the site are contaminated with BHC isomers; HCB also is known to have been disposed at the site.

6. The significant routes of exposure associated with existing site conditions are direct contact, airborne transport, and surface water transport.

7. Under the lower limit case, which assumed (conservatively) a total BHC concentration of 18 ppm across the site surface, low risks are associated with all routes of exposure except direct contact. As explained in the Risk Assessment of Appendix B (Assessment of Potential Risks), risks associated with the direct contact exposure route were assessed on the basis of an individual disturbing the site surface through digging or planting with no level of personal protection (i.e., gloves or other protective clothing).

8. Significant exposures are associated with the assumed upper limit concentrations (28 percent total BHC over the site surface) for all routes of exposure. Such conditions could exist only during major site disturbance conditions such as excavation.

1.3 REMEDIAL ACTION OBJECTIVES

Objectives of any remedial actions taken at the site must address the site problems defined in the previous section. Ideally, the appropriate remedial action would eliminate or minimize all problems that have been defined. However, even the most aggressive application of all appropriate remedial response actions may not completely eliminate all problems defined at the site.

General objectives of remedial activities at the site would entail actions that control, minimize, or eliminate the migration of contaminants (specifically, the BHC isomeric forms) from the site. Specific remedial activity goals include:

1. Minimize the amount of precipitation which infiltrates and subsequently percolates through the site and subsequently discharges to the Cayuga Creek.

2. Control the water table condition which causes direct contact between the wastes contained at the site and the shallow groundwater table.

3. Mitigate contaminant migration from the site through remedial actions consisting of either containment technologies or removal technologies.

General remedial response actions and their related technologies are presented in Table 3 as they apply to the site. Table 3 represents the initial consideration of remedial technologies that may be appropriate for the site.

Certain remedial technologies may address one or more of the specific remedial activity goals listed above. Figure 7 compares general remedial technology categories to the specific site problems listed previously and describes whether a remedial technology category is applicable to a site problem.

As implied by Figure 7, most of the defined site problems may be remediated through a combination of surface water controls and leachate and/or groundwater controls. Most of the other remedial technology categories, with the exception of waste and soil excavation and removal or in situ treatment, are classified as only partially applicable (or not applicable in some cases) to remediating the site problems.

2.0 SCREENING REMEDIAL ACTION TECHNOLOGIES

2.1 GENERAL

Specific technologies from each category depicted on Figure 7 that have the potential to remediate specific site problems are presented and evaluated in this section. These technologies are then subjected to a screening process to identify the most appropriate remedial action technologies. Remedial action technologies that are chosen as most appropriate are considered for synthesis of remedial alternatives. Technologies are screened on a technical basis to determine their appropriateness for addressing the site problems.

A comprehensive list of remedial technologies established by the USEPA (USEPA, October 1985) was utilized to determine the potentially feasible technologies within each remedial technology category depicted on Figure 7. These technologies are listed in Table 4. The potentially feasible technologies listed in Table 4 were selected from the comprehensive USEPA list based upon engineering judgment of their appropriateness for solving the site problems indicated on Figure 7.

Each potentially feasible technology was then subjected to a technical screening process, as summarized in Table 5. Each potentially feasible technology is evaluated in Table 5 for its general compatibility with both site conditions and waste characteristics, and any technological factors that would limit a potentially feasible technology's effectiveness as a remedial action.

Based upon the technology screening process developed in Table 5, the most feasible technologies for application at the site are summarized in Table 6. These technologies and their specific application to the site are described below.

2.2 CAPPING

The primary purpose for placing a cap over the site is to prevent infiltration and percolation of precipitation through the fill and wastes contained within the site. Precipitation entering the site leads to the formation of a perched water table condition within the wastes contained in the site, with subsequent migration of this potentially contaminated water into the adjacent Cayuga Creek. A secondary purpose for capping the site is to prevent direct contact with waste materials and to control the possible airborne migration of waste compounds from the site.

Of the numerous capping technologies considered, the use of a double flexible membrane liner (FML), such as high-density polyethylene (HDPE), with a soil and vegetative protective cover appears most appropriate for application to the site. Figure 8 shows a typical cap section and anchor trench detail for the double FML cap system. The cap itself would consist of a subgrade material (crushed stone or sand/gravel mixture), which would be placed directly on the existing vegetative surface at the site to serve as a clean base for equipment operation. This subgrade would also be graded for the required cap slope. Other key features of the double FML membrane cap include a non-woven needle-punched polypropylene geotextile for gas venting, sand bedding layers that act as protective cushions for the two FML materials, and a coarse sand drainage layer above the upper FML to provide lateral drainage of precipitation. This drainage layer would be separated from the upper 1 foot of topsoil by a geotextile membrane that would permit vertical drainage of precipitation while keeping the topsoil and coarse sand effectively separated. A suitable grass species would be established on the topsoil. Total cap thickness would be approximately 3.5 feet over the entire existing site.

Major considerations for choosing the dual FML-soil cover technology include:

- <u>Aesthetics</u> - The FML-soil cover cap, while it would raise the elevation of the existing site approximately 3.5 feet, it would provide a uniform vegetated surface which is compatible with existing site conditions.

- Effectiveness - The dual FML cap design is superior to the other capping technologies considered in that the overall permeability of the structure is much lower than any of the other technologies.

- Maintenance - The FML-soil cover cap would be essentially maintenance-free, with the exception of mowing and occasional repair of the soil protective layer from erosion, while other caps such as asphalt (bituminous concrete) and/or concrete would require significant periodic maintenance.

- The use of an FML Cap would effectively minimize both airborne migration of contaminants and infiltration/percolation of precipitation, which would reduce the potential for surface water contact by limiting seepage.

2.3 CONTAINMENT BARRIERS

The primary objective of barrier wall technologies is to minimize both the amount of horizontal groundwater movement into the site and the amount of perched groundwater leaving the site into Cayuga Creek. A soil-bentonite slurry wall or a combination slurry wall/FML barrier appear to be the most appropriate containment barrier technologies for the site. On the stream side of the site, a support structure such as galvanized steel sheet piling or a concrete retaining wall with a FML barrier would prevent migration of site groundwater. The FML barrier could also be integrated into the FML cap to provide complete encapsulation of the wastes.

A soil-bentonite slurry wall that would surround the site on the south and west sides appears to be the most appropriate containment barrier technology for those areas. The slurry wall would be installed to an average depth of 10 to 12 feet. The slurry wall would be approximately 3 feet wide and would key a minimum of 3 feet into the clay aquiclude. Connection between the slurry wall and the FML barrier would then be made on the stream side. Material from the trench may be suitable for use in the backfill, which would have to be determined by laboratory testing. For the purposes of this Feasibility Study, it is assumed that backfill would have to be imported. The slurry wall could also circumscribe the site as part of the stream rerouting option described later in this section.

A downgradient (along the two creek sides of the site) perimeter collection drain system should be incorporated into the barrier wall design as shown on Figures 9A, 9B, and 9C. This perimeter collection drain system (hereafter referred to as "toe drain") would serve two functions:

- o Relieve hydrostatic pressure on the back side of the containment barrier;
- o Collect water from within the containment area and route this water to a sump which would be pumped as needed. This would act to depress the shallow perched water table within the containment area and eliminate the perched water-waste contact which presently exists within the site. Water withdrawn from this toe drain system would be removed for off-site treatment.

2.4 SURFACE WATER CONTROLS

From Table 6, three surface water control technologies appear most feasible for application at the site. These are:

- o Capping
- o Dikes
- o Stream rerouting

Capping has been discussed previously in Section 2.2.

Construction of dikes would take place in connection with a stream rerouting option. Relocating the Cayuga Creek channel from its present position, to a channelized alignment located just east (i.e., away from the site) of its existing location appears feasible. This relocation would serve two major functions:

- o Construction procedures for placement of a barrier wall along the creek sides of the site would be simplified.
- o The potential surface water contaminant pathway would be moved farther from the site.

2.5 EXCAVATION/REMOVAL OF WASTE AND SOIL

Excavation of fill and waste within the site is feasible, but would be complicated by the limited work area, the need for adequate flood protection from Cayuga Creek, and the saturated nature of the fill. The excavation process represents an intermediate material handling technology that would vary, depending upon the handling requirements of subsequent disposal technologies. For instance, on-site excavation for subsequent transport and disposal at a commercial hazardous waste incineration facility would require the material be placed in fiber drums and transported to the disposal facility in this containerized form. However, if the excavated material is to be disposed at a dedicated waste incineration facility or at a hazardous waste landfill, it could be loaded out in bulk.

Because the fill/waste is saturated as a result of a perched water table, excavation below this water table and above the clay aquitard would require the material be dewatered somewhat before it was transported off-site. Various methods for accomplishing this dewatering could include the importation of a drying agent, such as flyash, which could be mixed with the waste material in order to lower its moisture content for acceptable transportation. On-site dewatering by gravity drainage of the water from the saturated fill/waste material is another possible technology for use in conjunction with the excavation process. This method could involve the excavation of trenches across the site where the perched groundwater would collect and be removed from the site for treatment off-site. An upgradient drain would also have to be constructed to prevent incoming groundwater from entering the work zone. Another method of drying could involve excavating the material and placing it in an area that uses drainage beds and trenches to collect the water for treatment off-site. This would involve double-handling the contaminated material and would require an area that would be dedicated to drying only.

2.6 THERMAL DESTRUCTION

Both HCB and BHC are thermally stable, chlorine-substituted cyclic aromatic and aliphatic compounds, respectively, with low heats of combustion. Incineration and thermal destruction by pyrolysis are the preferred disposal methods in EPA's Toxic Chemical Status Assessment Reports on HCB and BHC (USEPA, December 1979 and April 1980). These compounds have been destroyed at efficiencies greater than 99.99 percent in both full- and pilot-scale incinerator tests and in laboratory thermal destruction units (USEPA October 1984). For complete destruction, an incineration temperature of approximately 880°C (1600°F) is required for a two-second residence time. This heat level must be maintained primarily by auxiliary fuel in the combustion unit because the heat value of the waste, depending upon its moisture content, will only be approximately 2000 BTUs per pound.

Both the pure product HCB in the buried drums and the estimated 8500 cubic yards of mixed soil and BHC cake are amenable to disposal by incineration. From an engineering standpoint, on-site incineration would be advantageous because it would reduce handling of the materials prior to thermal destruction. However, the physical constraints of the site and of the distribution of the buried materials within the site, which is located in a residential/commercial area, eliminates this possibility from consideration.

Accordingly, off-site incineration options include:

- o Processing through a commercial hazardous waste incinerator

- o Processing through a dedicated semiportable incineration unit located at a nearby industrial area.

2.6.1 COMMERCIAL OFF-SITE HAZARDOUS WASTE INCINERATION

Disposal of the wastes from the site through a commercial hazardous waste incineration facility would require packaging the waste materials in fiber drums and transporting these drums to the incineration facility for processing. At this writing, no commercial incinerators have bulk solid waste handling capabilities.

Commercial rotary kiln incinerators closest to the site include the Robert Ross incinerator in Grafton, Ohio (near Cleveland) and the Rollins Incinerator near Bridgeport, New Jersey. These commercial incineration facilities could accept and process wastes from the site.

However, commercial incineration would require a lengthy time period (up to 8 years or more) to process the wastes due in part to the changing rate of incinerator availability which characterizes the commercial incineration market in 1980s. Because of the high chlorine content (up to 75 percent) of the waste materials from the site and high ash content of the majority of the waste materials, commercial fees for incineration would be high: on the order of $400.00 per fiber drum for the mixed waste and $700.00 per fiber drum for the HCB waste. For purposes of this Feasibility Study, and based upon waste characteristics, the commercial incinerator acceptance rate was estimated at 80 fiber drums per week.

2.6.2 DEDICATED OFF-SITE INCINERATION

This technology would involve installing a modular incineration unit dedicated to handling only wastes from the site at an appropriate location near the site. Typically, these incineration units are positioned on a site and then peripheral utilities, such as electric power, water, auxiliary fuel supply are connected. Material handling/loading equipment for the incinerator is typically emplaced under contractual arrangements. Air emission discharge permitting would be required and the permitting process could take 12 to 18 months.

Various modular incineration technologies are suitable for treatment of the solid materials from the site. All of these units would require air pollution control devices capable of handling the high chlorine content (approximately 0.77 pound HCl per pound of pure BHC/HCB burned) of the off-gases. These units include:

- <u>Fluidized-bed incinerator</u> - Wastes are incinerated in or on a bed medium of sand or other material fluidized by combustion air blown upward through the bed. Combustion initiated in the bed is completed in the overhead section of the vertically oriented reactor vessel. The high heat content of the bed materials allow stable burning of low or variable heat value materials. Efficient off-gas scrubbing equipment is required.

- <u>Rotator kiln incinerator</u> - Wastes are fired in a slowly rotated horizontally inclined, refractory-lined, cylindrical chamber. Waste materials are repeatedly lifted and tumbled as they progress through the kiln. A secondary chamber provides gas mixing, excess oxygen, and the required residence time to complete combustion. These units require very efficient off-gas scrubbing equipment.

- <u>Circulating-bed combustor</u> - Waste is fed into a vertical fluidized circulating bed reactor which is entirely enclosed. The reactor uses high turbulence and variable bed media velocity to destroy organic constituents at much lower temperatures than other incinerator technologies. This unit is particularly applicable to wastes consisting of fine solids, sludges, and/or liquids. Generally, gas scrubbing equipment requirements are less stringent with this type unit than with the other incinerator technologies.

- o <u>Fixed-hearth incinerator</u> - This incinerator design adds a moving furnace floor feature to the standard dual-chamber fixed-hearth incinerator. No mechanical parts are exposed to burning materials or hot gases and the unit continuously distributes the wastes and moves ash residue towards the ash collection pit. Efficient off-gas scrubbing equipment is required.

All four of the incineration technologies described are proven, available technologies which meet or exceed regulatory requirements for destruction efficiency and air emissions. These systems are generally available in units with waste feed rates varying from 1.5 to 3.0 tons per hour; which means that the waste material from the site could be processed within one year from start of the unit, assuming feed can be produced at an equivalent rate and/or a storage area is available.

2.7 OFF-SITE DISPOSAL

Other potentially feasible off-site disposal technologies for wastes at the site include commercial hazardous waste landfills and off-site water treatment facilities.

2.7.1 LANDFILL DISPOSAL

At this writing, the two authorized hazardous waste landfills in New York State (SCA Services, Inc. and CECOS, both in Niagara Falls) are subject to NYDEC permit conditions which prohibit their accepting solid wastes contaminated with greater than 2 percent hazardous organics. This permit condition has been in effect since April 1986 and will probably remain in effect for an undeterminable period of time (personal communication between J. Husted of WCC and C. Vanguilder of NYDEC, October 1986). Although a variance may be obtained from the landfill ban, operators of the landfills listed above have indicated they have established a policy not to accept such wastes.

Because much of the waste materials at the site contain greater than 2 percent hazardous organics (up to 28 percent total BHC), disposal of these materials in landfills within the state of New York is, at this writing, prohibited. Accordingly, commercial hazardous waste landfills outside the State of New York are considered for this technology. Two facilities have given preliminary indication that they could accept the waste materials:

- o Fondessy Enterprises secure chemical landfill near Oregon, Ohio;
- o A secure hazardous waste landfill operated by CECOS International in Ohio.

2.7.2 OFF-SITE WATER TREATMENT

Other off-site disposal requirements include the treatment of water collected from the downgradient toe drain system which would be installed with the technologies involving the installation of permanent barrier walls.

Flow into the toe drain system would decrease with time (from an estimated initial maximum of 7300 gallons per year) as the water table elevation within the containment barrier walls gradually decreases. Because the site would be surrounded by a perimeter barrier wall, groundwater flow to Cayuga Creek (estimated at 20 gallons per day or 7300 gallons per year under the existing, uncontrolled conditions), would be eliminated. This water would be hauled by a tank trailer truck to the CECOS International facility in Niagara Falls for treatment. Acceptability of this mode of treatment would depend upon the concentrations of BHC and/or HCB in the water to be treated.

Other water that would require off-site treatment is that which would be generated during on-site dewatering operations for the excavation of the contaminated site soils (and subsequent off-site disposal/treatment). This would be a short-term disposal (i.e., one-year or less) and is estimated to be approximately 100,000 gallons during the excavation process. For purposes of this Feasibility Study, it was assumed that this water could be transported by tank truck to the CECOS International facility in Niagara Falls for treatment.

2.8 TECHNOLOGY SCREENING SUMMARY

2.8.1 MOST FEASIBLE TECHNOLOGIES

The remedial technologies summarized in Table 6 were considered to be most feasible for subsequent incorporation into complete remedial alternatives for the following reasons:

- **Capping:** A double FML was chosen as the most feasible capping technology for purposes of eliminating infiltration/percolation of precipitation into and through the soil and waste in the site. The other capping technologies considered have significant limitations such as excessive permeability and compaction quality assurance/quality control (QA/QC) requirements that make them less technically desirable than the double FML liner. The double FML liner would provide a high degree of assurance that the cap would be impermeable.

- **Containment Barriers:** Of the containment barriers, a soil-bentonite slurry wall either on the east and south sides of the site or circumscribing the site appears to be the most feasible barrier. The average depth to the clay aquiclude is about 10 feet and site conditions should be compatible with the soil-bentonite slurry wall technology. The low permeability of the slurry wall (i.e., less than 10^{-7}) would minimize groundwater movement across the site.

On the east and north sides along Cayuga Creek, an FML barrier supported by either permanent galvanized steel sheet piling or a concrete retaining wall appear to be the most feasible technologies, along with the circumscribing slurry wall. They would both provide adequate support for the FML barrier and both could be tied into the slurry wall for containment barrier continuity around the entire site. As an alternative to the FML, clay could be compacted against either the sheet piling or the concrete wall to form the required impermeable barrier. These barrier technologies would include a toe drain along the entire length of the structure to relieve hydraulic pressure and to provide a means for removal of possibly contaminated groundwater from inside the barriers.

- **Surface Water Controls:** The most feasible technologies for surface water controls are believed to be capping, stream relocation, and dikes constructed in the existing stream. Capping has been described previously and stream relocation and dike construction are parts of an overall surface water control strategy. Stream relocation would remove one of the pathways of off-site migration - Cayuga Creek - from contact with the waste, and would facilitate construction of the containment barrier in the existing creek bed. The most feasible containment barrier in the existing stream bed for the stream relocation option is believed to be continuing the slurry wall after the existing streambed has been backfilled. The circumscribing slurry wall would complete the encapsulation of the waste, preventing groundwater movement both into and out of the site. A toe drain would be constructed inside the slurry wall prior to backfilling to provide a means of removing the encapsulated groundwater.

- **Excavation/Removal of Waste and Soil:** As described previously, excavation of the site wastes and contaminated soil is a feasible technology that could be implemented at the site. Excavation would be complicated by the saturated condition of the site fill materials below depths of 4 to 5 feet. Because waste materials would be exposed during excavation, an elevated level of personnel protection would be required to protect against direct contact with the wastes.

- **Thermal Destruction:** Of the thermal destruction technologies evaluated, either incineration at an off-site commercial hazardous waste facility or processing through a dedicated off-site circulating-bed combustor unit appear most feasible. The circulating-bed combustor technology was selected because of its generally superior ability to handle fine-grained organic materials with lower combustion temperatures and less emission control equipment requirements than the other incinerator technologies considered.

- **Off-Site Disposal:** Disposal of soil and waste materials off-site would involve use of an authorized commercial chemical waste landfill outside the State of New York. Because much of the solid material within the remediation zone contains greater than 2 percent hazardous organic constituents, it cannot be disposed at chemical waste landfills within New York State. This is in accordance with the New York State program for the phased reduction of the land burial of hazardous organic wastes after March 31, 1986. Accordingly, chemical waste landfills in Ohio would probably be the closest available facilities.

  Off-site disposal/treatment of water from the site could be done through the industrial wastewater treatment facility operated by CECOS International at Niagara Falls.

2.8.2 REJECTED TECHNOLOGIES

Certain potentially feasible technologies were eliminated from further consideration for the general reasons described in Table 5. Major technology groups, including in situ treatment and solidification/stabilization were screened out for the following reasons:

- **In Situ Treatment** - Major technologies in this group include in situ bioreclamation and chemical treatment. Neither bioreclamation nor chemical treatment were considered feasible for application at the site because the fill permeability is too low to allow permeation of the material by a microbiological or chemical agent within a reasonable time period. Bioreclamation was not considered feasible because the material

(BHC) is essentially a pesticide residue and is highly resistant to biodegradation. Chemical treatment technologies (oxidation, reduction, hydrolysis, and polymerization) were not considered feasible because they are generally unproven on a full-scale basis. In addition, any in situ chemical reactions must be closely controlled to prevent release of toxic gases (chlorine) from the site.

- **Solidification/Stabilization** - Because of the low water solubility of the BHC and HCB within the site, solidification and/or stabilization technologies are generally unnecessary to prevent migration of these compounds from the site in the groundwater. Variations in waste concentration and in the permeability of the waste-soil matrix over the site would make uniform application of solidifying/stabilizing agents for in situ treatment difficult.

  Solidification/stabilization technologies that require excavation and mixing of the wastes would not decrease appreciably the environmental mobility of the BHC/HCB. This would apply whether the solidified/stabilized wastes were placed back in the on-site excavation or land-disposed at a secure landfill off-site.

- **Detoxification** - Various emerging technologies that could possibly detoxify the BHC/HCB wastes were investigated. However, none of these technologies have been applied to BHC/HCB wastes nor have they been used or proven on a full-scale basis.

3.0 REMEDIAL ACTION ALTERNATIVES

3.1 DESCRIPTION OF ALTERNATIVES

Complete remedial alternatives are synthesized and described in this section. The most feasible technologies from Table 6 are combined into complete alternatives for subsequent detailed evaluation. While many permutations of the feasible technologies listed in Table 6 may be developed, those believed to be the most appropriate (and possibly cost-effective) are listed in Table 7. The remedial alternatives are classified into three primary groups:

- No Action
- Source removal actions
- Source containment actions

3.1.1 NO ACTION

ALTERNATIVE 1 - MONITOR ONLY: The no-action alternative would involve no physical remedial activities, and only the existing quarterly groundwater monitoring program would continue. For the purposes of this Feasibility Study, a 30-year time period was considered in accordance with general RCRA post-closure requirements. This alternative is considered not acceptable because it does not adequately control possible migration of contaminants from the site, but will be used later in this study for the purposes of comparison.

3.1.2 SOURCE REMOVAL ACTIONS

The three alternatives described below involve excavation and removal of the contamination source from the site for disposal. Two incineration options are considered along with a landfill disposal alternative.

A schematic plan view of the site for the three source removal alternatives (as completed) is shown on Figure 10 and a typical section is shown on Figure 11. All construction work would have to be done in a elevated level of protection, which slows the progress of work. Measures would have to be taken to minimize dust migration, such as wetting the excavation area with a fine mist during excavation for each alternative. Excavation and dewatering would proceed as described in Section 2.5

for each alternative. Backfilling would commence soon after excavation was completed, with a buffer zone established between the two operations. Backfill would consist of common fill. Once a section is backfilled to grade, topsoil would be placed and the area seeded. Because the contaminant source would be removed, post-closure monitoring would be done for a relatively short period (5 years was assumed for purposes of this Feasibility Study) after completion of closure.

ALTERNATIVE 2A - EXCAVATE AND INCINERATE COMMERCIALLY: This alternative involves excavation of the contaminated material and loading it into fiber drums for shipment to a commercial hazardous waste incineration facility. The excavation rate would be limited by the handling problems associated with placing the material in fiber drums. Dewatering of the excavated area would take place prior to backfilling so that the backfill can be placed and properly compacted.

ALTERNATIVE 2B - EXCAVATE AND DEDICATED INCINERATOR: This alternative would involve excavation of the site wastes with bulk load-out and hauling to an off-site dedicated incinerator that would be set up at some nearby location. Establishment of a dedicated incinerator would involve land acquisition, air emissions permitting, and disposal of ash residues, as described in Section 2.7.2. The excavation could proceed at a faster pace than Alternative 2A because the material could be loaded out in bulk, with dewatering taking place prior to backfilling as described for Alternative 2A. Monitoring requirements would be similar to those described for Alternative 2A.

ALTERNATIVE 2C - EXCAVATE AND COMMERCIALLY LANDFILL: This alternative would involve excavation of the material and bulk load-out and transport of the material to a commercial landfill. Dewatering would be necessary before excavation in the saturated zone could proceed. This dewatering could involve the excavation of an upgradient drain to intercept non-contaminated groundwater. The drain could be placed outside the contaminated area on both the south and east sides of the site. Diverted groundwater could probably be released into Cayuga Creek. Dewatering is necessary because there can be no "free liquid" in any solid disposed in a hazardous waste landfill. The excavated soil and wastes would then be transported by tractor-trailer for disposal in a landfill (Section 2.7.3).

3.1.3 SOURCE CONTAINMENT ACTIONS

Alternatives described in this section involve containment of site contaminants using the FML cap/barrier and slurry wall technologies. Implementation of the source containment alternatives would involve construction in and eventual filling of part or all of the existing channel of Cayuga Creek adjacent to the site. Before any work in the stream channel could commence, various federal, state, and possibly local permits would be required. Permitting could take approximately 6 to 18 months, depending on the permit requirements. Strict permitting requirements are in place under state and federal laws for altering the channel or filling of watercourses, or creating any obstruction in navigable waters. These requirements are established by the New York Environmental Conservation Law (ECL) Article 15 Title 5, Section 404 of the Federal Water Pollution Control Act and Section 10 of the River and Harbor Act of 1899. Both the NYDEC and U.S. Army Corps of Engineers review permit applications. In addition, applications for state and federal permits would trigger requirements of the New York State Environmental Quality Review Act and the National Environmental Policy Act. These statutes and their implementing regulations may require preparation of environmental impact statements (EIS) for actions which may significantly affect the environment. If an EIS is required, completion and approval of the EIS could take 12 to 15 months.

For all of the source containment alternatives, a toe drain would be placed as shown on Figures 9A through 9C, with an access manhole and sump placed in the southeast corner, as shown on Figure 12. The sump would have to be pumped periodically. Monitoring after the containment is completed is estimated to be quarterly for the first 5 years and then annually for the remainder of the post-closure monitoring period (assumed to be 30 years after completion).

ALTERNATIVE 3A - SHEET PILING AND FML BARRIER/CAP WITH SLURRY WALL: This alternative involves the integration of permanent galvanized steel sheet piling backed with an FML keyed into the clay aquiclude on the north and east sides of the site, with a slurry wall placed on the south and west sides, as shown schematically on Figure 12. A cross section of the permanent sheet piling conceptual design is shown on Figure 9A and a typical section of the completed containment is shown schematically on Figure 13. The double-layered FML cap, as described in Section 2.4, would cover the entire site and be tied into the FML barrier that is supported by the permanent galvanized steel sheet piling.

ALTERNATIVE 3B - CONCRETE RETAINING WALL AND FML BARRIER/CAP WITH SLURRY WALL: As shown on Figure 9B, this alternative is essentially identical to Alternative 3A, with the exception that the FML barrier is supported by a concrete retaining wall instead of permanent sheet piling. Figure 14 shows a schematic plan view of the alternative and Figure 15 shows a typical completed site cross-section.

ALTERNATIVE 3C - REROUTE CREEK WITH CIRCUMSCRIBING SLURRY WALL AND FML CAP: This alternative involves rerouting Cayuga Creek by removing the meander in the creek to the north of the site and rejoining the existing creek channel, as shown schematically on Figure 16. This rerouting would involve obtaining permission to relocate the new creek channel on the property plus the permitting that is described above. The channel would be excavated so that the volume of the stream would not diminish, and the channel would be rip-rapped for slope protection. The existing stream channel would be diked when the new channel is completed, with the trapped water pumped out. When the old stream channel is dried out, the sediments would be pulled back from the middle of the channel so that structural fill can be placed in the old stream bed, along with the downgradient toe drain. Then, fill would be placed and compacted in the old stream channel until the site grade has been reached. A typical section of the rerouted stream and the existing creek bed is shown on Figure 17. After backfilling, the slurry wall can be constructed, as shown on the conceptual design section shown on Figure 9C.

4.0 ALTERNATIVES ANALYSIS

4.1 PRELIMINARY ANALYSIS

Each remedial alternative is subjected to a preliminary screening process and other evaluations in this section of the report. Table 8 presents a preliminary alternative screening matrix that subjectively describes the environmental and/or public health factors associated with each alternative. From Table 8, Alternative 1 (no action, monitor only) does not provide the necessary degree of source control to be considered further. The lack of source control would manifest itself in continued contact between the waste and the shallow groundwater which discharges into Cayuga Creek, and the potential for off-site migration of possibly contaminated dust would not be reduced. Alternatives 2B, 2C, 3A, 3B, and 3C appear to effectively control the contamination sources within the site. These alternatives appear to satisfy the objective of the remediation effort, which is to control the sources of contamination within the site, and therefore warrant further consideration. These alternatives will be carried through for more detailed analysis.

Preliminary costs, including capital cost, annual operation and maintenance (O&M) costs, and a preliminary calculation of present worth are also presented for each alternative. The no action alternative is carried over for purposes of comparison.

Cost factors listed in Table 8 are preliminary and should only be used in the context of the preliminary alternatives screening process. Capital costs represent those associated with the design, implementation, and construction of the items connected with each alternative. Alternatives 2A and 2B have the greatest capital cost, due to the high cost of incineration, with Alternative 2A 5 million dollars greater than Alternative 2B.

Annual O&M costs involve those costs which can be expected to be incurred on an annual basis in order to operate and maintain each alternative. The current annual cost for quarterly analysis is estimated at $25,000, which was used as a basis for determining the annual cost for monitoring. In addition to sampling, maintenance of the vegetative cover will be included in the O&M costs for each alternative. The source containment alternatives (3A, 3B, and 3C) include a cost for removal and treatment of the contained groundwater and an additional cost was assumed for possible cap repair work.

After the remediation work is completed, the length of the remedial performance period was assumed, for economic comparison purposes only, to be 30 years. This performance period was selected in accordance with guidance documents provided by the USEPA (USEPA, April 1985). During this period, the O&M costs were assumed to change after 5 years. After 5 years, it is possible that the source removal alternatives will no longer require quarterly analysis, and may only require maintenance of the vegetative cover. For the source containment alternatives, it was assumed that the quarterly analysis could be reduced to a yearly analysis after 5 years; and that the contained groundwater will have been removed and disposed of. Table 8 presents the estimates of the O&M costs for the first 5 years and the next 25 years.

Present worth costs for each alternative allow comparison between alternatives on the basis of a single cost figure. This number represents the amount of money that, if invested in 1987 and disbursed as needed, should be sufficient to cover all costs associated with the remedial alternative over a remediation period of 30 years.

As shown in Table 8, Alternative 2A has the greatest present worth value of $15,123,000. Alternatives 2B and 2C are the second highest and third highest, respectively, while present worth costs for Alternatives 3A, 3B, and 3C are approximately equal. Because of the high costs, long processing time, material handling (i.e., fiber drum loading) requirements, and uncertain commercial incinerator capacity problems associated with Alternative 2A, it will not be considered further in the detailed analysis of the alternatives.

