932001

SUPPORT DOCUMENT FOR

AN APPLICATION TO CONSTRUCT AND OPERATE

A SOLID WASTE MANAGEMENT FACILITY

AT

SKW ALLOYS, INC.

WITMER ROAD SITE

TOWN OF NIAGARA,

NEW YORK

LANDFILL CELL NUMBER TWO

This report has been prepared under the guidance and direction of Richard R. Snyder, P.E. State of New York Licensed Professional Engineer No. 54616

Richard R. Snyder

Richard R. Snyder, P.E.
December 5, 1980

Alteration of this report by any person not acting under the direction of a Professional Engineer Licensed to practice in New York is a violation of the law.

STATE OF NEW YORK
R. R. SNYDER
No. 54616
Licensed Professional Engineer

Environmental Conservation. The landfill is now being operated on a daily basis.

1.4 Site Surroundings

The Niagara River is located approximately 1.5 miles west and the Niagara Power Project about 1.0 miles north of the site (refer to Figure 1-1). In addition, Gill Creek (a small perennial stream) is located approximately 0.5 miles east of the site and flows from north to south toward the Niagara River which is designated as Class A - Special Waters (International Boundary Waters). No potable water wells are known to be located within the immediate area of the site.

The surrounding area is generally of low relief. The site is located in a highly industrialized section of the Town of Niagara. A large portion of the Niagara Falls residential area lies to the east and south of the site. The closest significant residential area is located approximately 0.3 miles south of the site. To the east lies a large tract of Niagara Mohawk Power Company land and to the north the power project's reservoir.

1.5 Past Utilization

The SKW Alloys, Incorporated site (refer to AAD-4) contains several buildings (laboratory, engineering, administrative and miscellaneous storage buildings).

These are located along the western and southern boundaries. In recent years, large portions of the site have been utilized for storage of coke, wood chips and iron turnings, purchased raw materials, ores and other raw materials. In addition, some slag may have been disposed of on this portion of the site. These uses are in addition to the current landfill.

The monitoring data (both surface and groundwater), geology, hydrogeology, site ecology and land utilization have been developed for the site. This was done for the following reasons:

1. To monitor for any environmental effects from past disposal of similar type materials (ferrochrome and ferrosilicon dusts),
2. To determine significance of various site factors (geology, hydrogeology, etc.) upon required methodology for future disposal, and
3. To gain a more complete understanding of the site.

Based upon anticipated future production, the following waste generation rates are expected:

Waste	Quantity tons/year
1) Ferrochromium silicon dust	5,500
2) Ferrosilicon dust	5,500

These materials will continue to be landfilled at the Witmer Road property. The proposed landfill facility #2 will be utilized for disposal of ferrosilicon dust while the ferrochromium silicon dust will continue to receive disposal in the first landfill facility or a future facility. In addition, ferrochromium silicon slag will continue to be generated. Presently, most of this material is marketed.

1.6 Site Topography and Slopes

Both an aerial survey (refer to AAD-6) and a topographic map (refer to AAD-3) have been prepared. These provide a clear picture of the phisical condition of the site. The only change in the sites topography resulted from the addition of Landfill Facility #1 as indicated on Drawing D0351.

PLANS AND REPORT FOR A

SOLID WASTE MANAGEMENT FACILITY

AIRCO INCORPORATED
3801 HIGHLAND AVENUE
NIAGARA FALLS, NEW YORK 14305

This report has been prepared under the guidance and direction of Richard R. Snyder, P.E. State of New York Licensed Professional Engineer No. 54616

Richard R. Snyder, P.E.
June 15, 1979

Alteration of this report by any person not acting under the direction of a Professional Engineer Licensed to practice in New York State is a violation of the law.

1.4 Site Surroundings

The Niagara River is located approximately 1.5 miles west and the Niagara Power Project about 1.0 miles north of the site (refer to Figure 1-1). In addition, Gill Creek (a small perennial stream) is located approximately 0.5 mile west of the site and flows from north to south toward the Niagara River which is designated as Class A - Special Waters (International Boundary Waters). No potable water wells are known to be located within the immediate area of the site.

The surrounding area is generally of low relief. The site is located in a highly industrialized section of the Town of Niagara. A large portion of the Niagara Falls residential area lies to the east and south of the site. The closest significant residential area is located approximately 0.3 mile south of the site. To the east lies a large tract of Niagara Mohawk Power Company land and to the north the power project's reservoir.

1.5 Past Utilization

The Airco Incorporated proposed site (refer to AAD-4) contains several buildings (laboratory, engineering, administrative and miscellaneous storage buildings). These are located along the western and southern boundaries. In recent years, large portions of the site have been utilized for storage of coke, wood chips, and iron turnings, purchased raw materials, ores and other raw materials. In addition, some slag may have been disposed of on this portion of the site.

The monitoring data (both surface and groundwater), geology, hydrogeology, site ecology and land utilization have been developed for the entire 62-acre site. This was done for the following reasons:

1. To monitor for any environmental effects from past disposal of similar type materials (ferrochrome and ferrosilicon dusts),
2. To determine significance of various site factors (geology, hydrogeology, etc.) upon required methodology for future disposal, and
4. To gain a more complete understanding of the potential site.

The following information relating to past disposal practices and waste identification has been supplied by Airco Incorporated. Approximately seven acres of this 62-acre site is now dedicated to solid waste disposal of slag, ferrosilicon, baghouse dust, ferrochromium silicon baghouse dust (deposited in slurry form) and trash (bricks, old equipment, pallets, etc.)

A summary of the sources, quantities, and typical composition of these wastes (when known) are as follows:

Waste	Source	Quantity est. tons	Composition
(1) Low carbon ferrochromium slag.	Vanadium Corporation	200,000	--------
(2) Steel Melting slag.	AIRCO Pittsburgh Metallurgical	150,000	SiO_2 - 25% CaO - 50% MgO - 5% Other - 10%
(3) Ferrochromium silicon slag.	AIRCO	6,000	SiO_2 - 40% MgO - 35% Al_2O_3 - 18% CaO - 3% Other - 4%
(4) Ferrosilicon baghouse dust	AIRCO Pittsburgh Metallurgical	~2,000	pH - 9-10 SiO_2 - 93% Fe_2O_3 - 2% MgO - 1% Other - 4%

Based upon anticipated future production, the following waste generation rates are expected.

Waste	Quantity tons/year
(1) Ferrochromium silicon dust	5,500
(2) Ferrosilicon dust	5,500

These materials will continue to be landfilled at the Witmer Road property. In addition, ferrochromium silicon slag will continue to be generated. Presently, most of this material can be marketed. However, any material which cannot be marketed will be stored, temporarily.

2.4 Surface Water

2.4.1 Site Watershed and Drainage

The site watershed is located within the Town of Niagara. It is bounded as follows: West-Witmer Road; North - Niagara Mohawk Power Company right of way; East - Airco Properties, Inc.; and South - Niagara Mohawk Power Company. The total site drainage area includes thirty - seven acres (Airco, Inc.) in addition to the twenty-five acres retained by Airco Properties, Inc. The only surface water entering the site is an intermittent stream which originates to the East of the site. However, this stream dries up during the late spring and summer months. Surface drainage is away from the drainage shed, along natural contours (refer to Dwg. AAD-3). The percentage of run-off is dictated both by ground slopes and soil permeabilities.

2.4.2 Floodplain Considerations

The Airco, Inc. Site is not a floodplain. This is predicated upon the Federal Insurance Administration's Flood Hazard Boundary Map No. H02 for the Town of Niagara, N.Y. (Niagara County) revised on April 30, 1976.

2.4.3 Quality and Potential Environmental Effects

The proposed solid waste management facility will provide adequate environmental protection against surface water contamination. Further information concerning this matter is found in Section 3 (Operations) and Section 4 (Site Monitoring) of this Report.

1.) Composition and quantities of waste generated, and
2.) Waste disposal facility siting,
3.) Disposal methodology, and
4.) Miscellaneous operational information.

3.3.1 Waste Generation

Ferrosilicon alloy is produced in an electric arc furnace. This process produces one waste, baghouse dust.

The captured baghouse dust is very fine and of low density. The quantity of dust generated depends, in large part, on the type of alloy being produced. Under present conditions, approximately 15 tons (dry weight basis/day) of dust is being generated. This equates to approximately 5,000 tons/yr.

An approximate composition of this material is as follows:

PARAMETER	ANALYSES
FeSi	93%
MgO	1%
Fe_2O_3	2%
Al_2O_3	---
Other	4%
pH	9-10

In addition, chromium, copper, zinc, manganese, nickel, and cobalt are present in a combined concentration of less than 1%. Care must be exercised or leaching problems might develop with the copper, nickel or chromium. However, ground water analyses do not indicate any environmental degradation.

Ferrochrome silicon alloy is also produced in an electric arc furnace. This process produces both slag and baghouse dust.

** 3.3.2 Proposed Waste Disposal Facility Siting

The proposed method of disposal will be in a landfill with leachate control (refer to Dwg. AAD - 1).

In order to help ascertain the site's suitability for the proposed type of disposal facility, a number of borings (refer to Dwg. AAD-5) were made. In addition, several Shelby tubes were taken for soil permeability analyses.

Boring number five indicates a refusal at 24.2 feet below grade or approximately 574.9 MSL (599.1'- 24.2'). A Shelby tube sample was taken from this boring between 8' and 10' below grade or between 591.1' MSL and 589.1' MSL. This Shelby tube sample exhibited a coefficient of permeability (k) of 7×10^{-9} cm/sec. (Appendix B). From the ground water elevation data presented in Table 2-2 ,2-3 it can be seen that the ground water elevation was declining during the data period. Therefore, in conjunction with local precipitation data, one can deduce that the high ground water elevation was at the beginning of this period. The base of the proposed cell will be at 593.19' or 10 feet above the water table. The "perched" water table was addressed under Section 2, "Site Analysis".

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Borings #6 and #7 were taken on June 8, 1979, and exhibited a coefficient of permeability (k) of 5×10^{-9} cm/sec. and 5×10^{-8} cm/sec., respectively. Additional borings and Shelby tubes were taken and permeability data will be forthcoming. This data will be reported at a later date. Future cell locations have been based primarily upon the clay thickness (refer to AAD-9) and depth to bedrock (refer to AAD-10). The progression of subsequent disposal areas will be first to the east and then to the north of the first cell (refer to AAD-7).

3.3.3 Methodology

Solid waste will be landfilled in a "controlled" area with leachate collection and site monitoring. The proposed method of disposal uses proven technology. The following steps will be taken to help ensure safe environmental disposal of the baghouse dusts.

A concrete truck is partially filled with city water. The concrete truck is then loaded with dust by an experienced, trained operator. Only enough water is added to provide a flowable mass from the concrete truck.

The cement truck then proceeds to the Witmer Road Site and is logged in by the security guard.

After being logged in the truck will proceed to the designated disposal area to deposit the thick, viscous slurry.

The sequence of operation will be to deposit the slurry starting in the northwest corner and work out into the landfill in a "fan" pattern. The material dries to approximately 100 lb/ft^3 and has the physical strength to support heavy construction equipment. An alternative is to spread the sludge equally on the banks to promote more rapid drying. At present plant production rates fourteen truck loads per day will be deposited.

Past experience has shown that the material "air-dries". This has been demonstrated by the fact that the material stays "pasty" if deposited in layers over 4 inches thick.

Daily cover <u>cannot</u> be applied since drying would be prevented and the viscous mass would be collected.

3.3.4 Miscellaneous Operational Information

3.3.4.1 Previous Site Wells

The site contains one well (refer to AAD-5) which existed prior to the implementation of the recent geohydrological study. However, it has been plugged and is presently unusable.

3.3.4.2 Maintenance and Standby Equipment

Routine and preventive maintenance is performed by Airco personnel. Other equipment maintenance is performed by reputable contractors.

Should additional construction equipment be required it will be required from the following local contractors:

(1) Huber Construction Company

(2) Haseley Trucking, Inc.

(3) Armond Cerrone, Inc.

3.3.4.3 Personnel Facilities

The Airco Incorporated Site contains both shower and sanitary facilities.

** The captured dust is very fine and of low density. The quantity of dust generated depends, in large part, on the type of alloy being produced. Under present condition, approximately 15 tons (dry weight basis/day) of dust is being generated. This equates to approximately 5,000 tons/yr.

An approximate composition of this material is as follows:

Parameter	Analyses
SiO_2	80%
MgO	9%
Al_2O_3	3%
Fe_2O_3	2%
Other	6%
pH	9-11

In addition, chromium, copper, zinc, manganese, nickel, and cobalt are present in varying amounts.

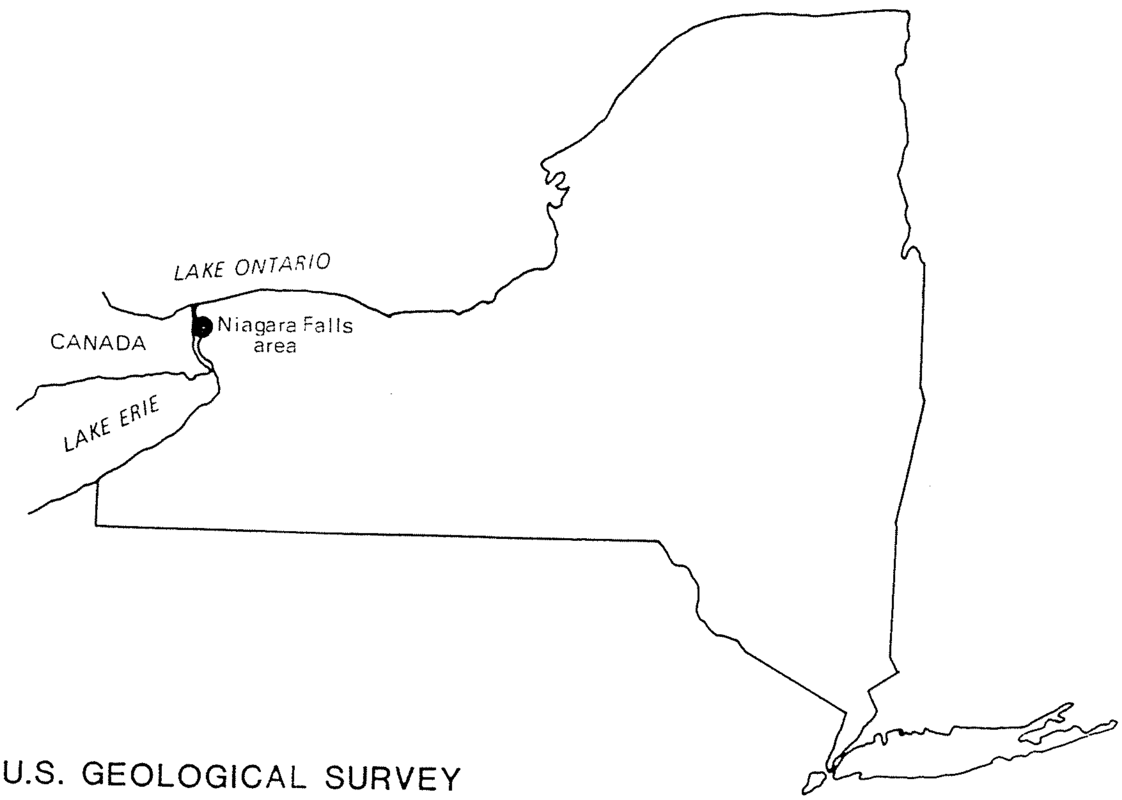
Although ground water analyses do not indicate any problems, a small concentration of chromium has been detected in the site's surface water.

The ferrochrome slag is presently marketed. Due to its structural make-up, the potential for leachate generating is much less than for the dust. If market demand does not keep pace with generation rates it will probably be necessary to also stockpile this material at the Witmer Road Site.

An approximate compostiion of this material is as follows:

Parameter	Analyses
SiO_2	40%
MgO	35%
Al_2O_3	18%
CaO	3%
Other	4%

Effect of Niagara Power Project on Ground-Water Flow in the Upper Part of the Lockport Dolomite, Niagara Falls Area, New York



U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Report 86-4130

Prepared in cooperation with the
U.S. ENVIRONMENTAL PROTECTION AGENCY
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

EFFECT OF NIAGARA POWER PROJECT ON GROUND-WATER FLOW IN THE UPPER PART OF THE LOCKPORT DOLOMITE, NIAGARA FALLS AREA, NEW YORK

By Todd S. Miller and William M. Kappel

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 86-4130

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U.S. ENVIRONMENTAL PROTECTION AGENCY, and the

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Ithaca, New York

1987

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

Subdistrict Chief
U.S. Geological Survey
521 W. Seneca Street
Ithaca, New York 14850
Telephone: (607) 272-8722

Copies of this report can
be purchased from:

U.S. Geological Survey
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Federal Center, Bldg. 41
Box 25425
Denver, CO 80225
Telephone: (303) 236-7476

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CONVERSION FACTORS

For readers who prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by the following factors:

Multiply inch-pound unit	By	To obtain SI unit
	Length	
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectare (ha)
	Volume	
acre-feet	1,233	cubic meter (m^3)
cubic yard (yd^3)	0.7646	cubic meter (m^3)
gallon (gal)	3.785	liter (L)
million gallons (Mgal)	3.785	cubic meter (m^3)
	Flow	
million gallons per day (Mgal/d)	3785	cubic meters per day (m^3/d)
foot per day (ft/d)	0.3048	meter per day (m/d)
cubic foot per second (ft^3/s)	0.01093	cubic meter per second (m^3/s)
	Mass	
pound (lb)	453.6	grams (g)
ton	907.2	kilograms (kg)
	Slope	
feet per mile (ft/mi)	0.1894	meters per kilometer (m/km)
	Hydraulic Conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Other Units	
	kilowatt (kw)	

Effect of Niagara Power Project on Ground Water Flow in the Upper Part of the Lockport Dolomite, Niagara Falls Area, New York

By Todd S. Miller and William M. Kappel

ABSTRACT

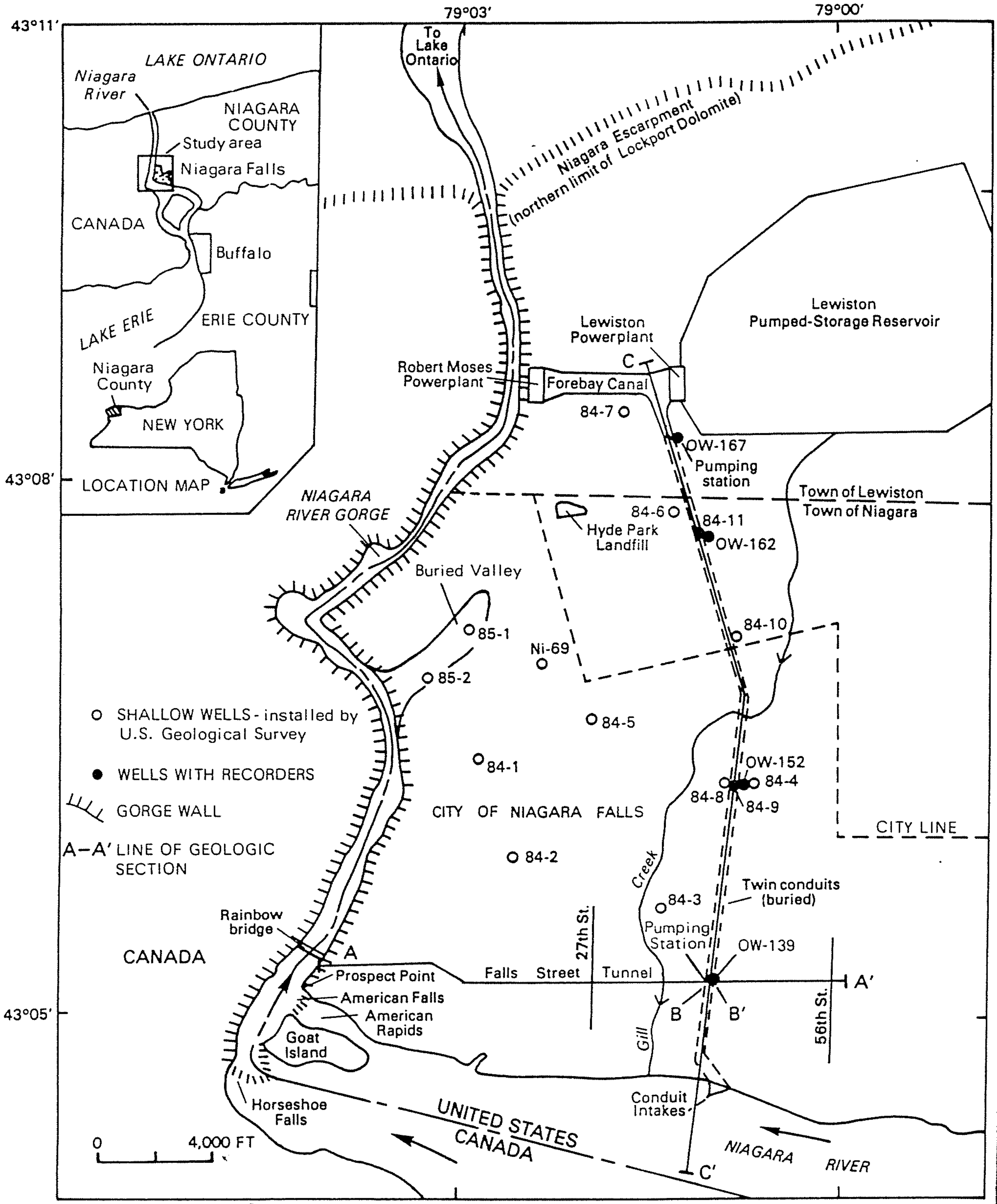
The Niagara River Power Project near Niagara Falls, N.Y., has created recharge and discharge areas that have modified the direction of ground-water flow east and northeast of the falls. Before construction of the power project in 1962, the configuration of the potentiometric surface in the upper part of the Silurian Lockport Dolomite generally paralleled the buried upper surface of the bedrock. Ground water in the central and east parts of the city of Niagara Falls flowed south and southwestward toward the upper Niagara River (above the falls), and ground water in the western part flowed westward into the Niagara River gorge.

