APPENDIX A

Town Of Conklin Landfills
Remedial Investigation
O'Brien & Gere
December 1988

Report

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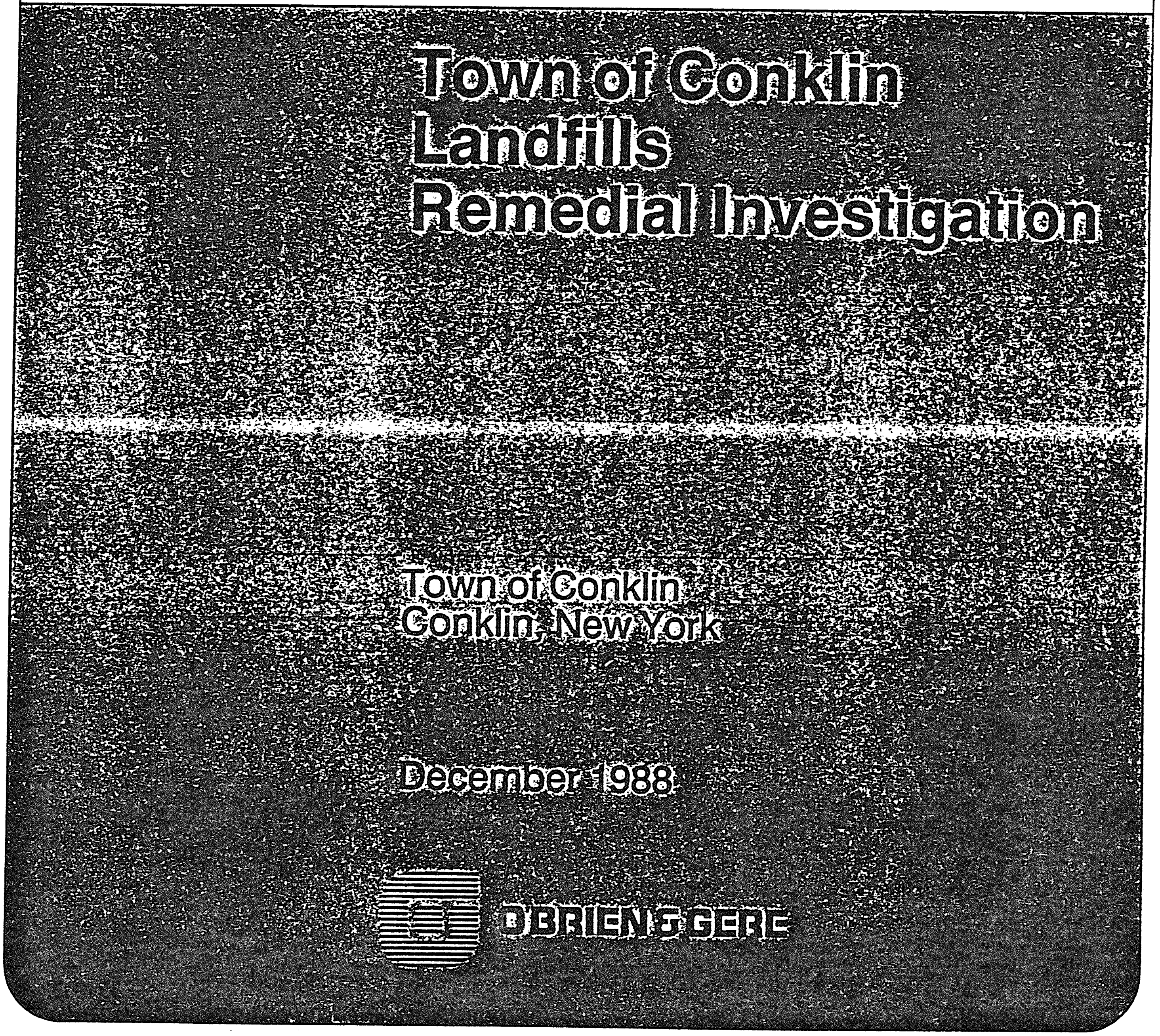
Region 7 Binghamton Sub. Office



Town of Conklin Landfills Remedial Investigation

Town of Conklin
Conklin, New York

December 1988

O'BRIEN & GERE

1-20-89 1:00pm
Rm 620

O'BRIEN & GERE

December 5, 1988

Mr. Brian Davidson
NYS Department of Environmental
Conservation
Room 222
50 Wolf Road
Albany, New York 12233-4011

Re: Town of Conklin
RI Report

File: 3362.001

Dear Brian:

Enclosed are five (5) copies of Town of Conklin Landfills Final Remedial Investigation Report for your review. The Report is presented in two volumes: Volume 1 contains the report text with tables, figures and exhibits. Volume 2 contains appendices for compilation of the data gathered in the RI.

The Final Report incorporates comments received September 15, 1988 from the reviewers at NYSDEC Air Resources and Hazardous Waste Remediation Divisions, NYS Department of Health, and USEPA. To assist in your further review, we are including explanations of how we have addressed these comments, along with references to the section of the report that has been revised.

Following your review of the Report, please contact me at your earliest convenience such that we can proceed with the Feasibility Study.

Very truly yours,

O'BRIEN & GERE ENGINEERS, INC.

John C. Tomik

John C. Tomik
Senior Project Hydrogeologist

JCT:ers/53.4
Enclosures

cc: M. Gorgus, Esq. (Coughlin and Gerhart)
P. Marks, Supervisor (Town of Conklin)
F. Trent (NYSDEC, Region 7, Kirkland)
S. Garver, Vice President (O'Brien & Gere Engineers, Inc.))
F. Hale, Manager (O'Brien & Gere Engineers, Inc.)
C. Kwan (USEPA)

O'Brien & Gere Engineers, Inc., an O'Brien & Gere Limited Company
Box 4873 / 1304 Buckley Road / Syracuse, NY 13221 / (315) 451-4700 FAX (315) 451-1242
Blue Bell, PA / Boston, MA / Corvallis, OR / Edison, NJ / Johnson City, NY / Landover, MD / New York, NY
Pittsburgh, PA / Pittsfield, MA / St. Louis, MO / Virginia Beach, VA / Watertown, NY

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233 - 7010

Thomas C. Jorling
Commissioner

SEP 15 1988

Mark Gorgos, Esq.
Coughlin and Gerhart
1 Marine Midland Plaza
PO Box 2039
Binghamton, New York 13902

Dear Mr. Gorgos:

RE: Town of Conklin Landfills
Remedial Investigation Report
Conklin(T), Broome Co.
I.D. #704013

The Remedial Investigation Report on the Town of Conklin Landfills dated July 1988 and received July 29, 1988, has been reviewed by the United States Environmental Protection Agency (USEPA), the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC).

The following comments were received from the NYSDOH:

1. The report states; "development of the industrial park has continued over the past three years and the assessment of topographic conditions and land use has been updated through additional site investigation studies." In what manner do study findings influence future development activity? Aside from plates which illustrate the basic infrastructure, future development activities need to be described in greater detail.

2. A map depicting downgradient homes utilizing private water supplies is necessary.

3. Findings from the risk assessment support the need for a feasibility study, although some points require qualification.

   a. In conservative fashion, all groundwater contaminants are viewed as if present in potable water supplies. Certain compounds (e.g., chloroethane, 170 ppb) have eluded discussion based on the "lack of regulatory standards." Actually, chloroethane is listed in the NYSDOH Proposed Standards Limiting Organic Chemical Contamination In Drinking Water," to be effective early 1989. A specific MCL (5ppb) is listed for chloroethane.

b. Direct contact with leachate seeps has not been addressed even though substances such as chorobenzene, ethylbenzene have been noted. Surface outbreaks of leachate have been noted in previous DOH inspections. Based on the inadequate description of future site activities (completion of the industrial development), it cannot be concluded that this exposure pathway is incomplete. A discussion of potential health risk associated with direct contact with leachate needs to be included.

c. Although numerous contaminants have been detected in groundwater, additive or synergistic effects are not considered. The consultant should reference USEPA. 1986. Guidelines for the Health Risk Assessment of Chemicals Mixtures to qualify or disqualify these effects.

In summary, although the NYSDOH does not wish to impede the initiation of the feasibility study, they are concerned that potential exposure routes will become a reality if the adjacent industrial park development proceeds irrespective of the remedial investigation findings.

The following comments were received from USEPA:

1. All data should be QA/QC approved and validated either by the NYSDEC or O'Brien and Gere. The validation package should be included with the report.

2. The ARAR should be cited when comparing data. Standards and/or criteria should be listed next to the analysis for convenience of comparison.

The following are the NYSDEC comments on the Remedial Investigation:

1. On Page 25, the report uses a standard of 0.05 mg/l for arsenic, while the Part 703 standard is 0.025 mg/l. On this basis, the standard was exceeded for HW-9 in 1984 and for HW-2 in 1983 and 1984. Section 6.05.1 Estimates of Groundwater Exposures on Page 65 omits this.

2. On Page 26, the report erroneously states that the standard for manganese is 0.05 mg/l. Since the Part 703 standard for manganese is 0.3 mg/l, Municipal Supply Well No. 3 is not over standard.

3. The comments on Page 29 regarding the 100 year flood plain are vague. The lower landfill appears to be within it. If so, the report should say so.

4. Some of the compounds which were included and excluded in the Waste and Source Characterization (Page 49) appear to be questionable. 1,1,1-trichloroethane is included but is not present in either the groundwater or the leachate at concentrations much greater than trichloroethene, which was excluded. Xylene, 1,1-dichloroethane and 1,2-dichloropropene are present in the groundwater and at fairly high levels in the upper-landfill leachate yet were excluded.

In addition, it was suggested by NYSDEC staff that infitrometer testing of the upper landfill cover would provide better data on the cover's permeability. The data could be used to determine a more accurate percolation rate and calculate leachate generation. The leachate generation data could then be used in evaluating leachate treatment alternatives in the Feasibility Study.

The NYSDEC Division of Air Resources expressed concern over the fact that no air testing has been performed on site. Air monitoring would certainly be necessary before the final selection of any remedial alternative that included a disturbance of on-site materials.

I have also reviewed your August 2, 1988 correspondence to Joseph S. Moskiewicz concerning gravel mining operations at the lower landfill. Mr. Moskiewicz has informed me that he will suspend the requirement for the Town of Conklin to submit a mined land reclamation plan for the lower landfill area until the completion of the remedial design. The suspension of this requirement, however, assumes that no gravel mining will occur at the lower landfill. Hopefully, the remedial design will satisfy the requirements in the Mined Land Reclamation Law.

The impacts on eventual remedial measures from changes in site conditions due to the gravel mining operations should also be addressed in the Feasibility Study.

RESPONSE TO COMMENTS ADDRESSED IN NYSDEC LETTER OF 9/15/88

TOWN OF CONKLIN
DRAFT REMEDIAL INVESTIGATION REPORT, JULY 1988

COMMENTS BY NYS DEPARTMENT OF HEALTH:

1. Additional detail regarding existing development and plans for future development in the area of the Town of Landfill has been received from the Broome Industrial Development Agency (BIDA) and is included as Exhibit A of the RI Report. For purposes of the RI Report, references regarding future development activities have been incorporated based on the Final Environmental Impact Statement for Broome Corporate Park, prepared by BIDA in June 1985. Since the proposed location of the Industrial Park includes development of access roads and utility lines in neighboring areas to the Upper and Lower Landfills, the RI has been revised to recommend that a buffer zone of at least 100 ft. from the Landfill property boundaries be maintained by the IDA (see Figure 1, BIDA, 1985). This buffer zone is judged to be sufficient based on the results of the risk evaluation presented in the RI. The boundaries of the Industrial Park are depicted in Figure 1 of the RI Report.

2. Figure 2 of the RI depicts downgradient homeowner wells currently or previously in services and identifies which homes are currently served by the public water system. Table 6 lists the sampling data collected for these wells and indicates which homeowners have switched to public water supplied by the Town.

3a. The proposed MCL for chloroethane listed in NYSDOH's Proposed Standards Limiting Organic Chemical Contamination in Drinking Water has been noted on Page 73.

3b. Risks from leachate direct contact have been estimated and added. See Section 6.05.3.

3c. Additive/synergistic potential of exposure to mixtures has been discussed, as appropriate, in Section 6.

COMMENTS BY USEPA:

1. Exhibit D has been added to the RI to incorporate Data Validation Comments for the RI data results. Qualifiers indicating excursions from the control limits or requirements of the Quality Assurance Project Plan (Appendix F, Preliminary Report, Town of Conklin Landfills, October 1987) are noted in the Data Appendices where these results are listed.

2. Chemical-specific ARARs are utilized for comparison and evaluation of the site data in Section 6, Data Analysis and Risk Assessment. Tables 3, 4, 6, 7 and 8 have been modified to include the appropriate standards or criteria for ease of comparison to site water quality results. Exhibit B, NYS and Federal Water Quality Criteria, includes listings of NYS Water

Quality Standards for Groundwater and Drinking Water, NYS Ambient Water Quality Standards for Surface Water, NYS Department of Health Proposed Standards Limiting Organic Chemical Contamination in Drinking Water, Federal Maximum Contaminant Levels, and Federal Ambient Water Quality Standards.

COMMENTS BY NYSDEC:

1. Arsenic concentrations in ground water have been addressed in revisions to Section 6.05 and 6.07. Page 26 has been revised to compare data to the more stringent applicable standard of 0.025 mg/l for arsenic, based on the NYCRR Part 703 Class GA Groundwater standard.

2. The standard for manganese has been corrected to 0.3 mg/l. It is also noted (Page 27) that Municipal Well #3 did not contain organic or inorganic parameters above the regulatory criteria or standards.

3. Information regarding the location of the landfills with respect to adjacent wetlands has been noted on Page 30. The northwest tip of Lower Landfill appears to border with Wetland BE4, which is classified as a wet meadow. Figure 9 has been modified to illustrate the extent of the 100 year flood plain.

4. Trichloroethane was not detected in monitoring wells nor in any residential wells since 1983. 1,2-Dichloropropene was not found in ground water. 1,2-Dichloropropane was not assessed because it was not detected in the Lower Landfill nearest residential wells, and because there is no basis for performing a chronic or carcinogenic risk estimate due to an insufficient database.

   Although the absence of trichloroethane and 1,1-dichloroethane from the Lower Landfill ground water suggests that transport to residential wells is very low, Section 6 incorporates assessments of these non-carcinogens, as well as xylene and toluene, to the ground water assessment.

   Benzene and methylene chloride were selected for the original ground water risk assessment on the basis of demonstrated human carcinogenicity of the former, and the potency of hepatotoxicity of the latter, even though neither was detected in residential or Lower Landfill ground water wells, but only in the Upper Landfill ground water.

5. The results of the infiltrometer testings of the Upper Landfill are discussed in Section 5.03.03 and included in Appendix C. Due to the gravelly nature of the soils within the Upper and Lower Landfills, the accuracy of the infiltrometer test was limited. Therefore, additional testing will be conducted during the FS to refine the estimates of leachate generation rates

6. The results of air monitoring recently conducted at the site are discussed in Section 6.03. These results will be taken into considerations for the development of remedial alternatives in the FS.

JCT:ers/53.5

3362.001

REPORT

TOWN OF CONKLIN LANDFILLS
REMEDIAL INVESTIGATION

DECEMBER, 1988

O'BRIEN & GERE ENGINEERS, INC.
1304 BUCKLEY ROAD
SYRACUSE, NEW YORK 13221

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SECTION 1 - INTRODUCTION

1.01 Site Background

The Town of Conklin owns two inactive municipal landfills (Upper and Lower) located south of Powers Road, approximately two kilometers (one mile) north of the Kirkwood Interchange of Interstate Route 81. The two landfills are located within the perimeter of the Broome Corporate Park (Industrial Park) in Broome County, New York. Figure 1 depicts the location of the Industrial Park and Figure 2 illustrates the boundaries of the Upper and the Lower Landfills.

The Lower Landfill was operated by the Town of Conklin from 1964 to 1969. The landfill was used to contain municipal refuse, and is estimated to contain a total fill volume of approximately 25,000 m^3 (32,500 yd^3). Designated wetlands surround a large portion of the Lower Landfill, which is located in the east central portion of the Industrial Park.

The Upper Landfill was operated by the Town of Conklin from 1969 until 1975, when a closure order was issued by the NYSDEC for the disposal of municipal wastes. The Upper Landfill, located in the west central portion of the Industrial Park, is estimated to contain a total filled volume of approximately 55,000 m^3 (71,900 yd^3) of waste material. Tree cover is adjacent to the south, east and north sides of the Upper Landfill.

1.02 Previous Studies

O'Brien & Gere Engineers, Inc. completed a two phase hydrogeologic investigation of the Industrial Park for the Broome

Industrial Development Agency (BIDA). The Phase I Hydrogeologic Investigation was completed in March 1984 and the investigation evaluated the potential for contamination and development limitations of the two inactive landfills located within the proposed Industrial Park. The Phase II Hydrogeologic Investigation was completed in February 1985. The investigation characterized the local hydrogeology and identified the hydrogeologic conditions that would affect development of the Industrial Park.

The hydrogeologic investigations have identified the presence of leachate seeps from both landfills. In addition, ground water monitoring wells which are in contact with fill have shown low levels of contaminants.

In 1985, a Remedial Investigation/Feasibility Study (RI/FS) Work Plan was prepared and submitted to the DEC. In January 1986, the field investigation was begun based on an approved Work Plan. In June 1986 the field efforts included in the approved Work Plan were completed, but negotiations between the Town and the State on the form of the Consent Order for funding of the project caused delays in finalizing the results of the investigations. Between November 1986 and June 1987, the Town advised O'Brien & Gere to suspend work, pending the renewal and completion of negotiations on the form of a Consent Order due to the availability of RI/FS funding under the Environmental Quality Review Act of 1986.

One requirement of the Consent Order signed by the NYSDEC and the Town was the preparation of a Preliminary Report. The Preliminary Report included a review of the data generated to date, proposed supplemental characterization studies, and revisions to the Work Plan as required by the Superfund Amendments and Reauthorization Act (SARA) passed by Congress in October 1986.

Sections 2 through 5 of this report incorporate the results of previous investigations as well as the results of the supplemental characterization efforts. The data have been reviewed and a discussion of the potential impacts to the environment and exposed populations has been included as Section 6. Section 7 summarizes the Remedial Investigation (RI) Studies, while Section 8 presents some initial stages of development of the Feasibility Study (FS).

1.03 Objectives

The purpose of the Remedial Investigation study is to define the conditions at the Conklin Landfill Site in order to complete a Feasibility Study. The RI/FS Work Plan was designed to accomplish the following goals:

A. Determine the nature of and the areal and vertical distribution of any hazardous wastes disposed of at the landfills.

B. Evaluate the on and off site impacts that any past, present or future release or migration of hazardous wastes may have on public health or the environment.

C. Screen possible response actions in accordance with the National Contingency Plan (NCP) 40 CFR Section 300.68, using interim guidance documents provided by USEPA, including Guidance on Superfund Selection of Remedy and the Preamble to the Revised NCP which addresses the required changes under SARA.

SECTION 2 - SITE FEATURES INVESTIGATION

2.01 Demography

The 1980 U.S. Census reported the total population of the Town of Conklin to be 6,204. Approximately 700 people reside within one mile of the Site. In 1980, the median age of the Town of Conklin residents was 29.9 years and the median family income of the Town of Conklin residents was $19,661 (BIDA, 1985).

2.02 Land Use

The predominant land uses in the Town of Conklin are agricultural/vacant and forest uses. These two land uses occupy approximately 89 percent of the land in the Town of Conklin. Single family homes account for the third single largest land area in the Town of Conklin, occupying approximately 8 percent of the land area in the Town of Conklin. Industrial areas comprise 0.5% of the land use in the Town of Conklin (BIDA, 1985).

The Industrial Park is zoned Industrial Limited (IL), Industrial Development (ID) and one- and two-family residential. The residentially zoned areas occupy the southern one third of the property. The Town of Conklin Comprehensive Plan has targeted the entire property for industrial development (1985). A map illustrates the existing and future development of the industrial park is included as Exhibit A.

2.03 Natural Resources

The Site is located within the Appalachian Plateau and the unconsolidated deposits underlying the site consist of glacial till, lacustrine deposits and outwash sand and gravel. The sand and gravel in the vicinity of the Lower Landfill is an unconfined aquifer that supplies drinking water to the homeowner wells along Route 7 and the aquifer for the Town's water supply wells. The Susquehanna River is located approximately one kilometer (0.6 miles) to the east of the Lower Landfill.

Approximately 16 hectares (40 acres) of state-regulated wetlands and 8 hectares (20 acres) of unregulated wetlands exist adjacent to the Site as illustrated in Figure 2, Site Plan.

2.04 Climatology

Climatological data for the geographic region have been gathered for the time period of 1972-1986. During this time period, the average yearly precipitation for the region was 38.88 inches; the average temperature for the area was 7.89°C (46.2°F), with low and high average monthly temperature data recorded over the time period of -10.22°C (13.6°F) and 22.67°C (72.8°F), respectively.

SECTION 3 - DISPOSAL SITE DEFINITION

3.01 General

The landfills were developed at different times at locations separated by approximately 1200 ft. Between 1964 and 1969, the Lower Landfill was used for the disposal of municipal solid waste. Between 1969 and 1975, the Upper Landfill was used for the disposal of municipal solid waste. Industrial wastes may have been disposed at either or both landfills, although no written records of industrial waste disposal activities exist. The Investigations described in this report are based on a characterization of various environmental matrices at the site (i.e. ground water, surface water, sediment) to determine the environmental impacts posed by the landfills. In addition, subsurface geophysical investigations, topographic surveys and exploratory trenches were performed to delineate the boundaries of the landfills.

The analytical program included samples of the leachate from the Lower and the Upper Landfills, surface water samples from Carlin Creek and the adjacent wetlands, sediment samples from Carlin Creek and the wetlands, and ground water samples from on and off-site monitoring wells and downgradient homeowner and municipal supply wells. Analytical parameters included site specific indicators and specific parameters such as purgeable priority pollutants, metals and pesticides/PCBs.

Sample identification was based on a horizontal location number, a depth/strata number, sample type, and the date collected. At a given horizontal location, several samples might be collected to characterize different strata, sediment/fill or ground water. Each sample was then given a discrete laboratory number to trace it through the various analytical protocols.

Well locations HW-1 through HW-20 include homeowner and municipal supply wells to the east of the Lower Landfill. Locations 13 through 16 and 23 through 26 represent leachate sampling areas. Leachate samples taken from locations 23 through 26 were composited in equal volumes and submitted for chemical analyses as Location 27. Treatability tests were conducted on leachate samples from wells 14 and 16, from the Upper Landfill. Locations 1 through 12, 17 through 22 and 36 through 38 are ground water monitoring well sites. Locations 30 through 35 were sample locations for both surface water and sediment samples. Locations 28 and 29 have been reserved for future sampling, if required. All sampling locations, with the exception of Location 19, are shown on Figure 2. Monitoring Well 19 is located approximately 4000 feet south along the roadway, opposite the Susquehanna River (see Figure 8).

3.02 Nature of Waste Materials

The wastes deposited in both the Lower and Upper Landfills are reported to be municipal solid waste as there is no record of disposal of any industrial waste. Sampling of leachate from the Lower Landfill revealed measurable concentrations of iron, manganese, mercury, copper and benzene. Ground water monitoring wells in the vicinity of the Lower Landfill have been sampled, and the analytical results have revealed measurable concentrations of iron, manganese, arsenic, mercury and benzene.

Sampling of leachate from the Upper Landfill have shown measurable concentrations of metals, and volatile organics, including, iron, manganese, cadmium, chloride, trichloroethene, tetrachloroethene, 1,1-dichloroethane, 1,2-dichloroethane, ethylbenzene and benzene. Ground water monitoring wells in the vicinity of the Upper Landfill have been sampled, and the analytical results have shown measurable concentrations of iron, manganese, sulfate, arsenic, vinyl chloride, 1,1-dichloroethane, 1,2-dichloroethane, benzene and toluene.

Additional analytical results for site investigations of ground water, leachate, sediment, and soil borings are presented in the following sections.

3.03 Topographic Site Map(s)

An update survey of the Lower and Upper Landfills was completed in March, 1988. The topographic maps developed are included as Figures 3 and 4, respectively. Elevations are based on U.S.G.S. datum with contour intervals of 2 feet.

Most sampling locations for site wells, soil borings, sediment and water samples are located on Figures 3 and 4.

3.04 Exploratory Trenching and Borings

Seven (7) borings (B57-B63) were installed within the fill area of the Lower Landfill to determine the depth of waste materials. The depth of the borings range from 16-20 feet with the depth of refuse ranging from 4-8 feet in B-59 to 2-14 feet in B-61. The borings were completed using a bulldozer rig and samples of the subsurface materials were collected continuously from the ground surface. Each boring was backfilled with the excavated materials and covered with on-site soils.

A series of fourteen (14) trenches were excavated adjacent to borings B57-B63 to delineate the horizontal boundaries of the fill materials. The trenches were excavated from clean soils towards the fill area, until fill was encountered. Each trench was backfilled with the excavated materials. Excavated waste materials were covered with on-site materials. The locations and elevations of these trenches and borings are shown on the topographic site maps presented in Figures 3 and 4.

3.05 Supplemental Information

Aerial Photographs

Aerial photographs from 1973, 1981, and 1987 were reviewed to provide historical information on the disposal practices at the Conklin Landfills. The 1973 photo shows a diamond-shaped bare patch where the Upper Landfill is located. The only activity evident at the Lower Landfill is gravel pit mining, and the area along the perimeter of the gravel pit which was previously filled with refuse is covered with vegetation.

The 1981 and 1987 photos show the Upper Landfill as a rectangular-shaped area, mostly located north of the east-west access road, although a small corner of the landfill appears to extend south of the road. In 1981 the Upper Landfill is partially covered in brush, but in 1987 it is completely vegetated. Gravel pit mining continues at the Lower Landfill. Figure 3 shows the 1987 aerial photograph.

Upper Landfill Cover Material Permeability Analysis

A sample of the existing cover material on the Upper Landfill was collected for permeability analysis. A Shelby tube sampling device was manually driven into the cover material at several locations. The maximum penetration achieved was 48 cm (19"), with a recovery of only 11 cm (4"). Penetration was limited by a coarse gravel layer encountered approximately 12" below the surface. A falling head flexible wall permeability test was performed on this sample.

The results of this test determined a permeability of 4.6×10^{-7} cm/sec. This relatively low permeability appears to be misleading, as a visual inspection of the sample analyzed described the material as organic topsoil material with a coarse gravel "plug" at the bottom of the Shelby tube. The relatively low test results may be due in part to compaction of the sample during collection and particularly during laboratory extrusion of the sample.

Additional testing using an infiltrometer was conducted to provide data on the cover permeability prior to beginning the FS. The results of this testing are discussed in Section 5.03.03.

Fill Volume Estimates

Fill volume estimates for both landfills have been developed using data obtained from aerial photographs, topographic surveys, borings, and exploratory trenching (Lower Landfill only). The fill area comprising the Lower Landfill is quite well defined. An estimated fill volume for the Lower Landfill has been calculated to be approximately 32,500 yd^3. An estimated fill volume for the Upper Landfill has been calculated to be approximately 71,900 yd^3.

SECTION 4 - HYDROGEOLOGIC INVESTIGATION

4.01 Soils

4.01.01 Soil Types

The Industrial Park is underlain by soils of the Lordstown-Volusia-Mardin association. The association is composed of the following soil series: Lordstown, Volusia, Mardin, Canaseraga, Chenango and Dalton.

The Lordstown series is composed of well-drained soils that offer high-bearing capacity and good stability over bedrock.

Volusia series soils are moderately well to poorly drained with high-bearing capacity and low compressibility. Volusia series soils also have a seasonally high water table which is typically found atop a slowly permeable fragipan layer.

The Mardin series is moderately well-drained and the subsoils bottom layer has a dense, very channery silt loam fragipan that often creates a perched water table. Mardin series soils have a high-bearing capacity.

Canaseraga series soils are deep, well-drained soils that are prone to seasonal wetness and have varying bearing capacities.

Chenango series soils are deep, well-drained soils and, like the Canaseraga series soils, are considered to be prime agricultural soils.

Dalton series soils contain two contrasting deposits with a dense fragipan that separates the two deposits and creates a seasonally high water table that results in varying bearing capacities (BIDA, 1985).

4.02 Geology

4.02.01 Regional Geology

The Site is located within the Susquehanna section of the glaciated Appalachian Plateau. The regional physiography is characterized by moderately to steeply sloping uplands and broad, flat to gently undulating valley bottoms. The landscape has been sculptured primarily by fluvial processes, which have created numerous drainage systems dissecting the plateau surface. Glacial processes have further modified the region by rounding hill tops, truncating bedrock spurs, steepening valley walls, and partially filling the Susquehanna River valley with unconsolidated deposits.

The bedrock that underlies the site consists predominantly of fine-grained shale and siltstone. These units were consolidated into rock formations from sediments deposited in a shallow sea during late Devonian time (approximately 350 million years ago). Individual shale and siltstone layers dip gently to the southwest at gradients of less than 0.004 m/m (20 feet per mile). Small post depositional horizontal and vertical fractures are present in the bedrock.

4.02.02 Site Geology

The local shale/siltstone bedrock topography in the vicinity of the Site is covered with varying thicknesses of unconsolidated sediments. Most of these sediments were deposited as the result of glacial processes and post glacial recession. These sediments have subsequently been dissected and modified by recent fluvial processes. The glacial sediments in the vicinity of the Lower

Landfill have been identified as till, outwash and glacio-lacustrine (lake) deposits.

Till is a dense, unsorted mixture of rock fragments and gravel in a silt, clay, and sand matrix. Outwash deposits are characteristically comprised of well sorted washed sands and gravels. Glaciolacustrine or glacial lake deposits are typically fine grained silts, clays and sands deposited in glacial lake beds that formed when meltwater drainage was blocked by the glacial ice mass. Recent alluvial sediments are identified as silts, sands, and gravels deposited by modern fluvial processes. Figure 5 shows the areal distribution of surficial unconsolidated deposits encompassing the Industrial Park.

Descriptive soil boring logs obtained in conjunction with the installation of monitoring wells have been used to characterize the horizontal and vertical extent of subsurface hydrogeologic units. The hydrogeologic cross section, Figure 6, defines the relative thicknesses and lateral continuity of unconsolidated deposits along a northwest-southeast trending traverse.

The local subsurface geology in the immediate vicinity of the Lower Landfill as shown by the boring logs of MW6 and MW15 is primarily glacial outwash overlying glacial till. Further downgradient, the outwash sand and gravels are underlain by lacustrine silt, fine sand, and clay. These deposits are superimposed on the dense glacial till deposits.

The local subsurface geology in the vicinity of the Upper Landfill is primarily glacial till. The refuse is bordered to the southeast by a lens of low permeability silt. The silt layer extends downgradient from the base of the refuse. Further downgradient, the silt changes to sand and gravel outwash overlying the till.

4.02.03 Subsurface Investigations

Test Borings

In July and August of 1983, eight (8) soil test borings were installed in the vicinity of the Lower Landfill and seven (7) soil test borings were installed in the vicinity of the Upper Landfill. All fifteen (15) of these test borings were converted into ground water monitoring wells 1-15.

A total of ten (10) soil borings were installed within the Industrial Park between October and November, 1984. Four (4) of the ten soil borings were converted into ground water monitoring wells (Wells 17-20), while the remaining exist as soil borings. Figures 3 and 4 show the locations for borings B1 through B3; borings B4 and B5 are located approximately 1/2 mile south of the landfills while B6 is located approximately 200 feet north of the upper landfill. Borings for monitoring wells 21 and 22 were installed in January 1986. As part of the supplemental RI/FS field efforts in December 1987 and January 1988, five (5) soil borings were taken along the perimeter of the Upper Landfill. Four of these borings were converted to ground water monitoring wells (Wells 36-38s). The remaining borings B64 and B65 are located along the east and west border of the Upper Landfill, respectively. The boring program was initiated to obtain information concerning the horizontal and vertical extent of overburden materials within the landfills and areas adjacent to the landfills. A geologic log was prepared for each of the borings describing soil types, formation depths, texture, color, density, etc. The soil sampling methods and boring logs are presented as Appendix A. Well 6 was originally installed using a well point of one meter (3 feet); however, this well was reportedly destroyed by a snow plow. A replacement well was installed using the standard hollow stem auger methods. (see Section 4.03).

Magnetometer Survey

A field magnetometer survey was performed to delineate the horizontal boundary of buried metallic fill in the Upper Landfill. A grid system with a 50-foot interval spacing was established from an existing topographic survey. A Geometric^{R} proton magnetometer Model G-816/6826 was used throughout the survey to collect total magnetic field data at each defined grid point station. At each grid point, data were collected pertaining to the grid point location, total magnetic field intensity, and the time the reading was collected. An offsite base station was defined and reoccupied periodically to correct for diurnal (magnetic drift) changes.

To supplement the magnetometer survey, aerial photographs encompassing the Upper Landfill were obtained. To review the historic development of the Industrial Park, photographs from 1973, 1981 and 1986 were reviewed. The information derived from these sources was used to estimate the horizontal extent of fill in the Upper Landfill.

The magnetometer survey also detected ferromagnetic objects within the forested area lying outside of the defined landfill boundaries. Further investigations indicated that the elevated magnetic field readings were the result of surface debris including wheels, cans, and other miscellaneous metallic debris.

A magnetometer survey has not been conducted on the Lower Landfill. Delineation of fill area in the Lower Landfill was determined using boring and trenching procedures described in Section 3.04.

4.03 Ground Water

4.03.01 General

An unconfined aquifer exists along the eastern portion of the Industrial Park and this aquifer supplied drinking water to the homeowner wells along Route 7. During the development of the Industrial Park a water main was installed along Route 7 for use of homeowners. The Town of Conklin Well 3, located approximately 610 meters (2,000 ft.) northeast of the Lower Landfill well, is capable of producing 0.85 m3/min. (224 gal/min.).

Six monitoring wells (Wells 5, 6, 7, 8, 9 and 10) were installed in the vicinity of the Lower Landfill and six monitoring wells (1, 2, 3, 4, 11, 12) were installed in the vicinity of the Upper Landfill from July 1983 through January 1984 during the Phase I Hydrogeologic Investigation. Four additional monitoring wells (Wells 17-20) were installed from October 1984 through December 1984 during the Phase II Hydrogeologic Investigation. Two additional monitoring wells (Wells 21 and 22) were installed during

January 1986. Wells 36, 37 and 38 were installed in December 1987 - January 1988 as part of the supplement characterization efforts. One shallow well, Well No. 38S, was installed nested with Well No. 38. A replacement well for Well 6 in the Lower Landfill was also installed since the original Well 6 was reportedly destroyed by a snow plow.

The wells were used to establish a ground water profile, provide information on the flow rate and direction of ground water movement and supply sampling points to determine ground water quality. The locations and elevations of all site monitoring wells are shown on Figures 3 and 4.

4.03.02 Well Installation and Development

All the wells were installed using hollow stem auger drilling methods. Well installation procedures, well development procedures and well descriptions are given in Appendix B.

4.03.03 Ground Water Flow Conditions

Part of the precipitation falling on the land surface of the landfills may be transported as surface water runoff, returned to the atmosphere as evapotranspiration, or percolated through the soils into the ground water table. Once infiltrating water reaches the water table, it enters the ground water flow system and flows under the influence of gravity until it reaches a point of discharge such as a wetland, stream or river. At the Lower Landfill, a portion of the ground water discharges locally into the Wetland BE6 but most of the ground water will flow beneath the local discharge point and discharge to the Susquehanna River. At the Upper Landfill, the ground water may discharge locally into the wetlands or Carlin Creek, but most of the ground water will likely flow beneath these local discharge points and discharge to the Susquehanna River.

Figure 7, the ground water elevation map, depicts the configuration of the potentiometric surface from the ground water elevation data collected on January 20, 1988. Ground water elevation data are summarized in Table 1. The ground water within the outwash occurs at a depth ranging from five to ten feet below the surface. The ground water gradient slopes in an eastward direction towards the Susquehanna River. The hydraulic gradient, measured from Figure 7, is steep in the uplands areas, approximately 0.07 m/m, and relatively gentle within the valley in the vicinity of the Lower Landfill, approximately 0.01 m/m.

The water transmitting capacity, or permeability, of the various geologic formations were estimated by conducting in-situ permeability tests on several monitoring wells. The tests were performed using the procedures outlined in Appendix C, by removing a volume of water from the well and measuring the recovery rate of the water level. The results of the tests conducted on Wells 1, 3-7, 9-12, and 17-20 are included in Appendix C. The permeability test data for Wells 1, and 19, which were installed within the glacial till, indicate that the permeability of the till ranges from 2.3×10^{-7} to 3.8×10^{-7} cm/sec (6.5×10^{-4} to 1.08×10^{-3} ft/day). The permeability test data for Wells 7, 9, and 10 indicate a permeability for the outwash sand and gravel ranging from 1.8 x 10^{-3} to 4.6 x 10^{-3} cm/sec (5.1 to 13.0 ft/day). Permeability tests were also conducted on Wells 5, 6, 17, 18, and 20. However, because these wells were installed within mixed deposits of sand and gravel interbedded with silts and clays, the permeabilities were highly variable, ranging from 9.63 x 10^{-5} cm/sec to 2.6 x 10^{-3} cm/sec (0.27 to 7.37 ft/day).

Supplemental in-situ permeability tests were conducted in March 1988 on newly installed Wells 2, 6, 8, 13-15, 21 and 22. The permeability test data for Wells 36 and 38 which were installed within the glacial till indicate that the permeability of the till ranges from 9.3 x 10^{-5} to 1.4 x 10^{-4} cm/sec. The permeability test MW-6 and MW-21 indicate a permeability for the outwash sand and gravel ranging from 6.0 x 10^{-3} to 3.5 x 10^{-2} cm/sec. The results of these tests are included in Appendix C, and are summarized in Table 2.

The velocity of ground water at the site can be approximated using Darcy's law and estimates of the hydraulic gradient, aquifer permeability and aquifer porosity. The ground water flow velocity equation is as follows:

$$V = \frac{K\ (dh/dL)}{a}$$

Where:

V = Velocity, in m per sec.

K = permeability, in m/sec.

dh/dL = hydraulic gradient; in m/m

a = porosity

The upland area encompassing the Upper Landfill is underlain by glacial till which has a low permeability, ranging from 2.3 x 10^{-7} cm/sec to 9.3 x 10^{-5} cm/sec, and an estimated porosity of 0.34 which is typical for glacial till (Todd, 1980). Based on this information, and a hydraulic gradient of 0.070, it is estimated that the ground water flow velocity within the glacial till beneath the Upper Landfill is approximately 1.3 x 10^{-4} ft/day to 0.05 ft/day.

The lowland area in the vicinity of the Lower Landfill is underlain by outwash sand and gravel that has a relatively high permeability ranging from 4.6 x 10^{-3} cm/sec to 6.0 x 10^{-3} cm/sec and an estimated porosity of 0.25. Based on these data, and a hydraulic gradient of 0.010 m/m, it is estimated that the ground water velocity of the lowland area ranges from 0.05 ft/day to 0.70 ft/day.

4.03.04 Ground Water Sampling and Analysis

Ground water quality in the vicinity of the Site was assessed by sampling supply wells and ground water monitoring wells in and around the Lower Landfill and Upper Landfill. Figures 3 though 5 present the locations of the wells sampled as part of this study. Locations 1-12, 17-18, 20-22 and 36-38S are ground water monitoring wells. Locations HW1 through HW17 are private homeowner wells. Homeowner wells HW1 through HW12 were sampled by the Broome Industrial Development Agency (BIDA) and were analyzed by O'Brien & Gere. Homeowner wells HW13 though HW17 were sampled by the Broome County Health Department and were analyzed by the New York State Department of Health (NYS DOH). A second round of sampling and analyses of all homeowner wells was conducted by O'Brien & Gere in January, 1988.

Homeowner supply wells were analyzed for purgeable priority pollutants, total iron, manganese and arsenic. The ground water from the monitoring wells was analyzed for pH, specific conductance, TOC, TDS, purgeable priority pollutants, chlorides, and soluble metals (iron, arsenic, copper, manganese and mercury). In addition, Wells 15, 18 and 21 were also analyzed for organic pesticides and base/neutral/acid extractables determined by EPA Methods 608 and 625. All monitoring wells sampled as part of the supplemental characterization were analyzed in accordance with Contract Laboratory Protocols (CLP) for dissolved metals (arsenic, iron, manganese), pH, specific conductance and purgeable priority pollutants.

4.03.05 Ground Water Quality

Analytical results of ground water from the monitoring wells are presented in Appendix D. A summary of inorganic parameters for ground water quality data in the vicinity of the Lower and Upper Landfills is given in Table 3. Table 4 presents a summary of ground water quality purgeable priority pollutants for the Lower and Upper Landfills. Exhibit E includes comments on QA/QC validation of the data. The CLP surrogate recoveries were within the acceptable criteria with the exception of Monitoring Wells 3 and 4 which were slightly over the criteria. All samples with the exception of Monitoring Well 18 (and its duplicate) were analyzed within the method holding times. The results for MW18 and

MW-18D are thus presented for qualitative interpretation only. CLP metals analyses of the monitoring wells were slightly outside of the control limits for matrix spike recoveries in some samples, but these should not affect the quality of the data. Additional data qualifiers have been noted in the data appendices for minor excursions from the target control requirements.