4.2 TECHNICAL FEASIBILITY EVALUATION

Table 9 presents a summary of the technical feasibility evaluation of each alternative. Only Alternatives 2B, 2C, 3A, 3B, and 3C will be carried through the technical feasibility evaluations because these alternatives, based on the screening matrix of Table 8, are the only ones that appear to provide satisfactory control of the site contaminants that are cost-effective.

Based on the subjective evaluation of technical feasibility presented in Table 9, no clear technical superiority between the alternatives could be determined. However, some strengths and weaknesses of the alternatives can be summarized as follows:

- **Alternative 2B** - The time to implement this alternative is 1 to 1.5 years longer than all the other alternatives because, due to air emission standards which must be met, only a limited amount of waste can be incinerated per day. This increases the length of time for potential exposure of both workers and neighboring facilities and communities. The potential for operation problems with the incinerator could also increase the length of time to implement. This alternative would also require the highest level of protection for workers over the longest time. A major advantage of this alternative is that the waste would be removed and destroyed.

- **Alternative 2C** - Drawbacks of this alternative are similar to those described for Alternative 2B. Because Alternative 2C could be implemented about one year earlier than Alternative 2B, the length of time for potential exposure to workers and neighboring facilities and communities would be shortened, in comparison to Alternative 2B. However, the waste materials would not be destroyed as they would in Alternative 2B. There is also the possibility of exposure and off-site contamination during waste hauling if an accident would occur. A major advantage of this alternative is that the wastes would be removed from the site.

- **Alternatives 3A and 3B** - These alternatives are very similar in their advantages and disadvantages. They would both effectively contain contaminants within the site when completed. There is a low potential for worker exposure to BHC while working in the creek bed, and there is the potential that sediments will be agitated and transported downstream during installation of the barrier structures. A potential problem during construction could be the connection between the FML barrier and the slurry wall. A potential problem associated with Alternative 3A is that the permanent sheet piling depth of embedment may require penetration of the clay aquitard. Both Alternatives 3A and 3B would require long-term monitoring to demonstrate that the contaminants are being contained.

- **Alternative 3C** - This alternative would require the most extensive permitting effort of the source containment alternatives because it has the greatest effect on the existing creek bed. However, the wastes would be effectively contained, and this alternative probably represents the most easily constructed source containment alternative. There is a low potential for worker exposure during the relocation of sediments and a low potential for contaminant migration during the cap subbase preparation and initial backfilling of the existing creek bed. This alternative would require long-term monitoring.

4.3 ENVIRONMENTAL AND PUBLIC HEALTH CONCERNS

Beneficial and adverse environmental effects of each alternative are summarized in Table 10. The environmental resources expected to be affected by the site remediation are the aquatic resource of Cayuga Creek and local air quality.

Table 11 presents a summary of the public health risks associated with candidate remedial actions. Each alternative was evaluated with respect to its ability to control potential exposures identified for the existing site conditions. In addition, potential impacts associated with construction of each alternative were considered.

In general, all the alternatives effectively mitigate risks associated with the no-action alternative, including direct contact, airborne exposures, and waterborne exposures. The following discussions summarize potential short-term adverse impacts associated with the construction phase, which are primarily related to surface runoff and airborne transport of contaminants. Additional details of analyses performed are included in Section 2 of Appendix B.

4.3.1 SURFACE RUNOFF

During the construction phase of the alternatives involved with excavation of contaminated material (2B and 2C), surface runoff impacts are expected to increase by a factor of 35, due to exposure of uncovered contaminated materials. During the period of construction, input of contaminants to Cayuga Creek may produce average water concentrations of BHC which exceed federal and state criteria for the protection of human health and aquatic life.

Source containment Alternatives 3A, 3B, and 3C are expected during the construction phase to reduce surface runoff impacts below those for the no action alternative. This reduction is anticipated because a subbase material would be placed over the site surface prior to construction of a cap. This interim cover should limit erosion of site soils. After construction, all proposed remedial actions are expected to essentially eliminate site-related contaminant loading of BHC to the Cayuga Creek.

4.3.2 AIRBORNE TRANSPORT

For alternatives involving excavation of contaminated material (2B and 2C), potential airborne transport of contaminants is expected to increase relative to existing site conditions, because contaminated material would be exposed to volatilization and wind erosion. Airborne impacts may increase during excavation by up to three orders of magnitude relative to the existing site conditions (upper limit volatilization rates for the no action and excavation alternatives are similar). These increased impacts would be expected for the duration of excavation. Although no risk from airborne exposure can be quantified due to the lack of toxicological data for airborne exposure, this exposure may be significant for residents at or near the site.

For those alternatives involving on-site containment (3A, 3B, and 3C), airborne impacts during construction are expected to be lower than those for the no action alternative, because the interim cover placed during construction will limit volatilization and wind erosion. All proposed remedial actions, when implemented, are expected to essentially eliminate off-site airborne contaminant transport.

4.4 ECONOMIC EVALUATION

Detailed cost estimates for Alternatives 2B, 2C, 3A, 3B, and 3C are summarized in Table 12. These estimates were prepared using standard cost estimating techniques and sources, including published cost estimating references (Means, 1986), vendor quotes, and engineering experience.

From Table 12, Alternative 3A has the lowest estimated capital cost at $429,000 and Alternatives 2B and 2C have the highest capital cost at $8,941,000 and $3,259,000, respectively. Alternatives 3B and 3C capital costs are estimated to be $472,000 and $534,000, respectively. Detailed cost estimates for the construction costs are included in Appendix C.

Estimated annual O&M costs, as shown in Table 12, were somewhat different for the source removal and source containment alternatives. Source removal O&M costs consist of monitoring at $25,000 per year for 5 years on a quarterly basis after the remediation has been completed in order to demonstrate that remediation was successful. After the initial 5-year period, monitoring was assumed unnecessary. Other

O&M costs consists of vegetative cover maintenance and caps repair at $3,000 per year for the remedial performance period of the source removal alternatives, which was assumed to be 30 years.

The estimated annual O&M costs associated with the source containment alternatives are somewhat higher than costs for the source removal options. It was assumed that monitoring would be done on a quarterly basis for the first 5 years at $25,000 and then reduced to an annual basis at $7,000 per year for the next 25 years. Other O&M costs associated with the source containment alternatives include removal and disposal of groundwater collected in the toe drain sump at an estimated cost of $5,000 per year (for the first 5 years and then it is assumed that the groundwater will have been removed). Vegetative cover maintenance was estimated at $2,000 per year, and an allowance was made for cap repair of $1,000 per year. The cap repair cost was assumed as a contingency for potential repair due to erosion of the topsoil. Site security costs, estimated at $2,000 per year, include fence repair costs and labor for weekly site inspections.

Major cost differences between the alternatives are the larger capital costs associated the source removal alternatives, when compared to the source containment alternatives. The O&M present worth values for the source removal alternatives are only about $77,000 less than the present worth values for the source containment alternatives, which are relatively insignificant when compared to differences in the capital cost and total alternative present worth costs, as shown in Table 12.

5.0 SUMMARY COMPARISON OF ALTERNATIVES

Table 13 presents an overall summary of the source control alternatives for the site. For the purposes of comparison, the no action alternative has been included to show that it is generally unacceptable. From Table 13, all of the alternatives listed (other than the no action alternative) appear to effectively control the contamination source within the site.

From a public health and an environmental impact viewpoint, Alternatives 2B and 2C appear to have the greatest potential for adverse effects on both public health and the environment, because of the off-site migration potential during the excavation and removal of the wastes and fill from the site. The containment alternatives (3A, 3B, and 3C) appear to be approximately equal in their potential for adverse effects on public health. However, Alternative 3C seems to have the greatest effect on the local environment due to the disturbance of the existing creek bed and new stream channel construction.

Based on the economic comparison criteria, Alternatives 2B and 2C have a much greater cost associated with them than do the source containment alternatives, which are roughly equal in cost. Total capital costs for all the containment alternatives are estimated at less than $600,000.

From a technical effectiveness standpoint, Alternatives 2B, 2C, 3B, and 3C appear to be the most effective. There is a possibility that the permanent sheet pile included in Alternative 3A would have to penetrate through the clay aquitard in order to provide the necessary embedment to resist overturn. The source removal alternatives (2B and 2C) have difficulties associated with the work necessary to complete them, which is reflected in their higher cost. Alternative 3C appears to be the easiest to construct, but would require the most permitting due to the degree of disturbance to Cayuga Creek.

6.0 RECOMMENDED REMEDIAL ACTION

WCC recommends that Alternative 3C (reroute creek, FML cap, toe drain, slurry wall, monitor) be considered for preliminary and final design for remediation of the Batrouny property portion of the Gibson site. This alternative includes rerouting Cayuga Creek, a circumscribing slurry wall, a downgradient toe drain, a FML cap, and monitoring. It was assumed that permitting for the rerouting of the creek can be done in a reasonable time period (12 to 15 months) and without great expense.

While the construction-related activities associated with Alternative 3C would be significant, they would not directly involve the wastes within the site, as would the source removal options (2A, 2B, and 2C). Accordingly, the short-term, construction-related potential risks from site wastes to the surrounding residential area would be less for Alternative 3C than for any of the other alternatives.

It is further recommended that, as part of the design/permitting phase, additional field and laboratory investigations be conducted to:

- o Evaluate whether the fill material on the south and west sides of the site and the soil along the proposed path of the new creek bed would make a suitable soil-bentonite mix. In addition, using the shallow groundwater from the site as a permeant, study the compatibility of the two soil-bentonite backfill mixes with the groundwater.

- o Evaluate the geotechnical properties of the soils along the proposed location of the new creek bed, specifically for slope stability and to evaluate if the material is suitable for use as structural fill.

- o Further evaluate the extent of the non-metallic debris indicated on Figure 3 so the slurry wall can be installed clear of this area.

7.0 LIMITATIONS

Assumptions, conclusions, and recommendations presented in this report are based on information and data obtained and/or collected by Olin Corporation and consultants other than WCC, with the exception of shallow test pit excavations in the site embankment, which were observed by WCC representatives. WCC assumes that the information provided is accurate and that the subsurface conditions do not deviate appreciably from those disclosed by the provided information. The assumptions, conclusions, and recommendations are subject to confirmation and revision should further information and data become available.

Tables

TABLE 1
SOIL CONTAMINANT SUMMARY

BORING NUMBER	SAMPLING INTERVAL (feet)	CONCENTRATION - PPM alpha-BHC	beta-BHC	gamma-BHC	delta-BHC	HCB
E5	6-8	< 0.67	< 0.67	< 0.67	< 0.67	< 0.67
E4	6-7	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60
E6	2-4	< 0.63	< 0.63	< 0.63	< 0.63	< 0.63
E2	4-6	< 0.61	< 0.61	< 0.61	< 0.61	< 0.61
C3	2-4	< 0.78	15.55	< 0.78	< 0.78	< 0.78
B3	4-6B	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60
X1	2-4	263	92.22	8.78	< 0.55	< 0.55
D5	4-6	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78
E5	0-2	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74
E5	2-4A	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75
A4	2-4	200,000	44,000	23,000	14,000	< 5.30
E2	6-8	< 0.63	< 0.63	< 0.63	< 0.63	< 0.63
D4	6-8	< 0.65	< 0.65	< 0.65	< 0.65	< 0.65
C3	2-4B	< 0.85	0.95	< 0.85	< 0.85	< 0.83
C3	4-6	6.3	9.67	< 0.85	< 0.85	< 1.20
B2	4-6	< 0.81	< 0.81	< 0.81	< 0.81	< 5.34
Y1	2-4	< 0.80	< 0.79	< 0.80	< 0.80	< 1.27
Y3	2-4	< 0.88	< 0.88	< 0.88	< 0.88	< 2.98
Y4	2-4	< 0.87	< 0.87	< 0.87	< 0.87	< 1.55
E4	0-2	< 0.57	< 0.57	< 0.57	< 0.57	< 0.57

NA - Not Analyzed
INS. - Insufficent Sample

TABLE 2

SUMMARY OF GROUNDWATER
ANALYTICAL RESULTS

Monitoring Well	Evaluation Period	Screened Interval (feet)	Number of Samples	Compound	Maximum Reported Conc.	Sampling Date	Minimum Reported Conc.	Number of Values Below Detection Limit	6/6/86 Results
MW-1	8/85-6/86	1-6	7	HCB	< 0.5	11/85	< 0.01	7 (1)	< 0.1
				alpha-BHC	2.3	8/85	0.28	0	0.5
				beta-BHC	10.0	8/85	1.3	0	2.1
				delta-BHC	0.75	8/85	< 0.01	0	< 0.1
				gamma-BHC	1.5	8/85	< 0.1	5 (6)	< 0.1
MW-5	8/85-6/86	6-11	6	HCB	< 1.0	10/85	< 0.01	7 (2)	< 0.1
				alpha-BHC	4.0	10/85	0.1	0	0.1
				beta-BHC	1.4	8/85	< 0.1	1 (6)	< 0.1
				delta-BHC	0.3	9/85	< 0.01	5 (3)	< 0.01
				gamma-BHC	0.04	8/85	< 0.01	6 (4)	< 0.1
MW-6	8/85-6/86	4-9	7	HCB	< 1.0	10/85	< 0.01	7 (2)	< 0.1
				alpha-BHC	6.5	9/85	< 0.1	4 (6)	< 0.1
				beta-BHC	18.0	8/85	1.3	0	7.6
				delta-BHC	0.01	8/85	< 0.01	7 (5)	< 0.01
				gamma-BHC	0.02	8/85	< 0.01	1 (4)	< 0.1
MW-7	8/85-6/86	3-8	2	HCB	< 0.1	2/86	< 0.1	2 (6)	NA
				alpha-BHC	10.3	2/86	5.1	0	NA
				beta-BHC	12.6	2/86	3.2	0	NA
				delta-BHC	0.18	2/86	0.1	0	NA
				gamma-BHC	0.32	2/86	0.20	0	NA

NA = Not Analyzed
All concentration data reported as parts per billion (ppb)

(1) Reported detection limits: 2 at 0.01, 4 at 0.1, and 1 at 0.5
(2) Reported detection limits: 2 at 0.01, 4 at 0.1, and 1 at 1.0
(3) Reported detection limits: 4 at 0.01 and 1 at 0.1
(4) Reported detection limits: 1 at 0.01 and 5 at 0.1
(5) Reported detection limit: 0.01
(6) Reported detection limit: 0.1

TABLE 3

PRELIMINARY SCREENING OF GENERAL RESPONSE ACTIONS

General Response Action	Technologies	Applicable	Not Applicable	May Be Applicable
No Action	Some monitoring and analyses may be performed.			X
Containment	Capping; groundwater containment barrier walls; bulkheads, gas barriers.	X		
Pumping	Groundwater pumping; liquid removal; dredging.			
On-Site		X		
Off-Site			X	
Collection	Sedimentation basins; French drains; gas vents; gas collection systems.	X		
Diversion	Grading; dikes and berms; stream diversion ditches; trenches; terraces and benches; chutes and downpipes; levees; seepage basins.	X		
Complete Removal	Tanks; drums; soils; sediments; liquid wastes; contaminated structures; sewers and water pipes.	X		
Partial Removal	Tanks; drums; soils; sediments; liquid wastes.	X		
On-Site Treatment	Incineration; solidification; land treatment; biological, chemical, and physical treatment.			X
In-Situ Treatment	Permeable treatment beds; bio-reclamation; soil flushing; neutralization; land farming.			X
Storage	Temporary storage structures.		X	
On-Site Disposal	Landfills; land application.	X		
Off-Site Disposal	Landfills; surface impoundments; land application.			X

TABLE 3
(Continued)

General Response Action	Technologies	Applicable	Not Applicable	May Be Applicable
Alternative Drinking Water Supply	Cisterns; aboveground tanks; deeper or upgradient wells; municipal water system; relocation of intake structure; individual treatment devices.		X	
Relocation of Receptors	Relocate residents temporarily or permanently.		X	

TABLE 4

SUMMARY OF POTENTIALLY FEASIBLE TECHNOLOGIES

Remedial Technology Category	Feasible Technology
Surface Water Controls	Capping Surface Water Diversion and Collection
Air Pollution Controls	Capping
Leachate and Groundwater Controls	Capping Subsurface Barriers Subsurface Drains
Excavation and Removal of Waste and Soil	Excavation and Removal
Removal/Containment of Contaminated Sediments	Mechanical Excavation
Direct Waste Treatment	Incineration
On-Site and Off-Site Disposal	Landfill On-Site Containment Off-Site Water Treatment
In-Situ Treatment	Bioreclamation Chemical/Physical Treatment

TABLE 5

SCREENING OF POTENTIALLY FEASIBLE TECHNOLOGIES

Technology	Compatibility With Site Conditions	Compatibility With Waste Characteristics	Technology Limitations
1. Capping			
1A. Clay	Compatible	Compatible	Compaction QA/QC
1B. Asphalt (Bituminous Concrete)	Compatible	Compatible	Too permeable
1C. FML (Flexible Membrane Liner)	Compatible	HDPE Compatible	Seaming QA/QC
1D. Concrete	Compatible	Compatible	Too permeable
1E. Soil Cement Composite (FML Membrane)	Compatible	Compatible	Shrinkage cracking
2. Containment Barriers			
2A. Grout Curtains	Compatible	Compatible	Barrier Continuity QA/QC
2B. Soil-Bentonite Slurry Wall	Compatible	Compatible	Practical depth limit 80 feet
2C. Vibrating Beam	Compatible	Compatible	Useful life/wall thickness
2D. Cement-Bentonite Slurry Wall	Compatible	Compatible	Too permeable

TABLE 5
(Continued)

Technology	Compatibility With Site Conditions	Compatibility With Waste Characteristics	Technology Limitations
2E. Steel Sheet Piling	Compatible	Compatible	Overturn resistance/ leakage at joints
2F. FML Barriers	Compatible	HDPE Compatible	Limited to shallow installations
3. Surface Water Controls			
3A. Capping	Compatible	Compatible	Section No.1
3B. Dikes and Berms	Compatible	Compatible	Compaction QA/QC
3C. Stream Rerouting	Compatible	Compatible	Proven
4. Excavation/Removal of Waste and Soil			
4A. Excavation	Limited work area and flood protection required	Dewatering required	Proven
5. In Situ Treatment			
5A. Bioreclamation	Low Permeability	Toxic-Pesticide	Unproven
5B. Chemical Treatment	Low Permeability	Unknown	Unproven
6. Solidification/Stabilization	Variable concentrations of wastes	Unknown	Unproven

TABLE 5
(Continued)

Technology	Compatibility With Site Conditions	Compatibility With Waste Characteristics	Technology Limitations
7. Thermal Destruction			
7A. Off-Site Commercial Hazardous Waste Incinerator	Compatible	Compatible (high chlorine)	Limited capacity
7B. Fluidized Bed Incinerator (Dedicated)	Not compatible	Compatible (high chlorine)	Proven
7C. Rotary Kiln Incinerator (Dedicated)	Not compatible	Compatible (high chlorine)	Proven
7D. Circulating Bed Combustor (Dedicated)	Not compatible	Compatible (high chlorine)	Proven
7E. Fixed Pulse Hearth Incinerator (Dedicated)	Not compatible	Compatible (high chlorine)	Proven
8. Off-Site Disposal			
8A. Commercial H.W. Landfill	Compatible	Compatible	Proven
8B. Treatment of Water	Compatible	Compatible	Proven

TABLE 6

SUMMARY OF MOST FEASIBLE TECHNOLOGIES

Capping

(1C) FML (Flexible Membrane Liner)

Containment Barriers

(2B) Soil-Bentonite Slurry Wall

(2F) FML Barriers (with structural support from steel sheet piling and/or concrete retaining walls)

Surface Water Controls

(3A) Capping
(3B) Dikes and Berms
(3C) Stream Rerouting

Excavation/Removal of Waste and Soil

(4A) Excavation

Thermal Destruction

(7A) Off-Site Commerical Hazardous Waste Incinerator
(7D) Circulating Bed Combustor (Dedicated Off-Site)

Off-Site Disposal

(8A) Commercial Hazardous Waste Landfill
(8B) Off-Site Water Treatment

TABLE 7

SYNTHESIS OF REMEDIAL ALTERNATIVES

Alternative Number	Description
1	No Action - Monitor Only
	SOURCE REMOVAL ACTIONS
2A	Excavate, Incinerate at Commercial H.W. Facility, Backfill Monitor
2B	Excavate, Incinerate in dedicated facility off-site, Backfill, Monitor
2C	Excavate, Landfill, Backfill, Monitor
	SOURCE CONTAINMENT ACTIONS
3A	Permanent Sheet Piling, FML Barrier/Cap, Downgradient Toe Drain, Slurry Wall, Monitor
3B	Concrete Retaining Wall, FML Barrier/Cap, Downgradient Toe Drain, Slurry Wall, Cap, Monitor
3C	Reroute Creek, FML Cap, Downgradient Toe Drain, Circum-scribing Slurry Wall, Monitor

TABLE 8

PRELIMINARY ALTERNATIVE SCREENING MATRIX

No.	Alternative Description	Environmental/Public Health Factors	Cost Factors ($1,000's) Capital	Annual O&M	Present Worth*
1	No Action, Monitor Only	No control effected over contaminant sources. Localized environmental degradation may continue unabated	-	25 for 30 yr	236
2A	Excavate, Incinerate at Commercial Facility, Backfill, Monitor	Most effective in controlling sources of contamination by removal. Potential risk to public health during excavation and removal.	15,000	28 for 5 yr 3 for 25 yr	15,123
2B	Excavate, Dedicated Incineration Off-Site, Backfill, Monitor	Same as Alternative 2A	10,000	28 for 5 yr 3 for 25 yr	10,123
2C	Excavate, Landfill/ Backfill, Monitor	Same as Alternative 2A	4,000	28 for 5 yr 3 for 25 yr	4,123
3A	Permanent Sheet Pile, Clay, FML Barrier, Downgradient Toe Drain, Slurry Wall, FML Cap, Monitor	Should effectively control contaminant sources by minimizing airborne and waterborne pathways. Low potential for public health during construction.	500	33 for 5 yr 10 for 25 yr	682
3B	Concrete Retaining Wall, FML Barrier/Cap, Downgradient Toe Drain, Slurry Wall, Monitor	Same as Alternative 3A	550	33 for 5 yr 10 for 25 yr	732
3C	Reroute Creek, Circumscribing Slurry Wall, FML Cap, Downgradient Toe Drain, Monitor	Should effectively control contaminant source by minimizing airborne pathway. Most effective in controlling waterborne pathway via relocation. Lowest potential for public health risk during construction.	600	33 for 5 yrs 10 for 25 yrs	782

* Present worth values were determined using a 10% discounted rate of return and standard present worth multipliers.

TABLE 9

SUMMARY OF TECHNICAL FEASIBILITY EVALUATION

	Performance		Reliability	
Alternative	Effectiveness	Useful Life	Operation and Maintenance Requirements	Possible Failure Modes
2B: Excavate, Dedicated Incineration Off-site, Backfill, Monitor	Removes contaminants/wastes from site and destroys	30 + years	- Monitor site for limited limited time period (5 ± years) - Maintain vegative cover	- Incomplete excavation/ waste removal - Incinerator failure
2C: Excavate, Landfill Backfill, Monitor	Removes contaminants/wastes from site	30 + years	Same as 2B	- Incomplete waste excavation and removal
3A: Permanent Sheet Pile, Cap/Barrier, Slurry Wall, Monitor	Isolates contaminants waste on-site from air, surface water and groundwater	30 years	- Monitor site for 30 years - Pump and dispose of site groundwater - Maintain cap and vegative cover	- FML rupture - Penetration of Clay with sheet pile - Incomplete connection between FML barrier and slurry wall
3B: Concrete Retaining Wall, FML Cap/Barrier, Slurry Wall, Monitor	Same as 3A	30 years	Same as 3A	- FML rupture - Incomplete connection between FML barrier and slurry wall
3C: Reroute Creek, Circumscribing Slurry Wall, FML Cap, Monitor	Same as 3A	30 years	Same as 3A	- FML rupture - Dike failure

(Continued)

TABLE 9 (Continued)

SUMMARY OF TECHNICAL FEASIBILITY EVALUATION

Alternative	Safety Considerations	
	Worker Health and Safety	Neighboring Facilities and Communities
2B: Excavate, Dedicated Incineration Off-Site, Backfill, Monitor	Possible exposure to BHC/HCB during excavation/packaging and transportation	- Possible exposure to BHC/HCB though airborne transport of dust particles - Possible exposure during transporting if accident occurs; low potential due to short haul
2C: Excavate, Landfill/ Backfill, Monitor	Same as 2B	- Possible exposure to BHC/HCB though airborne transport of dust particles - Possible exposure during transporting if accident occurs; higher potential due to long haul
3A: Permanent Sheet Pile, FML Cap/Barrier, Slurry Wall, Monitor	Low potential for exposure to BHC/HCB during construction to Creek bed	- Potential for migration of BHC/HCB due to agitation of sediments
3B: Concrete Retaining Wall, FML Cap/Barrier, Slurry Wall Monitor	Same as 3A	Same as 3A
3C: Reroute Creek, Circum-scribing Slurry Wall, FML Cap, Monitor	Minimal potential for exposure to BHC/HCB during removal of sediments	Short term low potential for airborne migration of BHC/HCB contaminated dust during initial backfilling of existing creek bed

TABLE 9 (Continued)

SUMMARY OF TECHNICAL FEASIBILITY EVALUATION

	Implementability		
	Constructability	Time	
Alternative	Site Conditions	To Implement	To See Desired Results
2B: Excavate, Dedicated Incineration Off-site, Backfill, Monitor	Saturated fill flood potential, limited work space, elevated level of protection for workers	2-3 years	2-3 years
2C: Excavate, Landfill Backfill, Monitor	Same as 2B	1-2 years	1-2 years
3A: Permanent Sheet Pile, FML Cap/Barrier, Slurry Wall Monitor	Limited work space possible elevated level of protection in stream-bank area	2 years	2 years
3B: Concrete Retaining Wall, FML Cap/Barrier, Slurry Wall, Monitor	Same as 3A	2 years	2 years
3C: Reroute Creek, Circum-scribing Slurry Wall, FML Cap, Monitor	Many permitting require-ments limited work space	2 years	2 years

TABLE 10

SUMMARY OF ENVIRONMENTAL FACTORS

Alternative	Beneficial Impacts	Adverse Impacts
1A - No Action	o Minimizes disturbance to site, Cayuga Creek	o Does not control potential loadings of contaminants to Cayuga Creek and air in vicinity of site. Surface water loadings may exceed NYSDEC criteria for protection of aquatic life.
2B - Excavate, Off-site Incineration	o Removes source of contamination (long-term) o Reduce or eliminate long-term contaminant loadings to air or water	o Construction activities may produce significant releases of contaminants to surface water and air for 1 year or more.
2C - Excavate, Off-site Landfill, Backfill	o Removes source of contamination (long-term) o Reduce or eliminate long-term contaminant loadings to air or water	o Construction activities may produce significant releases of contaminants to surface water and air for up to 1 year.
3A - Permanent Sheet Pile, FML Barrier/Cap, Slurry Wall	o Controls airborne and waterborne migration of of contaminants (long-term) o Construction activities not expected to generate significant airborne releases	o Construction activities in creek affect aquatic resources
3B - Retaining Wall, FML Barrier/Cap, Slurry Wall	o Controls airborne and waterborne migration of of contaminants (long-term) o Construction activities not expected to generate significant airborne releases	o Construction activities in creek affect aquatic resources
3C - Reroute Creek, Circumscribing Slurry Wall/FML Cap	o Creek rerouted away from potentially contaminated area o Controls airborne and waterborne migration of contaminants (long-term) o Construction activities have minimum opportunity to increase contaminant loading to creek. o Construction activities not expected to generate significant airborne releases.	o Major disturbance of of the creek and associated aquatic resources

TABLE 11

PUBLIC HEALTH EVALUATION OF ALTERNATIVES

Alternative	Long-Term Risk	Short-Term (Construction) Risks)
1 - No Action	o Direct Contact - significant potential exposures if waste is disturbed. o Airborne - significant potential exposures under "worst case" scenario. o Surface Water - projected "worst case" concentrations exceed criteria for drinking water; however, there is no expected ingestion of Cayuga Creek water. o Groundwater - exposure assumed insignificant.	Not Applicable
2B, 2C	o Direct Contact - virtually eliminated. o Airborne contaminant migration virtually eliminated o Contaminant migration to surface water virtually eliminated. o Groundwater exposure assumed insignificant.	o Airborne exposures expected to be greater than for No Action alternative during construction. o Surface water contamination is expected to be greater than for No Action Alternative during construction.
3A, 3B, 3C	o Direct Contact - virtually eliminated. o Airborne contaminant migration virtually eliminated. o Contaminant migration to surface water virtually eliminated. o Groundwater exposure assumed insignificant.	o Airborne exposures expected to be less than for No-Action Alternative. o Surface water contamination expected to be less than for No-Action Alternative.

