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PRELIMINARY ENGINEERING AND ENVIRONMENTAL EVALUATION OF THE REMEDIAL ACTION ALTERNATIVES

for the

SEAWAY INDUSTRIAL PARK SITE
TONAWANDA, NEW YORK

Formerly Utilized MED/AEC Sites

Remedial Action Program

December 1981

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ABSTRACT

This combined engineering and environmental evaluation of the contaminated site area at the Seaway Industrial Park in Tonawanda, New York, is sponsored by the U.S. Department of Energy and is managed by the Oak Ridge Operations Office. The site is included in the Formerly Utilized MED/AEC Sites Remedial Action Program, or FUSRAP. The objective of this report is to propose various options for remedial action specific to the Seaway Industrial Park site, and their associated environmental impacts. The proposed options range from the no cost Option A, No Action, to the highest cost ($87,174,000) Option D3, Interim Off-Site Storage and Final Seabed Disposal under Strict Regulatory Controls. Option E1 ($42,071,000), Decontamination and Restoration with Direct Disposal at an Existing Moderately Distant Disposal Facility, is the recommended option based on the engineering evaluation, FUSRAP objectives, cost, and environmental impacts.

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CHAPTER 1

INTRODUCTION AND SUMMARY

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1.1 PROGRAM HISTORY AND REPORT PURPOSE

1.1.1 FUSRAP Program History[1]

During the 1940's and 1950's the Manhattan Engineer District (MED) and its successor, the Atomic Energy Commission (AEC), conducted a program involving research, development, processing, and production of uranium and thorium, and the storage of radioactive ores and residues. This program was carried out under the First War Powers Act of 1941 and the Atomic Energy Acts of 1946 and 1954. Virtually all of this work was performed by private contractors, on land that was federally, privately, or institutionally owned.

Most of the original uranium processed for the nuclear energy weapons program was extracted from pitchblende ore that first was stored, then transported to sampling plants in the east, and then dispersed to mills and refineries for uranium extraction. After World War II, some ores also were processed to obtain thorium. A mill concentrate was obtained from the ores. This concentrate was either refined and converted to other uranium or thorium compounds or was transformed into metal. The resulting products were further dispersed to other participants in the program. As a consequence of these activities, processing sites became contaminated. Such sites eventually were decontaminated in accordance with the criteria and survey methods then in existence. Since those early days, radiological criteria and proposed guidelines for the release of such sites for "unrestricted" use have become more stringent.

In 1974, as a result of the more stringent criteria, the U.S. Government instituted the "Formerly Utilized MED/AEC Sites Remedial Action Program," or FUSRAP. The objectives of this program were as follows:

(a) Identify and assess all former MED/AEC sites that processed radioactive materials to determine whether further decontamination is needed

(b) Decontaminate these sites to conform with current Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) criteria

(c) Develop remedial action programs which are designed to preclude any further radiological problems at sites which were formerly utilized by MED/AEC

(d) Dispose of all radioactive residues in an environmentally acceptable manner

(e) Certify the sites, to the extent possible, for unrestricted future use

(f) Accomplish all work in accordance with land owners agreements, local and state environmental and land-use requirements to the extent permitted by Federal law, and applicable National Environmental Policy Act (NEPA) and Department of Energy (DOE) policies and procedures

(g) Document site radiological conditions, quantify material at the site, and document disposition of materials

Efforts by many Federal, state, local, and commercial organizations have been under way since 1974 in pursuit of these objectives. Before 1974, the essential radiological survey work was carried out at sites identified at that time by the AEC under implied authority of the Atomic Energy Acts of 1946 and 1954, as amended. The Energy Research and Development Administration (ERDA) and the DOE continued this work under the same authority.

Since 1974, FUSRAP work has been carried out by the DOE office of the Assistant Secretary for Environment (ASEV) to recover and regenerate radiological site status information and records and to perform site surveys of locations that have incomplete radiological records. To date, 31 FUSRAP sites which may require some form of remedial action have been identified. The Remedial Action Programs Office (RAPO) of the Deputy Assistant Secretary for Nuclear Waste Management is continuing the program, in conjunction with the ASEV, to identify and remedy radiological conditions at sites formerly utilized by the MED and the AEC.

The authority enabling the FUSRAP to proceed is a result of legislation passed by the U.S. Congress. The Atomic Energy Acts of 1946 and 1954, as amended, authorized the DOE to decontaminate sites under the FUSRAP where Federal ownership or control existed providing that two conditions were met: (a) the MED or AEC were contractually responsible for the decontamination costs, and (b) the contractors or property transferees involved were not aware of the presence of contamination. If authority regarding an MED/AEC site is not clear, the Assistant Secretary for Nuclear Energy (ASNE) may authorize preliminary studies at that site to define the remedial action options and to develop technology to implement the remedial actions. The detailed engineering and National Environmental Policy Act (NEPA) review process may not begin for a site under questionable authority until the following occur: (a) the legislation authorizing the performance of remedial action is enacted, (b) radiological criteria leading to unrestricted site use are placed in force, and (c) disposal

sites for MED/AEC wastes become available. Finally, a contaminated site that is being operated under an NRC license or an Agreement State license is not subject to remedial action under FUSRAP auspices.

Another recent legislative act that has affected the FUSRAP program was the FY 1978 Authorization Act. Through this act, the U.S. Congress has expressed its intent that, at the completion of the FUSRAP survey, the DOE should begin implementation of remedial actions at those identified FUSRAP sites where authority already exists; in addition, the DOE should seek new legislative authority to implement remedial actions at remaining sites for which no congressional authorization exists.

In the spirit of the congressional intent expressed in the FY 1978 Authorization Act, the DOE has plans for the submittal of the Residual Radioactive Material Control Act for congressional enactment in 1982. This act would authorize remedial actions at MED/AEC sites which pose a threat to the public or to the environment because of radiological contamination above the criteria levels. The Seaway Industrial Park (Seaway) site at Tonawanda, New York would be subject to this new congressional legislation. However, before implementation of the selected remedial action option can begin, a DOE-approved disposal site either in New York or in a nearby regional state must be made available, as explained in Chapter 3, Section 3.2.

1.1.2 Report Purpose

The purpose of this report is to present the results of the preliminary engineering evaluation and the environmental assessment leading to the selection of appropriate remedial action options for the Seaway Industrial Park site.

1.2 BACKGROUND AND CURRENT SITE CONDITIONS[2]

The Seaway Industrial Park is presently owned by the Seaway Industrial Park Development Company, Inc. The site is located on Lot 94 in the Town of Tonawanda, New York, which is approximately 9 mi (14 km) north of Buffalo, New York.

The Seaway Industrial Park site covers 100 acres (40 ha), most of which have been and continue to be used as a sanitary landfill. There are no buildings on site; however, two firms (Murphy Motor Freight Lines, Inc. and Air Products and Chemical, Inc.) do occupy parts of the site. Both firms are located on the northwest portion of the site, as shown on the ownership map in Figure 3-6. The three contaminated combined areas cover 13 acres (5 ha) and are located in the central portion of the site, as shown in Figure 3-3. According to radiological surveys made by the Oak Ridge National Laboratory (ORNL)[2] and by Ford,

Bacon & Davis Utah Inc. (FB&DU), the contamination in Areas A, B, and C averages about 2 to 3 ft (0.6 to 1 m) in depth.

The Seaway Industrial Park site is accessible from River Road on the northwest side. The Niagara River lies approximately 300 ft (90 m) to the northwest, and rail service is available 650 ft (200 m) to the southwest.

Elevation of the area surrounding the site is about 590 ft (180 m) above mean sea level and portions of the landfill itself presently rise to over 640 ft (200 m) above mean sea level.

Most of the drainage from the site flows north or northeast into drainage ditches feeding Twomile Creek which flows into the Niagara River. Some runoff accumulates near the southern boundary of the site. This runoff is, in part, from both the Ashland and Seaway properties. The contaminated site areas are not in a flood plain. A hydrogeologic investigation prepared by Wehran Engineering[3] indicated that vertical leaching of precipitation into the landfill and recent alluvial deposits does occur. Under the recent alluvium, however, an aquiclude consisting of two impermeable clayey geologic formations inhibits further vertical migration. The ground water table within the landfill radially discharges to the landfill perimeter eventually finding its way into surface water drainage ditches. The alluvial deposits vary in thickness from 0 to 17 ft (0 to 5 m).

From 1944 through 1946, the former Haist property received residue from uranium processing. The present owner of the Haist property, Ashland Oil, Inc., in 1974 removed approximately 6,000 yd (4,590 m)[3] of this residue and deposited it on the Seaway Industrial Park site. The residue, being comprised mostly of low-grade uranium ore tailings, was dumped in Areas A, B, and C, as shown in Figure 3-3.