The ground water analytical results are compared to background Wells 1, 6 and 21, and to the natural quality of ground water within glacial till lacustrine and outwash aquifers (Table 5) in the following sections.

Background Wells

Examination of Figure 7 demonstrates that hydraulically up-gradient wells to the Town of Conklin landfills include Wells 1 and 36. Well 1 was installed as part of the initial investigations in 1983, while Well 36 was installed during the supplemental field efforts in December 1987. Based on the analysis of ground water from these two background wells (see Tables 3 and 4 for inorganic and organic parameters, respectively), manganese and iron were slightly elevated above normal ground water levels within these aquifers of the Susquehanna River. All other parameters were within the typical ranges as shown in Table 5. Specific conductivity levels ranged from 195 to 330 umhos/cm and pH ranged from 6.7 to 8.3 s.u. for Wells 1 and 36. Total Organic Carbon (TOC) concentrations of 8-9 mg/l were observed, and all volative organic compounds were below the part-per-billion detection limits.

Wells 6 and 21 represent water quality upgradient of the Lower Landfill, but downgradient of the Upper Landfill. Well 6 was originally installed in 1983 but was destroyed and had to be replaced with a new well in December, 1987. The new location of Well 6 was selected approximately 150 ft northeast of the previous location, due to the presence of sewer lines and anticipated construction work in the area. Well 6 was used as a background well during the 1983-84 studies and again for the most recent supplemental studies; however, it was damaged and unavailable for use during the 1986 investigations. Well 21 was installed during early 1986. Well 18 might be considered representative of water quality to the north of the site, since it is removed from either of the landfills, offset approximately 90 degrees from the direction of ground water flow.

Examination of data for Wells 6 and 21 within Tables 3 and 4 suggests that the ground water upgradient of the Lower Landfill is characterized by moderate pH (5.7 - 7.5 s.u.) and high iron and manganese content (0.95 - 8.1 mg iron/l; 1.0 - 4.1 mg manganese/l). TOC values varied from 6 to 90 mg/l. All other parameters analyzed including other inorganics, indicators and organics, were similar in concentration to background ground water quality.

Monitoring Wells

Nine wells (in addition to background Wells 1 and 36) were sampled within the Upper Landfill. The analyses of Wells 3, 4, and 11 represent the ground water quality beneath and immediately downgradient of the Upper Landfill. The analytical results for most inorganic parameters were similar to those detected for the background wells, with the exception of iron and manganese. Some of the highest concentrations of these two parameters were detected in unfiltered samples, during the surveys conducted in 1983. The maximum dissolved levels of iron (2.17 and 2.26 mg/l) were found in Wells 38s and 11; the maximum concentrations of dissolved manganese (4.23 and 4.66 mg/l) were detected in Wells 11 and 12. One unfiltered sample from Well 3 taken in 1983 contained 0.015 mg/l cadmium, but subsequent analyses did not detect this parameter at a detection limit of 0.01 mg/l. Recent (1988) analysis of Well 22 exhibited a low pH of 5.2 S.U.; otherwise, all wells within the Upper Landfill showed pH levels within the normal range of 6 - 9 S.U.

Total organic carbon measurements were elevated in the 1983 survey of Wells 2 and 11 at the Upper Landfill (390 and 280 mg/l respectively). Well 2 showed traces of methylene chloride (4 ug/l, and 1 ug/l in one subsequent sampling), benzene (2 ug/l, or 1 ug/l in one latter sample analyses), and toluene (1 ug/l, or 2 ug/l in a latter sampling). All other volatiles in Well 2 were below the detection limit (1 ug/l for most parameters). A 1988 sampling of ground water at Well 11 showed chloroethane (170 ug/l), methylene chloride (2 ug/l), 1,1-dichloroethane (44 ug/l), 1,2-dichloroethene (4 ug/l), 1,2-dichloropropane (34 ug/l), benzene (2 ug/l), toluene (3 ug/l) and xylenes (3 ug/l). All other wells did not contain detectable concentrations of volatile organics.

In addition to Wells 6, 18 and 21 upgradient or north of the Lower Landfill, five monitoring wells were installed within the Lower Landfill area. Well 5 and Wells 8 through 10 are located immediately downgradient of the fill area, while Well 7 is located within the fill. Iron and manganese were the only inorganic parameters above ground water concentrations found in upgradient wells. The highest concentrations of dissolved iron were found in upgradient Well 21 (8 mg/l) and Well 18 (20.7 mg/l). Well 18 also showed the highest level of dissolved manganese (5.72 mg/l), followed by Well 10 (4.78 mg/l). The remaining wells ranged from 0.1 to 4.51 mg iron/l and from 1.14 to 3.67 mg manganese/l. Wells 5 and 8 showed pH levels on the order of 5.7 - 5.8 S.U.; while the pH levels for all other wells was within the range of 6 - 9 S.U.

Well 18 north of the Lower Landfill contained the highest concentration of total organic carbon (139 mg/l); toluene (2 ug/l) and xylene (3 ug/l) were detected in the volatile organics scan for this well. Well 18 also showed a trace of 2-butanone (3 ug/l), but this compound was also detected in the method QA/QC blank. Wells 7 and 8 showed 6 and 2 ug/l benzene, respectively, in one sampling event in 1983 but the same parameter was below the detection limit for samples analyzed in 1988.

Homeowner Supply Wells

Seventeen (17) homeowner wells were sampled during November 1983 to determine supply well water quality. The homes that were sampled are located east of the Lower Landfill along Route 7. The sampling was done by the BIDA, with the analytical work provided by O'Brien & Gere Engineers, Inc. and the New York State Department of Health (NYSDOH). Homeowner well analytical results are summarized in Table 6, with a complete listing of NYS Department of Health and O'Brien & Gere data presented in Appendix H. Pertinent water quality limits for contaminants in water are included in Exhibit A.

The inorganics analyses showed the presence of arsenic, manganese and iron in several of the supply wells. The level of arsenic in homeowner wells 2 and 9 exceeded the State Class GA ground water standard of 0.025 mg/l in samples collected in November, 1983 and January, 1984. One sample collected from HW-7 in 1983 was slightly above the standard, although subsequent analysis showed arsenic levels had decreased well within the 0.025 mg/l limit. Arsenic levels in HW-2 were also below the standard in the 1988 sampling. HW-9 could not be sampled in the 1988 survey. All wells were within the arsenic standard for the most recent (1988) sampling survey. Iron and manganese concentrations were above the corresponding drinking water secondary standards (0.3 mg/l for each, maximum 0.5 mg/l if both are present). It should be noted that the standards for iron and manganese were established based on aesthetic concerns for color staining and taste, and do not represent a risk to the public health.

The organics analyses for the homeowner supply wells did not show detectable concentrations of volatile compounds, with only two exceptions, at the Town Hall and Homeowner supply Well 6. Well 6 at 1262 Conklin Road contained traces of t-1,3-dichloropropene (2 ug/l) and trichloroethene (4 ug/l) in the sample collected in 1983. However, the homeowner at this address has since been connected to the public water distribution system. The Town Hall supply well contained low levels of trihalomethane compounds, which tend to form following chlorination of raw water supplies. According to Town Officials, chlorination treatment may have been applied in the well prior to the sampling tap. Neither of these compounds have been detected at either the Lower or Upper Landfill. Traces of 1,2-dichlopropane (1 ug/l) and carbon tetrachloride (2 ug/l) were detected in 1988 but not in 1983 in well samples from the Town Hall, again presumably due to chlorination of the water supply. A sample from Municipal Supply Well #3 did not show detectable levels of organics or inorganic parameters outside the relevant standards.

SECTION 5 - SURFACE WATER, SEDIMENT & LEACHATE INVESTIGATIONS

5.01 General

The Final Environmental Impact Statement for development of the Broome Corporate Park prepared by the Broome Industrial Development Agency in June 1985 presented a detailed section describing the surface water hydrology present at the Industrial Park. The Lower Landfill is surrounded by the surface waters described. Excerpts from that document are presented as the following sections on Streams and Drainage and Wetlands.

5.01.01 Streams and Drainage

The land area near the Lower Landfill is drained by a dendritic pattern of permanently flowing and intermittent streams. The streams are associated with three small watersheds that ultimately drain into the Susquehanna River. The three small watersheds are: the Carlin Creek watershed, 807 hectares (1,993 acres), the South Tyler watershed, 106 hectares (262 acres), and the North Park watershed, 163 hectares (404 acres).

Carlin Creek, traveling through poorly drained soils, tends to maintain a surface flow. The North Park watershed has similar characteristics, although the South Tyler drainage network tends to lose water through the more permeable Canaseraga soils. In all three watersheds, stream flow is intermittent in nature. Peak run-off rates were calculated for each watershed under existing conditions using the U.S. Soil Conservation Service Method for small watersheds and are as follows: Carlin Creek at 40 m3/sec

(1,415 cubic feet per second (cfs)), South Tyler at 22 m3/sec (780 cfs), and North Park at 9 m3/sec (305 cfs).

5.01.02 Wetlands

Approximately 16 hectares (40 acres) of State regulated wetlands are located west of the Lower Landfill. The wetlands are comprised of 9 hectares (23 acres) of standing ponds and emergent marsh (Wetland BE5) and 7 hectares (17 acres) of wet meadow (Wetland BE5) as illustrated in Figure 2. Another wetland lies just to the east of Delaware & Hudson rail line (Wetland BE6). Although Wetland BE6 is unregulated by the State, it contains approximately 8 hectares (20 acres) of emergent marsh that might be considered an extension of the local wetland system.

Wetland BE4, located to the northwest of the Lower Landfill is flooded seasonally by Carlin Creek as well as by surface run-off from upland slopes. The slowly permeable Wayland soils that underlie the wetland keep the area wet throughout much of the year although little, if any, standing water remains for prolonged periods of time. Because of the continuously wet condition in Wetland BE4, a sedge, rush grass-dominated plant community has evolved. As a result, Wetland BE4 is classified as a wet meadow. Wetland BE6 is also classified as wet meadow.

Wetland BE5, located to the southwest of the Lower Landfill is classified as an emergent marsh because of the constant presence of standing water. Considerable acreage in Wetland BE5 remains an average of three feet underwater through the year which creates a pond about 9 hectares (23 acres) in area. Several factors account for this condition. Surface water run-off and precipitation contribute some input, yet it is primarily discharging ground water that is responsible for maintaining standing water in the pond (BIDA, 1985).

Geologic borings taken in the area of Wetland BE5 show that a low-permeability, glacio-lacustrine deposit of silt and clay extends along the 870-foot and 890-foot contour west of the pond. The lacustrine deposit thins considerably toward the 870-foot contour where it intergrades with a much more permeable sand and gravel deposit. Ground water is most likely discharged into the pond along the plane of increasing permeability that begins at approximately the 870-foot contour. An embankment constructed around Wetland BE5 prevents water from leaving the pond. As a result, little water, if any, leaves the impoundment except through evaporation or transpiration.

Flood Potential

The landfills are located in close proximity of the 100 year flood-plain demarcation (See Figure 9), but outside of the area which could flood occasionally. The lower landfill is located southeast to Wetland BE4, as noted in Figures 2 and 9. The northwest tip of the lower landfill appears to border with this wetland which is classified as a wet meadow.

5.02 Carlin Creek and Wetlands Investigations

5.02.01 Carlin Creek and Wetlands Sampling and Analysis

Surveys in 1984, 1986 and 1988 of Carlin Creek and Wetlands BE5 and BE6 included collection of sediment cores (0-1 ft. depth) and leachate or surface water from nine locations. Sampling locations are illustrated on Figure 2 (Site Plan).

Sediment and leachate samples were collected from locations 23, 24, 25 and 26 (leachate only) within Wetland BE6, downgradient of the Lower Landfill. As discussed in Section 5.03 on Leachate Investigations, the leachate samples from these locations were composited as Location 27 for analysis. Sediment and surface water samples were collected at Locations 33, 34 and 35 from Wetland BE5 west of the Lower Landfill, downgradient from the Upper Landfill. The sediments from the Wetlands BE5 and BE6 were analyzed for total arsenic, cadmium, chromium, copper, iron, lead, nickel, mercury, manganese, zinc and total phenols.

Sampling of sediments and surface water from Carlin Creek Locations 30, 31 and 32 have also been completed. Creek sediments were collected in 1986 and were analyzed for several metals including arsenic, cadmium, chromium, mercury, manganese, and lead, in addition to other inorganic parameters and indicators. As part of the most recent characterization efforts (January 1988), surface water samples at Locations 30, 31 and 32 along Carlin Creek were analyzed for pH, specific conductance, dissolved oxygen, total arsenic, cadmium, chromium, copper, iron, lead, nickel, mercury, manganese, zinc, and total phenols. These data were collected for comparison with data from two previous sampling occasions for creek surface water in 1986.

5.02.02 Carlin Creek and Wetlands Quality

Table 7 and Appendices E and G present analytical results for the surface water and sediment samples. Exhibit D includes an assessment of the validity of the data, with respect to target QA/QC protocols specified in the Quality Assurance Project Plan for the site. Some minor excursions are noted but overall the data was judged acceptable. Data qualifiers noting these excursions are included in the appendices where the data results are listed. Exhibit A includes listings of relevant water quality standards.

No volatile organics were detected in the sediment samples from either the wetlands or Carlin Creek. One sediment sample from Location 23 (BE6 Wetland) was found to contain 78 mg/kg arsenic (29 mg/kg wet weight), while the other two sampling locations from this area showed only 10 mg/kg dry weight of arsenic. Traces of cadmium (2 mg/kg wet weight) were detected in sediments from Wetland BE5 and from Carlin Creek. Neither of these metals were detected in the corresponding surface water analyses, however.

In accordance with 6 NYCRR 17 931.3, Carlin Creek (SR-57) is classified as a class D stream subject to the corresponding D standards. Based on data from February 1986, mercury (0.0031 mg/l) was the only constituent found to be in excess of the State and Federal water standards of 0.002 mg/l. However, mercury was not detected either upstream or downstream of this sample location during the same sampling event, and has not been detected in either of two subsequent analyses (November 1986 and January 1988) at a detection limit of 0.0005 mg/l. All parameters tested in January 1988 were within Ambient Water Quality Criteria for protection of aquatic organisms published in May 1986 (USEPA, 1986. See Exhibit A).

5.03 Leachate Investigations

5.03.01 Leachate Sampling and Analysis

As noted above under the Wetlands investigations, leachate samples were taken from four locations in Wetland BE6 near the Lower Landfill (23, 24, 25, 26); these four samples were composited as Leachate Location 27.

Leachate samples from the Lower Landfill were collected from Leachate Wells 13 and 15. Wells 13 and 15 are screened within the saturated refuse of the Lower Landfill. Leachate samples from the Upper Landfill were collected from a leachate monitoring well (Well 14). Well 14 was installed within the saturated refuse of the Upper Landfill and location 16 is a surface grab of a leachate seep.

The leachate sampling locations are depicted in Figure 2. Leachate samples were analyzed for pH, specific conductance, TOC, TDS, purgeable priority pollutants, chlorides, filterable iron, arsenic, copper, manganese, mercury, and organic pesticides and base/neutral/acid extractables determined using EPA protocols 608 and 625.

In addition, during the January 1988 field characterization efforts, two gallons of leachate were collected from the Upper Landfill Leachate Well 14 and location 16 to conduct treatability tests. These tests are described in Section 5.03.04.

5.03.02 Leachate Quality

Table 8 and Appendix F contain analytical results for the leachate samples.

Leachate Well 14 from the Upper Landfill contained in excess of 50 ug/l of several volatile compounds, including, methylene chloride, 1,1-dichloroethane, 1,2-dichloropropane, toluene, chlorobenzene, ethylbenzene and xylene. Chloroethane, 1,2-dichloroethane, benzene and tetrachloroethene were detected at concentrations below 50 ug/l. Toluene, chlorobenzene, ethylbenzene and xylene were also found at levels below 50 ug/l in samples from Leachate Seep 16 (Upper Landfill) and at Leachate Well 13 (Lower Landfill). The presence of trace quantities of organic constituents is typical for municipal refuse leachate (Khare et al., 1977).

Analytical results for inorganic parameters in leachate samples indicate the presence of iron (0.01 mg/l in Well 15 up to 6200 mg/l in Well 14) and manganese (0.8 mg/l in Seep 16 up to 120 mg/l in Well 14). Specific conductance measurements ranges from 270 umhos/cm (Well 13) to 11,460 umhos/cm (Well 14), while pH levels ranged from 5.9 s.u. (Well 14) to 7.7 s.u. (Seep 16). Most of the inorganic and indicator parameters were within the representative ranges for sanitary landfill leachate (see Table 9), with the exception of iron and manganese.

5.03.03 Leachate Volume Generation

The Phase I Hydrogeologic Investigation conducted by O'Brien & Gere estimated that 10.5 inches of precipitation percolated annually through the surface of the Upper Landfill. Previous investigations have estimated that 13.2 inches of precipitation percolates annually through the Lower Landfill. The results of infiltrometer tests (Appendix C) indicate that the cover material of the upper landfill ranges from 1.8×10^{-4} cm/sec to 5.5×10^{-5} cm/sec. The percolation rate estimated in the Phase I Hydrogeologic Investigation is within this range. However, the gravelly nature of the soils within the upper and lower landfill limited the accuracy of the infiltrometer testing. Therefore, additional testing will be conducted during the Feasibility Study to refine the leachate generation rates for the upper and lower landfill.

5.03.04 Leachate Compatibility Tests

General

The analytical data for the Upper Landfill leachate (MW#14), presented in Table 8, indicate that the leachate quality is within the respective ranges for sanitary landfill leachate (Table 9). Biological treatability tests were conducted on samples from the Upper Landfill leachate to evaluate its compatibility for treatment in a municipal sewage treatment plant. The type of biological treatment system selected for the treatment of the leachate is dependent on several factors such as volume of the leachate, strength of the leachate and effluent or discharge limitations.

Currently, there are several testing protocols for toxicity or inhibitory effect of wastewater to microorganisms. The application of a particular protocol depends on the objectives of the study. Three test methods were selected for the compatibility tests of the leachate from the Upper Landfill:

1. Extended Dilution Oxygen Uptake Test (Marks, 1972)
2. Ultimate Biochemical Oxygen Demand (UBOD) Test (Standard Methods, 1985)
3. Gilson respirametric tests

The extended dilution oxygen uptake test is generally employed to determine an inhibitory effect during carbonaceous degradation of organics while the UBOD will determine a long-term effect during nitrogenous degradation of organics. Thus, the combined results from the methods can be used to estimate the short-term and long-term impacts of the leachate.

The volume of the leachate generated by precipitation and ground water flow through the Upper Landfill was estimated in the Preliminary Report to be approximately 1.6 million gallons per year or roughly 5,000 gallons per day. If the leachate is to be discharged to the Binghamton/Johnson City Wastewater Treatment Plant (WWTP) where the daily average flow is currently approximately 18 MGD, the expected ratio of the leachate to be discharged to the WWTP is approximately 3:10,000 (0.03 percent) by volume.

Unfortunately, during the field investigation, the WWTP was being upgraded and microbes from that plant were not available. To provide an indication of compatibility, the extended dilution oxygen uptake test was conducted using a microbial population from another similar treatment facility. Testing conducted for evaluation of the ultimate biological oxygen demand using microbes from an alternate WWTP did not yield useable data, therefore, these tests will be repeated with samples from the Johnson City Plant and will be reported in the FS. Testing for compatibility with the Binghamton WWTP will be attempted during the review of the RI, and will be reported with the FS.

Test Procedures

Extended Dilution Oxygen Uptake Test

The microbial inhibition test procedure was described by Marks (1972) to detect the threshold inhibition level under a set of defined conditions. The test involved measuring oxygen depletion caused by microbial activity on organic compounds present in the leachate. The experiment was designed such that the ratio of leachate added to the BOD bottles (between 0.017 to 6.66 percent by volume) covered the expected ratio of leachate to be discharged to the WWTP. Various amounts of leachate were added to BOD bottles containing approximately 250 ml of unseeded BOD dilution water and 3 ml glucose/glutamic standard food (150 mg/l each). Then, 3 ml of seed (10 ml of Syracuse Metro WWTP mixed liquor in equal volumes with deionized water) was added to each bottle and the final volume was brought to 300 ml with dilution water. Blank bottles contained only dilution water and control bottles contained 5 ml of standard food and 3 ml of seed and dilution water, with no leachate added. All of the test conditions were conducted in duplicate except the blanks and controls which were conducted in triplicate. The initial dissolved oxygen was measured using a membrane electrode method (Standard Methods, 1985) and recorded. After incubation at 20°C for 12 days, the final dissolved oxygen was measured.

Results and Discussion

Table 10 presents the test conditions and results of the extended dilution oxygen uptake test. Figure 10 shows the plot of the leachate volumes used vs. residual D.O. of the respective test bottles of extended dilution oxygen uptake test. Figure 11 shows a typical inhibition curve of the extended dilution oxygen uptake test.

The data indicate that there is no apparent inhibitory or toxicity effect of the leachate to the domestic WWTP microorganisms for the extended dilution oxygen uptake short-term test. Based on the results of the extended dilution tests, additional short-term impacts to be evaluated through Gilson Respirametric tests were deemed unnecessary. Supplemental tests to be conducted in the FS will be used to determine longer term impacts.

SECTION 6 - DATA ANALYSIS AND RISK ASSESSMENT

6.01 Risk Assessment Introduction

The following is an assessment of the potential public health risks that may be associated with the Conklin landfill site. This assessment focuses on the potential impact of the sediment, surface water and ground water volatile organic compounds (VOC) and metals identified during field investigations. The objectives of the assessment include:

1. presentation of findings of field and laboratory investigations to identify the nature and extent of contamination
2. identification of potential receptors in the area
3. performance of risk analysis using available data approximating minimum and maximum concentrations of indicator chemicals in surface and ground water.

This assessment was conducted based on available analytical and toxicological information, in accordance with guidelines and procedures of the United States Environmental Protection Agency (U.S. EPA) for evaluating public health risks related to uncontrolled hazardous waste sites (U.S. EPA 1986a, 1986b). The overall risk characterization approach is outlined in Figure 14. Using this approach, only two exposure pathways were determined to be complete or functionally complete. These are the ground water pathway for humans who may consume site-related ground water and the surface water (sediment) pathway for benthic organisms potentially present in the wetlands adjacent to the site. For the ground water pathway, the arsenic, methylene chloride, and benzene concentrations in the ground water used for drinking water purposes are well below the levels that might constitute an unacceptable health risk, given standard worst case assumptions regarding ingestion. Due to the current lack of regulatory risk assessment guidance in the form of reference doses or carcinogenicity potency factors for chloroethane, no quantitative risk assessment was possible for this compound. For the benthic organisms, due to the lack of data concerning the toxicity of the sediment residues of arsenic to these organisms, it was not possible to draw any conclusions concerning the level of risk represented by the observed concentrations of site indicators in the wetland sediments.

A third exposure pathway, direct contact with landfill leachate, is potentially functional and complete under a future scenario involving development/construction of neighboring properties.

6.01.1 Identification of Potential Exposure Pathways

A hazardous chemical may represent human or environmental risks only if humans, animals, wildlife or sensitive ecosystems have the potential to be exposed to (i.e. contact) the material in sufficient quantity to affect either the health of individuals or the general ecological balance. Exposures to the waste materials can occur in numerous ways. Examples of potential exposure scenarios related to an uncontrolled hazardous waste site include the following:

- Ingestion of surface water or ground water containing solubilized contaminants or ingestion of contaminated surface water sediments.
- Inhalation of volatile contaminants or contaminants airborne in association with particulates.

- Ingestion of biota (e.g. fish) that have bioaccumulated a contaminant released from the waste site.
- Dermal absorption or ingestion of contaminated materials resulting from direct contact with the source of materials at the waste site.

Four basic exposure pathways are considered: the air, surface water, ground water, and direct contact exposure pathways. Each of these exposure pathways may have one or more exposure scenarios associated with them. Although it may be possible to postulate numerous hypothetical scenarios of exposure for each of the basic exposure pathways, a "complete" exposure scenario (i.e. one potentially posing a risk) must include the following components:

1. A waste source and a mechanism of release from it. Examples of release mechanisms include volatilization, wind scour, surface runoff, and leaching.
2. A viable transport mechanism (air, surface water, or ground water) from the waste source to a potential receptor point.
3. A potential receptor population (humans, plants, or animals) or location (i.e. sensitive ecosystem) for a contaminant released and transported from the waste source.
4. An exposure and uptake route (inhalation, ingestion, or dermal absorption); i.e. a mechanism by which the receptor absorbs the contaminant, allowing it to exert its toxic effect.

If any one or more of these components are missing, an exposure scenario is by definition incomplete and, therefore, poses no risk to health or the environment. Therefore, the first phase of a risk assessment is a qualitative assessment, in which site and waste characterization and the identification of "complete" (or potentially complete) exposure pathways are performed. Scenarios determined not to be "complete" are not considered further. "Complete" scenarios are subjected to further analysis. However, those scenarios determined to be complete do not necessarily indicate that an unacceptable condition exists. The magnitude of impacts associated with these conditions are further evaluated in the next phase, the "quantitative" assessment.

6.01.2 Risk Characterization Process

As mentioned above, quantitative risk assessment is carried out only for potentially "complete" pathways and their identified scenarios. The quantitative risk assessment involves three steps:

1) selection of waste components to serve as indicators of potential environmental and health significance;
2) measurement or the prediction of exposure point concentrations at receptor locations; and
3) the comparison of the predicted or measured exposure point concentrations to relevant action levels established for the protection of human health.

This is often performed under "worst case" exposure and uptake conditions to establish whether the waste could represent an unacceptable risk to human health and/or the environment.

Indicator chemicals for use in the quantitative analysis are based on a "waste characterization" that considers

1) the nature, volume, and disposal history of the waste material
2) the waste components' environmental dynamics and
3) the toxicology of the waste's components. The objective of the indicator chemical evaluation is to focus on specific chemicals to provide a manageable set of compounds for further analysis. These compounds represent those waste components that are the most toxic, persistent and mobile and thus have the greatest potential of environmental impact. Exposure point concentrations are then established for each selected indicator chemical. Site specific data for each indicator chemical and conservative modeling procedures depicting "worst case" scenarios are used in this process.

The Superfund Amendments and Reauthorization Act of 1986 requires that decision-making regarding remedial action at hazardous waste sites under the authority of the act be guided by health-based standards or criteria that are legally applicable or are relevant and appropriate, often termed applicable or relevant and appropriate requirements (ARARs). Therefore, the predicted or measured exposure point concentrations for each indicator species are first compared to established relevant action levels for the protection of human health.

Drinking water maximum contaminant levels (MCL's), National Ambient Air Quality Standards (NAAQS), federally approved state water quality standards developed under the Clean Water Act (e.g. NYS ambient surface water quality standards), EPA Health

Advisories (SNARL's: suggested no adverse impact levels), and EPA ambient water criteria (AWQC) are often used as ARAR's for evaluating target concentration levels. In those cases where the appropriate contaminant action levels or standards are not exceeded by the concentrations shown by the complete exposure pathways, it is concluded that the exposure pathway poses no health risk to the receptor.

If, however, the action level is exceeded, a toxicological assessment is performed, with the objective of identifying the magnitude of toxic impact, if any. It should be noted that the ARARs are action levels established with the goal of identifying exposures that will not produce an adverse effect on human health or the environment. However, because of the conservative methodology and margins of safety typically employed to establish these levels, they do not represent levels which, if exceeded, will necessarily produce an adverse effect.

The toxicological assessment of exposures above established standards is performed as follows. In order to assess the potential risks associated with a given contaminant level, exposures are first quantified for all active exposure routes (diet, drinking water, inhalation, dermal absorption) to determine intakes for acute, subchronic, and chronic lifetime exposures of the receptor. For carcinogens, unit risk factors generated from animal test data using recently promulgated guidelines or performing risk assessments of carcinogens (U.S. EPA 1986b), are combined with intake data to derive a quantitative estimate of the incremental cancer risk. This value is compared to site circumstances, the size of the exposed receptor populations, and other factors in order to determine the acceptability of the exposures. For non-carcinogens (e.g. reproductive and developmental toxins, organ and systemic toxins), acute toxicity information as well as acceptable daily intakes (ADIs) established by the U.S. EPA or other agencies are used for comparison to estimated exposure levels under acute, subchronic, and chronic conditions.

6.02 Introduction to Qualitative Exposure Pathway Analysis

A qualitative exposure evaluation is a determination of the continuity of the waste source, transport routes and receptors at a particular site. The objective of the evaluation is to determine if the three components are acting together to facilitate transport of wastes from within the site to a particular receptor. An exposure scenario in which all three components are determined to be functioning is termed "complete" and is further evaluated by a quantitative risk assessment. This section is divided into three subsections; each concerned with evaluation of one of the components.

The first subsection is description of the waste source. The second subsection evaluates each of the transport routes to determine the manner and extent to which the routes are interacting with the waste source to transport components to off-site locations and receptors. The third subsection identifies each of the potential receptors in the study area and determines whether they can be reached by each of the transport mechanisms. The product of the qualitative assessment is the identification of specific transport routes and receptors for which a "complete" pathway of exposure exists.

It should be emphasized that this section is concerned only with the identification and documentation of complete exposure scenarios, and does not consider the magnitude of any of the potential exposures identified.

6.02.1 Waste and Source Characterization

The site contains two inactive municipal landfills (Upper and Lower). The Upper and Lower landfill were operated from 1969-1975 and 1964-1969, respectively, by the Town of Conklin. The only documented wastes at the Upper and Lower landfills are municipal wastes. The estimated total fill volumes in the Lower and Upper Landfills were 32,500 and 71,900 cubic meters, respectively.

The substances detected in area environmental samples include:

arsenic
cadmium
iron
manganese
lead
methylene chloride
benzene
toluene
ethylbenzene
xylene
1,1,1-trichloroethane
1,2-dichloropropane

1,1-dichloroethane

1,2-dichloroethane

chloroethane

Tables 3 through 8 present summary data for the above compounds.

The following chemicals from the above list have been selected as "site specific indicator parameters" or simply "site indicators," based on their environmental mobility (i.e. volatility, migration in ground water), persistence, detection in area environmental samples, toxicity and, depending on the compound, known or suspected carcinogenicity based on laboratory studies with animals. Specific information which provides justification for the selection of these compounds as the site indicators, i.e. their toxicological and environmental effects, are presented in Sections 6.02.3 and 6.02.4, respectively. Detailed analytical data derived from monitoring activities at the site are presented in previous sections. Additional information regarding these topics is presented in Exhibit B, Contaminant Properties.

Several trace organic compounds were detected in wells (predominantly in Well 11) in the Upper Landfill, including 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethane, methylene chloride, chloroethane, xylene, toluene, benzene, and vinyl chloride. These compounds were not found in the Lower Landfill ground water, nor in residential well water. Trace (9 ug/L) trichloroethylene was detected in one residential well one time in 1984. Because of the very low incidence of detection, trichloroethylene will not be assessed quantitatively. Similarly, 1,2-dichloroethane and vinyl chloride will not be considered.

The selection of these particular compounds, rather than the others listed above, was due primarily to their relatively higher concentration in one or more environmental matrices in more recent sampling rounds.

benzene
chloroethane
1,1-dichloroethane
ethylbenzene
methylene chloride
toluene
1,1,1-trichloroethane
xylene
arsenic

Key physicochemical and toxicological data that were used to select these indicator chemicals are compiled in Table 11. Complete analytical results of the monitoring studies that have been conducted at the site were discussed in previous sections. In addition to trace levels of organic and inorganic compounds found in association with the site, municipal landfills have several environmental issues which can also have an environmental impact, including gas generation and the acidity/alkalinity of site leachate. These factors will be considered in the risk assessment in addition to the assessment of toxicological issues.

6.02.2 Environmental Chemistry and Dynamics

Profiles of the physicochemical properties and environmental fate and transport of the site indicator chemicals are attached in Exhibit B, Contaminant Properties.

Some physicochemical data that were used to predict the environmental fate of the site indicators are compiled in Table 11. The organic site indicators have low molecular weights and moderate to high water solubilities (152-20,000 mg/L) and vapor pressures (7-1000 Torr) (Callahan et al. 1979). Measured Henry's Law constant values for the organic site indicators ranged from 2E-3 to 2E-2 atm cubic meter/mol (Hine and Mookerjee 1975). As a result, the organic site indicators are expected to readily volatilize from surface water.

For the organic site indicators, the log octanol/water partition coefficient (Kow) values range from 1.25-3.15 and estimated log soil sorption coefficients (Koc) values range from 1.4-2.94 (Callahan et al. 1979). The high value in the range of Koc values is for ethylbenzene. This substance will, therefore, be expected to bind fairly strongly to soils and sediments and will be fairly immobile (Kenaga 1980). The remaining values are indicative of weak adsorption to soil and sediment (Kenaga 1980), and suggest that these organic site indicators will leach when applied to soil, especially sandy soils, given adequate precipitation. The relatively low Kow values of the organic site indicators suggest that they will not bioconcentrate significantly in fish or other aquatic organisms. The vapor pressure and Henry's Law constant values are such that all the organic site indicators should volatilize from surface water and exposed soils. Estimated volatilization half-lives from water are on the order of hours from streams and rivers, and on the order of days from lakes (Lyman et al. 1979). The site indicators are not expected to hydrolyze (Mabey and Mill 1978) or photolyze (Silverstein and Bassler 1967) in aqueous media. Benzene, toluene, and ethylbenzene may biodegrade in water (Tabak 1981, Sasaki 1978), but the remaining site indicators are not expected to do so (Sasaki 1978).

Volatilization resulting in transport to the atmosphere is expected to result in rapid photooxidation of all the organic site indicators with the exception of 1,1,1-trichloroethane and methylene chloride (Atkinson 1979). Half-lives for the reaction of the vapor phase benzene, ethylbenzene, and toluene with photochemically generated hydroxyl radicals in the atmosphere calculated from experimental data range from 1.4-6.6 days (Atkinson 1979). For methylene chloride, chloroethane, and 1,1,1-trichloroethane, the half-lives are 67, 40, and 694 days, respectively (Atkinson 1979).

Because arsenic is an element capable of existing as a variety of compounds in the environment, its physical properties in the environment cannot be easily summarized. The most important fate processes of arsenic compounds are sorption to clays, iron oxides and organic material and conversion to volatile species by biological activity. In general, arsenic is highly mobile in the aquatic environment. A more detailed treatment of the overall environmental fate of arsenic is contained in Callahan et al. (1979) and is reproduced in Exhibit C.

In conclusion, the aliphatic organic site indicators are mobile in soil, and can therefore be leached by infiltration and transported to ground water. Once there, the aliphatic organic site indicators tend to resist degradation by chemical and biochemical reactions. Benzene and toluene, on the other hand, may biodegrade, but are not expected to chemically degrade. Excluding ethylbenzene, the relatively low Koc values of the organic site indicators suggests that only weak adsorption to organic material will occur. Also, the site indicators have moderate to high water solubilities. Any organic matter that may be present in the ground water, therefore, is not expected to significantly retard the rate of migration of these site indicators. Movement of these organic site indicators in ground water, therefore, is expected to be close to the rate of ground water movement. Ethylbenzene, on the other hand, is expected to bind fairly strongly to soils and sediments and any organic material present in ground water may significantly slow its rate of movement in aquifers. Release of the organic site indicators to surface water is likely to result in rapid volatilization and subsequent photooxidation for benzene, toluene and ethylbenzene. Methylene chloride and 1,1,1-trichloroethane are expected to persist in the atmosphere for several months to several years, respectively.

6.02.3 Toxicological Profile - Health Effects

Toxicity profiles of the organic site indicators and arsenic are attached in Exhibit C (Clement 1985). Generally, chronic exposures in animal tests have shown that the organic site indicators are capable of inducing various systemic effects including damage to liver, kidneys, reproductive system and the central nervous system. Except where stated otherwise, the following information was taken from Clement (1985).

6.02.3.1 Benzene

According to the U.S. Public Health Service (1987a), insufficient data are available to positively link ingestion of benzene in water to an increased risk of cancer in humans. Rats exposed to benzene in drinking water, however, exhibited a carcinogenic response.

Epidemiological studies in workers exposed to benzene yielded sufficient evidence to conclude that inhalation of benzene in humans causes leukemia. The air concentrations of benzene in one of these studies ranged from 10 ppm (1969) to 100 ppm (1941) (USEPA 1984). Other blood system effects of benzene in humans include aplastic anemia, leukopenia, and thrombocytopenia, which may produce pancytopenia. In animals exposed to benzene, similar effects on the blood cell producing system occur. In humans and animals, benzene exposure is associated with chromosomal damage, but is not mutagenic in microorganisms. Benzene is fetotoxic by inhalation in mice (156-500 ppm), rats (47-2200 ppm), and rabbits (156-500 ppm) (U.S. Public Health Service 1987a).

Inhalation exposure to high benzene concentrations (20,000 ppm) causes CNS depression and convulsions, and leads to death by cardiovascular collapse within minutes.

Inhalation of lower benzene concentrations causes vertigo, drowsiness, headache, nausea, and eventually unconsciousness. Prolonged dermal exposure to benzene can cause blistering, erythema, and a dry, scaly dermatitis.

6.02.3.2 Ethylbenzene

Ethylbenzene is a skin irritant, and in the vapor phase is an eye irritant at a concentration of 200 ppm and above. Inhalation exposure in rats and guinea pigs at 600 ppm for 7 hours/day for 6 months causes slight changes in liver and kidneys weights, and histopathological changes in the tests of monkeys and rabbits. Similar liver and kidney effects were observed in rats on a diet including 408 and 680 mg/kg/day for 6 months.

6.02.3.3 Methylene Chloride

Inhalation exposure to methylene chloride at 2,000-4,000 ppm increases the incidence of liver and lung sarcomas and tumors in mice and rats. However, the carcinogenicity of methylene chloride via oral exposure is less clear cut, with existing data currently considered to provide "borderline" evidence of carcinogenicity in test rodents (U.S. Public Health Service 1987b). It is mutagenic in bacterial test systems. Methylene chloride is an eye, skin, and mucous membrane irritant (Clement 1985). High levels of methylene chloride affect the central nervous system (6,000-16,000 ppm) and caused myocardial contractility changes (GT 20,000 ppm).

Inhalation of methylene chloride for 100 days by laboratory animals causes kidney and liver damage at doses of 25 and 100 ppm, and 100 ppm, respectively (U.S. Public Health Service 1987b).

6.02.3.4 Toluene

Toluene produced a significant increase in embryolethality in mice following ingestion of doses as low as 260 mg/kg. At doses of 434 mg/kg and 867 mg/kg, it caused decreased fetal weight and increased incidence of cleft palate, respectively. It is not clear from available results, however, whether toluene is teratogenic or embryotoxic. Central nervous system depression and narcosis results from acute inhalation exposure to toluene at 375-1,500 ppm.

6.02.3.5 1,1,1-Trichloroethane

1,1,1-Trichloroethane induced liver tumors, based on preliminary evidence, in female mice. Results from the Ames bacterial assay indicated that it is mutagenic. 1,1,1-Trichloroethane also caused transformation in cultured rat embryo cells. Inhalation exposure to high concentrations of 1,1,1-trichloroethane causes depression of CNS, impaired cardiovascular function, and lung, liver, and kidney damage in humans and animals. Human exposure to 1,1,1-trichloroethane also causes irritation of mucous membranes and skin. In particular, the potential for chloroethane to induce cancer or produce other chronic or subchronic toxicity is currently underfined through lack of data.

6.02.3.6 Chloroethane

The toxicological data for chloroethane are very limited. The acute toxicity of chloroethane in guinea pig has been studied. Concentrations of 230,000 - 240,000 ppm in air produced unconsciousness and some deaths in 5-10 minutes. At 153,000 ppm, some deaths occurred in 30 minutes. At 90,000 ppm for 30 minutes, all animals tested survived, but showed histological alterations in the lungs, liver, and kidneys. In humans, two inhalations at 40,000 ppm produced stupor, eye irritation, and stomach cramps; at 25,000 ppm, coordination was impaired; and at 19,000 ppm for 12 minutes, weak analgesia was observed (ACGIH 1983).

The potential carcinogenicity and other chronic effects are currently under investigation by the National Toxicology Program in animal studies.

6.02.3.7 Arsenic

Oral ingestion of arsenic in drinking water has been associated with an increased risk of skin cancer in humans (U.S. Public Health Service 1987c). Extensive evidence also exists that implicates the inhalation of arsenic compounds in the incidence of lung cancer in human workers. No information was located on the specific form(s) of arsenic responsible for these effects. Arsenic compounds can also cause chromosome damage in animals and increased incidence of chromosomal aberrations in humans. Arsenic compounds are reported to be teratogenic, fetotoxic, and embryotoxic in several animal species. Increased incidence of multiple malformations in children born to women occupationally exposed to arsenic has been observed. Damage to peripheral nervous system neurons has been observed following occupational exposure to arsenic.