TABLE 12

DETAILED COST ESTIMATE SUMMARY

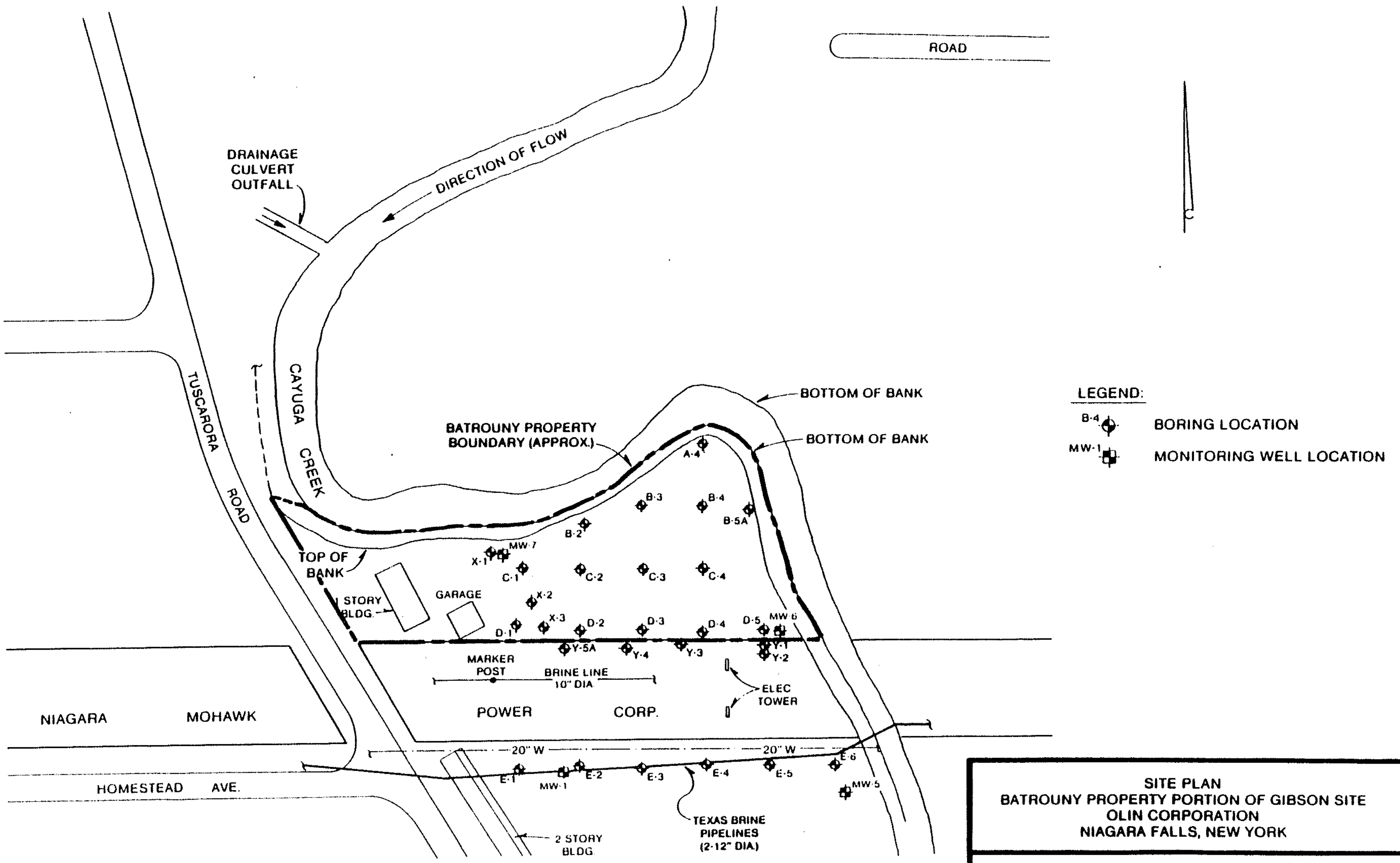
Item	2B Excavate Incinerate Backfill	2C Excavate Landfill, Backfill	Alternative 3A Sheet Pile, FML Barrier/Cap, Toe Drain Slurry Wall, Cap	3B Concrete Retaining Wall FML Barrier/Cap, Toe Drain, Slurry Wall, Cap	3C Reroute Creek, FML Cap/ Barrier, Toe Drain Slurry Wall
CAPITAL COSTS					
1. Site Preparation	$ 32,000	$ 11,000	$ 4,000	$ 4,000	$ 6,000
2. Removal & Disposal	$7,414,000	$2,178,000	----	----	----
3. Dewater	----	$ 125,000	----	----	$ 3,000
4. Backfill	$ 145,000	$ 145,000	----	----	$ 55,000
5. Permanent Sheet Piling	----	----	$ 54,000	----	----
6. Retaining Wall	----	----	----	$ 98,000	----
7. Stream Relocation	----	----	----	----	$ 30,000
8. Slurry Wall	----	----	$ 46,000	$ 46,000	$ 68,000
9. Cap	----	----	$122,000	$122,000	$130,000
10. Security Fence	----	----	$ 7,000	$ 7,000	$ 7,000
TOTAL CONSTRUCTION COST	$7,591,000	$2,459,000	$233,000	$277,000	$299,000
Engineering	$ 250,000	$ 250,000	$ 70,000	$ 70,000	$ 60,000
Legal/Fiscal	$ 250,000	$ 200,000	$ 50,000	$ 50,000	$100,000
Contingency	$ 750,000	$ 250,000	$ 50,000	$ 50,000	$ 50,000
Health & Safety	$ 100,000	$ 100,000	$ 25,000	$ 25,000	$ 25,000
TOTAL CAPITAL COST	$8,941,000	$3,259,000	$429,000	$472,000	$534,000
ANNUAL OPERATION & MAINTENANCE COSTS					
A. First Five Years					
1. Monitoring	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000
2. Vegetative Cover Maintenance	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
3. Cap Repair	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
4. Sump Pumping and	$ 0	$ 0	$ 5,000	$ 5,000	$ 5,000
5. Site Security	$ 0	$ 0	$ 2,000	$ 2,000	$ 2,000
FIVE YEAR SUBTOTAL	$ 28,000	$ 28,000	$ 35,000	$ 35,000	$ 35,000
B. Next Five Years					
1. Sampling	$ 0	$ 0	$ 7,000	$ 7,000	$ 7,000
2. Vegetative Cover Maintenance	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
3. Cap Repair	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
4. Security	$ 0	$ 0	$ 2,000	$ 2,000	$ 2,000
25 YEAR SUBTOTAL	$ 3,000	$ 3,000	$ 12,000	$ 12,000	$ 12,000
TOTAL O&M PRESENT WORTH	$ 123,000	$ 123,000	$200,000	$200,000	$200,000
TOTAL ALTERNATIVE PRESENT WORTH	$9,064,000	$3,382,000	$629,000	$672,000	$734,000

TABLE 13

SOURCE CONTROL ALTERNATIVES COMPARISON SUMMARY

	Alternative	Cost ($1,000) Capital	Annual O&M	Present Worth	Public Health Concerns	Environmental Concerns	Technical Concerns	Community Response Concerns
1	No Action Monitor Only	---	25 for 30 yr	236	Continued exposure via air, surface water and direct contact	Continued seepage into creek affects aquatic life, continued adverse effects on air quality	None	Unacceptable
2B	Excavate, Dedicated Incineration Off-Site, Backfill, Monitor	8,941	28 for 5 yr 3 for 25 yr	9,064	Possible exposure to BHC/HCB from airborne dust particles increased during construction	Construction activities may release contaminants to surface water and air	Excavation of saturated fill. Flooding Potential	Probably Unacceptable
2C	Excavate, Landfill Backfill Monitor	3,259	28 for 5 yr 3 for	3,382	Same as Alternative 2B	Same as Alternative 2B	Same as Alternative 2B	Probably unacceptable
3A	Permanent Sheet Pile, FML Barrier/ Cap, Toe Drain, Slurry Wall,	429	35 for 5 yr 12 for 25 yr	629	Low potential for exposure to BHC/ HCB from airborne dust particles	Construction activities in stream bed may release contaminants to air	Depth of embedment may penetrate clay aquiclude FML Barrier - Slurry wall connection	Some resistance
3B	Concrete Retaining Wall, FML Barrier/ Cap, Toe Drain Slurry Wall, Monitor	472	35 for 5 yr 12 for 25 yr	672	Same as Alternative 3A	Same as Alternative 3A	Structural stability of retaining wall FML Barrier - Slurry wall connection	Some resistance
3C	Reroute Creek Circumscribing Slurry Wall, FML Cap, Toe Drain, Monitor	534	35 for 5 yr 12 for 25 yr	734	Same as Alternative 3A	Construction activities may release contaminants to surface water and air. Disturbance of the creek and associated aquatic life.	Stability for slurry wall construction in backfilled stream bed	Some resistance

Figures

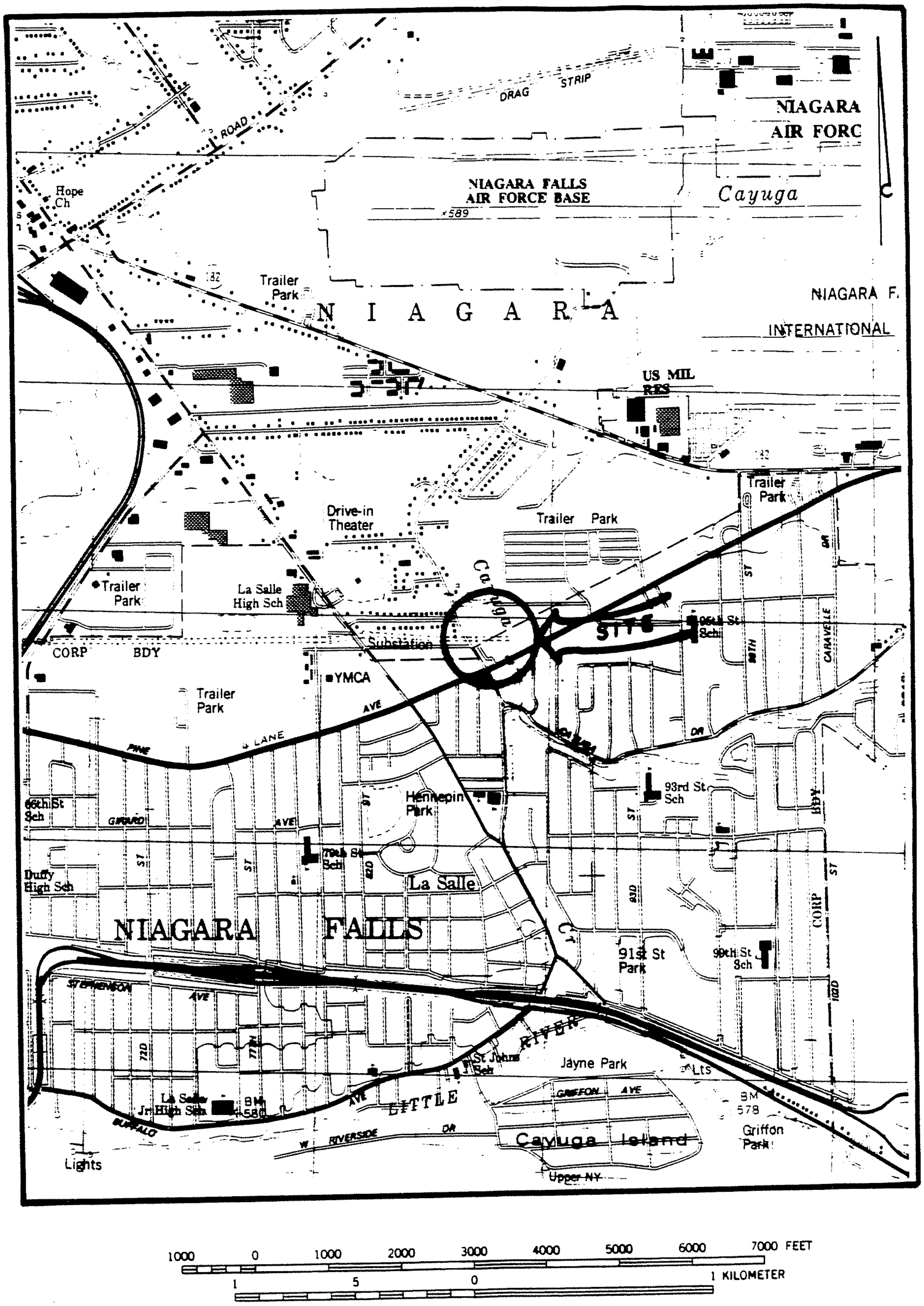


SITE PLAN
BATROUNY PROPERTY PORTION OF GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

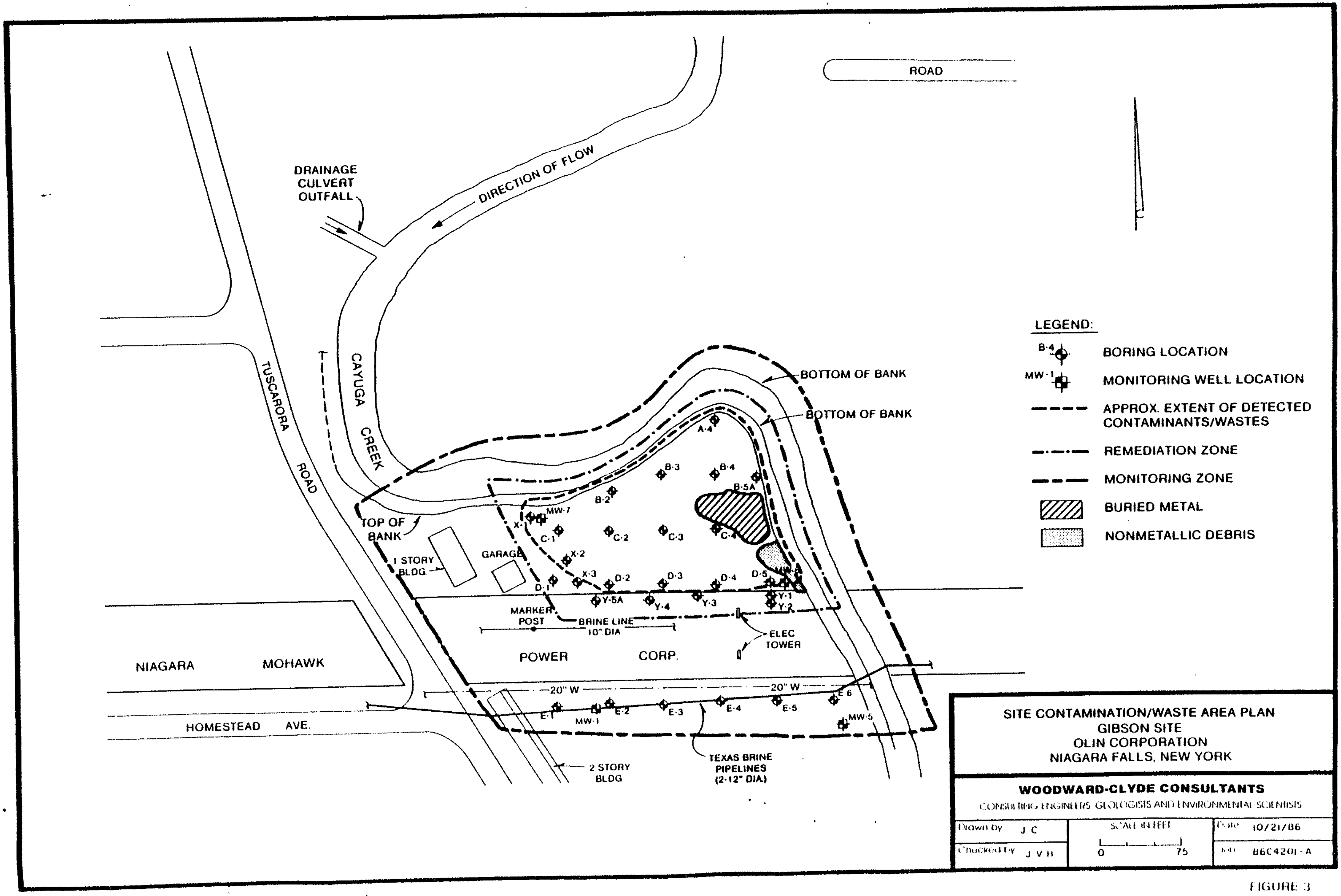
Drawn by J C	SCALE IN FEET 0 75	Date 10/21/86
Checked by J V H		No. 86C4201-A

FIGURE 2



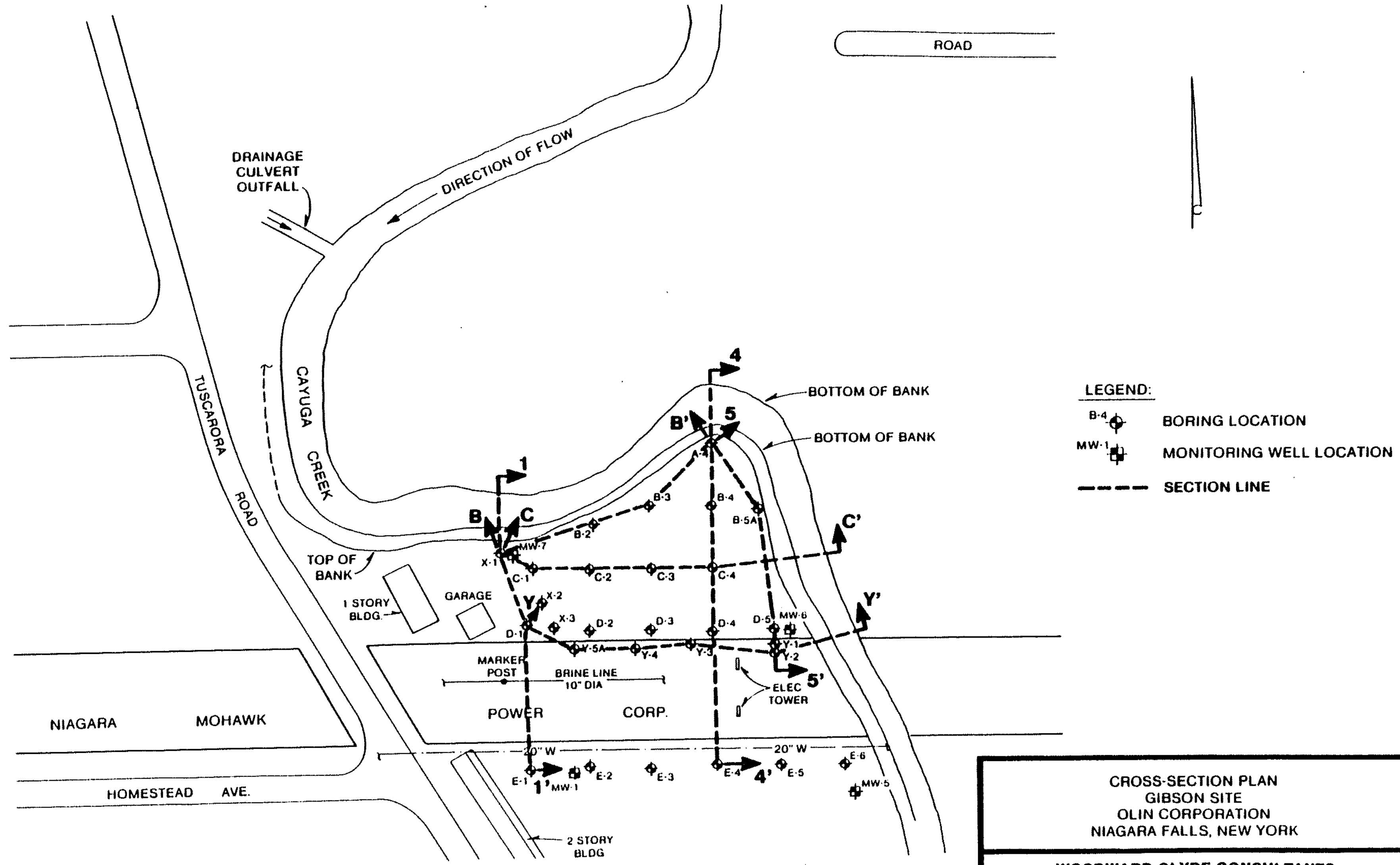
REGIONAL LOCATION PLAN

FIGURE 1



ROAD
DRAINAGE CULVERT OUTFALL
DIRECTION OF FLOW
CAYUGA CREEK
TUSCARORA ROAD
BOTTOM OF BANK
BOTTOM OF BANK
TOP OF BANK
1 STORY BLDG
GARAGE
MARKER POST
BRINE LINE 10" DIA
ELEC TOWER
POWER CORP.
NIAGARA MOHAWK
HOMESTEAD AVE.
20" W
20" W
2 STORY BLDG
TEXAS BRINE PIPELINES (2-12" DIA.)
A-4
B-2
B-3
B-4
B-5A
C-1
C-2
C-3
C-4
D-1
D-2
D-3
D-4
D-5
X-1
X-2
X-3
Y-1
Y-2
Y-3
Y-4
Y-5A
E-1
E-2
E-3
E-4
E-5
E-6
MW-1
MW-5
MW-7
LEGEND:
B-4 BORING LOCATION
MW-1 MONITORING WELL LOCATION
APPROX. EXTENT OF DETECTED CONTAMINANTS/WASTES
REMEDIATION ZONE
MONITORING ZONE
BURIED METAL
NONMETALLIC DEBRIS
SITE CONTAMINATION/WASTE AREA PLAN
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
Drawn by J C
Checked by J V H
SCALE IN FEET
0 75
Date 10/21/86
Job 86C4201-A

FIGURE 3

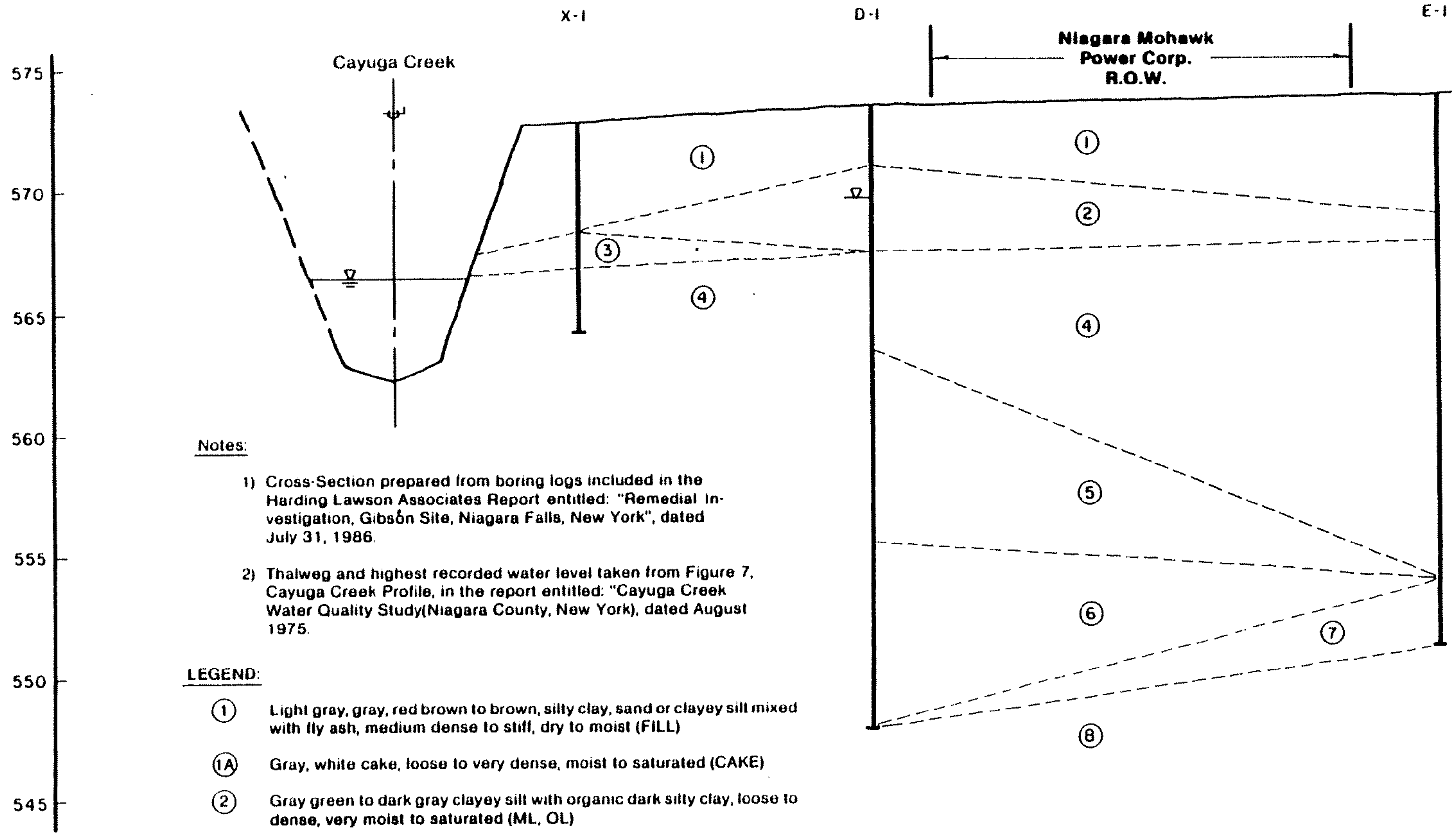


CROSS-SECTION PLAN
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J C	SCALE IN FEET		Date	10/21/86
Checked by J V H	0	75	Job	86C4201-A

FIGURE 4



Notes:

1) Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

2) Thalweg and highest recorded water level taken from Figure 7, Cayuga Creek Profile, in the report entitled: "Cayuga Creek Water Quality Study(Niagara County, New York), dated August 1975.

LEGEND:

(1) Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)

(1A) Gray, white cake, loose to very dense, moist to saturated (CAKE)

(2) Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)

(3) Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)

(4) Gray, red brown clay, stiff to hard, moist to saturated (CH)

(5) Brown silty clay, medium stiff, saturated (CL)

(6) Brown silty gravelly sand loose to dense, saturated (SW)

(7) Clayey sandy silt medium dense, saturated (ML)

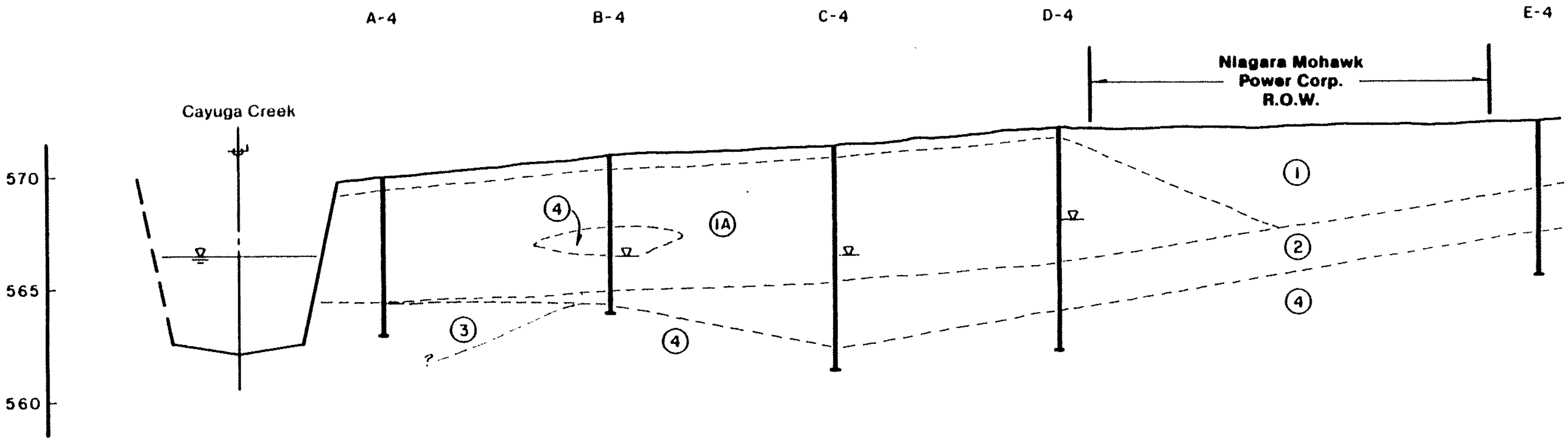
(8) Bedrock

INFERRED CROSS-SECTION 1-1'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J.C.	SCALE IN FEET	Date	10/15/86
Checked by J.V.H.	0 25	Job	86C4201-A

Figure 5A



Notes:

1) Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

2) Thalweg and highest recorded water level taken from Figure 7, Cayuga Creek Profile, in the report entitled: "Cayuga Creek Water Quality Study(Niagara County, New York), dated August 1975.

LEGEND:

(1) Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)

(1A) Gray, white cake, loose to very dense, moist to saturated (CAKE)

(2) Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)

(3) Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)

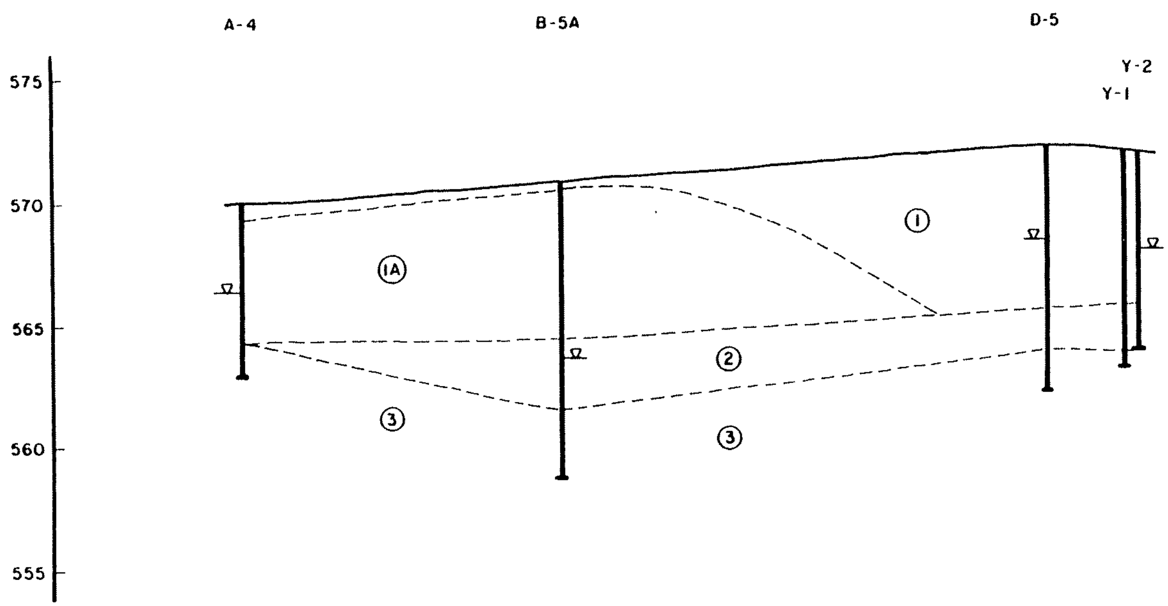
(4) Gray, red brown clay, stiff to hard, moist to saturated (CH)

INFERRED CROSS-SECTION 4-4'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by D.B.	SCALE IN FEET	Date 10/14/86
Checked by J.V.H.	0 25	Job 86C4201-A

Figure 5B



LEGEND:

1. Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)

1A. Gray, white cake, loose to very dense, moist to saturated (CAKE)

2. Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)

3. Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)

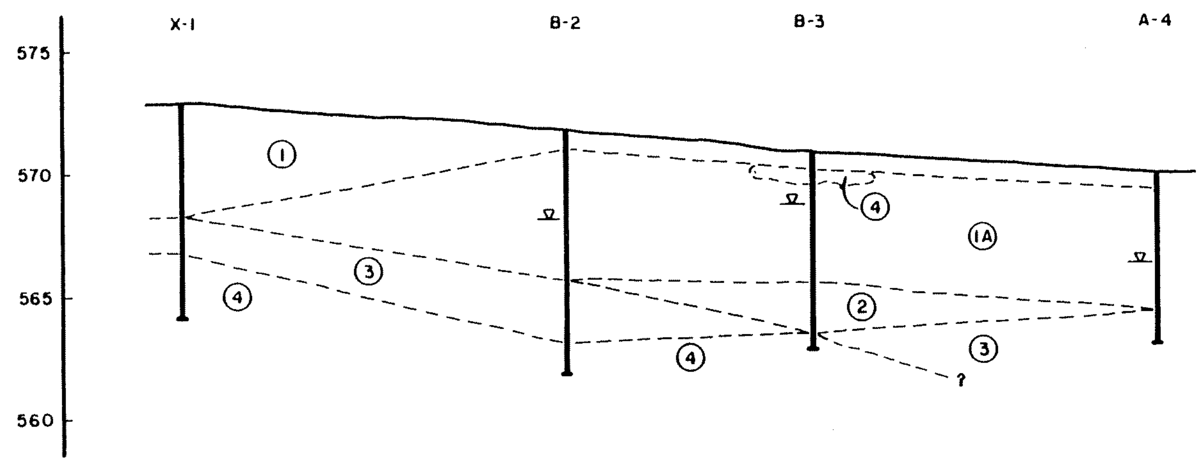
Note: Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

INFERRED CROSS-SECTION 5-5'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J.C.	SCALE IN FEET	Date	10/15/86
Checked by J.V.H.	0 25	Job	86C4201-A

Figure 5C



LEGEND:

(1) Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)

(1A) Gray, white cake, loose to very dense, moist to saturated (CAKE)

(2) Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)

(3) Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)

(4) Gray, red brown clay, stiff to hard, moist to saturated (CH)