Because of moving and spreading of the residue, much mixing has occurred with clean soil, greatly increasing the volume of contaminated material. According to ORNL soil sample data, Area A contains contamination above EPA criteria to a depth of approximately 2 ft (0.6 m). Areas B and C contain contaminated soils to approximately 3 ft (1 m) in depth. The total in-place volume of contamination in or near Areas A, B, and C is estimated at 49,400 yd^3 (37,800 m^3).[3] According to samples taken by FB&DU, Area B seems to have been dispersed. Soil samples taken in Area B were not elevated, and external gamma readings were only slightly elevated. Area C seems to have increased in size possibly due to erosion down the slope to the south. Volumes of contaminated residues in Area B were conservatively calculated using the ORNL area estimation and a depth of 3 ft (1 m). The Area C volume was calculated using the FB&DU increased size and a depth of 3 ft (1 m).

Water sample data taken by ORNL and FD&DU show slightly elevated ^{226}Ra and ^{238}U concentrations in drainage areas on or near the Seaway site. Both radionuclides show concentrations near the EPA standards but well below the NRC release limits. External gamma radiation and radon flux results also were above background levels; however, health effects due to radiologic conditions were calculated as negligible. No immediate action is required to alleviate either health effects or environmental impacts.

1.3 ENGINEERING EVALUATION

There are five alternatives from which site-specific remedial action options can be devised for contaminated properties:

Basic Alternative I - No Action

Basic Alternative II - Minimal Action

Basic Alternative III - Stabilization/Entombment

Basic Alternative IV - Partial Decontamination

Basic Alternative V - Decontamination and Restoration

These basic alternatives were evaluated according to the site-specific requirements at the Seaway Industrial Park site. It was determined that Basic Alternatives II and IV were not applicable for the reasons presented below.

Basic Alternative II, the minimal action alternative, was rejected on the basis that contamination could not be adequately stabilized under present conditions nor under the proposed manner of maintaining the landfill, which is outlined in a report by Wehran Egineering, Inc.[3] and includes covering the landfill with a layer of clay, vegetating the cover, and monitoring the local ground water for leachates. Workers would continue to be exposed to direct gamma radiation, and radon flux rates would not be reduced to a level which is attainable under other basic alternatives.

Basic Alternative IV, the partial decontamination alternative, is not justified because the site does not pose an immediate health or environmental hazard. The main objective of the partial decontamination option is to remove immediate health hazards and leave the less hazardous material for future consideration. Soil contamination is fairly uniform resulting in little immediate gain from partially decontaminating.

As a result of the evaluation above, 10 options for remedial action are proposed at the Seaway site:

Option A - No Action

No action would be taken to clean up the site. This option is used to compare impacts of the current conditions with those of the other options.

Option B - On-Site Stabilization

This option involves excavation and reburial of the contaminated residues on site with engineered ground water control and radon gas encapsulation. A 3-ft (1-m) layer of clay would serve as a hydrological barrier around the buried residues. In addition, an extra 6 ft (2 m) of topsoil would be used as a cover to meet NRC proposed guidelines for 1,000 yr of stabilization. The U.S. Government would have to purchase the site and assume future liability for it.

Option C - Decontamination and Restoration with Interim On-Site Storage

Option C requires earthmoving equipment to stockpile the contaminated residues in a seldom used section of the site. A plastic cover would be used to stabilize the residues and restrict rainwater contact during the interim storage.

Option C1 - Contaminated materials would be taken from interim storage, loaded into trucks an assumed distance of 500 mi (800 km) to a state or regional disposal facility.

Option C2 - Contaminated materials would be taken from interim storage by truck an assumed distance of 500 mi (800 km) to an embarkation point for final seabed disposal under relaxed regulatory controls.

Option C3 - Contaminated materials would be taken from interim storage, packaged to meet stringent requirements, and transported an assumed distance of 500 mi (800 km) to an embarkation point for final seabed disposal under strict regulatory controls.

Option D - Decontamination and Restoration with Interim Off-Site Storage

Decontamination and restoration would proceed as in Option C; however, interim storage would take place off site.

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Option D1 - Interim off-site storage would be at an assumed distance of 150 mi (240 km), with final disposal at a state or regional disposal facility at an assumed distance of 500 mi (800 km).

Option D2 - Interim off-site storage would be at an assumed distance of 150 mi (240 km), with final seabed disposal under relaxed regulatory controls at an assumed distance of 500 mi (800 km) to the embarkation point.

Option D3 - Interim off-site storage would be at an assumed distance of 150 mi (240 km), with final seabed disposal under strict regulatory controls at an assumed distance of 500 mi (800 km) to the embarkation point.

Option E - Decontamination and Restoration with Direct Disposal t an Existing Disposal Facility

This approach would require the same on-site remedial action as that in Option C. The contaminated waste would be shipped directly to an existing disposal facility.

Option E1 - Direct disposal would be at an existing moderately distant disposal facility at a distance of 1,000 mi (1,600 km).

Option E2 - Direct disposal would be at an existing distant disposal facility at a distance of 2,300 mi (3,700 km).

The estimated number of working days to completion, the estimated worker crew sizes, and the estimated cost of each option are as follows:

Option A 0 days, with a crew size of 0, and a total cost of 0.

Option B 88 days, with a crew size of 20, and a total cost of $2,137,000.

Option C1 363 days, with a crew size of 69, and a total cost of $52,341,000.

Option C2 363 days, with a crew size of 69, and a total cost of $22,226,000.

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Option C3 393 days, with a crew size of 69, and a total cost of $73,989,000.

Option D1 440 days, with a crew size of 69, and a total cost of $65,776,000.

Option D2 440 days, with a crew size of 69, and a total cost of $35,028,000.

Option D3 470 days, with a crew size of 69, and a total cost of $87,174,000.

Option E1 40 days, with a crew size of 35, and a total cost of $42,071,000.

Option E2 45 days, with a crew size of 35, and a total cost of $54,277,000.

1.4 ENVIRONMENTAL EVALUATION

An environmental survey was performed to ensure that relevant facts would be available and included in the evaluation of the various options. After engineering evaluations had led to the identification of practicable remedial action options that could be implemented at the site, the environmental impact evaluation was outlined to include the appropriate environmental parameters. Data from the engineering and environmental surveys were analyzed and placed into relevant formats, such as health effects, worker and transportation accident potentials, costs, etc. The impact analysis was then performed and used as input for the environmental evaluation of each of the proposed options.

As a result of the environmental evaluation, it was determined that the Seaway Industrial Park site was not an environmentally sensitive area. The potential impacts of remedial action on human health, quality of life, environmental integrity, and nonrenewable resources were determined to be insignificant.

1.5 UTILIZATION OF ENGINEERING AND ENVIRONMENTAL INFORMATION

The engineering and environmental information used to evaluate the proposed options was compiled into an evaluation matrix, which permits a comparison of options needed for the selection of the recommended and environmentally preferred options. This matrix reflects an objective evaluation of the 16 environmental and nonenvironmental parameters potentially affecting the Seaway Industrial Park site. The parameters include issues such as air and water quality, health effects, and future liability. The impacts of all of these parameters were not quantifiable in an absolute sense. Therefore, subjective judgement also had to be utilized to determine the

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severity of the adverse impacts or the magnitude of the benefits under each proposed option.

As a result of the matrix analysis, Option E1 was determined to be the recommended option as well as the environmentally preferred option.

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CHAPTER 1 REFERENCES

1. "Program Management Plan"; Draft Report, Formerly Utilized Sites Remedial Action Program; Department of Energy; p. 1-20; Oct 1980.

2. R. W. Leggett, et al.; "Radiological Survey of the Seaway Industrial Park, Tonawanda, New York"; Final Report; Report No. DOE/EV-0005/6; Oak Ridge National Laboratory; Oak Ridge, Tennessee 37830; May 1976.

3. "Hydrogeologic Investigation Seaway Industrial Park Sanitary Landfill"; Wehran Engineering, P.C.; Kenmore, New York 14217; May 1979.

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CHAPTER 2

RECOMMENDED OPTION

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CHAPTER 2

RECOMMENDED OPTION

Option E1 is the recommended option. This chapter summarizes the rationale for selecting Option E1 for implementation at the Seaway Industrial Park site. The engineering effort required for implementation of Option E1, which proposes the decontamination and restoration with direct disposal at an existing moderately distant facility, is described in detail, along with environmental impacts, in Chapter 6. An evaluation of these impacts is given in Chapter 7, where Option E1 is identified as the recommended option as well as the environmentally preferred option.