6.02.4 Toxicological Profile - Environmental Effects

As noted in the toxicity profiles contained in Exhibit B (Clement 1985), information on the environmental effects of the indicator chemicals is limited.

6.02.4.1 Benzene

Benzene EC50 values in invertebrate species range from 5,300-386,000 ug/L. In rainbow trout, an EC50 value of 5,300 ug/L was obtained from a flow through test.

6.02.4.2 Ethylbenzene

Ethylbenzene is acutely toxic to freshwater organisms at greater than 32,000 ug/L. No chronic toxicity data were available.

6.02.4.3 Methylene Chloride

Acute toxicity values of methylene chloride in Daphnia magna, fathead minnows, and bluegills are 224,000, 193,000, and 224,000 ug/L, respectively. No chronic toxicity data were available.

6.02.4.4 Toluene

The acute toxicity of toluene in five freshwater species range from 12,700-313,000 ug/L. No chronic toxicity data were available.

6.02.4.5 1,1,1-Trichloroethane

The LC50 concentration of 1,1,1-trichloroethane is 52,800 ug/L in the most sensitive species. No chronic toxicity data were available.

6.02.4.6 Chloroethane

No toxicity data for chloroethane were available. However, toxicity generally decreases with decreasing chlorine content, so chloroethane is probably less acutely toxic than is 1,2-dichloroethane. Acute and chronic toxicity levels of 1,2-dichloroethane are about 118,000 and 20,000 ug/L in unspecified freshwater species (Clement 1985).

6.02.4.7 Arsenic

Inorganic compounds of arsenic have similar acute toxicities and are all more toxic than the organic arsenic compounds. In adult, freshwater animals, acute toxicity to arsenic trioxide occurs at concentrations of 812 ug/L.

Arsenic toxicity does not appear to greatly increase with chronic exposure.

6.02.5 Environmental Monitoring

Complete results of the monitoring studies that have been conducted at the site were presented in previous sections (See also Table 4 and Appendices D&G). Analyses of ground water samples underlying the Upper Landfill taken in 1983 revealed arsenic concentrations ranging from less than (LT) 10 ug/L-60 ug/L. Arsenic concentrations ranged from LT 0.01 ug/L-10 ug/L in samples collected in 1984. Methylene chloride, benzene, chloroethane, and toluene concentrations ranged from LT 1 ug/L-4 ug/L, LT 1 ug/L-2 ug/L, LT 1 ug/L-170 ug/L, and LT 1 ug/L-3 ug/L, respectively, in samples collected from 1983-1988.

In the Lower Landfill ground water samples, arsenic concentrations ranged from LT 10 ug/L-80 ug/L in 1983 and from LT 10 ug/L-10 ug/L in 1984.

The concentrations of purgeable priority pollutants in the ground water samples taken from the Lower Landfill in 1988 were not above detection limits.

Homeowner well samples were analyzed for inorganic compounds and purgeable priority pollutants (See results in Table 6). Arsenic concentrations ranged from LT 10 ug/L-110 ug/L in samples collected in 1983-84. In 1988, the arsenic concentrations ranged from LT 10 ug/L-120 ug/L. Trichloroethylene and t-1,3-dichloropropene concentrations ranged from LT 1 ug/L-2 ug/L and LT 0.5 ug/L-9 ug/L, respectively, in 1983. Samples collected in

1988 contained non-detectable (LT 0.5-1 ug/L) concentrations of these compounds. Samples collected in 1988 from the Town Hall well contained 13 ug/L chloroform and 2 ug/L carbon tetrachloride. It should be noted here that these compounds were not detected in the environmental samples taken from the site.

Sediment samples from the wetlands areas collected from 1986-88 contained (see Table 7) 0.5 mg/kg-29 mg/kg arsenic, LT 0.05 mg/kg-24 mg/kg lead, and non-detectable concentrations (LT 10 mg/kg) of volatile organic compounds, whereas water from Carlin Creek did not contain detectable levels of arsenic, cadmium, chromium, copper, or lead. Leachate samples collected in 1983 from the Upper Landfill contained benzene at LT 1 ug/L-47 ug/L, methylene chloride at LT 1 ug/L-2100 ug/L, toluene at LT 1 ug/L-1400 ug/L, 1,2-dichloropropane at LT 1 ug/L-350 ug/L, ethylbenzene at LT 1 ug/L-140 ug/L, chloroethane at LT 1 ug/L-19 ug/L, and total xylenes at LT 1 ug/L-300 ug/L. In samples collected in 1988, the residues were much lower, containing non-detectable concentrations of benzene, methylene chloride, toluene, chloroethane, and 1,2-dichloropropane, 1 ug/L of ethylbenzene and 3 ug/L of total xylenes. Arsenic was detected in Upper Landfill leachate at 5 ug/L in one sample.

Leachate samples collected in 1983 from the Lower Landfill contained benzene at LT 1 ug/L-2 ug/L, methylene chloride at LT 1 ug/L-4 ug/L, toluene at LT 1 ug/L-17 ug/L, 1,2-dichloropropane at LT 1 ug/L-45 ug/L, ethylbenzene at LT 1 ug/L-8 ug/L, and total xylenes at LT 1 ug/L-26 ug/L. Leachate samples from the Upper Landfill in 1983 showed an average of 1,850 ug/L methylene chloride, 71 ug/L 1,1-dichloroethane, 250 ug/L 1,2-dichloropropane, 43 ug/L benzene, 1150 ug/L toluene, 46.5 ug/L ethylbenzene, and 80 ug/L xylenes.

This leachate well (#14), when resampled in 1988, showed similar levels of organics with the exception of methylene chloride and 1,2-dichloropropane which were not detected (below 10 ug/L) in this latter sampling. Chlorobenzene was measured at 150 ug/L in 1988 after it was not detected (below 1 ug/L) in 1983. Xylenes (300 ug/L), ethylbenzene (140 ug/L) and toluene (1400 ug/L) were slightly higher than the previous analyses had shown.

A leachate seep from the same landfill also collected in 1983, showed much lower levels of volatile organics; the only detection worth noting in this seep are 23 ug/L of ethylbenzene and 40 ug/L total xylenes. The same seep resampled in 1988 showed only microgram traces of some volatiles.

Additional analytical results for leachate from the Lower and Upper Landfills are listed in Table 8 and Appendix F.

In conclusion, excluding arsenic in sediments, the site indicators when detected were present at concentrations in the ug/L range in the environmental matrices that were sampled. Arsenic was present in the low mg/kg range in the wetlands sediments analyzed. As this is within the range of naturally occurring arsenic concentrations in surface soils (U. S. Public Health Service, 1987), it is difficult to determine what contribution transport of arsenic residues from the landfills to the wetlands has made to the wetland residues. The potential health and environmental risks associated with these concentrations of site indicator compounds are assessed in the qualitative and quantitative risk assessments which follow.

6.03 Transport Route Analysis

6.03.1 Air Pathway

General Method

This section of the transport route evaluation examines the potential for waste materials to be transported to off-site locations in air by the action of wind currents in the volatilized state or as fugitive dusts. In order for the air route to be considered complete, a source of waste materials must exist which is capable of volatilizing into the air above it.

Air containing the volatilized waste component must then be capable of entering general wind circulation and be transported toward on- or off-site receptors. In general, for a waste component to represent a source for the air route, it must be exposed to the air and be in a state that allows it to exert a vapor pressure high enough for the compound to become volatilized.

Volatilization of soil gases is limited to components that can diffuse through the stagnant soil air spaces. Unless accelerated by the movement of gases, such as is often observed during the release of methane from sanitary landfills, this mechanism represents a low release rate. More quantitative information concerning release rates is not available. Thus, a waste material contained within a unit not in contact with air, such as materials covered with solid or other barriers, cannot volatilize and enter the air exposure pathway. Wind erosion of wastes or solid particles to which wastes are adsorbed can also function to transport wastes in air. This mechanism is facilitated by scouring by winds or the generation of fugitive dusts by heavy vehicular movement through a waste site. The general requirement for the generation of such "fugitive dusts" is the existence of exposed, friable wastes in an area which is accessible to wind shear or which is travelled upon by heavy machinery.

Site Specific

The surface soil samples from the Upper and Lower Landfills have not been analyzed for volatile organics. The fill material is covered to a depth of about two feet, however, and the surface is well vegetated. Based on the generally low concentrations of the volatile site indicators recently detected in site ground water or landfill leachate (see Section 6.02.5), therefore, it is not considered likely that volatilization of site indicators from the landfill soil surface will occur to a great enough extent to constitute a health or environmental hazard. Migration of site volatiles with the ground water is addressed in the following section on ground water exposure pathway (Section 6.03.4).

During the Phase I Hydrogeologic Investigation (O'Brien & Gere, 1984) soil samples collected from the test borings and monitoring wells were monitored for organic vapor content with an HNU meter and Dreager tubes. The organic vapor analyses revealed that the organic vapor levels within all the soil samples were less than detectable. In addition, air monitoring at the Upper Landfill was completed on 10/20/88 using a Protovac Tip, calibrated for isobutylene. The monitoring results were as follows:

LW-14, 1.2 ppm; LW-16, 0.0 ppm; leachate seep at east end of landfill, 0.1 ppm; MW-11, 0.3 ppm. This information further supports the conclusion that it is not likely that volatilization of organic compounds will constitute a health or environmental hazard.

In addition, as reviewed in O'Leary et al. (1986) and Khare and Dondero (1977), sanitary landfills generate large volumes of methane and other gases as a result of waste decomposition under anaerobic conditions. In addition to the potential explosion hazard posed by methane, an asphyxiation hazard to plants and burrowing animals in the landfill may be present due to methane and other gases including carbon dioxide and hydrogen sulfide.

The Upper Landfill has been inactive for thirteen years, and the Lower Landfill for nearly twenty years. In the absence of methane measurements at the site, it is not possible to determine whether a functional air pathway exists for this concern. Given sufficient biodegradable fill, methane generation could continue for ten to twenty years (O'Leary et al. 1986). Given the long period of site inactivity, it would seem that methane generation is of little concern at the present time, and will not be considered further in this assessment.

6.03.2 Soil and Direct Contact Exposure Pathway

General Method

There are two possible mechanisms for surface contact exposures to contaminant materials originating at a site. The first mechanism is through direct contact with the exposed contaminants located within a site, while the second mechanism involves air or surface water-facilitated transport of waste materials from within a site to off-site locations followed by direct contact of the wastes at their point of off-site deposition. Both mechanisms require the existence of exposed wastes and or contaminated soils.

Site Specific

As mentioned in Section 6.03.1, no surface soils have been analyzed for the presence and quantity of site indicators. Due to the vegetative cover on the landfills, and the relatively low concentrations of site indicators found in the recent ground water and leachate samples taken from the site, however, it is not expected that high levels of site indicators will be found on the landfill surface soils. Direct contact exposures to contaminant bearing leachate is possible under potential future scenarios such as construction work in and around the landfill. For this reason, the direct contact route will be considered functional and will be further considered.

6.03.3 Surface Water Exposure Pathway

General Method

Exposed waste materials may be transported to off-site receptors by the movement of surface water. For materials that bind readily to soil and other organic particles, surface water-facilitated erosion is the most feasible mechanism of transport. For more water soluble materials, transport in the dissolved state can also occur. A surface water exposure pathway may also exist for contaminant-bearing ground waters that discharge to surface waters. Materials that persist in surface water present several pathways for exposure including:

1. intentional ingestion with drinking water
2. inadvertent ingestion while swimming
3. inadvertent ingestion of materials that bioaccumulate in food fish, shell fish, and other aquatic food sources
4. dermal contact and inhalation (of volatiles) during bathing or showering
5. acute, subchronic, and/or subchronic exposure of aquatic organisms

Site Specific

Surface water samples collected in the wetlands did not contain detectable concentrations of either organic site indicators or arsenic. Arsenic was present in the sediment samples from the wetlands and Carlin Creek but was non-detectable in surface water samples from Carlin Creek. Regarding surface water, therefore, this pathway is non-functional but is functional for the associated sediment mediated pathway. This pathway will be considered in Section 6.04.2.1.

An additional surface water concern associated with sanitary landfills is the potential adverse impact on local water quality produced by leachate containing large quantities of ammonia, acids, materials that could elevate BOD and COD, and a number of other materials (O'Leary et al. 1986 and Khare and Dondero 1977, also see Table 9). In view of the potential for leachate runoff from the Lower Landfill to adjacent wetlands, this aspect of the surface water pathway will also be evaluated in Section 6.04.2.1.

6.03.4 Ground water Exposure Pathway

General Method

Transport of waste materials towards receptors via the ground water pathway requires the existence of waste materials with sufficient water solubility to become dissolved by and transported with ground water, a mechanism by which surface infiltration and/or ground water can come into contact with and leach out components of the waste material, and a mechanism for the movement of the leachate into and along with ground water downgradient from the site. Each of the above characteristics acts to promote or limit the movement of waste constituents from the point of deposition to off-site locations. Human exposure via this route requires use of ground water containing site indicators. Most commonly, exposure may occur by:

1. ingestion of drinking water
2. dermal contact and inhalation of volatiles while bathing or showering.

Site Specific

The presence of site indicators in ground water and leachate samples from the site and the high expected mobility of these compounds in ground water renders this pathway functional. The ground water pathway will be considered further in Section 6.04.1.1.

6.04 Identification of Human Receptors and Exposure Routes

This section reviews each of the transport routes identified in the previous sections as functional and evaluates each route for completeness relative to human or wildlife receptors identified in the study area. The surface water (sediment, leachate runoff) and ground water transport routes were determined to be functional. These pathways will be considered regarding the existence of potential receptors in the following sections.

6.04.1 Human

6.04.1.1 Ground Water

The study area is rural in nature, with land use predominantly for agriculture and forest (see Sections 1 and 2). There are several residences downgradient of the Lower Landfill, 500 feet or more away which may be ground water users. None of the site indicators were detected at measurable concentrations in the homeowner wells currently in operation hydraulically downgradient from the landfills. The ground water pathway, therefore, is not currently complete. Benzene (2 ug/L) and methylene chloride (4 ug/L) were detected in ground water monitoring wells in the Lower Landfill in 1983, however, and it is possible that ground water containing benzene and methylene chloride may eventually reach homeowner wells located over 500 feet from the landfill. The presence of benzene and methylene chloride in ground water that may eventually migrate to drinking water wells renders this pathway potentially complete. For this reason, a quantitative risk assessment of this pathway will be conducted in Section 6.05.1.

6.04.1.2 Direct Contact

Because several contaminants have been monitored in leachate in the landfill, the direct contact will be considered complete for potential future exposure scenarios such as construction and will be evaluated in Section 6.05.3.

6.04.2 Wildlife

6.04.2.1 Surface Water and Sediments

A site indicator was detected in the sediments of the wetland areas that are proximal to the site. The probable presence of benthic organisms such as aquatic invertebrates renders this pathway complete. Exposure of wildlife to site indicators in leachate runoff is also a possibility to be addressed.

6.04.2.2 Ground water

There are no known opportunities for the use of ground water by wildlife in the vicinity of the landfill. For this reason, this pathway is considered to be incomplete for wildlife.

6.05 Quantitative Risk Assessment

6.05.1 Estimates of Ground water Exposures

Arsenic is considered by the U.S. EPA to be carcinogenic by oral exposure, based on an association of skin cancer in humans exposed to elevated arsenic in drinking water in Taiwan. Federal and New York State Maximum Contaminant Levels (MCLs) for arsenic in drinking water are set at 50 ug/L and the New York Maximum Allowable Concentration (MAC) in ground water is 25 ug/L (Exhibit B). Since available landfill ground water data show a maximum arsenic concentration of 80 ug/L (1983, unfiltered), applicable federal and state water quality standards for arsenic were exceeded on a low percentage of landfill and homeowner wells. Two homeowner wells sampled contained levels of arsenic exceeding the New York State MAC: well number 2 in 1983 (40 ug/L) and 1984 (33 ug/L); and well number 9 in 1983 (33 ug/L). Other supply wells closer to the landfill and more directly downgradient from the landfill showed lower residue levels, or no residue at an analytical detection limit of 10 ug/L. In addition, arsenic may occur naturally within the ground water from the underlying bedrock formations. Data from 1988 sampling of homeowner wells showed no values over 12 ug/L arsenic, with most wells containing no detectable residue. Thus, there is little, if any, basis to conclude that arsenic residues have migrated from the landfill and have impacted downgradient ground water supplies.

To provide an estimate of carcinogenic risks associated with consumption of water at the New York State standard of 25 ug/L for a lifetime (an improbable event at this site given the fluctuations in monitoring data), it will be assumed that a 70 kg adult ingests 2 liters of water per day. This translates into a daily intake rate of 0.71 ug/kg/day. U.S.EPA's Integrated Risk Integration System presents a revised carcinogenic potency factor for ingested arsenic of 1.5 $(mg/kg/day)^{-1}$. Multiplying this factor by the daily intake rate in mg/kg/day provides an estimate of excess cancer risk of 1 x 10^{-3}, well above levels typically considered acceptable for drinking water. Thus, if ground water containing 40 ug/L arsenic (as was one residential well on one occasion) was to be consumed every day over a lifetime, the associated cancer risk would rise to 1.6 x 10^{-3}.

It should also be noted in this regard that arsenic is an essential human nutrient. Arsenic is typically present in vegetables, fruits, meat, eggs, milk, cereal, nuts, and sugar products in the range of 10-40 ug/kg, and in fish and shellfish in the range 70-1,470 ug/kg (U.S. Public Health Service 1987). Thus, application of routine risk assessment procedures may not be entirely appropriate in the case of arsenic in drinking water.

Regarding the risks associated with organic site indicators, it does not appear, from the available monitoring data collected in 1988, that any site indicators are present at detectable concentrations in homeowner ground water wells. Chloroform and carbon tetrachloride, although not site indicators, were detected in samples taken from the Town Hall well. According to G. Tampkins, a town official, this water was subjected to chlorination for disinfection purposes. It is possible, but cannot be conclusively determined with available data, that these compounds may have resulted from the effects of the chlorination process. Since no source of these residues can be conclusively identified, they will not be considered further in this quantitative risk assessment.

Benzene (2 ug/L), 1,1-dichloroethane (44 ug/L), methylene chloride (4 ug/L), toluene (3 ug/L), and xylene (3 ug/L) were detected in site ground water (Upper Landfill) in 1988. Also, chloroethane was detected in a monitoring well in the Upper Landfill at levels of up to 170 ug/L. Public water is now available to homeowners along Route 7. However, the ground water containing these residues may potentially be used as drinking water should the residues eventually be transported to wells still in use or installed in the future. Because of concern for the health effects of these compounds, the ground water exposure pathway will be quantitatively evaluated.

The maximum contaminant level (MCL) for benzene in drinking water is currently 5 ug/L. A comparable value for methylene chloride is not available. The carcinogenic health risks associated with the lifetime daily consumption of water containing 2 ug/L benzene were estimated as follows:

For benzene, assuming ingestion of 2 L/day of water by a 70 kg individual, 2 ug/L of benzene corresponds to a Chronic Daily Intake (CDI) of 5.7×10^{-5} mg/kg/day. Multiplying by a carcinogenic potency factor of 5.2×10^{-2} (1/(mg/kg/day)) for oral ingestion of benzene, a potential carcinogenic risk of 3×10^{-6} is obtained. This value is within the range of risk factors (10^{-4} to 10^{-7}) considered to be acceptable by the U.S. EPA. Additionally, the measured benzene concentration of 2 ug/L does not exceed the MCL for benzene of 5 ug/L. Ingestion of benzene at 5 ug/L, using the same assumptions as above, corresponds to a potential carcinogenic risk of 7.4×10^{-6}. This estimates are small compared to risk estimates for arsenic presented above.

For methylene chloride, insufficient evidence exists to positively conclude that it is carcinogenic by the oral route. Therefore, the chronic, non-carcinogenic health risks of lifetime ingestion of ground water containing 4 ug/L methylene chloride were derived as follows. A reference dose (equivalent to an acceptable daily intake) of 5×10^{-2} mg/kg/day has been determined for methylene chloride based upon observations of liver pathology in a two year oral exposure study in rats (U.S. Public Health Service 1987).

Using a maximum methylene chloride concentration of 4 ug/L from monitoring studies, and assuming ingestion of 2 L/day by a 70 kg individual, a CDI value of 1×10^{-4} mg/kg/day was calculated. This value is 500-fold less than the aforementioned Rfd for methylene chloride. It is concluded, therefore, that the presence of this concentration of methylene chloride in drinking water does not constitute a chronic risk to human health.

The chronic health risks from exposure to the other non-carcinogenic indicators found in Upper Landfill ground water at 1988 levels can be determined similarly using reference doses given in U.S. EPA 1986b as presented below:

Indicator	Ground Water Concentration (ug/L)	CDI (mg/kg/day)	RfD	$\frac{CDI}{RfD}$
1,1-dichloroethane	44	0.001	0.12	0.01
toluene	3	0.0009	0.3	0.0003

Indicator	Ground Water Concentration (ug/L)	CDI (mg/kg/day)	RfD	$\frac{CDI}{RfD}$
1,1,1-trichlorethane	9	0.0003	0.54	0.0005
xylene	3	0.0001	0.01	0.0086
methylene chloride	4	0.0001	0.05	0.002

As discussed in U.S. EPA (1986b), some measure of cumulative chronic toxicity can be estimated by summing the ratios of CDI to RfD. For the above analysis, this sum equals 0.02, or 50 fold less than the threshold value of one which might be a level of concern for sensitive individuals exposed at these levels. Even at maximum concentration observed at earlier sampling times, the sum of ratios is 0.09. This still provides a margin of safety of 10 over the threshold level in excess of the safety margins (typically 100) incorporated into the Rfd. Mixtures may act synergistically depending on the components of the mixture and other factors (disease, drug use, age, etc.). There is insufficient evidence for these site indicators to predict whether they may produce toxicity of more than additive in magnitude. However, this added margin of safety of 10 to 50 fold helps ensure that a conclusion can be made that worst case exposure levels to chronic toxins will not produce adverse effects, even in sensitive populations.

It should be reiterated that the concentrations of benzene and other non-carcinogens evaluated were the maximum detected in ground water wells on the site itself in the 1988 sampling round. The nearest residence is over 500 feet from the landfill. As discussed in Section 4.03.03, ground water velocity in the vicinity of the Lower Landfill is of the order of 0.20 to 0.52 feet per day. Thus, it can be expected that during the period of time it would take site ground water to reach a potential ground water-using receptor (a minimum of 1,000 days assuming no retardation of contaminant movement by the aquifer substrate), dissipative mechanisms including biodegradation and ground water dilution would act to reduce site indicator concentrations to non-detectable levels. This would correspondingly reduce the level of potential risk associated with these residues.

Levels of chloroethane observed in ground water (up to 170 ug/L) in the Upper Landfill are in exceedance of the proposed New York State Department of Health MCL of 5 ug/L (NYSDEC 1988) for that compound. No regulatory guidance factors such as reference doses (RfDs) or carcinogenicity potency factors by oral exposure have been developed for chloroethane due to the lack of supporting experimental data. It was not possible, therefore, to quantitatively assess the risk to health and the environment posed by the presence of this compound should it occur in the future in potable ground water.

6.05.2 Estimates of Sediment and Runoff Exposures

The landfills are adjacent to wetlands, surface streams and forests which are host to both terrestrial and aquatic wildlife. The 1988 and 1986 monitoring of wetland sediments and Carlin Creek water and sediment indicated the presence of low levels of several metals (Table 7). Of these, only arsenic is potentially associated with the landfills. Benthic organisms such as aquatic invertebrates are expected to be exposed to arsenic residues of unknown chemical nature in sediments of the wetlands and Carlin Creek at concentrations ranging from LT 10 mg/kg-29 mg/kg. The LC50 value for arsenic trioxide toxicity in the snail, Aplexa hypnorum, is 24.5 mg/L, and for sodium arsenite in the amphipod, Gammarus pseudolimnaeus, is 0.874 mg/L. These acute studies were performed in water, however, and cannot be used as a direct measure of toxicity, particularly for chronic exposures, of the concentrations of arsenic measured in the sediments. No data were available concerning the toxicity of sediment sorbed arsenic residues. It is not possible, therefore, to quantitatively assess the health risks to benthic organisms that may derive from the observed concentrations of arsenic. It is likely, however, that sediment-sorbed arsenic residues will have diminished ability to be taken up and systemically absorbed by benthic organisms. This would decrease the level of concern for exposure to these residues. Furthermore, the arsenic residues detected are within the range observed for virgin soils (U.S. Public Health Service 1987), and therefore may not be associated with site-related activities.

The Lower Landfill is adjacent to wetlands, which potentially could receive leachate via surface runoff which might adversely impact water quality in the wetland. As shown in Table 8, only trace (i.e. low ppb) levels of volatile organics were found in leachate from the Lower Landfill, and in the course of transport to the wetland, it is likely that through volatilization and dilution, the residues would be rendered non-detectable. In addition, analysis of leachate samples collected during 1986 demonstrated no detectable pesticides or PCBs in the leachate.

One of the most potentially damaging effects of landfill leachate is attributable to the presence of toxic levels of ammonia or organic acids generated during the biodegradation process. Lower Landfill leachate pH was measured in the range of 6.6 to 6.8, indicating that this effect is not operative at the present time, perhaps due to the length of time, nearly twenty years, since the landfill was active. This would tend to diminish other concerns, including increased oxygen demand which decreases rapidly after landfill closure (O'Leary et al. 1986).

6.05.3 Direct Contact

As previously discussed, the direct contact exposure route has been considered potentially functional and complete due to the presence of contaminants in landfill leachate. Future development of the landfill could involve dermal exposure on a short term (subchronic) basis such as for construction workers, or on a longer term (chronic) basis for landscapers, gardeners and the like.

For the purpose of a worst case exposure analysis, the subchronic exposure scenario will be represented by a 70 kg construction worker who directly contacts 10 ml of leachate per day for one month. Chronic exposure will be estimated for an individual who directly contacts 10 ml of leachate for 160 days per year over a chronic exposure period of several years. Complete dermal absorption of leachate contaminants is assumed.

To assess non-carcinogenic risk, daily exposure rates are estimated for a 70 kg adult and compared to available acceptable daily intake rates (oral data are used as dermal values are lacking) as provided in U.S. EPA (1986b). These estimates and acceptable daily intake rates are:

Contaminant	Concentration ug/L	Subchronic Exposure Rate ug/kg/day	Chronic Exposure Rate ug/kg/day	ADI Subchronic ug/kg/day	ADI Chronic ug/kg/day
Chlorobenzene	1400	0.2	0.09	270	27
Ethylbenzene	150	0.02	0.009	970	100
Xylenes	300	0.04	0.018	100	10
Toluene	1400	0.2	0.09	430	300

For the subchronic exposure scenario, none of the daily exposure rates exceed the acceptable daily intake value on an individual basis. In order to judge the subchronic risk of exposure to the mixture, U.S. EPA (1986b) recommends calculating the sum of the ratios of exposure rate to the acceptable daily intake. For the four leachate contaminants, this sum of ratios equals 0.002. Thus, under the assumed subchronic exposure conditions, which include an assumption of complete dermal absorption, a risk of subchronic effects does not exist.

Under the worst case chronic exposure conditions, the sum of the individual ratios of exposure rates to acceptable intake rates equals 0.004. Thus, a risk of chronic toxicity from long term dermal exposure to non-carcinogenic leachate contaminants does not exist under the exposure scenario analyzed.

Benzene, a human carcinogen, was also detected in landfill leachate, at a maximum 1988 value of 33 ug/L. Under the above worst case exposure scenario, this is equivalent to a daily exposure of 0.002 ug/kg/day for a 70 kg adult. To estimate the carcinogenic risk associated with this exposure rate, the exposure rate is multiplied by the carcinogenic potency factor for oral exposure to benzene of 0.052 (1/mg/kg/day), or

$$\frac{(2\times10^{-6}\ \text{mg/kg/day})\ (0.052)}{\text{mg/kg/day}} = 10^{-7}$$

Thus, long term dermal exposure to benzene-containing leachate does not appear to be associated with an unacceptable excess risk of cancer.

6.06 Analysis of Uncertainties

The conclusions presented herein are based on available data, therefore, a degree of uncertainty is present. The lack of environmental samples taken from the soil surfaces of the landfill prevents verification of conclusions regarding the possibility of volatilization of site indicators from the landfill surface. However, in view of the two feet of soil covering the fill, this data gap does not affect the conclusion of the qualitative risk assessment for the soil and direct contact pathway.

Another source of uncertainty is the general trend of decreasing site indicator concentrations in the 1983 versus 1988 samples. The reason for this decrease is not known. It is reasonable, however, that given a static amount of site indicators at a given location and a large annual leachate volume, such as is the case at the Conklin landfills, a decrease in the concentration of leachable indicators in environmental samples taken from the site would be observed during the interval between samplings.

6.07 Summary and Conclusions

In summary, three exposure pathways are identified in the risk assessment as being complete or potentially complete. These are the ground water pathway for humans, who may consume site-related ground water, the direct contact pathway for humans under a future exposure scenario involving development of the landfill, and the surface water (sediment) pathway for benthic organisms in wetlands adjacent to the landfills. Due to the lack of data concerning the toxicity of the sediment residues of arsenic to benthic organisms, no conclusions can be made concerning the level of risk from the observed concentrations in the wetland sediments. However, the arsenic residues observed are within the range expected for background and may not be derived from landfill activities. For the ground water pathway, the most recent sampling efforts show that concentrations of arsenic, dichloroethane, trichloroethane, toluene, xylene, methylene chloride, and benzene in the ground water that may be transported downgradient or may be used for drinking are well below those which might constitute an unacceptable health risk, given standard upper bound conservative assumptions regarding ingestion. For chloroethane, no regulatory risk factors have been developed. It was not possible, therefore, to quantitatively assess the risk posed by the concentration of this substance in ground water underlying the Upper Landfill. For the direct contact pathway, it was concluded that contact with landfill leachate under worst case potential future exposure conditions would not present an unacceptable health risk.

SECTION 7 - SUMMARY AND CONCLUSIONS OF RI INVESTIGATIONS

A series of environmental samples have been collected and evaluated as part of the Remedial Investigation for two inactive municipal landfills at the Town of Conklin. Interest in the impact of the landfills has arisen due to the development of an Industrial park in the area, and the vicinity of homeowner drinking water supply wells within 500 ft. from the site.

Based on sampling ground water, surface water, homeowner wells, site soil borings and sediments between 1983 to 1988, the conclusions of the Remedial Investigation show that, presently, the landfills do not pose unacceptable risks to human health or wildlife. The risk assessment (Section 6) determined only two complete exposure pathways: the ground water pathway for humans, and the surface water (sediment) pathway of exposure to benthic organisms in adjacent wetlands. For humans, it is concluded that the trace levels of arsenic, methylene chloride and benzene detected in site ground water are well below the levels which might begin to constitute a concern. Uncertainty regarding the toxicity of arsenic residues in wetland sediments to benthic organisms precludes a definitive conclusion regarding the risks associated with these sediments. However, the levels of arsenic detected in the sediment (not detected in the surface water) are within the range observed for virgin soils and thus cannot be attributed only to site landfill activities. Conclusions regarding chloroethane could not be derived due to lack of data or regulatory standards for this compound.

The site investigations confirm that proposed development activities in areas neighboring the landfills would not pose a risk to humans working in the area. However, due to the proximity of existing and proposed access roads and utility lines for Industrial Park, and concern regarding future impact to downgradient ground water wells, a Feasibility Study will be conducted to recommend preventive measures or remedial actions necessary to ensure continued protection of human health and the environment. For purposes of development activities for the Broome Corporate Industrial Park, it is recommended that a buffer zone of 100 ft from the property boundaries of the landfills be preserved. A similar buffer zone would be observed both for remedial purposes and for Industrial development activities, for protection of wetlands in the area in accordance with NYCRR Part 662 and 663.

SECTION 8 - FEASIBILITY STUDY APPROACH

8.01 General Procedures

Subsequent to the preparation of the Work Plan for this site, legislation has been enacted and guidance documents have been developed which modify the procedures utilized in the development of the RI/FS. As these changes have come into effect, each task associated with the RI/FS including field investigations and the approach to selection of remedy has been updated to accommodate the recommended procedures outlined by the agencies. This RI/FS is developed in accordance with recent Federal guidance for assessing and determining appropriate remedial actions at Superfund sites, as established in the proposed revisions to the National Contingency Plan (NCP) for evaluation of sites listed on the National Priorities List (NPL).

Remediation of a Superfund site involves the selection and implementation of a remedy which will reduce, mitigate, or eliminate contaminant transport, and which will prevent or minimize exposure or risk to humans and the environment. The selection of a remedy is supported by the Remedial Investigation and the Feasibility Study. Once the conditions and hazards present at the site have been identified and quantified in the RI, the principal objectives of the FS are to develop and screen appropriate remedial alternatives, and, following a detailed evaluation of these alternatives, to recommend the most promising remedy which can be implemented at the site.

In accordance with the Superfund Amendments and Reauthorization Act (SARA), the FS should give preference to a subset of 'permanent' remedial alternatives which utilize, to the maximum extent practicable, technologies which reduce toxicity, mobility, or volume of hazardous substances. The selection of a final remedy results from the detailed evaluation of the remedial alternatives based on nine criteria, including protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs), as detailed under section 8.01.03.

The NCP distinguishes three phases of the FS: a) Development of Remedial Alternatives, b) Initial Screening of Alternatives, c) Detailed Analysis of Alternatives.

8.01.01 Development of Alternatives (FS Phase I)

Based on the results of the Remedial Investigation, a set of remedial alternatives for source control or off-site remedial actions or both will be developed. This phase begins with the development of remedial objectives which address the contaminant hazards and pathways of transport identified in the RI. General response actions and their associated potential treatment and/or containment technologies are selected to address the remedial objectives. The list of technologies are then evaluated against specific technology screening criteria. The technologies determined to be acceptable based on these criteria are assembled into remedial alternatives.

A master list of general response actions and associated technologies to be considered for this site is presented in Section 8.02, Initial Screening of Technologies. The general list of technologies is screened during the FS based on several criteria outlined in the NCP including: a) applicability to site conditions; b) effectiveness in reducing toxicity, mobility or volume of the contaminants in the matrices of contamination; c) feasibility; d) reliability; and e) proven effectiveness when used under similar circumstances. A preliminary screening of remedial technologies may eliminate or modify those technologies that do not apply to site conditions, are ineffective for the required treatment task, are infeasible to implement, are far more costly than alternatives that provide the same result, require unreasonable time periods for completion, or rely on insufficiently developed technology. Innovative alternative technologies will be identified and evaluated in the FS, and will be retained over demonstrated technologies during the screening of technologies if there is reasonable belief they offer an advantage in the form of treatment performance, ease of implementation, fewer or lesser adverse impacts, or lower cost.

Technologies which pass the technology screening are assembled into potential remedial alternatives. The grouping of alternatives under the existing NCP considers primarily the extent to which such alternatives attain, exceed, or do not attain ARARs. At least one Off-Site and one No Action Alternative are also included under the existing FS process. Utilizing the proposed NCP, however, the grouping of alternatives and their evaluation considers ARARs as one of nine criteria to be met, and these criteria are judged as part of Phase III of the FS in the detailed analysis of alternatives.

The FS for the Town of Conklin Landfills will be prepared based on recent guidance incorporating changes made by SARA, in which the following groupings of alternatives are developed:

1) Alternatives that employ treatment which reduces toxicity, mobility, or volume as a principal element;
2) At least one alternative in which engineering controls comprise the principal element; and,
3) A no action alternative.

The range of remedial alternatives will be delineated primarily by the degree to which each alternative relies on long-term management of treated residuals or untreated waste. One end of the range will be defined by an alternative that utilizes treatment to such a degree that long-term management requirements (including monitoring) are eliminated or reduced to the maximum extent practicable. The other end of the range of treatment options will be defined by an alternative that employs treatment to reduce a principal threat(s) posed by a site, but does not involve treatment of all waste or the highest degree of treatment. Additional alternatives are developed within the categories of treatment-containment and purely containment remedies, which combine different technologies for treatment and/or containment controls to reduce the principal threats posed by the site but also rely on long-term management (monitoring) of contained waste or treated residuals.

8.01.02 Initial Screening of Alternatives (FS Phase II)

The remedial alternatives developed in Phase I are screened to reduce the number of alternatives which undergo detailed analyses, while preserving a range of viable choices. Each alternative, with the exception of the No Action Alternative must address all identified response objectives and must attain ARARs.

The screening of alternatives is conducted on the basis of effectiveness, ease of implementation, and cost. The intent of screening is to eliminate alternatives within the same category (e.g. treatment, containment) that are significantly less implementable or more costly than comparably effective alternatives. The list of potential remedial alternatives is reduced through this screening effort and those alternatives which pass this point are subjected to detailed analysis. The no action alternative is always carried through to the detailed analysis step.

According to SARA, effectiveness is related to the overall performance of an alternative in reducing toxicity, mobility or volume of a waste through the use of treatment technologies, long-term effectiveness and permanence, short-term impacts which the alternative may pose during implementation, and how quickly the protection an alternative offers can be achieved. Any alternatives that do not protect human health and the environment to the least acceptable degree are not carried through the initial screening of alternatives.

Implementability is associated with the difficulty in constructing a particular alternative. The time necessary to complete a remedial action is subject to a number of technical, administrative and logistical problems. These factors are assessed to characterize the implementability of a specific remedial alternative. An alternative which would be more difficult or time consuming to implement than a comparably effective remedy is not carried through the initial screening of alternatives.

Cost factors include costs necessary to construct a remedial action and any operating and maintenance costs associated with an action. Cost is used within a particular alternative category (treatment, containment, etc.) to eliminate alternatives which provide results which can be achieved through another, significantly less costly method.

The alternatives to be analyzed in detail will include at least one alternative from each of the three categories of treatment, containment, and no action. If not already included in the set of alternatives, an alternative incorporating innovative treatment technology will be analyzed in detail, if these offer the potential for better treatment performance or implementability, fewer adverse impacts than other approaches, or lower costs for similar levels of performance than demonstrated treatment technologies.

8.01.03 Detailed Analysis of Alternatives (FS Phase III)

Alternative remedies which pass the initial screening will be evaluated in depth prior to recommending a particular alternative. The alternatives evaluation shall include a detailed description, environmental assessment, and cost analysis. The detailed analysis for each alternative will consider nine criteria:

- Overall protection of human health and the environment,
- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, or volume,
- Short-term effectiveness,

- Implementability,
- Cost,
- State acceptance,
- Community acceptance, and,
- Compliance with applicable and appropriate or relevant requirements.

The identification of environmental regulatory cleanup criteria or ARARs will be continued throughout the FS during the process of developing suitable remedial response alternatives for each remediated site. The evaluation of potential ARARs will include chemical-specific ARARs, depending on the contaminants identified as a concern for remediation; location or site-specific ARARs; and action-specific ARARs pertaining to the response actions selected.

The detailed description of alternatives in the FS will address:

1. Description of appropriate treatment and disposal technologies considered at this stage.
2. Special engineering considerations required to implement the alternative, e.g., additional studies needed to proceed with conceptual remedial design. These studies will include such items as leachate treatability and cover material assessment, including Atterberg liquid and plastic limits, grain size, moisture density relation, and permeability. However, the exact studies cannot be determined until the screening process is completed.
3. Environmental impacts, proposed methods, and costs for mitigating any adverse effects.

4. Operation, maintenance, and monitoring requirements of the remedy.
5. Off-site disposal needs and transportation.
6. Temporary storage requirements, if any.
7. Safety requirements for remedial implementation (including both on-site and off-site health and safety considerations).
8. A description of how the alternative could be phased into individual segments. The description will include a discussion of how various segments of the total remedy could be implemented individually or in groups, resulting in the least disturbance but accomplishing significant improvement to the environment or savings in costs.
9. A review of any off-site disposal facilities to ensure compliance with applicable environmental laws.

8.02 Initial Screening of Technologies

In accordance with the proposed NCP, the list of general response actions and potential technologies to be considered for potential implementation at the Conklin Landfills includes:

1. NO ACTION - Monitoring, Fencing, Site Use Limitations
2. ON-SITE ACTIONS - CONTROL OF RELEASES
    - A. Air emissions controls
    - B. Surface water controls
        - a. Surface seals
        - b. Surface water diversions and collection systems.
            - i. Dikes and berms
            - ii. Ditches, diversions, waterways

        - iii. Chutes and downpipes
        - iv. Levees
        - v. Seepage basins and ditches
        - vi. Sedimentation basins and ditches
        - vii. Terraces and benches
    - c. Grading
    - d. Revegetation
- C. Ground water controls
    - a. Impermeable barriers
        - i. Slurry walls
        - ii. Grout curtains
        - iii. Sheet pilings
    - b. Permeable treatment beds
    - c. Ground water pumping
        - i. Water table adjustment
        - ii. Plume containment
    - d. Leachate control
        - i. Subsurface drains
        - ii. Drainage ditches
        - iii. Liners

3. ON-SITE ACTIONS - TREATMENT TECHNOLOGIES

- A. Gaseous emissions treatment
    - a. Vapor phase adsorption
    - b. Thermal oxidation
- B. Direct waste treatment methods
    - a. Biological methods
    - b. Chemical methods

      - i. Chlorination
      - ii. Precipitation, flocculation, sedimentation
      - iii. Neutralization
      - iv. Equalization
      - v. Chemical oxidation
    - c. Physical Methods
      - i. Air stripping
      - ii. Carbon adsorption
      - iii. Ion exchange
      - iv. Reverse osmosis
      - v. Permeable bed treatment
      - vi. Wet air oxidation
      - vii. Incineration
  - C. Contaminated Soils and Sediments
    - a. Incineration
    - b. Wet air oxidation
    - c. Solidification
    - d. Encapsulation
    - e. On-site treatment
      - i. Solution mining
      - ii. Neutralization/Detoxification
      - iii. Microbiological degradation

4. OFF-SITE TRANSPORT FOR STORAGE
5. PROVISION OF ALTERNATE WATER SUPPLIES
  - A. Individual treatment units
  - B. Water distribution system
  - C. New wells in a new location or deeper wells

D. Cisterns

E. Bottled or treated water

F. Upgraded treatment for existing distribution systems

6. RELOCATION OF RESIDENTS, BUSINESSES, AND COMMUNITY FACILITIES

The technology screening criteria are defined below. A technology must meet all four criteria to pass the technology screening.