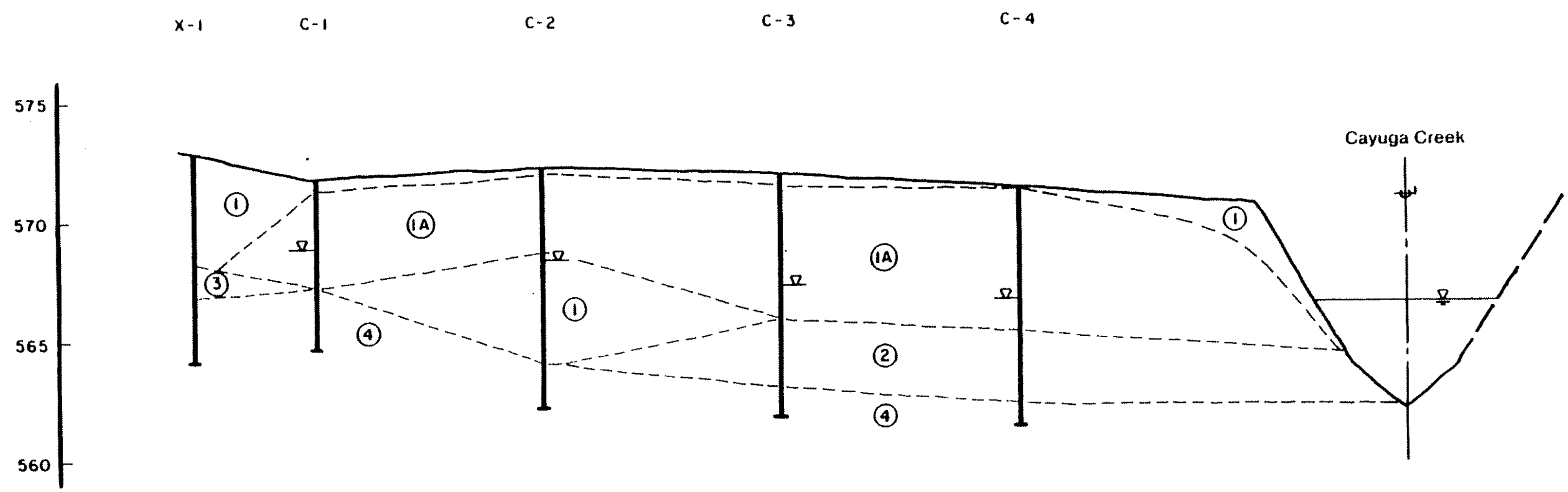
Note: Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

INFERRED CROSS-SECTION B-B'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by D.B.	SCALE IN FEET	Date 10/14/86	
Checked by J.V.H.	0 25	Job 86C4201-A	

Figure 5D



LEGEND:

- (1) Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)
- (1A) Gray, white cake, loose to very dense, moist to saturated (CAKE)
- (2) Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)
- (3) Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)
- (4) Gray, red brown clay, stiff to hard, moist to saturated (CH)

Notes:

1) Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

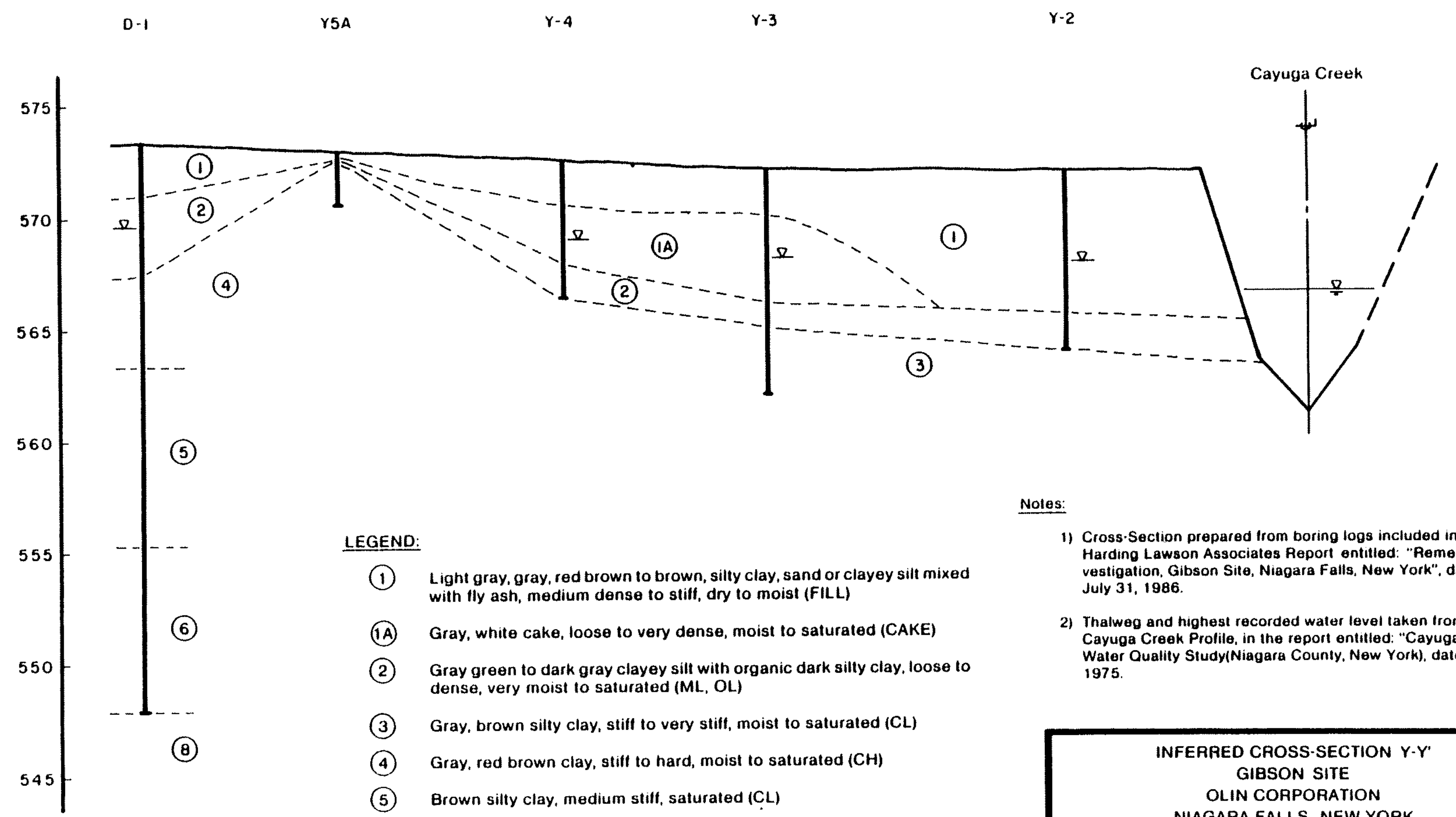
2) Thalweg and highest recorded water level taken from Figure 7, Cayuga Creek Profile, in the report entitled: "Cayuga Creek Water Quality Study(Niagara County, New York), dated August 1975.

INFERRED CROSS-SECTION C-C'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J. C.	SCALE IN FEET	Date	10/14/86
Checked by J. V. H.	0 25	Job	86C4201-A

Figure 5E



LEGEND:

1. Light gray, gray, red brown to brown, silty clay, sand or clayey silt mixed with fly ash, medium dense to stiff, dry to moist (FILL)
1A. Gray, white cake, loose to very dense, moist to saturated (CAKE)
2. Gray green to dark gray clayey silt with organic dark silty clay, loose to dense, very moist to saturated (ML, OL)
3. Gray, brown silty clay, stiff to very stiff, moist to saturated (CL)
4. Gray, red brown clay, stiff to hard, moist to saturated (CH)
5. Brown silty clay, medium stiff, saturated (CL)
6. Brown silty gravelly sand loose to dense, saturated (SW)
7. Clayey sandy silt medium dense, saturated (ML)
8. Bedrock

Notes:

1) Cross-Section prepared from boring logs included in the Harding Lawson Associates Report entitled: "Remedial Investigation, Gibson Site, Niagara Falls, New York", dated July 31, 1986.

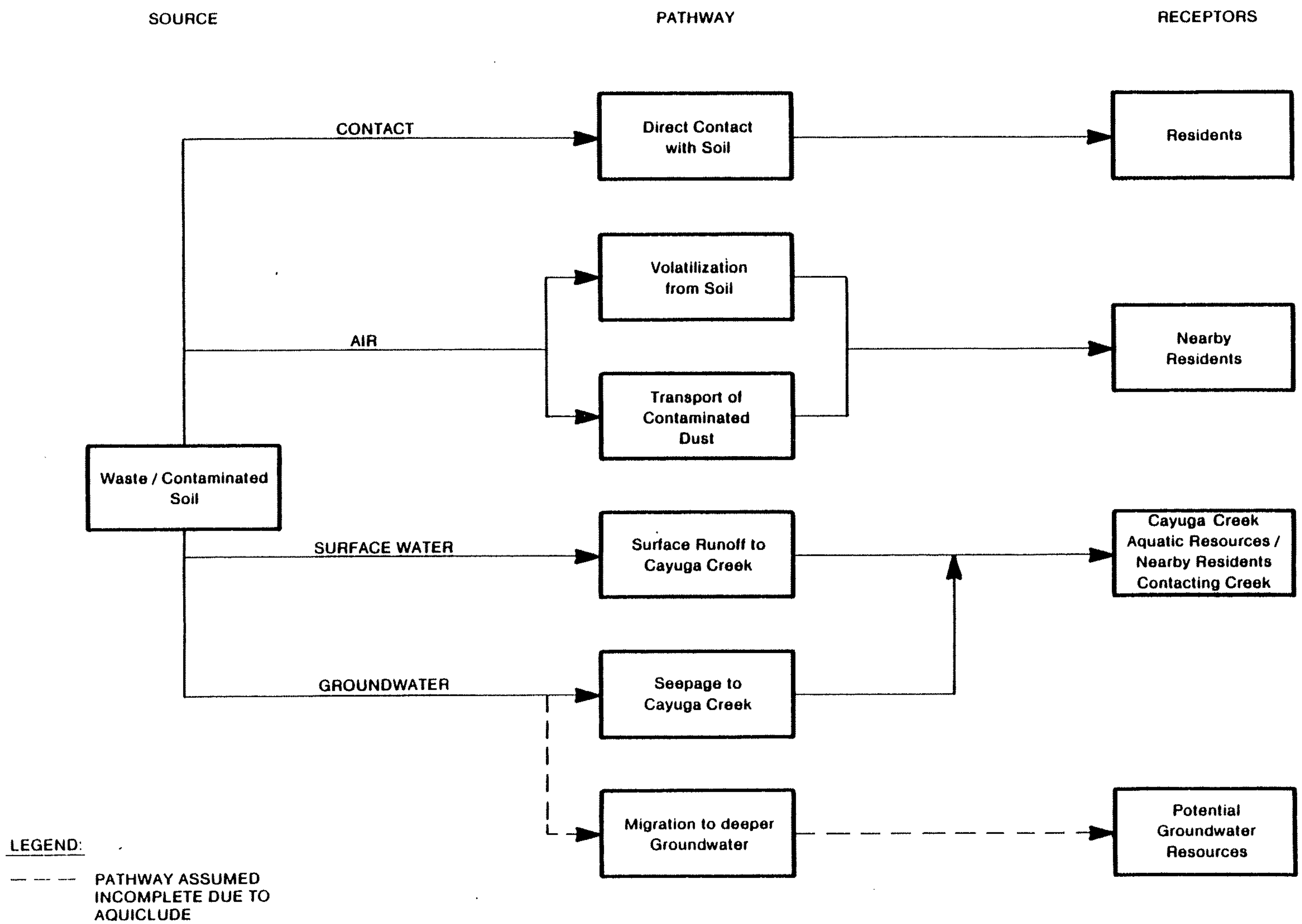
2) Thalweg and highest recorded water level taken from Figure 7, Cayuga Creek Profile, in the report entitled: "Cayuga Creek Water Quality Study(Niagara County, New York), dated August 1975.

INFERRED CROSS-SECTION Y-Y'
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by D.B.	SCALE IN FEET	Date 10/15/86	
Checked by J.V.H.	0 25	Job 86C4201-A	

Figure 5F



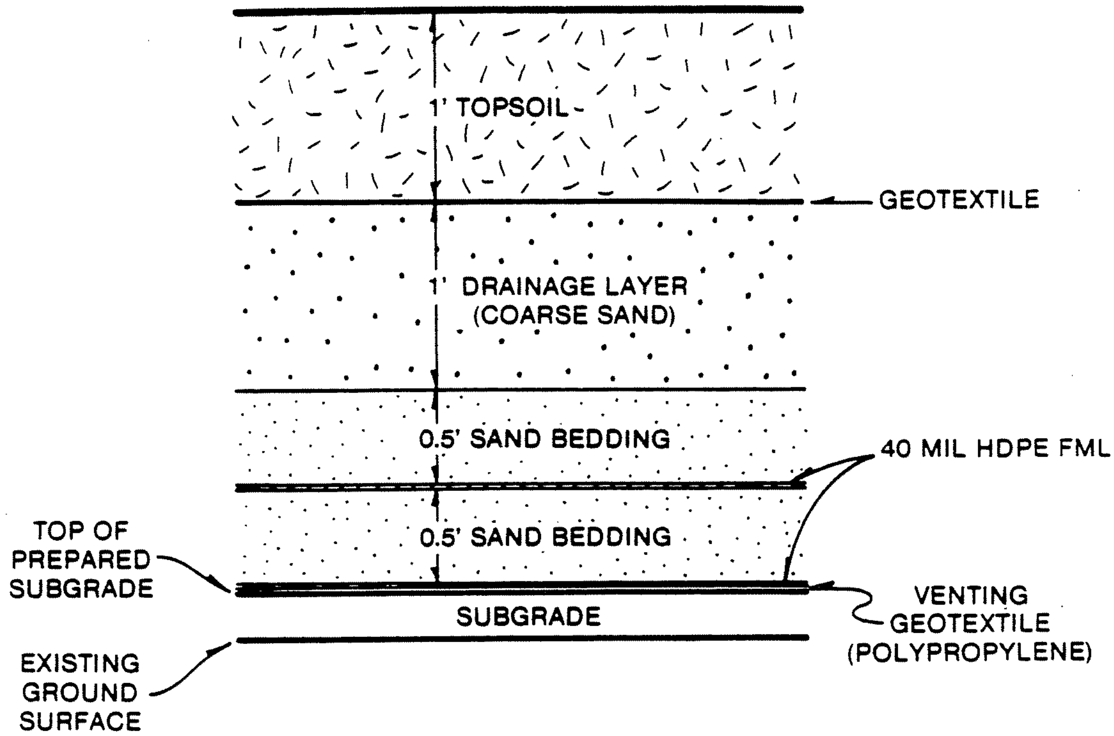
Potential Contaminant Exposure Pathways

Figure 6

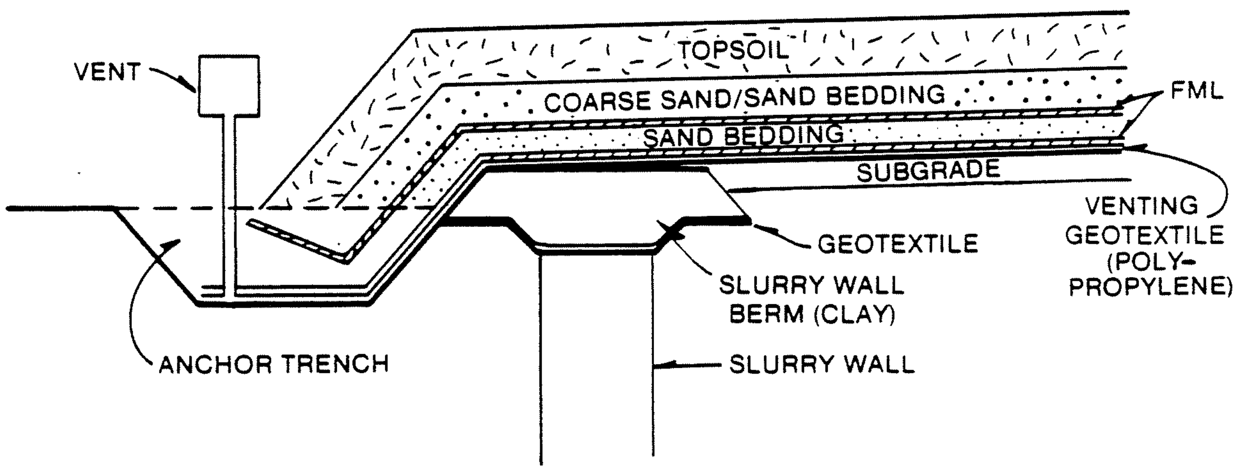
SITE PROBLEM	Air pollution control	Surface water controls	Leachate and groundwater controls	Gas migration control	Waste and soil excavation and removal	Contaminated sediments removal and containment	In situ treatment	Direct waste treatment	Land disposal and temporary storage	Contaminated water and sewer line controls
1. Surface seepage of contaminated groundwater		●	●				●	●		Not Applicable
2. Contaminated site runoff		●	●							Not Applicable
3. High water table resulting in contact between wastes and groundwater		●	●							Not Applicable
4. Precipation infiltrating / percolating through site to form leachate		●	●							Not Applicable
5. Volatilization of chemicals into air	●			●						Not Applicable
6. Contaminated soils	●	●	●		●		●		●	Not Applicable
7. On-site waste materials	●	●	●		●		●		●	Not Applicable
8. Contaminated stream banks and sediments		●	●		●	●	●		●	Not Applicable

APPLICATION OF GENERAL REMEDIAL TECHNOLOGY CATEGORIES TO SITE PROBLEMS
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 7



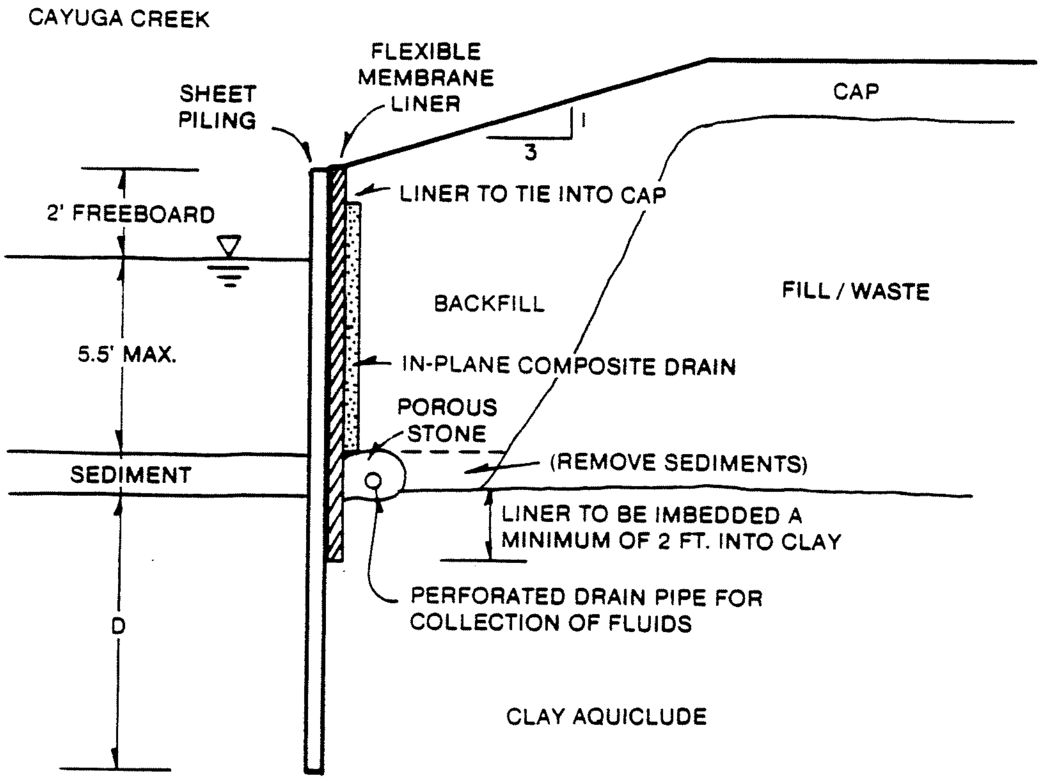
TYPICAL CAP SECTION
N.T.S.



ANCHOR TRENCH DETAIL
N.T.S.

TYPICAL CAP SECTION
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 8

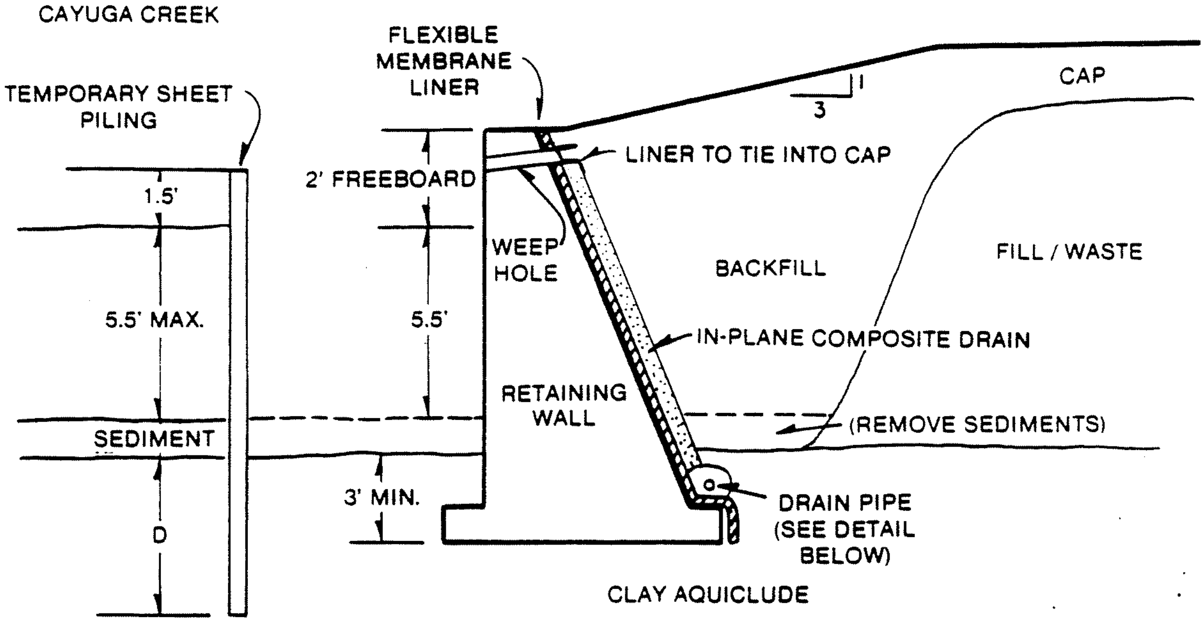


NOT TO SCALE

NOTES: DEPTH OF EMBEDMENT (D) OF SHEET PILING IS DEPENDENT UPON SOIL CONDITIONS AND BACKFILL PROPERTIES

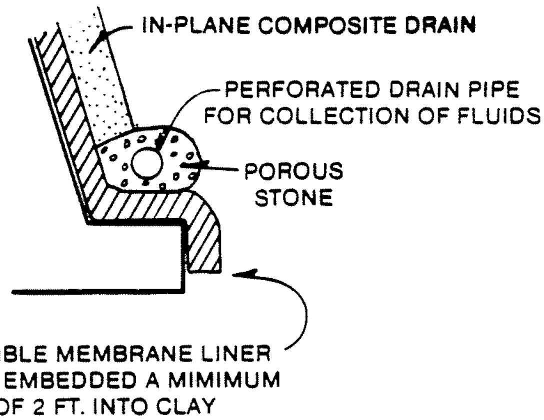
CONCEPTUAL DESIGN OF
PERMANENT SHEET PILING
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 9A



NOTES: DEPTH OF EMBEDMENT (D) OF SHEET PILING IS DEPENDENT UPON SOIL CONDITIONS AND BACKFILL PROPERTIES

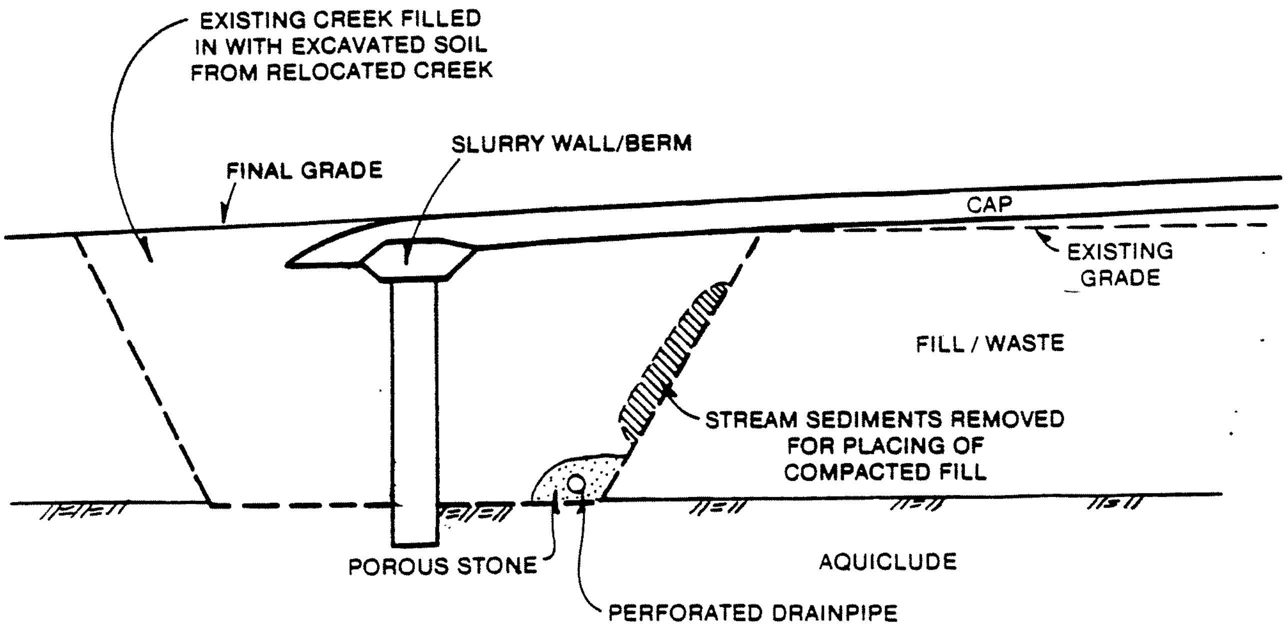
FINAL DESIGN OF RETAINING WALL IS DEPENDENT UPON SOIL CONDITIONS AND BACKFILL PROPERTIES



NOT TO SCALE

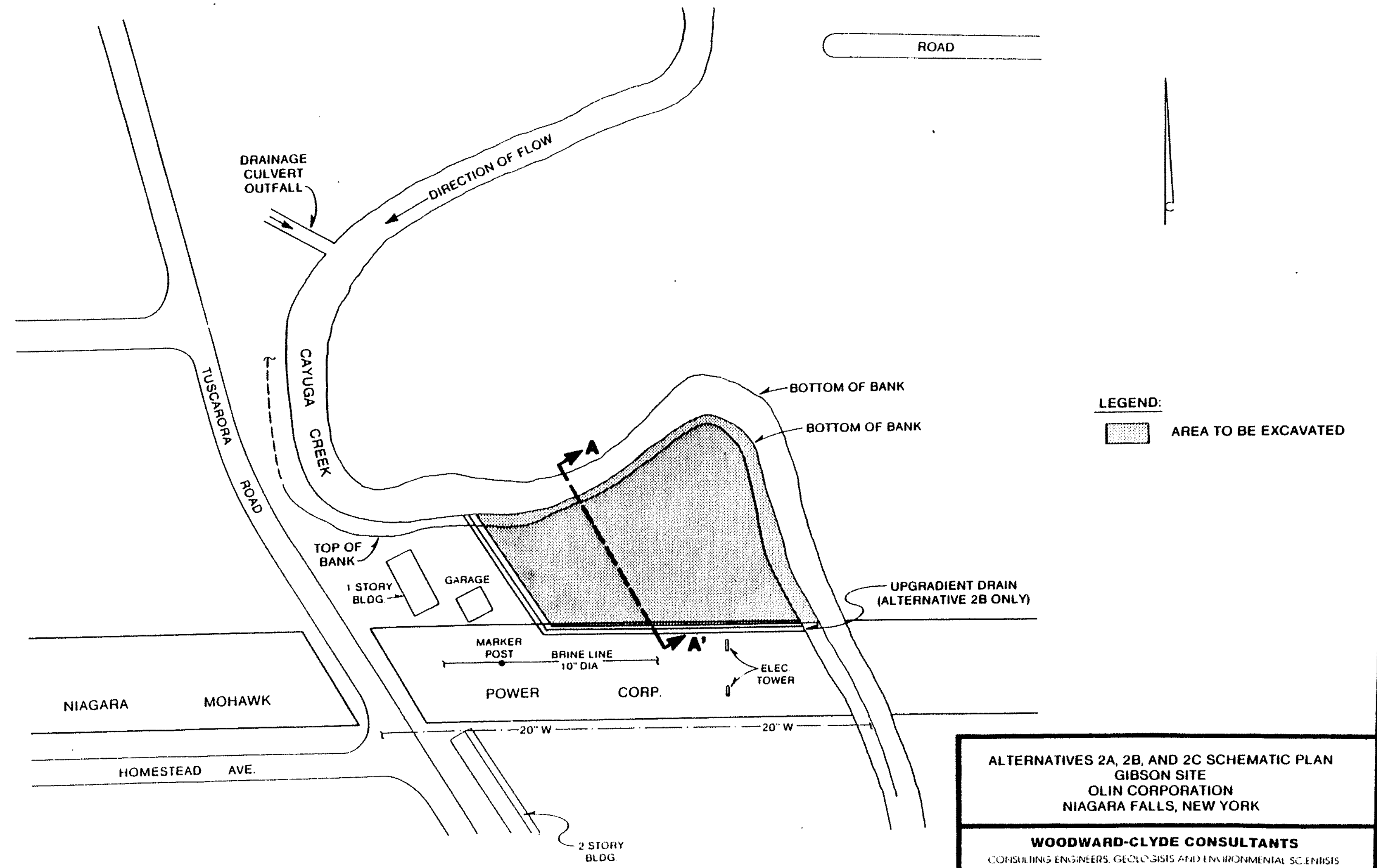
CONCEPTUAL DESIGN OF
CONCRETE RETAINING WALL
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 9B