Option E2 would require a large-scale effort to remove over 49,400 yd^3 (37,800 m^3) of in-place contaminated materials from the site. Monitoring of gamma radiation during excavation would be required. Soil samples would be taken for confirmation of decontamination.

The excavated contaminated soils and materials would be transported by rail to an existing moderately distant disposal facility, which is assumed to be a distance of 1,000 mi (1,600 km) from Tonawanda, New York. At this distance, rail haulage would be more cost-effective than truck haulage.

Several of the other proposed options appear to offer significant advantages over Option E1 when considering individual evaluation parameters. Option B, which rpoposes on-site stabilization, offers a distinct advantage in the cost category over Option E1. Option B would cost about $40,000,000 less than Option E2; however, Option B sustains more adverse ratings in the future liability, fulfillment of FUSRAP objectives and public sentiment categories than does Option E1. Option E2 also has high overall weighted points totals in the evaluation matrix but has a longer distance to a disposal site (and therefore costs more), uses more nonrenewable resources (petroleum fuels), and has greater chances of transport accidents than does Option E1.

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CHAPTER 3

BACKGROUND AND DESCRIPTION OF SITE

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BACKGROUND AND DESCRIPTION OF SITE

3.1 HISTORY AND SITE BACKGROUND

This section describes the location of the Seaway Industrial Park site relative to its surroundings, characteristics of the materials present on the site, past and current operations at the site, and present site ownership.

3.1.1 Site Location

The Seaway Industrial Park site is located within the official limits of the Town of Tonawanda, Erie County, New York. The Town of Tonawanda, shown in Figure 3-1, is located about 9 mi (15 km) northwest of Buffalo, New York. The City of Tonawanda is located on the north side of the town, about 0.75 mi (1.2 km) north of the Seaway site. Lake Erie is located less than 10 mi (16 km) to the southwest. The Seaway property is bounded by Ashland Oil, Inc.; River Road; Murphy Trucking, Inc.; Leffler Auto Parts; property owned by Niagara Mohawk Power Corporation; and Agway Petroleum Corporation, as shown in Figures 3-2 and 3-6.

3.1.2 Site Description[1]

The Seaway Industrial Park (Lot 94 of the Town of Tonawanda) covers almost 100 acres (40 ha), most of which has been used as a sanitary landfill for about 50 yr. The site is located in a large industrial area, and the areas containing the radioactive waste are more than 0.5 mi (0.8 km) from the nearest dwellings. There are no permanent buildings on the Seaway Industrial Park site, and there is little vegetation. Some parts of the site are at a higher elevation than the surrounding terrain, as shown in Figure 3-3.

Most of the drainage from the Seaway Industrial Park site flows north or northeast into drainage ditches or a creek and eventually into the nearby Niagara River. A portion of the drainage, from the area just south of Murphy Trucking, Inc., flows down a steep incline toward River Road, and some of this runoff also accumulates near Murphy Trucking. Drainage from the Ashland Oil property flows around the Seaway site and eventually into the nearby Niagara River, as shown in Figure 3-4.

3.1.3 Site History

The Seaway Industrial Park is a landfill disposal site which was not associated with any MED or AEC operations. The Seaway site is located next to the former Haist property which received residues from uranium processing during the years 1944 through 1946. However, in 1974, Ashland Oil, the owner of

the former Haist property, excavated about 6,000 yd^3 (4,600 m^3) of surface soils contaminated with low levels of radioactive waste residues.

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The residue was dumped into three separate areas. One area covers about 10 acres (4 ha), and the other 2 areas combined cover about 3.5 acres (1.8 ha). Within the 10-acre (4-ha) area, the residue was generally spread to a depth of less than 2 ft (0.6 m). In the other two areas, the residue was left in small isolated mounds. Although most of the contaminated soils are not covered, they have been partially mixed with clean soil during recent years due to earthmoving associated with landfill operations.

The Health and Safety Research Division of Oak Ridge National Laboratory (ORNL) performed a radiological survey of the Seaway Industrial Park site during the period of August 6 through 13, 1976.[1] The purpose of the survey was to determine radiation levels and the extent of movement of radioactive residues by natural means, such as runoff. The results of this survey indicated that external gamma radiation (EGR), radon, and radon daughter levels exceed guideline values over small, isolated areas of the landfill. Supplemental radiological data and site conditions were obtained by Ford, Bacon & Davis Utah Inc. (FB&DU) in June 1981.

3.1.4 Site Ownership

The Seaway Industrial Park site is owned by Seaway Industrial Park Development Company, Inc., of Tonawanda, New York, and is operated by Niagara Landfill, Inc.

3.2 WASTE ISOLATION AND DISPOSAL POLICY

Implementation of the recommended remedial action option selected for the Seaway Industrial Park site and disposal of the low-level radioactive wastes from the site must be accomplished in accordance with the legislation enacted as part of the National Plan for Radioactive Waste Management. Consequently, in addition to the legislation already in force concerning some specific FUSRAP sites, discussed in Chapter 1, Federal legislation, discussed in Subsection 3.2.1, must yet be passed to authorize implementation of remedial action options at other specific FUSRAP sites such as the Seaway Industrial Park site.

3.2.1 Residual Radioactive Material Control Act

This proposed legislation is designed to authorize the Secretary of Energy to conduct remedial actions at those formerly utilized MED/AEC sites which, according to established criteria, pose a potential health threat to the public or adverse impact to the environment because of residual radiological contamination. The term "residual radioactive material" means any radioactive material on site that results in radiation

levels that exceed background levels. The Seaway Industrial Park is a site containing MED/AEC residual radioactive contamination. Consequently, based on FUSRAP guidelines the site requires remedial action, which would be authorized with passage of the proposed legislation. Currently, plans are that the Residual Radioactive Material Control Act will be submitted for congressional action in 1982.

3.2.2 Low-Level Waste Disposal Policy

Also important to implementation of the recommended remedial action option at the Seaway Industrial Park site is selection of the disposal site. Public Law 96-573, the Low-Level Waste Policy Act, enacted December 22, 1980, makes each state responsible for providing its own disposal site for the low-level radioactive wastes of certain categories (e.g., MED/AEC wastes) produced within its borders. The disposal site, whose location must be approved by the DOE, may be located within the state, or in another regional state, by agreement with that state and with approval of the DOE. It is important to recognize that a DOE-approved disposal site specified to receive the MED/AEC wastes from the Seaway Industrial Park site does not currently exist, either within New York or within a regional state.

3.2.3 Radiological Risks to Health and Environment

The specific activity of the contaminants is low and the health hazard resulting from the radioactive contaminants is low, with the wastes in their present condition. However, control and security cannot be assured for the significant period of time that these materials will remain radioactive. Consequently, the DOE has determined that these wastes must not be exposed to the environment in an uncontrolled manner. It has, therefore, considered the Seaway Industrial Park site eligible for "studies to define remedial action options and develop technology for remedial action."(2)

3.2.4 Public Awareness and Attitudes

The owners, operator, manager, and workers at the site are aware of the presence of contaminated materials. State and local health officials are also aware of this situation. There does not appear to be significant adverse publicity concerning the presence of the contamination on site. Discussions of FB&DU personnel with workers and managers at the site revealed that most personnel at the site had few reservations about working in the present environment.

3.3 OTHER AGENCY INVOLVEMENT

New York is a Nuclear Agreement State, and consequently jurisdiction over matters involving radioactive materials (e.g., licensing of facilities, and selection of disposal site)

rests with the state. However, key participants in the FUSRAP activities as they are being applied to the tasks involved at the Seaway Industrial Park site and other FUSRAP sites include several organizations within Federal, state and local governments.

3.3.1 Major Department of Energy Organizations

The Assistant Secretary for Nuclear Energy (ASNE) is assigned to the Remedial Action Programs Office (RAPO), which has overall program responsibility for design and operation of the remedial action projects. The RAPO is integral to: establishing program requirements and priorities; assessing project progress; and managing program funding, technical objectives, and major schedule milestones within which the Oak Ridge Operations (ORO) Office must operate.

The Assistant Secretary for Environment (ASEV) must, along with many other assigned responsibilities, determine the need for NEPA documentation, review NEPA documents prepared by the ASNE, interact with the ASNE on policy and on ASNE/ASEV-shared program responsibilities, and assist the ASNE with environmental and safety aspects of interagency agreements and memorandums of understanding with state and local governments.

The ORO Office has primary responsibility for management and administration of remedial actions in the field. Within the scope of work for the ORO Office is the responsibility for providing contractual and technical administration for the remedial action projects. To administer as prescribed, the ORO Office must guide a multitude of specific tasks leading to implementation of remedial actions and to unrestricted use of the decontaminated site.