Performance

The performance criterion evaluates the effectiveness of the technology relative to meeting the pertinent remedial response objectives. It also evaluates the ability of a technology to maintain its function over the expected life of the remedial action. The "track record" of a technology to perform its intended function is considered. Technologies that have not been fully demonstrated under the conditions experienced at the site are eliminated from further consideration. However, innovative technologies are carried through to the next phase of the evaluation if there is good reason to believe that they could offer better treatment or implementability, fewer or lesser adverse impacts, and/or lower costs than other demonstrated technologies.

Reliability

The reliability criterion evaluates the ability of a technology to perform its intended function. Included in this assessment is an appraisal of the frequency and complexity of operation and maintenance (O&M) activities required for the technology to remain effective.

Implementability

The implementability criterion evaluates the feasibility of implementing a technology under site conditions. Considered are both the ease of construction of the technology and the safety practices involved to protect workers, adjacent property, and the environment, during and after construction.

Applicability

The applicability criterion evaluates the appropriateness of a technology relative to site chemical and physiographic conditions. Technologies which exhibit a limited effectiveness because of waste and/or site characteristics are eliminated from further consideration.

The technologies which passed the preliminary screening are listed below. Additional discussion of the screening will be developed in the FS, to arrive at a suitable subset of remedial technologies for the Town of Conklin Landfills.

APPLICABLE TECHNOLOGIES
(For Further Evaluation In The FS)

General Response	Technologies
1. No Action	Monitoring, Fencing, Site use Limitations
2. Surface Water Controls	Grading, Revegetation, Ditches, Diversions, Waterways.

3. Ground Water Control (Leachate)	Drainage Ditches, Slurry Walls, Ground Water Pumping
4. Containment	Capping
5. Complete or Partial Removal	Excavation of Wastes, Soil
6. On-Site Disposal	Sanitary Landfill
7. Off-Site Disposal	Sanitary Landfill

8.03 Conceptual Design

A conceptual design of the recommended remedial alternative shall include the engineering approach, including implementation schedule, special implementation requirements, institutional requirements, phasing and segmenting considerations, preliminary design criteria, preliminary site and facility layouts, budget cost estimate (including operation and maintenance costs), operating and maintenance requirements and duration, and an outline of the safety plan including cost impact on implementation. A description of any additional information, which will be required as the basis for the completion of the final remedial design for the site, will also be included.

8.04 Final Feasibility Study Report

The Feasibility Study report will recommend the alternative to be implemented for the Conklin Landfills Remedial Program. The report will contain:

- A summary of all health and environmental hazards and potential hazards attributable to the Conklin Landfills.
- Identification of remedial actions necessary to eliminate existing or potential hazards.
- Identification of alternatives capable of achieving the project objectives.
- A detailed evaluation for each applicable alternative.
- Identification of a recommended alternative, including implementation schedule.

In addition, the Feasibility Study report will specify the names, titles, and disciplines of all professionals engaged in the preparation of the report, and include references to all scientific or technical literature used in preparing the report.

Respectfully submitted,

O'BRIEN & GERE ENGINEERS, INC.

Steven R. Garver, P.E.
Vice President

Prepared by:

Henry T. Appleton, Ph.D., Senior Toxicologist
Susan E. Cox, Hydrogeologist
Frank D. Hale, Project Manager
Cynthia M. Klevens, Project Engineer
John J. LaManche, Research Engineer
Mark D. LaRue, Researcher
Jeff P. Robinson, Toxicologist
John C. Tomik, Senior Project Hydrogeologist
Teeradet Tong-Ngork, Project Engineer

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Tables

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7-12-88

TABLE 1
TOWN OF CONKLIN
GROUND WATER MONITORING WELL DATA

WELL NO.	GRADE ELEVATION	TOP OF STEEL CASING ELEVATION	TOP OF PVC CASING ELEVATION	WELL DEPTH BELOW GRADE	GROUND WATER ELEVATION DATA							
					8/16/83	11/9/83	12/20/84	1/30/86 -2/3/86	12/1/86	1/20/88	3/28/88	4/12/88
1	944.40	947.41	947.30	60.0	937.34	933.79	943.16	942.73	943.32	941.31	-	942.41
2	914.80	916.16	915.93	45.0	891.37	890.56	909.84	896.30	896.30	-	896.54	895.56
3	891.82	892.12	891.88	20.0	881.21	879.57	885.60	885.54	-	-	-	885.54
4	890.90	893.58	893.42	20.0	881.85	881.80	886.80	887.42	887.55	886.92	-	886.76
5	860.31	860.31	860.24	33.5	853.25	852.17	853.86	855.71	-	854.69	-	855.14
6	868.80	868.82	868.59	17.9	861.97	860.57	865.59	866.10	-	-- replaced by Well 6R --		
6R	863.04	866.04	865.94	14.0	-	-	-	-	-	856.03	865.83	853.39
7	865.20	868.37	868.27	25.0	853.54	852.02	856.22	859.16	859.16	855.99	-	856.91
8	860.20	860.24	860.08	18.0	853.34	851.60	853.89	855.26	-	854.77	855.23	855.14
9	861.30	864.21	864.11	18.0	853.31	851.66	854.66	855.25	856.88	854.74	-	855.21
10	863.80	863.76	863.47	18.0	853.69	851.76	855.29	856.71	-	855.92	-	856.16
11	896.20	898.97	898.82	30.5	882.31	881.82	890.77	886.69	887.34	889.94	-	886.95
12	898.60	901.62	901.51	16.0	-	-	889.17	889.53	889.43	889.19	-	888.68
13	865.70	868.62	868.55	15.0	853.94	-	860.07	-	861.78	-	859.85	859.2
14	914.80	917.25	917.14	15.0	908.45	-	-	-	912.03	910.48	911.8	912.2
15	873.80	876.62	876.49	18.0	859.76	-	-	-	865.04	-	863.17	863.09
16	-	-	-	2.5	-	-	-	-	-	-	-	-
17	948.46	950.89	950.38	30.0	-	-	947.06	-	-	-	-	947.05
18	861.00	863.37	862.74	15.0	-	-	859.97	860.70	861.54	-	-	859
19	912.39	914.94	914.61	31.5	-	-	908.89	-	-	-	-	-
20	898.77	898.77	898.77	31.5	-	-	885.70	887.46	887.46	-	-	890.33
21	-	875.06	874.76	20.0	-	-	-	871.84	872.43	872.19	872.82	872.51
22	-	885.41	885.02	22.0	-	-	-	877.99	880.48	880.04	880.54	879.88
36	941.87	944.57	944.15	14.0	-	-	-	-	-	940.51	940.94	940.23
37	906.88	909.36	909.01	25.0	-	-	-	-	-	899.69	900.91	903.16
38	886.29	888.94	888.61	35.0	-	-	-	-	-	883.35	884.22	883.31
38S	886.83	889.73	889.49	14.0	-	-	-	-	-	-	885.29	884.2

ALL ELEVATIONS GIVEN IN FT. ABOVE MEAN SEA LEVEL. WELL DEPTHS BELOW GRADE GIVEN IN FT.
Wells 1-15 were installed prior to 8/16/83; Wells 16-20 were installed prior to 12/20/84.
Wells 21-22 were installed 1/27/86; Wells 36-38S were installed 12/15/87 - 12/22/87.

TABLE 2

TOWN OF CONKLIN LANDFILLS
IN-SITU PERMEABILITY DATA

WELL #	PERMEABILITY (cm/sec)	PERMEABILITY (ft/day)	PERMEABILITY (gpd/SF)	GEOLOGIC FORMATION
LOWER LANDFILL				
5	4.3E-04	1.2	9.1	Mixed sand, silt & clay
6	6.0E-03	17.0	127.2	Mixed sand, gravel & silt
7	4.6E-03	13.0	9.7	Sand & gravel (outwash)
8	---	--	--	----
9	1.8E-03	5.1	3.8	Sand & gravel (outwash)
10	2.1E-03	6.0	4.4	Sand, silt & gravel (outwas
13	2.5E-5	0.07	0.53	Sand, silt & gravel (outwas
15	1.4E-4	0.39	2.96	Sand, silt & gravel (outwas
18	6.8E-04	1.9	1.4	Sand, gravel & silt (mixed)
UPPER LANDFILL				
1	2.3E-07	6.5E-04	4.8E-03	Glacial Till
2	1.6E-4	0.45	3.39	Sand, gravel & silt (mixed)
3	2.6E-04	7.4E-01	5.6	Silt (lacustrine)
4	1.3E-02	36.8	265.0	Glacial Till
11	2.7E-05	7.7E-02	5.8	Silt (lacustrine)
12	2.5E-03	7.1	5.3	Mixed sand & silt
14	4.2E-3	11.9	89.0	Sand, gravel & silt (mixed)
17	9.6E-05	2.7E-01	2.1	Gravel, silt & sand (mixed)
19	3.8E-07	1.1E-03	8.4E-03	Till
20	2.6E-03	7.4	54.9	Sand, gravel & silt (mixed)
21	3.5E-2	99.2	742.06	Mixed sand, silt & clay
22	---	--	--	----
36	1.4E-4	0.40	2.9	Mixed sand & silt
37	1.5E-5	0.04	0.32	Mixed sand, silt & clay
38	9.3E-5	0.26	1.97	Sand, gravel & silt (mixed)
38S	1.6E-3	4.5	33.9	Sand, gravel & silt (mixed)

Table 3 (p. 1 of 2)

GROUNDWATER - UPPER LANDFILL
SELECTED INORGANIC AND INDICATOR PARAMETER ANALYSES
See Appendix D for Complete Data Listing

		Well Number										
PARAMETER, units Standard- See Exhibit B	Date	1 Bkgd	2	3	4	11	12	22	36 Bkgd	37	38	38s
Arsenic, mg/l	8/83	<0.01	<0.01	<0.01	<0.01	<0.01	--	--	--	--	--	--
NY Class GA Grndwater	11/83	<0.01	0.06	0.02	<0.01	0.06	--	--	--	--	--	--
Std = 0.025 mg/l	1/84	--	0.01	<0.01	<0.01	<0.01	--	--	--	--	--	--
Arsenic-F, mg/l	1/86	<0.001	--	<0.001	<0.001	0.002	--	<0.001	--	--	--	--
	4/86	--	--	--	--	--	--	0.006	--	--	--	--
	1/88	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium, mg/l	8/83	<0.01	<0.01	0.015	<0.01	--	--	--	--	--	--	--
NY/FED Std= 0.01 mg/l	11/83	<0.01	<0.01	<0.01	<0.01	--	--	--	--	--	--	--
Iron, mg/l	8/83	1.8	<0.01	<0.01	0.05	<0.01	--	--	--	--	--	--
NY/FED Std= 0.3 mg/l	11/83	<0.01	0.38	<0.01	0.01	2.20	--	--	--	--	--	--
Iron-F, mg/l	11/84	--	--	--	--	--	--	--	--	--	--	--
	1/86	<0.01	--	<0.01	0.05	0.95	0.12	0.29*	--	--	--	--
	4/86	--	--	--	--	--	--	0.10	--	--	--	--
	1/88	0.351	--	1.48	<0.10	2.26	0.442	<0.10	<0.10	0.974	0.184	2.17
Manganese, mg/l	8/83	0.18	0.31	0.40	0.33	4.40	--	--	--	--	--	--
NY/FED Std= 0.3 mg/l	11/83	0.02	1.9	1.3	<0.01	11	--	--	--	--	--	--
Manganese-F, mg/l	11/84	--	--	--	--	--	--	--	--	--	--	--
	1/86	<0.01	--	0.09	0.07	5.78	1.28	0.045*	--	--	--	--
	4/86	--	--	--	--	--	--	0.03	--	--	--	--
	1/88	0.052	--	2.3	0.098	4.23	4.66	0.018	0.163	0.038	0.205	1.95
pH, s.u.	8/83	7.8	7.5	6.7	7.0	7.1	--	--	--	--	--	--
NY/FED Std= 6.5-8.5 SU	11/83	8.3	7.6	7.8	8.2	7.7	--	--	--	--	--	--
	11/84	--	--	--	--	--	--	--	--	--	--	--
	1/86	6.7	--	5.8	6.3	6	5.9	6.1*	--	--	--	--
	4/86	--	--	--	--	--	--	6.2	--	--	--	--
	1/88	6.8	--	6.9	6	6.1	7	5.2	7.4	9.3	6.6	6.2
Conductivity, umhos/cm	8/83	330	310	200	160	750	--	--	--	--	--	--
	11/83	319	420	212	160	995	--	--	--	--	--	--
	11/84	--	--	--	--	--	--	--	--	--	--	--
	1/86	200	--	280	95	960	95	60*	--	--	--	--
	4/86	--	--	--	--	--	--	80	--	--	--	--
	1/88	125	--	130	120	550	200	90	195	290	300	110
TOC, mg/l	8/83	--	--	--	--	--	--	--	--	--	--	--
	11/83	8	390	59	1	280	--	--	--	--	--	--
	11/84	--	--	--	--	--	--	--	--	--	--	--
	1/86	9	--	6	1	<10	10	16*	--	--	--	--
	4/86	--	--	--	--	--	--	6	--	--	--	--

(*) Average of two sample analyses.

Table 3 (p. 2 of 2)

GROUNDWATER - LOWER LANDFILL
SELECTED INORGANIC AND INDICATOR PARAMETER ANALYSES

See Appendix D for Complete Data Listing

PARAMETER, units Standard- See Exhibit B	Date	Well Number 5	6	7	8	9	10	18	21
Arsenic, mg/l	8/83	0.020	<0.01	<0.01	<0.01	<0.01	<0.01	--	--
NY Class GA Grndwater	9-11/83	0.01	0.08	0.07	0.08	<0.01	<0.01	--	--
Std = 0.025 mg/l	1984	<0.01	0.01	0.01	0.01	--	<0.01	<0.01	--
Arsenic-F, mg/l	1/86	<0.001	--	--	0.002	<0.001	<0.001	0.001	0.0012*
	4/86	--	--	--	--	--	--	--	<0.001
	1/88	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01*	<0.01
Cadmium, mg/l	8/83	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	--
NY/FED Std= 0.01 mg/l	11/83	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	--
Iron, mg/l	8/83	<0.01	2.4	<0.01	<0.01	<0.01	<0.01	--	--
NY/FED Std= 0.3 mg/l	11/83	0.02	38	7.80	10	0.03	0.07	--	--
Iron-F, mg/l	11/84	--	--	--	--	--	--	2.7	--
	1/86	0.05	--	--	5.7	<0.01	<0.01	0.86	1.09*
	4/86	--	--	--	--	--	--	--	0.61
	1/88	1.36	0.947	4.03	4.51	<0.10	<0.10	20.7*	8.06
Manganese, mg/l	8/83	1.40	2.80	4.10	4.40	1.70	3.30	--	--
NY/FED Std= 0.3 mg/l	11/83	1.9	4.1	4.3	4.8	2	2.3	--	--
Manganese-F, mg/l	11/84	--	--	--	--	--	--	4.1	--
	1/86	0.26	--	--	1.59	1.74	3.14	2.94	1.68*
	4/86	--	--	--	--	--	--	--	1.01
	1/88	3.32	3.67	2.77	1.33	1.14	4.78	5.72*	1.98
pH, s.u.	8/83	7.1	5.9	6.2	6.2	6.2	6.8	--	--
NY/FED Std= 6.5-8.5 SU	11/83	8.3	6.6	7.1	7.1	7	7.5	--	--
	11/84	--	--	--	--	--	--	6.2	--
	1/86	6.3	--	--	6.5	5.8	6.7	5.8	5.7*
	4/86	--	--	--	--	--	--	--	6.0
	1/88	5.7	7.4	7.1	5.8	7.2	7.1	6.7	7.5
Conductivity, umhos/cm	8/83	190	140	90	90	90	100	--	--
	11/83	161	115	94	84	100	106	--	--
	11/84	--	--	--	--	--	--	170	--
	1/86	75	--	--	75	65	85	85	90*
	4/86	--	--	--	--	--	--	--	80
	1/88	110	90	80	95	80	100	170	80
TOC, mg/l	8/83	--	--	--	--	--	--	--	--
	11/83	14	19	4	4	2	3	--	--
	11/84	--	--	--	--	--	--	139	--
	1/86	9	--	--	2	1	<1	12	91*
	4/86	--	--	--	--	--	--	--	6

(*) Average of two sample analyses.

TABLE 4 (p. 1 of 2)

GROUNDWATER - UPPER LANDFILL
PURGEABLE PRIORITY POLLUTANTS ANALYSES SUMMARY

See Appendix D for Complete Listing

Well Number:	1*	2**	3*	4*	11	11	11	11	12+	22+	36	37	38	38s	Blank
Sample Date:	1/88	1983	1/88	1/88	8/83	11/83	2/86	1/88	1/88	1/88	1/88	1/88	1/88	1/88	1/88
	Bkgd										Bkgd				
PARAMETER (Standard -See Exhibit B˜)	Concentrations expressed as ug/l (ppb)														
1 Chloromethane (5 ug/l)	<10	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
2 Bromomethane (5 ug/l)	<10	<1	<10	<10	<10	2	<10	<10	<10	<10	<10	<10	<10	<10	<10
3 Vinyl Chloride (5 ug/l#)	<10	<1	<10	<10	16	1	<10	<10	<10	<10	<10	<10	<10	<10	<10
4 Chloroethane (5 ug/l)	<10	<1	<10	<10	5	18	63	170	<10	<10	<10	<10	<10	<10	<10
5 Methylene Chloride (50 ug/l)	<5	4(<1)	<5	<5	2	32	1	2	<1	<1	<1	<1	<1	<1	<5
6 Acetone (50 ug/l)	<10		<10	<10	<10	<10	<10								<10
7 Carbon Disulfide	<5		<5	<5	<5	<5	<5								<5
8 1,1-Dichloroethene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
9 1,1-Dichloroethane (5 ug/l)	<5	<1	<5K	<5K	26	150	210	44	<1	<1	<1	<1	<1	<1	<5
10 1,2-Dichloroethene (5 ug/l total)	<5	<1	<5	<5	<5	<5	1	4	<1	<1	<1	<1	<1	<1	<5
11 Chloroform (100 ug/l##)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	1J
12 1,2-Dichloroethane (5 ug/l)	<5	<1	<5	<5	<5	3	3	<1	<1	<1	<1	<1	<1	<1	<5
13 2-Butanone (50 ug/l)	<10		<10	<10	<10	<10	<10								4J
14 1,1,1-Trichloroethane (5 ug/l)	<5	<1	<5	<5	8	1	9	<1	<1	<1	<1	<1	<1	<1	<5
15 Carbon Tetrachloride	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
16 Vinyl Acetate (50 ug/l)	<10		<10	<10	<10	<10	<10								<10
17 Bromodichloromethane (100 ug/l##)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
18 1,2-Dichloropropane (5 ug/l)	<5	<1	<5	<5	<5	40	43	34	<1	<1	<1	<1	<1	<1	<5
19 c-1,3-Dichloropropene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
20 Trichloroethene (10 ug/l#)	<5	<1	<5	<5	<5	1	2	<1	<1	<1	<1	<1	<1	<1	<5
21 Dibromochloromethane (100 ug/l##)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
22 1,1,2-Trichloroethane (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
23 Benzene (5 ug/l#)	<5	2(<1)	<5 (1)	<5	<5	3	<5	2	<1	<1	<1	<1	<1	<1	<5
24 t-1,3-Dichloropropene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
25 2-Chloroethylvinylether (5 ug/l)		<10						<10	<10	<10	<10	<10	<10	<10	
26 Bromoform (100 ug/l##)	<5	<10	<5	<5	<5	<5	<5	<10	<10	<10	<10	<10	<10	<10	<5
27 4-Methyl-2-Pentanone (50 ug/l)	<10	<1	<10	<10	<10	<10	<10								<10
28 2-Hexanone (50 ug/l)	<10	<1	<10	<10	<10	<10	<10								<10
29 Tetrachloroethene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
30 1,1,2,2-Tetrachloroethane(5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
31 Toluene (5 ug/l)	<5	1 (2)	<5	<5	<5	110	40	3	<1	<1	<1	<1	2	<1	<5
32 Chlorobenzene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5	<1	<1	<1	<1	<1	<1	<1	<5
33 Ethylbenzene (5 ug/l)	<5	<1	<5	<5	<5	1	<5	<1	<1	<1	<1	<1	<1	<1	<5
34 Styrene (5 ug/l)	<5	<1	<5	<5	<5	<5	<5								<5
35 Total Xylenes (5 ug/l)	<5	<1	<5	<5	<5	11	7	3	<1	<1	<1	<1	<1	<1	<5

Previous analytical results, if different, are noted in brackets.

(˜) NYSDOH Proposed Standards Limiting Organic Chemical Contamination in Drinking Water, unless otherwise noted.

(#) NYS Water Quality Standards for Class GA Waters

(##) NYS/FED MCL for sum of Total Trihalomethanes

(*) Previous sampling results from 8/83, 11/83 and 1/86 confirm the above results for 1/88.

(**) Results presented are based on two sampling events (8/83 and 11/83).

(+) Previous sampling results from 1/86 confirm the above results for 1/88.

A Holding time exceeded for analysis.

J Concentration detected is below detection limit.

K Surrogate % recovery outside QC/limits.

GROUNDWATER - LOWER LANDFILL
PURGEABLE PRIORITY POLLUTANTS ANALYSES SUMMARY
See Appendix D for Complete Listing

Well Number:	5*	6**	7***	8***	9*	10*	18+	18(Dup)	21+	Blank
Sample Date:	1/88	1/88	1/88	1/88	1/88	1/88	1/88	1/88	1/88	1/88
PARAMETER (Standard -See Exhibit B¯)	Concentrations expressed as ug/l (ppb)									
1 Chloromethane (5 ug/l)	<1	<10	<10	<1	<10	<10	<10A	<10A	<10	<10
2 Bromomethane (5 ug/l)	<1	<10	<10	<1	<10	<10	<10A	<10A	<10	<10
3 Vinyl Chloride (5 ug/l#)	<1	<10	<10	<1	<10	<10	<10A	<10A	<10	<10
4 Chloroethane (5 ug/l)	<1	<10	<10	<1	<10	<10	<10A	<10A	<10	<10
5 Methylene Chloride (50 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
6 Acetone (50 ug/l)		<10	<10		<10	<10	<10A	<10A	<10	<10
7 Carbon Disulfide		<5	<5		<5	<5	<5A	<5A	<5	<5
8 1,1-Dichloroethene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
9 1,1-Dichloroethane (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
10 1,2-Dichloroethene (5 ug/l total)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
11 Chloroform (100 ug/l##)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	1J
12 1,2-Dichloroethane (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
13 2-Butanone (50 ug/l)		<10	<10		<10	<10	<10A	3JA	<10	4J
14 1,1,1-Trichloroethane (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
15 Carbon Tetrachloride	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
16 Vinyl Acetate (50 ug/l)		<10	<10		<10	<10	<10A	<10A	<10	<10
17 Bromodichloromethane (100 ug/l##)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
18 1,2-Dichloropropane (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
19 c-1,3-Dichloropropene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
20 Trichloroethene (10 ug/l#)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
21 Dibromochloromethane (100 ug/l##)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
22 1,1,2-Trichloroethane (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
23 Benzene (5 ug/l#)	<1	<5	<5 (6	<1 (2)	<5	<5	<5A	<5A	<5	<5
24 t-1,3-Dichloropropene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5A	<5A	<5	<5
25 2-Chloroethylvinylether (5 ug/l)	<10			<10						
26 Bromoform (100 ug/l##)	<10	<5	<5	<10	<5	<5	<5	<5	<5	<5
27 4-Methyl-2-Pentanone (50 ug/l)		<10	<10		<10	<10	<10	<10	<10	<10
28 2-Hexanone (50 ug/l)		<10	<10		<10	<10	<10	<10	<10	<10
29 Tetrachloroethene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5	<5	<5	<5
30 1,1,2,2-Tetrachloroethane(5 ug/l)	<1	<5	<5	<1	<5	<5	<5	<5	<5	<5
31 Toluene (5 ug/l)	<1	<5	<5	<1	<5	<5	2J	<5	<5	<5
32 Chlorobenzene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5	<5	<5	<5
33 Ethylbenzene (5 ug/l)	<1	<5	<5	<1	<5	<5	<5	<5	<5	<5
34 Styrene (5 ug/l)		<5	<5		<5	<5	<5	<5	<5	<5
35 Total Xylenes (5 ug/l)	<1	<5	<5	<1	<5	<5	3J	<5	<5	<5

Previous analytical results, if different, are noted in brackets.
(¯) NYSDOH Proposed Standards Limiting Organic Chemical Contamination in Drinking Water, unless noted.
(#) NYS Water Quality Standards for Class GA Waters
(##) NYS/FED MCL for sum of Total Trihalomethanes
(*) Previous sampling results from 8/83, 11/83 and 1/86 confirm the above results for 1/88.
(**) Previous sampling results from 8/83 and 11/83 confirm the above results for 1/88.
(***) Previous sampling results from 8/83 and 11/83 confirm the above results for 1/88, except for benzene.
(+) Previous sampling results from 1/86 confirm the above results for 1/88.
A Holding time exceeded for analysis.
J Concentration detected is below detection limit.
K Surrogate % recovery outside QC/limits.

Table 5

Groundwater Quality Within the Aquifers of the Susquehanna River Basin in New York State (values in mg/l) (from Hollyday, 1969)

	Glacial Till and Bedrock			Lacustrine Deposits			Outwash Deposits		
*	G	M	P	G	M	P	G	M	P
Temperature	48	50	52	50	52	53	47	50	53
Silica	6.7	8.3	9.6	2.0	7.8	15	6.8	7.4	8.8
Iron	.08	.30	.65	.21	1.0	1.8	.03	.06	.15
Manganese	.01	.03	.05		.02		0	.01	.05
Calcium	29	41	51		30		45	50	74
Magnesium	3.8	8.3	9.7		9.0		6.0	12	19
Sodium	4.8	11	64		7.6		6.6	8.9	13
Potassium	.5	1.5	2.3		.5		1.1	1.4	1.6
Bicarbonate	140	170	250		130		150	180	230
Sulfate	3.6	12	27		15		25	31	50
Chloride	4.0	16	58		3.0		7.8	13	22
Fluoride	.1	.1	.2		.1		.05	.1	.2
Nitrate	.09	.18	.53		0		.24	1.0	2.1
Dissolved Solids	160	200	310		140		190	240	330
Calcium and Magnesium	54	90	140		120		150	200	220
Alkalinity	110	150	190		110	130	130	150	170
pH	7.3	7.7	8.1		7.5		7.4	7.6	7.8
Color	0	2	10		1		1	2	5

*Values tabulated are taken from a frequency distribution of reported chemical analysis of well water. Good (G), medium (M) and poor (P) refer to values equaled or exceeded for 75, 50 and 25 percent of available analyses, respectively.

TABLE 6 (p. 1 of 6)

SELECTED INORGANIC PARAMETERS IN HOMEOWNER WELLS
See Appendix H for Complete Data Listing

		PARAMETER (units):	pH s.u.	SPCOND (umhos/cm)	---- ARSENIC (mg/l) ----			- IRON (mg/l) --		-- MANGANESE ---	
		NYS/FED MCL or SMCL (See Exhibit B):	6.5-8.5 SU	--	0.025 mg/l			0.3 mg/l		0.3 mg/l	
		Date Sampled:	11/14/83	11/14/83	11/14/83	1/19/84	1/19/88	11/14/83	1/19/88	11/14/83	1/19/88
WELL No.	HOMEOWNER	ADDRESS									
1	D. Eckelberger	Box 339 R.D.#2	7.3	158	<0.01		0.012	2.1	11	1.5	1.9
2	G. Tamkins	1282 Conklin Rd	8.8	524	0.04	0.033	0.01	<0.01	0.14	0.06	0.05
3	R. Edminster	1287 Conklin Rd	6.3	426	<0.01		<0.01	<0.01	0.06	0.14	0.47
4	M. Smith	1285 Conklin Rd	8.8	379	<0.01		<0.01	<0.01	0.81	1.1	1.3
5	D. Kernan	1253 Conklin Rd	8.9	223	0.02		<0.01	0.03	0.37	0.45	0.58
6	J. Villano	1262 Conklin Rd	5.9	112	<0.01			<0.01	PW	0.01	PW
7	O. Desimone	1248 Conklin Rd	7.7	236	0.03	0.01	<0.01	0.04	0.55	0.54	0.67
8	A. Dahteria	1251 Conklin Rd	8	248	0.01		<0.01	0.01	0.44	0.13	0.45
9	R. Johnson	1281 Conklin Rd	7.9	399	0.11	0.033	NA	0.04	NA	0.42	NA
10	A. Allen	1279 Conklin Rd	6.3	517	<0.01		PW	<0.01	PW	<0.01	PW
11	R. Pessarchick	1283 Conklin Rd	7.7	348	<0.01		<0.01	<0.01	0.76	1	1.2
12	R. Gleason	Conklin Rd	6.2	539	<0.01		NA	<0.01	NA	<0.01	NA
13	D. Hamm	Box 53 Conklin Rd	7.6	586	0.023		NA	0.44	NA	0.27	NA
14	Town Hall	Conklin Rd	7	281	<0.01		<0.01	6.6	3.8	1.9	0.42
15	R. Rowse	1258 Conklin Rd	6.5	142	<0.01		PW	8.4	PW	0.22	PW
16	McGee	1269 Conklin Rd	7.5	256	<0.01		<0.01	<0.02	1.8	0.08	0.94
17	L. Brown	1278 Conklin Rd	6.6	118	<0.01		<0.01	0.66	<0.05	0.2	<0.01
18	Petrick	1250 Conklin Rd					<0.01		0.89		0.64
19	Petrick	1248.5 Conklin Rd					<0.01		0.87		0.63
20	E. Smith	1275 Conklin Rd					<0.01		1.1		0.22
21	Municipal Well #3	Town of Conklin					<0.01		0.06		0.15
22	QC Field	Blank					<0.01		<0.05		<0.01

PW = Connected to Public Water System.
NA = Not accessible for sampling.

TOWN OF CONKLIN LANDFILLS
EXHIBIT D
RI DATA VALIDATION

VOLATILES

Volatile samples were received on January 21, 1988 and scheduled to be analyzed by CLP. Problems arose because of workload and a decision was made to analyze several samples by Method 601 and 602. If the decision was to analyze the samples by GC/MS they would have exceeded holding times by several weeks. Two samples MW-18 and MW-18 Duplicate were missed during the first round of analysis and were not discovered until the data was ready for distribution. The following table presents the analytical method and date of analysis.

SAMPLE		METHOD	DAYS HELD
F0001	MW-1	CLP-GC/MS	7
F0002	MW-3	CLP-GC/MS	7
F0003	MW-4	CLP-GC/MS	7
F0004	MW-5	601-602-GC	13
F0005	MW-6	CLP-GC/MS	7
F0006	MW-7	CLP-GC/MS	7
F0007	MW-8	601-602-GC	13
F0008	MW-9	CLP-GC/MS	7
F0009	MW-10	CLP-GC/MS	7
F0010	MW-11	601-602-GC	14
F0011	MW-12	601-602-GC	14
F0013	MW-21	CLP-GC/MS	7
F0014	MW-22	601-602-GC	13
F0015	MW-36	601-602-GC	14
F0016	MW-37	601-602-GC	13
F0017	MW-38	601-602-GC	14
F0018	MW-38 SHALLOW	601-602-GC	14
F0012	MW-18	CLP-GC/MS	36
F0044	MW-18 DUP	CLP-GC/MS	36

The samples that were analyzed by GC had bromochloromethane, bromochloropropane and trifluorotoluene added as surrogates. The recoveries ranged from 68%-109% for these surrogates. The CLP surrogate recoveries were within acceptance criteria except for samples MW-3 and MW-4. The dichloroethane recoveries should be 76-114% and they were 116% and 125%, respectively.

The initial calibration curve and continuing calibration check sample was acceptable for samples analyzed within the seven days holding time. The calibration curve and continuing calibration check sample for the samples shot 36 days from collection had excursions for the bromoform RF and Chloroform %RSD.

Data qualifiers denoting the excursions discussed are listed with the data in the corresponding appendices.

ORGANIC ANALYSES OF HOMEOWNER WELLS

WELL NUMBER	1		2		3		4		5	
OWNER	D. Eckelberger		G. Tamkins		R. Edminster		M. Smith		D. Kernan	
ADDRESS	Box 339 R.D.#2		1282 Conklin Rd		1287 Conklin Rd		1285 Conklin Rd		1253 Conklin Rd	
DATE	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88
PARAMETER (Standard~, See Exhibit B)	CONCENTRATIONS EXPRESSED IN UG/L (PPB)									
1,1,1-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,1,2,2-Tetrachloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,1,2-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,1-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,1-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,1-Dichloropropene (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
1,2,3-Trichlorobenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,2,3-Trichloropropane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
1,2,4-Trichlorobenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,2,4-Trimethylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,2-Dibromo-3-chloropropane(5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
1,2-Dibromoethane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
1,2-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,2-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,2-Dichloropropane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,3,5-Trimethylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,3-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1,3-Dichloropropane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
1,4-Bromofluorobenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,4-Cymene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,4-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
1-Chlorocyclohexene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
2,2-Dichloropropane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
2,3-Benzofuran (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
2-Chloroethylvinyl ether (5 ug/l)	< 10		< 10		< 10		< 10		< 10	
2-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
4-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Benzene (5 ug/l#)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
bis-2-Chloroisopropyl ether (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
Bromobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Bromochloromethane (100 mg/l##)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
Bromodichloromethane (100 mg/l##)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Bromoform (100 mg/l##)	< 10	< 0.5	< 10	< 0.5	< 10	< 0.5	< 10	< 0.5	< 10	< 0.5
Bromomethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
c-1,3-Dichloropropene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Carbon tetrachloride (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Chlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Chloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Chloroform (100 mg/l##)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Chloromethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Cyclopropylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Dibromochloromethane (100 ug/l##)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Dibromomethane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
Dichlorodifluoromethane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
Ethylbenzene (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Hexachloro-1,3-butadiene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Isopropylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Methylene Chloride (50 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
n-Butylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
n-Propylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Naphthalene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Pentachloroethane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
sec-Butylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Styrene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
t-1,2-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
t-1,3-Dichloropropene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
tert-Butylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Tetrachloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Toluene (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Trichloroethene (10 ug/l#)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Trichlorofluoromethane (5 ug/l)		< 0.5		< 0.5		< 0.5		< 0.5		< 0.5
Vinyl Chloride (5 ug/l#)	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5	< 1	< 0.5
Xylenes (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

(~) NYSDOH Proposed Std unless noted
(#) NYS Water Quality Criteria
(##) MCL for Total Trihalomethanes
NA= Tap Not Accessible for sampling.

ORGANIC ANALYSES OF HOMEOWNER WELLS

WELL NUMBER	6		7		8		9		10	
OWNER	J. Villano		O. Desimone		A. Dahteria		R. Johnson		A. Allen	
ADDRESS	1262 Conklin Rd		1248 Conklin Rd		1251 Conklin Rd		1281 Conklin Rd		1279 Conklin Rd	
DATE	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88	11/9/83	1/19/88
PARAMETER (Standard~, See Exhibit B)				CONCENTRATIONS EXPRESSED IN UG/L (PPB)						
1,1,1-Trichloroethane (5 ug/l)	< 1	|	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	|
1,1,2,2-Tetrachloroethane (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
1,1,2-Trichloroethane (5 ug/l)	< 1	|	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	|
1,1-Dichloroethane (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
1,1-Dichloroethene (5 ug/l)	< 1	|	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	|
1,1-Dichloropropene (5 ug/l)				< 0.5		< 0.5		NA		
1,2,3-Trichlorobenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
1,2,3-Trichloropropane (5 ug/l)				< 0.5		< 0.5		NA		
1,2,4-Trichlorobenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
1,2,4-Trimethylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
1,2-Dibromo-3-chloropropane(5 ug/l)		|		< 0.5		< 0.5		NA		|
1,2-Dibromoethane (5 ug/l)				< 0.5		< 0.5		NA		
1,2-Dichlorobenzene (5 ug/l)	< 1	|	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	|
1,2-Dichloroethane (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
1,2-Dichloropropane (5 ug/l)	< 1	C	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	C
1,3,5-Trimethylbenzene (5 ug/l)	< 1	o	< 1		< 1		< 1		< 1	o
1,3-Dichlorobenzene (5 ug/l)	< 1	n	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	n
1,3-Dichloropropane (5 ug/l)		n		< 0.5		< 0.5		NA		n
1,4-Bromofluorobenzene (5 ug/l)	< 1	e	< 1		< 1		< 1		< 1	e
1,4-Cymene (5 ug/l)	< 1	c	< 1		< 1		< 1		< 1	c
1,4-Dichlorobenzene (5 ug/l)	< 1	t	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	t
1-Chlorocyclohexene (5 ug/l)	< 1	e	< 1		< 1		< 1		< 1	e
2,2-Dichloropropane (5 ug/l)		d		< 0.5		< 0.5		NA		d
2,3-Benzofuran (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
2-Chloroethylvinyl ether (5 ug/l)	< 10	t	< 10		< 10		< 10		< 10	t
2-Chlorotoluene (5 ug/l)	< 1	o	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	o
4-Chlorotoluene (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Benzene (5 ug/l#)	< 1	P	< 1	< 1	< 1	< 1	< 1	NA	< 1	P
bis-2-Chloroisopropyl ether (5 ug/l)		u		< 0.5		< 0.5		NA		u
Bromobenzene (5 ug/l)	< 1	b	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	b
Bromochloromethane (100 mg/l##)		l		< 0.5		< 0.5		NA		l
Bromodichloromethane (100 mg/l##)	< 1	i	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	i
Bromoform (100 mg/l##)	< 10	c	< 10	< 0.5	< 10	< 0.5	< 10	NA	< 10	c
Bromomethane (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
c-1,3-Dichloropropene (5 ug/l)	< 1	W	< 1		< 1		< 1		< 1	W
Carbon tetrachloride (5 ug/l)	< 1	a	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	a
Chlorobenzene (5 ug/l)	< 1	t	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	t
Chloroethane (5 ug/l)	< 1	e	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	e
Chloroform (100 mg/l##)	< 1	r	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	r
Chloromethane (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Cyclopropylbenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
Dibromochloromethane (100 ug/l##)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Dibromomethane (5 ug/l)		|		< 0.5		< 0.5		NA		|
Dichlorodifluoromethane (5 ug/l)				< 0.5		< 0.5		NA		
Ethylbenzene (5 ug/l)	< 1	|	< 1	< 1	< 1	< 1	< 1	NA	< 1	|
Hexachloro-1,3-butadiene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Isopropylbenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
Methylene Chloride (50 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
n-Butylbenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
n-Propylbenzene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
Naphthalene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
Pentachloroethane (5 ug/l)				< 0.5		< 0.5		NA		
sec-Butylbenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
Styrene (5 ug/l)	< 1		< 1		< 1		< 1		< 1	
t-1,2-Dichloroethene (5 ug/l)	< 1	|	< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	|
t-1,3-Dichloropropene (5 ug/l)	2		< 1		< 1		< 1		< 1	
tert-Butylbenzene (5 ug/l)	< 1	|	< 1		< 1		< 1		< 1	|
Tetrachloroethene (5 ug/l)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Toluene (5 ug/l)	< 1	|	< 1	< 1	< 1	< 1	< 1	NA	< 1	|
Trichloroethene (10 ug/l#)	4		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Trichlorofluoromethane (5 ug/l)		|		< 0.5		< 0.5		NA		|
Vinyl Chloride (5 ug/l#)	< 1		< 1	< 0.5	< 1	< 0.5	< 1	NA	< 1	
Xylenes (5 ug/l)	< 1	|	< 1	< 1	< 1	< 1	< 1	NA	< 1	|

(~) NYSDOH Proposed Std unless noted
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NA= Tap Not Accessible for sampling.