The power project consists of two hydroelectric powerplants separated by a forebay canal that receives water from the upper Niagara River through two 4-mile-long, parallel, buried conduits. During periods of nonpeak power demand, some water in the forebay canal is pumped to a storage reservoir for later release to generate electricity during peak-demand periods.

Since the power project began operation in 1962, ground water within 0.5 mile of the buried conduits has seeped into the drain system that surrounds the conduits, then flows both south from the forebay canal and north from the Niagara River toward the Falls Street tunnel--a former sewer that crosses the conduits 0.65 mile north of the upper Niagara River. Approximately 6 million gallons of ground water a day leaks into the Falls Street tunnel, which carries it 2.3 miles westward to the Niagara River gorge below the falls.

Daily water-level fluctuations in the forebay canal affect water levels in the drain system that surrounds the conduits, and this, in turn, affects the potentiometric surface in the Lockport Dolomite within 0.5 mile of the conduits. The resulting water-level fluctuations in the drains and Lockport Dolomite diminish with distance from the forebay canal. The drains transmit changes in pressure head near the forebay canal southward at least as far as the Falls Street tunnel area and possibly to the upper Niagara River. High water levels in the forebay canal decrease the gradient of the potentiometric surface toward the conduit drains, and low water levels in the forebay canal increase the gradient.

Some water in the pumped-storage reservoir recharges ground water in the Lockport Dolomite by seepage through bedding joints, which are exposed in the unlined reservoir bottom, and through the grout curtain beneath the reservoir's dike. Water-level fluctuations in the reservoir cause slight ground-water fluctuations near the reservoir.



Base from U.S. Geological Survey
Lewiston, 1965, and Niagara Falls, 1965, 1:24,000

Figure 1.--Major features of Niagara Power Project and location of wells installed or monitored by the U.S. Geological Survey during 1984-85.

INTRODUCTION

The Niagara Falls area has many industrial and chemical-processing plants because electric power there is relatively inexpensive and because water for industrial processing is readily available. The Niagara Falls area contains 31 hazardous-waste-disposal sites that have significant potential for ground-water contamination (Koszalka and others, 1985). The possibility of chemical migration from these sites to the ground water in the underlying Lockport Dolomite and from there to the Niagara River, which provides fishing and other recreation below the falls and a public water supply above the falls, has created a need for information on ground-water recharge, discharge, direction of flow, and any effects the Niagara Power Project may have on the ground-water flow system.

The Niagara Power Project (fig. 1) was built in 1962 by the Power Authority of the State of New York, now called the New York Power Authority (NYPA), and is one of the largest hydroelectric facilities in the United States. Major components of the facility are the twin buried conduits, the forebay canal, the Lewiston and Robert Moses powerplants, and the Lewiston pumped-storage reservoir (fig. 1).

The two buried conduits are 4 mi long and constructed of concrete in trenches excavated 100 to 160 ft deep in the Silurian Lockport Dolomite. The conduits divert between 50,000 and 75,000 ft^3/s of water from the upper Niagara River north to the forebay canal, a 4,000-ft-long basin between the Lewiston and Robert Moses powerplants (fig. 1). The pumped-storage reservoir stores surplus water pumped from the forebay canal during periods of low power demand (usually at night) and releases it to generate electricity during periods of high power demand (during the day) through the Lewiston powerplant back into the forebay canal. Water from the forebay canal eventually flows through the Robert Moses powerplant and is discharged into the Niagara River gorge about 5 mi below Niagara Falls. Surrounding each conduit is a drain system designed to reduce hydrostatic pressure on the outer conduit walls should the interior of the conduits need to be drained. Two pumping stations--one just south of the forebay canal and the other at Royal Avenue, 0.65 mi north of the upper Niagara River--are the only locations at which water in the drain system can be removed.

The Falls Street tunnel crosses the twin buried conduits 0.65 mi north of the upper Niagara River. This unlined tunnel, excavated in the early 1900's, extends east-west 3.3 mi from 56th Street to the Niagara River gorge and was designed to carry sewage from the southern part of the city to a treatment plant below the Falls. A new interceptor sewer now carries the sewage, but the Falls Street tunnel still carries storm-water runoff to the Niagara gorge.

Purpose and Scope

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation, studied the hydrogeology of the Niagara Falls area during 1984-85. The purpose of the study was to define the effects of the Niagara Power Project on ground-water flow and to refine and extend knowledge of ground-water movement in the upper part of the Lockport Dolomite in the central part of Niagara Falls. The study addressed mainly the upper 10 to 25 ft of the Lockport Dolomite, which is the most weathered and permeable zone and therefore the most vulnerable to contamination from surface sources. This information provides a basis for the development of plans for remedial action at toxic-waste sites in the Niagara Falls area.

This report describes the geohydrology of the upper part of the Lockport Dolomite and the effect of power-project facilities and other alterations of the natural flow system in the Niagara Falls area. Plate 1 depicts the bedrock-surface altitude and the potentiometric-surface altitude in the upper part of the Lockport Dolomite; other maps herein show the direction of ground-water flow before and after construction of the Niagara Power Project in the Niagara Falls area. Also included are hydrographs showing the effects of water-level fluctuations in the forebay canal on water levels adjacent to the buried conduits, and vertical sections showing geologic units and construction details of the buried conduits.

Approach

The study was done in several stages:

1) Eleven observation wells were installed in the central part of the study area where no data were available to define ground-water levels and movement.

2) Four test wells were installed in the backfill above the buried conduits to identify the backfill material and obtain water-level measurements to determine whether the backfill is a discharge area and significant pathway for ground-water (and contaminant) movement. Geophysical surveys were used to locate the buried bedrock trenches that contain the conduits.

3) Water-level measurements were made in 104 wells on October 23 and 24, 1984, a period of low water levels, and on March 26 and 27, 1985, a period of high water levels, to delineate the directions of regional ground-water movement.

4) Water-level recorders were installed at six wells near the buried conduits to determine effects of water-level fluctuations in the forebay canal and pumped-storage reservoir on water levels in the upper part of the Lockport Dolomite in that area.

5) Seismic surveys were used to delineate a buried valley in the northwestern part of the study area (fig. 1).

Previous Investigations

Johnston (1964) described the hydrologic conditions of the Niagara Falls area with emphasis on water-bearing characteristics of the Lockport Dolomite. Maslia and Johnston (1982) developed a two-dimensional cross-sectional ground-water model of the Hyde Park landfill area in the northern part of the study area (fig. 1). Koszalka, Paschal, Miller, and Duran (1985) summarized results of studies by the New York State Department of Environmental Conservation, private consultants, and by the U.S. Geological Survey to describe ground-water conditions at many waste-disposal sites in the Niagara Falls area.

Acknowledgments

The New York Power Authority provided construction details of the power-project facilities, water-level data from the forebay canal and pumped-storage reservoir, and assistance in measuring water levels in NYPA wells in the vicinity of the pumped-storage reservoir. The New York State Department of Environmental Conservation coordinated the water-level measurements at industrial sites. Several industries, including Occidental Petroleum and E.I. Dupont De Nemours and Company, provided water-level data. The City of Niagara Falls provided construction details on many sewer and building projects and assisted in obtaining permits and permission to drill observation wells within the city.

GEOHYDROLOGY OF THE LOCKPORT DOLOMITE

Stratigraphy and Lithology

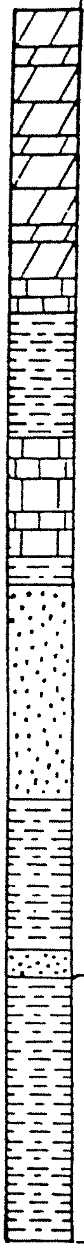
Unconsolidated glacial deposits of till and lacustrine silt and clay, generally 5 to 15 ft thick but ranging to 48 ft thick, overlie the 80- to 158-ft-thick Lockport Dolomite of Middle Silurian age within the Niagara Falls area (Tesmer, 1981). The thickest unconsolidated deposits (up to 48 ft) are in a shallow buried valley in the western part of the city (pl. 1B).

Underlying the Lockport Dolomite is a 27-ft-thick sequence of Middle Silurian shale, limestone, and dolomite in the lower part of the Clinton Group, which is underlain by a 113-ft-thick sequence of Lower Silurian sandstone and shale that is in turn underlain by 1,200-ft-thick Upper Ordovician shale. These rocks are exposed only in the Niagara River gorge and are shown in the stratigraphic column in figure 2. The strata are gently folded and dip slightly to the south-southwest at about 30 ft/mi (Fisher and Brett, 1981).

The Lockport Dolomite is a fine to coarse crystalline, thin to massive bedded dolomite, limestone, and shaly dolomite, with vugs containing gypsum (calcium sulfate) and calcite (calcium carbonate). Other minor minerals disseminated throughout the formation are sphalerite (zinc sulfide), pyrite (iron sulfide), and galena (lead sulfide) (Tesmer, 1981).

Hydraulic Conductivity

The Lockport can be divided into two zones on the basis of water-transmitting properties. The upper 10 to 25 ft of rock is a moderately permeable zone that contains relatively abundant bedding planes and vertical joints enlarged by dissolution of dolomite and abundant solution cavities left by dissolution of gypsum; the remainder of the formation contains low to moderately permeable bedding planes of which as many as seven may be major water-bearing zones that are surrounded by fine-grained crystalline dolomite of low permeability. Hydraulic-conductivity values obtained from model simulations and limited aquifer-test data (Maslia and Johnston, 1982) range from 5 to 15 ft/d in the upper part and from 1 to 2 ft/d in the lower part. Well yields commonly range from 10 to 100 gal/min.



System	Series	Group	Formation	Thickness (feet)	Description
Silurian	Middle	Lockport	Lockport Dolomite	158	Dark-gray to brown, massive to thin-bedded dolomite locally containing algal reefs and small, irregularly shaped masses of gypsum. Near the base are light-gray coarse-grained limestone (Gasport Limestone Member, dark-gray shaley dolomite)
		Clinton	Rochester Shale	60	Dark-gray calcareous shale weathering light-gray to olive.
			Irondequoit Limestone	12	Light-gray to pinkish-white coarse-grained limestone.
			Reynales Limestone	10	White to yellowish-gray shaly limestone and dolomite.
			Neahga Shale	5	Greenish-gray soft fissile shale.
	Lower	Medina	Thorold Sandstone	8	Greenish-gray shaly sandstone.
			Grimsby Sandstone	45	Reddish-brown to greenish-gray cross-bedded sandstone interbedded with red to greenish-gray shale.
			Power Glen Shale	40	Gray to greenish-gray shale interbedded with light-gray sandstone.
			Whirlpool Sandstone	20	White, quartzitic sandstone
Ordovician	Upper	Richmond	Queenston Shale	1,200	Brick-red sandy to argillaceous shale.

Figure 2.--Stratigraphy of the Niagara Falls area. (Modified from Fisher, 1959.)

Ground Water

Occurrence

The Lockport Dolomite is the principal source of ground water in the Niagara Falls area. Although the effective primary porosity is negligible, significant ground-water movement occurs through secondary openings such as bedding joints (planes), vertical joints (fractures), and solution cavities, described below. The upper 25 ft of the Lockport has a greater potential for movement of ground water (and contaminants) than the deeper parts because it has more interconnected vertical and horizontal joints that have been widened by solutioning, which allows direct entry of contaminants from surface sources.

Bedding planes.--The bedding planes, which transmit most of the water in the Lockport (Johnston, 1964), are relatively continuous fracture planes parallel to the natural layering of the rock. These openings were caused by crustal movements and the expansion of the rock during removal of weight by erosion of overlying rock units and by retreat of the glaciers. Johnston (1964) identified seven water-bearing zones, which consist either of a single open-bedding plane or an interval of rock layers containing several open planes. The top 10 to 25 ft of rock may contain one or two significant bedding planes; these are probably connected by vertical joints, which are abundant in the upper part of the formation.

The lower part of the Lockport Dolomite contains fewer water-bearing bedding planes that are interconnected by vertical joints. These deeper water-bearing zones are underlain and overlain by essentially impermeable rock. Each water-bearing bedding plane can be considered a separate and distinct artesian aquifer (Johnston, 1964). The hydraulic head within each water-bearing zone is lower than that in the zone above it; this indicates a downward component of ground-water flow.

Vertical joints.--Vertical joints in the Lockport Dolomite are not significant water-bearing openings except (1) in the upper 10 to 25 ft of rock, (2) within about 200 ft of the Niagara River Gorge, and (3) in the vicinity of the buried conduits. Physical and chemical weathering have increased the number, continuity, and size of vertical fractures in the upper part of the Lockport. The major joints, oriented N 70°E to N 80°E, are generally straight, spaced 10 to 80 ft apart, and penetrate 10 to 25 ft (American Falls International Board, 1974). Intersecting the major joint set are less extensive high-angle joints that are confined to particular beds. Vertical joints become narrower, less numerous, and less connected with depth.

In addition to the major regional fractures, extensive tension-release fractures were formed near the gorge wall by the erosion and removal of the supporting rock mass in the gorge; openings up to 0.3 ft wide have been observed (American Falls International Board, 1974). Less developed tension-release joints and blasting-originated joints are common along the twin conduits. These fractures probably extend less than 100 ft from the trench walls.

Solution cavities.--Solution cavities are formed by the dissolution of gypsum pockets and stringers by percolating ground water. These cavities range in diameter from 1/16 in to 5 in; they are most abundant in the upper 10 to 15 ft of rock but occur also along water-bearing bedding zones throughout the Lockport. The solution cavities become less continuous with depth and therefore have little effect on the water-transmitting ability of the lower parts of the formation.

Recharge

Most of the recharge to the Lockport Dolomite results from infiltration of rainfall and snowmelt through the soil to the water table. Precipitation in the Niagara Falls area averages 30 in/yr and is fairly evenly distributed throughout the year (Dethier, 1966). Snow usually accumulates from mid-December to mid-March, during which time several thaws may reduce or entirely melt the snow pack. Seven 14-month hydrographs of U.S. Geological Survey wells installed in the upper part of the Lockport (fig. 3) and a 10-year hydrograph of a long-term observation well, Ni-69 (fig. 4) indicate that most recharge occurs from late fall through winter (November to April), when evapotranspiration is low. Generally, water levels fluctuate less than 6 ft annually.

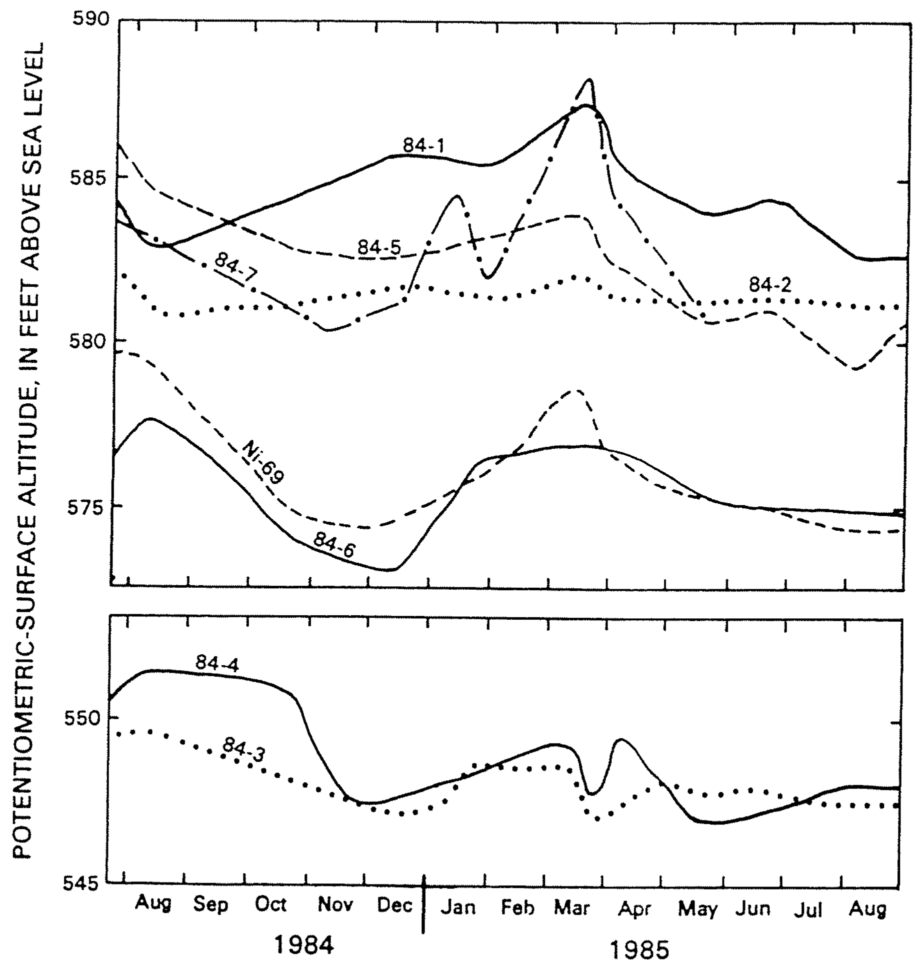


Figure 3.--Hydrographs of wells 84-1 through 84-7 in and near the City of Niagara Falls.

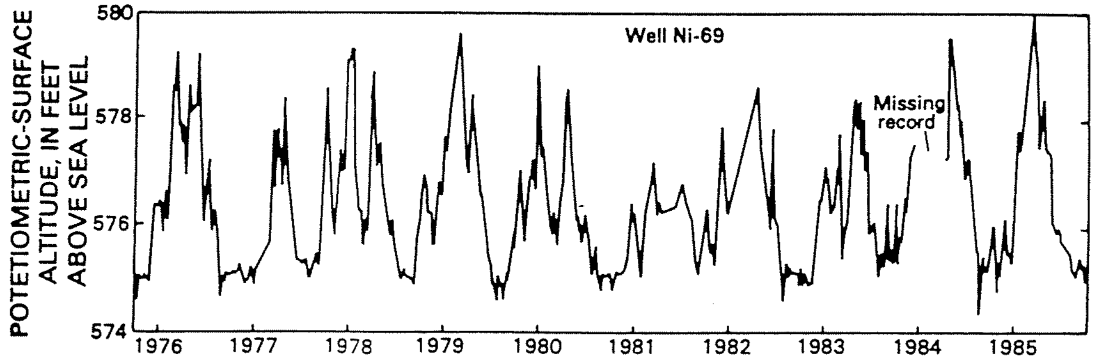


Figure 4.--Hydrograph of well Ni-69 in northern part of the city of Niagara Falls.

The rate and amount of recharge to a formation from precipitation depends on the permeability of the overlying lacustrine fine sand, silt, clay, and till, which in the Niagara Falls area is relatively low, with hydraulic conductivity ranging from 0.0014 to 0.27 ft/d. The average annual recharge from precipitation is estimated to be 5 to 6 in/yr (LaSala, 1967) but is probably greater in several small areas where the Lockport, whose hydraulic conductivity ranges from 5 to 15 ft/d, crops out at land surface.

Movement and Discharge

Before construction of Niagara Power project and Falls Street tunnel.--Little information is available on ground-water levels in the Niagara Falls area before 1960; therefore, interpretation of ground-water movement in the upper part of the Lockport Dolomite before that time is based largely on fundamental assumptions governing ground-water flow. These assumptions are that (1) ground-water divides coincide with topographic highs; thus the major divides in the region were at the Niagara Escarpment, north of the study area (fig. 1), and in the central part of the City of Niagara Falls (pl. 1A); (2) regional flow of ground water followed the south-southwestward slope of the land surface and the southwestward dip of major bedding planes, (3) local ground-water movement followed the configuration of the buried bedrock surface; and (4) ground water in the central and southern parts of the city discharged to the upper Niagara River, while water in the western part discharged to the lower Niagara River in the gorge. The general inferred directions of ground-water movement in the upper part of the Lockport Dolomite before any major construction or industrial pumping is shown in figure 5.