CONCEPTUAL DESIGN FOR SLURRY WALL
IN THE EXISTING STREAM BED
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 9C

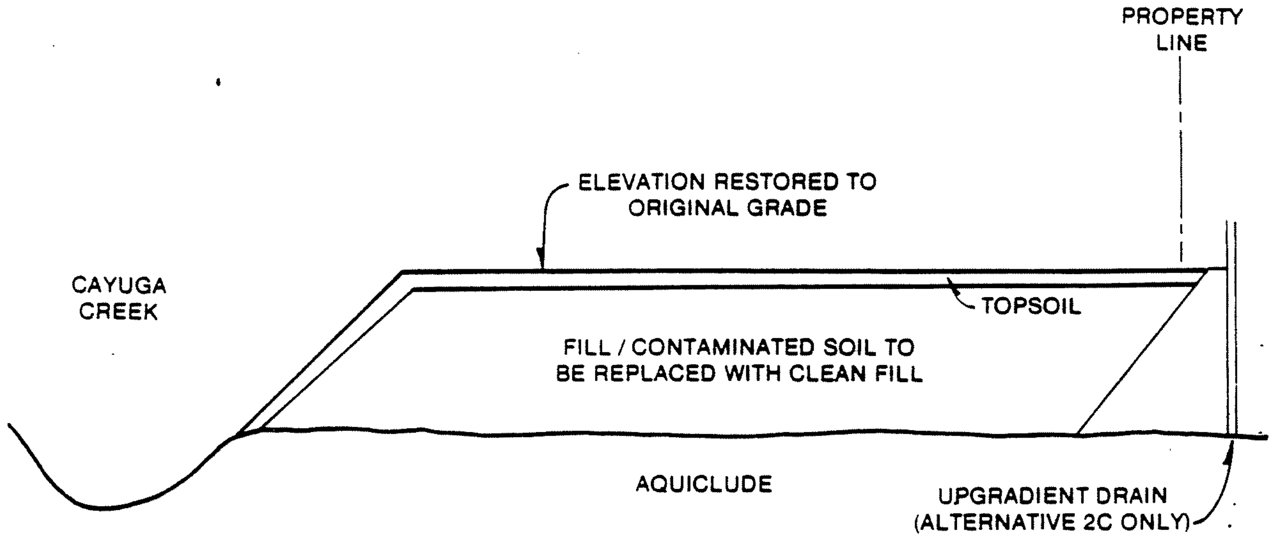


ALTERNATIVES 2A, 2B, AND 2C SCHEMATIC PLAN
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J C	SCALE IN FEET 0 — 75	Date 10/21/86
Checked by J V H		Job 86C4201-A

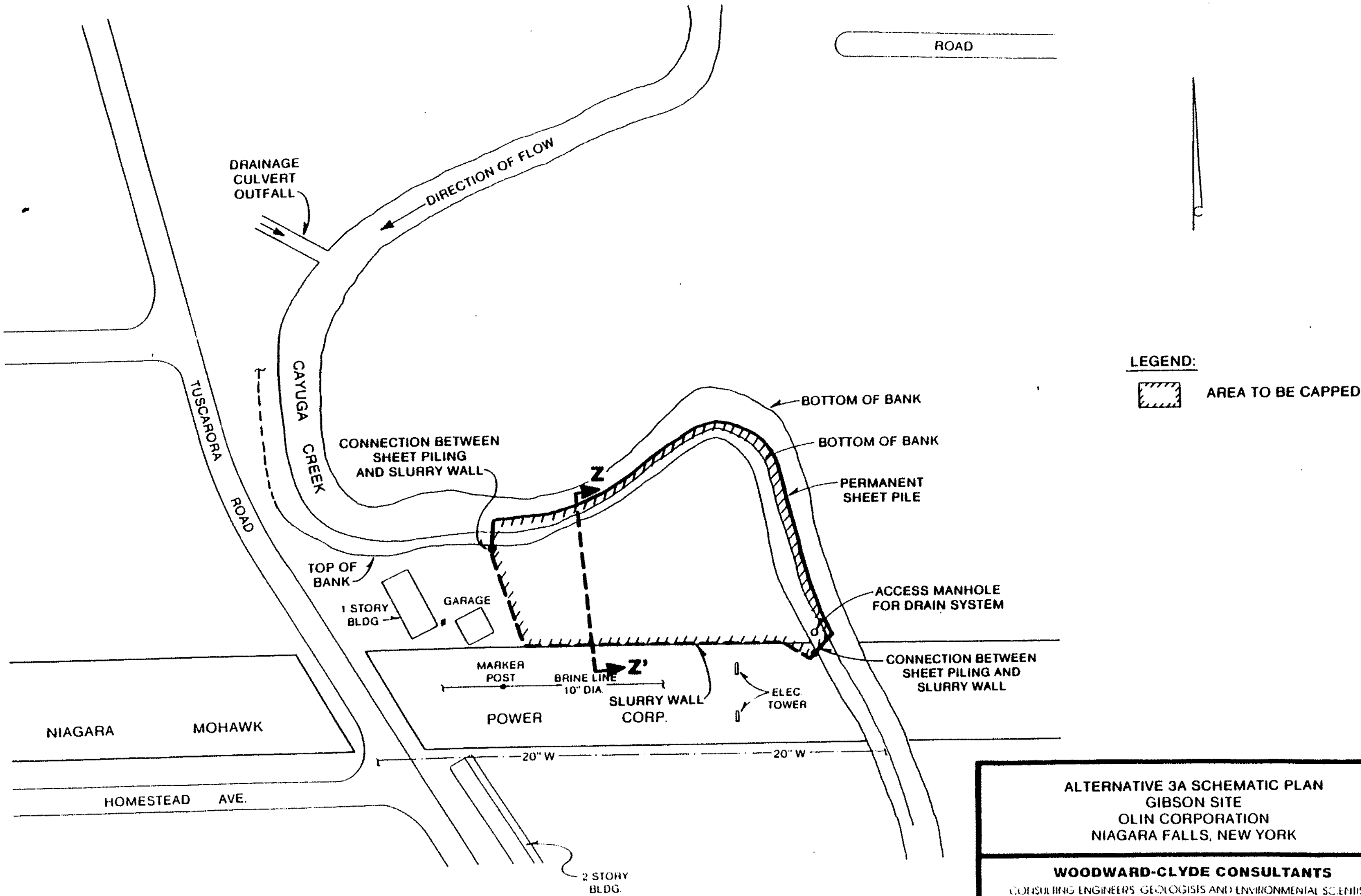
FIGURE 10



SECTION A-A'
N.T.S.

ALTERNATIVES 2A, 2B, AND 2C TYPICAL SECTION
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 11

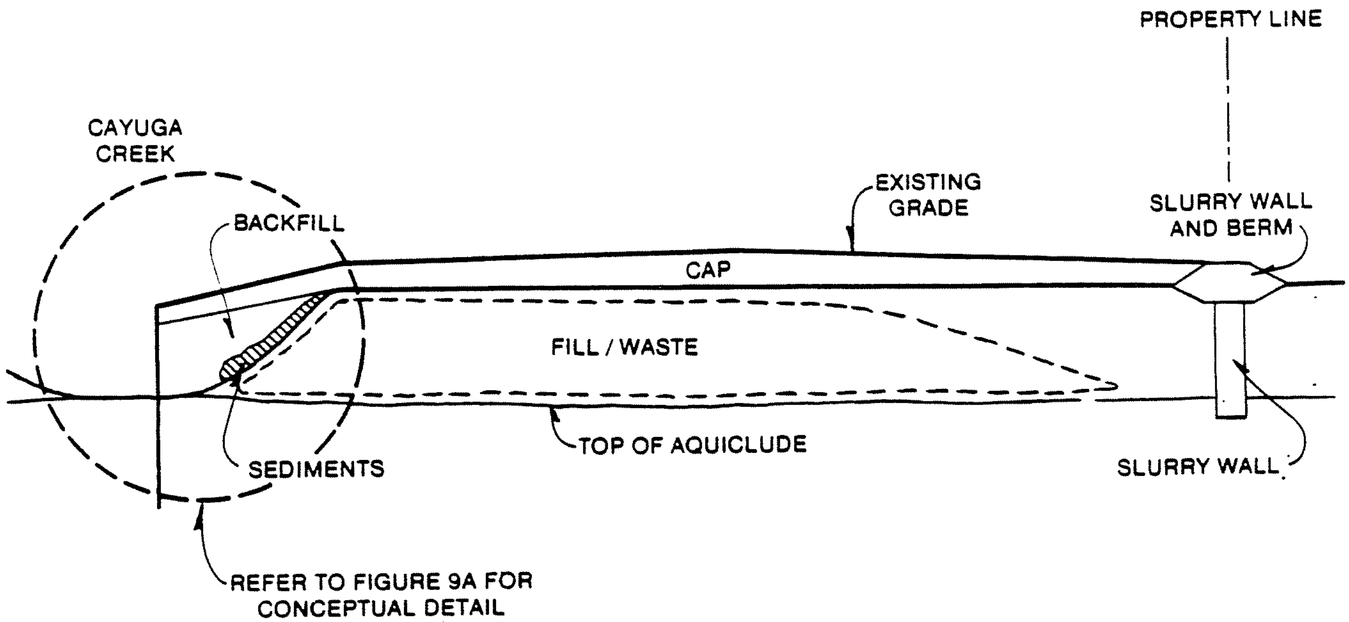


ALTERNATIVE 3A SCHEMATIC PLAN
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J C	SCALE IN FEET 0 75	Date 10/21/86	
Checked by J V H		No. 86C4201 A	

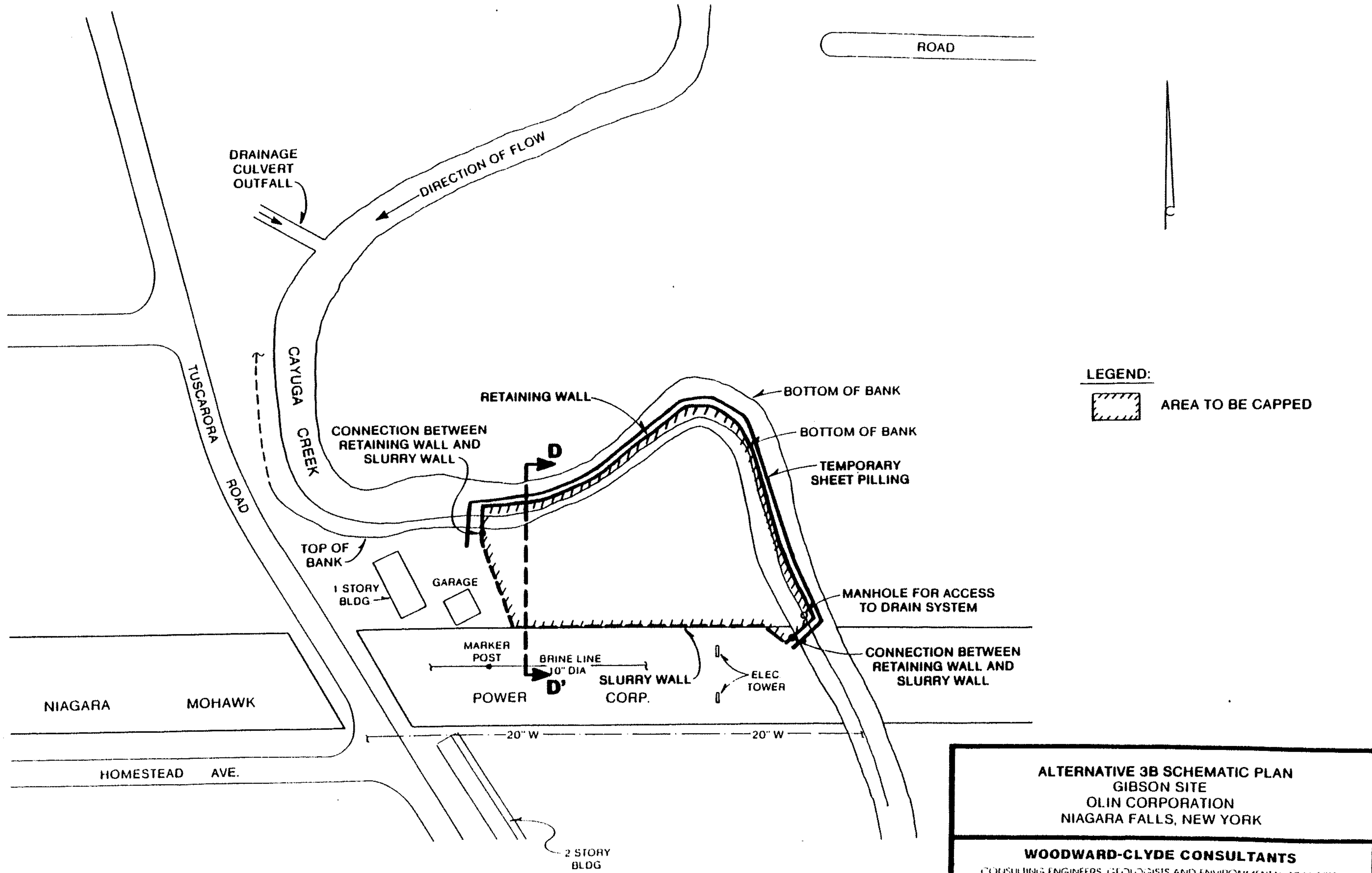
FIGURE 12



SECTION Z-Z'
N.T.S.

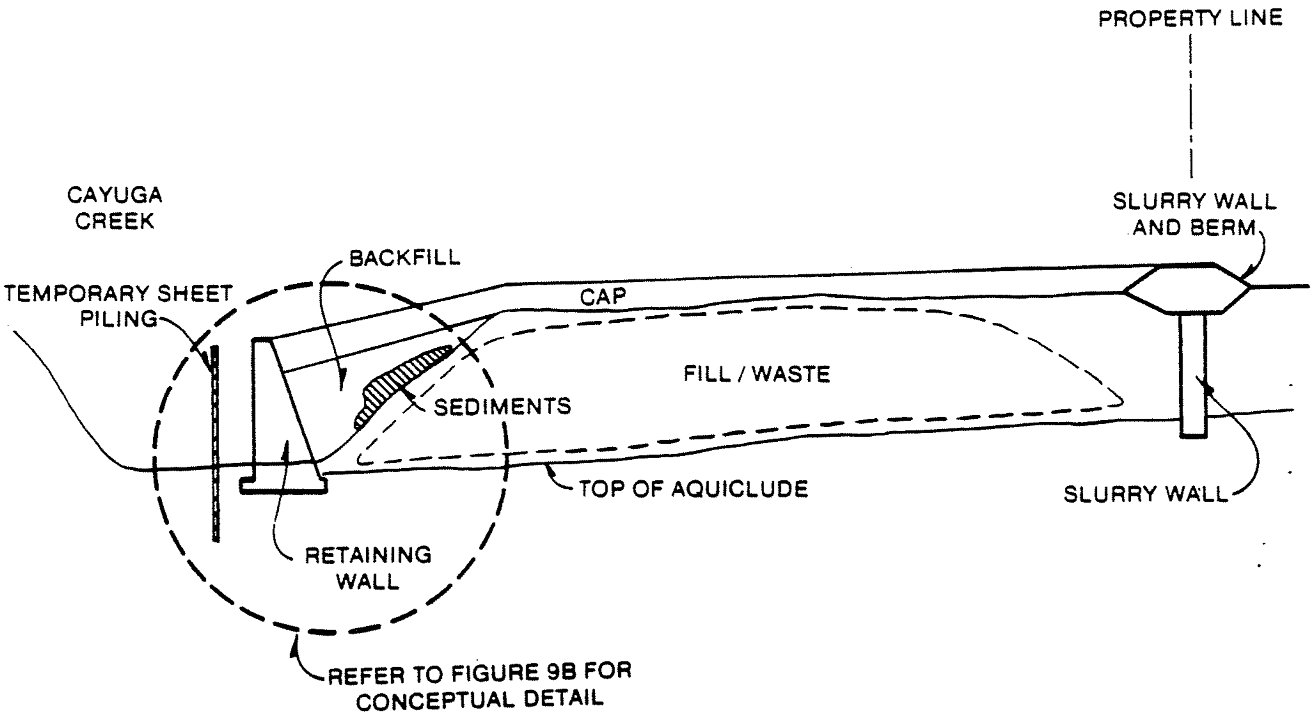
ALTERNATIVE 3A TYPICAL SECTION
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 13



ALTERNATIVE 3B SCHEMATIC PLAN GIBSON SITE OLIN CORPORATION NIAGARA FALLS, NEW YORK		
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS		
Drawn by J C	SCALE IN FEET	Date 10/21/86
Checked by J V H	0 75	86C4201-A

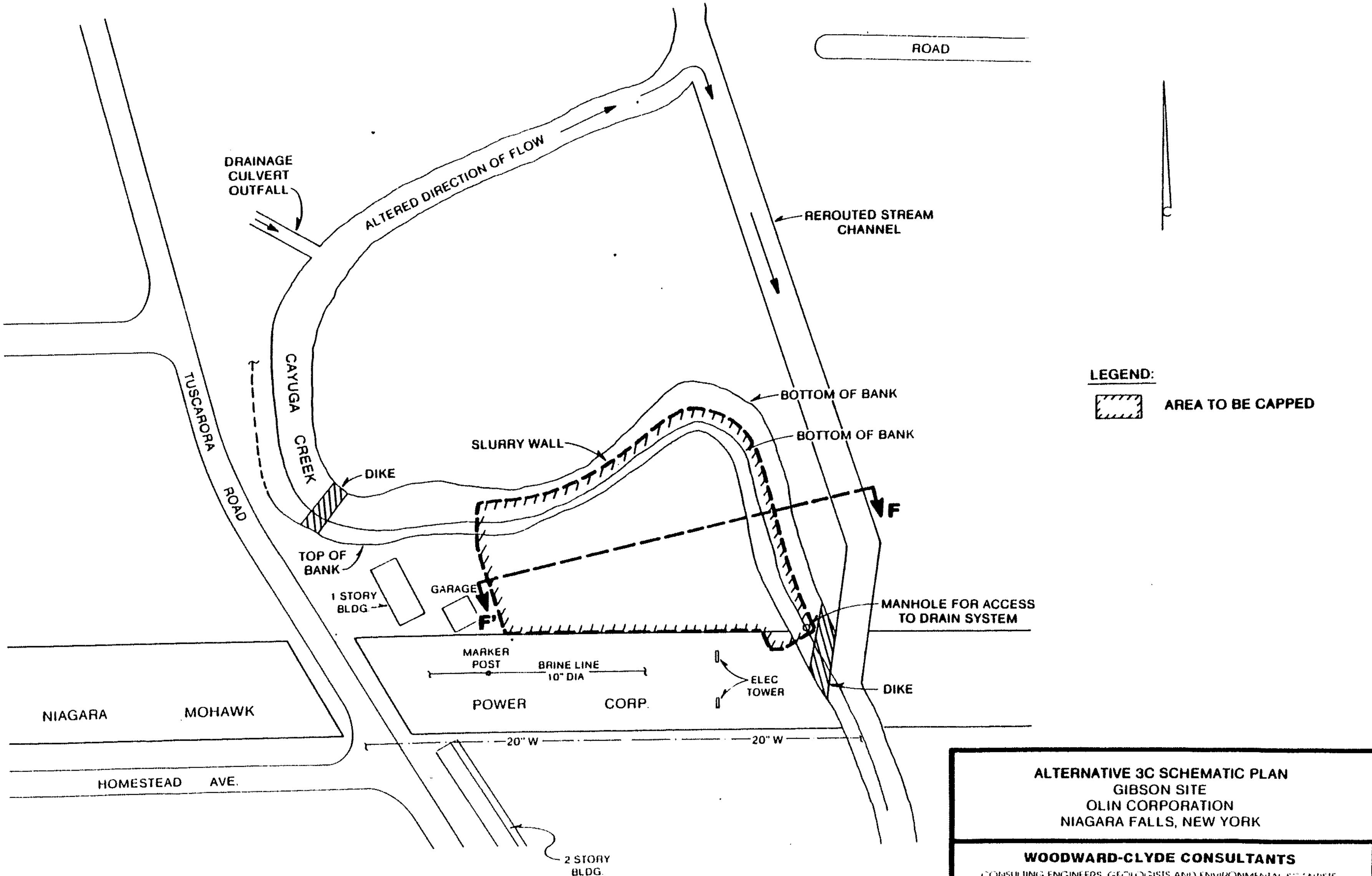
FIGURE 14



SECTION D-D'
N.T.S.

ALTERNATIVE 3B TYPICAL SECTION
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

FIGURE 15

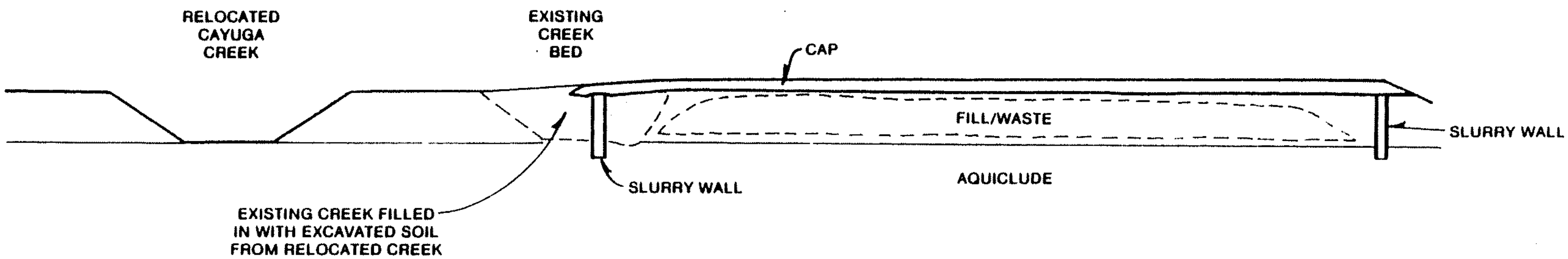


ALTERNATIVE 3C SCHEMATIC PLAN
GIBSON SITE
OLIN CORPORATION
NIAGARA FALLS, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J C	SCALE IN FEET 0 75	Date 10/21/86
Checked by J V H		86C4201-A

FIGURE 16



SECTION F-F'
N.T.S.

ALTERNATIVE 3C TYPICAL SECTION GIBSON SITE OLIN CORPORATION NIAGARA FALLS, NEW YORK		
WOODWARD-CLYDE CONSULTANTS CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS		
Drawn by J.C.	SCALE IN FEET	Date 10/28/86
Checked by J.V.H.	N.T.S	Job 86C4201-A

FIGURE 17

Appendix A

APPENDIX A

BORING LOGS

The boring logs contained in this Appendix are located as shown on Figure 2. These boring logs were taken from the Harding-Lawson Associates report entitled, "Remedial Investigation, Gibson Site, Niagara Falls, New York," dated July 31, 1986.

LOG OF BORING A4

Equipment: Hollow-Stem Auger

Elevation: - Date: 6/7/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
12	5.0(A) 9.0(B)	1.0
26	16.5	1.0
14	12.6	1.0
14	5.5	1.0

Depth (ft): 0, 5, 10, 15

INTERMIXED BROWN CLAY AND CLAYEY SILT
stiff, dry — Fill

WHITE CAKE
medium dense, moist, gray below 4 feet

RED-BROWN SILTY CLAY (CL)
stiff, moist, with roots

End of Boring - 7 feet

LOG OF BORING B2

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/2/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
16	0.9(A) 1.0(B)	0.9
25	1.0	0.9
7	3.2	0.9
6	1.6	0.7
8	5.7	0.8

Depth (ft): 0, 5, 10, 15

BROWN SILTY GRAVELLY SAND
loose, dry

GRAY CAKE AND LIME GRIT — Fill
medium dense, moist
loose, saturated below 4 feet
gravelly 4.5 to 5 feet
intermixed with black fill at 5.5 feet

GRAY SILTY CLAY (CL)
stiff, saturated

RED-BROWN CLAY (CH)
stiff, saturated, with some silt

End of Boring - 10 feet

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LOGS OF BORINGS A4 and B2
Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B2**

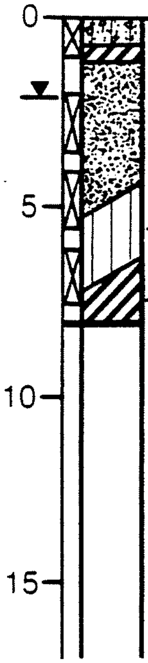
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES.	17497,001.12	KH	10/10/85		

LOG OF BORING B3

Equipment: Hollow-Stem Auger

Elevation: - Date: 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
24	4.9(A) 4.2(B)	1.0
38	4.8	0.9
21	7.6(A) 5.3(B)	0.8
10	42(A) 36(B)	1.0



SILTY SANDY GRAVEL
medium dense, dry
RED-BROWN CLAY
very stiff, moist
GRAY CAKE
very dense, saturated
intermixed with black fill 4.5 to 4.8 feet
BROWN AND GRAY CLAYEY SILT (ML)
medium dense, saturated
RED-BROWN CLAY (CH)
very stiff, very moist
End of Boring - 8 feet

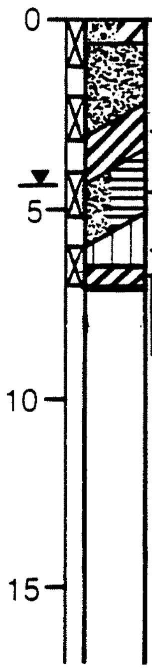
Fill

LOG OF BORING B4

Equipment: Hollow-Stem Auger

Elevation: - Date: 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
20	6.1	1.0
45	15.5(A) 5.6(B)	1.0
10	4.3	0.9
17	5.4(A) 3.2(B)	1.1



BROWN SANDY GRAVEL AND CLAY
medium dense, dry
WHITE CAKE
hard, moist
RED-BROWN AND GRAY CLAY
very stiff, moist
GRAY CAKE AND BLACK GLASS
medium dense, saturated
RED-BROWN CLAYEY SILT (ML)
medium dense, saturated
RED-BROWN CLAY (CH)
very stiff, saturated
End of Boring - 7 feet

Fill

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LOGS OF BORINGS B3 and B4

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B3

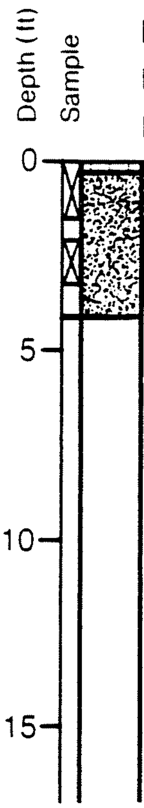
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	17497,001.12	KJH	10/10/85		

LOG OF BORING B5

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/3/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	2.3(A)	
45	31(B)	0.8
77	92	0.8



CLAYEY SILT
dense, slightly moist
WHITE CAKE
very dense, moist
obstruction at 3.9 feet
End of Boring - 4 feet

Fill

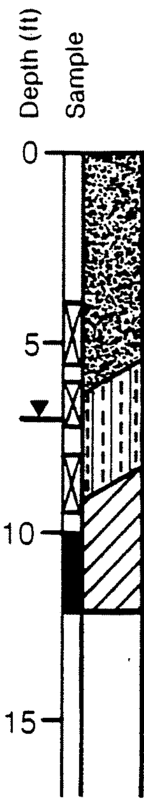
LOG OF BORING B5A

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/3/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	12.3(A)	
31	3.6(B)	0.8
5	6.9	0.7
	16.6(A)	
5	2.2(B)	0.7

Perm.
8.8×10^{-8} cm/sec



Note: Drilled to 4 feet without sampling.

Fill

WHITE CAKE
dense, moist, intermixed with black fill 5 to 5.25 feet
ORGANIC DARK GRAY SILTY CLAY (OL)
soft, moist, with roots in upper 4 inches
sandy 8.4 to 8.7 feet
BROWN CLAY WITH SILT (CL)
very soft, saturated

End of Boring - 12 feet

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LOGS OF BORINGS B5 and B5A
Pine and Tuscarora Site
Niagara Falls, New York

PLATE B4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
Eg. Hg.	17497,001.12	GH	10/10/85		

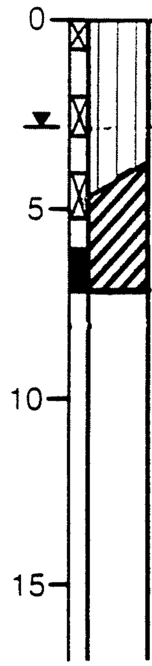
LOG OF BORING C1

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/2/85

Pocket Penetrometer (ksf)	Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	8	2.6	1.3
	7	2.8(A) 1.8(B)	1.3
	15	7.6	1.3
4.5			

Perm. 2.5×10^{-8} cm/sec



BROWN SANDY CLAYEY SILT
loose, dry, trace gravel, with white and gray cake below 0.5 feet — Fill

RED-BROWN CLAY (CH)
hard, moist, blocky, with few silt pockets
End of Boring - 7 feet

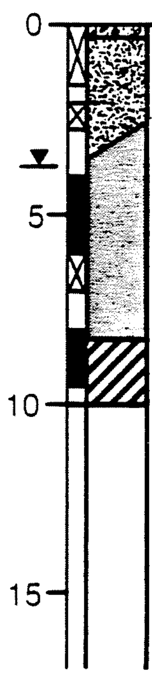
LOG OF BORING C2

Equipment: Hollow-Stem Auger

Elevation: - Date: 6/28/85

Pocket Penetrometer (ksf)	Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	21	5.0(A) 4.0(B)	0.9
	12	4.5	1.0
-	29	5.3 3.2	1.0
1.5			

Perm. 3.3×10^{-8} cm/sec



SILTY SAND AND GRAVEL
medium dense, dry, with roots
WHITE CAKE
medium dense, moist
WHITE AND SPECKLED FLY ASH — Fill
medium dense, layered, saturated

BROWN CLAY (CH)
stiff, saturated
End of Boring - 10 feet

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LOGS OF BORINGS C1 and C2
Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES.	17497,001.12	KHH	10/10/85		

LOG OF BORING C3

Equipment: Hollow-Stem Auger
Elevation: - Date: 6/28/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	5.7(A)	
10	6.0(B)	1.3
10	5.5	1.6
6	3.7	1.6
-	11.4	1.5

Depth (ft): 0, 5, 10, 15

GRAVELLY SILT AND SAND
stiff, dry
WHITE CAKE WITH SOME SILT — Fill
loose to medium dense, dry to 2 feet
moist 2 to 3.75 feet
gray and saturated below 3.75 feet
DARK BROWN ORGANIC CLAY (OL)
soft, saturated
wood encountered at 6.2 feet
End of Boring - 6.2 feet

LOG OF BORING C4

Equipment: Hollow-Stem Auger
Elevation: - Date: 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
	5.1(A)	
13	5.8(B)	1.0
	5.4(A)	
15	4.8(B)	1.0
7	10.2	1.0
10	1.0	0.8
13	3.2	1.0

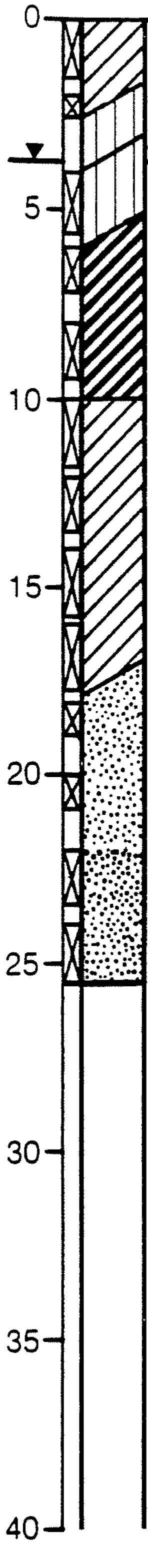
Depth (ft): 0, 5, 10, 15

LIGHT GRAY SILT
medium dense, dry to 3 feet
intermixed with white cake 0.3 to 5.8 feet — Fill
intermixed with black glassy fill 2.0 to 3.8 feet
GRAY CLAYEY SILT (ML)
medium dense, saturated
RED-BROWN CLAY (CH)
stiff, saturated
End of Boring - 10 feet

Equipment Hollow-Stem Auger D1

Elevation - Date 7/2/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
10	2.3	1.3
16	4.4	1.2
5	4.1	1.3
26	2.4	1.3
22	2.4	1.3
7	2.9	1.4
5	3.4	1.3
3	3.2	1.3
6	3.7	1.3
2	15.3	1.3
13	6.2	1.2
41	2.5	1.2
43	3.2	1.0



LIGHT BROWN AND BROWN SILTY CLAY stiff, moist, dry in top 6 inches — Fill

LIGHT BROWN CLAYEY SILT (ML) medium dense, moist

LIGHT BROWN AND GRAY SANDY SILT (ML) loose, saturated

RED-BROWN CLAY (CH) very stiff, moist, with few sandy silt pockets

BROWN SILTY CLAY (CL) medium stiff, saturated very silty with trace of sand from 12.8 to 13.3 feet

BROWN SILTY GRAVELLY SAND (SW) loose to 20 feet, saturated

medium dense 20 to 23 feet

gravel is mainly black metamorphic rock

dense below 23 feet
very gravelly 23 to 23.6 feet

End of Boring 25.6 feet

Bedrock encountered at 25.6 feet.