3.3.2 Environmental Protection Agency (EPA)

The EPA establishes and enforces pollution control standards. It also establishes radiation protection standards used by other Federal agencies and general criteria for control of radioactivity in the environment. These criteria are providing guidance to FUSRAP for uranium residues containing radium until EPA criteria specifically designed for FUSRAP are established.

3.3.3 Council on Environmental Quality (CEQ)

The original mission of the CEQ was to provide guidelines to Federal agencies; it now issues regulations which are mandatory under the law. Specifically, the CEQ has issued guidelines on the preparation of environmental impact statements (EIS's) and reviews EIS's to ensure their compatibility with the NEPA process.

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3.3.4 Nuclear Regulatory Commission (NRC)

The NRC issues disposal site licenses to the DOE. The NRC coordinates closely with the DOE in preparing disposal site development plans. The NRC also is developing rules to regulate waste management activities, and performs independent research and development in waste management.

3.3.5 State Planning Council (SPC)

The SPC is comprised of governors, state and local governmental officials, Indian tribal representatives, and representatives of Federal agencies. The SPC participates in all phases of disposal site selection and qualification, and exercises a key role in the consultation and concurrence approach with the various states where FUSRAP sites have been identified. The state and local governments are expected to participate in a major way in planning remedial actions and developing waste disposal sites.

3.3.6 Department of Transportation (DOT)

If the waste on the FUSRAP site is sufficiently high in radioactivity, the DOT must be included in the planning necessary to transport the waste to the selected disposal site. The waste at the Seaway Industrial Park site is classified as a low-specific activity material, and consequently participation in transportation planning by the DOT probably will not be necessary.

3.3.7 Specific State and Local Agencies

The State of New York is a Nuclear Agreement State; and, as such, the New York State Department of Labor, Division of Safety and Health, Radiological Health Unit, has jurisdiction over matters involving radioactive material such as the licensing of facilities using or processing nuclear material. The State of New York has not yet developed disposal sites to receive these or other FUSRAP wastes.