Effect of Falls Street tunnel.--In the early 1900's, the Falls Street tunnel was excavated through the upper part of the Lockport Dolomite from 56th Street to the Niagara gorge (fig. 6). This 3.5-mi-long unlined tunnel trends

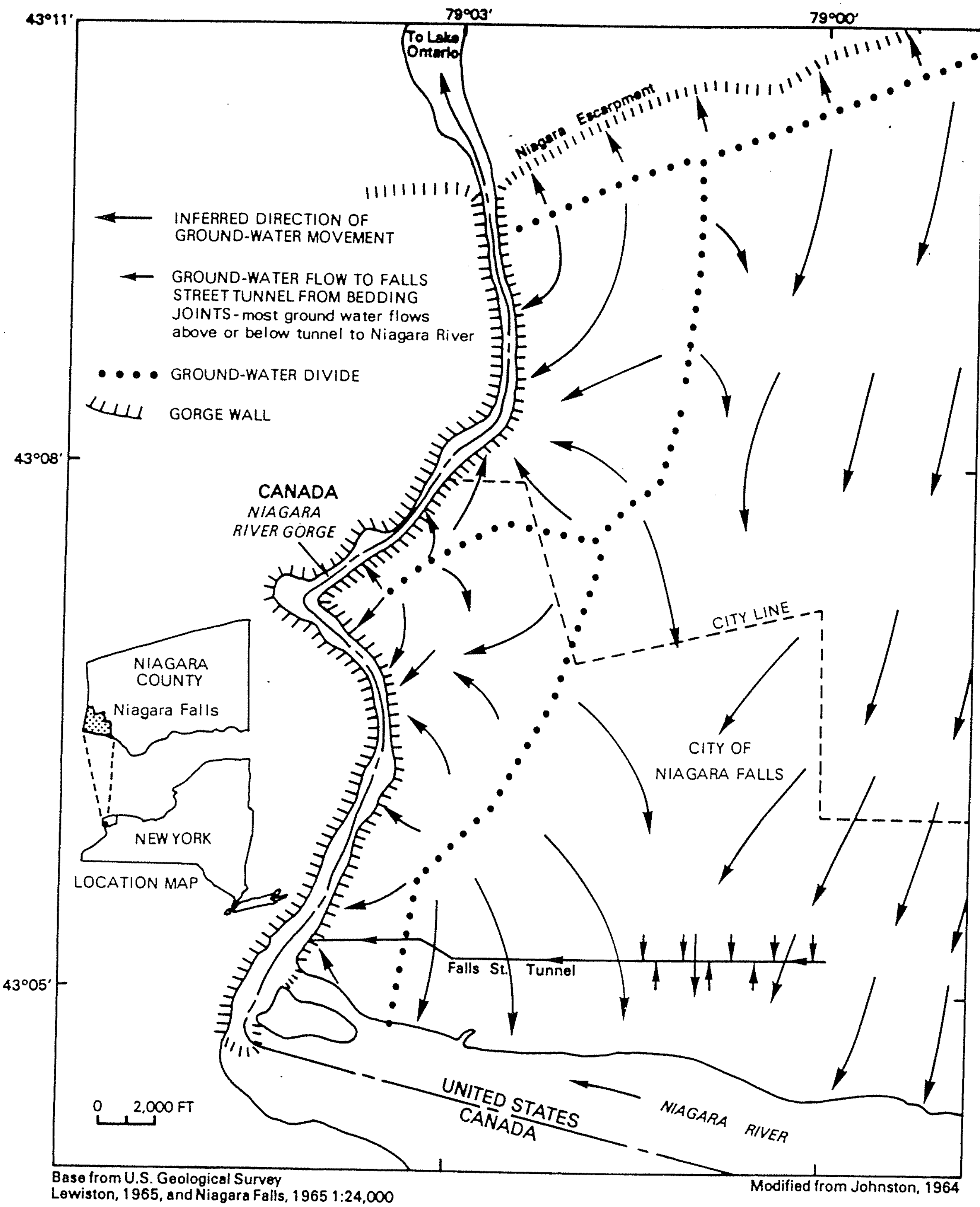
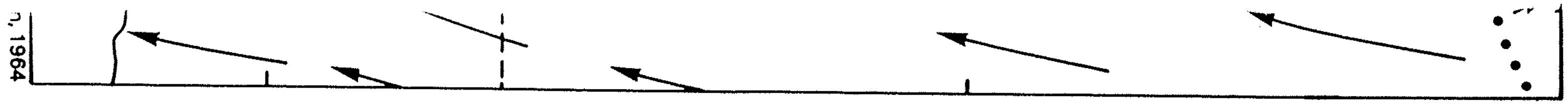


Figure 5.--Inferred directions of ground-water movement in the upper part of the Lockport Dolomite in the Niagara Falls area before any major construction.



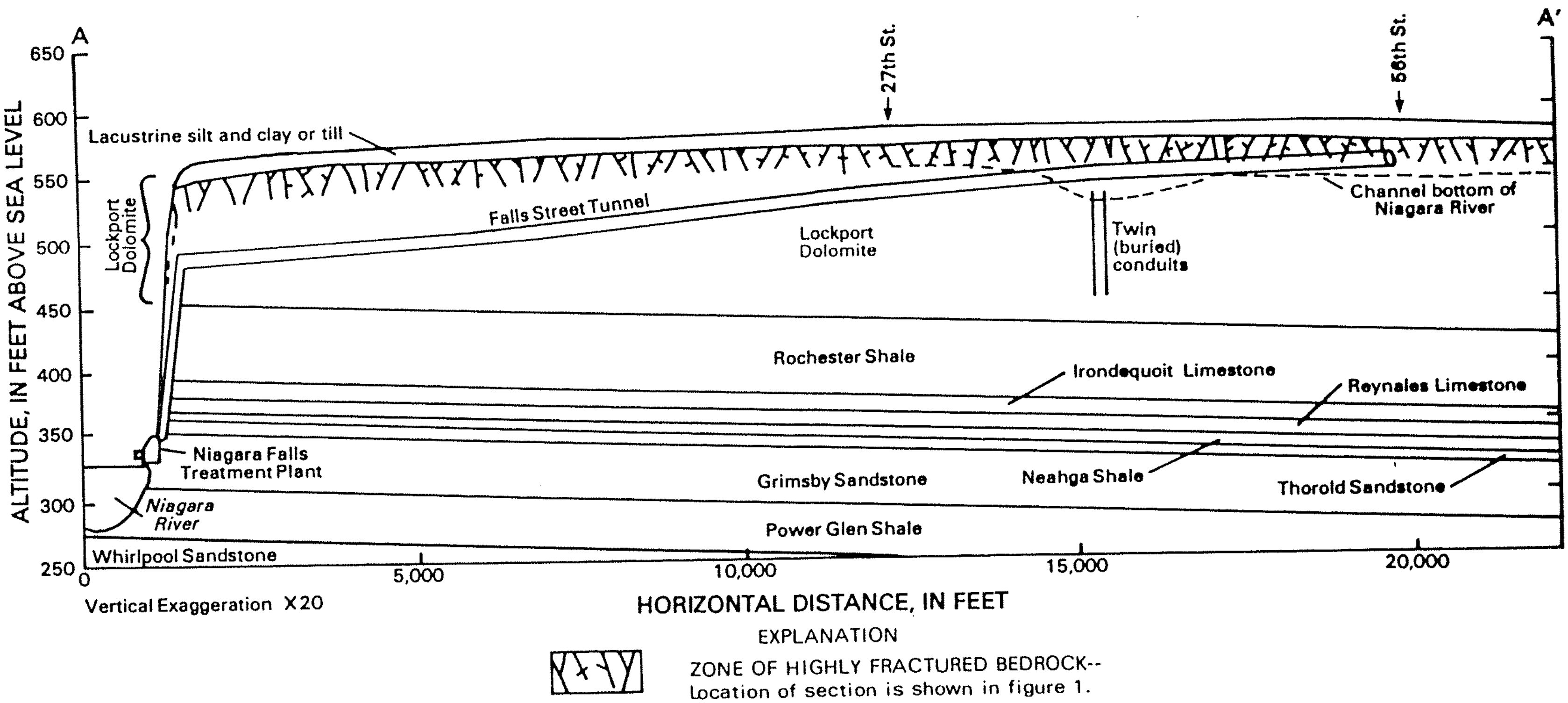


Figure 6.--Vertical section A-A' at Falls Street tunnel. (Location is shown in fig. 1.)

east-west and slopes 20 ft/mi beneath the southern part of the city approximately 0.65 mi north of the upper Niagara River (fig. 1). Runoff and ground water that drained into the tunnel flowed west with sewage to a treatment plant in the Niagara River gorge below the Falls.

The bottom of the Falls Street tunnel slopes westward from 549 ft above sea level at 56th Street to 533 ft at 27th Street (fig. 6), which places the tunnel at or above the altitude of the lowest part of the Niagara River channel in this reach. Thus, in the reach from 56th Street to 27th Street, water from the Niagara River (surface altitude about 560 ft) probably moves through the upper part of the Lockport northward toward the tunnel through the relatively permeable upper 15 to 20 ft of the Lockport. A shallow bedrock valley in this area (pl. 1B) may be a major zone of infiltration to the tunnel because the depth of weathering would be deepest under this channel. Ground water north and south of the tunnel probably drains into the tunnel also, but the size of the area affected by the tunnel is unknown.

The Falls Street tunnel from 24th Street west to the Niagara gorge is 25 ft or more below the relatively permeable upper zone of the Lockport. Thus, the tunnel in this area is overlain by less fractured, less permeable beds that limit downward flow. A study of ground-water infiltration into the tunnel (Camp, Dresser and McKee, 1982) found only minimal seepage to the Falls Street tunnel between 24th Street and the gorge. Although the amount of water that drained into the tunnel before construction of the conduits is unknown, the Falls Street tunnel east of 27th Street probably altered ground-water movement by creating a local ground-water low as water drained into the tunnel from the upper 25 ft of bedrock and possibly from the Niagara River.

During the 1930's and 1940's, several companies drilled and pumped water from an industrialized area within 2,000 ft of the Niagara River near Gill Creek (fig. 1); yields from these wells were as high as 1,800 gal/min. Johnston 1964) and Woodward-Clyde Consultants (1983) reported that most of the pumped water was induced recharge from the Niagara River that moves predominantly through the upper part of the Lockport Dolomite. The induced recharge from the Niagara River by industrial pumping and possibly some infiltration to the Falls Street tunnel are the only known changes in natural ground-water flow patterns in this part of the city before the construction of the Niagara Power Project.

HYDROLOGIC EFFECTS OF NIAGARA POWER PROJECT

The Niagara Power Project, constructed by New York Power Authority during 1958-62, has an electrical production capacity of 1,950,000 kw. Part of the flow of the upper Niagara River 2.5 mi above the Falls is diverted 4 mi north through the twin buried conduits to the L-shaped forebay canal, which is between the Robert Moses powerplant and the Lewiston powerplant (fig. 1). The conduits can divert 50,000 to 75,000 ft^3/s of water, which is at least 25 percent of the river's flow.

Seasonal Diversions

A seasonal operating schedule determines the quantity of water diverted from the river to the forebay canal (table 1). During the tourist season (April 1 to October 31), at least 100,000 ft^3/s must flow over the falls during daylight hours, and at least 50,000 ft^3/s must flow over the falls at night. During the rest of the year, a minimum of 50,000 ft^3/s must flow over the falls at all times. The remainder of the flow, usually between 100,000 and 150,000 ft^3/s, is divided between the NYPA project and the Canadian Ontario Hydropower project. Average flow in the Niagara River at Buffalo, N.Y., 12 mi upstream from the falls, is 204,000 ft^3/s (U.S. Geological Survey, 1984).

The water level in the forebay canal also is regulated by a daily schedule, depending on the amount of water needed for power generation at the Robert Moses and Lewiston powerplants. During periods of peak power demand, generally weekdays from 8:00 a.m. to 4:00 p.m., water is discharged from the pumped-storage reservoir to the forebay canal through the Lewiston powerplant, which supplements flow from the twin conduits; the combined flow is then discharged through the Robert Moses powerplant. The combined discharge of water from the reservoir and conduits raises the water level in the forebay canal (fig. 7). During periods of low power demand, generally weeknights from 8:00 p.m. to 4:00 a.m. and during weekends, the Lewiston powerplant turbines are used as pumps to lift water from the forebay canal up into the reservoir; this generally lowers water level in the forebay canal. During the weekend, the water is pumped from the forebay canal to the Lewiston Reservoir until Monday morning, when it reaches its peak level, about 650 ft above sea level (fig. 8). This power-generation schedule causes water levels in the forebay canal to fluctuate 4 to 20 ft a day (fig. 7) and those in the reservoir to fluctuate by as much as 10 ft a day. The reservoir's water level is highest on Monday morning and slowly decreases through the week.

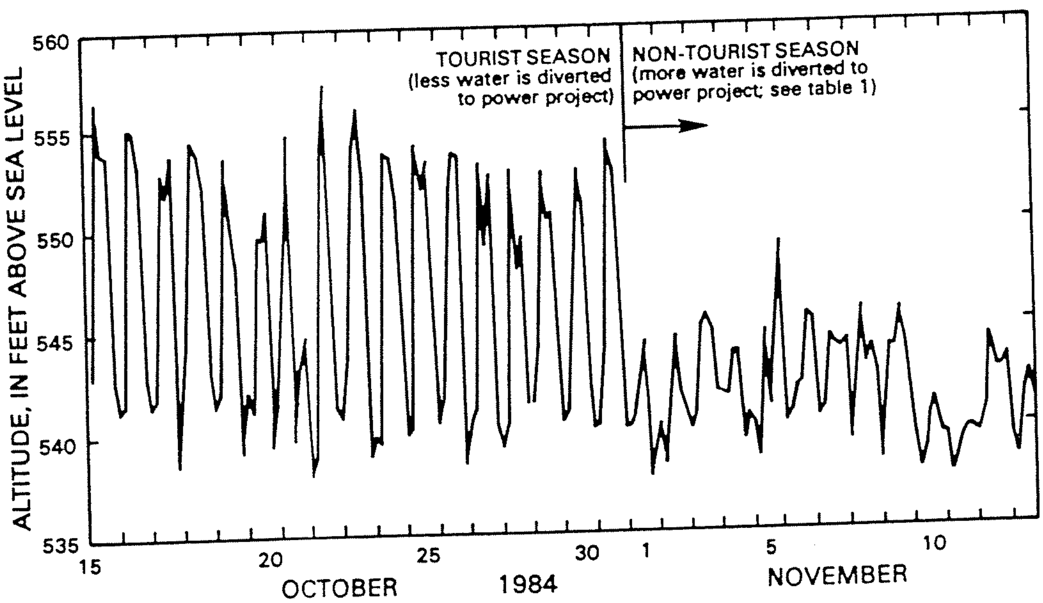


Figure 7.--Daily water-level fluctuation in the forebay canal during late October and early November 1985, showing effect of change in annual diversion schedule.

Table 1.--Flow of Niagara River over Horseshoe and American Falls.[1]

Season	Dates		Hours	Minimum flow over falls (ft^3/s)
Tourist season	Apr. 1 to Sept. 15	Day:	8:00 am to 10:00 pm	100,000
		Night:	10:00 pm to 8:00 am	50,000
	Sept. 1 to Oct. 31	Day:	8:00 am to 8:00 pm	100,000
		Night:	8:00 pm to 8:00 am	50,000
Non-tourist season	Nov. 1 to Mar. 30		12:00 am to 12:00 am	50,000

[1] The diverted water (average total flow of river, 204,000 ft^3/s, minus flow over falls) is divided between Canada and United States.

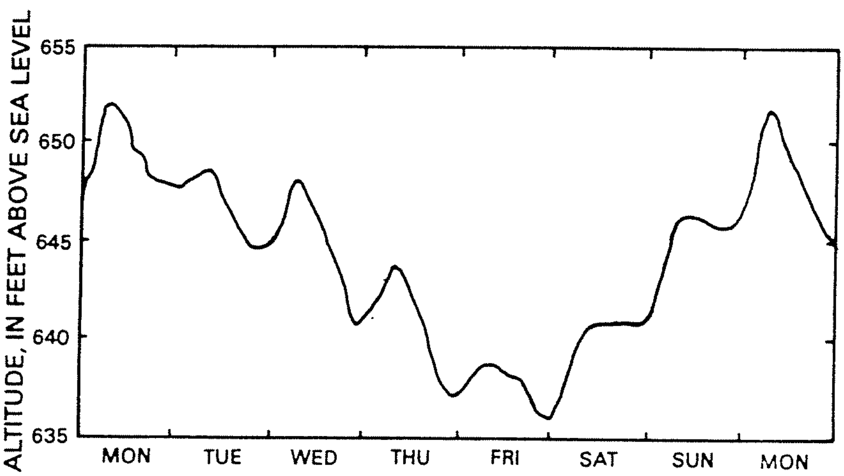


Figure 8.

Typical Lewiston Reservoir water levels during a weekly pumped-storage/release cycle.

Ground-Water Flow and Water Levels

Construction of the twin buried conduits, the forebay canal, and the pumped-storage reservoir has modified hydrologic conditions within the Niagara Falls area. The daily and seasonal regulation of water levels in the reservoir and forebay canal have changed the natural flow patterns and water levels in the upper part of the Lockport Dolomite. To determine the effect of the power project on ground-water movement, water levels in the upper part of the Lockport Dolomite were measured at 104 wells on October 23-24, 1984 and on March 26-27, 1985 (values are given in table 2, at end of report). The difference between water levels in October and those in March were relatively small (generally within 3 to 5 ft); therefore, only the water levels measured in March were used to construct a potentiometric-surface map (pl. 1A), which includes arrows showing the directions of ground-water flow.

Effect of Twin Buried Conduits

The twin buried conduits were constructed in two separate parallel bedrock trenches approximately 4 mi long. Each trench is 52 ft wide and penetrates 100 to 160 ft into the Lockport Dolomite; at the north end they

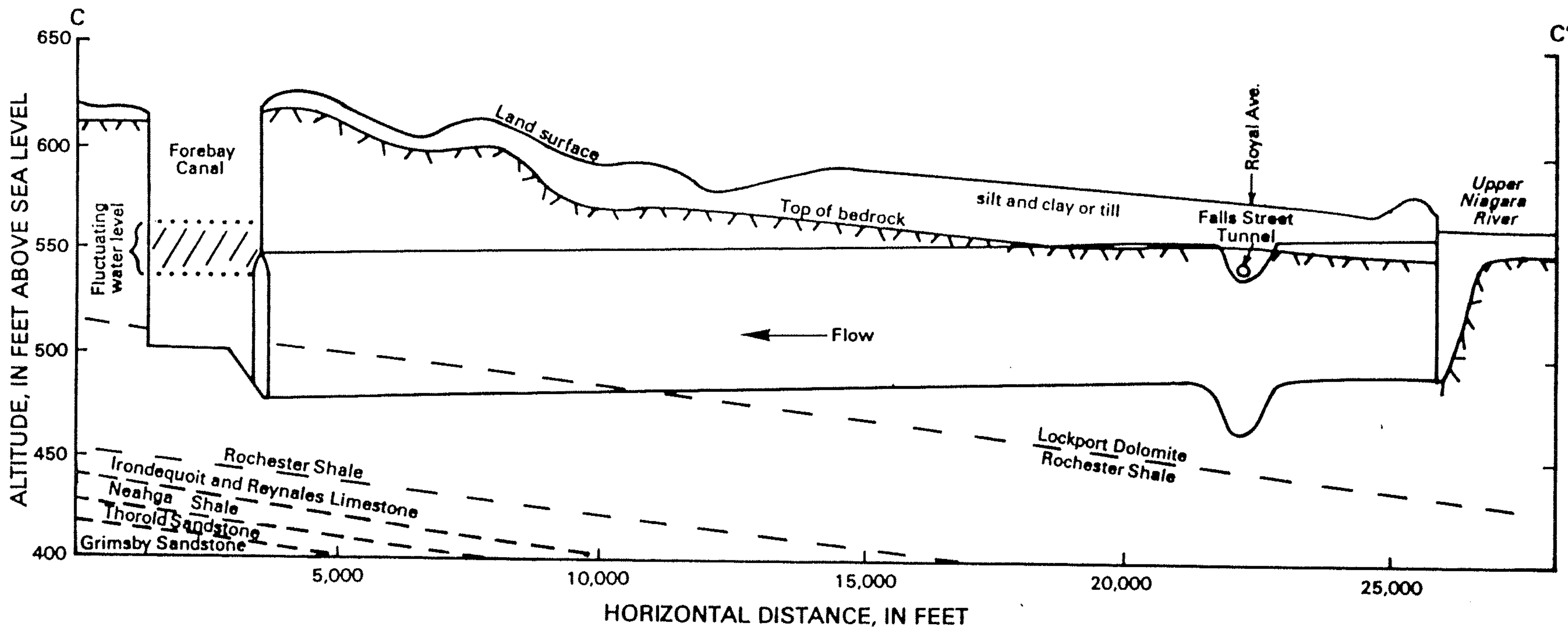


Figure 9.--Vertical section C-C' along twin buried conduits. (Location is shown in fig. 1.)

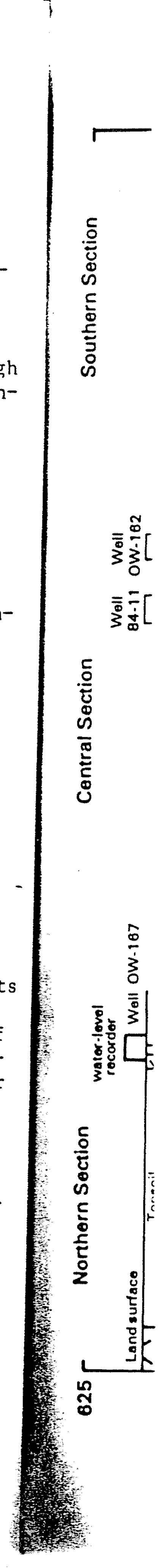
penetrate the Lockport and upper part of the underlying Rochester Shale (fig. 9). The top of the conduits averages more than 40 ft below land surface. General construction details for the conduits are shown in figure 10.

Along the conduits are two dewatering stations--one at the intersection of the Falls Street tunnel at Royal Avenue, the other just south of the forebay canal (fig. 1). Each pumping station has direct access to water in both conduits and to water in the drain system that surrounds the conduits, which is in hydraulic contact with the surrounding bedrock. The pumping stations were designed to drain water from the bedrock surrounding each conduit through the drain system to reduce hydrostatic pressure, which could collapse the conduits should they need to be dewatered.