ORGANIC ANALYSES OF HOMEOWNER WELLS

WELL NUMBER	11		12		13	14		15	
OWNER	R. Pessarchick		R. Gleason		D. Hamm	Town Hall		R. Rowse	
ADDRESS	1283 Conklin Rd		Conklin Rd		Box 53 Conklin Rd	Conklin Rd		1258 Conklin Rd	
DATE	11/9/83	1/19/88	11/9/83	1/19/88	11/15/84	11/15/84	1/19/88	11/15/84	1/19/88
PARAMETER (Standard~, See Exhibit B)	CONCENTRATIONS EXPRESSED IN UG/L (PPB)								
1,1,1-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	|
1,1,2,2-Tetrachloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
1,1,2-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	|
1,1-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
1,1-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	|
1,1-Dichloropropene (5 ug/l)		< 0.5		NA			< 0.5		
1,2,3-Trichlorobenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
1,2,3-Trichloropropane (5 ug/l)		< 0.5		NA			< 0.5		
1,2,4-Trichlorobenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
1,2,4-Trimethylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
1,2-Dibromo-3-chloropropane(5 ug/l)		< 0.5		NA			< 0.5		|
1,2-Dibromoethane (5 ug/l)		< 0.5		NA			< 0.5		
1,2-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	|
1,2-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
1,2-Dichloropropane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	1	< 1	C
1,3,5-Trimethylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	o
1,3-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	n
1,3-Dichloropropane (5 ug/l)		< 0.5		NA			< 0.5		n
1,4-Bromofluorobenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	e
1,4-Cymene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	c
1,4-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	t
1-Chlorocyclohexene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	e
2,2-Dichloropropane (5 ug/l)		< 0.5		NA			< 0.5		d
2,3-Benzofuran (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
2-Chloroethylvinyl ether (5 ug/l)	< 10		< 10		< 10	< 10		< 10	t
2-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	o
4-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Benzene (5 ug/l#)	< 1	< 1	< 1	NA	< 1	< 1	< 1	< 1	P
bis-2-Chloroisopropyl ether (5 ug/l)		< 0.5		NA			< 0.5		u
Bromobenzene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	b
Bromochloromethane (100 mg/l##)		< 0.5		NA			< 0.5		l
Bromodichloromethane (100 mg/l##)	< 1	< 0.5	< 1	NA	< 1	< 1	9	< 1	i
Bromoform (100 mg/l##)	< 10	< 0.5	< 10	NA	< 10	< 10	< 0.5	< 10	c
Bromomethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
c-1,3-Dichloropropene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	W
Carbon tetrachloride (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	2	< 1	a
Chlorobenzene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	t
Chloroethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	e
Chloroform (100 mg/l##)	< 1	< 0.5	< 1	NA	2	2	13	< 1	r
Chloromethane (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Cyclopropylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
Dibromochloromethane (100 ug/l##)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Dibromomethane (5 ug/l)		< 0.5		NA			< 0.5		|
Dichlorodifluoromethane (5 ug/l)		< 0.5		NA			< 0.5		
Ethylbenzene (5 ug/l)	< 1	< 1	< 1	NA	< 1	< 1	< 1	< 1	|
Hexachloro-1,3-butadiene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
Isopropylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
Methylene Chloride (50 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
n-Butylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
n-Propylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
Naphthalene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
Pentachloroethane (5 ug/l)		< 0.5		NA			< 0.5		
sec-Butylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
Styrene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
t-1,2-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	|
t-1,3-Dichloropropene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	
tert-Butylbenzene (5 ug/l)	< 1		< 1		< 1	< 1		< 1	|
Tetrachloroethene (5 ug/l)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Toluene (5 ug/l)	< 1	< 1	< 1	NA	< 1	< 1	< 1	< 1	|
Trichloroethene (10 ug/l#)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Trichlorofluoromethane (5 ug/l)		< 0.5		NA			< 0.5		|
Vinyl Chloride (5 ug/l#)	< 1	< 0.5	< 1	NA	< 1	< 1	< 0.5	< 1	
Xylenes (5 ug/l)	< 1	< 1	< 1	NA	< 1	< 1	< 1	< 1	|

(~) NYSDOH Proposed Std unless noted
(#) NYS Water Quality Criteria
(##) MCL for Total Trihalomethanes
NA= Tap Not Accessible for sampling.

ORGANIC ANALYSES OF HOMEOWNER WELLS

WELL NUMBER	16		17		18	19	20
OWNER	McGee		L. Brown		Petrick	Petrick	E. Smith
ADDRESS	1269 Conklin Rd		1278 Conklin Rd		1250 Conklin Rd	1248.5 Conklin Rd	1275 Conklin Rd
DATE	11/15/84	1/19/88	11/15/84	1/19/88	1/19/88	1/19/88	1/19/88
PARAMETER (Standard~, See Exhibit B)				CONCENTRATIONS EXPRESSED IN UG/L (PPB)			
1,1,1-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2-Trichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloropropene (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
1,2,3-Trichlorobenzene (5 ug/l)	< 1		< 1				
1,2,3-Trichloropropane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
1,2,4-Trichlorobenzene (5 ug/l)	< 1		< 1				
1,2,4-Trimethylbenzene (5 ug/l)	< 1		< 1				
1,2-Dibromo-3-chloropropane(5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dibromoethane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloropropane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,3,5-Trimethylbenzene (5 ug/l)	< 1		< 1				
1,3-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1,3-Dichloropropane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
1,4-Bromofluorobenzene (5 ug/l)	< 1		< 1				
1,4-Cymene (5 ug/l)	< 1		< 1				
1,4-Dichlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
1-Chlorocyclohexene (5 ug/l)	< 1		< 1				
2,2-Dichloropropane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
2,3-Benzofuran (5 ug/l)	< 1		< 1				
2-Chloroethylvinyl ether (5 ug/l)	< 10		< 10				
2-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
4-Chlorotoluene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Benzene (5 ug/l#)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
bis-2-Chloroisopropyl ether (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
Bromobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Bromochloromethane (100 mg/l##)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
Bromodichloromethane (100 mg/l##)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Bromoform (100 mg/l##)	< 10	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5
Bromomethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
c-1,3-Dichloropropene (5 ug/l)	< 1		< 1				
Carbon tetrachloride (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Chlorobenzene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Chloroethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Chloroform (100 mg/l##)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Chloromethane (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Cyclopropylbenzene (5 ug/l)	< 1		< 1				
Dibromochloromethane (100 ug/l##)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Dibromomethane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
Dichlorodifluoromethane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
Ethylbenzene (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Hexachloro-1,3-butadiene (5 ug/l)	< 1		< 1				
Isopropylbenzene (5 ug/l)	< 1		< 1				
Methylene Chloride (50 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
n-Butylbenzene (5 ug/l)	< 1		< 1				
n-Propylbenzene (5 ug/l)	< 1		< 1				
Naphthalene (5 ug/l)	< 1		< 1				
Pentachloroethane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
sec-Butylbenzene (5 ug/l)	< 1		< 1				
Styrene (5 ug/l)	< 1		< 1				
t-1,2-Dichloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
t-1,3-Dichloropropene (5 ug/l)	< 1		< 1				
tert-Butylbenzene (5 ug/l)	< 1		< 1				
Tetrachloroethene (5 ug/l)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Toluene (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Trichloroethene (10 ug/l#)	< 1	< 0.5	9	< 0.5	< 0.5	< 0.5	< 0.5
Trichlorofluoromethane (5 ug/l)		< 0.5		< 0.5	< 0.5	< 0.5	< 0.5
Vinyl Chloride (5 ug/l#)	< 1	< 0.5	< 1	< 0.5	< 0.5	< 0.5	< 0.5
Xylenes (5 ug/l)	< 1	< 1	< 1	< 1	< 1	< 1	< 1

(~) NYSDOH Proposed Std unless noted
(#) NYS Water Quality Criteria
(##) MCL for Total Trihalomethanes
NA= Tap Not Accessible for sampling.

TABLE 6 (p. 6 of 6)

ORGANIC ANALYSES OF HOMEOWNER WELLS

WELL NUMBER	21	22
OWNER	Municipal Well #3	Quality Control
ADDRESS	Town of Conklin	Field Blank
DATE	1/19/88	1/19/88
PARAMETER (Standard~, See Exhibit B)	CONCENTRATIONS EXPRESSED IN UG/L (PPB)	
1,1,1-Trichloroethane (5 ug/l)	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane (5 ug/l)	< 0.5	< 0.5
1,1,2-Trichloroethane (5 ug/l)	< 0.5	< 0.5
1,1-Dichloroethane (5 ug/l)	< 0.5	< 0.5
1,1-Dichloroethene (5 ug/l)	< 0.5	< 0.5
1,1-Dichloropropene (5 ug/l)	< 0.5	< 0.5
1,2,3-Trichlorobenzene (5 ug/l)		
1,2,3-Trichloropropane (5 ug/l)	< 0.5	< 0.5
1,2,4-Trichlorobenzene (5 ug/l)		
1,2,4-Trimethylbenzene (5 ug/l)		
1,2-Dibromo-3-chloropropane(5 ug/l)	< 0.5	< 0.5
1,2-Dibromoethane (5 ug/l)	< 0.5	< 0.5
1,2-Dichlorobenzene (5 ug/l)	< 0.5	< 0.5
1,2-Dichloroethane (5 ug/l)	< 0.5	< 0.5
1,2-Dichloropropane (5 ug/l)	< 0.5	< 0.5
1,3,5-Trimethylbenzene (5 ug/l)		
1,3-Dichlorobenzene (5 ug/l)	< 0.5	< 0.5
1,3-Dichloropropane (5 ug/l)	< 0.5	< 0.5
1,4-Bromofluorobenzene (5 ug/l)		
1,4-Cymene (5 ug/l)		
1,4-Dichlorobenzene (5 ug/l)	< 0.5	< 0.5
1-Chlorocyclohexene (5 ug/l)		
2,2-Dichloropropane (5 ug/l)	< 0.5	< 0.5
2,3-Benzofuran (5 ug/l)		
2-Chloroethylvinyl ether (5 ug/l)		
2-Chlorotoluene (5 ug/l)	< 0.5	< 0.5
4-Chlorotoluene (5 ug/l)	< 0.5	< 0.5
Benzene (5 ug/l#)	< 1	< 1
bis-2-Chloroisopropyl ether (5 ug/l)	< 0.5	< 0.5
Bromobenzene (5 ug/l)	< 0.5	< 0.5
Bromochloromethane (100 mg/l##)	< 0.5	< 0.5
Bromodichloromethane (100 mg/l##)	< 0.5	< 0.5
Bromoform (100 mg/l##)	< 0.5	< 0.5
Bromomethane (5 ug/l)	< 0.5	< 0.5
c-1,3-Dichloropropene (5 ug/l)		
Carbon tetrachloride (5 ug/l)	< 0.5	< 0.5
Chlorobenzene (5 ug/l)	< 0.5	< 0.5
Chloroethane (5 ug/l)	< 0.5	< 0.5
Chloroform (100 mg/l##)	< 0.5	< 0.5
Chloromethane (5 ug/l)	< 0.5	< 0.5
Cyclopropylbenzene (5 ug/l)		
Dibromochloromethane (100 ug/l##)	< 0.5	< 0.5
Dibromomethane (5 ug/l)	< 0.5	< 0.5
Dichlorodifluoromethane (5 ug/l)	< 0.5	< 0.5
Ethylbenzene (5 ug/l)	< 1	< 1
Hexachloro-1,3-butadiene (5 ug/l)		
Isopropylbenzene (5 ug/l)		
Methylene Chloride (50 ug/l)	< 0.5	< 0.5
n-Butylbenzene (5 ug/l)		
n-Propylbenzene (5 ug/l)		
Naphthalene (5 ug/l)		
Pentachloroethane (5 ug/l)	< 0.5	< 0.5
sec-Butylbenzene (5 ug/l)		
Styrene (5 ug/l)		
t-1,2-Dichloroethene (5 ug/l)	< 0.5	< 0.5
t-1,3-Dichloropropene (5 ug/l)		
tert-Butylbenzene (5 ug/l)		
Tetrachloroethene (5 ug/l)	< 0.5	< 0.5
Toluene (5 ug/l)	< 1	< 1
Trichloroethene (10 ug/l#)	< 0.5	< 0.5
Trichlorofluoromethane (5 ug/l)	< 0.5	< 0.5
Vinyl Chloride (5 ug/l#)	< 0.5	< 0.5
Xylenes (5 ug/l)	< 1	< 1

(~) NYSDOH Proposed Std unless noted
(#) NYS Water Quality Criteria
(##) MCL for Total Trihalomethanes
NA= Tap Not Accessible for sampling.

TABLE 7 (p. 1 of 2)

WETLANDS & CARLIN CREEK
SEDIMENT & SURFACE WATER CHARACTERIZATION DATA SUMMARY
See Appendices E and G for Additional Parameters

			---BE6 Wetlands---			---BE5 Wetlands---			--Carlin Creek--		
			Sediment			Sediment			Sediment		
	Sample Location:		23	24	25	33	34	35	30	31	32
	Sample Date:		1/88	1/88	1/88	1986	1986	1986	2/86	2/86	1986
	VOLATILE ORGANICS	UNITS									
1	Chloromethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
2	Bromomethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
3	Vinyl Chloride	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
4	Chloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
5	Methylene Chloride	ug/kg	<10	<10	<10	<50	<50	<50	-	-	-
6	Acetone	ug/kg									
7	Carbon Disulfide	ug/kg									
8	1,1-Dichloroethene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
9	1,1-Dichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
10	1,2-Dichloroethene (total)	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
11	Chloroform	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
12	1,2-Dichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
13	2-Butanone	ug/kg									
14	1,1,1-Trichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
15	Carbon Tetrachloride	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
16	Vinyl Acetate	ug/kg									
17	Bromodichloromethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
18	1,2-Dichloropropane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
19	cis-1,3-Dichloropropene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
20	Trichloroethene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
21	Dibromochloromethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
22	1,1,2-Trichloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
23	Benzene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
24	trans-1,3-Dichloropropene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
25	2-Chloroethylvinylether	ug/kg	<100	<100	<100	<100	<100	<100	-	-	-
26	Bromoform	ug/kg	<100	<100	<100	<100	<100	<100	-	-	-
27	4-Methyl-2-Pentanone	ug/kg									
28	2-Hexanone	ug/kg									
29	Tetrachloroethene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
30	1,1,2,2-Tetrachloroethane	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
31	Toluene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
32	Chlorobenzene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
33	Ethylbenzene	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
34	Styrene	ug/kg									
35	Total Xylenes	ug/kg	<10	<10	<10	<10	<10	<10	-	-	-
	SELECT INORGANICS/INDICATORS										
36	Arsenic	mg/kg ww	29	5	2.9	1	0.5	0.7	1.29	1.46	1.29
37	Cadmium	mg/kg ww	2	<1	<1	2	2	2	2	2	2
38	Chromium	mg/kg ww	<5	8	2	6	5	4	10	6	8
39	Copper	mg/kg ww	1	8	3	21	18	18	30	25	27
40	Mercury	mg/kg ww	<0.5	<0.5	<0.5	0.03	0.04	0.13	<0.01	0.11	0.6
41	Manganese	mg/kg ww	--	--	--	--	--	--	--	--	--
42	Lead	mg/kg ww	24	14	7	18	11	12	16	15	15
43	Zinc	mg/kg ww	25	35	15	460	170	210	610	510	510
44	Percent Total Solids	%	37	49	28	--	--	--	--	--	--

TABLE 7 (p. 2 of 2)

WETLANDS & CARLIN CREEK
SEDIMENT & SURFACE WATER CHARACTERIZATION DATA SUMMARY

See Appendices E and G for Additional Parameters

			--BE6 Wetlands--	----BE5 Wetlands---			---Carlin Creek---		
			Leachate Compos.	Surface Water			Surface Water		
Sample Location:			27	33	34	35	30	31	32
Sample Date:			2/86	11/84	11/84	11/84	1986	1986	1986
VOLATILE ORGANICS	UNITS	Exhibit A Standard							
1 Chloromethane	ug/l	5 ug/l¯	<1				<1	<1	<1
2 Bromomethane	ug/l	5 ug/l¯	<10				<10	<10	<10
3 Vinyl Chloride	ug/l	5 ug/l#	<1				<1	<1	<1
4 Chloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
5 Methylene Chloride	ug/l	50 ug/l¯	<1				<1	<1	<1
6 Acetone	ug/l	50 ug/l¯							
7 Carbon Disulfide	ug/l	--							
8 1,1-Dichloroethene	ug/l	5 ug/l¯	<1				<1	<1	<1
9 1,1-Dichloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
10 1,2-Dichloroethene (total)	ug/l	5 ug/l¯	<1				<1	<1	<1
11 Chloroform	ug/l	100 ug/l##	<1				<1	<1	<1
12 1,2-Dichloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
13 2-Butanone	ug/l	50 ug/l¯							
14 1,1,1-Trichloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
15 Carbon Tetrachloride	ug/l	5 ug/l¯	<1				<1	<1	<1
16 Vinyl Acetate	ug/l	50 ug/l¯							
17 Bromodichloromethane	ug/l	100 ug/l##	<1				<1	<1	<1
18 1,2-Dichloropropane	ug/l	5 ug/l¯	<1				<1	<1	<1
19 cis-1,3-Dichloropropene	ug/l	5 ug/l¯	<1				<1	<1	<1
20 Trichloroethene	ug/l	10 ug/l#	<1				<1	<1	<1
21 Dibromochloromethane	ug/l	100 ug/l##	<1				<1	<1	<1
22 1,1,2-Trichloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
23 Benzene	ug/l	5 ug/l#	<1				<1	<1	<1
24 trans-1,3-Dichloropropene	ug/l	5 ug/l¯	<1				<1	<1	<1
25 2-Chloroethylvinylether	ug/l	5 ug/l¯	<10				<10	<10	<10
26 Bromoform	ug/l	100 ug/l##	<10				<10	<10	<10
27 4-Methyl-2-Pentanone	ug/l	50 ug/l¯							
28 2-Hexanone	ug/l	50 ug/l¯							
29 Tetrachloroethene	ug/l	5 ug/l¯	<1				<1	<1	<1
30 1,1,2,2-Tetrachloroethane	ug/l	5 ug/l¯	<1				<1	<1	<1
31 Toluene	ug/l	5 ug/l¯	<1				<1	<1	<1
32 Chlorobenzene	ug/l	5 ug/l¯	<1				<1	<1	<1
33 Ethylbenzene	ug/l	5 ug/l¯	<1				<1	<1	<1
34 Styrene	ug/l	5 ug/l¯							
35 Total Xylenes	ug/l	5 ug/l¯	<1				<1	<1	<1
SELECT INORGANICS/INDICATORS									
	Date:						1/88	1/88	1/88
36 Arsenic	mg/l	0.025 mg/l#	0.006	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
37 Cadmium	mg/l	0.01 mg/l#	--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
38 Chromium	mg/l	0.05 mg/l#	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
39 Copper	mg/l	1.0 mg/l#	20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
40 Mercury	mg/l	0.002 mg/l#	0.0008	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005
41 Manganese	mg/l	0.3 mg/l#	--	0.13	0.19	0.21	<0.05	0.13	0.19
42 Lead	mg/l	0.05 mg/l#	--	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05
43 Zinc	mg/l	5.0 mg/l#	--	<0.01	0.02	0.02	<0.01	<0.01	<0.01
44 Percent Total Solids	%		--	--	--	--	--	--	--

(¯) NYSDOH Proposed Standards for Limiting Organic Chemical Contamination in Drinking Water

(#) NYS Water Quality Standard MCL or Max. Allowable Concentration (MAC)

(##) MCL for sum of Total Trihalomethanes

TABLE 8

LEACHATE CHARACTERIZATION DATA SUMMARY
See Appendix F for Complete Listing

		------- Lower Landfill--------				------------- Upper Landfill ------------					
Leachate Well Number:		13	13	15	15	14	14	14	14	16	16
Sample Date:		8/8/83	8/20/83	8/8/83	8/20/83	8/8/83	8/19/83	2/13/86	1/88	8/83	1/88
VOLATILE ORGANICS (Standard˜)	UNITS										
1 Chloromethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	2	<10	<10	<1	<1
2 Bromomethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
3 Vinyl Chloride (5 ug/l#)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
4 Chloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	19	15	<10	<10	<1	1
5 Methylene Chloride (50 ug/l)	ug/l	<1	2	2	4	1600	2100	150	<10	4	<1
6 Acetone (50 ug/l)	ug/l										
7 Carbon Disulfide	ug/l										
8 1,1-Dichloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
9 1,1-Dichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	62	80	<10	<10	<1	<1
10 1,2-Dichloroethene (5 ug/l total)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	4
11 Chloroform (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
12 1,2-Dichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	6	10	<10	<10	<1	<1
13 2-Butanone (50 ug/l)	ug/l										
14 1,1,1-Trichloroethane (5 ug/l)	ug/l	2	2	<1	<1	<1	<1	<10	<10	<1	2
15 Carbon Tetrachloride (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
16 Vinyl Acetate (50 ug/l)	ug/l										
17 Bromodichloromethane (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
18 1,2-Dichloropropane (5 ug/l)	ug/l	<1	<1	45	20	150	350	<10	<10	<1	<1
19 c-1,3-Dichloropropene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
20 Trichloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
21 Dibromochloromethane (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
22 1,1,2-Trichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
23 Benzene (5 ug/l)	ug/l	2	<1	<1	<1	40	47	33	32	7	<1
24 t-1,3-Dichloropropene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
25 2-Chloroethylvinylether (5 ug/l)	ug/l	<10	<100	<10	<10	<10	<100	<100	<100	<100	<100
26 Bromoform (100 ug/l##)	ug/l	<10	<100	<10	<10	<10	<100	<100	<100	<100	<100
27 4-Methyl-2-Pentanone (50 ug/l)	ug/l										
28 2-Hexanone (50 ug/l)	ug/l										
29 Tetrachloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	5	4	<10	<10	<1	<1
30 1,1,2,2-Tetrachloroethane(5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
31 Toluene (5 ug/l)	ug/l	17	13	<1	1	1100	1200	1200	1400	8	<1
32 Chlorobenzene (5 ug/l)	ug/l	2	2	<1	<1	<1	<1	150	150	<1	<1
33 Ethylbenzene (5 ug/l)	ug/l	8	5	<1	<1	34	59	89	140	23	1
34 Styrene (5 ug/l)	ug/l										
35 Total Xylenes (5 ug/l)	ug/l	26	7	<1	<1	<1	160	190	300	40	3
SELECTED INORGANICS & INDICATORS											
36 Arsenic (0.025 mg/l#)	mg/l	<0.01	<0.01	<0.01	--	<0.01	<0.01	0.005	<0.01	<0.01	<0.01
37 Cadmium (0.01 mg/l#)	mg/l	--	--	--	--	--	--	--	0.02	--	<0.01
38 Iron (0.3 mg/l#)	mg/l	3.6	0.84	<0.01	0.03	190	640	6200	110	--	53
39 Manganese (0.3 mg/l#)	mg/l	16	15	7.2	15	110	120	16.2	1.2	0.8	3.4
40 pH (6.5-8.5 SU#)	s.u.	6.8	6.6	6.8	--	6	5.9	6.7	6.7	7.7	6.3
41 Sp. Conductance	umhos/cm	430	272	330	--	10342	11458	3300	2800	4586	550
42 Total Organic Carbon	mg/l	--	--	--	--	--	--	1760	32	--	320

See Exhibit A for listing of State and Federal Water Quality Standards
(˜) NYSDOH Standards Limiting Organic Chemical Contamination in Drinking Water, unless otherwise noted.
(#) NYS Water Quality Standards MCL or Maximum Allowable Concentration (MAC)
(##) MCL for sum of Total Trihalomethanes
(*) Average of two analyses performed 8/8/83 and 8/20/83.

TABLE 9
REPRESENTATIVE RANGES FOR VARIOUS INORGANIC CONSTITUENTS IN LEACHATE FROM SANITARY LANDFILLS

(Sources: Griffin et al., 1976; Leckie et al., 1975)

PARAMETER	RANGE (mg/l)
Alkalinity	500 - 10,000
Ammonium (NH4+)	10 -1,000
Chemical Oxygen Demand (COD)	1,000 - 90,000
Chloride (Cl-)	200 - 1,000
Copper (Cu)	10
Iron - total (Fe)	1 - 1,000
Lead (Pb)	5
Magnesium (Mg+2)	100 - 1,500
Manganese (Mn)	0.01 - 100
Mercury (Hg)	0.2
Nickel (Ni)	0.01 - 1
Nitrate (NO3)-	0.1 - 10
Organic Nitrogen	10 -1,000
pH (s.u.)	4 - 8
Phosphorus (PO4)-3	1- 100
Potassium (K+)	200 - 1,000
Sodium (Na+)	200 - 1,200
Sulfate (SO4)-2	10 -1,000
Total Dissolved Organic Carbon	200 - 30,000
Total Dissolved Solids (TDS)	5,000 - 40,000
Zinc (Zn)	0.1 - 100

TABLE 10

TOWN OF CONKLIN
EXTENDED DILUTION OXYGEN UPTAKE
INHIBITION TEST (12 days @ 20 C)
LEACHATE MW#14

SAMPLE	SAMPLE VOL. ml	STD.FOOD(1) ml	SEED(2) ml	DIL.WATER(3) ml	INIT.D.O. mg/l	RES.D.O. mg/l	AVG.RES.D.O. mg/l	D.O.DEPLET. mg/l	AVG.DEPLET mg/l
BLANK	0	0	0	300	9.3	8.9		0.4	
"	0	0	0	300	9.3	8.8	8.9	0.5	0.4
"	0	0	0	300	9.3	8.9		0.4	
CONTROL	0	3	5	292	9.3	6.8		2.5	
"	0	3	5	292	9.3	6.9	6.8	2.4	2.5
"	0	3	5	292	9.3	6.8		2.5	
LEACHATE	0.05	3	5	QS(4)	9.3	6.7	6.7	2.6	2.6
"	0.05	3	5	"	9.3	6.7		2.6	
"	0.1	3	5	"	9.3	6.4	6.5	2.9	2.9
"	0.1	3	5	"	9.3	6.5		2.8	
"	0.2	3	5	"	9.3	6.5	6.5	2.8	2.9
"	0.2	3	5	"	9.3	6.4		2.9	
"	0.5	3	5	"	9.3	6.5	6.5	2.8	2.9
"	0.5	3	5	"	9.3	6.4		2.9	
"	1	3	5	"	9.3	5.9	6.0	3.4	3.4
"	1	3	5	"	9.3	6.0		3.3	
"	1.5	3	5	"	9.3	5.3	5.4	4.0	4.0
"	1.5	3	5	"	9.3	5.4		3.9	
"	2	3	5	"	9.3	5.0	5.0	4.3	4.4
"	2	3	5	"	9.3	4.9		4.4	
"	5	3	5	"	9.3	2.3	2.4	7.0	6.9
"	5	3	5	"	9.3	2.5		6.8	
"	10	3	5	"	9.3	0.2	0.2	9.1	9.1
"	10	3	5	"	9.3	0.2		9.1	
"	20	3	5	"	9.3	0.1	0.1	9.2	9.2
"	20	3	5	"	9.3	0.1		9.2	

NOTES : (1) STANDARD FOOD - 150 mg GLUCOSE-GLUTAMIC ACID/l DI WATER
(2) SEED -10 ml METRO WTP MIXED LIQUOR IN 1 l DI WATER
(3) DILUTION WATER - STANDARD BOD DILUTION WATER WITHOUT SEED
(4) QS - DILUTION WATER MADE UP TO 300 ml BOD BOTTLE

TABLE 11

PHYSICOCHEMICAL PROPERTIES OF SITE INDICATORS

Site Indicator	Water Solubility (mg/L)[a]	Vapor Pressure[a] (Torr)	Log Kow[a]	Log Koc	Henry's Law Constant (atm .m^3/mol)	Volatilization Half-lives (days)[e] Lake	River	Stream	Photooxidation Half-lives[f] (days)
Benzene	1780 (25°C)	95.2 (25°C)	1.95	1.74[b]	5×10^{-3}[d]	129	0.1	0.06	6.6
Ethylbenzene	152 (20°C)	7 (20°C)	3.15	2.94[b]	8×10^{-3}	151	0.1	0.07	1.4
Methylene Chloride	13200-20,000 (25°C)	362.4 (20°C)	1.25	1.4[c]	2×10^{-3}	135	0.1	0.07	67
Toluene	534.8 (25°C)	28.7 (25°C)	2.69	2.5[b]	7×10^{-3}	140	0.1	0.06	1.7
1,1,1-Trichloroethane	480-4400 (20°C)	96.0 (20°C)	2.17	2.3[c]	2×10^{-2}	169	0.1	0.07	694
Chloroethane	5740 (20°C)	1000 (20°C)	1.54	1.5[c]	8×10^{-3}	117	0.1	0.05	40

[a] Callahan et al. (1979)

[b] Lyman et al. (1982) Equation 4-10

[c] Lyman et al. (1982) Equation 4-7

[d] Hire and Mookerjee (1975)

[e] Computer program derived from Chapter 15 equations in Lyman et al. (1982). A copy of the program is included as Exhibit D.

[f] Atkinson et al. (1979)

TABLE 21

LEACHATE CHARACTERIZATION DATA SUMMARY

		------- Lower Landfill--------				------------- Upper Landfill ------------					
Leachate Well Number:		13	13	15	15	14	14	14	14	16	16
Sample Date:		8/8/83	8/20/83	8/8/83	8/20/83	8/8/83	8/19/83	2/13/86	1/88	8/83	1/88
VOLATILE ORGANICS (Standard˜)	UNITS										
1 Chloromethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	2	<10	<10	<1	<1
2 Bromomethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
3 Vinyl Chloride (5 ug/l#)	ug/l	<1	<1	<1	<1	36	25	<10	<10	<1	<1
4 Chloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	19	15	<10	<10	<1	1
5 Methylene Chloride (50 ug/l)	ug/l	<1	2	2	4	1600	2100	150	<10	4	<1
6 Acetone (50 ug/l)	ug/l							1500			
7 Carbon Disulfide	ug/l										
8 1,1-Dichloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
9 1,1-Dichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	62	80	<10	<10	<1	<1
10 1,2-Dichloroethene (5 ug/l total)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	4
11 Chloroform (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
12 1,2-Dichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	6	10	<10	<10	<1	<1
13 2-Butanone (50 ug/l)	ug/l										
14 1,1,1-Trichloroethane (5 ug/l)	ug/l	2	2	<1	<1	<1	<1	<10	<10	<1	2
15 Carbon Tetrachloride (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
16 Vinyl Acetate (50 ug/l)	ug/l										
17 Bromodichloromethane (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
18 1,2-Dichloropropane (5 ug/l)	ug/l	<1	<1	45	20	150	350	<10	<10	<1	<1
19 c-1,3-Dichloropropene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
20 Trichloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	23	23	<10	<10	<1	<1
21 Dibromochloromethane (100 ug/l##)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
22 1,1,2-Trichloroethane (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
23 Benzene (5 ug/l)	ug/l	2	<1	<1	<1	40	47	33	32	7	<1
24 t-1,3-Dichloropropene (5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
25 2-Chloroethylvinylether (5 ug/l)	ug/l	<10	<100	<10	<10	<10	<100	<100	<100	<100	<100
26 Bromoform (100 ug/l##)	ug/l	<10	<100	<10	<10	<10	<100	<100	<100	<100	<100
27 4-Methyl-2-Pentanone (50 ug/l)	ug/l										
28 2-Hexanone (50 ug/l)	ug/l										
29 Tetrachloroethene (5 ug/l)	ug/l	<1	<1	<1	<1	5	4	<10	<10	<1	<1
30 1,1,2,2-Tetrachloroethane(5 ug/l)	ug/l	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1
31 Toluene (5 ug/l)	ug/l	17	13	<1	1	1100	1200	1200	1400	8	<1
32 Chlorobenzene (5 ug/l)	ug/l	2	2	<1	<1	<1	<1	150	150	<1	<1
33 Ethylbenzene (5 ug/l)	ug/l	8	5	<1	<1	34	59	89	140	23	1
34 Styrene (5 ug/l)	ug/l										
35 Total Xylenes (5 ug/l)	ug/l	26	7	<1	<1	<1	160	190	300	40	3
SELECTED INORGANICS & INDICATORS											
36 Arsenic (0.025 mg/l#)	mg/l	<0.01	<0.01	<0.01	--	<0.01	<0.01	0.005	<0.01	<0.01	<0.01
37 Cadmium (0.01 mg/l#)	mg/l	--	--	--	--	--	--	--	0.02	--	<0.01
38 Iron (0.3 mg/l#)	mg/l	3.6	0.84	<0.01	0.03	190	640	6200	110	--	53
39 Manganese (0.3 mg/l#)	mg/l	16	15	7.2	15	110	120	16.2	1.2	0.8	3.4
40 pH (6.5-8.5 SU#)	s.u.	6.8	6.6	6.8	--	6	5.9	6.7	6.7	7.7	6.3
41 Sp. Conductance	umhos/cm	430	272	330	--	10342	11458	3300	2800	4586	550
42 Total Organic Carbon	mg/l	--	--	--	--	--	--	1760	32	--	320

See Exhibit A for listing of State and Federal Water Quality Standards
(˜) NYSDOH Standards Limiting Organic Chemical Contamination in Drinking Water, unless otherwise noted.
(#) NYS Water Quality Standards MCL or Maximum Allowable Concentration (MAC)
(##) MCL for sum of Total Trihalomethanes
(*) Average of two analyses performed 8/8/83 and 8/20/83.

Revised 12/13/90

Figures

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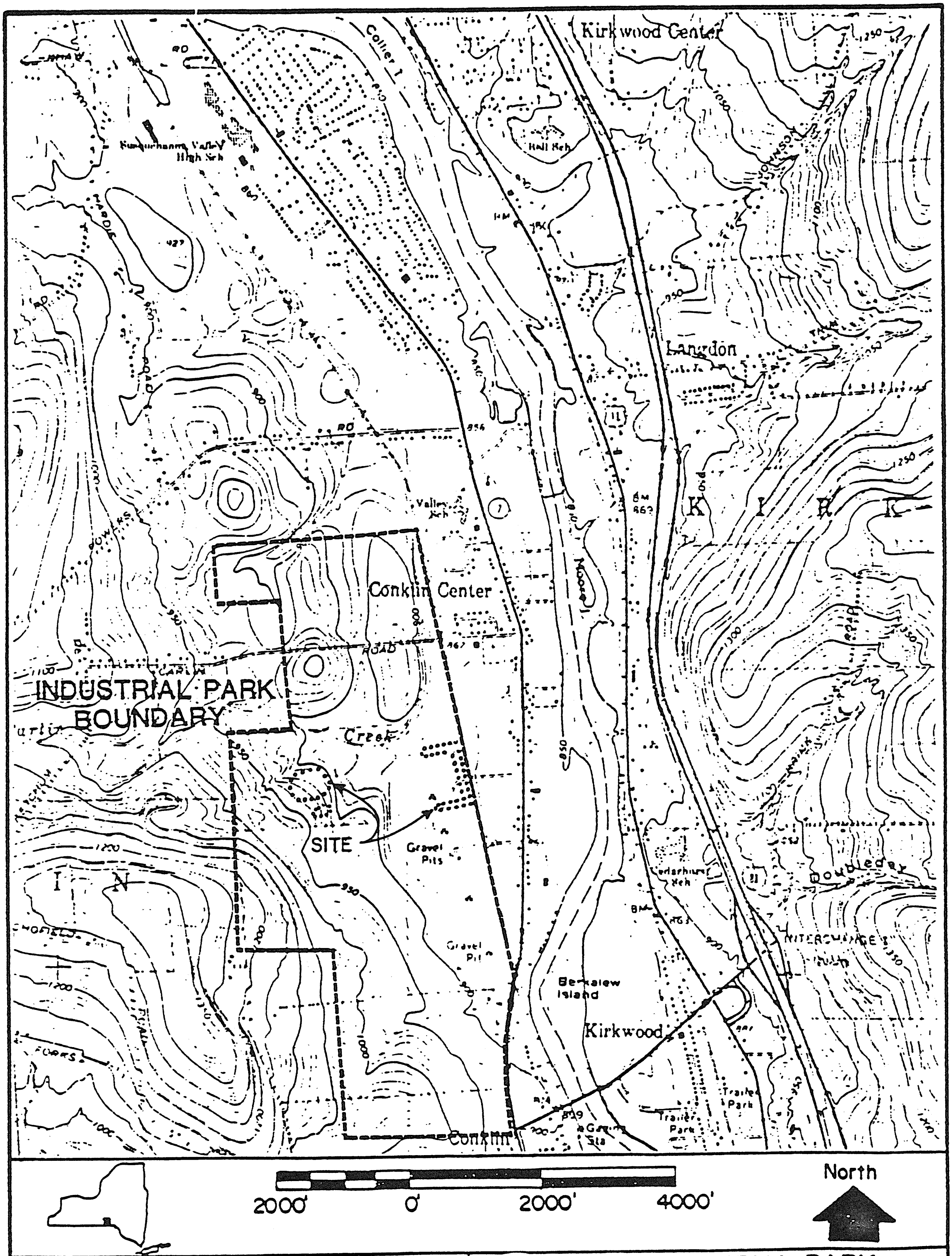
FIGURE 1



BROOME COUNTY INDUSTRIAL
DEVELOPMENT AGENCY

BROOME INDUSTRIAL PARK
CONKLIN, N.Y.
LOCATION MAP

O'BRIEN & GERE
ENGINEERS INC

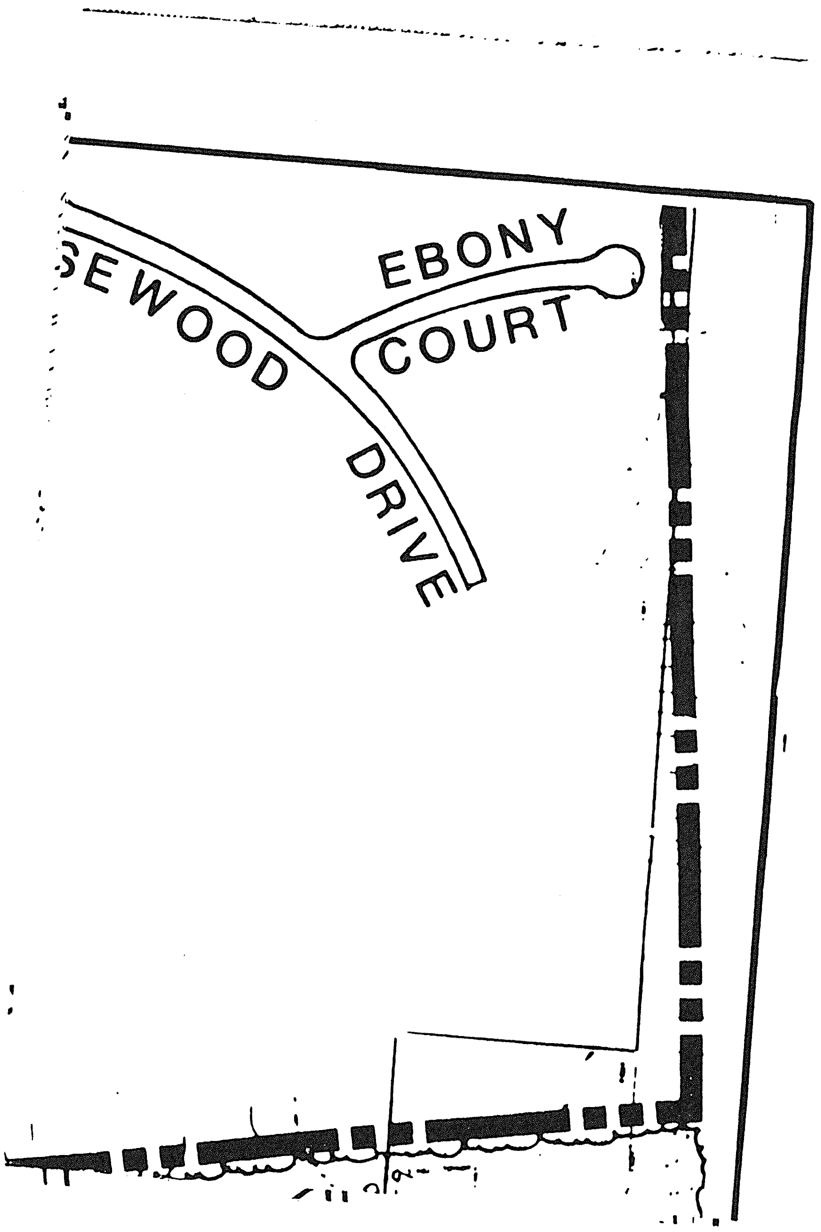
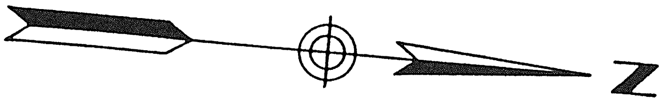