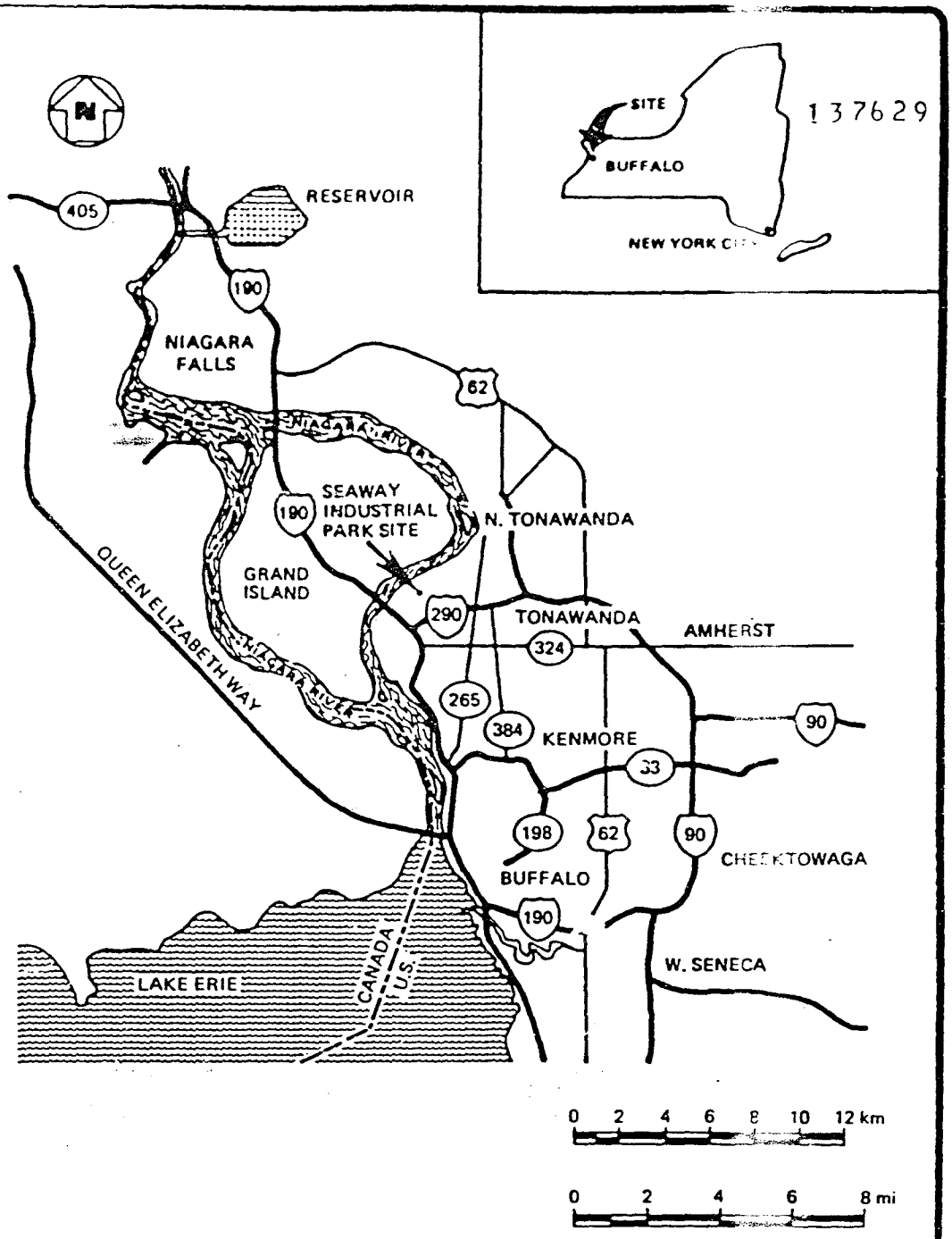

FIGURE 3-1. SITE LOCATION MAP

FIGURE 5

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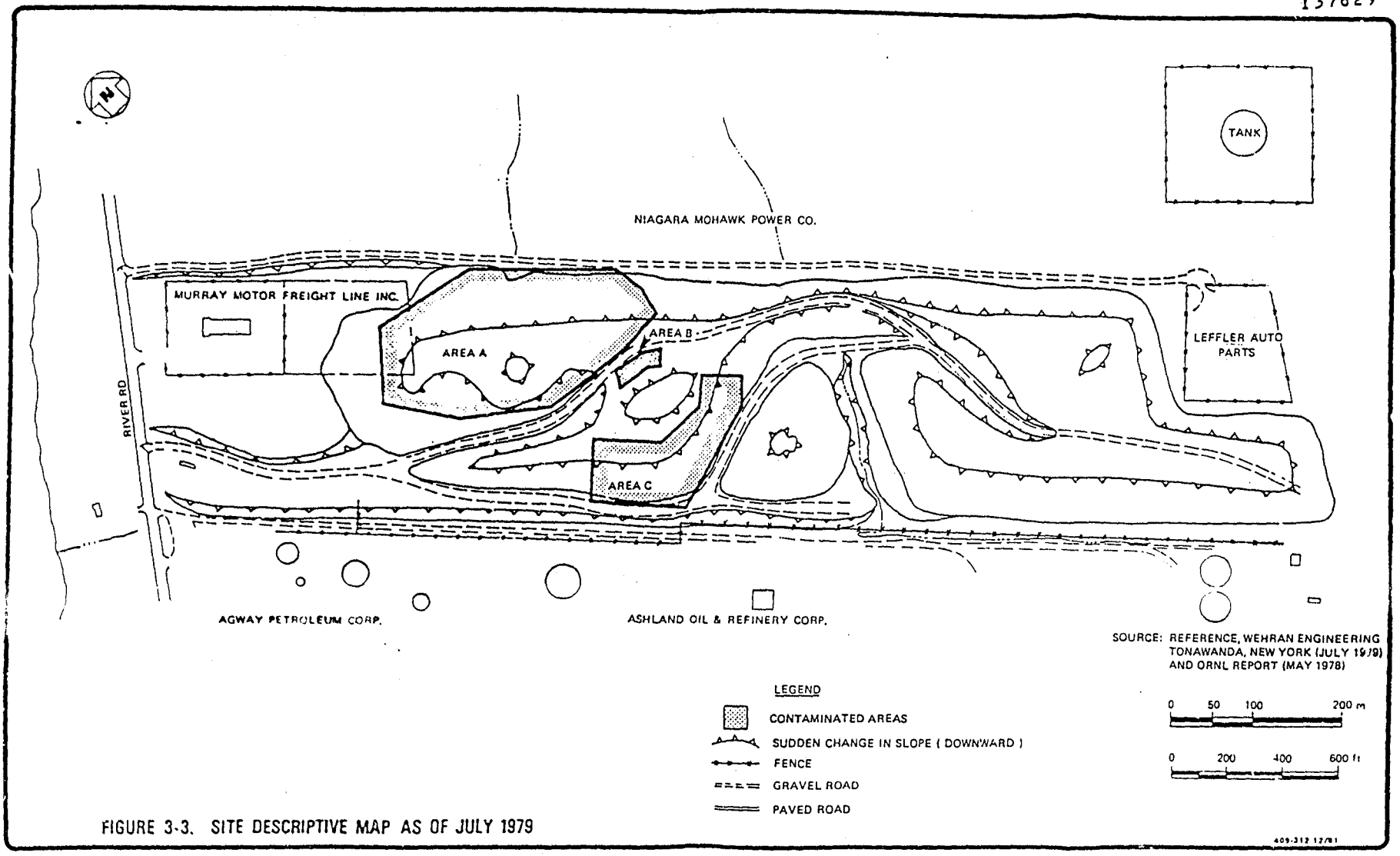
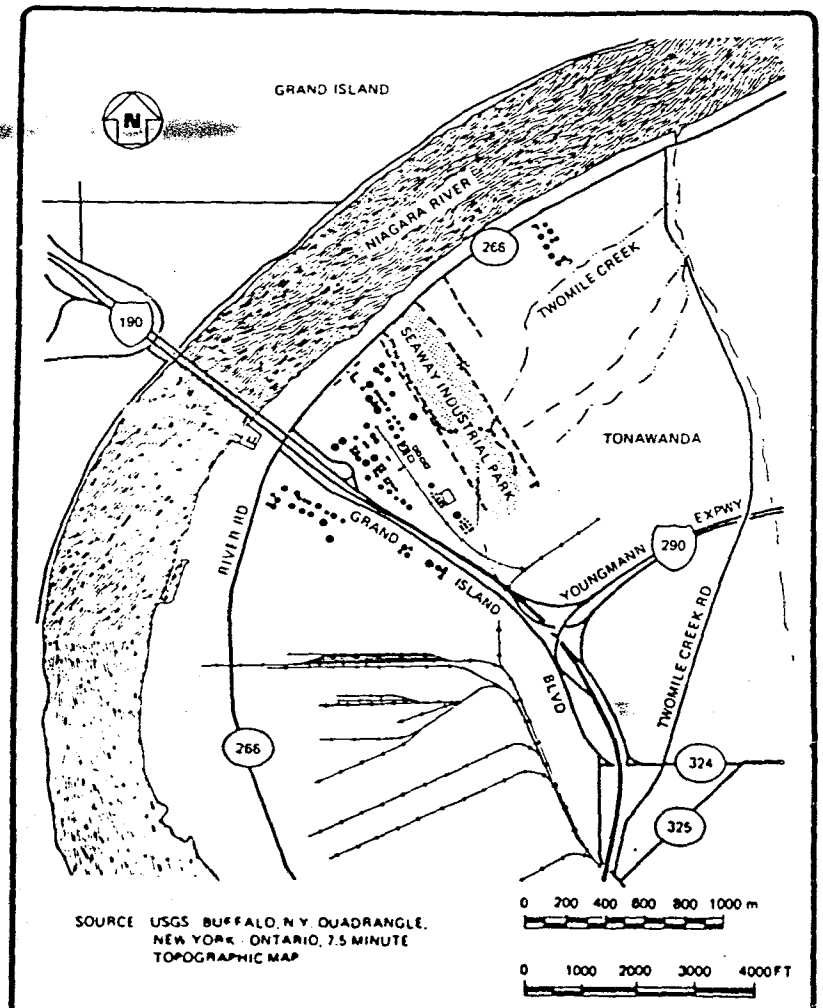


FIGURE 3-3. SITE DESCRIPTIVE MAP AS OF JULY 1979



SOURCE USGS BUFFALO, N.Y. QUADRANGLE, NEW YORK - ONTARIO, 7.5 MINUTE TOPOGRAPHIC MAP

FIGURE 3-4. SITE VICINITY MAP

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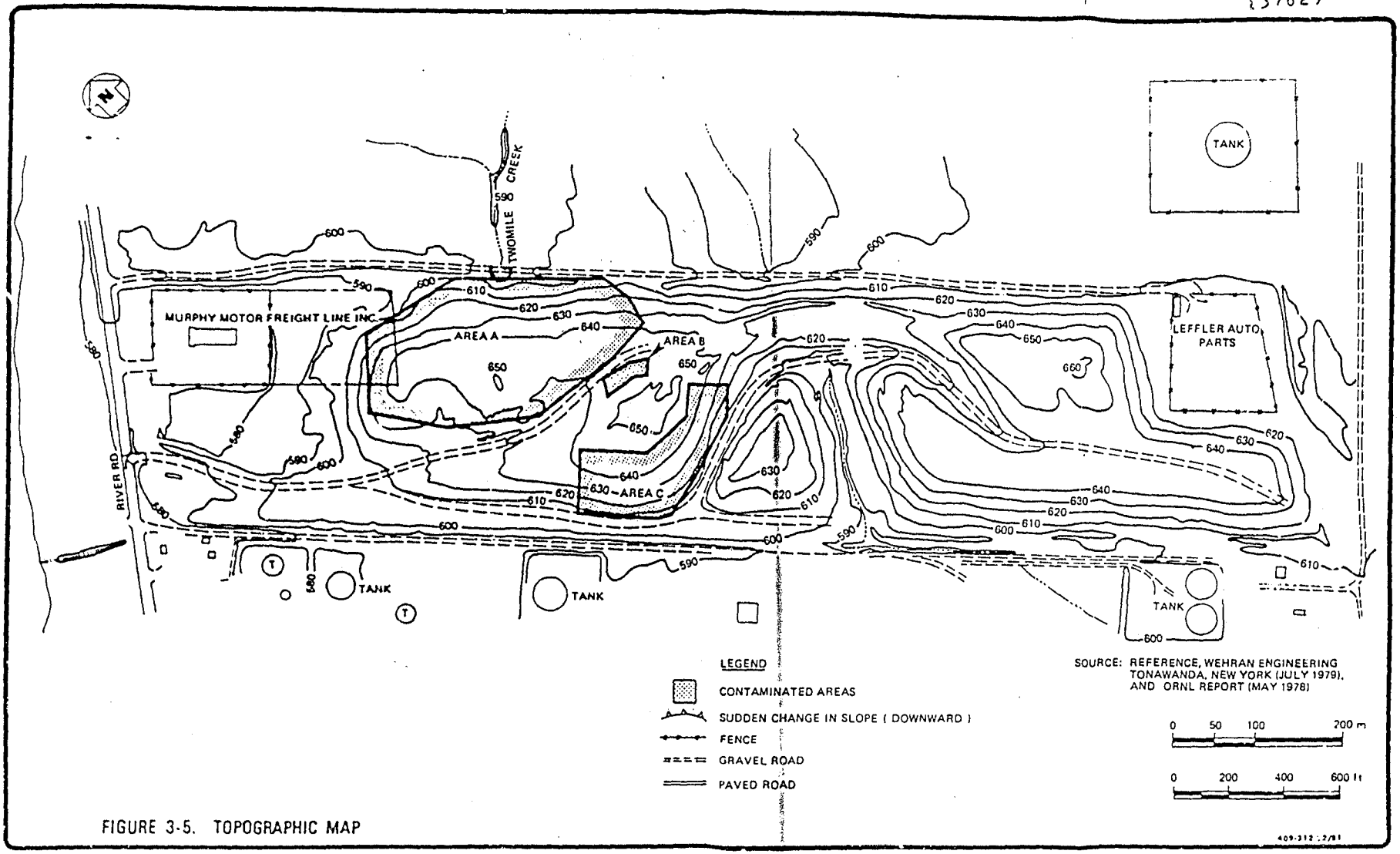