The drain system surrounding the conduits consists of formed, vertical 6-in-diameter drains placed every 10 ft along both sides of each conduit (fig. 11A), and two semicircular (2-ft radius) floor drains beneath the full length of the conduits at the bottom of each trench. The wall and floor drains are connected to continuous concrete-formed side drains in the lower corners of each bedrock trench (fig. 11A). All drains were formed into the concrete-conduit structure and are open to the bedrock walls and floor of conduit trenches but are not open directly to the river or forebay canal.

The only locations where water in the drain system can mix with water inside the conduits is at the two pumping stations. Each station has three sumps (fig. 11B)--a central sump connected to the conduit drain system that surrounds both conduits, and the two outer sumps, each of which is connected to the adjacent conduit. Both pumping stations have a pair of balancing weirs; one is near the Falls Street tunnel and operates at an altitude of 560 ft; the other is at the conduit outlet on the forebay canal and operates at an altitude of 550 ft. When the water level in the drain system exceeds the altitude of the balancing weir, water from the drains flows through the weir to the outer sumps and into the conduits, which discharge into the forebay canal.

Ground-water discharge into the backfill.--Backfill on top of the conduits was found to be relatively permeable where the Falls Street tunnel and conduits intersect (Koszalka and others, 1985, p. 56); however, no description of the backfill materials elsewhere along the conduits could be found. To determine whether the backfill is permeable elsewhere and forms a major pathway for ground-water movement, four wells were drilled during this study, three over the east conduit (wells 84-9, 84-10, and 84-11) and one over the west conduit (84-8, fig. 1). Drill cuttings indicated that the backfill consists of 2 to 5 ft of topsoil overlying 30 to 75 ft of shotrock (cobble- to boulder-size clasts of Lockport Dolomite that was blasted and removed during trench excavation), which overlies 5 to 15 ft of sandy, clayey silt fill of low permeability that overlies the conduits. The shotrock is permeable but unsaturated; only the lower part of the sandy, clayey silt was saturated. Water-level recorders installed on two wells in the sandy clayey silt (84-9 and 84-11, location shown in fig. 1) indicated that the water levels took several months to recover to a static level after the wells were pumped dry (fig. 12), which indicates that the sandy, clayey silt backfill has very low permeability and therefore transmits little ground water. Well 84-9 did not respond to fluctuations of water levels in the forebay canal, and water levels in well 84-11 fluctuated only when water levels in the forebay rose to altitudes greater



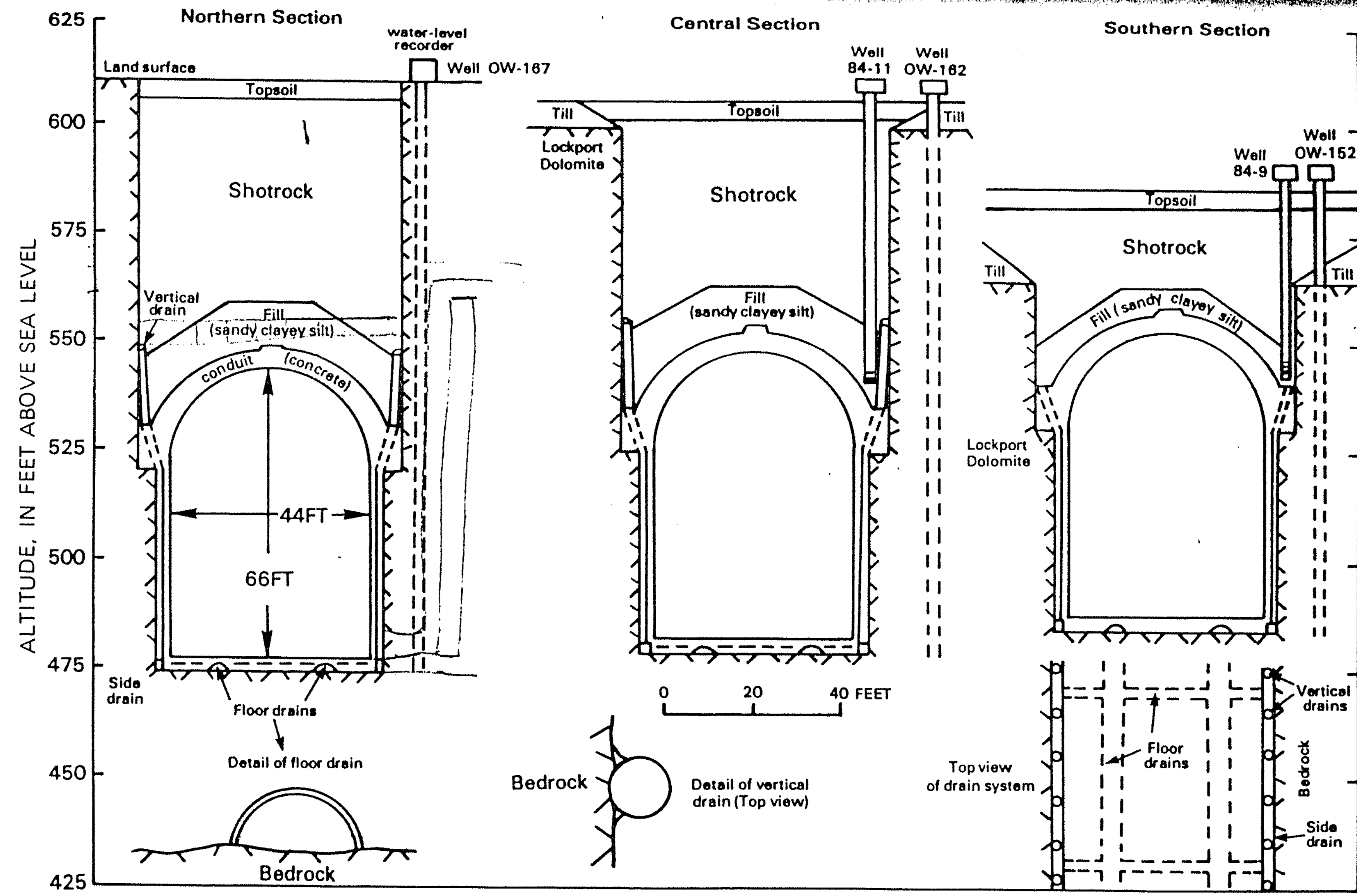


Figure 10.--General construction details of the Niagara Falls conduits at the northern, central, and southern parts of the conduit system. (Modified from Uhl, Hall and Rich, 1961.)

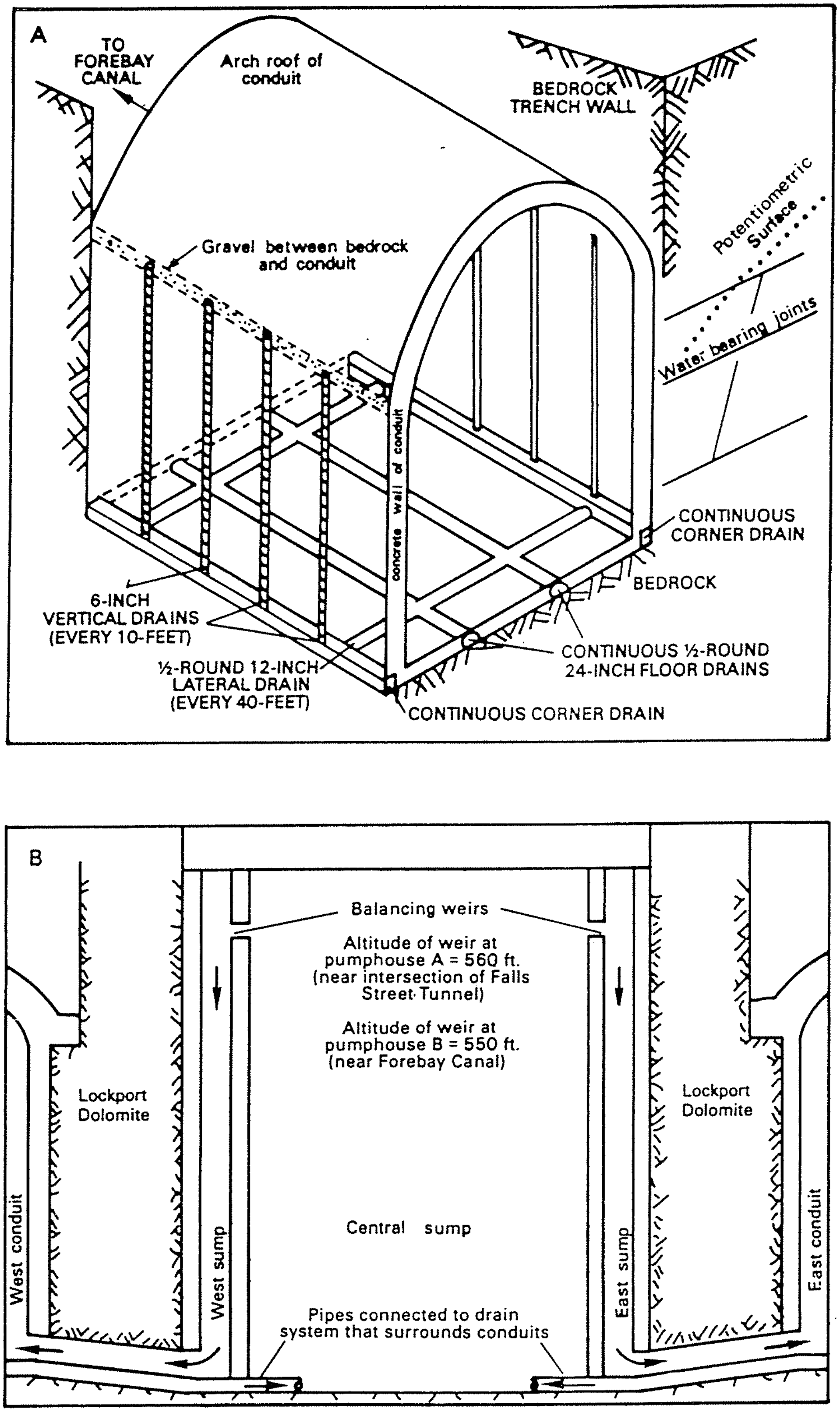


Figure 11.--General details of conduit construction: A. Exterior drain system. B. Pumphouse.

than 560 ft, which occurred at the end of January and beginning of February 1985, when NYPA raised the water level in the forebay canal to clear a large accumulation of pack ice from the conduit intakes along the upper Niagara River. When this occurred, the water level in well 84-11 rose 10 ft to an altitude of 556.11 ft, then began a slow, steady decline (fig. 12). Water-level altitudes greater than 560 ft at well 84-11 would have caused the lower zone of the permeable shotrock fill to become saturated. Water probably entered the well relatively rapidly by leakage down the side of the casing, which could explain the rapid rise of the water level in the well; normally this should not have occurred because the well was installed in relatively impermeable sediment. Well 84-11 does not respond to water-level fluctuations in the bedrock or forebay canal below this altitude.

The relatively impermeable, sandy, clayey silt in the saturated part of the backfill prevents significant ground-water movement in the backfill. An exception may be at the intersection of the Falls Street tunnel and the conduits, where more permeable backfill was found. The method of backfilling there may have been different from that used elsewhere along the conduits because the conduits dip where they pass under the Falls Street sewer (fig. 9).

Ground-water discharge into drains surrounding the conduits.--The drain system that surrounds the conduits has lowered ground-water levels near the conduit trenches, which causes ground water in the Lockport Dolomite to flow toward the conduits (pl. 1A). Ground water within 0.5 mi of the conduits that previously flowed southward now flows toward the conduits and discharges into the drain system. To determine the direction of flow in the drains, water levels were measured in the central chamber in the pumping stations and in several NYPA open-hole wells installed in the bedrock 5 to 10 ft from the vertical wall drains. Because the drain system is in direct hydraulic contact

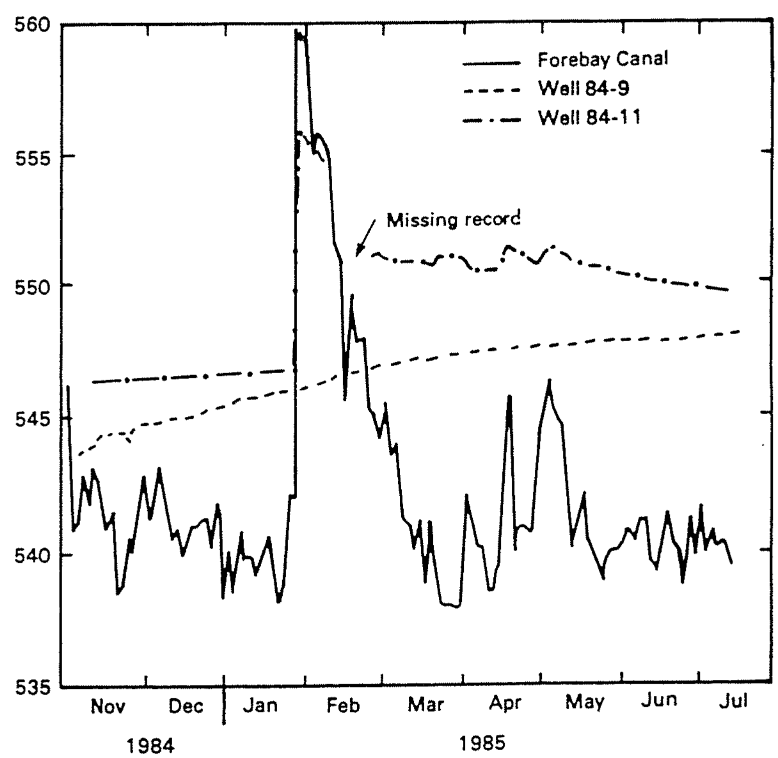


Figure 12.

Average daily water-level fluctuations in the forebay canal and recovery of water levels in wells 84-9 and 84-11 (installed in backfill atop conduits) after evacuation of water from the casing, November 1984 through July 1986.

with ground water in the Lockport Dolomite, the hydraulic heads measured in the NYPA wells are the same or nearly the same as water levels in the drains that surround the conduits (fig. 10). Water levels in wells adjacent to the conduits indicate that, most of the time, water from the vicinity of the forebay canal that enters the drains flows southward to where the Falls Street tunnel crosses the conduits (pl. 1A), whereas water from the upper Niagara River that enters the drains flows northward to the tunnel. The drain system acts as the path of least resistance to ground-water flow in and near the conduit trenches.

The major discharge point for water in the conduit drains is the Falls Street tunnel where it crosses the conduits (fig. 9). The method of construction at the conduit/tunnel intersection probably created this discharge zone. During construction of the conduit trenches, a 400-ft section of the Falls Street tunnel was rebuilt with precast concrete pipe sections, and the conduit trenches were then excavated beneath the Falls Street pipeline. After backfill was placed over the conduits and around the Falls Street tunnel pipe section, ground-water levels in the backfill fluctuated at or above the top of the rebuilt section of the Falls Street tunnel (fig. 13). Apparently the seals between the concrete pipe sections failed, and water from the drains began to leak into the Falls Street tunnel.

In 1982, the Falls Street tunnel was inspected for ground-water infiltration, and a large amount of inflow, estimated at approximately 6 Mgal/d, was found to leak into the Falls Street tunnel through joints in the concrete pipe where the tunnel passes over the conduits (Camp, Dresser and McKee, 1982). Most of this leakage is probably water from the conduit drain system, which drains ground water from 0.5 mi on both sides of the 4-mi-long trenches. The Lockport Dolomite is too impermeable to supply the quantity of water that

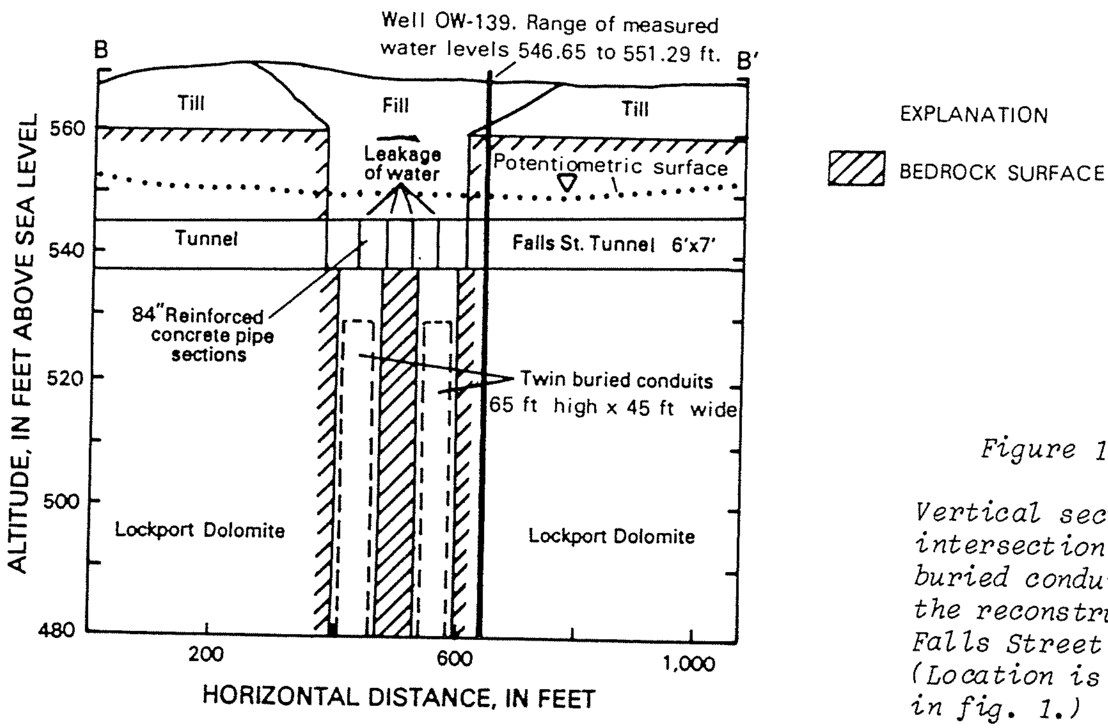


Figure 13.

Vertical section of intersection of twin buried conduits and the reconstructed Falls Street tunnel. (Location is shown in fig. 1.)

leaks into the tunnel. Estimation of how much water enters the Falls Street tunnel from either the north (powerplant) or south (river) side of the tunnel was beyond the scope of this project, however.

Effect of Forebay Canal

The forebay canal is an L-shaped excavation that penetrates the Lockport Dolomite and upper part of the Rochester Shale at the north end (outlet) of the twin conduits (fig. 1). It is 4,000 ft long, 500 ft wide, and 110 ft deep. The walls and floor are unlined. Water that enters the forebay canal from the conduits is routed to the Robert Moses powerplant, and some is pumped up to the Lewiston Reservoir, depending on the daily power-demand schedule.

The daily range of water-level fluctuations in the canal is dependent on the seasonal diversion schedule, the demand for power generation, and the flow of the Niagara River. During the summer and early fall, when the flow in the Niagara River is generally lower, daily fluctuations in the canal are greatest, as much as 25 ft. The water level in the forebay canal is increased by the release of water from the Lewiston Reservoir, which supplements the flow entering from the conduits. This combined flow into the forebay canal increases the hydraulic head in the canal to drive the Robert Moses powerplant turbines more efficiently. During high-flow periods (generally during spring) or when allowable diversions from the Niagara River are higher (table 1), daily water-level fluctuations in the forebay are less, usually ranging from 5 to 10 ft even during peak power-demand periods (fig. 7).

Ground-water discharge into the forebay canal.--The walls and floor of the forebay canal consist of bedrock. Observations of ground-water seepage from bedding planes in the forebay canal walls to the forebay canal (Lockport Dolomite) and higher water levels in nearby wells than in the forebay (pl. 1A and table 2) indicate that ground water generally discharges into the forebay canal. Little, if any, water enters the forebay canal from the underlying Rochester Shale, which has low permeability.

Effects of water-level fluctuations in the forebay canal.--The daily water-level fluctuations in the forebay canal, which can range to as much as 25 ft (fig. 7), cause instantaneous water-level fluctuations in wells along the conduits to as least 3.4 mi south of the forebay canal. The water-level fluctuations in the forebay canal also cause hydraulic-pressure changes in the drain system that surrounds the conduits. Instantaneous head responses in wells adjacent to the twin conduits to water-level fluctuations in the forebay canal suggest a direct hydraulic connection between the forebay canal and the drains. Water probably moves from the canal to the drains through gently southward dipping water-bearing bedding planes that are exposed in the walls of the forebay canal and is intercepted by the drain system that surrounds the conduits.

Water levels were recorded at four NYPA observation wells adjacent to the conduits at various distances south of the forebay canal; well OW-167 is at the outlet of the conduits, and wells OW-162, OW-152, and OW-139 are 0.8, 2.2, and 3.4 mi south of the forebay canal, respectively (fig. 1). Comparison of water levels in these wells with those in the forebay canal shows an immediate response (fig. 14). The magnitude of water-level fluctuations in the drains decreases with distance south of the forebay canal. Well OW-167, closest to the forebay canal, fluctuates daily as much as 12 ft, whereas well OW-139, 3.4 mi from the forebay canal, fluctuates less than 2.5 ft.

Water levels in the NYPA observation wells are nearly always higher than those in the forebay canal. Rising water levels in the forebay canal raises the water level in the drains and adjacent Lockport Dolomite, which reduces the water-table gradient toward the drains and therefore reduces the amount of flow to the drains. Declining water levels in the forebay canal cause the water level in the drains to decline, which increases the water-table gradient toward the drains and increases the amount of ground-water flow from the Lockport Dolomite to the drains.