FIGURE 2



TOWN OF CONKLIN LANDFILLS
REMEDIAL INVESTIGATION

SITE PLAN

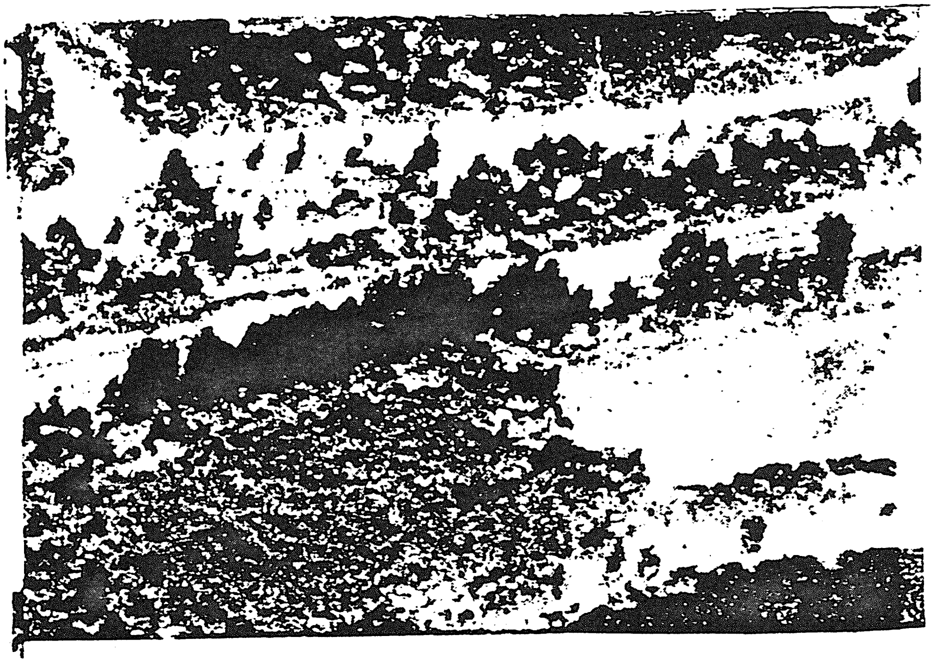


FIGURE 3

WN OF CONKLIN LANDFILLS
REMEDIAL INVESTIGATION

AERIAL PHOTOGRAPH

••• - APPROXIMATE LIMITS OF FILL

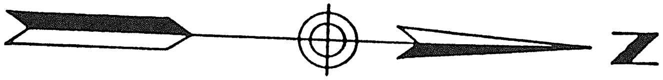
— - APPROXIMATE PROPERTY BOUNDARY

100 0 100 200

100'

O'BRIEN & GERE

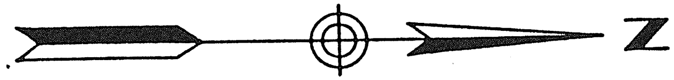
FIGURE 4



TOWN OF CONKLIN LANDFILLS
REMEDIAL INVESTIGATION

SCALE

FIGURE 5



TOWN OF CONKLIN LANDFILLS
REMEDIAL INVESTIGATION

SURFICIAL GEOLOGY MAP

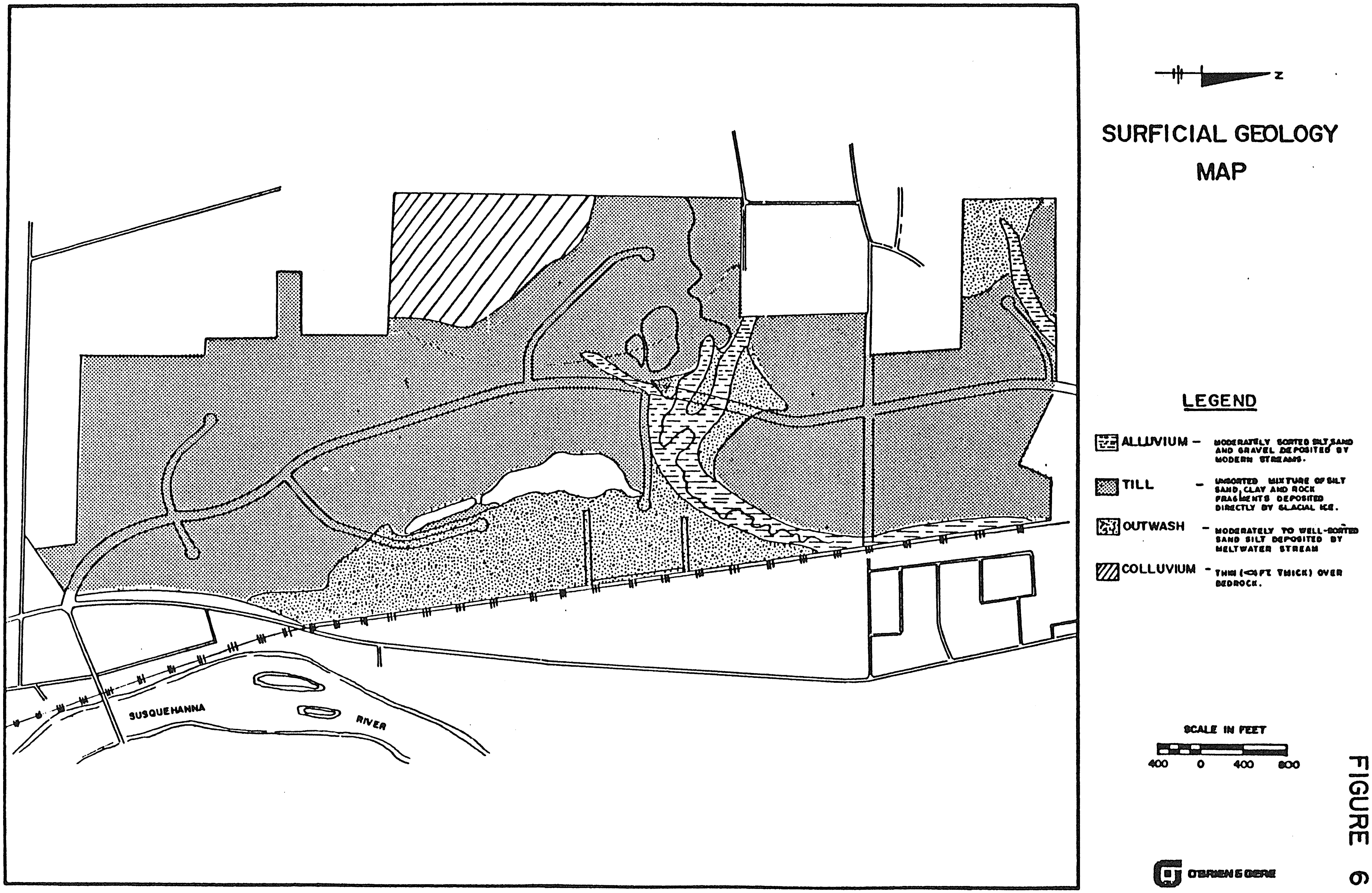
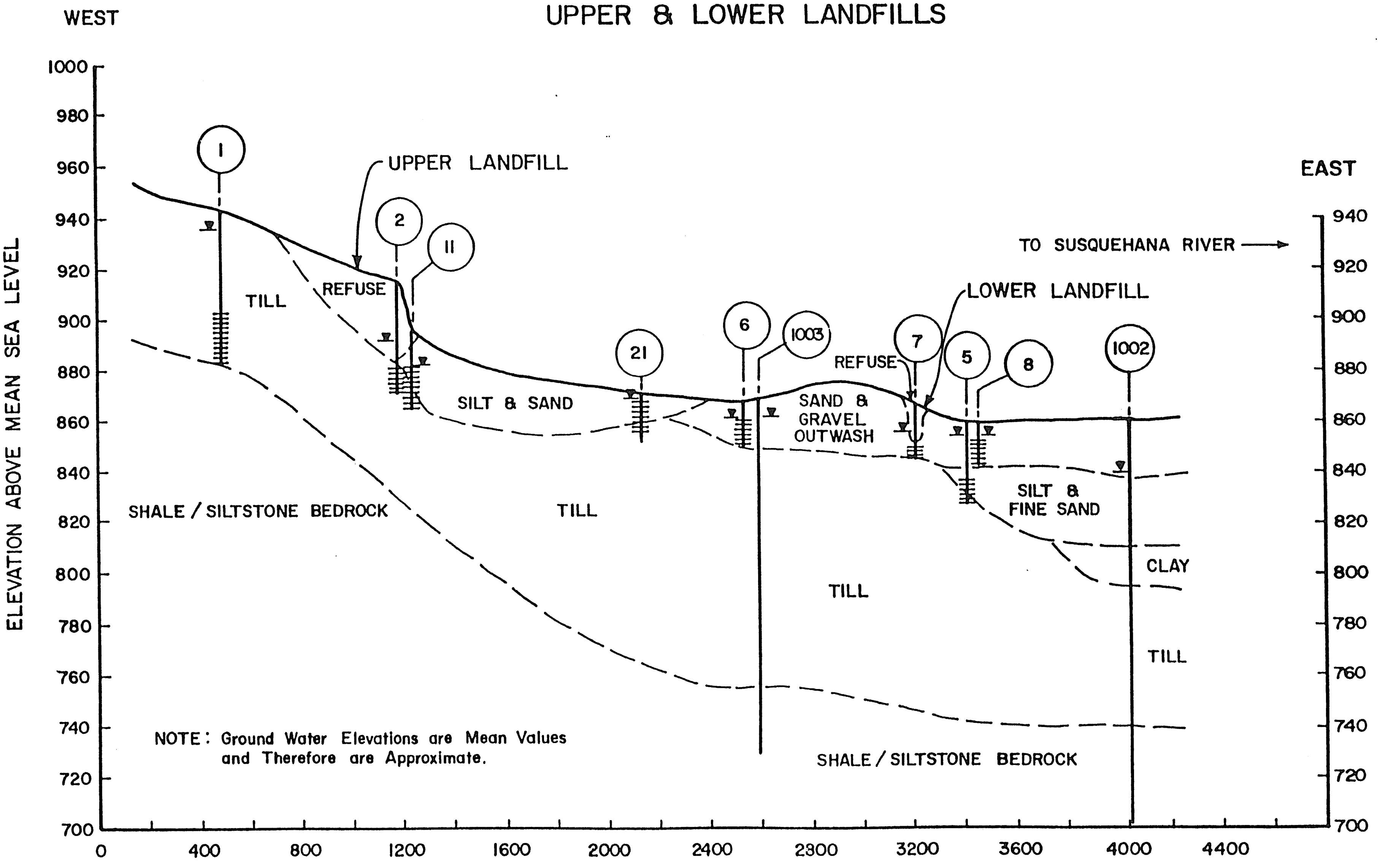


FIGURE 6

FIGURE 7

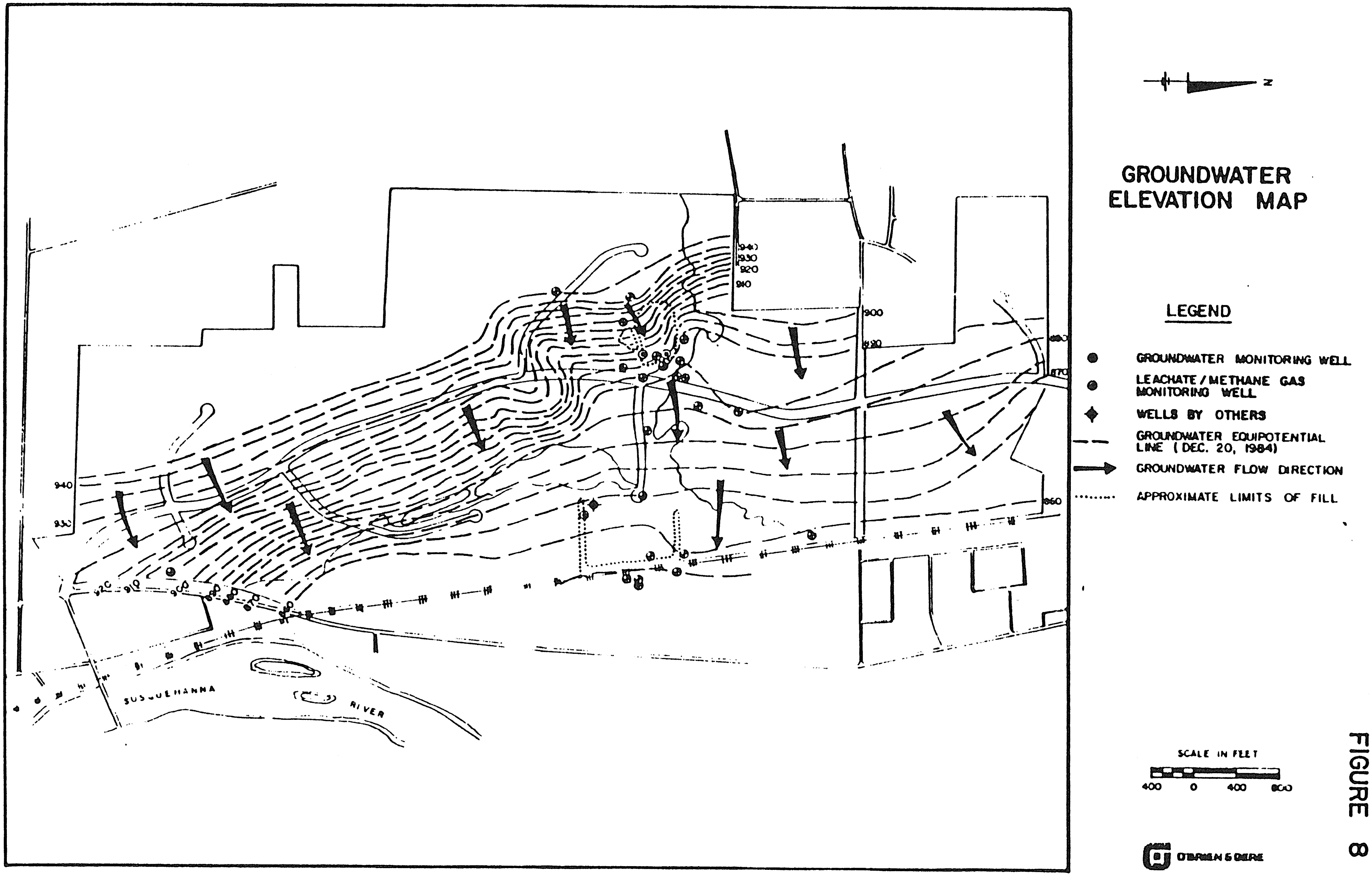
HYDROGEOLOGIC CROSS SECTION
TOWN OF CONKLIN
UPPER & LOWER LANDFILLS



NOTE: Ground Water Elevations are Mean Values and Therefore are Approximate.

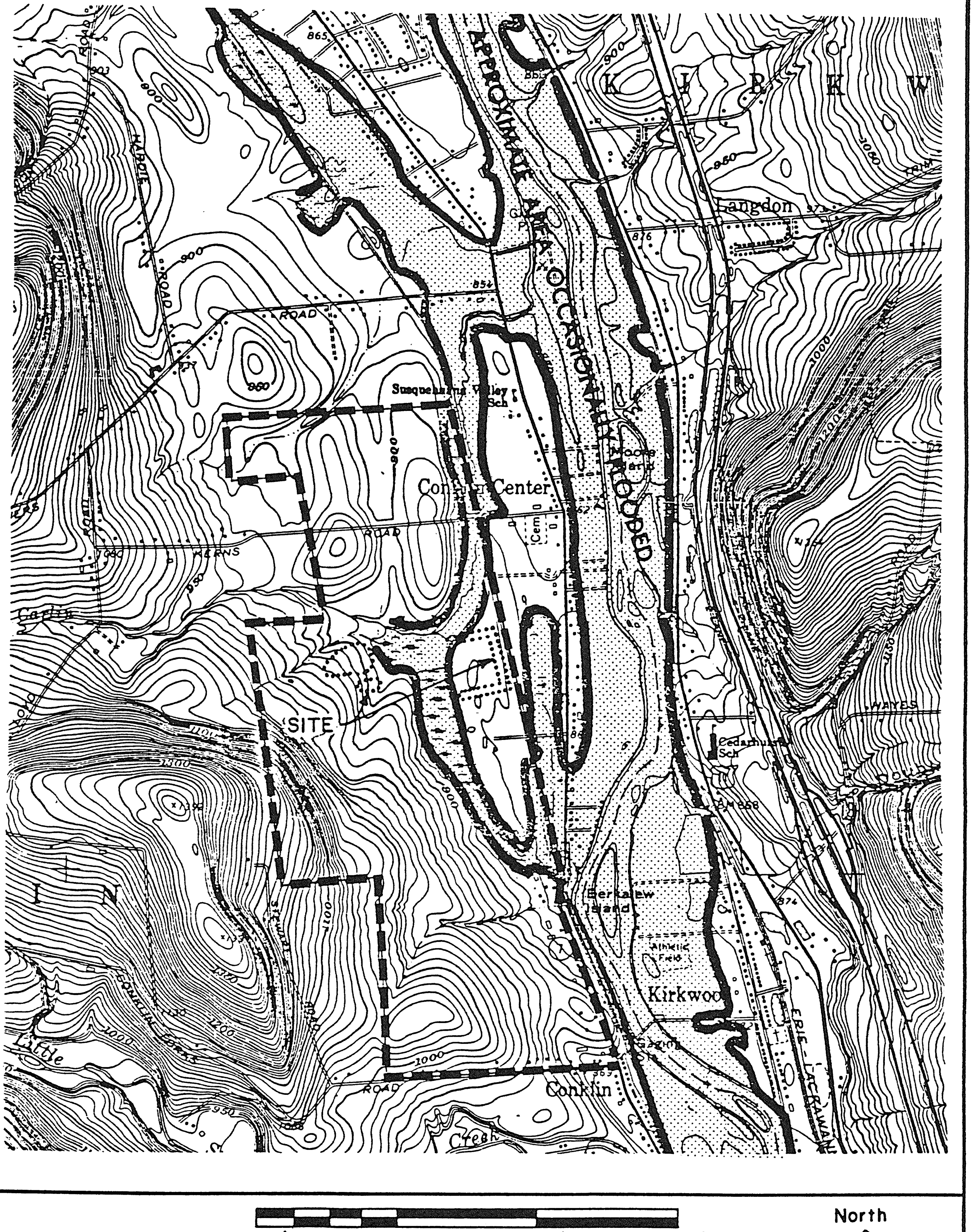
O'BRIEN & GERE ENGINEERS, INC

FIGURE 8



GROUNDWATER ELEVATION MAP

FIGURE 9



2000' 0 2000' 4000'

North

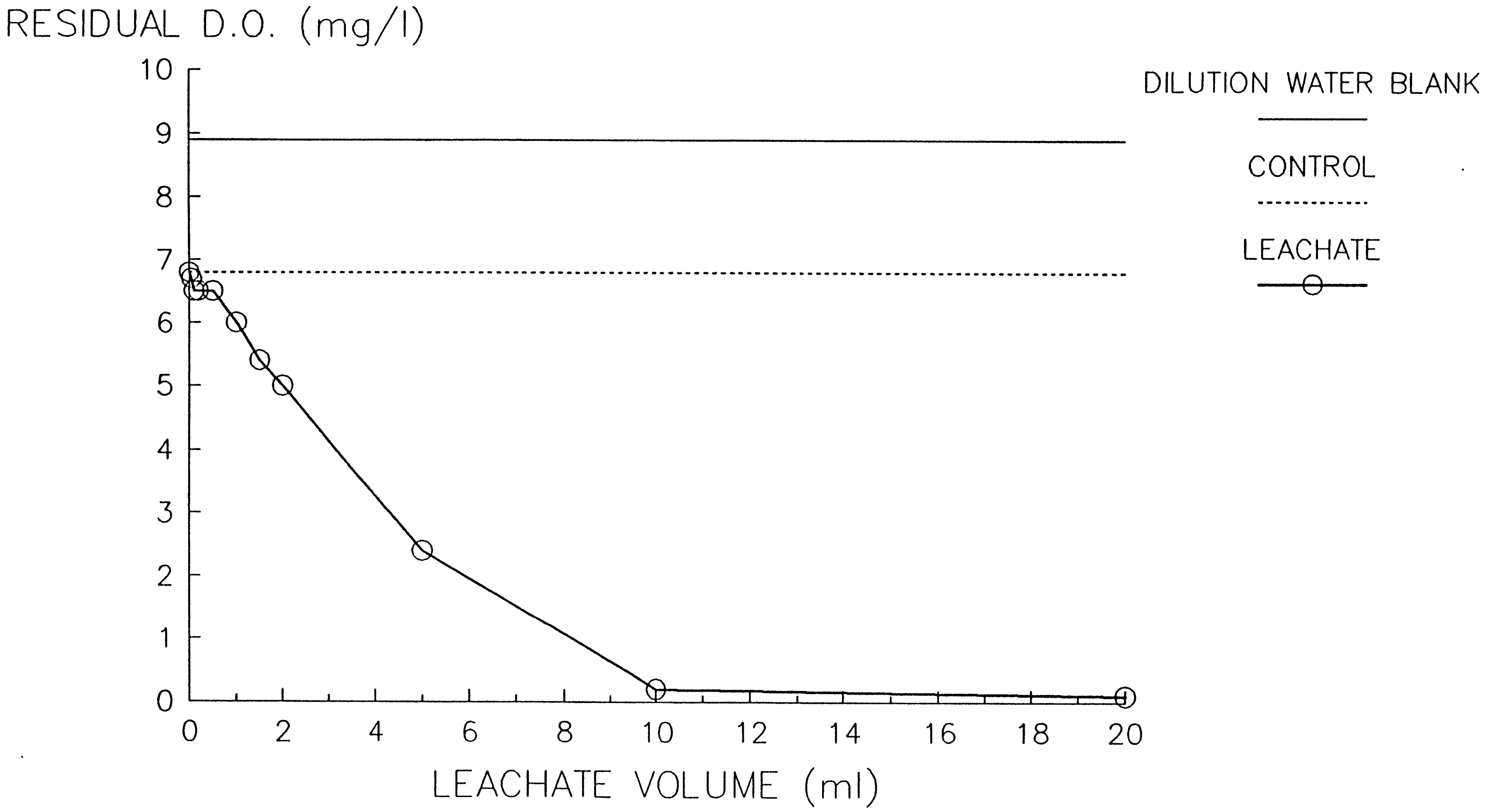
NOTE: Map developed from U.S. Army Corps. of Engineers Mapping – 100 yr. Floodplain ▨

BROOME COUNTY INDUSTRIAL DEVELOPMENT AGENCY	BROOME INDUSTRIAL PARK CONKLIN, N.Y. FLOOD ZONE MAP

O'BRIEN & GERE ENGINEERS, INC

FIGURE 10

TOWN OF CONKLIN
EXTENDED DILUTION OXYGEN UPTAKE TEST
LEACHATE MW #14



EXTENDED DILUTION OXYGEN UPTAKE TEST

TYPICAL CURVE

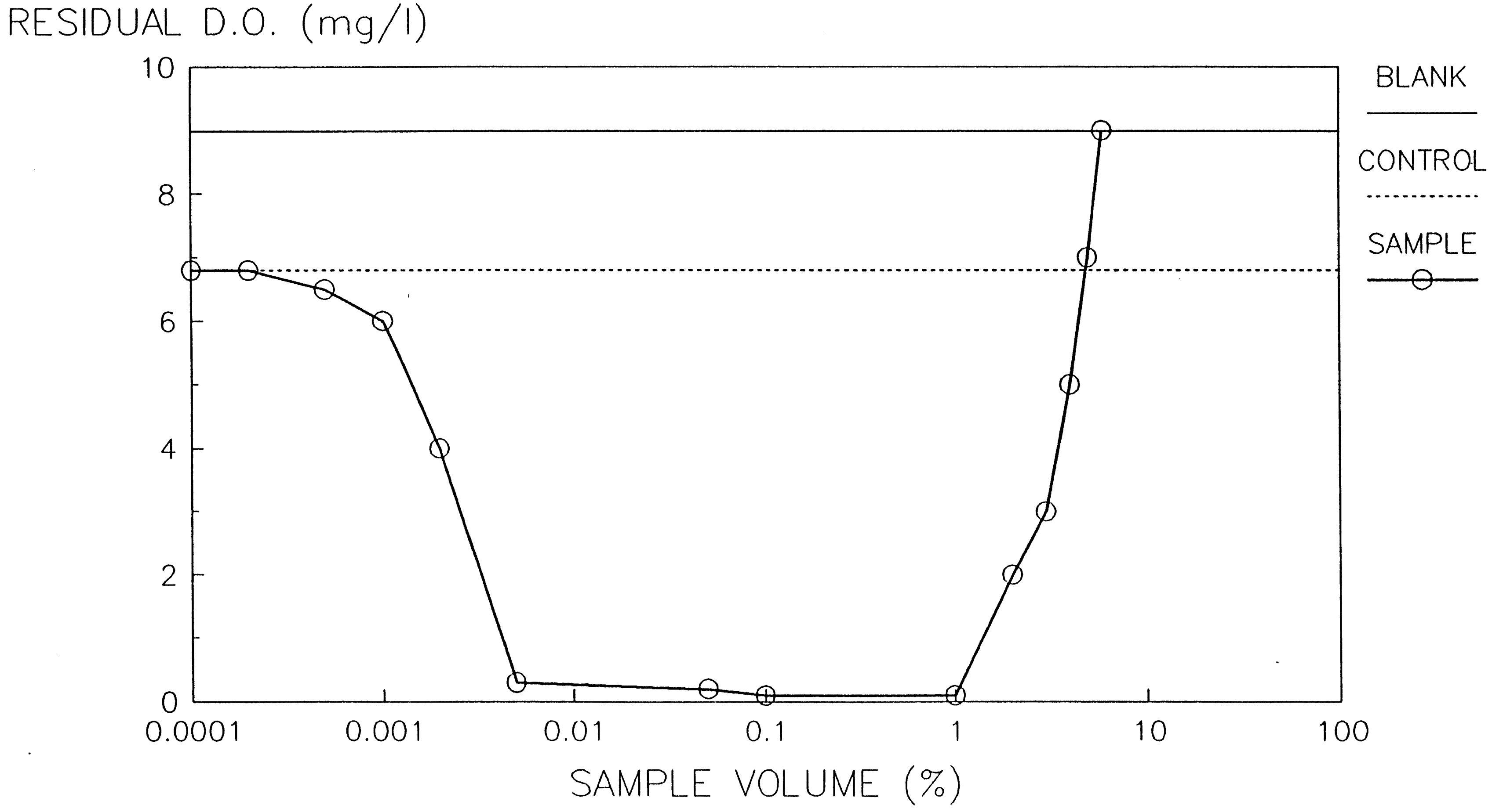
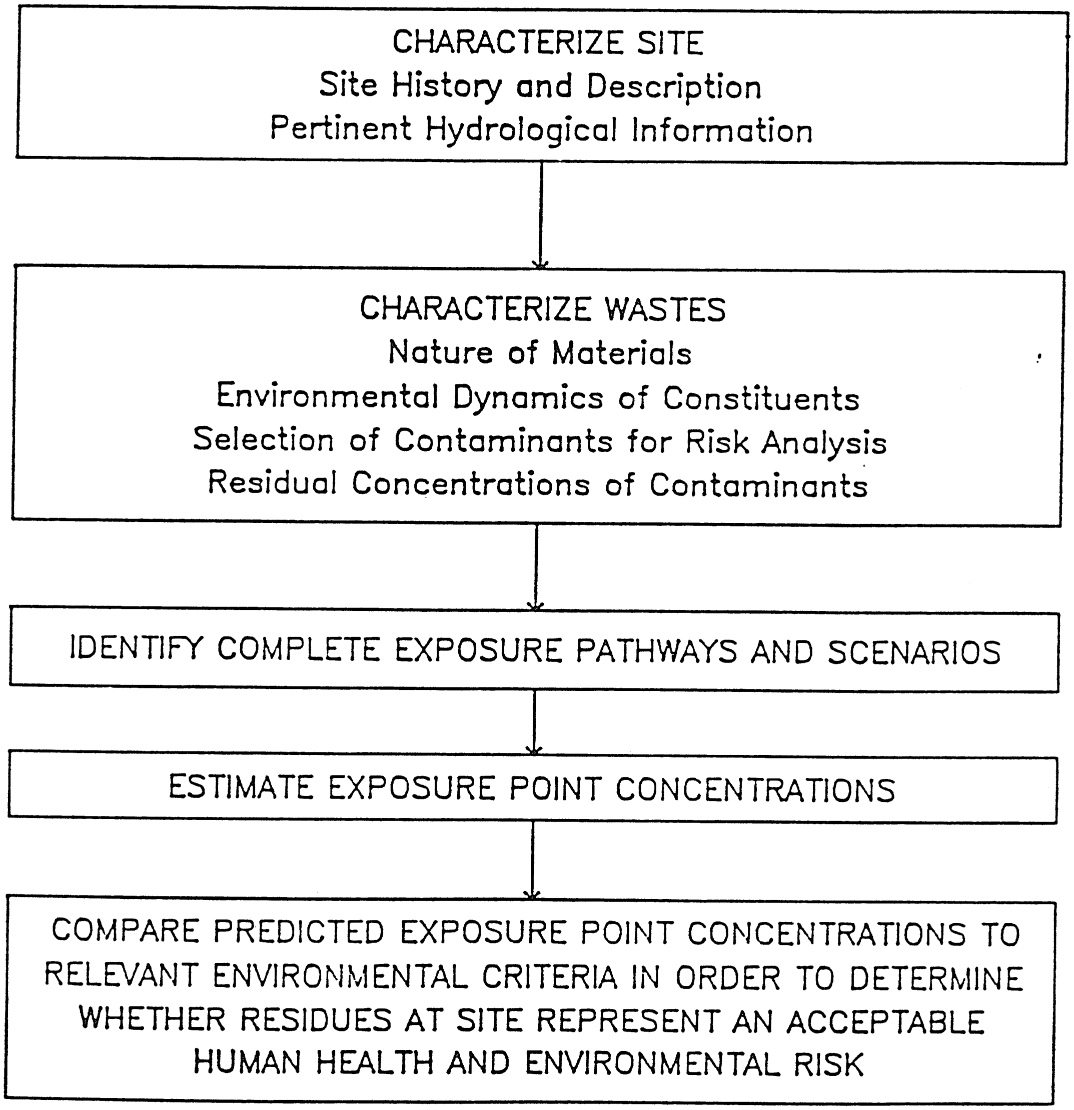


FIGURE 11

FIGURE 12

Risk Characterization Process

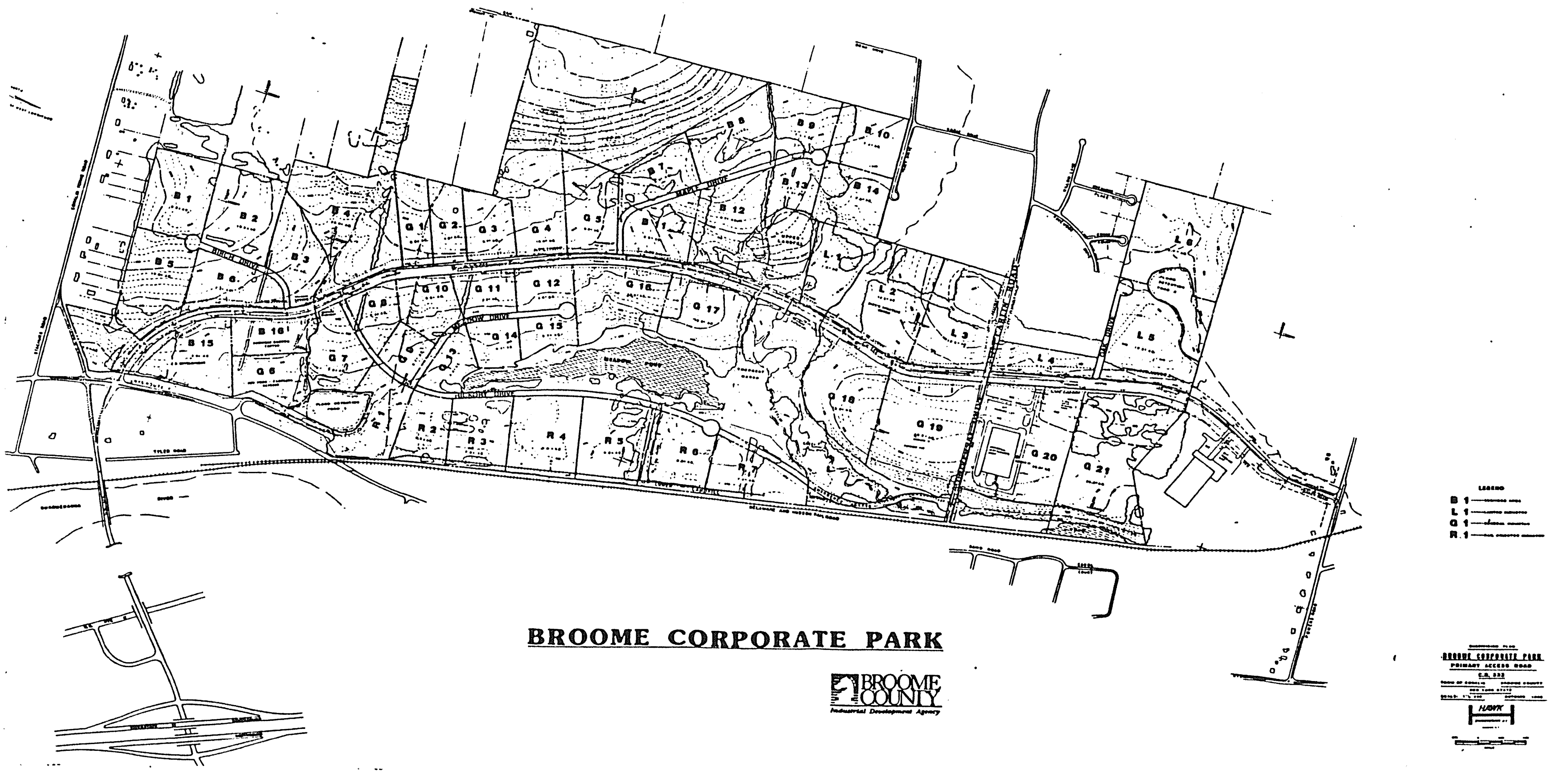


Exhibits

O'BRIEN & GERE

EXHIBIT A

EXISTING AND PROPOSED DEVELOPMENT OF BROOME INDUSTRIAL PARK



BROOME CORPORATE PARK

BROOME COUNTY

Industrial Development Agency

EXHIBIT B

NEW YORK STATE AND FEDERAL WATER QUALITY

NEW YORK STATE DEPARTMENT OF HEALTH
BUREAU OF PUBLIC WATER SUPPLY PROTECTION

JANUARY 1988 PROPOSAL FOR

STANDARDS LIMITING ORGANIC CHEMICAL CONTAMINATION IN DRINKING WATER

SUMMARY

PARAMETERS	PROPOSED (ug/l)
1. GENERAL ORGANIC CHEMICALS	
Principal Organic Contaminant (POC) POCs Include: - Halogenated Alkanes (RX); e.g. Chloromethane - Halogenated Ethers (ROR'); e.g. 2-Chloroethylvinyl ether - Halobenzenes and Substituted Halobenzenes (Aryl Halides ArX); e.g. Bromobenzene - Benzene and Alkyl- or Nitrogen-Substituted Benzenes (ArR, ArNO2, ArNH2); e.g. Nitrobenzene, Toluene - Substituted, Unsaturated Aliphatic Hydrocarbons: branched or straight-chain non-aromatic hydrocarbons which are not saturated with hydrogen, (e.g they contain double bonds); such as Dichloroethene. - Halogenated Non-aromatic Cyclic Hydrocarbons; e.g. Cyclohexane - Trihalomethanes and other organic chemicals with a specific MCL are EXCLUDED by definition from the list of POCs.	5
Unspecified Organic Chemicals (UOC) UOC = any organic chemical not covered by another MCL.	50
Total of POCs and UOCs	100
Vinyl Chloride	2
2. CHLORINATED HYDROCARBONS: PESTICIDES/HERBICIDES	
Endrin	0.2
Lindane	4
Methoxychlor	50
Toxaphene (Chlorophenoxys)	5
2,4,D	50
2,4,5-TP Silvex	10
3. TRIHALOMETHANES	
Total of Chloroform, Bromoform, Bromodichloromethane, and Dibromochloromethane	100

Notes on Chemical Abbreviations
R = alkyl group such as CH3- or CH3CH2-
R' = a second alkyl group
O = Oxygen atom
X = a halogen atom such as F, Cl, Br or I
Ar = an aromatic group such as benzene

NEW YORK STATE WATER QUALITY STANDARDS

Parameter	NYSDOH Drinking Water Standards/Maximum Contaminant Level	NYSDEC Class GA Groundwater Standards/Maximum Allowable Concentration
Arsenic (As)	.05 mg/l	.025 mg/l
Barium (Ba)	1.0 mg/l	1.0 mg/l
Cadmium (Cd)	.01 mg/l	.01 mg/l
Chloride (Cl)	250. mg/l	250. mg/l
Chromium (Cr)	.05 mg/l	.05 mg/l
Copper (Cu)	1.0 mg/l	1.0 mg/l
Cyanide (CN)	- -	.2 mg/l
Fluoride (F)	2.2 mg/l	1.5 mg/l
Foaming Agents		.5 mg/l
Iron (Fe)	.3* mg/l	.3 mg/l
Lead (Pb)	.05 mg/l	.025 mg/l
Manganese (Mn)	.3* mg/l	.3 mg/l
Mercury (Hg)	.002 mg/l	.002 mg/l
Nitrate (N)	10. mg/l	10.0 mg/l
Phenols	- -	.001 mg/l
Selenium (Se)	.01 mg/l	.02 mg/l
Silver (Ag)	.05 mg/l	.05 mg/l
Sulfate (SO_4)	250. mg/l	250. mg/l
Zinc (Zn)	5.0 mg/l	5. mg/l
pH Range	- -	6.5 - 8.5
Chlordane		.1 ug/l
Endrin	.0002 mg/l	not detectable
Heptachlor	- -	not detectable
Lindane	.004 mg/l	not detectable
Methoxychlor	.1 mg/l	35. ug/l
Toxaphene	.005 mg/l	not detectable
2,4-Dichlorophenoxyacetic Acid	.1 mg/l	4.4 ug/l
2,4,5-Trichlorophenoxyproploric Acid	.01 mg/l	.26 ug/l
Vinyl Chloride	- -	5 ug/l
Benzene	- -	not detectable
Chloroform	- -	100 ug/l
Trichloroethylene	- -	10 ug/l

*If iron and manganese are both present, the total concentration of both substances should not exceed 0.5 milligrams per liter.