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LOG OF BORING D1
Pine and Tuscarora Site
Niagara Falls, New York

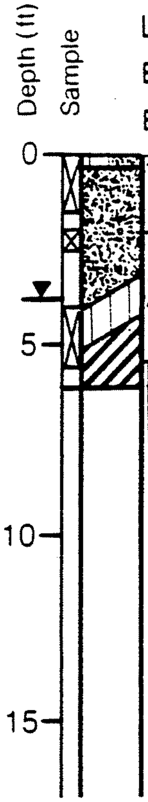
PLATE **B7**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
Eg. Kg.	17497,001.12	[illegible]	10/10/85		

LOG OF BORING D2

Equipment: Hollow-Stem Auger
Elevation: - Date: 6/28/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
16	4.3	1.2
16	4.1	1.0
3	2.7(A) 4.7(B)	1.2



INTERMIXED SANDY SILT AND WHITE CAKE (Fill)
loose, dry with roots

WHITE CAKE
medium dense, moist 1.5 to 3.7 feet

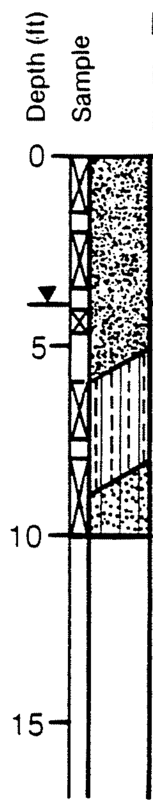
DARK GRAY CLAYEY SILT (ML)
loose, saturated, trace sand

RED-BROWN CLAY (CH)
stiff, very moist
End of Boring - 6 feet

LOG OF BORING D3

Equipment: Hollow-Stem Auger
Elevation: - Date: 6/28/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
8	6.7(A) 3.0(B)	1.6
9	4.7	1.2
7	4.3	1.4
7	13.6(A) 5.4(B)	1.3
5	3.0(A) 1.6(B)	1.3



WHITE CAKE (Fill)
loose, moist, mixed with gravel to 0.35 feet
gray and saturated below 4 feet

DARK GRAY ORGANIC CLAYEY SILT (OL)
loose, saturated, with roots
gray and less silty 7 to 7.3 feet

LIGHT BROWN SILTY SAND (SM)
loose, saturated, trace clay
End of Boring - 10 feet

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LOGS OF BORINGS D2 and D3

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
Ty. Hz.	17497,001.12	KH	10/11/85		

LOG OF BORING D4

Equipment: Hollow-Stem Auger
Elevation: -
Date: 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
16	8.0(A) 3.2(B)	1.2
6	5.2	1.3
7	6.7	1.2
6	5.9	1.2
13	4.5(A) 3.6(B)	1.1

Depth (ft): 0, 5, 10, 15

BROWN TOPSOIL AND SILTY CLAY
stiff, dry
WHITE CAKE
loose, moist
saturated below 4 feet
DARK GRAY CLAYEY SILT (ML)
loose, saturated
(Fill)
GRAY CLAY (CH)
stiff, saturated
red-brown, very stiff below 9 feet
End of Boring - 10 feet

LOG OF BORING D5

Equipment: Hollow-Stem Auger
Elevation: -
Date: 7/10/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
8	0.4	0.3
7	0.4	0.3
7	0.6	0.3
4	0.4(A) 0.4(B)	0.4
5	0.4(A) 0.4(B)	0.4

Depth (ft): 0, 5, 10, 15

FLY ASH
loose, moist
brown clayey silt to 1.5 inches
clayey 1.1 to 1.3 feet
DARK GRAY CLAYEY SILT (ML)
loose, saturated, with wood fibers
RED-BROWN SILTY CLAY (CL)
soft, saturated
End of Boring - 10 feet

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LOGS OF BORINGS D4 and D5
Pine and Tuscarora Site
Niagara Falls, New York

PLATE
B9

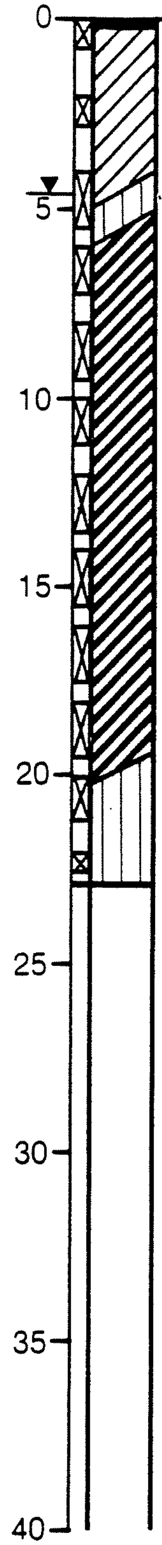
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
Gy Hg	17497,001.12	KH	10/10/85		

Equipment Hollow-Stem Auger E1

Elevation - Date 6/25/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
19	0.2	0.2
10	0.3	0.2
6	1.5(A) 0.7(B)	0.3
26.	4.0	0.4
26	7.2	0.4
11	0.2	0.2
3	0.2	0.2
1	0.4	0.2
3	0.2	0.2
WH*	1.3	0.2
12	1.7	0.2
35/3"	60	0.1

Depth (ft) Sample



3-Inch Paving (Asphalt)
GREEN GRAY SILTY CLAY (CL)
stiff, dry, moist 2 to 4.7 feet

GREEN GRAY SANDY SILT (ML)
loose, saturated
RED-BROWN CLAY (CH)
very stiff, saturated, with trace silt

with iron nodules 8 to 9.5 feet

stiff 10 to 12 feet

soft below 12 feet

CLAYEY SANDY SILT (ML)
medium dense, saturated, trace gravel

End of Boring - 22.75 feet

Bedrock encountered at 22.75 feet.

WH* - Weight of Hammer

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LOG OF BORING E1

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B10

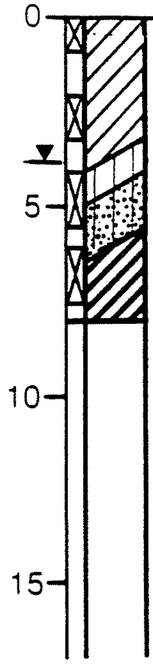
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
Tg. Kg.	17497,001.12	[illegible]	10/10/85		

LOG OF BORING E2

Equipment Hollow-Stem Auger

Elevation - Date 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
22	2.6	1.6
13	1.4	1.2
6	18	1.3
41	34	1.1



BROWN AND GRAY SILTY CLAY (CL)
very stiff, moist, gravelly to 0.5 feet

GRAY CLAYEY SILT (ML)
loose, saturated

GRAY SILTY SAND WITH CLAY (SM)
loose, saturated

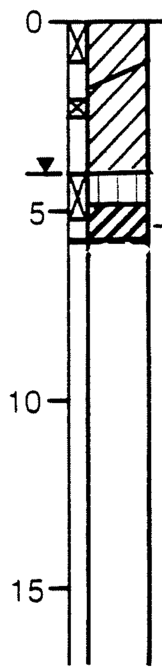
RED-BROWN CLAY (CH)
very stiff, saturated
End of Boring - 8 feet

LOG OF BORING E3

Equipment Hollow-Stem Auger

Elevation - Date 6/26/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
21	5.6	0.6
17	5.1	0.8
15	22(A) 44(B)	0.8



LIGHT BROWN SILTY CLAY
very stiff, moist

BROWN SANDY CLAY
very stiff, moist, trace gravel

Fill

DARK BROWN SANDY SILT (ML)
medium dense, saturated

RED-BROWN CLAY (CH)
stiff, moist
End of Boring - 5.5 feet

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LOGS OF BORINGS E2 and E3

Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B11**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES	17497,001.12	KH	10/11/85		

LOG OF BORING E4

Equipment: Hollow-Stem Auger

Elevation: -   Date: 6/26/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
18	9.0(A) 16.0(B)	0.8
10	46	1.2
22	8.0	0.8

Depth (ft): 0, 5, 10, 15

BROWN SANDY SILT — Fill
medium dense, dry, trace gravel

RED-BROWN AND GRAY SILTY CLAY (CL)
stiff, moist

GRAY-GREEN CLAYEY SILT (ML)
medium dense, moist

RED-BROWN CLAY (CH)
very stiff, moist

End of Boring - 5.5 feet

LOG OF BORING E5

Equipment: Hollow-Stem Auger

Elevation: -   Date: 6/26/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
18	10.8	1.0
10	12.3(A) 9.4(B)	1.2
7	34	0.9
4	28	1.0
5	31(A) 8.8(B)	0.8
4	11.7	1.0
2	5.2(A) 4.6(B)	1.0

Depth (ft): 0, 5, 10, 15

LIGHT GRAY SILTY SAND
medium dense, dry, trace gravel
Fill

BROWN SILTY CLAY (CL)
medium stiff, moist

DARK GRAY ORGANIC CLAYEY SILT (OL)
loose, saturated, with roots and trace gravel

DARK GRAY CLAYEY SILT (ML)
loose, saturated
sandy 9.5 to 10 feet

RED-BROWN CLAY WITH SOME SILT (CL)
soft, saturated

DARK GRAY CLAYEY SANDY SILT (ML)
loose, saturated, with small teeth

End of Boring - 14 feet

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LOGS OF BORINGS E4 AND E5

Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B12**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
EB.	17497,001.12	KH	10/11/85		

LOG OF BORING E6

Equipment: Hollow-Stem Auger

Elevation: - Date: 6/27/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
12	1.6	1.0
3	1.6	1.2
4	5.9	1.4
5	43(A) 8.0(B)	1.4

Depth (ft): 0, 5, 10, 15

CLAYEY CONSTRUCTION DEBRIS AND GRAVEL
loose, dry to 2 feet

BROWN SILTY CLAY
soft, moist

RED-BROWN CLAY
soft, saturated

BROWN ORGANIC CLAY (OH)
soft, saturated

End of Boring - 7.5 feet

Fill

LOG OF BORING F2

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/1/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
15	4.0(A) 1.7(B)	1.0
13	42	1.3
6	14.6(A) 16.3(B)	1.7
38	13.6	1.6

Depth (ft): 0, 5, 10, 15

BROWN GRAVELLY SILT
medium dense, dry

Fill

GRAY AND LIGHT BROWN INTERLAYERED SANDY SILT (ML) AND SILTY SAND (SM)
loose, saturated

RED-BROWN CLAY (CH)
hard, moist, with few silt pockets

End of Boring - 8 feet

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LOGS OF BORINGS E6 AND F2

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B13

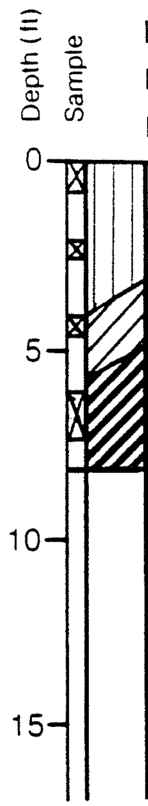
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES	17497,001.12	KHH	10/11/85		

LOG OF BORING X1

Equipment Hollow-Stem Auger

Elevation - Date 7/3/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
6	2.0	1.0
8	2.0	1.0
13	23	0.9
20	3.6	1.0



LIGHT BROWN AND GRAY CLAYEY SILT
loose, moist, trace gravel
Fill

BROWN SILTY CLAY (CL)
stiff, moist

RED-BROWN CLAY (CH)
very stiff, moist

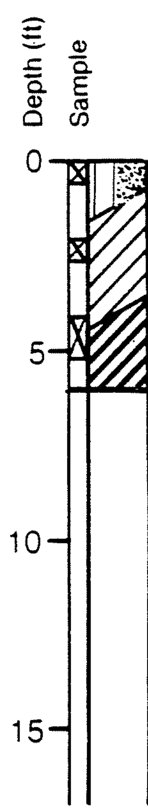
End of Boring - 8 feet

LOG OF BORING X2

Equipment Hollow-Stem Auger

Elevation - Date 7/3/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
5	4.3	1.4
10	2.5	1.0
21	6.1	1.0



CLAYEY SILT WITH SOME CAKE Fill
loose, dry

LIGHT BROWN SILTY CLAY (CL)
stiff, moist

RED-BROWN CLAY (CH)
very stiff, moist, with few silt pockets

End of Boring - 6 feet

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LOGS OF BORINGS X1 AND X2

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B23

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES.	17497,001.12	KH	10/11/85		

LOG OF BORING X3

Equipment: Hollow-Stem Auger
Elevation: - Date: 7/3/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Description
10	3.8(A) 2.7(B)	1.2	0	GRAVELLY CLAYEY SILT medium dense, moist, with trace cake (or fly ash) — Fill
12	3.2	1.2		
16	36	1.2	5	RED-BROWN CLAY (CH) very stiff, moist
				End of Boring - 6 feet
			10	
			15	

LOG OF BORING Y1

Equipment: Hollow-Stem Auger
Elevation: - Date: 7/9/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Description
14	0.5(A) 0.5(B)	0.5	0	MIXED Fill AND FLY ASH WITH SILTY SAND medium dense, moist loose below 2 feet saturated below 4 feet wood 4.5 to 4.7 feet — Fill
8	0.4	0.4		
7	1.0(A) 0.9(B)	0.4	5	
5	20	0.3		
5	5.8(A) 2.0(B)	0.4		BROWN CLAYEY SILT (ML) loose, saturated, trace sand
			10	End of Boring - 10 feet
			15	

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LOGS OF BORINGS X3 AND Y1

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B24

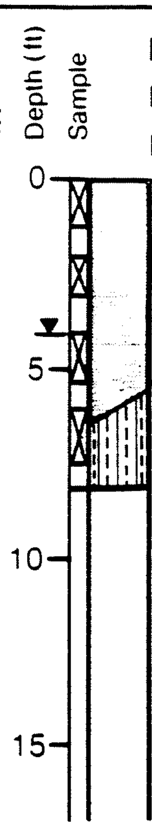
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
EB.	17497,001.12	KH	10/11/85		

LOG OF BORING Y2

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/9/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
24	9.7	0.4
7	3.8	0.4
13	3.1	0.4
5	3.1	0.4



MIXED FLY ASH, AND BROWN SILTY SAND
medium dense, moist
loose 2 to 3.5 feet

Fill

DARK GRAY ORGANIC SILTY CLAY (OL)
soft, saturated

End of Boring - 8 feet

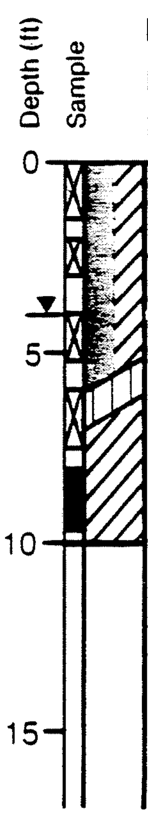
LOG OF BORING Y3

Equipment: Hollow-Stem Auger

Elevation: - Date: 7/9/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)
10	2.3(A) 1.2(B)	1.0
8	1.8	0.9
14	1.7	0.7
6	2.9(A) 2.8(B)	0.8

Perm.
13.4×10^{-8} cm/sec



FLY ASH WITH BROWN SILTY CLAY
medium dense with some white cake 1 to 2 feet

Fill

DARK GRAY CLAYEY SILT (ML)
loose, saturated, with wood fibers

GRAY SILTY CLAY (CL)
very stiff, saturated

End of Boring - 10 feet

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LOGS OF BORINGS Y2 AND Y3
Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B25**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	17497,001.12	KHL	10/11/85		

LOG OF BORING Y4

Equipment: Hollow-Stem Auger
Elevation: - Date: 7/9/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Description
			0	FLY ASH loose, moist, with some white cake 1 to 2 feet — Fill
5	1.1	0.8		
5	0.8	0.7		
2	7.8(A) 7.3(B)	0.8	5	DARK GRAY ORGANIC CLAYEY SILT (OL) loose, saturated
				End of Boring - 6 feet
			10	
			15	

LOG OF BORING Y5

Equipment: Hollow-Stem Auger
Elevation: - Date: 7/9/85

Depth (ft)	Description
0	BROWN CLAYEY SILT — Fill loose, dry (refusal encountered at 0.75 feet) End of Boring - 0.75 feet
5	
10	
15	

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LOGS OF BORINGS Y4 AND Y5

Pine and Tuscarora Site
Niagara Falls, New York

PLATE B26

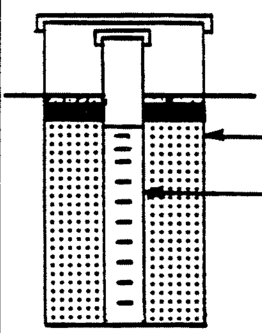
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	17497,001.12	[signature]	10/11/85		

LOG OF BORING Y5A

Equipment: Hollow-Stem Auger
Elevation: -   Date: 7/9/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Sample	Description
17	1.7	0.9	0	X	DARK BROWN TOPSOIL AND FLY ASH (Fill)
					RED-BROWN AND BROWN CLAY (CH) very stiff, moist
					End of Boring - 2 feet
			5		
			10		
			15		

MONITORING WELL DETAIL *



LOG OF BORING MW1

Equipment: Hollow-Stem Auger
Elevation: -   Date: 7/5/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Sample	Description
			0		BROWN AND GRAY SILTY CLAY (CL) saturated below 3.5 feet
					BROWN SILTY SAND (SM) loose, saturated, with trace clay
	0.6(A)				
17	0.7(B)	0.6	5	X	RED-BROWN SILTY CLAY (CL) very stiff, moist
					End of Boring - 6.5 feet
			10		
			15		

Note: Augered without sampling to 4.5 feet. Classification based on auger cuttings and nearby boring(s).

* For Detail refer to plate 12

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LOGS OF BORINGS Y5A AND MW1
Pine and Tuscarora Site
Niagara Falls, New York

PLATE B27

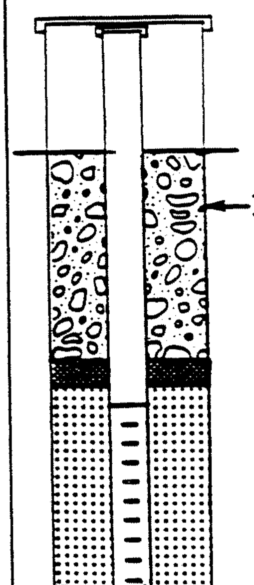
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	17497,001.12	KH	10/10/85	DH	7/22/86

LOG OF BORING MW5

Equipment: Hollow-Stem Auger
Elevation: -
Date: 7/8/85

PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Sample	Description
		0		BROWN SANDY CLAYEY SILT with trace gravel — Fill
				refusal (concrete) encountered at 5.2 feet
0.3	0.5	5		End of Boring - 5.2 feet
				Note: Augered without sampling. Classification based on auger cuttings.
		10		
		15		

MONITORING WELL DETAIL *



LOG OF BORING MW5A

Equipment: Hollow-Stem Auger
Elevation: -
Date: 7/8/85

Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Sample	Description
			0		BROWN SANDY CLAY AND SILT WITH CONSTRUCTION DEBRIS — Fill
			5		concrete 5.5 to 5.7 feet
13	0.4	0.4			
	0.5(A)				DARK GRAY CLAYEY SILT (ML) loose, saturated, with wood fibers
9	0.5(B)	0.5			
4	0.7	0.4	10		brown and gray below 10 feet
					End of Boring 11.2 feet
					Note: Augered without sampling to 5 feet. Classification based on auger cuttings and nearby boring(s).
			15		

* For Detail refer to Plate 12

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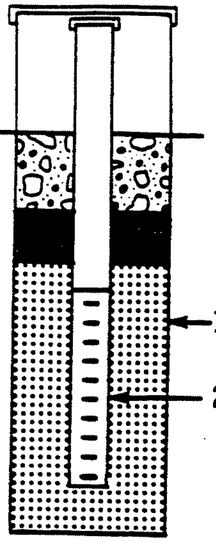
LOGS OF BORINGS MW5 AND MW5A
Pine and Tuscarora Site
Niagara Falls, New York

PLATE B30

DRAWN: ES | JOB NUMBER: 17497,001.12 | APPROVED: [signature] | DATE: 10/11/85 | REVISED: [signature] | DATE: 7/22/86

MONITORING WELL *

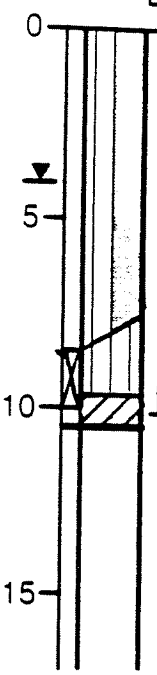


Blows/foot	PID Headspace (ppm)	PID Background (ppm)	Depth (ft)	Sample
	0.5(A)			
4	0.4(B)	0.3	10	

LOG OF BORING MW6

Equipment Hollow-Stem Auger

Elevation - Date 7/10/85



BROWN CLAYEY SILT WITH CONCRETE, GRAVEL, AND PARTIALLY CEMENTED FLY ASH

Fill

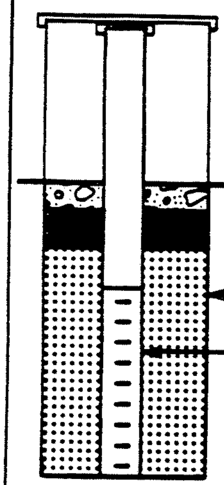
DARK GRAY CLAYEY SILT (ML)
loose, saturated

RED-BROWN SILTY CLAY (CL)
soft, saturated

End of Boring - 10.5 feet

Note: Augered without sampling to 8 feet. Classification based on auger cuttings and nearby boring(s).

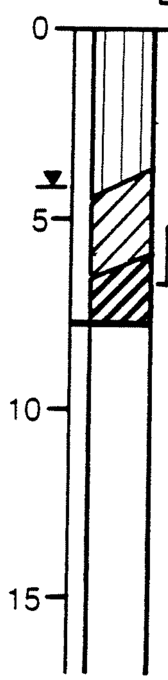
MONITORING WELL *
DETAIL



LOG OF BORING MW7

Equipment Hollow-Stem Auger

Elevation - Date 7/8/85



LIGHT BROWN AND GRAY CLAYEY SILT
with trace gravel

Fill

BROWN SILTY CLAY (CL)

RED-BROWN CLAY (CH)

End of Boring - 7.8 feet

Note: Augered without sampling. Classification based on auger cuttings.

* For Detail refer to plate 12

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LOGS OF BORINGS MW6 AND MW7

Pine and Tuscarora Site
Niagara Falls, New York

PLATE **B31**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	17497,001.12	KB	10/11/85	BH	7/22/86

Appendix B

APPENDIX B

RISK ASSESSMENT

ASSESSMENT OF POTENTIAL RISK FOR NO ACTION ALTERNATIVE

INTRODUCTION

The assessment of potential risk for the no action alternative considers the potential pathways of site contaminants in the environment, as well as the physical/chemical and toxicological properties of the contaminants. The contaminants considered in this assessment are hexachlorobenzene (HCB), and the various isomers of benzene hexachloride (BHC), also known as hexachlorocyclohexane, which represent the major contaminants known to be present at the site. Only BHC has been detected in environmental samples collected from the site to date. The HCB wastes are suspected to be contained in drums in the eastern portion of the site.

CONTAMINANT PATHWAYS

Figure B-1 illustrates the major potential pathways for contaminants at the site, including sources, pathways, and potential receptors. The primary sources of contaminants are wastes deposited at the site and contaminated soils. Four general exposure routes are considered:

- o Direct contact;
- o Airborne;
- o Surface water; and
- o Groundwater.

Direct contact with soils is expected to be limited to residents or visitors to the site.

Airborne exposure may occur through volatilization of contaminants or by airborne transport of contaminated soil or waste particulates (fugitive dust). Potential airborne exposures could impact nearby residents.

Surface water exposures may occur from transport of contaminated particulates in surface runoff from the site into Cayuga Creek. Seepage of groundwater may also carry contaminants to the Creek. Because Cayuga Creek discharges to the Niagara River, affected populations could potentially include aquatic resources in Cayuga Creek or the Niagara River. There is also the potential for exposure to people contacting these water bodies or by ingesting water and/or aquatic biota.

The only known potential route of exposure to groundwater contaminants is via seepage of shallow groundwater to Cayuga Creek. Based upon results of geotechnical testing performed during the RI, the clay layer beneath the site is believed to form an aquiclude that prevents migration of contaminants to deeper water-bearing zones.

CONTAMINANT PROPERTIES

This section summarizes the physical/chemical and toxicological properties of site contaminants. Physical/chemical properties are discussed in relation to potential environmental transport routes. Toxicological properties are discussed to identify known and suspected hazards associated with these contaminants.

BENZENE HEXACHLORIDE

Table B-1 illustrates the major physical properties of BHC, which is a mixture of as several different isomers. The most studied isomer is the gamma isomer, commonly known as the pesticide lindane. Because it has been extensively studied, data on lindane as presented for comparison to the alpha and beta isomers.

ENVIRONMENTAL FATE

All isomers of BHC have similar chemical and physical properties and therefore behave in a similar way in the environment. The two main properties that affect the fate of BHC in the environment are its very low solubility and vapor pressure, which reduce the possibility of transport via water or volatilization. These factors, combined with a high oil/water partition coefficient, result in BHC's affinity for soil particles. BHC present in soil will tend to remain adhered to soil particles. BHC present in surface or groundwater will tend to be adsorbed onto sediment and suspended particulates. Transport in air would be primarily via dust particles, although volatilization of BHC from soils has been reported.

BHC is degraded in the environment primarily through biotransformation and biodegradation. However, quantitative data on these processes and others, such as photolysis, oxidation, and hydrolysis are limited. Most degradation studies were performed on lindane, but may be representative of the degradation of the alpha and beta isomers. Many studies have suggested that lindane will first degrade to beta-BHC, thus accounting for its quicker apparent loss in laboratory studies. Overall, data are lacking to establish a half-life for any degradation process or conditions that may effect degradation.

TOXICITY

The gamma isomer of BHC (lindane) is used as a pesticide in seed treatment, wood preservation, and various pharmaceutical preparations. The majority of toxicological research has been limited to the gamma isomer because of its extensive use as a pesticide.

Lindane exposure can be via inhalation, ingestion, or dermal absorption. The lethal dose for adult humans appears to be approximately 100 mg/kg body weight. Below the lethal dose, nervous system effects include seizure and uncontrollable eye movements. The effects of sub-lethal dose appear to be reversible within one year after exposure. Laboratory studies have shown that lindane affects white blood cell production and cell growth.

Short-term acute effects consist mostly of nervous system aberrations. The minimum dose to see acute effects vary widely between species. Because of its relatively high solubility and rapid adsorption, a very narrow range is observed between the minimum effective dose and the lethal dose. Symptoms occur soon after exposure, but toxic effects are reversible due to rapid metabolization.

Data on the effects of long-term exposure to humans are limited and concerned mostly with chronic and sub-chronic toxic effects rather than carcinogenicity. Extensive tests have been conducted with animals for long-term toxic, mutagenic, and carcinogenic effects. Lindane appears to have a low bioaccumulation rate. The long-term effects of chronic and subchronic doses manifest themselves in liver and kidney damage. Studies show that lindane is not mutagenic, but data on its mutagenicity are limited.

Carcinogenic studies with animals utilized ingestion as the route of exposure. The results of these studies show possible carcinogenicity, but these results are inconclusive. Lindane and beta-BHC are classified as Group C carcinogens by the USEPA Carcinogen Assessment Group (CAG), which means there is a lack of human data and ambiguous animal data on their carcinogenicity. However, alpha-BHC is classified as a Group B2 carcinogen by CAG, which means that the animal data are strongly suggestive of carcinogenicity (Personal communication, Robert McCaughey, Senior Scientist with the CAG, October 23, 1986).

Exposure limits for various systemic and carcinogenic effects of BHC isomers are shown on Table B-2. Details of how these numbers were reached and other supporting evidence can be obtained from the documents referenced in Table B-2.

SUMMARY OF TOXICITY CRITERIA

Exposure limits for BHC listed on Table B-2 are all calculated for an adult human weighing 70 kg. The limits are based on a 1 in 100,000 (10^{-5}) increased risk of cancer (over a lifetime), with the route of exposure assumed to be a daily ingestion of 2 liters of water with either 0.03, 0.19, or 0.265 ug/l of alpha-, beta-, or gamma-BHC, respectively. This is equivalent to a daily dose of 0.06, 0.38, or 0.53 ug per day of alpha-, beta-, or gamma-BHC. The NYS water quality criterion for protection of human health is 0.02 ug/l for the sum of all isomers.

The maximum allowable dose (for no systemic effects) of gamma-BHC through ingestion of 2 liters of water per day (with 10 ug/l gamma-BHC) is 20 ug per day. Data are not available for alpha- or beta-BHC. The maximum allowable dose (for no systemic effects) of gamma-BHC via airborne contamination through skin absorption is 0.5 mg/m^3, assuming the duration of exposure is 8 hours per day, 5 days per week. There are no data for skin absorption of alpha- or beta-BHC. Data are not available concerning either systemic toxic effects or carcinogenic effects for any BHC isomer via inhalation. Transport of HCB via air is possible by either adherence to dust particles or by volatilization.

HEXACHLOROBENZENE

ENVIRONMENTAL FATE

The physical properties of Hexachlorobenzne (HCB) are presented in Table B-3. The two main properties that determine the fate of HCB in the environment are its very low solubility and low vapor pressure. Its low solubility make transport of HCB via water unlikely. This, combined with a high oil/water partition coefficient, result in HCB's high affinity for soil. Because of its affinity to soil, transport via water would likely be through adherence to suspended sediments.

HCB is highly resistant to photodegradation, oxidation, and hydrolysis. Its rate of biodegradation is relatively low, but high enough to prevent significant bioaccumulation in fatty tissues.

TOXICOLOGY

HCB has been used as a fungicide in the past but currently occurs mostly as a by-product or impurity in related chemical syntheses. Toxic effects observed in humans include hyperpigmentation, porphyria, and neurologic and skeletal degeneration. Human exposure data are based mostly on one large exposure incident and distinctions between symptoms of high and low doses over short- and long-term periods are not available.

Extensive animal studies of long term exposure have shown toxic effects in neurologic, skeletal, lever, kidney, and thyroid degeneration. HCB also persists in blood and fat tissues long after the initial exposure.

Animal studies have also provided strong evidence of carcinogenicity. These studies are concerned with ingestion only. Because human carcinogen data is limited, the USEPA classifies HCB as a group B2 carcinogen (Personal communication, Robert McCaughey, CAG and Bruce Pierano, Office of Health and Environmental Assessment, October 23, 1986).