Most of the time the potentiometric surface, as determined from wells adjacent to the conduits, slopes southward, which indicates that water in the drains usually flows southward (pl. 1A), parallel to the conduits, from the forebay canal to at least where the Falls Street tunnel crosses the conduits. Sometimes, however, when water levels in the forebay canal are low, the water-level gradient in the drains may reverse between wells OW-152 and OW-167 for several hours, which indicates that water in the drains flows northward toward

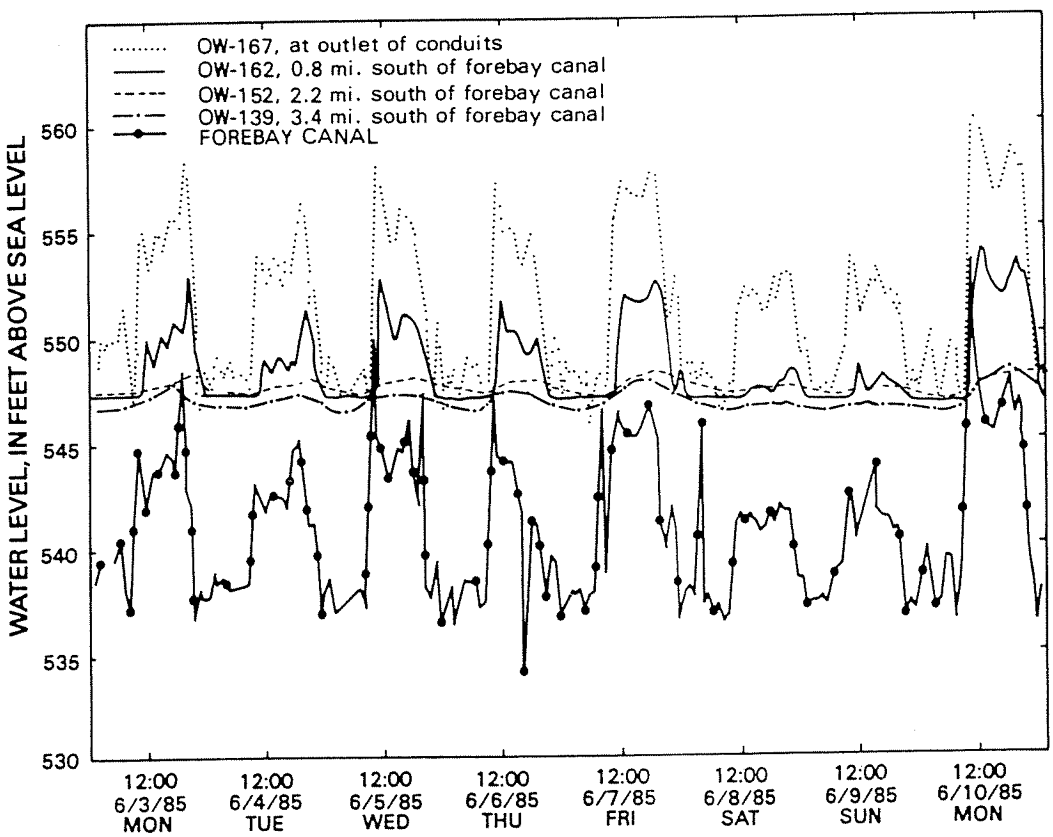


Figure 14.--Water-level response of selected New York Power Authority observation wells adjacent to the conduits to water-level fluctuations in the forebay canal from June 3 through June 10, 1985.

intervals. The water level in well OW-139 is always lower than in the other wells, probably because this well is in the cone of depression formed by the leakage of water into the Falls Street tunnel where it crosses the conduits.

Fluctuation of water levels in the drains can affect the ground-water levels to 0.5 mi on either side of the conduits (pl. 1A). From late December 1960 through early January 1961, the exterior conduit drain pumps at the pumping stations were shut off as the conduits were flooded. Ground-water levels in wells 10 ft, 75 ft, and 450 ft from the conduits rose 50 to 60 ft, but a well 2,400 ft away was not affected (fig. 15). Water levels in these wells show that the flooding of the conduits affected the ground-water levels to at least 450 ft to either side, but probably not beyond 2,400 ft.

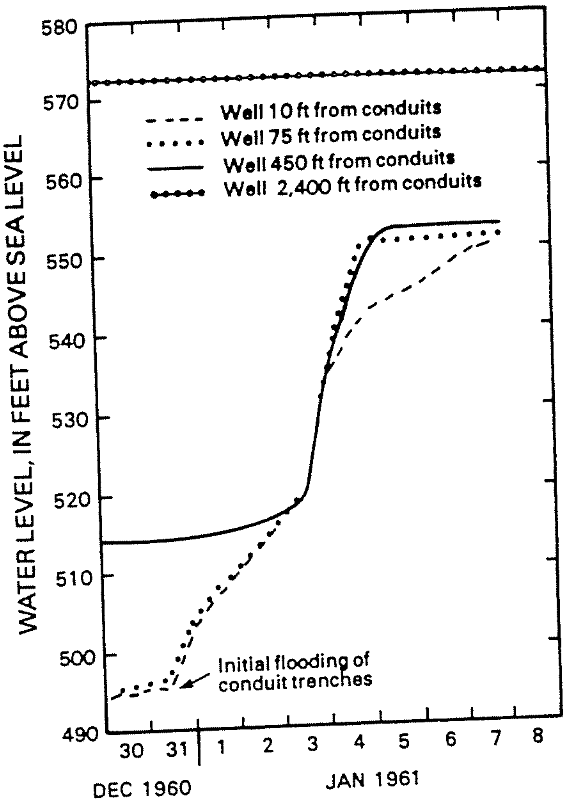


Figure 15.

Effects of 1960-61 flooding of the conduit trenches on water levels in wells 10, 75, 450, and 2,500 feet from the buried conduits.

Effect of Pumped-Storage Reservoir

The 2.97-mi^2 Lewiston pumped-storage reservoir is confined by a 55-ft-high, 6.5-mi-long dike that can contain as much as 60,000 acre-feet of water. The dike consists of a compacted-clay core capped by crushed rock fill and topsoil. The bedrock directly beneath the dike has been sealed with a grout wall (holes drilled at 15-ft intervals into the Lockport to a depth of approximately 70 ft with grout pumped in under pressure) to minimize leakage from the reservoir; the bedrock floor of the reservoir is not sealed. Water levels in the reservoir fluctuate daily; they range between 620 and 650 ft above sea level and average 640 ft (fig. 9).

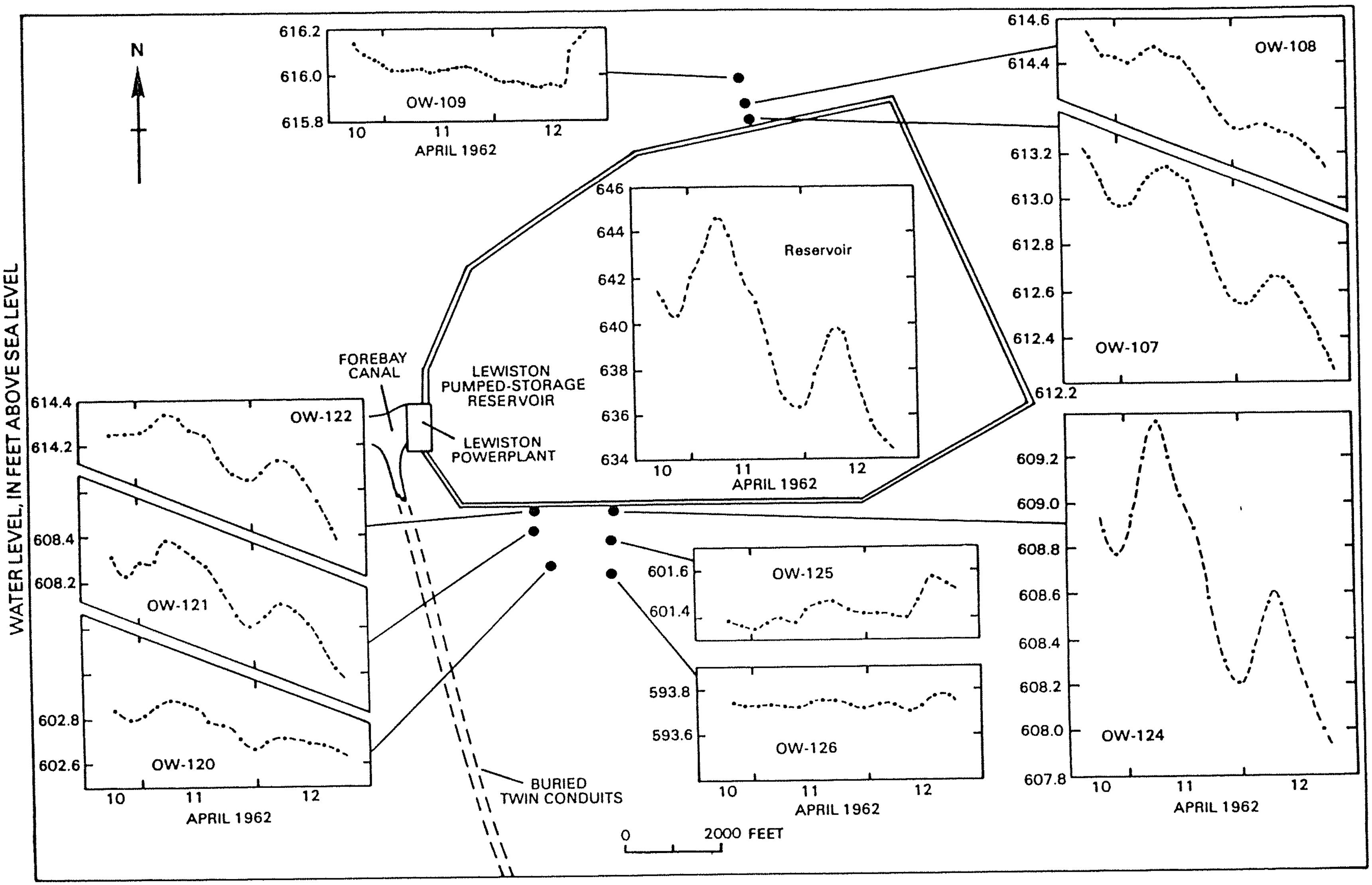


Figure 16.--Response of ground-water levels in vicinity of Lewiston pumped-storage reservoir to water-level fluctuations in reservoir. (Modified from Johnston, 1964.)

Ground-water recharge from the reservoir.--Within 3 weeks after the reservoir was first filled in October 1961, water levels in nearby wells that tap the upper parts of the Lockport Dolomite rose between 1.6 and 17.0 ft, and several wells near the southwest corner of the reservoir started to flow (Johnston, 1964). Johnston attributes the artesian flow and water-level rise to seepage through joints exposed on the floor of the reservoir that intersect the open-hole wells south of the reservoir. Apparently the grout wall beneath the dike did not completely seal off flow beneath the dike. Heads measured elsewhere along the south side of the reservoir reflected the increased reservoir water level, but to a much lesser degree.

Effects of water-level fluctuations.--Ground-water levels in some areas near the reservoir are affected by water-level fluctuations in the reservoir. The degree of fluctuation is dependent on a well's location, the effectiveness of the grout curtain upgradient from the well, and whether the well intersects bedding planes or fractures that extend back to the ungrouted reservoir floor (Johnston, 1964, p. 61-62). Water-level fluctuations in the reservoir affect ground-water levels to the southwest and, to a lesser degree, to the south, but the fluctuations are generally minor (fig. 16), ranging from 0.1 to 1.0 ft (Johnston, 1964). Water-level measurements taken in October 1984 and March 1985 at wells on the south side of the reservoir (table 2, at end of report) indicate that the same range of fluctuation still occurs.

SUMMARY

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation, studied the hydrogeology of the Niagara Falls area during 1984-85 to extend knowledge of ground-water movement in the upper part of the Lockport Dolomite in the area and define the hydraulic effects of the Niagara Power Project. The power project has created recharge and discharge zones that have modified the direction of ground-water flow in the Niagara Falls area. Before construction of the power project in 1958-62, ground water in the upper part of the Lockport Dolomite generally flowed southward, parallel to the buried surface of the Lockport Dolomite. Ground water in the central and eastern parts of the city flowed south and southwestward toward the upper Niagara River, and ground water in the western part of the city flowed westward to the Niagara River gorge.

Since completion of the power project, ground water within 0.5 mi of both sides of the buried twin conduits flows toward the conduits and into the drain system that surrounds them. Water in the drains flows southward from the forebay canal to Royal Avenue, where it leaks into the Falls Street tunnel. In addition, water from the upper Niagara River flows northward in the drains to Royal Avenue, where it also leaks into the Falls Street tunnel. Approximately 6 Mgal/d leaks into the Falls Street tunnel where it crosses the conduits. Water in the tunnel flows westward to the Niagara River gorge below the falls.

Water-level fluctuations in the forebay canal, which connects the Lewiston pumped-storage reservoir with the Robert Moses powerplant, affects the potentiometric-surface gradient in the upper part of the Lockport Dolomite. The potentiometric surface within about 0.5 mi of the conduits slopes toward the conduits from both sides. High water levels in the canal raise the water level in the drains that surround the conduits and thus decreases the water-table gradient toward the conduits and reduces ground-water discharge to the drains. Low water levels in the forebay canal decrease the water level in the drains, which increases the water-table gradient toward the conduits and increases ground-water discharge to the drains.

Water levels in bedrock wells adjacent to the conduits fluctuate instantaneously with those in the forebay canal, but the magnitude of fluctuation diminishes with distance from the forebay canal. The drains that surround the conduits transmit changes in hydraulic pressure head from the forebay canal at least 3.4 mi south to the Fall Street tunnel area.

Water in the Lewiston pumped-storage reservoir recharges ground water south of the reservoir by seepage through bedding joints that crop out in its unlined bottom. Water then flows through the partially effective grout curtain, which was constructed under the reservoir's dike, then flows south-southwestward to the conduits. Water-level fluctuations in the Lewiston pumped-storage reservoir cause only slight fluctuations of water levels in nearby wells.

Although the Niagara Power Project has altered the natural pattern of ground-water movement in the Niagara Falls area, the effects occur primarily within 0.5 mi of any part of the project. Localized changes in flow direction may have a direct bearing on how and where solutes from known hazardous waste sites could be migrating.

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Table 2.--Records of selected wells in Niagara Falls, New York.

NUMBERING AND ARRANGEMENT OF WELLS

All wells are identified by latitude and longitude to the nearest second, as measured from 7 1/2-minute topographic maps, scale 1:24,000. The location of each well was plotted on these maps by U.S. Geological Survey staff during a visit to the site, from large-scale engineering drawings, or from consultant reports. All measuring points have been leveled to National Geodetic Vertical Datum (sea level) unless otherwise noted.

The location of each well is shown on plate 1A. Data are arranged in 1-minute strips of latitude. Each table begins with the southernmost strip followed by other strips successively farther north.

FOOTNOTES AND ABBREVIATIONS

Owner

NYPA - New York Power Authority
USGS - U.S. Geological Survey
CNF - City of Niagara Falls

Date Drilled

Year in which well was drilled. NYPA wells drilled between 1958 and 1960.

Well Depth

Total depth of well from land surface unless noted: PKR indicates level of packer in borehole.

Screen Interval

Screen located at bottom of well unless noted:
OH - open hole
OE - open end

Aquifer Type

Lock. Dol. - Lockport Dolomite
Roch. Sh. - Rochester Shale
Backfill - Well screened in backfill (sandy-silt) on top of NYPA conduits.

Measuring Point

(e) indicates estimated measuring point.

Geologic Log

Geologic log available at U.S. Geological Survey, Ithaca, N.Y.

Table 2.--Records of selected wells in Niagara Falls, New York.

(Dashes indicate no data.)

Location lati-tude	Location long-itude	Local well no.	Owner	Date drilled	Well depth (ft)	Casing depth (ft)	Screen interval (ft)	Depth to bedrock (ft)	Aquifer type	Measuring point (ft above sea level)	Water level (ft above sea level) Oct. 23-24, 1984	Water level (ft above sea level) Mar. 26-27 1985	Geologic log
4304 29	7900 25	SP8	Occidental	1979	44	39	5	35	Lock.Dol.	570.10	562.09	561.29	yes
4304 32	7900 15	16	Occidental	1979	36	31	5	31	Lock.Dol.	570.4	562.11	561.43	yes
4304 35	7900 45	SP6	Occidental	1979	31	26	5	26	Lock.Dol.	568.0	554.18	551.46	yes
4304 36	7900 36	10	Occidental	1979	30.5	20.5	10	20.5	Lock.Dol.	569.7	560.46	559.37	yes
4304 38	7900 45	SP5	Occidental	1979	40.0	35.0	5	30	Lock.Dol.	569.1	553.92	550.91	yes
4304 39	7900 52	OW130	NYPA	1958	90.5	30	OH	30	Lock.Dol.	570.80	554.58	552.10	no
4304 40	7901 01	OW133	NYPA	1958	91.2	30	OH	30	Lock.Dol.	570.65	552.34	549.16	no
4304 43	7901 18	20	Occidental	1979	31	26	5	26	Lock.Dol.	572.2	560.49	559.30	yes
4304 43	7901 35	RMP-3	USGS	1982	30.5	27.5	3.0	21.5	Lock.Dol.	576.(e)	562.16	562.66	yes
4304 43	7901 43	RMP-4	USGS	1982	25.0	22.0	3.0	19.5	Lock.Dol.	577.(e)	---	565.90	yes
4304 43	7901 54	RMP-5	USGS	1982	30.0	27.0	3.0	20.0	Lock.Dol.	583.(e)	---	562.78	yes
4304 43	7902 03	RMP-6	USGS	1982	25.5	22.5	3.0	20.5	Lock.Dol.	583.(e)	---	563.38	yes
4304 44	7901 13	RMP-1	USGS	1982	27.0	24.0	3.0	--	Clay	588.(e)	565.33	565.45	yes
4304 44	7901 22	RMP-2	USGS	1982	27.0	24.0	3.0	21.0	Lock.Dol.	583.(e)	562.96	562.96	yes
4304 45	7901 35	1B	Dupont	1983	29	16	OH	12.2	Lock.Dol.	571.61	561.34	561.34	yes
4304 45	7901 52	4C	Dupont	1983	46	30	OH	13.5	Lock.Dol.	569.98	559.40	559.33	yes
4304 47	7900 30	40	Occidental	1979	27	22	5	22	Lock.Dol.	572.1	553.69	551.88	yes
4304 47	7900 46	27	Occidental	1979	28	23	5	23	Lock.Dol.	572.3	554.00	551.13	yes
4304 47	7901 13	8B	Dupont	1983	28.6	14	OH	12	Lock.Dol.	568.02	562.01	562.18	yes
4304 47	7902 00	5B	Dupont	1983	26	17	OH	13	Lock.Dol.	572.82	557.00	557.47	yes
4304 48	7901 07	7C	Dupont	1983	45	30	OH	16	Lock.Dol.	571.17	550.06	549.01	yes
4304 49	7901 04	OW137	NYPA	1958	86.9	20	OH	20	Lock.Dol.	568.10	552.14	548.89	no
4304 49	7901 30	12B	Dupont	1983	27.0	14	OH	11	Lock.Dol.	572.14	559.74	560.20	yes
4304 50	7901 23	10C	Dupont	1983	19.5	19.0	OE	7.5	Lock.Dol.	570.58	557.76	557.76	yes
4304 50	7901 36	14C	Dupont	1983	70.0	25.0	OH	8.0	Lock.Dol.	572.10	554.63	552.72	yes
4304 50	7901 43	15C	Dupont	1983	31.0	22.5	OH	6.0	Lock.Dol.	571.30	556.36	556.58	yes
4304 51	7900 43	26	Occidental	1979	25	20	5	19.5	Lock.Dol.	571.2	551.41	--	yes
4304 52	7900 17	18C	Dupont	1983	35.9	21.3	OH	13.0	Lock.Dol.	570.67	560.46	560.35	yes
4304 54	7901 08	23B	Dupont	1983	--	--	--	--	Lock.Dol.	569.63	549.66	548.05	no
4304 54	7901 51	19B	Dupont	1983	23.1	13.5	OH	10.5	Lock.Dol.	573.26	554.79	553.43	yes
4304 57	7900 25	41	Occidental	1979	29	19	10	19	Lock.Dol.	571.8	551.03	549.16	yes
4305 06	7902 39	82-4	USGS	1982	25	23	2	10.5	Lock.Dol.	575.10	564.08	568.20	yes
4305 07	7859 45	82-8	USGS	1982	25	23	2	21.0	Lock.Dol.	571.60	560.00	559.70	yes
4305 10	7901 48	82-5	USGS	1982	21	19	2	10.5	Lock.Dol.	570.28	553.85	554.18	yes
4305 11	7900 58	82-9	USGS	1982	38	35	3	none	Backfill	569.62	549.92	546.72	yes

Table 2.--Records of selected wells in Niagara Falls, New York (continued).