FIGURE 3-5. TOPOGRAPHIC MAP

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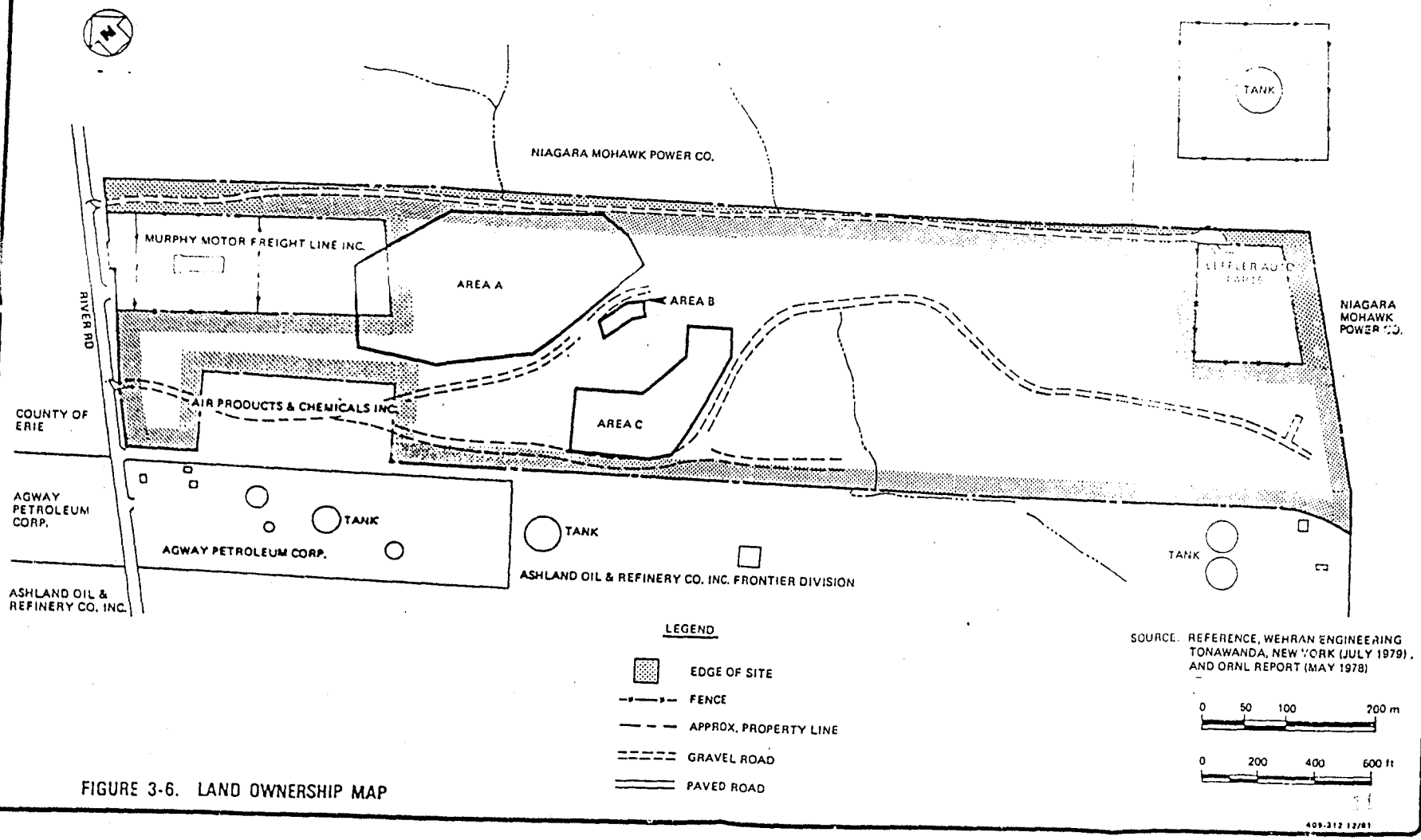

FIGURE 3-6. LAND OWNERSHIP MAP

0 0 3 5 1 8

CHAPTER 3 REFERENCES

1. R.W. Leggett, et al.; "Radiological Survey of the Seaway Industrial Park, Tonawanda, New York"; Final Report; Report No. DOE/EV-0005/6; Oak Ridge National Laboratory; Oak Ridge, Tennessee 37830; May 1978.

2. "Program Management"; Draft Report; Formerly Utilized Sites Remedial Action Program; U.S. Department of Energy; pp. 1-20; 1980.

CHAPTER 4

EXISTING RADIOLOGICAL CONDITIONS

CHAPTER 4

EXISTING RADIOLOGICAL CONDITIONS

A radiological survey of the contaminated areas of the Seaway Industrial Park was performed in 1976 for ERDA, the predecessor agency to the DOE, by the Health and Safety Research Division of ORNL.[1] Data on surface and subsurface soil and water contamination were obtained, as well as direct readings of beta-gamma, external gamma radiation, and radon gas emanation in the contaminated areas. The information presented here is a summary of the 1976 ORNL radiological survey results, with additional survey data from the FB&DU site visit in June 1981, and is given to indicate the amount of contaminated soils and materials.

Remedial action criteria are presented first to establish the standards that the FUSRAP program will follow. Water sample data and analyses are then presented, followed by soil sample data, external gamma radiation measurements, surface contamination, and radon and radon daughter concentrations. Background measurements of each are addressed. At the conclusion of this chapter, a discussion of contaminated areas is presented. Tables and figures indicate specific locations of measurements and of the contaminated areas. Figure 3-3 depicts the contaminated areas in relationship to the larger site area.

4.1 REMEDIAL ACTION CRITERIA

No formal criteria have been established that apply specifically to decontamination of FUSRAP sites. However, several criteria have been established by Federal agencies for other programs. These criteria are important to the analysis of the radiological data presented in this chapter, since they are considered to apply in lieu of formal criteria. The criteria are discussed in terms of concentrations of radionuclides in soil, air, and water; external gamma radiation levels; and alpha and beta-gamma surface contamination levels.

4.1.1 Soil Concentrations

The U.S. Environmental Protection Agency (EPA) has established soil concentration limits for ^{226}Ra for inactive uranium processing sites.[2] This standard provides that "The average concentration of ^{226}Ra attributable to residual radioactive material from any designated processing site in any 5-cm thickness of soils or other materials on open land within 1 ft of the surface, or in any 15-cm thickness below 1 ft, shall not exceed 5 pCi/g."

Standards have not been established for soil concentrations of other radionuclides. However, Healy, et al. of the Los

Alamos National Laboratory (LANL) have proposed guidelines for decontamination of contaminated sites,[3] and FB&DU has used these guidelines in the absence of other established standards. The proposed soil concentration limits based on the Healy, et al. guidelines are listed in Table 4-1.

4.1.2 Air Concentrations

The EPA standard[2] for decontamination of lands and buildings establishes a maximum permissible annual indoor radon decay product concentration, including background, of 0.015 WL, where tailings or other process materials are present. Studies quoted within the presentation of the standard show that at least 10% of houses with basements not constructed over tailings exceed this level. Therefore, the standard states that "if the allowable level is still exceeded after all apparent tailings have been removed or otherwise prevented from affecting the interior of the building, then the standard does not require further remedial measures."[2]

For all other radionuclides, including ^{238}U and ^{232}Th, air concentrations after decontamination are not to exceed the limits given in Title 10 of the Code of Federal Regulations, Part 20, Appendix B (10 CFR 20, Appendix B), Table II, Column 1.

4.1.3 Water Concentrations

The EPA has established a maximum contaminant level for combined ^{226}Ra and ^{228}Ra of 5 pCi/l, for ^{238}U of 10 pCi/l and for gross alpha of 15 pCi/l, for community drinking water systems. In addition, the average annual concentration of radioactive materials not specifically identified is limited to that concentration which will produce a maximum total body dose equivalent of 4 mrem/hr.[4] Water concentrations of radionuclides in effluents from the site are not to exceed the limits described in 10 CFR 20, Appendix B, Table II, Column 2.

4.1.4 External Gamma Radiation Levels

Nonoccupationally exposed individuals are not to be exposed to ionizing radiation in excess of 500 mrem above background annually.[5] In addition, the EPA standards have set a maximum exposure, whether indoor or outdoor, of 0.02 mrem/hr (20 μrem/hr) above background[2] which is roughly one third the level found in 10 CFR 20.

4.1.5 Surface Contamination

Surface contamination at the Seaway site is from beta-gamma-emitting nuclides. Criteria for decontamination of facilities and equipment for release to unrestricted use have been established by the U.S. Nuclear Regulatory Commission

(NRC).[6] The criteria for beta-gamma surface cont
are summarized in Table 4-2.

4.2 WATER ANALYSES

Seven surface water samples were collected by ORNL at locations shown in Figure 6 of the ORNL report, includes in Appendix A of this report, and added to Fi of this report. The FB&DU survey team collected 16 water samples, locations of which are shown in Figure 4 maximum ^{226}Ra concentration in the ORNL samples was 6 and in the FB&DU samples was 6.0 pCi/l, compared EPA drinking water standard of 5 pCi/l and with the NRC limit of 30 pCi/l. The maximum ^{238}U water concentra served was 53 pCi/l at the off-site junction of the two streams about 1,500 ft (460 m) northeast of the site. limit for ^{238}U in drinking water is 15 pCi/l, while standard for plant effluents is 40,000 pCi/l. Result FB&DU surface water samples are given in Table 4-3. S Seaway site does not involve drinking water, the above concentrations should be considered as the limiting

4.3 SOIL ANALYSES

Soil samples were collected by ORNL from 60 bore site, as shown in Figure 4-2. This figure also sh locations of 10 additional boreholes drilled for th survey. Tables 2 and 3 of the ORNL report (Appendix soil concentrations of ^{226}Ra above the EPA criterion of above background in the first 2 ft (0.6 m) of soil of Area A and to the north of the area, and in the first m) of soils on and near Areas B and C. The FB&DU boreho drilled to determine if contaminated material had penet deeper levels and to define more specifically the oute of contamination. Soil concentration data from FB&DU are given in Table 4-4. The maximum concentration samples was 141 pCi/g ^{226}Ra and 74 pCi/g ^{238}U in the part of Area A; contamination above criteria was found as 6 ft (1.8 m) below the surface in Area A.