NEW YORK STATE AMBIENT WATER QUALITY STANDARDS FOR SURFACE WATER
NYS DEC, April 1987

Parameter	Standard (S) or Guidance (G) Value			
	Human (AA)		Aquatic (A,B,C)	
Arsenic (As)	0.05 mg/l	(S)	0.19 mg/l *	(S)
Barium (Ba)	1.0 mg/l	(S)	-	
Cadmium (Cd)	0.01 mg/l	(S)	(1)	(S)
Chloride (Cl)	250.0 mg/l	(S)	-	
Chromium (Cr)	0.05 mg/l	(S)	(2)	(S)
Copper (Cu)	0.2 mg/l	(S)	(3)	(S)
Cyanide (CN)	0.1 mg/l	(S)	0.052 mg/l **	(S)
Fluoride (F)	1.5 mg/l	(S)	(4)	(S)
Iron (Fe)	0.3 mg/l	(S)	0.3 mg/l	(S)
Lead (Pb)	0.05 mg/l	(S)	(5)	(S)
Magnesium (Mg)	35.0 mg/l	(S)	-	
Manganese (Mn)	0.3 mg/l	(S)	-	
Mercury (Hg)	0.002 mg/l	(S)	0.2 ug/l	(G)
Nitrate as N (NO_3)	10.0 mg/l	(S)	-	
Phenols (total)	0.001 mg/l	(S)	-	
Selenium (Se)	0.01 mg/l	(S)	0.001 mg/l	(S)
Silver (Ag)	0.05 mg/l	(S)	0.1 ug/l	(S)
Sulfate (SO_4)	250.0 mg/l	(S)	-	
Zinc (Zn)	0.3 mg/l	(S)	0.03 mg/l	(S)
Chlordane	0.02 ug/l	(G)	0.002 ug/l	(G)
Endrin	0.2 ug/l	(S)	0.002 ug/l	(S)
Heptachlor	0.009 ug/l	(S)	0.001 ug/l	(S)
Methoxychlor	35 ug/l	(S)	0.03 ug/l	(S)
Toxaphene	0.01 ug/l	(G)	0.005 ug/l	(S)
Vinyl Chloride	0.3 ug/l	(G)	-	
Benzene	1.0 ug/l	(G)	6.0 ug/l	(G)
Chloroform	0.2 ug/l	(S)	-	
Trichloroethylene	3.0 ug/l	(G)	11.0 ug/l	(G)

AA = Protection for waters classified as Drinking Water Supplies

A,B,C = Protection for fresh waters classified for Fishing and Fishing Propagation

* dissolved arsenic form

** free cyanide

Hardness is the sum of magnesium and calcium concentrations expressed as mg/l $CaCO_3$

(1) exp(0.7852 [ln(ppm hardness)] - 3.49)

(2) exp(0.819 [ln(ppm hardness)] + 1.561)

(3) exp(0.8545 [ln(ppm hardness)] - 1.465)

(4) (0.02) exp(0.907 [ln(ppm hardness)] + 7.394)

(5) exp(1.266 [ln(ppm hardness)] - 4.661)

FEDERAL DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS IN WATER

	PARAMETER	ABBREV.	UNITS	MCL	MCLG	SMCL
	VOLATILES & SEMIVOLATILES					
1	1,1,1-Trichloroethane	CL3CCH3	ug/L	200	200	
4	1,1-Dichloroethane	DCETAN11	ug/L			
5	1,1-Dichloroethene	DCLEN11	ug/L	7	7	
6	1,2-Dichloroethane	DCETAN12	ug/L	5	0	
14	Benzene	BENZ	ug/L	5	0	
21	Carbon tetrachloride	CCL4	ug/L	5	0	
22	Chlorobenzene	CLOROBZ	ug/L		60	
28	Ethylbenzene	ETHBENZ	ug/L		680	
33	Styrene	STYRENE	ug/L		140	
35	t-1,2-Dichloroethene	DCLEN12	ug/L		70	
37	Tetrachloroethene	CL4C2	ug/L			
38	Toluene	TOLUENE	ug/L		2000	
	Total Trihalomethanes	TTHM	ug/L	100		
39	Total Xylenes	XYLENES	ug/L		440	
40	Trichloroethene	CL3C2H	ug/L	5	0	
43	Vinyl chloride	CH2CHCL	ug/L	2	0	
110	Pentachlorophenol	PNCLPHOL	ug/L		220 #	
	PESTICIDES/PCBs					
236	2,4-Dichlorophenoxyacid	H24-D	ug/L	100	70	
237	2,4,5-TP Silvex	H245-TP	ug/L	10	52	
134	Endrin	ENDRIN	ug/L	0.2		
137	Gamma-BHC (Lindane)	LINDANE	ug/L	4	0.2	
140	Methoxychlor	METHXYCR	ug/L	100	340	
141	Toxaphene	TXPHENE	ug/L	5		
227	Total PCB Arochlors	TPCBAR	ug/L		0	
	METALS					
160	Arsenic	AS	mg/L	0.05	0.05	
162	Barium	BA	mg/L	1	1.5	
166	Cadmium	CD	mg/L	0.01	0.005	
170	Chromium	CR	mg/L	0.05	0.12	
174	Copper	CU	mg/L		1.3	1
176	Iron	FE	mg/L			0.3
178	Lead	PB	mg/L	0.05	0.02 #	
182	Manganese	MN	mg/L			0.05
184	Mercury	HG	mg/L	0.002	0.003 #	
190	Selenium	SE	mg/L	0.01	0.045 #	
192	Silver	AG	mg/L	0.05		
202	Zinc	ZN	mg/L			5
	INDICATORS					
231	Chloride	CL	mg/L			250
216	Fluoride	F	mg/L	4	4	2
217	Nitrate Nitrogen	NO3N	mg/L	10	10	
218	Nitrite Nitrogen	NO2N	mg/L		1	
219	PH	PH	su.	6.5-8.5		6.5-8.5
233	Sulfate	SO4	mg/L	250		250
235	Total Dissolved Solids	TDS	mg/L	500		500

SMCL Secondary Maximum Contaminant Level
* Potential MCL, Federal Register - March 4, 1982
# Proposed MCLG

SELECTED PARAMETERS FROM SEPT. 1986 WQC

		Freshwater Aquatic Life		Human Health
PARAMETER	UNITS	24 Hr Avg Chronic	Max Conc. Acute	Water and Fish Consumption
VOLATILES				
1,1,1-Trichloroethane	ppb			1.84E+04
1,1,2,2-Tetrachloroethane	ppb	2,400**		1.70E-01 #
1,1,2-Trichloroethane	ppb	9,400**		6.00E-01 #
1,2-Dichloroethane	ppb	20,000**	118,000**	9.40E-01 #
Benzene	ppb		5,300**	6.60E-01 #
Carbon tetrachloride	ppb		35,200**	4.00E-01 #
Chlorinated benzenes	ppb	50**	250**	4.88E+02
Chlorinated naphthalenes	ppb		1,600**	
Chloroform	ppb	1,240**	28,900**	1.90E-01 #
Dichloroethylenes	ppb		11,600**	3.30E-02 #
Dichloropropanes	ppb	5,700**	23,000**	
Dichloropropenes	ppb	244**	6,060**	8.70E+01
Ethylbenzene	ppb		32,000**	1.40E+03
Tetrachloroethanes	ppb		9320**	
Tetrachloroethene	ppb	840**	5,280**	8.00E-01 #
Toluene	ppb		17,500**	1.43E+04
Trichloroethene	ppb	21,900**	45,000**	2.70E+00 #
Vinyl chloride	ppb			2.00E+00 #
SEMI-VOLATILES				
1,2-Diphenylhydrazine	ppb		270**	
2,4,5-Trichlorophenol	ppb			2.60E+03
2,4,6-Trichlorophenol	ppb	970**		1.20E+00 #
2,4-Dichlorophenol	ppb	365**	2,020**	3.00E+03
2,4-Dimethylphenol	ppb		2,120**	
2,4-Dinitrophenol	ppb			7.00E+01
2,4-Dinitrotoluene	ppb	230**	330**	1.10E-01 #
2-Chlorophenol	ppb	2,000**	4,380**	
3,3-Dichlorobenzidine	ppb			1.00E-02 #
Acenaphthene	ppb	520**	1,700**	
Benzidine	ppb		2,500**	1.20E-04 #
Bis (2-chloroethyl) ether	ppb			3.00E-02 #
Bis (2-chloroisopropyl) ether	ppb			3.47E+01
Bis (2-ethylhexyl) phthalate	ppb			1.50E+04
Dichlorobenzenes	ppb	763**	1,120**	4.00E+02
Di-n-butyl phthalate	ppb			3.50E+04
Diethylphthalate	ppb			3.50E+05
Dimethyl phthalate	ppb			3.13E+05
Fluoranthene	ppb		3,980**	4.20E+01
Hexachlorobenzene	ppb			7.20E-04 #
Hexachlorobutadiene	ppb	9.3**	90**	4.50E-04 #
Hexachlorocyclopentadiene	ppb	7**	5.2**	2.06E+02
Hexachloroethane	ppb	540**	980**	1.90E+00
Isophorone	ppb		117,000**	5.20E+03
N-nitrosodimethylamine	ppb			1.40E-03 #
N-nitrosodiphenylamine	ppb			4.90E+00 #

		SELECTED PARAMETERS FROM SEPT. 1986 WQC		
		Freshwater Aquatic Life		Human Health
PARAMETER	UNITS	24 Hr Avg Chronic	Max Conc. Acute	Water and Fish Consumption
Naphthalene	ppb	620**	2,300**	
Nitrobenzene	ppb		27,000**	1.98E+04
Nitrophenols	ppb	150**	230**	
Pentachlorophenol	ppb	3.2**	55**	1.01E+03
Phthalate ethers	ppb	3**	940**	
Phenol	ppb	2,560**	10,200**	3.50E+03
Polynuclear Aromatic Hydrocarbons				2.80E-03 #
PESTICIDES/PCB				
4,4'-DDT	ppb	0.001	1.1	2.40E-05 #
Aldrin	ppb	ND	3	7.40E-05 #
Alpha-BHC	ppb			9.20E-04 #
Beta-BHC	ppb			1.62E-02 #
Chlordane	ppb	0.0043**	2.4**	4.60E-04 #
Dieldrin	ppb	0.0019	2.5	7.10E-05 #
Endosulfan	ppb	0.056	0.22	7.40E+01
Endrin	ppb	0.0023	0.18	1.00E+00
Gamma-BHC (Lindane)	ppb	0.08	2	1.86E-02 #
Heptachlor	ppb	0.0038	0.52	2.80E-04 #
Polychlorinated Biphenyls	ppb	0.014	2	7.90E-05 #
Toxaphene	ppb	0.013	1.6	7.10E-04 #
METALS & OTHERS				
Antimony	ppb	1,600*	9,000*	1.46E+02
Arsenic	ppb			2.20E-03 #
Arsenic (Pent)	ppb	48**	850**	
Arsenic (Tri)	ppb	390**	360**	
Beryllium	ppb	5.3**	130**	6.80E-03 #
Cadmium	ppb	1.1*	3.9*	1.00E+01
Chromium VI	ppb	11	16	5.00E+01
Chromium III	ppb	210*	1,700*	1.70E+05
Copper	ppb	12*	18*	
Lead	ppb	3.2*	82*	5.00E+01
Mercury	ppb	0.012	2.4	1.44E-01
Nickel	ppb	96*	1,800*	1.34E+01
Selenium	ppb	35	260	1.00E+01
Silver	ppb	0.12	4.1*	5.00E+01
Thallium	ppb	40**	1,400**	1.30E+01
Zinc	ppb	47	320*	
Cyanide	ppb	5.2	22	2.00E+02

* Hardness Dependent Criterion (100 mg/l used)

** Lowest Observed Effect Level (freshwater aquatic life)

ND Insufficient data to develop criterion

Human Health Criteria for Carcinogens Reported for 10E-6 Level

EXHIBIT C

CONTAMINANT PROPERTIES

Agency
Washington DC 20460

Water

EPA

Water-Related Environmental Fate of 129 Priority Pollutants

Volume I

Introduction
Technical Background
Metals and Inorganics
Pesticides
Polychlorinated Biphenyls

EPA-440/4-79-029a
December 1979

WATER-RELATED ENVIRONMENTAL FATE OF 129 PRIORITY POLLUTANTS

Volume I:

Introduction and Technical Background, Metals and Inorganics, Pesticides and PCBs

by

Michael A. Callahan, Michael W. Slimak,
Norman W. Gabel, Ira P. May, Charles F. Fowler, J. Randall Freed,
Patricia Jennings, Robert L. Durfee, Frank C. Whitmore, Bruno Maestri,
William R. Mabey, Buford R. Holt, and Constance Gould

EPA Contract No. 68-01-3852
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Project Officer: Donald J. Ehreth
Monitoring and Data Support Division (WH-553)
Office of Water Planning and Standards
Washington, D.C. 20460

OFFICE OF WATER PLANNING AND STANDARDS
OFFICE OF WATER AND WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

6. ARSENIC

6.1 Statement of Probable Fate

The fate of arsenic in the aquatic environment depends largely on prevailing pH and Eh conditions. Arsenic is extremely mobile in the aquatic environment and cycles through the water column, sediments and biota. Although the equilibrium chemistry of arsenic has been extensively discussed in the literature, no information regarding the kinetics of arsenic reactions in the environment was found. It appears that, in most cases, the sediments and the oceans are the primary sinks for arsenic in the aquatic environment.

6.2 Identification - Geochemistry of Arsenic

Arsenic is considered to be a rare but ubiquitous element in the earth's crust. The average abundance of crustal arsenic has been established at 5 ppm (Weast 1977). Arsenic is the third member of group VB of the periodic system, which also includes nitrogen, phosphorus, antimony, and bismuth. In some of its chemical reactions, arsenic behaves much like phosphorus and antimony.

In the natural environment, four oxidation states are possible for arsenic: the-3 state, the metallic (0) state, and the +3 and +5 states. The metallic state is not uncommon for the element in certain types of mineral deposits. The +3 and +5 states are common in a variety of complex minerals and in dissolved salts in natural waters. The -3 stae is present in gaseous AsH_3 (arsine) which may form under some natural conditions. Because of its multiple oxidation states and its tendency to form soluble complexes, the geochemistry of arsaenic is intricate and not well characterized. The element most commonly associated with arsenic in nature is sulfur (Boyle and Jonasson 1973).

In all, there are 100 or more arsenic bearing minerals known to occur in nature. The principal arsenic minerals are arsenopyrite (FeAsS), niccolite (NiAs), cobaltite (CoAsS), tennantite ($Cu_{12}As_4S_{13}$), enargite (Cu_3AsS_4), native arsenic (As), orpiment (As_2S_3), realgar (AsS), prousite (Ag_3AsS_3), scorodite ($(Fe,Al)(AsO_4)\cdot 2H_2O$), bendantite ($PbFe_3(AsO_4)(SO_4)(OH)_6$), olivenite ($Cu_2AsO_4OH$), mimetite ($Pb_5(PO_4,AsO_4)_3Cl$), arsenolite ($As_2O_3$), erythrite ($Co_3(AsO_4)_2\cdot 8H_2O$), and annabergite ($Ni_3(AsO_4)_2\cdot 2H_2O$). Arsenic also occurs in minor quantities in practically all the common sulfides and in a great variety of secondary oxidation products, particularly in sulfates and phosphates (Boyle and Jonasson 1973). The generalized geochemical cycle of arsenic is shown in Figure 6-1.

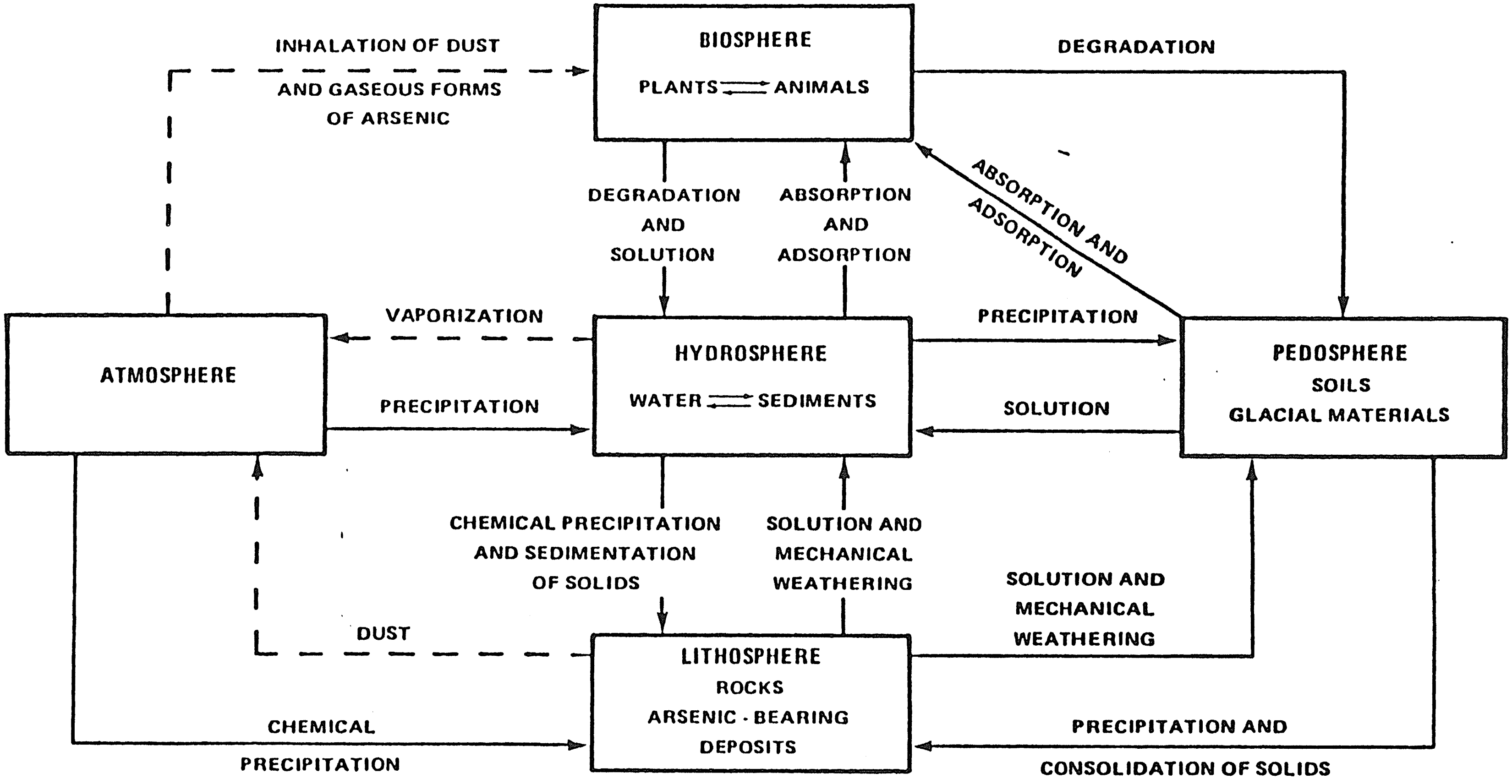


Figure 6-1 The generalized geochemical cycle of arsenic. From Boyle and Jonasson (1973).

Arsenic has no aqueous cationic chemistry other than in organic quarternary salts (Cotton and Wilkinson 1972). The oxo acids, arsenious acid (H_3AsO_3) and arsenic acid (H_3AsO_4), are the prevalent forms of arsenic in aerobic waters. Arsenic can form complexes with a number of organic compounds, most of which increase solubility.

The atomic number of arsenic is 33; its atomic weight is 74.91; density is 5.72 (20°C); melting point (28 atm.) is 817°C; and boiling point is 613°C (Weast 1977).

The CAS number of arsenic is 7440-38-2; the TSL number is A-1418-8227.

6.3 Summary of Fate Data

6.3.1 Photolysis

No evidence was found that photolysis is an important mechanism in determining the fate of arsenic compounds.

6.3.2 Chemical Speciation

In aquatic systems, arsenic has an unusually complex chemistry with oxidation-reduction, ligand exchange, precipitation, and adsorption reactions all taking place. Arsenic is stable in four oxidation states (+5, +3, 0, -3) under Eh conditions occurring in aquatic systems. Arsenic metal occurs only rarely and the -3 oxidation state is stable only at extremely low Eh values. Since the valence state of arsenic is extremely important in determining toxicity (the +3 state is much more toxic than the +5 state; National Academy of Sciences 1976) as well as complexation behavior, the chemical speciation of arsenic is very important when considering its aquatic fate.

Wagemann (1978) examined the typical concentrations of major and minor ionic constituents in freshwater systems in an attempt to find the possible controls on total dissolved arsenic in freshwater. He selected four metals (Ba, Cr, Fe, Ca) as possible controlling factors and studied their metal arsenates more closely in the laboratory. Barium ion, at typical freshwater concentrations, was the most likely freshwater constituent that would be capable of holding total dissolved arsenic to rather low concentrations. Based on these studies, an Eh-pH diagram (Figure 6-2), which summarizes theoretical arsenic speciation in freshwater environments, was developed.

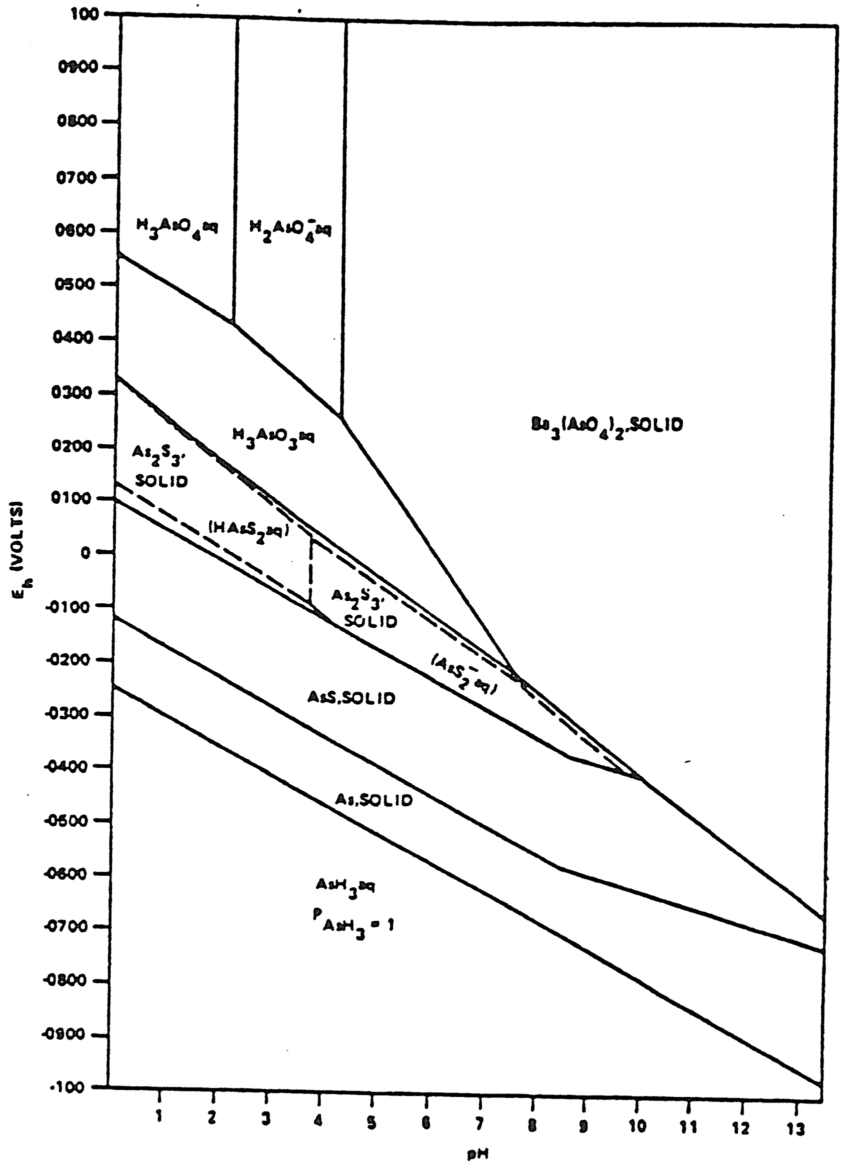


Figure 6-2 Eh-pH diagram for arsenic at 25°C and 1 atm. pressure, showing the fields of stability for the most important arsenic species in the presence of 10^{-5}M of total arsenic, 10^{-3}M of total sulfur and 2.2×10^{-7}M of total barium. Dashed lines define domains for species enclosed in parentheses. From Wagemann (1978).

Andreae (1978) analyzed seawater from the Southern California Coast and terrestrial waters from several locations in the United States for four arsenic species: arsenite, arsenate, monomethylarsonic acid, and dimethylarsinic acid. Generally, arsenate was dominant, but in waters of the photic zone, the other species were found in significant concentrations. A positive correlation was evident between the concentrations of arsenite and methylated arsenicals and biological activity. These results indicate that the speciation of arsenic in natural waters is significantly influenced by the biota. In the waters below the euphotic zone, arsenate concentrations increased with depth, suggesting regeneration from biological material. Inasmuch as arsenate is the thermodynamically stable form of arsenic under the conditions prevalent in most natural waters, the non-equilibrium species reflect the biological activity in natural waters.

These results were confirmed by the work of Waslenchuk and Windom (1978) in estuaries and Waslenchuk (1979) in rivers. Waslenchuk and Windom (1978) found that in estuaries the only detectable species was arsenate which remained in solution as fresh and salt water mixed. Complexes occurred between arsenic and low molecular weight dissolved organic matter. These complexes presumably prevented adsorptive and coprecipitative interactions with the sediments and allowed the arsenic to travel to the ocean in a dissolved form. Arsenic which enters the estuary associated with particulates, however, apparently remained so and accumulated in the sediments.

Waslenchuk (1979) found that the levels of dissolved arsenic in ivers in the southeast of the United States are controlled by the availability of arsenic, by rainwater dilution, by the extent of complexation with dissolved organic matter, and perhaps by the metabolic activity of aquatic plants. Arsenic complexation by dissolved organic matter prevents adsorptive interactions between the arsenic and solid-phase organic and inorganic materials. Despite high arsenate solubility, arsenate concentration is limited to levels below saturation, due to reactions which remove the free arsenate ion from solution. The particulate arsenic load may be as important as the dissolved load with respect to material transport in rivers. Only the dissolved load, however, is delivered to the ocean. It appears further that those biologically mediated reactions which result in arsenic species disequilibria, in the ocean and lakes, have an insignificant effect on arsenic speciation in rivers.

6.3.3 Volatilization

Volatilization of arsenic may be a significant process in extremely reducing environments where arsine (AsH_3) is formed, but under normal circumstances, it is not an important mechanism in determining the fate of arsenic after the element's introduction to the aqueous environment.

Arsine is probably oxidized rapidly in aerobic waters or the atmosphere (Parris and Brinkman 1975, 1976).

Methylated arsine derivatives may have more potential for volatilization. Trimethylarsine is quite volatile at room temperature (vapor pressure 322 torr) and is oxidized to more soluble products very slowly. Parris and Brinkman (1976) reported a rate constant of less than $10^{-2}M^{-1}s^{-1}$ for oxidation of $(CH_3)_3As$ by dissolved oxygen. In the gas phase, the rate constant for oxidation by oxygen was $10^{-6}M^{-1}s^{-1}$. Thus, trimethylarsine can travel considerable distances without undergoing chemical change, even in aerobic systems.

6.3.4 Sorption

Cycling of arsenic in the aquatic environment is dominated by adsorption and desorption to sediments. Arsenic may be sorbed onto clays, aluminum hydroxide, iron oxides, and organic material (Ferguson and Gavis 1972; Jackson et al. 1978). In areas where phosphate minerals occur, arsenate may isomorphously substitute for phosphate (Hem 1970). Under most conditions, coprecipitation or sorption of arsenic with hydrous oxides of iron is probably the prevalent process in the removal of dissolved arsenic. The oxyanions of both arsenic and arsenous acid can coprecipitate with hydrous iron and manganese oxides (Ferguson and Gavis 1972).

Gupta and Chen (1978) studied the adsorption of As(III) and As(V) onto alumina, bauxite, and carbon under various pH and salinity conditions in the laboratory. The results indicate that: (1) the rate of adsorption and the extent of arsenic removal decrease with increasing salinity; (2) pentavalent arsenic species have a greater adsorptive affinity for the materials tested than do trivalent species; (3) alumina and bauxite are much more effective adsorbents than carbon; and (4) adsorption decreases with increasing pH above pH 9 for As(III) and above pH 7 for As(V). These data show that adsorption will be most important in aerobic, acidic, fresh waters. As conditons become more reducing, alkaline, and/or saline, arsenic is less likely to be adsorbed and more likely to remain dissolved.

At Tacoma, Washington, a smelter discharges large amounts of As_2O_5 into the air and Puget Sound. Sediments near the smelter contain high levels of arsenic (up to 10,000 ppm). Surface seawater samples taken next to the smelter contained a maximum 1200 ppb arsenic. The concentration decreased very rapidly with distance to about 4 ppb within one mile. Crecelius et al. (1975) explained this phenomenon by the rapid absorption of arsenic into the sediments of Puget Sound. Crecelius (1975) estimated that for Lake Washington, which received high loadings of arsenic, approximately 55% of the arsenic entering the lake was removed to the sediments. About 60% of the arsenic in the sediments was extractable with the iron-manganese compounds, indicating that sorption or coprecipitation was the primary removal process. Of the riverine input to the lake, 65% of the arsenic was dissolved and 35% was associated with particles. Since much of the arsenic entering the lake originated from the nearby smelter and was probably chemically bound to particles which subsequently settled to the sediments, it is quite possible that in uncontaminated environments, less arsenic would be removed to the sediments and a greater proportion of the arsenic in the sediments would be associated with the extractable iron-manganese compounds.

La Peintre (1954) demonstrated that arsenate species are coprecipitated or adsorb onto hydrous iron oxide. Shnyukov (1963) observed that iron ores are always enriched with arsenic, owing to the high adsorptive capacity of the hydrous iron oxides and the fact that ferric arsenate is very insoluble. Arsenate species are adsorbed by aluminum hydroxide and by clays; however, bauxite and silicates are usually only moderately enriched in arsenic (Onishi and Sandell 1955). It appears, therefore, that adsorption of arsenic by sediments is one of the controlling mechanisms for its fate in the aquatic environment.

6.3.5 Bioaccumulation

Although arsenic is toxic, a number of studies have shown that it is bioaccumulated. Arsenic is accumulated by fish both from water and from food, but reported concentration factors for arsenic in aquatic organisms are generally quite low (Table 6-1).

Reay (1973) studied the arsenic levels in an arsenic-rich river, the Waikato (New Zealand), and related bioaccumulation of arsenic by aquatic plants to the total amount transported by the river. By estimating total production (ecological) and the amount of arsenic transported by the river, the author estimated that only 3-4% of the annual arsenic input to the river was bioaccumulated, with much of the balance being discharged to the sea and the remainder settling out with sediment at impoundments.

In a microcosm experiment, Isensee *et al.* (1973) investigated the bioaccumulation of two organic arsenicals, cacodylic acid and dimethylarsine, for a total of 32 days in a model ecosystem that contained algae, snails, daphnia, and fish. Fish exhibited the least accumulation, with a bioconcentration factor of 21 for cacodylic acid and 34 for dimethylarsine. Snails accumulated the compounds to a greater extent (the bioconcentration factor ranged from 110 to 446), and the two planktonic components concentrated arsenic the most, with bioconcentration factors ranging from 736 to

Table 6-1

Bioconcentration Factors for Arsenic

Taxon	Bioconcentration Factor[a]	Reference
Freshwater Plants	333 6000	Chapman *et al*. 1968 Reay 1973
Freshwater Invertebrates	333	Chapman *et al*. 1968
Freshwater Fish	333	Chapman *et al*. 1968
Marine Plants	333	Chapman *et al*. 1968
Marine Invertebrates	333	Chapman *et al*. 1968
Marine Fish	333	Chapman *et al*. 1968

---

a. Bioconcentration factors are the ratio derived from the concentration of the element in the aquatic organism (in ppm wet weight) divided by the concentration of the element in water (in ppm).

75. It was concluded that the arsenic compounds did not show a tendency o biomagnify (increase in concentration as trophic level increases); and after 32 days, about 30% of the original arsenic in solution was incorporated by the biota.

Sorensen (1976a) exposed green sunfish (*Lepomis cyanellus*) to various concentrations of arsenic (as sodium arsenate) in water and measured the accumulation. There appeared to be a relationship between exposure concentration and arsenic accumulation, but the data were not statistically correlated. In further experiments green sunfish were exposed to sodium arsenate under varying temperature and exposure intervals (Sorensen 1976b). Arsenic uptake by liver, gut and muscle increased with arsenic concentration in water and with temperature and exposure interval. Dead sunfish did not passively accumulate arsenic and no useful method was found for confirming arsenic-caused fish kills. Biological half-life for arsenic in gut and liver was about seven days.

Gilderhus (1966) observed the arsenic uptake by young and adult bluegills (*Lepomis marcochirus*) placed in ponds that had been treated with various concentrations of sodium arsenate as a herbicide. After sixteen weeks exposure, whole adult bluegills contained arsenic levels very similar to the concentration of arsenic remaining in the pond after that period. Immature bluegills attained arsenic concentrations nearly twice those present in adults. By the end of the experiment, 20 to 80 percent of he arsenic applied to the ponds remained in solution.

Sandhu (1977) measured arsenic content of fish and water in a pond accidentally sprayed with an arsenical herbicide. Arsenic levels in the pond reached 2.5 mg As/l; fish accumulated up to 12.4 μg As/g in muscle, representing a concentration factor of only five. Lake Michigan plankton and benthos were found to contain 6.0 and 6.6 μg As/g, respectively (Seydel 1972). Lake Superior plankton contained about 30 percent less. The arsenic concentrations present in phytoplankton and zooplankton were similar.

In general, fat contains more arsenic than other tissue fractions. Fish muscle tissue also accumulates arsenic; however, the biological half-life of arsenic is only seven days in green sunfish. Shellfish concentrate arsenic to a much greater extent than fish, and marine organisms contain more arsenic than freshwater species.

6.3.6 Biotransformation

Arsenic has been shown to undergo a number of biologically mediated transformations in aquatic environments, most of which involve methylation to derivatives of arsine (Johnson 1972; Wood 1975; Zingaro and Irgolic 1975). Arsenic forms stable bonds with sulfur and carbon in organic compounds, and it is the affinity of trivalent arsenic for sulfhydryl groups, most notably in amino acids, which accounts for the primary mode of arsenic toxicity (National Academy of Sciences 1976). Pentavalent arsenic is not reactive with sulfhydryl groups, but since some organisms are capable of reducing arsenate to arsenite, biological reduction in natural waters could cause an increase in the ratio of arsenite to arsenate (Braman and Foreback 1973).

In methylation studies, McBride and Wolfe (1971) demonstrated that Methanobacterium reduced and methylated arsenate under anaerobic conditions to dimethylarsine. A methyl donor, methylcobolamin in this case, was necessary. Cox and Alexander (1973) demonstrated that three species of fungi, found in sewage sludge, could produce trimethylarsine. Two of the fungi were able to form trimethylarsine from mono- or dimethylarsine, while the third was able to produce trimethylarsine from arsenite and arsenate as well. In general, more trimethylarsine was produced in acidic media than under neutral conditions. The methylarsines can be produced by a number of yeasts, bacteria, and fungi. This literature has been reviewed by Ferguson and Gavis (1972) and Woolson (1977).

The biological function of the methylation of arsenic is not known, but Braman and Foreback (1973) speculate that methylation may be a detoxification mechanism since most of the organic metabolites are considerably less toxic than arsenite. Alternatively, methylation of arsenic could be purely adventitious. In an anaerobic environment, it may be energetically preferable for organisms to transmethylate metals rather than to synthesize methane. Only aerobic metabolism has been found to yield methylarsines and methylation may occur in the aerobic upper layer of the sediment. The probable mobility of methylarsines from the sediments to solution and to the aquatic food chain plus the increased anthropogenic discharges of arsenic could bring about ever increasing arsenic concentrations in the aquatic environment. This cyclic behavior of arsenic in biological systems has been summarized in Figure 6-3.

6.4 Data Summary

Arsenic is extremely mobile in the aquatic environment. Although a number of studies have described the equilibrium chemistry of arsenic, the rates of most of these reactions are unknown. It is evident that once in the aquatic system, arsenic cycles through several components, i.e., the water column, the sediments, the biota, and the atmosphere. Figure 6-4 summarizes this cyclical nature of arsenic.

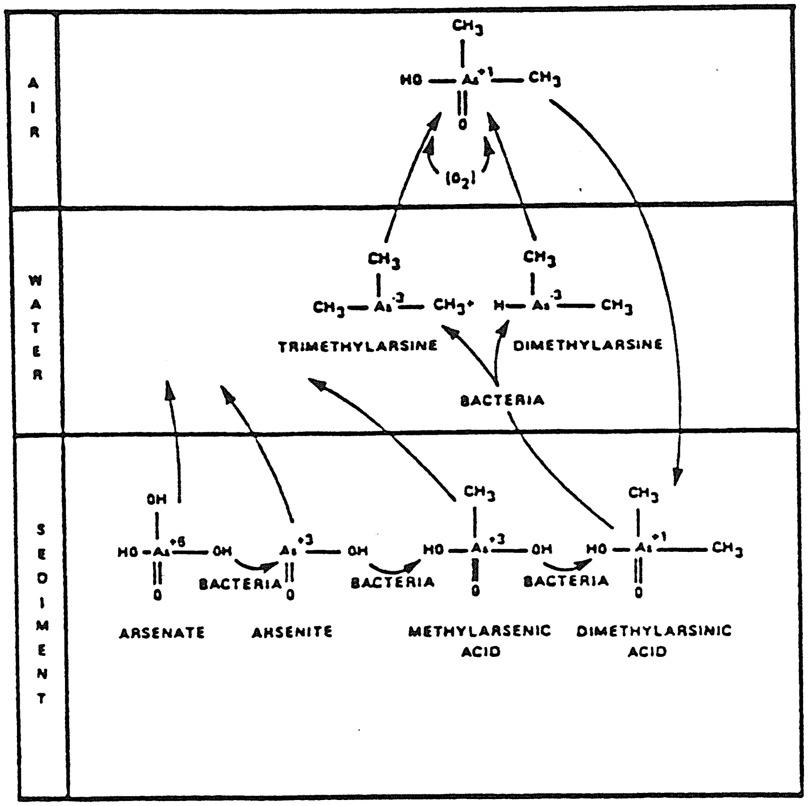
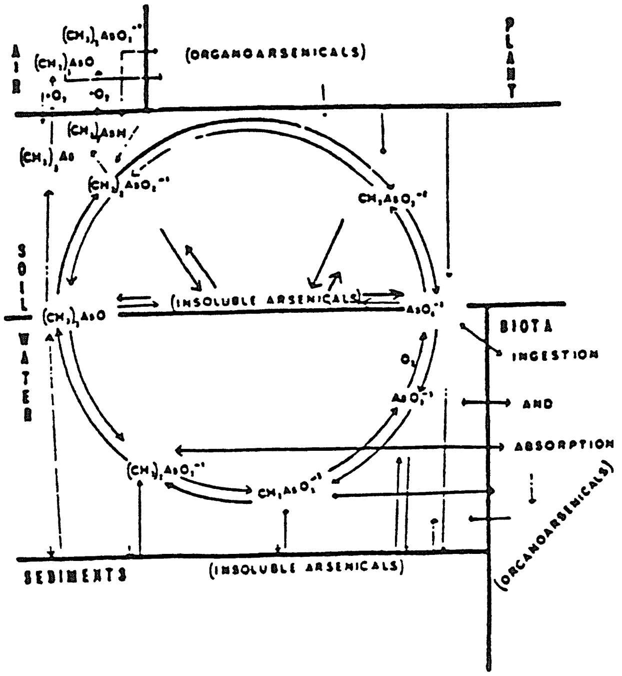


Figure 6-3 The biologic arsenic cycle in the aquatic environment. From Wood (1975).



5-4 Cycle of arsenic through different environmental compartments. From Woolson (1977).

Obviously, the fate of arsenic in the aquatic environment is a complex problem, depending on a number of factors including Eh, pH, metal sulfide and sulfide ion concentrations, presence of phosphorus minerals, iron concentration, temperature, salinity, and distribution and composition of the biota. It appears that, in most cases, the sediment is the major sink for arsenic, but that mobilization by bacteria and other benthic organisms returns much of this arsenic to the cycle. Much, if not most, of the arsenic introduced to the aquatic ecosystem is eventually transported in solution to the oceans. Table 6-2 summarizes the aquatic fate of arsenic.

Table 6-2

Summary of Aquatic Fate of Arsenic

Environmental Process	Summary Statement	Confidence of Data
Photolysis	Not an important process.	Medium
Chemical Speciation[a]	Important in determining arsenic distribution and mobility. Interconversions of +3 and +5 state and organic complexation are most important.	High
Volatilization[a]	Important when biological activity or highly reducing conditions produce AsH_3 or methylarsenics.	High
Sorption[a]	Sorption onto clays, iron oxides, and organic material are a controlling mechanism for the fate of arsenic in the aquatic environment.	High
Bioaccumulation[a]	Appears to be most significant in lower trophic levels. High toxicity lowers overall accumulation by aquatic organisms.	Medium
Biotransformation[a]	Arsenic is metabolized by a number of organisms to organic arsenicals, thereby increasing arsenic mobility in the environment.	High

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a. All of the noted environmental processes are important; however, their relative importance with respect to each other is uncertain for determining final fate.

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ARSENIC

Summary

Arsenic is a metal that is present in the environment as a constituent of organic and inorganic compounds; it also occurs in a number of valence states. Arsenic is generally rather mobile in the natural environment, with the degree of mobility dependent on its chemical form and the properties of the surrounding medium. Arsenic is a human carcinogen; it causes skin tumors when it is ingested and lung tumors when it is inhaled. Arsenic compounds are teratogenic and have adverse reproductive effects in animals. Chronic exposure to arsenic is associated with polyneuropathy and skin lesions. It is acutely toxic to some early life stages of aquatic organisms at levels as low as 40 µg/liter. The EPA Ambient Water Quality Criterion for the protection of human health corresponding to an excess cancer risk of 10^{-6} is 2.2 ng/liter. The criteria for the protection of aquatic life after acute exposure are 440 µg/liter for freshwater species and 508 µg/liter for saltwater species.

Background Information

Arsenic can be found in the environment in any of four valence states (-3, 0, +3, and +5) depending on the pH, Eh, and other factors. It can exist as either inorganic or organic compounds and often will change forms as it moves through the various media. The chemical and physical properties depend on the state of the metalloid. Only the properties of metallic arsenic have been listed; properties of other arsenic compounds are often quite different.

CAS Number: 7440-38-2

Chemical Formula: As

IUPAC Name: Arsenic

Chemical and Physical Properties

Atomic Weight: 74.91

Boiling Point: 613°C

Melting Point: 817°C

Specific Gravity: 5.72 at 20°C

Solubility in Water: Insoluble; some salts are soluble

Transport and Fate

In the natural environment, arsenic has four different oxidation states, and chemical speciation is important in determining arsenic's distribution and mobility. Interconversions of the +3 and +5 states as well as organic complexation, are the most important. Arsenic is generally quite mobile in the environment. In the aquatic environment, volatilization is important when biological activity or highly reducing conditions produce arsine or methylarsenics. Sorption by the sediment is an important fate for the chemical. Arsenic is metabolized to organic arsenicals by a number of organisms; this increases arsenic's mobility in the environment. Because of its general mobility, arsenic tends to cycle through the environment. Its ultimate fate is probably the deep ocean, but it may pass through numerous stages before finally reaching the sea.