Location: latitude	Location: longitude	Local well no.	Owner	Date drilled	Well depth (ft)	Casing depth (ft)	Screen interval (ft)	Depth to bedrock (ft)	Aquifer type	Measuring point (ft above sea level)	Water level (ft above sea level): Oct. 23-24, 1984	Water level (ft above sea level): Mar. 26-27 1985	Geologic log
4305 11	7901 02	82-11	USGS	1982	38	36	2	19.0	Lock.Dol.	569.43	548.09	545.13	yes
4305 13	7900 58	OW139	NYPA	1958	--	9.5	OH	9.5	Lock.Dol.	569.44	551.29	547.70	no
4305 14	7900 58	82-10	USGS	1982	38	35	3	17.0	Lock.Dol.	569.77	550.60	547.02	yes
4305 16	7902 45	82-3	USGS	1982	23	21	2	7.0	Lock.Dol.	580.71	567.04	567.81	yes
4305 16	7903 57	82-1	USGS	1982	113.7	109.2	4.5	23.0	Roch.Sh.	554.13	504.73	514.73	yes
4305 18	7901 49	82-6	USGS	1982	22.0	20	2.0	10.5	Lock.Dol.	571.81	556.88	557.51	yes
4305 20	7859 41	82-7	USGS	1982	24.0	22	2.0	18.0	Lock.Dol.	572.78	558.46	558.68	yes
4305 27	7903 44	82-2	USGS	1982	124.2	118.5	5.7	18.5	Roch.Sh.	570.46	501.72	504.06	yes
4305 33	7859 41	51	CECOS	--	--	--	--	--	---	574.11	--	568.44	no
4305 35	7900 00	83	CECOS	--	--	--	--	--	---	577.63	--	566.38	no
4305 37	7859 18	81	CECOS	1980	50.0	35	--	20.0	Lock.Dol.	577.26	--	564.39	yes
4305 38	7901 24	84-3	USGS	1984	29.5	24.5	5	13.5	Lock.Dol.	573.15	548.18	546.90	yes
4305 43	7859 36	VH129C	Dupont	1983	42.2	31.0	OH	24.5	Lock.Dol.	586.13	570.37	568.95	yes
4305 44	7859 55	VH116C	Dupont	1983	30	22.2	OH	12.2	Lock.Dol.	584.15	569.82	571.09	yes
4305 46	7859 31	VH117C	Dupont	1983	42	31.5	OH	21.5	Lock.Dol.	580.78	565.41	566.30	no
4305 47	7859 50	VH115C	Dupont	--	36.5	30.0	OH	20.0	Lock.Dol.	594.41	572.03	573.62	yes
4305 54	7902 23	84-2	USGS	1984	29.7	24.7	5	8.5	Lock.Dol.	592.48	581.23	581.58	yes
4305 56	7900 10	14	Reichold	1984	--	--	--	--	Lock.Dol.	595.60	585.10	579.90	no
4305 58	7900 06	18	Reichold	1984	--	--	--	--	Lock.Dol.	595.98	583.99	589.65	no
4305 58	7900 07	16	Reichold	1984	--	--	--	--	Lock.Dol.	596.10	582.08	588.88	no
4305 58	7900 13	12	Reichold	1984	--	--	--	--	Lock.Dol.	597.34	586.79	585.56	no
4306 03	7900 08	9	Reichold	1984	--	--	--	--	Lock.Dol.	598.89	588.38	594.48	no
4306 05	7859 54	76	CECOS	--	--	--	--	--	Lock.Dol.	602.50	---	589.75	no
4306 17	7859 08	29	CECOS	--	--	--	--	--	Lock.Dol.	595.91	---	583.24	no
4306 18	7900 51	OW151	NYPA	1958	106.6	22.5	--	22.5	Lock.Dol.	587.47	551.14	545.29	no
4306 18	7900 52	84-8	USGS	1984	47.0	43.0	2.0	none	Backfill	588.03	---	541.35	yes
4306 18	7900 53	OW150	NYPA	1960	107.4	23.0	OH	23.0	Lock.Dol.	588.03	551.57	547.51	no
4306 20	7900 43	84-4	USGS	1984	46.0	41.0	5.0	29.0	Lock.Dol.	586.66	550.85	547.64	yes
4306 20	7900 48	OW152	NYPA	1958	111.6	26.0	OH	26.0	Lock.Dol.	586.83	549.99	543.90	no
4306 20	7900 49	84-9	USGS	1984	47.0	45.0	2.0	none	Backfill	590.45	---	547.41	yes
4306 20	7900 50	OW153	NYPA	1958	104.2	27.0	OH	27.0	Lock.Dol.	587.45	551.22	545.81	no
4306 27	7902 49	84-1(a&b)	USGS	1984	40.3	35.3	5.0	19.0	Lock.Dol.	598.16	582.64	585.76	yes
4306 40	7901 55	84-5	USGS	1984	41.8	36.8	5.0	18.5	Lock.Dol.	600.22	582.71	582.67	yes
4306 44	7900 45	OW154	NYPA	1958	114.6	18.0	OH	18.0	Lock.Dol.	586.24	551.50	550.96	no
4306 44	7900 48	OW157	NYPA	1958	110.2	17.5	OH	17.5	Lock.Dol.	592.75	551.78	544.20	no

Table 2.--Records of selected wells in Niagara Falls, New York (continued).

4306 44 7900 48 OW157 NYPA 1958 110.2 17.5 OH 17.5 Lock.Dol. 592.75 551.78 544.20 no

Table 2.--Records of selected wells in Niagara Falls, New York (continued).

Location lati-tude	Location long-itude	Local well no.	Owner	Date drilled	Well depth (ft)	Casing depth (ft)	Screen interval (ft)	Depth to bedrock (ft)	Aquifer type	Measuring point (ft above sea level)	Water level (ft above sea level) Oct. 23-24, 1984	Water level (ft above sea level) Mar. 26-27 1985	Geologic log
4306 45	7900 49	OW155	NYPA	1958	121.5	20.0	OH	20.0	Lock.Dol.	591.02	551.28	---	no
4306 53	7903 12	85-1	USGS	1985	60.0	55.0	5.0	42.5	Lock.Dol.	588.10	---	---	yes
4306 56	7902 19	NI-69	CNF	1958	36.0	17.0	OH	17.0	Lock.Dol.	598.98	574.77	576.88	no
4307 05	7902 53	84-10	USGS	1984	54.0	52.0	2.0	none	Backfill	595.69	---	549.00	yes
4307 05	7900 54	OW160	NYPA	1958	113.6	23.5	OH	23.5	Lock.Dol.	595.18	551.45	---	no
4307 13	7902 55	85-2	USGS	1985	65.0	63	2.0	45.0	Lock.Dol.	589.66	---	---	yes
4307 31	7900 38	OW105	NYPA	1958	73.8	18	OH	18	Lock.Dol.	593.38	574.75	580.02	no
4307 34	7901 03	OW162	NYPA	1958	131.8	17.8	OH	17.8	Lock.Dol.	605.88	552.58	543.76	no
4307 34	7901 04	84-11	USGS	1984	67.0	65.0	2.0	none	Backfill	611.26	---	550.48	yes
4307 34	7901 05	OW164	NYPA	1958	94.5	18.5	OH	18.5	Lock.Dol.	608.64	552.52	544.13	no
4307 34	7901 06	OW166	NYPA	1958	130.6	18.3	OH	18.3	Lock.Dol.	608.23	555.77	544.24	no
4307 38	7900 56	OW101	NYPA	1958	73.5	19.2	OH	19.2	Lock.Dol.	597.92	---	580.53	no
4307 40	7900 33	OW102	NYPA	1958	48.7	10.5	OH	10.5	Lock.Dol.	600.74	577.37	583.26	no
4307 46	7901 58	24	Occidental	1980	23.0	18	5.0	6.0	Lock.Dol.	616.74	602.20	610.18	yes
4307 47	7901 18	84-6	USGS	1984	50.0	47.5	2.5	9	Lock.Dol.	618.32	573.85	577.07	yes
4307 50	7901 55	7	Occidental	1979	20.8	18.8	2	6.2	Lock.Dol.	613.80	599.48	604.84	yes
4307 52	7902 22	18	Occidental	1979	85.5	80.5	5	35.6	Lock.Dol.	599.14	551.27	554.91	yes
4307 53	7859 58	OW119	NYPA	1958	39.4PKR	11.6	OH	11.6	Lock.Dol.	615.60	603.63	610.54	no
4307 59	7900 23	OW126	NYPA	1958	20.2PKR	8.3	OH	8.3	Lock.Dol.	601.42	597.01	598.30	no
4307 59	7901 16	OW169	NYPA	1958	149.2	9.2	OH	9.2	Lock.Dol.	624.13	553.47	542.35	no
4307 59	7901 17	OW170	NYPA	1958	121.0	10.5	OH	10.5	Lock.Dol.	625.15	554.44	542.53	no
4307 59	7901 18	OW171	NYPA	1958	132.0	10.5	OH	10.5	Lock.Dol.	625.20	554.31	542.12	no
4308 02	7859 58	OW106	NYPA	1958	33.9PKR	18.7	OH	18.7	Lock.Dol.	618.20	601.22	604.33	no
4308 03	7902 16	22	Occidental	1980	43.4	38.4	5.0	23.4	Lock.Dol.	591.75	549.70	---	yes
4308 04	7859 18	OW129	NYPA	1958	35.1PKR	15.0	OH	15.0	Lock.Dol.	614.84	604.47	609.16	no
4308 06	7859 58	OW118	NYPA	1958	38.5PKR	16.4	OH	16.4	Lock.Dol.	613.89	602.19	603.28	no
4308 07	7859 18	OW128	NYPA	1958	33.0PKR	11.5	OH	11.5	Lock.Dol.	613.13	604.83	609.10	no
4308 07	7900 24	OW125	NYPA	1958	34.9PKR	9.0	OH	9.0	Lock.Dol.	612.45	600.85	603.24	no
4308 08	7901 22	OW168	NYPA	1958	136.1	7.5	OH	7.5	Lock.Dol.	610.39	559.77	548.41	no
4308 09	7901 18	OW167	NYPA	1958	135.4	7.5	OH	7.5	Lock.Dol.	609.30	559.31	545.40	no
4308 11	7859 58	OW104	NYPA	1958	64.6	11.9	OH	11.9	Lock.Dol.	609.34	595.25	596.03	no
4308 11	7900 23	OW124	NYPA	1958	35.2PKR	11.5	OH	11.5	Lock.Dol.	613.58	596.62	597.30	no
4308 15	7901 12	OW185	NYPA	1958	60.0	10.0	OH	10.0	Lock.Dol.	619.25	596.61	599.28	no
4308 15	7901 35	84-7	USGS	1984	46.2	41.2	5.0	13.5	Lock.Dol.	613.95	580.87	584.68	yes

90-34-1476
SMF

RESUBMISSION

SKW
ALLOYS, INC. P. O. BOX 368, NIAGARA FALLS, NEW YORK 14302 . TELEPHONE: 716-285-1252

REC'D
4/29/87

April 28, 1987

New York State Department of
Environmental Conservation
600 Delaware Avenue
Buffalo, New York 14202-1073

Attn: Mr. James P. Goehrig
Junior Sanitary Engineer

Dear Mr. Goehrig:

The following is being supplied in response to your October 17, 1986 and Mr. Robert J. Mitrey's (NYSDEC) April 9, 1987 correspondence to SKW Alloys, Inc. Some of this information was previously supplied to your office in our correspondence of November 10, 1986. This correspondence will deal with each of the items addressed in your previous letter. This will help ensure an administratively complete application for renewal of Cell No. 2's operating permit.

At anticipated plant production rates Cell No. 3 will be required within the near future. We are therefore proceding with development of the required application. In the interim we will proceed in such a manner as to optimize the waste fill capacities of Cells No. 1 and No. 2.

Information pertinent to your Department's list of items that are either missing or need to be updated are as follows:

1) NYSDEC: Copy of deed.
   SKW Alloys: A copy of the deed for the solid waste management facility is provided by Attachment Item 1.
2) NYSDEC: Engineering Report - Plan of Operations (12/5/80 report on file).
   a) Daily operations - update
   b) Personnel responsibilities - update
   c) Fill progression - current and future
   d) Contingency plan in case of such emergencies as illegal dumping
   e) Type of equipment used, including backup equipment - update
   f) Nearby water supplies - update
   SKW Alloys: A copy of "Update of December 5, 1980 Engineering Report - Plan of Operations for Landfill Cell No. 2 at SKW Alloys,

Inc.'s Witmer Road Site" is provided by Attachment 2.

3) NYSDEC: Engineering plans
   a) Existing and final elevations of Cell No. 2
   b) Surface water drainage - any changes from 5/20/81 DEIS
   c) Bench mark for elevation control
   d) Fill progress drawings - update if needed
   e) Updated topographic map

   SKW Alloys: A copy of "Update of Engineering Plans for Landfill Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site" is provided by Attachment 3.

4) NYSDEC: Program for addressing nuisance conditions update from 5/20/81 DEIS

   SKW Alloys: Refer to Section 3 of "Update of Engineering Plans for Landfill Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site" which is provided by Attachment 3.

5) NYSDEC: Closure plan
   a) Quality assurance/quality control program for cap placement.
   b) Anticipated duration of post closure maintenance and monitoring (30 years of post closure maintenance and monitoring is the current standard)
   c) Update closure/post closure costs

   SKW Alloys: A copy of "Closure and Post Closure Plan for Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Landfill" is provided by Attachment 4.

6) NYSDEC: Specify again exactly which type of wastes will be landfilled.

   SKW Alloys: Refer to Section 2.1 of "Update of December 5, 1980 Engineering Report - Plan of Operations for Landfill Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site" which is provided by Attachment 3.

7) NYSDEC: What is original capacity of Cell No. 2 and what is remaining capacity that can be utilized for disposal? From this figure, site life should be calculated.

   SKW Allys: Refer to Section 2 of "Update of Engineering Plans for Landfill Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site" which is provided by Attachment 3.

8) NYSDEC: Approximate annual amount of waste to be landfilled.

   SKW Alloys: Refer to Section 2.1 of "Update of December 5,1980 Engineering Report - Plan of Operations for Landfill Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site" which is provided by Attachment 3.

9) NYSDEC: Leachate Management Plan - 12/5/80 Report states that precipitation in the area generally is 6 inches greater per year than evaporation. Other later information indicates that leachate is reused to wet down the baghouse dust. The resulting sludge then "air dries" according to a 2/22/85

document. It is apparent that leachate is leaving the site via percolation into the ground. The Leachate Management Plan should be re-thought if this is the case.
SKW Alloys: Refer to Section 4 of "Update of December 5, 1980 Engineering Report - Plan of Operations for Landfill Cell No.2 at SKW Alloys, Inc.'s Witmer Road Site" which is provided by Attachment 3.

Should you have any questions concerning either this submission or our future plans give me a call (285-1252) at your earliest possible convenience.

Sincerely,

Arthur D Elmquest

Arthur D. Elmquest

enc:

ATTACHMENT 1

SKW PROPERTY DEED

THIS INDENTURE, made the 29TH day of JUNE ,
nineteen hundred and seventy nine (1979), between AIRCO, INC., a corporation organized under the laws of the State of Delaware (formerly, Air Reduction Company, Incorporated, a New York corporation), having its principal office at 85 Chestnut Ridge Road, Montvale, Bergen County, State of New Jersey, party of the first part, and SKW ALLOYS, INC., a corporation organized under the laws of the State of Delaware having its principal office at 3801 Highland Avenue, Niagara Falls, Niagara County, State of New York, party of the second part:

WITNESSETH, that the party of the first part, in consideration of One and more Dollars ($1.00 and more) lawful money of the United States, paid by party of the second part, does hereby grant and release unto the party of the second part, its successors and assigns forever, all:

That Tract or Parcel of Land situate in the Town of Niagara, County of Niagara and State of New York, being part of Lot 24, Township 13, Range 9 of the Holland Land Company's Survey, bounded and described as follows:

BEGINNING at a point in the center line of the Witmer Road at the southwest corner of lands conveyed by the Niagara Falls Power Company to the Vanadium Corporation of America by deed recorded in the Niagara County Clerk's office in Liber 660 at Page 319.

Running thence easterly along the southerly line of lands so conveyed, a distance of 2264.89' to a point.

Running thence northerly at right angles to the last previous course, a distance of 295.2' to a point.

Running thence northwesterly on a line deflecting to the left 67° 47' 54" from the last previous course a distance of 105.52' to the point of curve.

Running thence northwesterly and westerly on a curve to the left, said curve having a radius of 326.5', an arc distance of 135.47' to the point of tangency.

Running thence westerly along said line of tangency, a distance of 51.0' to a point.

(The last 3 herein described courses being 5.7' ± northerly from the center line of an existing railroad spur.)

Running thence northwesterly, on a line deflecting to the right 53° 00' 55" from the last course, a distance of 284.0' to a point.

Running thence northerly, on a line deflecting to the right 38° 10' 30" from the last previous course, a distance of 483.75' to a point on the southerly line of lands appropriated by the Power Authority of the State of New York as shown on Power Authority of the State of New York Map No. 1295, Parcel 1295.

Running thence westerly at right angles to the last previous course and along the southerly line of lands appropriated by the Power Authority of the State of New York as aforesaid, a distance of 906.56' to the center line of the Witmer Road.

Running thence southwesterly, along the center line of the Witmer Road, said center line being also the Mile Line, a distance of 1386.83' to the point of beginning.

Excepting and reserving a triangular parcel of land in the southwest corner of the above described parcel conveyed to the Niagara Mohawk Power Corporation by deed recorded in Liber 1352 at Page 358, August 31, 1960 described as follows:

ALL THAT TRACT OR PARCEL OF LAND situate in the Town of Niagara, County of Niagara and State of New York, being part of Lot 24, Township 13, Range 9 of the Holland Land Company's Survey, bounded and described as follows:

BEGINNING at the point of intersection of the easterly line of Witmer Road and the southerly line of lands conveyed to Niagara Falls Power Company by deed dated March 22, 1940 recorded in Niagara County Clerk's Office in Liber 660 of Deeds page 319; thence northerly along the easterly line of Witmer Road 80.40 feet to a point; thence southerly along a line which is at right angles to the southerly line of lands conveyed as aforesaid

61.32 feet to a point; thence westerly along said southerly line 52 feet to the point of beginning;

SAVING, reserving and excepting therefrom to party of the first part, its successors and assigns, an easement for ingress and egress, by motor vehicles, earth moving equipment or otherwise, onto, upon, over and across an existing dirt road approximately fifteen (15) feet wide along the southerly side of the premises conveyed herein to a contiguous parcel of land owned by party of the first part to the east of the within premises, which parcel consists of ± 25.142 acres. If it becomes impractical or unreasonable for party of the first part to continue using the existing dirt road over which this easement runs, or if party of the second part elects to relocate this easement, then party of the second part shall within ten (10) days of receipt of written notice by either party to the other, designate another location over which this easement shall run, which location provides comparable access to the premises retained by party of the first part. The easement herein reserved shall run with the land and shall inure to the benefit and use of party of the first part, as owner of the contiguous land hereinabove mentioned, its successors and assigns, as well as to the benefit and use of party of the second part, its successors and assigns.

SUBJECT to the rights of the public in so much of the lands hereby conveyed as lies within the limits of Witmer Road;

The parcel being conveyed containing 37.089 ± acres of land, calculated to the center line of the Witmer Road and exclusive of the triangular parcel conveyed to Niagara Mohawk as aforesaid, and being a portion of the same premises conveyed to Air Reduction Company, Incorporated (now Airco, Inc., and party of the first part herein), by Vanadium Corporation of America, by Deed dated February 26, 1964 and recorded in Liber 1422, page 747, in the Niagara County Clerk's Office.

SUBJECT to all easements, reservations and restrictions of record;

ALSO SUBJECT to the reservations, limitations and conditions contained in the following deeds:

Deed from the Niagara Falls Power Company to United States Ferro Alloys

Corporation dated July 19, 1926 and recorded in Niagara County Clerk's Office in Liber 507 of Deeds at page 390;

Deed from The Niagara Falls Power Company to Vanadium Corporation of America dated March 22, 1940 and recorded in Niagara County Clerk's Office in Liber 660 of Deeds at Page 319;

Deed from the Niagara Falls Power Company to Vanadium Corporation of America dated September 16, 1947 and recorded in Niagara County Clerk's Office in Liber 887 of Deeds at page 122.

TOGETHER with the right, privilege and easement reserved to Vanadium Corporation of America, its successors and assigns, in a deed from Vanadium Corporation of America to Niagara Mohawk Power Corporation dated July 18, 1960 and recorded in Niagara County Clerk's Office in Liber 1352 of Deeds at page 358, August 31, 1960;

TOGETHER with the appurtenances and all the estate and rights of the party of the first part in and to said premises.

TO HAVE AND TO HOLD the above granted premises unto the party of the second part, its successors and assigns forever.

AND the party of the first part covenants that it has not done or suffered anything whereby the premises have been encumbered in any way whatever.

IN WITNESS WHEREOF, the party of the first part has caused its corporate seal to be hereunto affixed and these presents to be signed by its duly authorized officer this 29TH day of JUNE , 1979.

In the presence of: AIRCO, INC.

C.A. Bonner
Secretary

By James G. Baldwin
James G. Baldwin
Its Vice President

STATE OF NEW JERSEY

COUNTY OF BERGEN

On the 29th day of June, 1979, before me personally came James G. Baldwin and C.A. Bonna, to me known (or satisfactorily proven to me) to be the persons described in and who executed the foregoing instruments as the Vice President and Secretary, respectively, of Airco, Inc., a Delaware corporation, and severally acknowledged that they executed same on behalf of the said Airco, Inc.