Surface soil samples were collected at 100-ft intervals along the drainage stream just north of Area maximum concentration of 3.8 pCi/g ^{226}Ra was found at (30 m) from the Seaway Industrial Park site; all others the normal background range.

4.4 EXTERNAL GAMMA RADIATION

Figures 7 through 10 of the ORNL report (Appendix the locations of external gamma radiation measurements a of elevated readings as determined by ORNL in 1976. S contamination is on the slopes of the landfill. FB&DU p a complete survey on a 100-ft (30-m) grid system to

contamination had moved down the slopes. The results of the FB&DU survey are shown in Figure 4-3; a reading is recorded on the figure only where it exceeded 25 R/hr. Natural background in the Tonawanda area is about 8 to 9 R/hr, and the EPA gamma criterion allows up to 20 R/hr above background. The value of 25 R/hr thus provides a slight degree of conservatism in the selection of a gamma action level.

A comparison of Figure 4-3 with Figures 7 and 8 of the ORNL report (Appendix A) shows that the contamination in Area A seems presently to be stabilized, with little movement in 5 y However, it appears that the radioactive material in Area C has washed down the slopes to the southeast and southwest, approaching the access road to the back part of the landfill. The maximum gamma reading recorded by ORNL was 80 R/hr on Area A, while the maximum FB&DU reading was 75 R/hr, also on Area A. Maximum readings on Area C were 60 R/hr by ORNL and 65 R/hr by FB&DU.

4.5 SURFACE CONTAMINATION

Surface beta-gamma measurements by ORNL in Area A showed that the distribution of elevated readings closely approximates the distribution of elevated external gamma readings. No buildings are found on the Seaway Industrial Park. Surface contamination appears to be entirely associated with the contaminated soils brought to the landfill.

4.6 RADON FLUX MEASUREMENTS

The ORNL, making several conservative assumptions, calculated the radon flux emanating from the soil surface at the Seaway site to be about 5 pCi/m^2-s on Area A.[1] The FB&DU survey team measured radon flux at seven locations on the site and at three locations on the Niagara Mohawk property directly northeast. These locations and measured flux values are shown in Figure 4-4. The two measurements on Area A showed flux values of 1.3 and 2.9 pCi/m^2-s. These levels are considered to be in reasonable agreement with ORNL's calculated flux of 5 pCi/m^2-s, since ORNL reported that their estimate could be in error by a factor of 5 or more for individual locations at the Seaway site.[1]

The maximum radon flux measured by FB&DU was 7.7 pCi/m^2-s on Area C, which compares well with the ORNL estimate of no more than 10 pCi/m^2-s. One measurement of interest was in the swampy area of the Niagara Mohawk property, where a flux value of 6.0 pCi/m^2-s was obtained. This anomaly was not confirmed by external gamma or surface soil sample data.

4.7 CONTAMINATED AREAS OF THE SITE

In the 1976 survey, ORNL identified three areas of the Seaway site as having contaminated material. These areas

are identified as Areas A, B, and C on the figures of this chapter. The FB&DU survey in 1981 determined that contamination in Area A has remained essentially constant. Soil contamination was above criteria as deep as 6 ft (1.8 m) below the surface near the top of the landfill, and about 2 ft (0.6 m) below the surface near the Lefler Road on the northeast side of the landfill.

Area B lies immediately south of the main access road. ORNL reported a maximum depth of contamination of 2 ft (0.6 m) through most of the area, with one spot where contamination was as deep as 3 ft (0.9 m) below the surface. Soil samples from boreholes drilled by FB&DU at the side of the access road had only background concentrations of ^{226}Ra and ^{238}U, suggesting that the contaminated material has not spread onto the road area. Data from the ORNL survey was used to estimate the volume of soil to be removed from Area B.

Contamination has eroded down the slope to the south of Area C. Elevated gamma readings were measured at points on this slope, as shown Figure 4-3. Contamination is probably only in the first 1 ft (0.3 m) of soil, although the topographical configuration and wet conditions made it impossible to drill any holes in the area. Soil concentrations of ^{226}Ra above criteria were found as deep as 4 ft (1.2 m) below the surface at one location by ORNL, and as deep as 6 ft (1.8 m) below the surface at another location by FB&DU. Also, a small area of contamination exists near the drainage ditch just northeast of Area A, as shown in Figure 4-4.

Based on the above information, the areas of contamination are shown in Figure 4-4 and include Areas A and B, and Area C with its extension down the slope to the south. The total surface area of Area A is 49,300 yd^2 (37,700 m^2); for Area B, 2,200 yd^2 (1,700 m^2); and for the extended Area C, 14,400 yd^2 (11,000 m^2). The total volume of contaminated material is estimated to be 61,700 yd^3 (47,200 m^3). These estimates represent a bulk volume with an assumed swell of 25%. The in-place volume that this bulk volume represents is 49,000 yd^3 (37,800 m^3).

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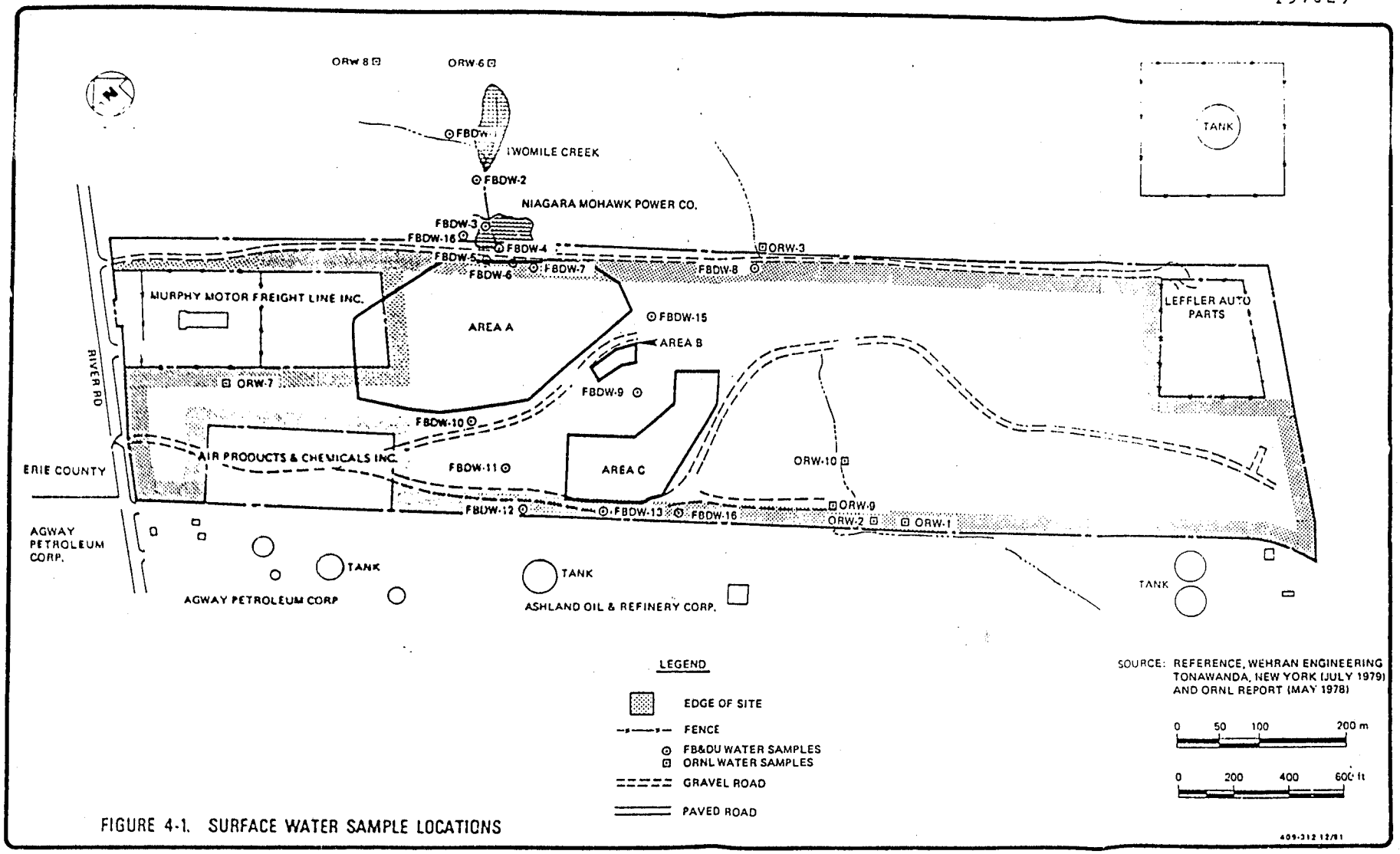