Health Effects

Arsenic has been implicated in the production of skin cancer in humans. There is also extensive evidence that inhalation of arsenic compounds causes lung cancer in workers. Arsenic compounds cause chromosome damage in animals, and humans exposed to arsenic compounds have been reported to have an elevated incidence of chromosome aberrations. Arsenic compounds have been reported to be teratogenic, fetotoxic, and embryotoxic in several animal species, and an increased incidence of multiple malformations among children born to women occupationally exposed to arsenic has been reported. Arsenic compounds also cause noncancerous, possibly precancerous, skin changes in exposed individuals. Several cases of progressive polyneuropathy involving motor and sensory nerves and particularly affecting the extremities and myelinated long-axon neurons have been reported in individuals occupationally exposed to inorganic arsenic. Polyneuropathies have also been reported after the ingestion of arsenic-contaminated foods.

Toxicity to Wildlife and Domestic Animals

Various inorganic forms of arsenic appear to have similar levels of toxicity; they all seem to be much more toxic than organic forms. Acute toxicity to adult freshwater animals occurs at levels of arsenic trioxide as low as 812 μg/liter and at levels as low as 40 μg/liter in early life stages of aquatic organisms. Acute toxicity to saltwater fish occurs at levels around 15 mg/liter, while some invertebrates are affected at much lower levels (508 μg/liter). Arsenic toxicity does not appear to increase greatly with chronic exposure, and it does not seem that arsenic is bioconcentrated to a great degree.

Arsenic poisoning is a rare but not uncommon toxic syndrome among domestic animals. Arsenic causes hyperemia and edema of the gastrointestinal tract, hemorrhage of the cardiac serosal surfaces and peritoneum, and pulmonary congestion and edema; and it may cause liver necrosis. Information on arsenic toxicity to terrestrial wildlife was not reported in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

Freshwater

Acute toxicity: 440 μg/liter
Chronic toxicity: No available data

Saltwater

Acute toxicity: 508 μg/liter
Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of arsenic in water are:

Risk	Concentration
10^{-5}	22 ng/liter
10^{-6}	2.2 ng/liter
10^{-7}	0.22 ng/liter

CAG Unit Risk (USEPA): 15 $(mg/kg/day)^{-1}$

National Interim Primary Drinking Water Standard (USEPA): 50 μg/liter

NIOSH Recommended Standard (air): 2 $\mu g/m^3$ Ceiling Level

OSHA Standard (air): 500 $\mu g/m^3$ TWA

ACGIH Threshold Limit Value: 200 $\mu g/m^3$ (soluble compounds, as As)

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BENZENE

Summary

Benzene is an important industrial solvent and chemical intermediate. It is rather volatile, and atmospheric photooxidation is probably an important fate process. Benzene is a known human carcinogen, causing leukemia in exposed individuals. It also adversely affects the hematopoietic system. Benzene has been shown to be fetotoxic and to cause embryolethality in experimental animals. Exposure to high concentrations of benzene in the air causes central nervous system depression and cardiovascular effects, and dermal exposure may cause dermatitis. The EPA Ambient Water Quality Criterion for the protection of human health corresponding to an excess cancer risk of 10^{-6} is 0.66 µg/liter.

CAS Number: 71-43-2

IUPAC Name: Benzene

Chemical Formula: C_6H_6

Chemical and Physical Properties

Molecular Weight: 78.12

Boiling Point: 80.1°C

Melting Point: 5.56°C

Specific Gravity: 0.879 at 20°C

Solubility in Water: 1,780 mg/liter at 25°C

Solubility in Organics: Miscible with ethanol, ether, acetic acid, acetone, chloroform, carbon disulfide, and carbon tetrachloride

Log Octanol/Water Partition Coefficient: 1.95-2.13

Vapor Pressure: 75 mm Hg at 20°C

Vapor Density: 2.77

Flash Point: -11.1°C

Transport and Fate

Volatilization appears to be the major transport process of benzene from surface waters to the ambient air, and atmospheric transport of benzene readily occurs. Although direct oxidation of benzene in environmental waters is unlikely, cloud chamber data indicate that it may be photooxidized rapidly in the atmosphere. Inasmuch as volatilization is likely to be the main transport process accounting for the removal of benzene from water, the atmospheric destruction of benzene is probably the most likely fate process. Values for benzene's log octanol/water partition coefficient indicate that adsorption onto organic material may be significant under conditions of constant exposure. Sorption processes are likely removal mechanisms in both surface water and groundwater. Although the bioaccumulation potential for benzene appears to be low, gradual biodegradation by a variety of microorganisms probably occurs. The rate of benzene biodegradation may be enhanced by the presence of other hydrocarbons.

Health Effects

Benzene is a recognized human carcinogen. Several epidemiologic studies provide sufficient evidence of a causal relationship between benzene exposure and leukemia in humans. Benzene is also a known inducer of aplastic anemia in humans, with a latent period of up to ten years. It also produces leukopenia and thrombocytopenia, which may progress to pancytopenia. Similar adverse effects on the blood cell producing system occur in animals exposed to benzene. In both humans and animals, benzene exposure is associated with chromosomal damage, although it is not mutagenic in microorganisms. Benzene was fetotoxic and caused embryolethality in experimental animal.

Exposure to very high concentrations of benzene [about 20,000 ppm (66,000 mg/m^3) in air] can be fatal within minutes. The prominent signs are central nervous system depression and convulsions, with death usually following as a consequence of cardiovascular collapse. Milder exposures can produce vertigo, drowsiness, headache, nausea, and eventually unconsciousness if exposure continues. Deaths from cardiac sensitization and cardiac arrhythmias have also been reported after exposure to unknown concentrations. Although most benzene hazards are associated with inhalation exposure, dermal absorption of liquid benzene may occur, and prolonged or repeated skin contact may produce blistering, erythema, and a dry, scaly dermatitis.

Toxicity to Wildlife and Domestic Animals

The EC_{50} values for benzene in a variety of invertebrate and vertebrate freshwater aquatic species range from 5,300 μg/liter to 386,000 μg/liter. However, only values for the rainbow trout (5,300 μg/liter) were obtained from a flow through test and were based on measured concentrations. Results based on unmeasured concentrations in static tests are likely to underestimate toxicity for relatively volatile compounds like benzene. A chronic test with *Daphnia magna* was incomplete, with no adverse effects observed at test concentrations as high as 98,000 μg/liter.

For saltwater species, acute values for one fish and five invertebrate species range from 10,900 μg/liter to 924,000 μg/liter. Freshwater and saltwater plant species that have been studied exhibit toxic effects at benzene concentrations ranging from 20,000 μg/liter to 525,000 μg/liter.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report the lowest concentrations of benzene known to cause toxic effects in aquatic organisms.

Freshwater

Acute toxicity: 5,300 μg/liter
Chronic toxicity: No available data

Saltwater

Acute toxicity: 5,100 μg/liter
Chronic toxicity: No available data

Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of benzene in water are:

Risk	Concentration
10^{-5}	6.6 μg/liter
10^{-6}	0.66 μg/liter
10^{-7}	0.066 μg/liter

CAG Unit Risk (USEPA): 5.2×10^{-2} $(mg/kg/day)^{-1}$

OSHA Standards: 30 mg/m^3 TWA
75 mg/m^3 Ceiling Level
150 mg/m^3/10 min Peak Concentration

ACGIH Threshold Limit Values: Suspected human carcinogen
30 mg/m^3 TWA
75 mg/m^3 STEL

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CHLOROETHANE

Summary

Chloroethane is used as a solvent, as a refrigerant, and as a raw material in the manufacture of tetraethyl lead. It is fairly volatile in the environment. Chloroethane caused headaches and dizziness in workers exposed to high levels. It causes kidney damage and liver changes in chronically exposed animals.

CAS Number: 75-00-3

Chemical Formula: C_2H_5Cl

IUPAC Name: Chloroethane

Important Synonyms and Trade Names: Ethyl chloride, monochloroethane

Chemical and Physical Properties

Molecular Weight: 64.52

Boiling Point: 12.3°C

Melting Point: -136.4°C

Specific Gravity: 0.8978 at 20°C

Solubility in Water: 5740 mg/liter at 20°C

Solubility in Organics: Soluble in alcohol and ether

Log Octanol/Water Partition Coefficient: 1.54

Vapor Pressure: 1,000 mm Hg at 20°C

Vapor Density: 2.23

Transport and Fate

Chloroethane is probably not very persistent in the environment. It volatilizes rapidly from water; once in the atmosphere, it is photooxidized, and formyl chloride is the initial oxidation product. Hydrolysis may also occur in surface water or in moist soil. Biodegradation, sorption, and bioaccumulation probably are not important fate processes for chloroethane.

Health Effects

Chloroethane is presently being tested by the National Toxicology Program (NTP) for carcinogenicity and genetic toxicity. No information evaluating its reproductive toxicity or teratogenicity was found. Chloroethane caused minor neurological effects (e.g., headache, dizziness) in workers exposed to high levels. In animals, chronic exposure to chloroethane caused kidney damage and fatty changes in the liver, and at high levels upset cardiac rhythm. Monochloroethane is considered to be the least toxic of the chlorinated ethanes.

Toxicity to Wildlife and Domestic Animals

No information was found on the toxicity of chloroethane to wildlife or domestic animals. The toxicity of other chlorinated ethanes to aquatic organisms generally declines with decreasing chlorine content. Therefore, chloroethane is probably less toxic than 1,2-dichloroethane, which causes acute toxicity at about 120 mg/liter and chronic toxicity at 20 mg/liter.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data were not adequate for establishing criteria.

OSHA Standard (air): 2,600 mg/m^3 TWA

ACGIH Threshold Limit Values:	2,600 mg/m^3 TWA
	3,250 mg/m^3 STEL

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1,1-DICHLOROETHANE

Summary

1,1-Dichloroethane is quite volatile and probably is not very persistent in aquatic environments. Inhalation exposure to high doses causes central nervous system depression in humans and may cause hepatotoxicity. In animals, high doses cause liver and kidney damage and retard fetal development.

CAS Number: 75-34-3

Chemical Formula: CH_3CHCl_2

IUPAC Name: 1,1-Dichloroethane

Important Synonyms and Trade Names: Ethylidene chloride, ethylidene dichloride

Chemical and Physical Properties

Molecular Weight: 98.96

Boiling Point: 57.3°C

Melting Point: -97.0°C

Specific Gravity: 1.1776 at 20°C

Solubility in Water: 5 g/liter

Solubility in Organics: Miscible in alcohol

Log Octanol/Water Partition Coefficient: 1.79

Vapor Pressure: 180 mm Hg at 20°C

Transport and Fate

1,1-Dichloroethane disperses from surface water primarily by volatilization into the troposphere, where it is subsequently broken down by hydroxylation. No studies on adsorption were found in the literature reviewed, but because of its water solubility and relatively low log octanol/water partition coefficient, 1,1-dichloroethane potentially could move through soil and enter the groundwater.

Health Effects

Limited toxicological testing of 1,1-dichloroethane has been conducted, although the literature indicates that 1,1-dichloroethane is one of the least toxic of the chlorinated ethanes. An NCI bioassay on 1,1-dichloroethane was limited by poor survival of test animals of test animals, but some marginal tumorigenic effects were seen. Inhalation exposure to high doses of 1,1-dichloroethane (over 16,000 mg/m^3) caused retarded fetal development in rats (Schwetz et al. 1974). 1,1-Dichloroethane was not found to be mutagenic using the Ames assay. 1,1-Dichloroethane causes central nervous system depression when inhaled at high concentrations, and evidence suggests that the compound is hepatotoxic in humans. Kidney and liver damage was seen in animals exposed to high levels of 1,1-dichloroethane. The oral LD_{50} value in the rat is 725 mg/kg.

Toxicity to Wildlife and Domestic Animals

No information on the toxicity of 1,1-dichloroethane to aquatic species was reported in the literature reviewed. However, the available information on the chloroethanes indicates that toxicity declines with decreases in chlorination and that the 1,1,1-isomer is less active than the 1,1,2-isomer. Therefore 1,1-dichloroethane is probably no more toxic than 1,2-dichloroethane, which is acutely toxic at levels of 100-500 mg/liter and has a chronic toxicity beginning at about 20 mg/liter.

No information on the toxicity of 1,1-dichloroethane to terrestrial wildlife or domestic animals was found in the sources reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

The available data were inadequate for establishing criteria.

OSHA Standard (air): 400 mg/m^3 TWA

ACGIH Threshold Limit Value: 810 mg/m^3 TWA

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ETHYLBENZENE

Summary

There is some evidence suggesting that ethylbenzene causes adverse reproductive effects in animals. Oral and inhalation exposure caused minor liver and kidney changes in rats. Ethylbenzene is a skin and eye irritant. The EPA Ambient Water Quality Criterion for the protection of human health is 1.4 mg/liter.

CAS Number: 100-41-4

Chemical Formula: $C_6H_5C_2H_5$

IUPAC Name: Ethylbenzene

Important Synonyms and Trade Names: Phenylethane, EB, ethylbenzol

Chemical and Physical Properties

Molecular Weight: 106.2

Boiling Point: 136.2°C

Melting Point: -95°C

Specific Gravity: 0.867 at 20°C (liquid)

Solubility in Water: 161 mg/liter at 25°C

Solubility in Organics: Freely soluble in organic solvents

Log Octanol/Water Partition Coefficient: 3.15

Vapor Pressure: 7 mm Hg at 20°C

Vapor Density: 3.66

Henry's Law Constant: 6.44 atm. m^3/mole

Flash Point: 17.2°C

Transport and Fate

Only limited data are available on the transport and fate of ethylbenzene. Volatilization is probably the major route of elimination from surface water. Subsequent atmospheric reactions, especially photooxidation, are responsible for its fate. However, its high log octanol/water partition coefficient suggests that a significant amount of ethylbenzene may be adsorbed by organic material in the sediment. Some soil bacteria are capable of using ethylbenzene as a source of carbon. However, the relative importance of this potential route of ethylbenzene elimination has not been determined.

Health Effects

Ethylbenzene has been selected by the National Toxicology Program to be tested for possible carcinogenicity, although negative results were obtained in mutagenicity assays in *Salmonella typhimurium* and *Saccharomyces cerevisiae*. There is recent animal evidence that ethylbenzene causes adverse reproductive effects. Ethylbenzene is a skin irritant, and its vapor is irritating to the eyes at a concentration of 200 ppm (870 mg/m^3) and above. When experimental animals were exposed to ethylbenzene by inhalation, 7 hours/day for 6 months, adverse effects were produced at concentrations of 600 ppm (2,610 mg/m^3) and above, but not at 400 ppm (1,740 mg/m^3). At 600 ppm rats and guinea pigs showed slight changes in liver and kidney weights, monkeys had slight changes in liver weight, and monkeys and rabbits experienced histopathologic changes in the testes. Similar effects on the liver and kidney were observed in rats fed ethylbenzene at 408 and 680 mg/kg/day for 6 months.

Toxicity to Wildlife and Domestic Animals

Ethylbenzene was acutely toxic to freshwater species at levels greater than 32 mg/liter. No chronic toxicity was reported, but the highest test dose (440 μg/liter) was only one-hundredth of the 96-hour LC_{50} for the particular species being tested. No studies on the bioaccumulation of ethylbenzene were reported in the information reviewed, but a bioconcentration factor of 95 was calculated using the log octanol/water partition coefficient. No information on the toxicity of ethylbenzene to domestic animals and terrestrial wildlife was found in the sources reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing final criteria. However, EPA did report the lowest values known to have toxic effects in aquatic organisms.

Freshwater

Acute toxicity: 32,000 μg/liter
Chronic toxicity: No available data

Saltwater

Acute toxicity: 430 μg/liter
Chronic toxicity: No available data

Human Health

Criterion: 1.4 mg/liter

OSHA Standard (skin): 435 mg/m^3 TWA

ACGIH Threshold Limit Values: 435 mg/m^3 TWA
545 mg/m^3 STEL

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METHYLENE CHLORIDE

Summary

Methylene chloride increased the incidence of lung and liver tumors and sarcomas in rats and mice. It was found to be mutagenic in bacterial test systems. In humans, methylene chloride irritates the eyes, mucous membranes, and skin. Exposure to high levels adversely affects the central and peripheral nervous systems and the heart. In experimental animals, methylene chloride is reported to cause kidney and liver damage, convulsions, and paresis. The EPA Ambient Water Quality Criterion for the protection of human health based solely on noncarcinogenic effects is 12.4 mg/liter.

CAS Number: 75-09-2

Chemical Formula: CH_2Cl_2

IUPAC Name: Dichloromethane

Important Synonyms and Trade Names: Methylene dichloride, methane dichloride

Chemical and Physical Properties

Molecular Weight: 84.93

Boiling Point: 40°C

Melting Point: -95.1°C

Specific Gravity: 1.3266 at 20°C

Solubility in Water: 13,200-20,000 mg/liter at 25°C

Solubility in Organics: Miscible with alcohol and ether

Log Octanol/Water Partition Coefficient: 1.25

Vapor Pressure: 362.4 mm Hg at 20°C

Vapor Density: 2.93

Transport and Fate

Volatilization to the atmosphere appears to be the major mechanism for removal of methylene chloride from aquatic systems and its primary environmental transport process. Photooxidation in the troposphere appears to be the dominant environmental fate of methylene chloride. Once in the troposphere, the compound is attacked by hydroxyl radicals, resulting in the formation of carbon dioxide, and to a lesser extent, carbon monoxide and phosgene. Phosgene is readily hydrolyzed to HCl and CO_2. About one percent of tropospheric methylene chloride would be expected to reach the stratosphere where it would probably undergo photodissociation resulting from interaction with high energy ultraviolet radiation. Aerial transport of methylene chloride is partly responsible for its relatively wide environmental distribution. Atmospheric methylene chloride may be returned to the earth in precipitation.

Photolysis, oxidation, and hydrolysis do not appear to be significant environmental fate processes for methylene chloride, and there is no evidence to suggest that either adsorption or bioaccumulation are important fate processes for this chemical. Although methylene chloride is potentially biodegradable, especially by acclimatized microorganisms, biodegradation probably only occurs at a very slow rate.

Health Effects

Methylene chloride is currently under review by the National Toxicology Program (NTP 1984). Preliminary results indicate that it produced an increased incidence of lung and liver tumors in mice and mammary tumors in female and male rats. In a chronic inhalation study, male rats exhibited an increased incidence of sarcomas in the ventral neck region (Burek et al. 1984). However, the authors suggested that the relevance and toxicological significance of this finding were uncertain in light of available toxicity data. Methylene chloride is reported to be mutagenic in bacterial test systems. It also has produced positive results in the Fischer rat embryo cell transformation test. However, it has been suggested that the observed cell-transforming capability may have been due to impurities in the test material. There is no conclusive evidence that methylene chloride can produce teratogenic effects.

In humans, direct contact with methylene chloride produces eye, respiratory passage, and skin irritation. Mild poisonings due to inhalation exposure produce somnolence, lassitude, numbness and tingling of the limbs, anorexia, and lightheadedness, followed by rapid and complete recovery. More severe poisonings generally involve correspondingly greater disturbances of the central and peripheral nervous systems. Methylene chloride also has acute toxic effects on the heart, including the induction of arrhythmia. Fatalities reportedly due to methylene chloride exposure have been attributed to cardiac injury and heart failure. Methylene chloride is metabolized to carbon monoxide in vivo, and levels of carboxyhemoglobin in the blood are elevated after acute exposures. In experimental animals, methylene chloride is reported to cause kidney and liver damage, convulsions, and distal paresis. An oral LD_{50} value of 2,136 mg/kg, and an inhalation LC_{50} value of 88,000 $mg/m^3/30$ min are reported for the rat.

Toxicity to Wildlife and Domestic Animals

Very little information concerning the toxicity of methylene chloride to domestic animals and wildlife exists. Acute values for the freshwater species Daphnia magna, the fathead minnow, and the bluegill are 224,000, 193,000, and 224,000 µg/liter, respectively. Acute values for the saltwater species, mysid shrimp and sheepshead minnow, are 256,000 and 331,000 µg/liter, respectively. No data concerning chronic toxicity are available. The 96-hour EC_{50} values for both freshwater and saltwater algae are greater than the highest test concentration, 662,000 µg/liter.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria.

Human Health

Criterion: 12.4 mg/liter (for protection against the noncarcinogenic effects of methylene chloride)

CAG Unit Risk (USEPA): $6.3 \times 10^{-4} (mg/kg/day)^{-1}$

NIOSH Recommended Standards:

261 mg/m^3 TWA in the presence of no more than 9.9 mg/m^3 of CO
1,737 mg/m^3/15 min Peak Concentration

OSHA Standards: 1,737 mg/m^3 TWA
3,474 mg/m^3 Ceiling Level
6,948 mg/m^3 Peak Concentration (5 min in any 3 hr)

ACGIH Threshold Limit Values: 350 mg/m^3 TWA
1,740 mg/m^3 STEL

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TOLUENE

Summary

Toluene has been shown to be embryotoxic in experimental animals, and the incidence of cleft palate was increased in the offspring of dosed mice. Chronic inhalation exposure to high levels of toluene caused cerebellar degeneration and an irreversible encephalopathy in animals. In humans, acute exposure depressed the central nervous system and caused narcosis. The EPA Ambient Water Quality Criterion for the protection of human health is 14.3 mg/liter.

CAS Number: 108-88-3

Chemical Formula: $C_6H_5CH_3$

IUPAC Name: Methylbenzene

Important Synonyms and Trade Names: Toluol, phenylmethane

Chemical and Physical Properties

Molecular Weight: 92.13

Boiling Point: 110.6°C

Melting Point: -95°C

Specific Gravity: 0.8669 at 20°C

Solubility in Water: 534.8 mg/liter

Solubility in Organics: Soluble in acetone, ligroin, and carbon disulfide; miscible with alcohol, ether, benzene, chloroform, glacial acetic acid, and other organic solvents

Log Octanol/Water Partition Coefficient: 2.69

Vapor Pressure: 28.7 mm Hg at 25°C

Vapor Density: 3.14

Flash Point: 4.4°C

Transport and Fate

Volatilization appears to be the major route of removal of toluene from aquatic environments, and atmospheric reactions of toluene probably subordinate all other fate processes. Photooxidation is the primary atmospheric fate process for toluene, and benzaldehyde is reported to be the principal organic product. Subsequent precipitation or dry deposition can deposit toluene and its oxidation products into aquatic and terrestrial systems. Direct photolytic cleavage of toluene is energetically improbable in the troposphere, and oxidation and hydrolysis are probably not important as aquatic fates.

The log octanol/water partition coefficient of toluene indicates that sorption processes may be significant. However, no specific environmental sorption studies are available and the extent to which adsorption by sedimentary and suspended organic material may interfere with volatilization is unknown. Bioaccumulation is probably not an important environmental fate process. Although toluene is known to be degraded by microorganisms, and can be detoxified and excreted by mammals, the available data do not allow estimation of the relative importance of biodegradation/biotransformation processes. Almost all toluene discharged to the environment by industry is in the form of atmospheric emissions.

Health Effects

There is no conclusive evidence that toluene is carcinogenic or mutagenic in animals or humans. The National Toxicological Program is currently conducting an inhalation carcinogenicity bioassay in rats and mice.

Oral administration of toluene at doses as low as 260 mg/kg produced a significant increase in embryonic lethality in mice. Decreased fetal weight was observed at doses as low as 434 mg/kg, and an increased incidence of cleft palate was seen at doses as low as 867 mg/kg. However, other researchers have reported that toluene is embryotoxic but not teratogenic in laboratory animals. There are no accounts of a teratogenic effect in humans being linked to toluene exposure.

Acute exposure to toluene at concentrations of 375-1,500 mg/m^3 produces central nervous system depression and narcosis in humans. However, even exposures to quantities sufficient to produce unconsciousness fail to produce residual organ damage. The rat oral LD_{50} value and inhalation LC_{LO} value are 5,000 mg/kg and 15,000 mg/m^3, respectively. Chronic inhalation exposure to toluene at relatively high concentrations produces cerebellar degeneration and an irreversible encephalopathy in mammals.

Toluene, in sufficient amounts, appears to have the potential to significantly alter the metabolism and resulting bioactivity of certain chemicals. For example, coadministration of toluene along with benzene or styrene has been shown to suppress metabolism of the benzene or styrene in rats. The estimated weighted average bioconcentration factor for toluene and the edible portion of all freshwater and estuarine aquatic organisms consumed by Americans is calculated to be 10.7.

Toxicity to Wildlife and Domestic Animals

Of five freshwater species acutely tested with toluene, the cladoceran Daphnia magna was most resistant. The EC_{50} and LC_{50} values for all species range from 12,700 to 313,000 µg/liter. No chronic tests are available for freshwater species. The two freshwater algal species tested are relatively insensitive to toluene with EC_{50} values of 245,000 µg/liter or greater being reported. For saltwater species, EC_{50} and LC_{50} values range from 3,700 µg/liter for the bay shrimp to 1,050 mg/liter for the Pacific oyster. The chronic value in an embryo-larval test for the sheepshead minnow is reported to be between 3,200 and 7,700 µg/liter and the acute-chronic ratio is between 55 and 97. In several saltwater algal species and kelp, effects occur at toluene concentrations from 8,000 to greater than 433,000 µg/liter.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report the lowest concentrations of toluene known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 17,500 µg/liter
Chronic toxicity: No available data

Saltwater

Acute toxicity: 6,300 µg/liter
Chronic toxicity: 5,000 µg/liter

Human Health

Criterion: 14.3 mg/liter

NIOSH Recommended Standards: 375 mg/m^3 TWA
560 mg/m^3 STEL

OSHA Standards: 750 mg/m^3 TWA
1,120 mg/m^3 Ceiling Level

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1,1,1-TRICHLOROETHANE

Summary

Preliminary results suggest that 1,1,1-trichloroethane (1,1,1-TCA) induces liver tumors in female mice. It was shown to be mutagenic using the Ames assay, and it causes transformation in cultured rat embryo cells. Inhalation exposure to high concentrations of 1,1,1-TCA depressed the central nervous system; affected cardiovascular function; and damaged the lungs, liver, and kidneys in animals and humans. Irritation of the skin and mucous membranes has also been associated with human exposure to 1,1,1-trichloroethane. The EPA Ambient Water Quality Criterion for the protection of human health is 18.4 mg/liter.

CAS Number: 71-55-6

Chemical Formula: CH_3CCl_3

IUPAC Name: 1,1,1-Trichloroethane

Important Synonyms and Trade Names: Methyl chloroform, chlorothene, 1,1,1-TCA

Chemical and Physical Properties

Molecular Weight: 133.4

Boiling Point: 74.1°C

Melting Point: -30.4°C

Specific Gravity: 1.34 at 20°C (liquid)

Solubility in Water: 480-4,400 mg/liter at 20°C (several divergent values were reported in the literature)

Solubility in Organics: Soluble in acetone, benzene, carbon tetrachloride, methanol, ether, alcohol, and chlorinated solvents

Log Octanol/Water Partition Coefficient: 2.17

Vapor Pressure: 123 mm Hg at 20°C

Vapor Density: 4.63

Transport and Fate

1,1,1-Trichloroethane (1,1,1-TCA) disperses from surface water primarily by volatilization. Several studies have indicated that 1,1,1-trichloroethane may be adsorbed onto organic materials in the sediment, but this is probably not an important route of elimination from surface water. 1,1,1-Trichloroethane can be transported in the groundwater, but the speed of transport depends on the composition of the soil.

Photooxidation by reaction with hydroxyl radicals in the atmosphere is probably the principal fate process for this chemical.

Health Effects

1,1,1-Trichloroethane was retested for carcinogenicity because in a previous study by NCI (1977), early lethality precluded assessment of carcinogenicity. Preliminary results indicate that 1,1,1-TCA increased the incidence of combined hepatocellular carcinomas and adenomas in female mice when administered by gavage (NTP 1984). There is evidence that 1,1,1-trichloroethane is mutagenic in *Salmonella typhimurium* and causes transformation in cultured rat embryo cells (USEPA 1980). These data suggest that the chemical may be carcinogenic.

Other toxic effects of 1,1,1-TCA are seen only at concentrations well above those likely in an open environment. The most notable toxic effects of 1,1,1-trichloroethane in humans and animals are central nervous system depression, including anesthesia at very high concentrations and impairment of coordination, equilibrium, and judgment at lower concentrations (350 ppm and above); cardiovascular effects, including premature ventricular contractions, decreased blood pressure, and sensitization to epinephrine-induced arrhythmia; and adverse effects on the lungs, liver, and kidneys. Irritation of the skin and mucous membranes resulting from exposure to 1,1,1-trichloroethane has also been reported. The oral LD_{50} value of 1,1,1-trichloroethane in rats is about 11,000 mg/kg.

Toxicity to Wildlife and Domestic Animals

The acute toxicity of 1,1,1-trichloroethane to aquatic species is rather low, with the LC_{50} concentration for the most sensitive species tested being 52.8 mg/l. No chronic toxicity studies have been done on 1,1,1-trichloroethane, but acute-chronic ratios for the other chlorinated ethanes ranged from 2.8 to 8.7. 1,1,1-Tricholoroethane was only slighty bioaccumulated with a steady-state bioconcentration factor of nine and an elimination half-life of two days.

No information on the toxicity of 1,1,1-trichloroethane to terrestrial wildlife or domestic animals was available in the literature reviewed.

Regulations and Standards

Ambient Water Quality Criteria (USEPA):

Aquatic Life

The available data are not adequate for establishing criteria. However, EPA did report, the lowest values of the two trichloroethanes (1,1,1 and 1,1,2) known to be toxic in aquatic organisms.

Freshwater

Acute toxicity: 18 mg/liter
Chronic toxicity: 8.4 mg/liter

Saltwater

Acute toxicity: 31.2 mg/liter
Chronic toxicity: No available data

Human Health

Criterion: 18.4 mg/liter

NIOSH Recommended Standard: 350 ppm (1,910 mg/m^3)/15 min Ceiling Level

OSHA Standard: 350 ppm (1,910 mg/m^3) TWA

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XYLENES

mary

Xylene has been shown to be fetotoxic in rats and mice. In humans, exposure to high concentrations of xylene adversely ffects the central nervous system and irritates the mucous embranes.

ackground Information

Xylene has three isomers, o-, m-, and p- xylene. These hree generally have similar chemical and biological characteristics and therefore will be discussed together.

AS Number: Mixed: 1330-20-7
m-Xylene: 108-38-3
o-Xylene: 95-47-6
p-Xylene: 106-42-3

Chemical Formula: $C_6H_4(CH_3)_2$

IUPAC Name: Dimethylbenzene

Important Synonyms and Trade Names:

Mixed xylene: Dimethylbenzene, xylol
m-Xylene: 1,3-Dimethylbenzene, m-xylol
o-Xylene: 1,2-Dimethylbenzene, o-xylol
p-Xylene: 1,4-Dimethylbenzene, p-xylol

Chemical and Physical Properties

Molecular Weight: 106.17

Boiling Point: Mixed: 137-140°C
m-Xylene: 139°C
o-Xylene: 144°C
p-Xylene: 138°C

Melting Point: m-Xylene: -48°C
o-Xylene: -25°C
p-Xylene: 13°C

Specific Gravity: 0.86

Solubility in Water: 160 mg/liter at 25 degrees Celsius

Solubility in Organics: Soluble in alcohol, ether, and other organic solvents

Log Octanol/Water Partition Coefficient: 3

Vapor Pressure: 10 mm Hg at 25 degrees Celsius

Vapor Density: 3.7

Flash Point: 25 degrees Celsius (closed cup)

Transport and Fate

Volatilization and subsequent photooxidation by reaction with hydroxyl radicals in the atmosphere are probably important transport and fate processes for xylene in the upper layer of soil and in aquatic environments. Products of the hydroxylation reaction include carbon dioxide, peroxyacetylnitrate (PAN), and cresol. Xylene binds to sediment in water and to organics in soils, and undergoes microbial degradation. Biodegradation is probably the most important fate process in both soils and in the aquatic environment. Xylenes have been shown to persist for up to 6 months in soil. Because of their low water solubility and rapid biodegradation, xylenes are unlikely to leach into groundwater in high concentrations.

Health Effects

The National Toxicology Program (NTP) is testing xylene for carcinogenicity by administering it orally to rats and mice. Although the results have not been finalized, it does not appear to be carcinogenic in rats.[1] Results have not been reported for mice. Xylene was found not to be mutagenic in a battery of short-term assays. Xylene was not teratogenic but has caused fetotoxicity in rats and mice. Acute exposure to rather high levels of xylene affects the central nervous system and irritates the mucous membranes. There is limited evidence of effects on other organ systems, but it was not possible to attribute these effects solely to xylene as other solvents were present. The oral LD_{50} value of xylene in rats was 5,000 mg/kg.

Toxicity to Wildlife and Domestic Animals

Xylene adversely affected adult trout at concentrations as low as 3.6 mg/liter in a continuous flow system and trout

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[1] W.C. Eastin, NTP Chemical Manager; personal communication, 1984.

fry avoided xylene at concentrations greater than 0.1 mg/liter. The LC$_{50}$ value in adult trout was determined to be 13.5 mg/liter. LC$_{50}$ values for other freshwater fish were around 30 mg/liter in a static system, which probably underestimated toxicity. Only a few studies have been done on the toxicity of xylene to saltwater species. These indicated that the m- and o-xylene isomers probably have similar toxicities and are probably less toxic than p-xylene, and that saltwater species are generally more susceptible than freshwater species to the detrimental effects of xylene (LC$_{50}$ = 10 mg/liter for m- and o-xylene and LC$_{50}$ = 2 mg/liter for p-xylene). However, it should be stressed that these generalizations are based on results from limited data.

No information on the toxicity of xylenes to terrestrial wildlife and domestic animals was available in the literature reviewed. However, because of the low acute toxicity of xylenes it is unlikely that they would be toxic to wild or domestic birds and mammals.

Regulations and Standards

NIOSH Recommended Standards (air): 435 mg/m^3 TWA
870 mg/m^3/10 min Ceiling Level

OSHA Standard (air): 435 mg/m^3 TWA

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH). 1983. Registry of Toxic Effects of Chemical Substances. Data Base. Washington, D.C. October 1983

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EXHIBIT D

VOLATILIZATION HALF-LIVES OF SITE INDICATORS - COMPUTER ANALYSIS

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10 CLS
20 PRINT "Please be sure that you have your caps lock OFF.":PRINT :PRINT
5 INPUT "Do you have a measured value of the Henry's Law constant (y/n)";A$:IF
$ = CHR$(121) THEN GOTO 120
  NPUT "What is the vapor pressure in atm";W#
 INPUT "What is the water solubility in mol/cubic meter";X#
 00 Y#=.024
110 H#=(W#/X#)/Y#
115 GOTO 130
 20 INPUT "What is the dimensionless Henry's Law constant";H#
130 INPUT "What is the molecular weight of your compound";M#
140 GOSUB 2990
 50 IF VW# <1.9 THEN GOTO 2000
00 B = 1137.5*(VW#+VC#)*(18/M#)^.5
210 PRINT "The gas-phase exchange coefficient is ";B;"."
 20 PRINT : IF VW#<1.9 THEN GOTO 280
 40 PRINT :PRINT
260 C=23.51*((VC#^.969)/(Z#^.673))*((32/M#)^.5)*(EXP(.526*(VW#-1.9)))
70 PRINT :PRINT "The liquid-phase exchange coefficient is ";C;"."
 75 PRINT
280 K=(H#*B*C)/(H#*B+C)
290 PRINT "The overall liquid-phase mass transfer coefficient is ";K;"."
 00 PRINT :PRINT
10 T=(.69*100)/K
315 T=INT(T*1000+.5)/1000
 20 PRINT "The volatilization half-life in hours is ";T;"."
 25 PRINT :PRINT
330 INPUT "Would you like a hard copy of your variables and estimates";A$
35 IF A$ = CHR$(121) THEN GOSUB 5000
    CLS
    INPUT  "Do you want to recalculate the half-life of your compound using a ne
w value for one of the parameters (y/n)";A$:IF A$ <> CHR$(121) THEN GOTO 350
 45 GOSUB 2990
46 GOTO 150
350 INPUT "Do you want to calculate the half-life of a new compound (y/n)";A$: I
  A$=CHR$(121) THEN GOTO 355 ELSE IF A$=CHR$(110) THEN GOTO 360
 55 CLS:GOTO 75
360 CLS:PRINT "" TAB(10);"Y'all come back now, hear?":END
90 PRINT
 000 PRINT :PRINT
2050 C=23.51 *((VC#^.969)/(Z#^.673))*(32/M#)^.5
060 PRINT :PRINT "The liquid-phase exchange coefficient is ";C;".":PRINT :PRINT
 070 GOTO 200
990 CLS
3000 PRINT  "PARAMETER"; TAB( 28);"VALUE":PRINT
 010 PRINT "(1) WIND VELOCITY"; TAB( 29);VW#: PRINT
 020 PRINT "(2) CURRENT VELOCITY"; TAB( 29);VC#:PRINT
3030 PRINT "(3) DEPTH"; TAB( 29);Z#:PRINT
040 INPUT  "Enter the number corresponding to the parameter you wish to change.
 ,A$
3050 IF A$ = CHR$(49) THEN INPUT "Enter the new value of the wind velocity in m/
s.",VW#
 060 IF A$=CHR$(50) THEN INPUT "Enter the new value of the current velocity in m
/s.",VC#
     IF A$=CHR$(51) THEN INPUT "Enter the new value of the water depth in m.",Z#
    .INPUT "Do you wish to make any other changes (y/n)";A$:IF A$ <>CHR$(110) TH
 N GOTO 2990
```

```
085 CLS
3090 RETURN
000 CLS
010 INPUT "What is the name of your compound";A$
 INPUT "Did you use a measured value of the Henry's Law constant";B$
30 IF B$ = CHR$(121) GOTO 5199
040 LPRINT "Volatilization half-life and associated information for ";A$;"."
5050 LPRINT : LPRINT
060 LPRINT "The vapor pressure is ";W#;" atm."
070 LPRINT : LPRINT
080 LPRINT "The water solubility is ";X#;" mol/cubic meter."
5090 LPRINT :LPRINT
100 LPRINT "The non-dimensional Henry's Law constant is ";H#;"."
110 LPRINT :LPRINT: GOSUB 5999
5120 RETURN
199 LPRINT "Volatilization half-life and associated information for ";A$;".":LP
INT:LPRINT
5200 LPRINT "The measured non-dimensional Henry's Law constant is ";H#;"."
210 GOSUB 5999
220 RETURN
999 LPRINT
6000 LPRINT "The wind velocity used was ";VW#;" m/s."
010 LPRINT:LPRINT "The current velocity used was ";VC#;" m/s."
013 LPRINT:LPRINT "The depth of the water used was ";Z#;" m."
6020 LPRINT:LPRINT "The gas-phase exchange coefficient is ";B;"."
030 LPRINT:LPRINT
040 LPRINT "The liquid-phase exchange coefficient is ";C;"."
6050 LPRINT:LPRINT
060 LPRINT "The overall liquid-phase mass transfer coefficient is ";K;"."
 LPRINT:LPRINT
30 LPRINT "The estimated volatilization half-life is ";T;" hours."
6090 RETURN
```

EXHIBIT E

DATA VALIDATION COMMENTS

TOWN OF CONKLIN LANDFILLS
EXHIBIT D
RI DATA VALIDATION

METALS

O'Brien & Gere Engineers, Inc. was awarded a contract to perform a Remedial Investigation for the Town of Conklin. A portion of the scope of services included the analysis of samples by O'Brien & Gere Laboratories. O'Brien & Gere personnel collected both aqueous and sediment samples on January 18-20, 1988 and submitted them to the laboratory on January 21, 1988. The parameters of interest were CLP volatiles, arsenic, iron, and manganese in monitoring wells and creek waters. Soil samples were analyzed for total and leachable metals and PCBs. The following text represents data excursions from the Quality Assurance/Quality Control Project Plan for the Town of Conklin site (Appendix F, Preliminary Report for Town of Conklin Landfills, October, 1987).

All metal samples were filtered and acidified in the field. The laboratory did not digest the aqueous samples, however, they did digest the sediment samples. The holding times for metal analysis were met and the 10 percent frequency for spikes and duplicates were met. One set of spike and duplicate results were outside the criteria of plus or minus 10 percent. The same sample that was replicated was also spiked. The RPD was outside acceptable range which reveals the non-homogeneity of the sample. The same sample was spiked and because of the non-homogenity of the sample the recovery failed. The second set of duplicate and spike results support this conclusion. The report forms further indicate that manganese and iron results are suspect. However, there were two sets of duplicates and spikes. The low spike recovery for manganese affects only samples F0001-F0005 (MW-1,3,5,6) and the high spike for iron affects samples F0006-11 (MW-7,8,9,10,12) and F0013-16 (MW-21,22,36,37). The arsenic continuing calibration verification sample and contract required detection limit check sample resulted in high recoveries. A review of the raw data shows that each sample was run in duplicate and spiked with a standard. The individual recoveries range from 101%-119% which is within acceptable recoveries for the method of addition.

The data for the homeowner wells and landfill sediments show acceptable replication and recoveries. Overall the data is acceptable because the excursions are minor and the data for the ground waters shows that the components analyzed are absent. Data qualifiers noting these excursions are listed in the appendices along with the data results.