Ethel M. Powers

Notary Public

ETHEL M. POWERS
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires January 2, 1983

ATTACHMENT 2

UPDATE OF DECEMBER 5, 1980 ENGINEERING REPORT
PLAN OF OPERATIONS FOR LANDFILL CELL NO. 2
AT SKW ALLOYS, INC.'S WITMER ROAD SITE

Snyder Engineering

86 Countryside Lane • Grand Island, New York 14072 • 716-773-5661

UPDATE OF DECEMBER 5, 1980 ENGINEERING REPORT
PLAN OF OPERATIONS FOR LANDFILL CELL NO. 2
AT SKW ALLOYS, INC.'S WITMER ROAD SITE

Prepared for: SKW Alloys, Inc.
Prepared by: Snyder Engineering
Date: April 27, 1987

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TABLES

APPENDICES

UPDATE OF DECEMBER 5, 1980 ENGINEERING REPORT - PLAN OF OPERATIONS FOR LANDFILL CELL NO. 2 AT SKW ALLOYS, INC.'S WITMER ROAD SITE

1. PERSONNEL RESPONSIBILITIES

The environmental control regulations mandate strict definition of personnel responsibilities. Plant personnel must be aware of these responsibilities and implement the required environmental control programs to ensure that regulatory compliance is maintained.

In line with this philosophy, the listing of involved individuals with their assigned responsibilities is as follows:

Individual	Responsibilities
1) Plant Manager Mr. Thomas Riscili	Overall responsibility for all environmental control programs at SKW Alloys, Inc.'s Niagara Falls, New York facilities
2) Corporation Engineer Mr. Art D. Elmquest	Responsible for the following: 1) Establishment and implementation of environmental programs at SKW Alloys, Inc.'s Niagara Falls, New York facilities necessary to satisfy applicable government regulations, 2) Permitting of environmental facilities , 3) Environmental reporting to the appropriate government agencies, 4) Environmental record keeping, and 5) Monitoring of all environmental activities to ensure compliance with governmental regulations
3) Landfill Site Supervisor	Responsible for daily planning and implementation of landfill

Mr. James Gouck	operations
4) Truck drivers	Responsible for moving waste from plant production facilities to the Witmer Road Landfill

2. FACILITY OPERATIONS

Items which are discussed in this section address the actual operation of SKW's Witmer Road Landfill Facility. They include the following:

(1) Waste generation at the SKW production facilities,
(2) Hours of landfill operation,
(3) Landfill security,
(4) Landfill daily operations,
(5) Existing landfill waste fill progression and anticipated future progression rate,
(6) Landfill equipment,
(7) Landfill contingency plan.

2.1 Waste Generation

Waste material deposited in SKW's Witmer Road Landfill is generated during the production of various silicon based materials in two electric arc furnaces. Baghouses are utilized in the control of particulate emissions from each furnace. The captured baghouse dusts are very fine and of low density. Types presently being generated include 50 percent ferrosilicon and silicon metal. Typical compositions are presented by Table 1 (50% ferrosilicon) and Table 2 (silicon metal).

Predicated on projected ferrosilicon and silicon metal production rates, the anticipated production of baghouse dust will be as follows:

TABLE 1

TYPICAL ANALYSES FOR DUST COLLECTED IN BAG FILTERS FROM PRODUCTION OF 50% FERROSILICON (CHEMICAL ANALYSIS IS ON A DRY BASIS)

Component	Percent
SiO_2	80.0-85.0
SiC	0.15-0.50
C	1.25-2.00
Fe_2O_3	2.00-3.50
Al_2O_3	2.00-3.00
CaO	0.50-1.00
MgO	2.50-3.50
Na_2O	0.10-0.50
K_2O	1.50-2.50
P	0.005-0.010
S	0.05-0.15
TiO_2	0.002-0.010
Cr	0.02-0.10
Mn	0.10-0.50
Ni	0.001-0.010
Co	0.001-0.010
Cd	0.001-0.005
Pb	0.05-0.20
Cu	0.01-0.05
Zn	<0.0001
Mo	<0.001
B	0.005-0.015

TABLE 2

TYPICAL ANALYSES FOR DUST COLLECTED IN BAG FILTERS FROM PRODUCTION OF SILICON METAL (CHEMICAL ANALYSIS IS ON A DRY BASIS)

Component	Percent
SiO_2	94-98
SiC	0.2-1.0
C	0.2-1.3
Fe_2O_3	0.02-0.15
Al_2O_3	0.1-0.4
CaO	0.08-0.3
MgO	0.3-0.9
Na_2O	0.1-0.4
K_2O	0.2-0.7
P	0.03-0.06
S	0.1-0.3
TiO_2	0.001-0.02
Mn	0.004-0.05
Ni	0.001-0.002
Co	0.001-0.002
Cd	<0.0001
Pb	0.001-0.002
Cu	0.002-0.01
Zn	0.006-0.015
Mo	<0.005
B	0.001-0.003

1987 - 11,000 tons
1988 - 11,000 tons
1989 - 11,000 tons

During the past few years significant amounts of this ferrosilicon dust were marketed as an animal food supplement. However, this market is not now available and is not expected to be reopened on a large scale in the near future. While the search for alternative markets is continuing, it is not known at this time if such markets will be found. Even if some markets are established it is extremely doubtful that they will be able to absorb all the baghouse dust which will be generated at anticipated ferrosilicon and silicon metal production rates.

2.2 Hours of Landfill Operation

The landfill will be operated eight hours per day and six days per week. If SKW Alloys, Inc. desires to modify these operating hours, a written application must be submitted to the Town of Niagara's Supervisor.

2.3 Landfill Security

The entire perimeter of the landfill site is fenced and the only access is from Witmer Road. Gate access is monitored by a security guard.

2.4 Landfill Daily Operations

Leachate is collected from Landfill Cell No. 2 in a standpipe system which is piped to a collection sump. An indicator light on the outside of the sump is on when the sump contains a sufficient amount of leachate for slurry use. If enough leachate is available, it is metered into a concrete mixer truck and transported to the dust silos at the Highland Avenue plant. During periods of dry weather the sump's leachate (water) must be supplemented with city water. A measured amount of baghouse dust is added to the truck. The leachate (water) and dust forms a mixture which is a flowable mass.

The truck proceeds after loading to the Witmer Road landfill site and is logged in by the security guard. After being logged in, the truck goes directly to Landfill Cell No. 2 and deposits the slurried dust. Experience has shown that the material does not dry well if it is deposited in layers over four inches thick. The slurried material is deposited in a manner which keeps the wet material spread out as much as possible. This promotes air drying. Variations in both weather and waste generation rates make it unrealistic to define an exact slurry dumping pattern which must be followed.

2.5 Landfill Fill Progression

A topographical survey was made of Landfill Cell No. 2 on April 2, 1985 by SLC Consultants/Constructors, Inc. to determine how much fill volume remained (refer to Appendix B). Based upon data from this survey, Cell No. 2 had approximately 38,700 cubic yards of volume remaining on April 2, 1985. From that time until April 2, 1987 an additional 22,000 tons of baghouse dust were placed in Cell No. 2. Approximately 2.2 cubic yards of landfill volume is required per ton of baghouse dust. Based upon data from the April 2, 1985 survey and the amount of waste landfilled since that date Cell No. 2 should now be full. Visual observation indicates that this is not the case. It appears that at existing production rates Cell No. 2 will be full in approximately three months. This discrepancy is probably due to the fact that waste elevations away from the edges of Cell No. 2 were much less than the average waste elevation of 610.0 feet which was used in the fill volume calculations (refer to Appendix B). An additional 9,300 cubic yards of disposal capacity will be provided in the facility's closure.

2.6 Landfill Equipment

Since the waste is not compacted and no daily cover is required for the operation of the SKW landfill, no heavy construction equipment is kept on site. However, heavy construction equipment such as bulldozers, backhoes, front end loaders, and tandem trucks can be obtained as required from several local contractors. These contractors include the following:

(1) SLC Consultants/Constructors, Inc.
6362 Robinson Road
Lockport, New York

(2) Huber Construction Company
365 Old Niagara Falls Blvd.
North Tonawanda, New York

(3) Haseley Trucking Co., Inc.
10315 Lockport Rd.
Niagara Falls, New York

2.7 Contingency Plan

The objective of this contingency plan is to ensure that SKW Alloys, Inc. has the necessary planned procedures to follow in the event an emergency situation should arise. Subject areas which are addressed include emergency coordinators, emergency response procedures, contingency plan implementation, emergency equipment, and incident reports.

It has been designed to minimize both human health and environmental hazards due to any unplanned sudden or non-sudden release of waste material constituents during the operation of the Witmer Road landfill facility. Since the waste materials which are managed at this facility are non-hazardous, the potential for such hazards is very small.

2.7.1 Emergency Coordinators

If an emergency situation develops during the disposal of waste material at the Witmer Road site, the discoverer should contact an emergency coordinator. The primary emergency coordinator should be contacted first, and if he is not available the others should be called (in the order listed) until someone is reached. The primary emergency coordinator and alternates have the authority to commit the necessary resources necessary to carry out the contingency plans in the event of an emergency. The list of SKW emergency coordinators is as follows:

(1) Landfill Site Supervisor
Name: James Gouck

Home address: 23 Swallow Lane
Orchard Park, N.Y. 14127
Home phone number: 716-662-6193

(2) Corporate Engineer
Name: Arthur Elmquest
Home address: 434 Burt Circle
Lewiston, N.Y. 14092
Home phone number: 716-754-7132

(3) Plant Manager
Name: Thomas Riscili
Home address: 156 Havenwood Lane
Grand Island, N.Y. 14072
Home phone number: 716-773-4020

2.7.2 Emergency Response Procedures

Response procedures have been developed and will be implemented in the event of illegal dumping, spills, inclement weather, or groundwater contamination at the SKW site. There is no possibility of fire, explosion, or odors at the site. Consequently no contingency plans have been developed in these specific areas.

2.7.2.1 Illegal Dumping

Due to the Witmer Road site's security (fencing and gate house attendant) it is extremely unlikely that illegal dumping will occur at this site. In the unlikely event that such dumping does occur, the material which is illegally dumped will be cleaned up and sent to a properly permitted waste management facility.

2.7.2.2 Spills

The potential exists for accidental spillage of waste materials during the baghouse dust loading operation at the Highland Avenue Plant, during waste transportation from the

Highland Avenue Plant to the Witmer Road landfill, and at the Witmer Road landfill site. A formal agreement exists between the Town of Niagara and SKW Alloys, Inc. This agreement mandates the immediate cleanup of any waste material spill. SKW personnel will be available with the appropriate cleanup equipment (shovels, brooms, drums, etc.) if the need should arise.

A major spill could occur if the waste transport vehicle were to have a collision or accidentally tip over in a drainage ditch. Immediate action will be taken to contain the spilled material by erection of a temporary containment barrier. Once the spill is contained, the material will be collected by shovelling into drums or other containers. In some instances absorbent materials might be required to facilitate recovery of the spilled material. Soil and other materials contaminated by the spilled materials will also be collected and all collected material will be transported to Cell No. 2 for disposal.

2.7.2.3 Inclement Weather

Because of the Witmer Road site's slag overburden and the roads constructed of slag, site access is not impaired by periods of heavy precipitation. Snow removal is performed using SKW's heavy equipment.

2.7.2.4 Groundwater Contamination

Based upon results to date from the site's groundwater monitoring program obtained during the operation of Cells No. 1 and No. 2 no future groundwater contamination problems are anticipated. In addition the 50% ferrosilicon and silicon metal baghouse dusts which are now being deposited in Cell No. 2 are considered by both the USEPA and the NYSDEC to be non-hazardous materials.

However, should the waste materials deposited in Cell No. 2 be reclassified as a hazardous waste or significant contamination of groundwater be detected a contingency plan will be enacted. This contingency plan will consist of the following:

(1) Immediately stop disposal of reclassified or groundwater contaminating waste in Cell No. 2,
(2) Prepare and submit plans for development of disposal facility at the site adequate to provide an environmentally safe depository for hazardous waste,
(3) Dispose of hazardous wastes at government approved off site disposal facilities until SKW's upgraded facilities can become operational, and
(4) Continue site monitoring program to evaluate whether or not any remedial site action will be necessary.

3. CONTROL OF NUISANCE CONDITIONS

The only conceivable nuisance condition associated with the operation of the Witmer Road landfill facility is the generation of fugitive dust. As noted in the 5/20/81 DEIS the potential for such dust generation exists during both the construction and operational phases of the various landfill cells at the Witmer Road site. The magnitude of this potential is dependent upon several factors. These include the amount of vehicular and construction equipment activity, condition of site roads, weather conditions, and waste disposal methodology.

Dust will undoubtedly be generated during various dry portions of the year by normal onsite truck traffic and machinery. Such emissions are impossible to quantify since they are dependent upon the prevailing atmospheric conditions, soil conditions, vegetative cover, and frequency of the dust generating operations. The majority of such dusts will normally settle near the source since they are typically characterized by large particle size. Therefore the probability of any off site impact is low. Dust generation from these sources is minimized by adhering to the following:

1) Vehicular traffic travels at speeds of less than ten miles per hour on site roads,
2) Site roads are watered during extremely dry periods.

In order to minimize dust generation during waste deposition at the landfill, the baghouse dusts are slurried with water in a concrete mixer truck. Landfill leachate and/or city water is combined with a measured amount of baghouse dust. This forms a mixture which is a flowable mass. Since the waste is a slurry no dust generation will occur when it is dumped into the landfill cell. In addition experience has shown that after drying the resultant material's potential for dust generation is much less than the potential which would be exhibited by the unslurried baghouse dust. This fact is clearly demonstrated by comparing sieve analyses (refer to Table 3) performed on the dry baghouse dust and on

TABLE 3

SIEVE ANALYSES OF BAGHOUSE DUST

Mesh Size	Baghouse Dust Retained Percent	Baghouse Dust After Slurry and Drying Retained Percent
+ 1/4		29.2%
+ 10		44.7%
+ 20		16.4%
+ 40		8.0%
+ 60	10.8%	1.2%
+ 100	17.5%	0.5%
+ 160	36.5%	
+ 200	1.3%	
+ 325	31.9%	

the material which remains after drying the slurry. The greatly increased average particle size considerably reduces the potential for significant fugitive dust generation. In addition wet slurry is deposited whenever possible over any material which has dried and been abraded to such a degree that conditions conducive to generation of fugitive dust might be present. This practice further reduces the potential for dust generation from the landfill surface.

4. LEACHATE MANAGEMENT PLAN

As noted in the 12/5/80 Engineering Report the precipitation in this area is generally 6 inches greater per year than evaporation. As noted in Section 2.4 of this Report leachate is collected from Landfill Cell No. 2 and is utilized to slurry the baghouse dust prior to landfilling. An analysis of the amount of potential leachate generated by both Landfill Cells No. 1 and No. 2 and the amount of water (leachate) required to slurry the baghouse dust is as follows:

Potential Leachate Generation

Potential Leachate Generation = (Cell Surface Area)(Precip. - Evap.)

Cell No. 1 = (238 ft.)(170 ft.)(.5 ft./yr.)(7.48 gal./cu. ft.)

= 151,320 gal./yr.

Cell No. 2 = (353 ft.)(246 ft.)(.5 ft./yr.)(7.48 gal./cu. ft.)

= 324,774 gal./yr.

Total potential leachate generation/yr. = (151,320 + 324,774) gal./yr.

= 476,094 gal./yr.

Baghouse Dust Slurry Requirements

Assume: 1) Produce 11,000 tons/year of baghouse dust,
2) Slurry 228 gal. of water (leachate) with each ton of baghouse dust

Slurry water/year = (11,000 tons/year)(228 gal./ton)

= 2,508,000 gal./yr.

A comparison of potential leachate generation per year from Landfill Cells No. 1 and No.2 (476,094 gal./yr.) with the amount of slurry water (2,508,000 gal./yr.) required at existing plant production rates (11,000 tons/yr. of baghouse dust) clearly indicates that all the landfill leachate presently being generated can be recycled. In addition based upon results to date from the site's groundwater monitoring program no groundwater contamination problems have been detected. There is absolutely no evidence that leachate is leaving the site via percolation into the ground.

5. NEARBY WATER SUPPLIES

There are no known wells within .5 mile of the landfill site which are utilized to supply drinking water.

Appendix A - Calculations for Original Capacity and Increased Capacity (Raised Berms) of Cell #2

In order to facilitate volume calculations the landfill cell was divided into sections.

<u>Calculations for Original Volume</u>

$$\text{Sec. "A"} = \frac{(267 + 255)}{2}\left(620.25 - \frac{596.75 + 597.75 + 597.5}{3}\right)(160)$$

$$= 261(620.25 - 597.33)(160)$$

$$= 957{,}139 \text{ cu. ft.}$$

$$\text{Sec. "B"} = \frac{(40 + 46)}{2}(160)(620.25 - 597.75)(.5)$$

$$= 43(160)(11.25)$$

$$= 77{,}400$$

$$\text{Sec. "C"} = (255)(46)(620.25 - 596.75)$$

$$= 275{,}655$$

$$\text{Sec. "D"} = \frac{(40 + 46)}{2}(160)(620.25 - 596.75)(.5)$$

$$= 43(160)(11.75)$$

$$= 80{,}840$$

$$\text{Sec. "E"} = .5(267)(40)(620.25 - 598.25)$$

$$= 133.5(40)(22)$$

$$= 117{,}480$$

$$\text{Sec. "F"} = .5(40)(40)\ (620.25 - 598.25)$$

$$= 20(40)(22)$$

$$= 17{,}600$$

$$\text{Sec. "G"} = .5(46)(620.25 - 598.25)$$

= 23(46)(22)

= 23,276

Sec. "H" = .5(46)(46)(620.25 - 595.25)

= 23(46)(25)

= 26,450

Sec. "I" = .5(40)(40)(620.25 - 598.25)

= 20(40)(22)

= 17,600

Volume = 957,139 + 77,400 + 275,655 + 80,840 + 117,480 + 17,600 + 23,276 + 26,450 + 17,600

= 1,593,440 cu. ft. or 59,016 cu. yds.

Calculations for Volume with Berms at 624.25 Feet

Additional volume = (347)(240)(4)

= 333,120 cu. ft. or 12,338 cu. yds.

Total volume = 59,016 + 12,338

= 71,354 cu. yds.

Calculation for Cap Volume

Volume = .3333(246)(353)(8.75)

= 253,252 cu. ft. or 9,379 cu. yds.

Appendix B - Calculations for Amount of Landfill Cell #2 Filled on April 2, 1985 Based on SLC Consultants/Constructors Survey

In order to facilitate volume calculations the landfill cell was divided into sections.

<u>Calculations for Volume Filled on April 2, 1985</u>

Sec. "A" = 261(610.0 - 597.33)(160)

= 261(12.67)(160)

= 529,099 cu. ft.

Sec. "B" = 43(160)(610.0 - 597.75)(.5)

= 43(160)(12.25)(.5)

= 42,140

Sec. "C" = (255)(46)(610.0 - 596.75)

= 255(46)(13.25)

= 155,423

Sec. "D" = 43(160)(610.0 - 596.75)(.5)

= 43(160)(13.25)(.5)

= 45,580

Sec. "E" = .5(267)(40)(610.0 - 598.25)

= .5(267)(40)(11.75)

= 62,745

Sec. "F" = .5(40)(40)(610.0 - 598.25)

= .5(40)(40)(11.75)

= 9,400

Sec. "G" = .5(46)(46)(610.0 - 598.25)

$= 23(46)(11.75)$

$= 12,432$

Sec. "H" $= .5(46)(46)(610.0 - 595.25)$

$= 15,606$

Sec. "I" $= .5(40)(40)(610.0 - 598.25)$

$= 9,400$

Volume $= 529,099 + 42,140 + 155,423 + 45,580 + 62,745 + 9,400 + 12,432 + 15,606 + 9,400$

$= 881,825$ cu. ft. or 32,660 cu. yds.

ATTACHMENT 3

UPDATE OF ENGINEERING PLANS FOR CELL NO. 2
AT SKW ALLOYS, INC.'S WITMER ROAD LANDFILL

Snyder Engineering

86 Countryside Lane • Grand Island, New York 14072 • 716-773-5661

UPDATE OF ENGINEERING PLANS FOR LANDFILL CELL NO. 2 AT SKW ALLOYS, INC.'S WITMER ROAD SITE

Prepared for: SKW Alloys, Inc.
Prepared by: Snyder Engineering
Date: April 27, 1987

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UPDATE OF ENGINEERING PLANS FOR LANDFILL CELL NO. 2 AT SKW ALLOYS, INC.'S WITMER ROAD SITE

1. EXISTING AND FINAL ELEVATIONS OF CELL NO. 2

The existing elevations of Cell No. 2 at SKW Alloys, Inc.'s Witmer Road Site are reflected by "as built" Drawings 3510 and 3511 which were submitted to the New York State Department of Environmental Conservation as part of the Cell No. 2 approval process. As is discussed in other sections of this submission, Cell No. 2 (with existing berm elevations) will be full in approximately three months at existing ferro-alloy production rates. It is clear that without raising the berms of the existing landfill cells, SKW will run out of waste disposal capacity prior to the approval and construction of Cell No. 3. In order to prevent this from occurring and optimize disposal capacity at the site, it is proposed to raise the berms of both Cells No. 1 and No. 2 to an elevation of 628.25 feet.

The containment berms of both Cells No. 1 and No. 2 will be extended upward in a vertical direction to a final elevation of 628.25 feet (mean sea level) around the entire periphery of the landfill cells. Any slag previously placed over the top of the clay containment berms will be removed prior to initiation of clay placement.

Clay will be placed in six inch lifts and compacted to a ninety percent compaction per ASTM D-1557 Method C. The clay will be blended into the existing 3:1 outer retaining slopes. Dried waste material will be piled against the interior side of this clay extension around the periphery of the landfill as clay placement progresses toward the final elevations. This will provide additional bearing support for the heavy construction equipment. As filling progresses, the leachate collection standpipes will be extended.

Upon completion of Cells No. 1 and No. 2 berm extension, a complete set of "as built" drawings will be submitted to the NYSDEC. The closure plan for Cell No. 2 (refer to Attachment 4) has been modified to reflect the increased berm heights. The final top elevation will be 633 feet (mean sea level) rather than 629 feet as previously submitted.