Exposure limits for various systemic and carcinogenic effects of HCB are shown on Table B-2. Details of how these levels were reached and other supporting evidence can be obtained from the documents referenced in Table B-2.

SUMMARY OF TOXICITY CRITERIA

Exposure limits for HCB listed on Table B-2 are calculated for an adult human weighing 70 kg. The limits are based on a 10^{-5} increased risk of cancer (over a lifetime) with the route of exposure assumed to be a daily ingestion of 2 liters of water with 0.2 ug/l HCB, which results in a daily dose of 0.4 ug of HCB.

The maximum allowable dose, resulting in no systemic effects for daily ingestion of 2 liters of water (with 28 ug/l HCB) is 56 ug per day. There is no data currently available for either systemic toxic effects or carcinogenic effects of HCB via either skin absorption or inhalation.

ASSESSMENT OF POTENTIAL RISKS

DIRECT CONTACT

The available data indicate that waste material at the site is covered by a 1 to 12-inch layer of soil and grass. In several areas of the site, minor disturbance of the cover exposes apparent waste material (BHC-cake). For this reason, direct exposure represents a significant potential exposure route for residents or visitors to the site, particularly when they are engaged in activities (such as digging, planting, etc.) which may expose subsurface soils.

Although it is difficult to quantify chemical exposures and doses resulting from direct contact with soils, several conservative assumptions were made to bound the potential significance of this exposure route, following methods suggested in the USEPA Draft Superfund Exposure Assessment Manual (USEPA, 1986). Dermal exposure (DEX) is estimated as:

$$DEX = DA \times A \times C$$

where

DA = Dust Adherence (mg/cm^2)

A = Body Area Exposed (cm^2)

C = Contaminant Concentration (weight fraction)

Dust adherence (for potting soil) is given as about 1.5 mg/cm^2 (USEPA, 1986). It was assumed that 1000 cm^2 (about 5 percent of body area) may be exposed to soil. Exposures were calculated for both upper limit (conservative) and lower limit values for contaminated soils at the site. The lower limit value was assumed to be 18 ppm total BHC, which was the concentration reported for the only near surface soil sample analyzed. A value of about 28 percent total BHC, representing the highest concentration of contaminated material reported at the site, was used as the upper limit. Table B-4 presents isomer-specific assumptions used in evaluating impacts from soil.

On this basis, exposures to BHC via direct contact with soils are expected to range from 0.028 to 420 mg for each event leading to contact with soil. Although the rate of absorption of BHC in dust adhering to skin cannot be accurately quantified, significant skin absorption of lindane (gamma-BHC) has been reported. Direct contact appears to represent a significant potential route of exposure, considering that long term oral doses on the order of less than 0.001 mg per day are associated with increased lifetime cancer risk of 10^{-5} (USEPA, 1980; USEPA, 1985).

AIRBORNE RISK

The airborne risks associated with the no action alternative could result from contaminant release to the atmosphere via the generation of contaminated wind blown dust (wind erosion) and volatilization to the atmosphere from both near and below surface contaminated soil. Emission rates for wind erosion and volatilization were calculated using appropriate emission factors and equations in conjunction with characteristic data (soil contamination concentrations) obtained from previous site investigations. However, there is only one surface or near surface (0 to 2 feet) soil sample that was analyzed for soil contamination. This one sample may or may not be representative of the entire site surface and, therefore, the resulting calculation of windblown and volatilization emission rates could be misleading. The potential impacts for the no action alternative were calculated from emissions based on the single near surface contaminant data point and the maximum detected soil contaminant levels. This results in a fairly wide range of potential down-wind concentrations. It is felt that the high end of the range represents extremely conservative impacts, particularly in light of the fact that the highest emission rate is assumed to be released over the entire site. The determined rates were then used in atmospheric dispersion models to determine the downwind contaminant concentrations at nearby residences, with both short and long-term concentrations determined.

Short-term concentrations were estimated for one and eight-hour averaging periods. Maximum short-term concentrations from ground level releases typically occur during stable (low wind speed) atmospheric conditions. For this reason short-term concentrations were determined using worst-case meteorological conditions of a 2.5 mps wind speed and an atmospheric stability classification of F (stable).

The maximum short-term concentrations estimated for the pollutants of concern at the nearest residences to the site are presented in Table B-5. The nearest residence, the Batrouny residence, is located approximately 15 meters west of the contamination zone. The next closest residence is located approximately 50 meters west of the site, on the west side of Tuscarora Road. Although the concentrations presented assume an easterly wind direction to transport the contaminants to the residences, similar short-term concentrations can be expected at equivalent down-wind distances in any direction from the site.

Long-term concentrations were estimated for an annual averaging period and were determined using meteorological conditions of 4.3 mps for wind speed and an atmospheric stability classification of D (neutral). The estimated long-term concentrations are also presented in Table B-5.

New York State Acceptable Ambient Levels (AAL) do not exist for BHC. However, a 500 ug/m^3 Threshold Limit Value (TLV) for dermal contact with lindane, the gamma isomer of BHC, can be compared to both the short and long-term eight-hour predicted concentrations. All predicted concentrations of BHC were below the TLV for lindane. For additional comparison, an oral dose of less than 1 ug per day can be equated to an increased cancer risk of 10^{-5} (1 in 100,000). No risk factors developed for the inhalation route are available. Using the assumption that the risk associated with oral exposure can be equated to the inhalation exposure, then an ambient concentration of 0.05 mg/m^3 would be associated with an increased cancer risk of 10^{-5}. This assumes that an average adult inhales about 20 m^3 of air per day. Projected upper limit concentrations exceeded this exposure value by about 2 orders of magnitude (see Table B-5), while lower limit concentrations were well below this value. Airborne transport is therefore considered a potentially significant route of exposure, although additional data would be required to more accurately assess actual risk.

SURFACE WATER RUNOFF AND GROUNDWATER INFILTRATION TO CAYUGA CREEK

BHC in the soils at the site can be transported to Cayuga Creek via two major transport mechanisms: surface water runoff and groundwater infiltration. Loading rates for each of these two pathways were calculated and the resulting concentration of each of the isomers in Cayuga Creek was estimated. The following discussion describes the methods used in these calculations.

Surface soil erosion during storm events is the primary mechanism by which BHC is likely to be transported off-site. The movement of surface soils is an effective medium for transport of BHC because of the affinity of relatively non-polar, hydrophobic substances, such as BHC, to adhere to surface soil particles. In order to evaluate this pathway, the draft Superfund Exposure Assessment Manual (USEPA, 1986) recommends use of the Modified Universal Soil Loss Equation (MUSLE). The MUSLE is given by:

$$Y(S)_E = a(V_r \times q_p)^{0.56} \ KLSCP$$

where

$Y(S)_E$ = sediment yield (tons/event)

a = Conversion constant

V_r = Volume of runoff

q_p = Peak flow rate

K = Soil erodibility factor

L = Slope-length factor

S = Slope-steepness factor

C = Cover factor

P = Erosion control practice factor.

Assumptions used in this calculation are discussed briefly below. Soils at the site were assumed to have moderately high runoff potential (Soil Group C in the

USEPA Manual). The soil erodibility factor (K) was assumed to be 0.49 based on Soil Conservation Service soil maps and erodibility data (USDA, 1972; NCSWCD, 1986). The slope-length and slope-steepness factors were based on the maximum distance and corresponding slope expected for runoff at the site. The cover factor (C) assumes a site with 80 percent ground cover consisting primarily of grass. The factor P refers to any erosion control practices that may be used at the site. A worst-case (conservative) P value of 1 was assumed.

Based on a statistical analysis of rainfall characteristics for the eastern United States (USEPA, 1982) the average total storm rainfall per individual storm for the period June to September is 0.48 inches with an average storm duration of 6 hours. Using these figures, no sediment transport would occur due to runoff from an average storm. Given a 6-hour storm, the total rainfall must exceed 0.82 inches before sediment transport due to runoff would occur.

Assuming a high-intensity storm occurs, an estimate was made of the sediment and contaminant transport expected. A six-hour storm with total rainfall of 1.0 inch, which is twice the average total storm rainfall, was used for this estimate. The total amount of sediment transport expected using the MUSLE is 0.5 pounds of soil per storm event. Assuming that all rainfall comes in high intensity (1 inch total rainfall) storms, a total of 35 such storms would be anticipated per year. Thus, a total of 17.5 pounds of soil is estimated to erode in runoff each year.

Soil data for BHC concentrations at the site are quite variable. Only one near surface soil sample (0 - 2 feet) was reported and concentrations of the BHC isomers in this sample ranged from below detection limit to 15 ppm. The highest concentrations of BHC isomers reported at the site were from samples taken from a depth of 2 to 4 feet below the surface. These concentrations were approximately four orders of magnitude greater than the surface soil sample. Because of this variability and the lack of data, separate loading rates were calculated for the low and high soil concentrations to give range of estimated potential impacts.

To estimate the loading of BHC to Cayuga Creek via groundwater infiltration, the groundwater seepage rate was multiplied by BHC concentrations in groundwater. Groundwater seepage rates were calculated based on reported transmissivity and flow velocity. The upper limit seepage rate was estimated to be 20 gallons per day. The highest reported concentration for each of the isomers in groundwater in downgradient wells was used in the calculation.

A total loading rate to Cayuga Creek was calculated by summing the loading rates from surface water runoff and groundwater infiltration for both lower limit soil concentration and upper limit soil concentration. These loading rates were used to generate estimated concentrations of each of the isomers in Cayuga Creek, as shown in Table B-6. Under the lower limit soil concentrations, BHC concentrations are estimated to range from 1.4×10^{-6} ppb to 5.3×10^{-5} ppb. Under the upper limit soil concentrations, BHC concentrations range from 0.0097 ppb to 0.136 ppb.

Table B-7 compares the estimated concentrations to USEPA and NYSDEC human health water quality criteria. The USEPA human health criteria presented correspond to a 10^{-5} increase in cancer risk. The NYSDEC human health criteria apply to Class A surface waters. Class A waters are best suited for drinking water supply, food processing, contact recreation, and fishing. Cayuga Creek is classified by the NYSDEC as Class C, which is suitable for fishing and secondary contact recreation. However, no human health criteria exist for Class C waters.

As indicated in Table B-7, predicted BHC concentrations in Cayuga Creek under the lower limit soil concentrations are well below their corresponding human health criteria for Class A waters. However, the total BHC concentration under the upper limit soil conditions (0.192 ug/l) exceeds the NYSDEC guidance value of 0.02 ug/l by almost an order of magnitude. The USEPA water quality criterion for alpha-BHC of 0.092 ug/l is also exceeded, with the estimated concentration of alpha-BHC being 0.136 ug/l. Predicted concentrations of beta-BHC and gamma-BHC are approximately one-fifth and one-twelfth of their respective criteria.

To evaluate impacts to aquatic life, Table B-7 presents the USEPA water quality criteria for the protection of freshwater life and the NYSDEC criteria for protection of aquatic life for Class C waters. As indicated in this table, predicted Cayuga Creek BHC concentrations under the lower limit soil concentrations are again well below their respective criteria. Under the upper limit soil concentrations, the USEPA water quality criteria for a mixture of isomers is not exceeded by the predicted concentrations. The predicted concentration of gamma-BHC is approximately one-fifth of the USEPA criterion. However, the NYSDEC water quality criterion for the sum of the isomers (0.01 ug/l) is exceeded by an order of magnitude.

In summary, upper limit projected concentrations of BHC in Cayuga Creek from the site may exceed criteria for protection of human health and aquatic resources by up to an order of magnitude. Lower limit projected concentrations are well below criteria. Since no ingestion of Cayuga Creek water is likely, actual risks to humans are probably low. Additional dilution is likely to eliminate any significant impacts in the Niagara River from site-related contaminants carried by Cayuga Creek.

RISKS ASSOCIATED WITH REMEDIAL ACTIONS

PRELIMINARY ALTERNATIVE SCREENING

Remedial alternatives were screened to determine their ability to control or eliminate potential exposure pathways associated with the no action alternative. Table B-8 presents results of this preliminary screening for both the construction phase and the long term (post-construction phase). All of the proposed alternative actions are expected to be effective at limiting long-term exposures from the identified potential routes. The primary differences are during the construction phase. Those alternatives (2A, 2B, and 2C) involving source removal may lead to increased potential exposures during construction via direct contact, airborne and surface water routes when compared to alternatives (3A, 3B, and 3C) involving source containment.

ENVIRONMENTAL AND PUBLIC HEALTH EVALUATION OF ALTERNATIVES

Beneficial and adverse environmental effects of each alternative are summarized in Table B-9. The environmental resources expected to be affected by the site are the aquatic resource of Cayuga Creek.

Table B-10 presents a summary of the public health risks associated with candidate remedial actions. Each alternative was evaluated with respect to its ability to control potential exposures identified for the no action alternative. In addition, potential impacts associated with construction of each alternative were considered.

In general, all of the proposed alternatives are effective at mitigating risks associated with the no-action alternatives. The following discussions summarize potential short-term adverse impacts associated with the construction phase, which are primarily related to surface runoff and airborne transport of contaminants. Additional details for environmental and health risks for potential surface water and airborne exposure routes are presented below.

SURFACE WATER IMPACTS

SOURCE REMOVAL ALTERNATIVES

Under both of the source removal action alternatives, excavation at the site would result in removal of vegetative cover and thus increase the potential for erosion. In order to quantify this impact, the same procedure outlined in the previous surface water runoff section was used. The only assumption which changes is the "C" term, cover factor, in the Modified Universal Soil Loss Equation. To be conservative, it was assumed that the entire site was cleared, resulting in a cover factor of 0.45. The estimated soil loss due to runoff under these conditions is then expected to be 17.5 pounds of soil per event, or a total of 613 pounds of soil per year. The concentrations of BHC in Cayuga Creek resulting from surface water runoff and groundwater infiltration under source removal conditions are presented in Table B-11. As was the case for the no action alternative, concentrations were calculated using both lower limit soil concentrations and upper limit soil concentrations. As indicated in Table B-12, lower limit estimated concentrations of BHC in Cayuga Creek range from 2.5×10^{-5} ug/l to 4.3×10^{-4} ug/l. Upper limit BHC concentrations range from 0.33 ug/l to 4.77 ug/l.

Table B-11 compares the estimated concentrations in Cayuga Creek under the source removal alternatives to USEPA and NYSDEC human health and aquatic life water quality criteria. These criteria are described earlier in this Appendix (Surface Water Runoff). Projected concentrations during removal are likely to be an order of magnitude higher than those for the no action alternative. With respect to potential human health impacts, predicted concentrations of BHC in Cayuga Creek under the lower limit conditions are well below the applicable criteria. However, under the upper limit conditions, both USEPA and NYSDEC water quality criteria for human health are exceeded in all cases. The estimated concentration for alpha-BHC exceeded the USEPA water quality criteria by over one order of magnitude, while the estimated concentrations of beta-BHC and gamma-BHC exceeded their respective USEPA criteria by less than an order of magnitude. The NYSDEC water quality guidance value for the sum of all isomers is exceeded by over 2 orders of magnitude.

With respect to potential aquatic life impacts, lower limit concentrations are below all applicable criteria. The USEPA water quality criteria for aquatic life was exceeded by gamma-BHC under upper limit conditions with a predicted concentration of 0.080 ug/l. The NYSDEC water quality criterion for the sum of all BHC isomers (0.01 ug/l) is exceeded by over 2 orders of magnitude under upper limit soil concentrations.

These impacts are temporary impacts only. Calculations were based on the site being cleared of vegetation for a period of one year during excavation operations. After the site is filled and covered, BHC loadings to Cayuga Creek via surface water runoff and groundwater infiltration are expected to be minimal.

SOURCE CONTAINMENT ALTERNATIVES

Estimated loadings to Cayuga Creek under the source containment alternatives were not quantified. During the construction phase, surface water runoff to the creek is expected to be less for the source containment alternatives than for the no action alternative. The site would be covered by a working surface prior to construction which would reduce runoff of contaminated soils. Under alternatives 3A and 3B, the sheet piling would serve to prevent runoff to the creek. Under alternative 3C, the creek would no longer be adjacent to the site. Following construction of any of the three alternatives, surface water runoff and groundwater infiltration to the creek would be minimal. In addition to the impacts to Cayuga Creek via transport of BHCs from the site discussed above, significant impacts to the creek are also expected due to disturbance from construction.

AIRBORNE IMPACTS

SOURCE REMOVAL ALTERNATIVES

The potential for exposure via the air pathway for the source removal alternatives would result from a contaminant release to the atmosphere via the generation of contaminated wind blown dust and volatilization to the atmosphere. The short-term impacts for these alternatives will increase over the no action alternative during construction activities then be reduced to essentially zero once removal and closure are completed. The short-term increase in airborne contaminant levels will result from increased dust generation during excavation activities and from increased volatilization. Volatilization will increase because more highly contaminated soils will be exposed to the air during excavation activities. The short-term increase in airborne contaminant levels is expected to last for up to a period of one year, depending on the removal alternative.

Emissions and concentrations at the nearest residences were estimated in the same manner as those for the no action alternative. Both short and long-term (annual) concentrations are presented in Tables B-13 and B-14 for Alternatives 2B and 2C, respectively. Projected airborne contaminant concentrations during the construction period are expected to be significantly greater (up to several orders of magnitude) than those associated with the no action alternative.

These concentrations are for the removal period only, as impacts are assumed to be at essentially zero after remedial activities are completed. The concentrations presented for the annual averaging period are only for the one year period during remedial activities.

SOURCE CONTAINMENT ALTERNATIVES

The potential for exposure via the air pathway will result from contaminant release to the atmosphere only via volatilization of contaminants during remedial activities for the source containment alternative. This is because the existing surface will be covered during remedial activities and wind blown contaminated dust would not be generated. Additionally, volatilization to the atmosphere will be reduced below the no action alternative levels during remedial activities. Volatilization will be reduced due to the increased thickness of clean materials above the contamination zone. Therefore, concentrations at the nearest residence resulting from volatilization will be less than those presented for the no action alternative in Table B-5. After implementation, the containment methods proposed for alternatives 3A, 3B, and 3C will effectively negate the release of contaminants either through volatilization or wind blown dust, and therefore, no significant impacts are expected.

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REFERENCES

"Draft Superfund Exposure Assessment Manual," USEPA, January 14, 1986 (Prepared for the Office of Emergency and Remedial Response).

"Health Advisory for Hexachlorobenzene," USEPA, Office of Drinking Water Standards, September 30, 1985.

"Health Advisory for Lindane," USEPA, Office of Drinking Water Standards, September 30, 1985.

Personal Communication, Niagara County Soil and Water Conservation District (NCSWCD), 1986.

"Preliminary Results of the Nationwide Urban Runoff Program," Volume 1, Water Planning Division, March 1, 1982.

"Soil Survey of Niagara County," U.S. Department of Agriculture (USDA) Soil Conservation Service, 1972.

TABLE B-1

PHYSICAL PROPERTIES OF BENZENE HEXACHLORIDE

	BHC Isomer alpha (1)	beta (1)	gamma (lindane) (2)	delta (1)
Molecular Weight:	291	291	291	291
Melting Point (°C):	157-160	309-310	112.9	138-139
Boiling Point (°C):	---	---	---	—
Vapor Pressure (torr):	2.5×10^{-5}	2.8×10^{-7}	9.4×10^{-6}	1.7×10^{-5}
Density:	1.85	1.85	1.85	1.85
Solubility (in water @ 25°C (mg/l)):	1.21-1.63	0.13-0.2	$7.52 \pm .04$	8.64-15.7
Log Octanol/Water Partition Coefficient (@ 25°C):	3.81	3.80	3.72	4.14
CAS No.:	319-84-6	319-85-7	58-89-9	319-86-8

ALTERNATE NAMES: Hexachlorocyclohexane
HCH
HCCH

REFERENCES:

(1) "Water Related Fate of 129 Priority Pollutants," USEPA, December 1979.
(2) "Draft Health Advisory for Lindane," Office of Drinking Water, USEPA, September 30, 1985.

TABLE B-2

Risk:			No Adverse Systemic Effect At 8-Hr/Day 5-Day/Week Exposure	10^{-5} Cancer Risk	Maximum Allowable Dose for No Lifetime Systemic Effects	10^{-5} Cancer Risk
Source:	NYS AWQ Human Health (1A)	NYS AWQ (1B)	TLV TWA (2)	NIPDWS RMCL (3)	Health Advisory (4)	Superfund Risk Assessment (5)
Route of Exposure:	Ingestion	Ingestion	Skin	Ingestion	Ingestion	Ingestion
Units:	ug/l	ug/l	mg/m^3	ug/l	ug/l	ug/l
alpha BHC	0.02	ND	NR	NR	NR	0.03
beta BHC	0.02	ND	NR	NR	NR	0.19
gamma BHC	0.02	ND	0.5	0.26	10	0.265
HCB	0.02	0.35	NR	NR	28	0.2

Notes: NR = Not Reported
ND = Not Detectable

(1) New York State Department of Environmental Conservation, Ambient Water Quality Standards and Guidance Values, 24 July 1985.
(A) Guidance for Surface Waters classifed as suitable for drinking with treatment.
(B) Standard for groundwater used as source of potable water supply.

(2) Threshold Limit Values and Biological Exposure Indices for 1985-86, American Conference of Governmental Industrial Hygenists, time weighted average for lindane.

(3) Recommended Maximum Contaminant Levels from the National Interim Primary Drinking Water Standards; Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms; Proposed Rule, FR50:219, 13 November 1985, for lindane.

(4) Draft Health Advisory, Office of Drinking Water, USEPA, 30 September 1985, for lindane and HCB.

(5) Draft Superfund Public Health Evaluation Manual, 18 December 1985, Office of Solid Waste and Emergency Response, USEPA: Exhibit C-4, Carcinogenic Effects Data.

TABLE B-3

PHYSICAL PROPERTIES OF HEXACHLOROBENZENE (HCB)

Molecular Weight:	284.79
Melting Point (°C):	230
Boiling Point (°C):	322.9
Vapor Pressure (mmHg) @ 20°C:	1.089×10^{-5}
Density (@ 23°C):	1.57
Solubility (mg/l @ 25°C):	0.005
Log Octanol/Water Partition Coefficient:	6.18
CAS No.:	118-74-1
Alternate Names:	HCB, Perchlorobenzene

REFERENCES:

"Draft Health Advisory for Hexachlorobenzene," Office of Drinking Water, USEPA, September 30, 1985.

TABLE B-4

SOIL CONTAMINANT CONCENTRATIONS USED IN RISK ANALYSIS

Compound	REPORTED CONCENTRATIONS Upper Limit	Lower Limit
Alpha - BHC	20%	< 1 ppm
Beta - BHC	4.4%	15.5 ppm
Gamma - BHC (lindane)	2.3%	< 1 ppm
Delta-BHC	1.4%	< 1 ppm
Total	28.1%	15.5 to 18.5 ppm

TABLE B-5

ESTIMATED CONCENTRATIONS RESULTING FROM THE NO-ACTION ALTERNATIVES

	BHC Concentration (ug/m^3)			
	Alpha	Beta	Delta	Gamma
One-Hour				
(Volatilization) Batrouny	3.4×10^{-4} - 67.7	5.1×10^{-3} - 14.9	3.4×10^{-4} - 4.7	3.4×10^{-4} - 7.8
Tuscarora	1.1×10^{-4} - 21.1	1.6×10^{-3} - 4.6	1.1×10^{-4} - 1.5	1.1×10^{-4} - 2.4
(Particulate) Batrouny	7.6×10^{-7} - 1.5×10^{-1}	1.1×10^{-5} - 3.4×10^{-2}	7.6×10^{-7} - 1.1×10^{-2}	7.6×10^{-7} - 1.8×10^{-2}
Tuscarora	2.4×10^{-7} - 4.7×10^{-2}	3.6×10^{-6} - 1.0×10^{-2}	2.4×10^{-7} - 3.3×10^{-3}	2.4×10^{-7} - 5.5×10^{-3}
Eight-Hour				
(Volatilization) Batrouny	2.6×10^{-4} - 51.0	3.8×10^{-3} x - 11.2	2.6×10^{-4} - 3.6	2.6×10^{-4} - 5.9
Tuscarora	7.9×10^{-5} - 15.8	1.2×10^{-3} - 3.5	7.9×10^{-5} - 1.1	7.9×10^{-5} - 1.8
(Particulate) Batrouny	5.7×10^{-7} - 1.1×10^{-1}	8.6×10^{-6} - 2.5×10^{-2}	5.7×10^{-7} - 8.0×10^{-3}	5.7×10^{-7} - 1.3×10^{-2}
Tuscarora	1.8×10^{-7} - 3.6×10^{-2}	2.7×10^{-6} - 7.9×10^{-3}	1.8×10^{-7} - 2.5×10^{-3}	1.8×10^{-7} - 4.1×10^{-3}
Annual				
(Volatilization) Batrouny	3.2×10^{-5} - 6.4	4.8×10^{-4} - 1.4	3.2×10^{-5} - 4.5×10^{-1}	3.2×10^{-5} - 7.4×10^{-1}
Tuscarora	7.3×10^{-6} - 1.5	1.1×10^{-4} - 3.2×10^{-1}	7.3×10^{-6} - 1.0×10^{-1}	7.3×10^{-6} - 1.7×10^{-1}
(Particulate) Batrouny	7.2×10^{-8} - 1.4×10^{-2}	1.1×10^{-6} - 3.2×10^{-3}	7.2×10^{-8} - 1.0×10^{-3}	7.2×10^{-8} - 1.7×10^{-3}
Tuscarora	1.6×10^{-8} - 3.3×10^{-3}	2.5×10^{-7} - 7.2×10^{-4}	1.6×10^{-8} - 2.3×10^{-4}	1.6×10^{-8} - 3.8×10^{-4}

TABLE B-6

ESTIMATED CONCENTRATIONS OF BHC
IN CAYUGA CREEK UNDER THE NO ACTION ALTERNATIVE

	Lower Limit (ppb)	Upper Limit (ppb)
alpha-BHC	2.5×10^{-5}	0.136
beta-BHC	5.3×10^{-5}	0.030
gamma-BHC	1.4×10^{-6}	0.016
delta-BHC	1.4×10^{-6}	0.0097
Total	8.1×10^{-5}	0.192

TABLE B-7

COMPARISON OF ESTIMATED BHC CONCENTRATIONS IN CAYUGA CREEK TO APPLICABLE HUMAN HEALTH AND AQUATIC LIFE WATER QUALITY CRITERIA NO ACTION ALTERNATIVE

			HUMAN HEALTH		AQUATIC LIFE	
	Lower Limit (ug/l)	Upper Limit (ug/l)	USEPA Water Quality Criteria(1) (ug/l)	NYSDEC Water Quality Guidance Value (ug/l)	USEPA Water Quality Criteria (ug/l)	NYSDEC Water Quality Criteria (ug/l)
alpha-BHC	2.5×10^{-5}	0.136	0.092	0.02(2)	100(4)	0.01(2)
beta-BHC	5.3×10^{-5}	0.030	0.163	0.02(2)	100(4)	0.01(2)
gamma-BHC	1.4×10^{-6}	0.016	0.186	0.02(2)	0.080(5)	0.01(2)
delta-BHC	1.4×10^{-6}	0.0097	(-)3	0.02(2)	100(4)	0.01(2)
Total	8.1×10^{-5}	0.192				

(1) 10^{-5} cancer risk criterion
(2) applies to sum of all isomers
(3) no criterion established
(4) acute toxicity for a mixture of isomers
(5) 24-hour average concentration

TABLE B-8

PRELIMINARY SCREENING OF ALTERNATIVES
PROJECTED ABILITY TO CONTROL EXPOSURE ROUTES

	Short-Term (Construction Phase)				Long-Term			
Alternative	Direct Contact	Airborne Transport	Surface Water Transport	Groundwater(1) Transport	Direct Contact	Airborne Transport	Surface Water Transport	Groundwater(1) Transport
1A	NA	NA	NA	NA	-	-	-	-
2A	?	?	?	?	++	++	++	++
2B	?	?.	?	?	++	++	++	++
3A	+	+	?	?	++	++	++	++
3B	+	+	?	?	++	++	++	++
3C	+	+	?	?	++	++	++	++

(1) Assumes no transport to deeper groundwater

++ = Very effective

\+ = Effective

? = Questionable or Unknown

\- = Ineffective

TABLE B-9

SUMMARY OF ENVIRONMENTAL FACTORS

Alternative	Beneficial Impacts	Adverse Impacts
1A - No Action	o Minimizes disturbance to site, Cayuga Creek	o Does not control potential loadings of contaminants to Cayuga Creek and air in vicinity of site. Surface water loadings may exceed NYSDEC criteria for protection of aquatic life.
2B - Excavate, Off-site Incineration	o Removes source of contamination (long-term) o Reduce or eliminate long-term contaminant loadings to air or water	o Construction activities may produce significant releases of contaminants to surface water and air for 1 year or more.
2C - Excavate, Off-site Landfill, Backfill	o Removes source of contamination (long-term) o Reduce or eliminate long-term contaminant loadings to air or water	o Construction activities may produce significant releases of contaminants to surface water and air for up to 1 year.
3A - Permanent Sheet Pile, FML Barrier/ Cap, Slurry Wall	o Controls airborne and waterborne migration of of contaminants (long-term) o Construction activities not expected to generate significant airborne releases	o Construction activities in creek affect aquatic resources
3B - Retaining Wall, FML Barrier/Cap, Slurry Wall	o Controls airborne and waterborne migration of of contaminants (long-term) o Construction activities not expected to generate significant airborne releases	o Construction activities in creek affect aquatic resources
3C - Reroute Creek, Circumscribing Slurry Wall/FML Cap	o Creek rerouted away from potentially contaminated area o Controls airborne and waterborne migration of contaminants (long-term) o Construction activities have minimum opportunity to increase contaminant loading to creek. o Construction activities not expected to generate significant airborne releases.	o Major disturbance of of the creek and associated aquatic resources

TABLE B-10

PUBLIC HEALTH EVALUATION OF ALTERNATIVES

Alternative	Long-Term Risk	Short-Term (Construction) Risks)
1 - No Action	o Direct Contact - significant potential exposures if waste is disturbed. o Airborne - significant potential exposures under "worst case" scenario. o Surface Water - projected "worst case" concentrations exceed criteria for drinking water; however, there is no expected ingestion of Cayuga Creek water. o Groundwater - exposure assumed insignificant.	Not Applicable
2B, 2C	o Direct Contact - virtually eliminated. o Airborne contaminant migration virtually eliminated o Contaminant migration to surface water virtually eliminated. o Groundwater exposure assumed insignificant.	o Airborne exposures expected to be greater than for No Action alternative during construction. o Surface water contamination is expected to be greater than for No Action Alternative during construction.
3A, 3B, 3C	o Direct Contact - virtually eliminated. o Airborne contaminant migration virtually eliminated. o Contaminant migration to surface water virtually eliminated. o Groundwater exposure assumed insignificant.	o Airborne exposures expected to be less than for No-Action Alternative. o Surface water contamination expected to be less than for No-Action Alternative.