2. CELL NO. 2 CAPACITY

In order to better understand the existing situation at SKW's Witmer Road landfill site, consideration is given to the following:

1) Disposal capacity of Cell No. 2 prior to initiation of waste filling,
2) Remaining disposal capacity of Cell No. 2 without raising containment berms, and
3) Remaining disposal capacity of Cells No. 1 and No. 2 if containment berms are raised.

2.1 Original Cell No. 2 Waste Capacity

Calculations (Refer to Appendix A) have been made to determine the original capacity of Cell No. 2. These calculations were based upon the facility's "as built" drawings and indicate that the facility had an original waste disposal capacity of approximately 59,000 cubic yards.

2.2 Remaining Cell No. 2 Waste Disposal Capacity

A topographical survey was made of Landfill Cell No. 2 on April 2, 1985 by SLC Consultants/Constructors, Inc. to determine how much fill volume remained (refer to Appendix B). Based upon data from this survey, Cell No. 2 had approximately 38,700 cubic yards of volume remaining on April 2, 1985. From that time until April 2, 1987 an additional 22,000 tons of baghouse dust were placed in Cell No. 2. Approximately 2.2 cubic yards of landfill volume is required per ton of baghouse dust. Based upon data from the April 2, 1985 survey and the amount of waste landfilled since that date Cell No. 2 should now be full. Visual observation indicates that this is not the case. It appears that at existing production rates Cell No. 2 will be full in approximately three months. This discrepancy is probably due to the fact that waste elevations away from the edges of Cell No. 2 were much less than the average waste elevation of 610.0 feet which was used in the fill volume calculations (refer to Appendix B).

2.3 Remaining Waste Disposal Capacity If Cells No. 1 and No. 2 Berms Are Raised

Additional waste disposal volume will be obtained by raising the berms of Cells No. 1 and No. 2 to 628.25 feet. Calculations (refer to Appendix C) have been made to determine the additional capacities of Cells No. 1 and No. 2 with the berms raised. The additional capacity of Cell No. 1 will be approximately 6,000 cubic yards and the additional capacity of Cell No. 2 will be approximately 12,300 cubic yards.

Based upon projected ferrosilicon and silicon metal production rates, approximately 22,000 cubic yards of fill volume will be required per year. Therefore if both the berms of Cells No. 1 and No. 2 are raised to the proposed elevations, the remaining life of these two cells (excluding closure volumes) will be approximately 1 year at the anticipated waste generation rate. If the berms are not raised the remaining fill life for Cell No. 2 is approximately 3 months. It is clear that without raising the berms of Cells No. 1 and No. 2, SKW will run out of waste disposal capacity prior to the approval and construction of Cell No. 3. These estmates will be modified if commercial usages for the dried material can be found.

3. SURFACE WATER DRAINAGE

The SKW Alloys, Inc.'s site watershed is located within the Town of Niagara. It is bounded as follows: West - Witmer Road, North - Niagara Mohawk Power Company right-of-way, East - Airco Properties, Inc., and South - Niagara Mohawk Power Company. Surface water runoff follows the site's natural drainage patterns.

No major changes are anticipated from the site's surface water drainage plan which was presented in the 5/20/86 DEIS. As noted in the 2/22/85 correspondence from SKW Alloys, Inc. to the NYSDEC, Cell No. 1 has reached its waste disposal capacity. It has not been covered because of the possible commercial usage of the dried material which it contains. A request for a variance from final cover was also submitted with the 2/22/85 correspondence. If this variance is approved and the waste material is eventually removed from the site, the existing locations of Cells No. 1 and 2 would eventually be regraded (after removal of all waste materials) and natural surface water drainage patterns re-established.

If Cells No. 1 and 2 are eventually capped, their final slopes will be adequate to provide good drainage from the tops of the cells. Precipitation will run off the north, south, and east sides of Cell No. 1 and the north, south, and west sides of Cell No. 2 and follow the natural drainage patterns of the site. Precipitation running off the west side of Cell No. 1 and the east side of Cell No. 2 will enter a swale between Cells No. 1 and No. 2 and be diverted away from the closed landfill cells. This drainage will also be dispersed so that it follows the natural drainage patterns of the site.

Appendix A - Calculations for Original Capacity and Increased Capacity (Raised Berms) of Cell #2

In order to facilitate volume calculations the landfill cell was divided into sections.

Calculations for Original Volume

$$\text{Sec. "A"} = \frac{(267 + 255)}{2} (620.25 - \frac{596.75 + 597.75 + 597.5}{3})(160)$$

$$= 261(620.25 - 597.33)(160)$$

$$= 957{,}139 \text{ cu. ft.}$$

$$\text{Sec. "B"} = \frac{(40 + 46)}{2} (160)(620.25 - 597.75)(.5)$$

$$= 43(160)(11.25)$$

$$= 77{,}400$$

$$\text{Sec. "C"} = (255)(46)(620.25 - 596.75)$$

$$= 275{,}655$$

$$\text{Sec. "D"} = \frac{(40 + 46)}{2} (160)(620.25 - 596.75)(.5)$$

$$= 43(160)(11.75)$$

$$= 80{,}840$$

$$\text{Sec. "E"} = .5(267)(40)(620.25 - 598.25)$$

$$= 133.5(40)(22)$$

$$= 117{,}480$$

$$\text{Sec. "F"} = .5(40)(40)\ (620.25 - 598.25)$$

$$= 20(40)(22)$$

$$= 17{,}600$$

$$\text{Sec. "G"} = .5(46)(620.25 - 598.25)$$

= 23(46)(22)

= 23,276

Sec. "H" = .5(46)(46)(620.25 - 595.25)

= 23(46)(25)

= 26,450

Sec. "I" = .5(40)(40)(620.25 - 598.25)

= 20(40)(22)

= 17,600

Volume = 957,139 + 77,400 + 275,655 + 80,840 + 117,480 + 17,600 +

23,276 + 26,450 + 17,600

= 1,593,440 cu. ft. or 59,016 cu. yds.

Calculations for Volume with Berms at 624.25 Feet

Additional volume = (347)(240)(4)

= 333,120 cu. ft. or 12,338 cu. yds.

Total volume = 59,016 + 12,338

= 71,354 cu. yds.

Calculation for Cap Volume

Volume = .3333(246)(353)(8.75)

= 253,252 cu. ft. or 9,379 cu. yds.

Appendix B - Calculations for Amount of Landfill Cell #2 Filled on April 2, 1985 Based on SLC Consultants/Constructors Survey

In order to facilitate volume calculations the landfill cell was divided into sections.

<u>Calculations for Volume Filled on April 2, 1985</u>

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Sec. "D" = 43(160)(610.0 - 596.75)(.5)

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= 45,580

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= .5(267)(40)(11.75)

= 62,745

Sec. "F" = .5(40)(40)(610.0 - 598.25)

= .5(40)(40)(11.75)

= 9,400

Sec. "G" = .5(46)(46)(610.0 - 598.25)

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$= 12{,}432$

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$= 15{,}606$

Sec. "I" $= .5(40)(40)(610.0 - 598.25)$

$= 9{,}400$

Volume $= 529{,}099 + 42{,}140 + 155{,}423 + 45{,}580 + 62{,}745 + 9{,}400 +$

$12{,}432 + 15{,}606 + 9{,}400$

$= 881{,}825$ cu. ft. or 32,660 cu. yds.

Appendix C - Calculations for Additional Capacity Increase by Raising Cell No. 1 and 2 Berms an Additional 4 Feet

Calculations for Cell No. 1 Volume Increase by Raising Berms to 628.25 Feet

Additional volume = (238)(170)(4)

= 161,840 cu. ft. or 5,994 cu. yds.

Calculations for Cell No. 2 Volume Increase by Raising Berms to 628.5 Feet

Additional volume = (347)(240)(4)

= 333,120 cu. ft. or 12,338 cu. yds.

ATTACHMENT 4

CLOSURE AND POST CLOSURE PLAN FOR CELL NO. 2
AT SKW ALLOYS, INC.'S WITMER ROAD LANDFILL

Snyder Engineering

86 Countryside Lane • Grand Island, New York 14072 • 716-773-5661

CLOSURE AND POST CLOSURE PLAN FOR CELL NO. 2 AT SKW ALLOYS, INC.'S WITMER ROAD LANDFILL

Prepared for: SKW Alloys, Inc.
Prepared by: Snyder Engineering
Date: April 27, 1987

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CLOSURE AND POST CLOSURE PLAN FOR CELL NO. 2 AT SKW ALLOYS, INC.'S WITMER ROAD LANDFILL

1. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM FOR CLOSURE CAP PLACEMENT

A quality assurance/quality control program has been developed for utilization during the capping of Cell No. 2 at SKW Alloys, Inc.'s Witmer Road landfill. Its primary objectives are to ensure that proper construction techniques and procedures are utilized and to verify that the materials used in the construction meet the specifications. In addition it will aid in identifying any problems that may occur during construction so that they can be corrected before construction is complete. The program will consist of both pre-construction and construction testing. Strict adherence to this program will help ensure that the final cover system is installed per the approved plans and specifications.

Data generated during the implementation of this quality assurance/quality control program will form an integral part of the professional engineer's facility certification report. The purpose of this report is to affirm that the facility's closure was completed in conformance with the approved design and specifications.

1.1 Description of Cell No. 2 Capping Process

All work will be constructed to the lines, grades, and dimensions as specified by the sections and details of the approved plans. Any modifications must receive prior approval from either SKW Alloys or their designated representative.

1.2 Specifications for Capping Materials

1.2.1 Clay

The clay for utilization in the landfill's cap will be brought from off site. It must be natural clay which is free from roots, organic material, stones larger than one inch, debris, and other deleterious material. Tests which will be performed on the clay include the following:

1) Laboratory moisture content: D2216-80,
2) Particle size analysis: D1140-54,
3) Liquid limit, plastic limit, and plasticity index of soil: D4318-83,
4) Hydraulic conductivity

Less than 15 percent of the material by weight shall not pass through a No. 200 sieve. The material shall have a liquid limit between 40 and 90 and a plasticity index greater than 15. Its classification must be CH or CL when classified in accordance with the United Soil Classification System.

The clay must be moist and pliable. It must be protected during stockpiling from drying and cracking by daily sprinkling, cover, or other means. No clay material which becomes hard, brittle, fissured, or cracked during stockpiling at the site will be utilized in the construction of the cap. If fissuring or cracking should occur during cap installation the clay material which is involved must be removed.

1.2.2 Topsoil

Topsoil utilized in the cap installation must be capable of supporting vegetative growth. It must be free of roots, sticks, hard clay and stones which will not pass through a one inch square opening. In addition it must be free of any type of contaminants.

1.2.3 Water for Compaction

Water for compaction is not available at the Witmer Road site. Therefore the contractor must supply water as required during soil placement and compaction as the cap is being constructed. This water must be free from any hazardous contaminants, oils, acids, alkalis, organic matter, or other deleterious substances.

1.3 Approvals for Capping Materials

Completion of the tests necessary to evaluate the suitability of materials for utilization in the capping of Cell No. 2 are the responsibility of the contractor. Samples of the materials at their source will be taken by the Contractor in accordance with ASTM D 75 under the supervision of the professional engineer responsible for construction certification. Confirmation that the material conforms to the specification requirements, in addition to copies of the test results from a commercial testing laboratory, must be submitted to the professional engineer at least thirty days before the material is required for use. In addition samples of the materials will be provided to the professional engineer. Each sample shall be representative of the material and be clearly marked to indicate the source of the material and its intended use on the capping project.

Samples for testing shall be taken from each 1,000 cubic yards of imported clay. If the material does not appear to meet the specifications more frequent sampling will be required at the direction of the professional engineer. The tests which may be required on the clay in such a case are as follows:

1) Grain size - D1140
2) Moisture content - D2216
3) Atterberg limits - D4318
4) Moisture density curve - D698 or D1557
5) Lab permeability

If the tests conducted by the contractor or the engineer indicate that the material does not meet the required specifications, material placement will be terminated until corrective measures are taken. Any material which does not conform to the specifications and is placed in the cap shall be removed and replaced.

1.4 Installation of Cap

Construction evaluation testing will consist of visual observations of the work, field density/moisture content checks, and hydraulic conductivity testing. Daily inspection reports will be prepared by either the professional engineer responsible for construction certification or his designated representative. These reports will include observations and test results as well as descriptions of any problems encountered and their solutions.

Typical observations which will be included in the daily reports are as follows:

1) Water content and other physical properties of the soil during processing, placement, and compaction,
2) Thickness of lifts as loosely placed and as compacted,
3) Action of the compaction and heavy hauling equipment on the construction surface,
4) Average number of passes used to compact each lift.

A summary certification report will be prepared by the professional engineer. It will include an evaluation of the project construction, certification of various field and laboratory test results, and an assessment as to whether or not the construction is in compliance with the approved plans and specifications.

1.4.1 Waste Preparation

Before construction of the cover system's low permeability clay liner, the waste material deposited in the landfill should be as dry as possible. For this reason the optimal time for initiating cell closure would probably be during the last two weeks of July. This waste material must be capable of supporting the construction equipment which will be utilized in capping the cell. Additional fill material may be required to either improve the material's bearing strength or adjust elevations prior to installation of the low permeability clay layer. This material must be free of large objects that could damage or make the placement of the overlying low permeability soil layer difficult.

1.4.2 Clay Placement and Compaction

The clay must be of the type and quality previously specified. Material shall be selectively excavated at the source to avoid the excavation of sand or silt seams and prevent contamination of the clay with sand, silt, debris or other unacceptable material. Shipping, handling, stockpiling, and/or placement of the material shall proceed in such a manner as to avoid mixing the clay with sand, silt, debris, or waste material deposited in Cell No. 2.

Thoroughly mix the clay to ensure uniformity of the material. Exercise particular care during placement to prevent the inclusion of sand or silt seams, pockets, inclusions or nonhomogeneous clay balls. Scarify the surface of the clay to provide a continuous, uniform layer free from seams, joints, inclusions or nonhomogeneous clay balls.

The clay will be placed in lifts, with each lift being approximately six inches thick after compaction. The clay's moisture content will be controlled within plus or minus 2 percentage points of optimum moisture content. It will be compacted to at least 95 percent of its maximum dry density as determined by nuclear density monitoring methods. A minimum of four tests will be taken per lift of clay. At the end of construction a series of three Shelby tube samples will be taken from random locations for laboratory permeability testing.

Compaction equipment shall be of a type suitable to obtain the required compaction densities. All compaction equipment shall be maintained and operated in strict accordance with the manufacturer's instructions and recommendations. This will help ensure that it will deliver the manufacturer's rated compactive effort.

During the compacting operations every attempt will be made to maintain the optimum practicable moisture content in each lift to achieve the best compaction results. The moisture content will be maintained uniformly throughout the lift. At the time of compaction, the water content of the clay will be at optimum water content plus or minus 2 percentage points. No material which contains excessive moisture will be compacted. Such material will by aerated by discing, harrowing or some other approved method to hasten the drying process. If too little moisture is present, the material will be supplemented as required by sprinkling with water.

As previously noted during the clay placement and compaction process, the contractor shall determine in-place density and moisture levels (D2922 and D3017). These measurements will be made using a nuclear density meter. Tests shall be conducted on every lift of the compacted clay cover. At least four tests shall be made for every lift of compacted clay surface. Tests will be performed at more frequent intervals if variations in the clay materials or loosening of compacted materials is observed. If tests indicate the specified density has not been obtained, the contractor will recompact the area until the specified minimum density is obtained. All perforations of the clay liner (nuclear density test probe locations and permeability sampling locations) will be backfilled with a dry clay-bentonite mixture. The mixture will then be compacted in place using hand tools.

No clay will be placed over frozen material or if the air temperature is under 35 degrees Fahrenheit. In addition under no circumstances will frozen clay be placed.

The surface of each completed lift will be protected from unnecessary traffic, rain, or other disturbances. Any section of the clay that becomes damaged, perforated, loosened or wetted will be removed.

During the clay installation the inspector will monitor soil type, moisture content, density, compactive effort, lift thickness, clod size, uniformity of compaction, and completeness of coverage. Compaction around penetrations such as the leachate collection standpipes will be closely observed. Where hand compaction is required strict attention will be given to the control of clod size. After completion of the permeability clay barrier, the surface slope of the clay barrier must be inspected to insure that it is constructed as designed and no depressions remain into which water will flow and stand.

1.4.3 Topsoil Placement

The topsoil layer functions are to protect the underlying layers from mechanical and frost damage, and (in conjunction with a vegetative cover) to protect against erosion. During construction of the topsoil layer, the inspector will monitor the placement procedure to ensure that the soil is not overly compacted. In addition he will also measure the thickness and slope of the topsoil layer and check to make sure that no damage occurs to the leachate standpipes from the construction equipment during the installation of the topsoil.

1.4.4 Revegetation

Hydroseeding will be utilized in the revegetation process. The inspector will ensure that the application equipment, rate of seed addition, and amount and uniformity of coverage is correct. In addition the inspector will check to make sure no bare spots are left after hydroseeding. This seeding will be done during the correct season and when the weather is favorable. No seeding will be done during periods of high wind or rain or when the soil is frozen.

The inspector's final inspection will check to make sure that the closure plan as implemented satisfies the approved closure design. Slopes will be surveyed, any significant depressions noted and corrected, and the leachate standpipes examined for alignment and orientation.

2. CELL NO. 2 CLOSURE AND POST CLOSURE

2.1 Cell No. 2 Closure Costs

The cost estimate for closure of Cell No. 2 must be representative of that point in the cell's operating life when the extent and manner of its operation would make closure the most expensive. Therefore economic evaluations are required for two cases. These are as follows:

1) Assume cell No. 2 is completely filled with waste prior to closure,
2) Assume cell No. 2 is closed prior to completion of filling with waste.

Assumptions basic to the cost development for both cases are as follows:

1) All prices are based on January 1987 costs.
2) Clay to meet the permeability specification of 10^{-7} cm/sec will be obtained from an area within 15 miles of the Witmer Road site,
3) Topsoil will be obtained from an area within 15 miles of the Witmer Road site,
4) In-place cost of clay will be $10.00 per cubic yard,
5) In-place cost of topsoil will be $16.00 per cubic yard,
6) Hydroseeding (including fine grading of topsoil with landscaping equipment) will cost $2,500 per acre

Additional assumptions basic to cost development for Case 2 are as follows:

1) Closure will be required when Cell No. 2 is 80% filled with wastes,
2) Portion of outer berms will be utilized to fill in remaining volume of cell prior to completing normal final closure.

Total closure costs for each case would be as follows:

Case 1 (Cell No. 2 completely filled with wastes prior to closure) - $132,600

Case 2 (Cell No. 2 is 80% filled with wastes at time of closure) - $140,000

2.2 Duration of Post Closure Period

The anticipated duration of Cell No. 2's post closure maintenance and monitoring requirements is thirty years. This may be shortened significantly if commercial uses for the ferrosilicon baghouse dust are developed.

2.3 Cell No. 2 Post Closure Monitoring Costs

The monitoring program for the SKW Alloys, Inc. Witmer Road Site was designed to accommodate all phases of the site's life (construction, operation, closure and post closure periods). This plan incorporates monitoring of both surface and ground water. Since its inception, such monitoring has been conducted on a quarterly basis. To date, no significant environmental problems have been detected. With this in mind, SKW anticipates continuing this program on a quarterly basis until one year after landfill cell closures have been completed. After closure of the Witmer Road Site, it is anticipated that such monitoring can be reduced to a semi-annual basis. In the unlikely event that a problem should be detected, additional monitoring will be implemented. After closure, the site's monitoring program will consist of sampling monitoring wells #3, 5, 12 and 13 and surface water monitoring points #6A and 7. Each sample will be analyzed for pH, conductivity, total dissolved solids, chemical oxygen demand, total organic carbon, barium, chromium (hexavalent and total), iron, manganese, silicon and zinc. Each complete sampling and analysis will cost approximately $1,000. Since this will be done twice per year, the total anticipated yearly cost will be $2,000.

2.4 Cell No. 2 Post Closure Maintenance Costs

The goals of the post closure maintenance plans for the Witmer Road Site are as follows:

1) Ensure that structural integrity of all closed landfill cells is being maintained,
2) Correct any problems that might occur at the site before they have a chance to develop to such a degree that adverse environmental impacts might result, and
3) Follow a program in which all parties (SKW, regulatory agencies, and the public) have a sense of confidence that the site will not create problems which cannot be reasonably handled with minimum impacts.

The post closure maintenance plan can be summarized as follows:

1) SKW Alloys, Inc. will designate a person or persons who will be responsible for filing a Waste Management Facility maintenance report. Included in this maintenance report will be a check list which covers the following:

   a) Bank and cover erosion,
   b) Settlement,
   c) Cover soil integrity,
   d) Condition of vegetative cover,
   e) Inspection of leachate control systems, and
   f) Inspection of monitoring wells.

2) The site will be physically walked by the responsible individual or individuals once a month for the first year after closure, once every three months beginning the second year through the fifth year, and semi-annually for the duration of the site's life.
3) If any problems are encountered that may be of significant environmental concern, immediate corrective actions will be undertaken. Notice of these actions will be reported to the NYSDEC explaining the nature and location of the problem and the corrective action taken.

Since landfill cell closure will be constructed in conformance with the most recent NYSDEC regulations, the possibility for development of significant post closure problems is minimal. Therefore, costs associated with the remediation of any post closure problems which might occur are not expected to exceed $3,000 per year.

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