TABLE B-11

ESTIMATED CONCENTRATIONS OF BHC IN CAYUGA CREEK UNDER THE SOURCE REMOVAL ALTERNATIVES

	Lower Limit (ppb)	Upper Limit (ppb)
alpha-BHC	4.8×10^{-5}	4.77
beta-BHC	4.3×10^{-4}	1.05
gamma-BHC	2.5×10^{-5}	0.55
delta-BHC	2.5×10^{-5}	0.33
Total	5.3×10^{-4}	6.70

TABLE B-12

COMPARISON OF ESTIMATED BHC CONCENTRATIONS IN CAYUGA CREEK TO APPLICABLE HUMAN HEALTH AND AQUATIC LIFE WATER QUALITY CRITERIA SOURCE REMOVAL ACTIONS

			HUMAN HEALTH		AQUATIC LIFE	
	Lower Limit (ug/l)	Upper Limit (ug/l)	USEPA Water Quality Criteria(1) (ug/l)	NYSDEC Water Quality Guidance Value (ug/l)	USEPA Water Quality Criteria (ug/l)	NYSDEC Water Quality Criteria (ug/l)
alpha-BHC	4.8×10^{-5}	4.77	0.092	0.02(2)	100(4)	0.01(2)
beta-BHC	4.3×10^{-4}	1.05	0.163	0.02(2)	100(4)	0.01(2)
gamma-BHC	2.5×10^{-5}	0.55	0.186	0.02(2)	0.080(5)	0.01(2)
delta-BHC	2.5×10^{-6}	0.33	(-)3	0.02(2)	100(4)	0.01(2)
Total	5.3×10^{-4}	6.70				

(1) 10^{-5} cancer risk criterion
(2) applies to sum of all isomers
(3) no criterion established
(4) acute toxicity for a mixture of isomers
(5) 24-hour average concentration

TABLE B-13

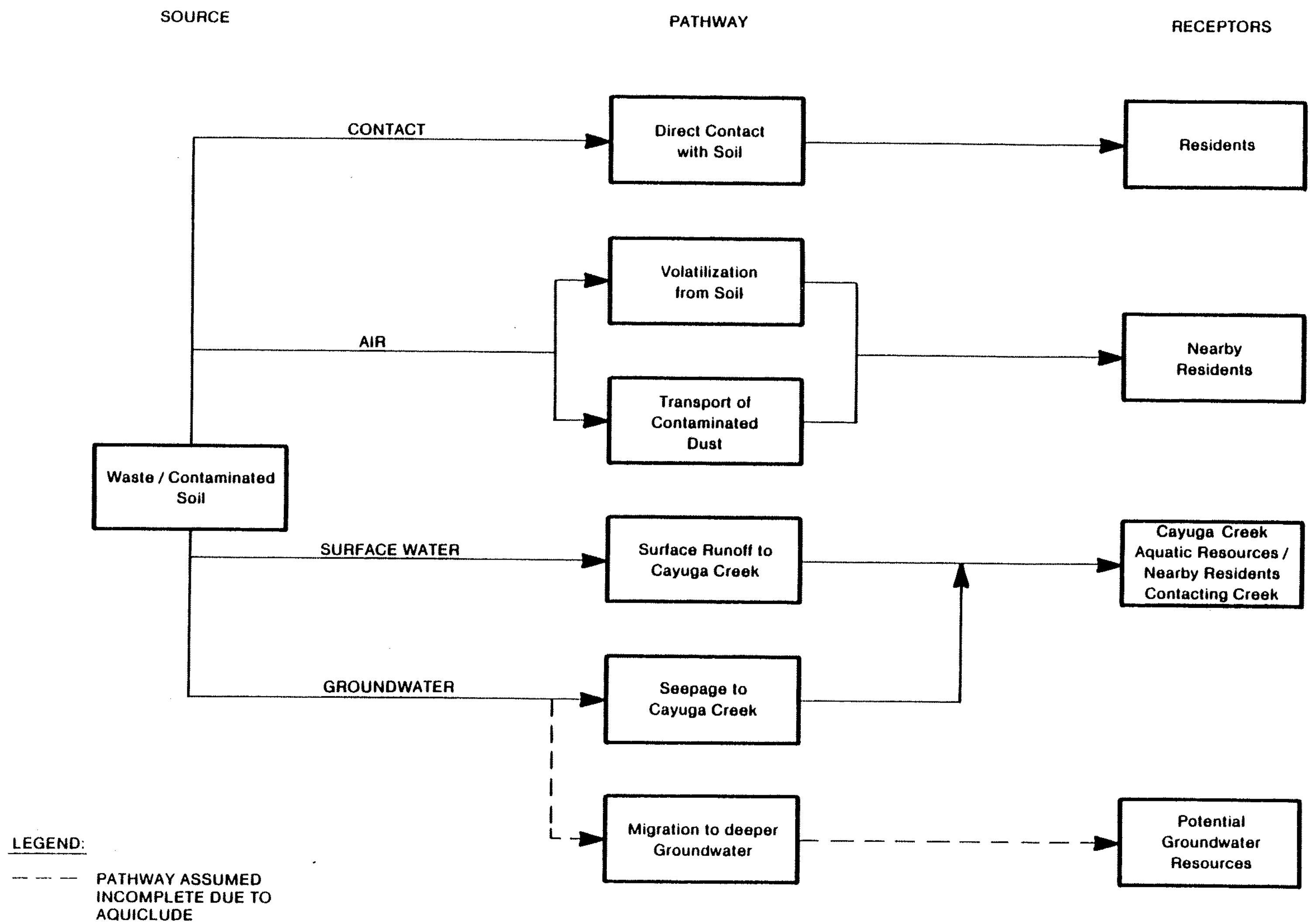
ESTIMATED CONCENTRATIONS RESULTING FROM REMOVAL ALTERNATIVE 2B

	BHC Concentration (ug/m^3)			
	Alpha	Beta	Delta	Gamma
One-Hour				
(Volatilization) Batrouny	2.7×10^{-1} - 13.3	4.0 x 13.3	2.7×10^{-1} - 13.3	2.7×10^{-1} - 13.3
Tuscarora	7.8×10^{-2} - 3.9	1.2 x 3.9	7.8×10^{-2} - 3.9	7.8×10^{-2} - 3.9
(Particulate) Batrouny	4.3×10^{-4} - 86	6.5×10^{-3} - 19	4.3×10^{-4} - 6.0	4.3×10^{-4} - 9.9
Tuscarora	1.3×10^{-4} - 25	1.9×10^{-3} - 5.6	1.3×10^{-4} - 1.8	1.3×10^{-4} - 2.9
Eight-Hour				
(Volatilization) Batrouny	2.0×10^{-1} - 10.0	3.0 - 10.0	2.0×10^{-1} - 10.0	2.0×10^{-1} - 10.0
Tuscarora	5.9×10^{-2} - 2.9	8.8×10^{-1} - 2.9	5.9×10^{-2} - 2.9	5.9×10^{-2} - 2.9
(Particulate) Batrouny	3.3×10^{-4} - 65	4.9×10^{-3} - 14	3.3×10^{-4} - 4.6	3.3×10^{-4} - 7.5
Tuscarora	9.6×10^{-5} - 19	1.4×10^{-3} - 4.2	$9.6 \times 10^{-5} \times 1.3$	9.6×10^{-5} - 2.2
Annual				
(Volatilization) Batrouny	1.3×10^{-2} - 6.6×10^{-1}	2.0×10^{-1} - 6.6×10^{-1}	1.3×10^{-2} - 6.6×10^{-1}	1.3×10^{-2} - 6.6×10^{-1}
Tuscarora	$3.1 \times 10^{-3} \times 1.6 \times 10^{-1}$	4.7×10^{-2} - 1.6×10^{-1}	3.1×10^{-3} - 1.6×10^{-1}	3.1×10^{-3} - 1.6×10^{-1}
(Particulate) Batrouny	2.2×10^{-5} - 4.3	3.2×10^{-4} - 9.5×10^{-1}	2.2×10^{-5} - 3.0×10^{-1}	2.2×10^{-5} - 5.0×10^{-1}
Tuscarora	5.1×10^{-6} - 1.0	7.7×10^{-5} - 2.2×10^{-1}	5.1×10^{-6} - 7.1×10^{-2}	5.1×10^{-6}- 1.2×10^{-1}

TABLE B-14

ESTIMATED CONCENTRATIONS RESULTING FROM REMOVAL ALTERNATIVE 2C

	BHC Concentration (ug/m^3)			
	Alpha	Beta	Delta	Gamma
One-Hour				
(Volatilization) Batrouny	5.5×10^{-1} - 27	8.2 - 27	$5.5 \times 10^{-1} \times 27$	5.5×10^{-1} - 27
Tuscarora	1.7×10^{-1} - 8.7	2.8 - 8.7	1.7×10^{-1} - 8.7	1.7×10^{-1} - 8.7
(Particulate) Batrouny	2.2×10^{-4} - 45	3.3×10^{-3} - 9.8	2.2×10^{-4} - 3.1	2.2 10^{-4} - 5.1
Tuscarora	7.1×10^{-5} - 14	1.1×10^{-3} - 3.1	$7.1 \times 10^{-5} \times 9.9 \times 10^{-1}$	7.1×10^{-5} - 1.6
Eight-Hour				
(Volatilization) Batrouny	4.1×10^{-1} - 21	6.2 - 21	4.1×10^{-1} - 21	4.1×10^{-1} - 21
Tuscarora	1.3×10^{-1} - 6.6	2.0 - 6.6	1.3×10^{-1} - 6.6	1.3×10^{-1} - 6.6
(Particulate) Batrouny	1.7×10^{-4} - 34	2.5×10^{-3} - 7.4	1.7×10^{-4} - 2.4	$1.7 \times 10^{-4} \times 3.9$
Tuscarora	5.3×10^{-5} - 11	8.0×10^{-4} - 2.3	5.3×10^{-5} - 7.5×10^{-1}	5.3×10^{-5} - 1.2
Annual				
(Volatilization) Batrouny	2.8×10^{-2} - 1.4	4.2×10^{-1} - 1.4	2.8×10^{-2} - 1.4	2.8×10^{-2} - 1.4
Tuscarora	7.7×10^{-3} - 3.8×10^{-1}	1.2×10^{-1} - 3.8×10^{-1}	7.7×10^{-3} - 3.8×10^{-1}	7.7×10^{-3} - 3.8×10^{-1}
(Particulate) Batrouny	1.1×10^{-5} - 2.3	1.7×10^{-4} - 5.1×10^{-1}	1.1×10^{-5} - 1.6×10^{-1}	1.1×10^{-5} - 2.6×10^{-1}
Tuscarora	3.1×10^{-6} - 6.2×10^{-1}	4.7×10^{-5} - 1.4×10^{-1}	3.1×10^{-6} - 4.4×10^{-2}	3.1×10^{-6} - 7.2×10^{-2}



Potential Contaminant Exposure Pathways

Figure B-1

Appendix C

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 2A: EXCAVATION, INCINERATE (COMMERCIAL) OFF-SITE, BACKFILL

TASK EXCAVATION	STREAMBANK AREA (acres) :	.30	
	PERIMETER (feet):	825	

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob & Demob	LUMP SUM	$3,000	1	$3,000
	Clearing		$6000/ac	.30	$1,800
	Security Fence		$7.45/ft	825	$6,146
TEMPORARY SHEET PILING	Rental				
	Installation		$2.32/ft2	3,160	$7,331
			$4.35/ft2	3,160	$13,746
			SITE PREPARATION SUBTOTAL -		$32,023

REMOVAL AND DISPOSAL	NO. OF DRUMS :	31,870	
	VOLUME (yd3) :	8,500	

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
Removal and Disposal	Excavating		$70/ton	11,900	$833,000
	Drum Purchase		$25/drum	31,870	$796,750
	Hauling		$990/trip	398	$394,020
	Incineration (HCB)		$725/drum	400	$290,000
	Incineration (BHC + Soil)		$400/drum	31,470	$12,588,000
			REMOVAL AND DISPOSAL SUBTOTAL-		$14,901,770
COMMON FILL	Buy and Deliver		$10.00/yd3	9,870	$98,696
	Spreading & Compaction		$2.75/yd3	9,870	$27,141
TOPSOIL	In Place		$15.00/yd3	1,180	$17,706
SEEDING	Hydroseeding		$35/1000 ft2	32	$1,115
			BACKFILL SUBTOTAL-		$144,659
			ALTERNATIVE 2A TOTAL COST		$15,078,452

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 2B: EXCAVATION, INCINERATE (DEDICATED) OFF-SITE, BACKFILL

TASK	STREAMBANK AREA (acres) :	.30
EXCAVATION	PERIMETER (feet):	825

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob & Demob	LUMP SUM	$3,000	1	$3,000
	Clearing		$6000/ac	.30	$1,800
	Security Fence		$7.45/ft	825	$6,146
TEMPORARY	Rental				
SHEET PILING	Installation		$2.32/ft2	3,160	$7,331
			$4.35/ft2	3,160	$13,746
			SITE PREPARATION SUBTOTAL -		$32,023

	WEIGHT (ton) :	11,900
REMOVAL AND DISPOSAL	VOLUME (yd3)	8,500

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
Removal	Excavating		$70/ton	11,900	$833,000
AND	Bulk Hauling		$100/ton	595	$59,500
Disposal	Incineration		$400/ton	11,900	$4,760,000
	Material Conditioning		$100/ton	11,900	$1,190,000
	Ash Disposal		$60/ton	9,520	$571,200
			REMOVAL AND DISPOSAL SUBTOTAL-		$7,413,700
COMMON FILL	Buy and Deliver		$10.00/yd3	9,870	$98,700
	Spreading & Compaction		$2.75/yd3	9,870	$27,142
TOPSOIL	In Place		$15.00/yd3	1,180	$17,700
SEEDING	Hydroseeding		$35/1000 ft2	32	$1,120
			BACKFILL SUBTOTAL-		$144,662
			ALTERNATIVE 2B TOTAL COST		$7,590,386

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 2C: EXCAVATION, LANDFILL, AND BACKFILL

TASK EXCAVATION		
	STREAMBANK AREA (acres) :	.30
	TOTAL LINEAR FEET (feet):	825

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob & Demob	LUMP SUM	$3,000	1	$3,000
	Clearing		$6000/ac	.30	$1,800
	Security Fence		$7.45/ft	825	$6,146
			SITE PREPARATION SUBTOTAL -		$10,946
DEWATERING					
Upgradient Drain	Excavation		$3.54/yd3	993	$3,515
	6" Perf. PVC in place		$3.15/ft	412	$1,299
	Fittings		.47/ft	412	$195
	Coarse Sand		$11.92/yd3	69	$820
	Stone		$11.50/yd3	688	$7,906
	Typar 3401		$.12/ft2	14,438	$1,732
	Backfilling		$2.42/yd3	672	$1,627
Site Dewatering	Dewatering Trenches		$35/yd3	2,370	$82,963
	Water Disposal		$.25/gal.	100,000	$25,000
TEMPORARY SHEET PILING	Rental		$2.32/ft2	3,160	$7,331
	Installation		$4.35/ft2	3,160	$13,746
			DEWATERING SUBTOTAL -		$125,058

REMOVAL AND DISPOSAL		
	AREA (ft2) :	31,000
	VOLUME (yd3) :	8,500
	SWELL FACTOR :	.30

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
Removal and Disposal	Excavating		$35/yd3	6,130	$214,537
	Hauling		$65/ton	11,900	$773,500
	Disposal		$100/ton	11,900	$1,190,000
			REMOVAL AND DISPOSAL SUBTOTAL-		$2,178,037
COMMON FILL	Buy and Deliver		$10.00/yd3	9,902	$99,018
	Spreading & Compaction		$2.75/yd3	9,902	$27,230
TOPSOIL	In Place		$15.00/yd3	1,148	$17,222
SEEDING	Hydroseeding		$35/1000 ft2	31	$1,085
			BACKFILL SUBTOTAL-		$144,556
			ALTERNATIVE 2C TOTAL COST -		$2,458,597

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 3A: SHEET PILE, FML BARRIER/CAP, TOE DRAIN, SLURRY WALL

TASK	LENGTH OF WALL :	400 ft.	
SHEET PILING	STREAMBANK AREA :	.30 ac.	

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob &Demob	Lump Sum	$2,000	1	$2,000
	Clearing and Grubbing		$6,000/ac.	.30	$1,800
SHEET PILING	Purchase (Galvanized)		$9.93/ft2	3,160	$31,379
	Installation		$4.36/ft2	3,160	$13,762
	Dewater		$750/day	1	$750
	Sediment Removal		$2.87/yd3	200	$574
TOE DRAIN	Placement	4" dia. PVC pipe	$2.44/ft	400	$976
	Fittings		15% place cost	$976	$146
	Filter Fabric Typar 3401		$.12/ft2	1,200	$144
	Crushed Stone-Purchase		$11.50/yd3	22	$256
	Placement		$2.42/yd3	22	$53
	Manhole		$1,260 ea.	1	$1,260
BACKFILL	Buy & Deliver		$10.00/yd3	381	$3,810
	Spreading & Compaction		$2.75/yd3	381	$1048
				SHEET PILING SUBTOTAL -	$57,958

TASK SLURRY WALL	LENGTH :	400 ft.	
	DEPTH to KEY :	10 ft.	

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SLURRY WALL	Mob & Demob	Lump Sum	$19,000	1	$19,000
	Backfill		$10.00/yd2	444	$4,444
	Placement		$4.63/ft2	4,000	$18,520
	Testing		$698/sample	2	$1,395
BERM	Buy & Deliver		$10.00/yd3	207	$2,074
	Spreading & Compaction		$2.75/yd3	207	$570
				SLURRY WALL SUBTOTAL -	$46,004
				ALTERNATIVE 3A COST (this page) :	$103,962

CONSTRUCTION COST ESTIMATE (cont'd)
ALTERNATIVE 3A: SHEET PILE, FML BARRIER/CAP, TOE DRAIN, SLURRY WALL

TASK	AREA (ft2)	:	37,119
CAPPING	SUB-BASE THICKNESS (ft)		.25
	SILTY SAND THICKNESS (ft)		.5
	COARSE SAND THICKNESS (ft)		1
	TOPSOIL THICKNESS (ft)		1

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob. and Demob	Lump Sum	$2000	1	$2,000
	Pre-roll surface		$1.69/yd2	4,124	$6,970
	Security Fence		$7.45/ft	825	$6,146
SUB-BASE	Buy & Deliver		$11.50/yd3	344	$3,952
	Spreading & Compaction		$2.48/yd2	4,124	$10,228
GEOTEXTILE	Venting		$.18/ft2	37,119	$6,681
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	41,919	$20,960
SILTY SAND	Buy & Deliver		$10.00/yd3	687	$6,874
	Spreading & Compaction		$2.75/yd3	687	$1,890
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	37,119	$18,560
COARSE SAND	Buy & Deliver		$10.00/yd3	1,375	$13,748
	Spreading & Compaction		$2.75/yd3	1,375	$3,781
GEOTEXTILE	Installation Typar 3401		$.12/ft2	37,119	$4,454
TOPSOIL	In Place		$15/yd3	1,375	$20,622
SEEDING	Hydroseeding		$35/1000 ft2	37,119	$1,299
				CAP SUBTOTAL-	$128,165
			ALTERNATIVE 3A TOTAL COST	:	$232,127

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 3B, CONCRETE RETAINING WALL, FML BARRIER/CAP,
TOE DRAIN, SLURRY WALL

TASK RETAINING WALL — LENGTH OF WALL : 400 ft.; STREAMBANK AREA : .30 ac.

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob & Demob	Lump Sum	$2,000	1	$2,000
	Clearing and Grubbing		$6,000/ac.	.30	$1,800
SHEET PILING	Rental		$2.32/ft2	3,160	$7,331
	Installation		$4.35/ft2	3,160	$13,746
	Dewater		$750/day	1	$750
	Sediment Removal		$2.87/yd3	200	$574
RETAINING WALL	Excavation (footing)		$2.21/yd3	356	$786
	Material &Installation		$180/L.ft	400	$72,000
TOE DRAIN	Placement	4" dia. PVC pipe	$2.44/ft	400	$976
	Fittings		15% place cost	$976	$146
	Filter Fabric Typar 3401		$.12/ft2	1,200	$144
	Crushed Stone-Purchase		$11.50/yd3	22	$256
	Placement		$2.42/yd3	22	$54
	Manhole		$1,260 ea.	1	$1,260
			RETAINING WALL SUBTOTAL -		$101,823

TASK SLURRY WALL — LENGTH : 400 ft.; DEPTH to KEY : 10 ft.

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SLURRY WALL	Mob & Demob	Lump Sum	$19,000	1	$19,000
	Backfill		$10.00/yd2	444	$4,444
	Placement		$4.63/ft2	4,000	$18,520
	Testing		$698/sample	2	$1,395
BERM	Buy & Deliver		$10.00/yd3	207	$2,074
	Spreading & Compaction		$2.75/yd3	207	$570
			SLURRY WALL SUBTOTAL -		$46,004
			ALTERNATIVE 3B COST (this page) -		$147,827

CONSTRUCTION COST ESTIMATE (cont'd)
ALTERNATIVE 3B: RETAINING WALL, FML BARRIER/CAP, TOE DRAIN, SLURRY WALL

TASK CAPPING	AREA (ft2)	:	37,119
	SUB-BASE THICKNESS (ft)		.25
	SILTY SAND THICKNESS (ft)		.5
	COARSE SAND THICKNESS (ft)		1
	TOPSOIL THICKNESS (ft)		1

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob. and Demob	Lump Sum	$2000	1	$2,000
	Pre-roll surface		$1.69/yd2	4,124	$6,970
	Security Fence		$7.45/ft	825	$6,146
SUB-BASE	Buy & Deliver		$11.50/yd3	344	$3,952
	Spreading & Compaction		$2.48/yd2	4,124	$10,228
GEOTEXTILE	Venting		$.18/ft2	37,119	$6,681
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	41,919	$20,960
SILTY SAND	Buy & Deliver		$10.00/yd3	687	$6,874
	Spreading & Compaction		$2.75/yd3	687	$1,890
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	37,119	$18,560
COARSE SAND	Buy & Deliver		$10.00/yd3	1,375	$13,748
	Spreading & Compaction		$2.75/yd3	1,375	$3,781
GEOTEXTILE	Installation Typar 3401		$.12/ft2	37,119	$4,454
TOPSOIL	In Place		$15.00/yd3	1,375	$20,622
SEEDING	Hydroseeding		$35/1000 ft2	37,119	$1,299
				CAP SUBTOTAL-	$128,165
			ALTERNATIVE 3B TOTAL COST	-	$275,992

CONSTRUCTION COST ESTIMATE
ALTERNATIVE 3C: REROUTE CREEK, FML CAP, TOE DRAIN,
CIRCUMSCRIBING SLURRY WALL

TASK STREAM RELOCATION	AREA (ft2)	:	30,000
	Length (ft)	:	500
	X-Sect. (ft2)	:	300

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob & Demob	LUMP SUM	$2,000	1	$2,000
	Clearing & Grubbing		$6000/ac	.69	$4,132
EXCAVATION	Scraper		$3.58/yd3	5,266	$18,853
	Backhoe		$2.21/yd3	289	$639
	Hauling		$1.40/yd3	289	$405
RIP-RAP	Purchase		$12.50/yd3	250	$3,125
	Placement		$21.00/yd3	250	$5,250
DEWATER	Pumps & Operator		$1,125/day	2	$2,250
BACKFILL	Purchase		$10.00/yd3	2,600	$26,000
	Spreading & Compaction		$3.46/yd3	8,200	$28,372
			STREAM RELOCATION SUBTOTAL -		$91,027

TASK SLURRY WALL	LENGTH	:	800 ft.
	DEPTH to KEY	:	10 ft.

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SLURRY WALL	Mob & Demob	Lump Sum	$19,000	1	$19,000
	Backfill		$10.00/yd2	533	$5,333
	Placement		$4.63/ft2	8,000	$37,040
	Testing		$679/sample	3	$1,358
BERM	Buy & Deliver		$10.00/yd3	415	$4,148
	Spreading & Compaction		$2.75/yd3	415	$1,141
			SLURRY WALL SUBTOTAL -		$68,020
			ALTERNATIVE 3C COST (this page) :		$159,047

CONSTRUCTION COST ESTIMATE (cont'd)
ALTERNATIVE 3C: REROUTE CREEK, CAP/FML BARRIER, TOE DRAIN, SLURRY WALL

TASK		
CAPPING	AREA (ft2) :	35,919
	SUB-BASE THICKNESS (ft)	.25
	SILTY SAND THICKNESS (ft)	.5
	COARSE SAND THICKNESS (ft)	1
	TOPSOIL THICKNESS (ft)	1

SUBTASK	PHASE	QUANTITY ESTIMATE	UNIT COST	QUANTITY	COST
SITE WORK	Mob. and Demob	Lump Sum	$2000	1	$2,000
	Pre-roll surface		$1.69/yd2	3,991	$6,745
	Security Fence		$7.45/ft	825	$6,146
SUB-BASE	Buy & Deliver		$11.50/yd3	332	$3,825
	Spreading & Compaction		$2.48/yd2	3,991	$9,898
GEOTEXTILE	Venting		$.18/ft2	35,919	$6,465
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	35,919	$17,960
SILTY SAND	Buy & Deliver		$10.00/yd3	665	$6,652
	Spreading & Compaction		$2.75/yd3	665	$1,829
GEOMEMBRANE	Installation 40 mil HDPE		$.50/ft2	35,919	$17,960
COARSE SAND	Buy & Deliver		$10.00/yd3	1,330	$13,303
	Spreading & Compaction		$2.75/yd3	1,330	$13,303
GEOTEXTILE	Installation Typar 3401		$.12/ft2	35,919	$4,310
TOPSOIL	In Place		$15/yd3	1,330	$19,955
SEEDING	Hydroseeding		$35/1000 ft2	35,919	$1,257
TOE DRAIN	Placement	4" dia PVC pipe	$2.44/ft	400	$976
	Fittings		15% place cost	$976	$1,122
	Filter Fabric		$.12/ft2	1,200	$144
	Crushed Stone-Purchase		$11.50/yd3	22	$253
	Placement		$2.42/yd3	22	$53
	Manhole		$1,260 ea.	1	$1,260
				CAP SUBTOTAL-	$135,416
			ALTERNATIVE 3C TOTAL COST	:	$294,463

Appendix D

APPENDIX D

RESPONSES TO NYDEC REVIEW COMMENTS ON DRAFT FEASIBILITY STUDY REPORT

The following responses address comments on the Draft Feasibility Study Report submitted by Olin to the NYDEC in November 1986, as itemized in the January 16, 1987 NYDEC letter. Where appropriate, these comments have been addressed in the Feasibility Study Report text (note referenced sections).

For ease of understanding, the responses are presented in the same order as they appear in the NYDEC January 16, 1987 letter.

1. Section 1.1 - The issues of possible contamination on other portions of the Gibson Site and off-site are addressed in the last paragraph of Section 1.1 as revised (see page 3 of the Feasibility Study text).

2. Section 1.2.4 - We respectfully disagree with the State's conclusion that inorganic contaminants of concern appear in significant concentrations in soil and/or water samples. The environmental monitoring data presented in Tables 1 and 2 of the Feasibility Study Report show that the inorganic contaminants of concern in soil and groundwater samples from the Batrouny property portion of the site do not appear in concentrations which would influence the selection of remedial technologies or alternatives. See revised item 4, Section 1.2.4 on page 8 of the Feasibility Study text. Additional groundwater monitoring wells are to be installed on the southern portion of the site only. Thus, analytical results from those wells are not available for consideration in this Feasibility Study and may be inappropriate for evaluating conditions on the northern portion of the site.

3. Section 1.2.6 - The potential risks associated with the direct contact exception are explained in items 7 (revised) and 8 (new) of Section 1.2.6 (see page 13 of the Feasibility Study text).

4. Section 2.7.2 - The apparent discrepancy in estimated base flow contribution to Cayuga Creek is clarified in the second paragraph of Section 2.7.2 as revised (see page 24 of the Feasibility Study text).

5. Section 4.1 - As explained in Section 4.1 as revised (on page 34 of the Feasibility Study text), the length of the remedial performance period was assumed to be 30 years for economic comparison purposed only. This performance period was selected in accordance with guidance provided by the USEPA for preparing feasibility studies.

6. The standard for evaluating remedial technologies is established by Sections 4(a) and (b) of the Stipulation and Consent Judgement. Those sections provide essentially that Olin shall use known engineering and construction practices, used or acceptable for use in the clean-up or containment of chemical contamination and applicable to materials and hydrogeological conditions found at the site, which will remove or isolate Olin contamination at the site from people and the environment. Olin is not obligated to employ technologies which achieve a permanent and significant reduction in the mobility, toxicity or volume of contamination. Nevertheless, in conducting the Feasibility Study, numerous technologies that have the potential to reduce the mobility, toxicity or volume of site contaminants were evaluated (including the 3 processes mentioned in Item 6 of the NYDEC's January 16, 1987 letter). Reasons for rejecting those technologies are itemized, by major technology group, in Section 2.8.2 as revised (see page 28 of the Feasibility Study text).

7. The proximity of the site to a residential area was considered in evaluating the recommended remedial option. That consideration is summarized in revised Section 6.0 of the Feasibility Study text. The need for security measures was recognized in evaluating the recommended remedial option. That fact is demonstrated by the inclusion of security costs in both the capital cost and operating and maintenance cost

estimates. See Section 4.4 of the Feasibility Study text, and Table 12, as revised. The details of appropriate security measures, an analysis of the probability of a containment breach and its likely consequences, and a contingency plan to address containment breaches are all the proper subject of the remediation plan called for by Section 5(e) of the Stipulation and Consent Judgement (i.e., Plan "C"). Finally, Olin is obligated to remove or isolate its contamination from people and the environment, so as to effectively protect the public health and environment. The recommended remedial option satisfies that obligation regardless of site ownership.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-

Henry G. Williams
Commissioner

January 16, 1987

Mr. Blaine Butaud
Olin Chemicals
P.O. Box 248
Charleston, TN 37310

Dear Mr. Butaud:

Re: Gibson Site, Niagara Falls, New York - Draft Feasibility Study Report, Dated November 7, 1986

The State has reviewed the subject report. Prior to our acceptance of this report, the following must be addressed, discussed and action taken upon as appropriate:

1. Section 1.1 - While this Feasibility Study addresses the Batrouny property, i.e., the northern portion of the site, it should be clarified other on-site, i.e., the southern portion, and off-site contamination will both be the subject of subsequent plans.

2. Section 1.2.4 - The State does not agree that inorganic contaminants of concern do not appear in significant concentrations in either soil or water samples. One intent of the installation of the additional wells is to facilitate any decision regarding these contaminants.

3. Section 1.2.6 - In Item 7, the exception should be explained; i.e., what is the risk associated with this exception.

4. Section 2.7.2 - The base flow contribution from the site to Cayuga Creek is estimated at 20 gpd in Section 1.2.3 - what is the association of this flow to the volume of 5000 gallons per year expected from the installation of permanent barrier wells?

5. Section 4.1 - Please explain why the useful life of the site is assumed to be 30 years.

6. The State believes further evaluation of technologies which address the contamination at the site can and should be performed in order to achieve permanent and significant reduction in the mobility, toxicity or volume of contamination such as the Chemfix process, the A-PEG process and the Shirco Infrared System.

7. The plausibility of the recommended option is in question due to the proximity of the site to a residential area, the lack of discussion regarding effective security at the site and other such concerns including ownership of the site. An evaluation of the possibility of a breach of the proposed containment system; i.e., the likelyhood of it happening, the discovery of the same and the likely affects should be performed.