FIGURE 4-1. SURFACE WATER SAMPLE LOCATIONS

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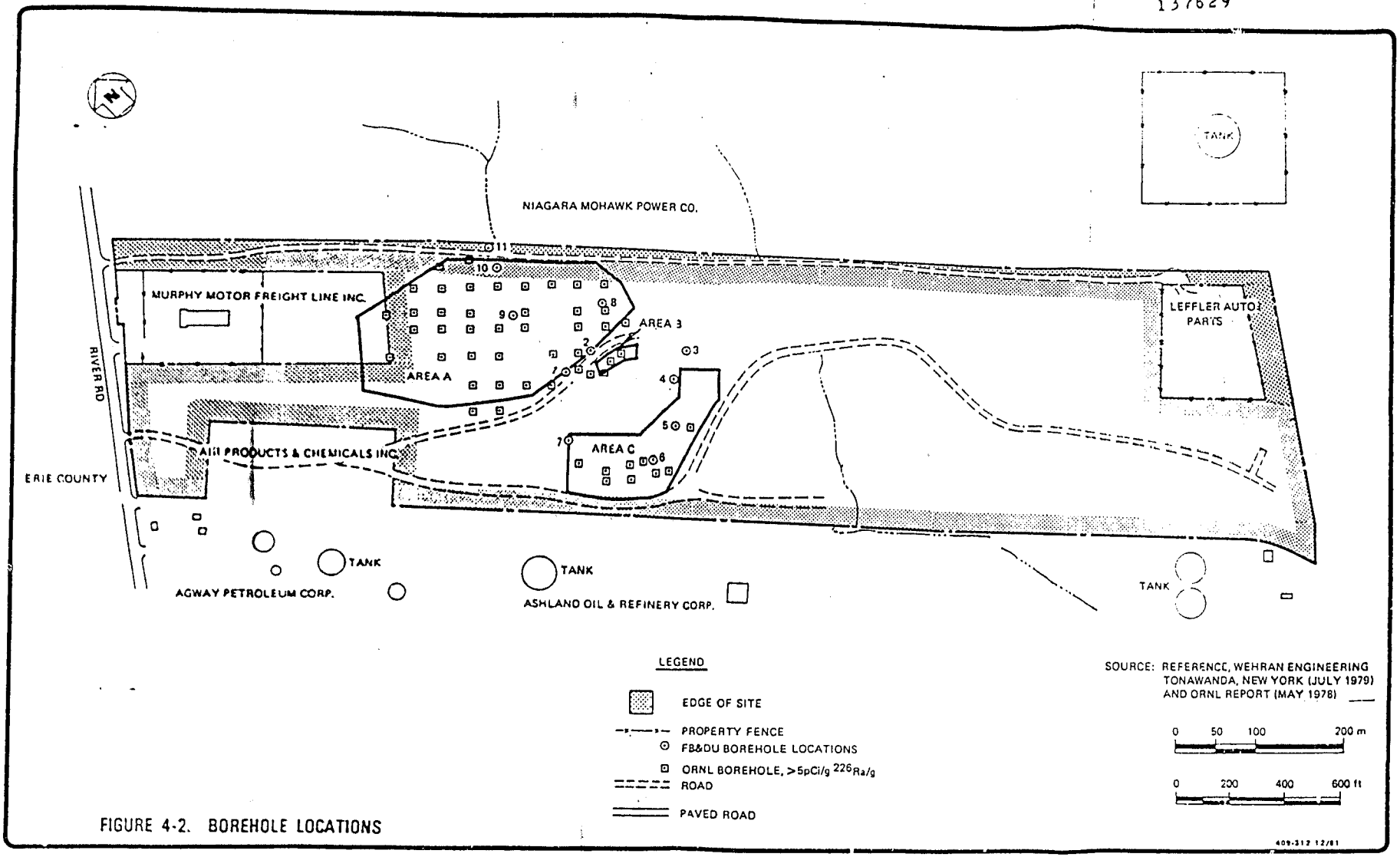

FIGURE 4-2. BOREHOLE LOCATIONS

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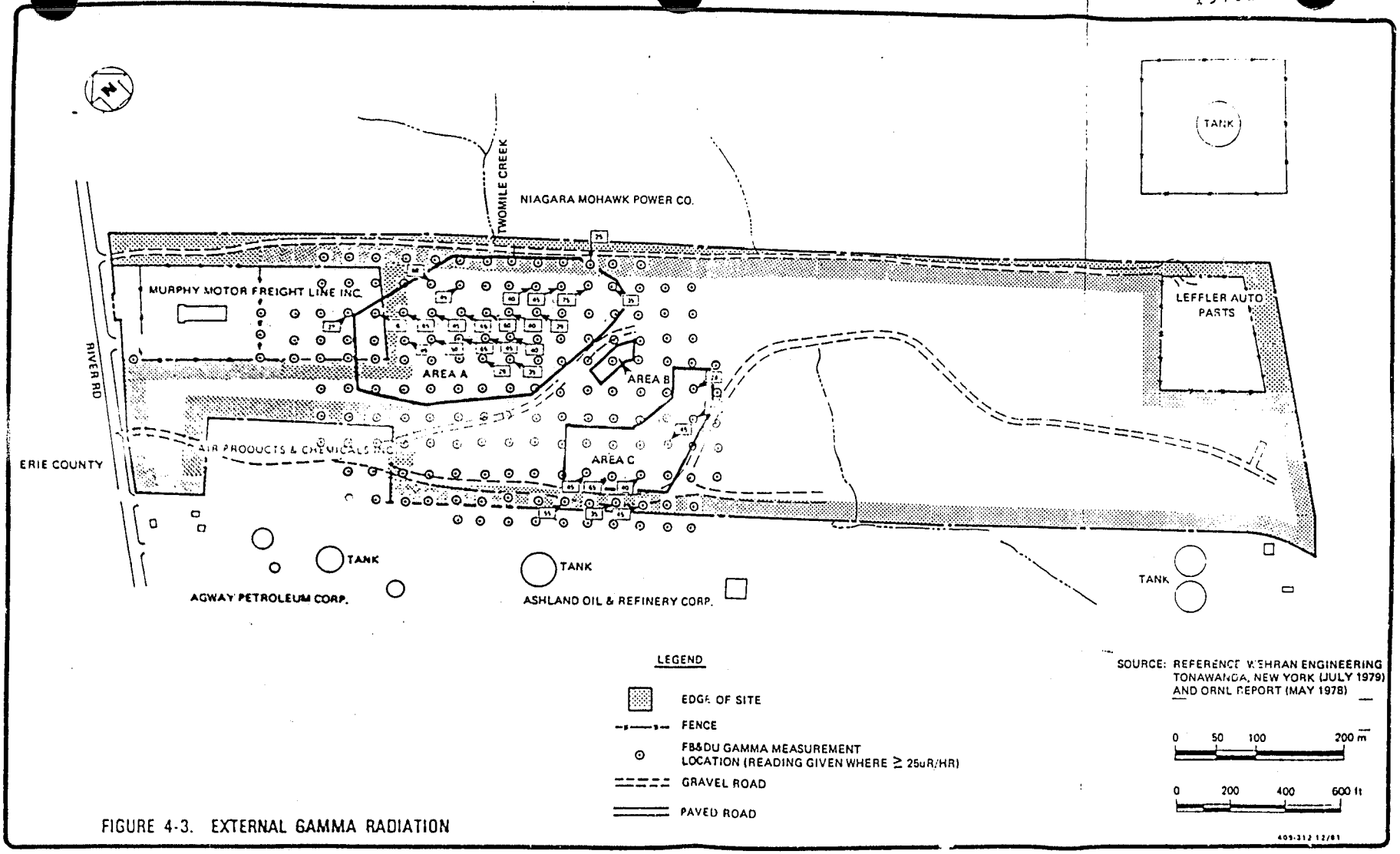

FIGURE 4-3. EXTERNAL GAMMA RADIATION

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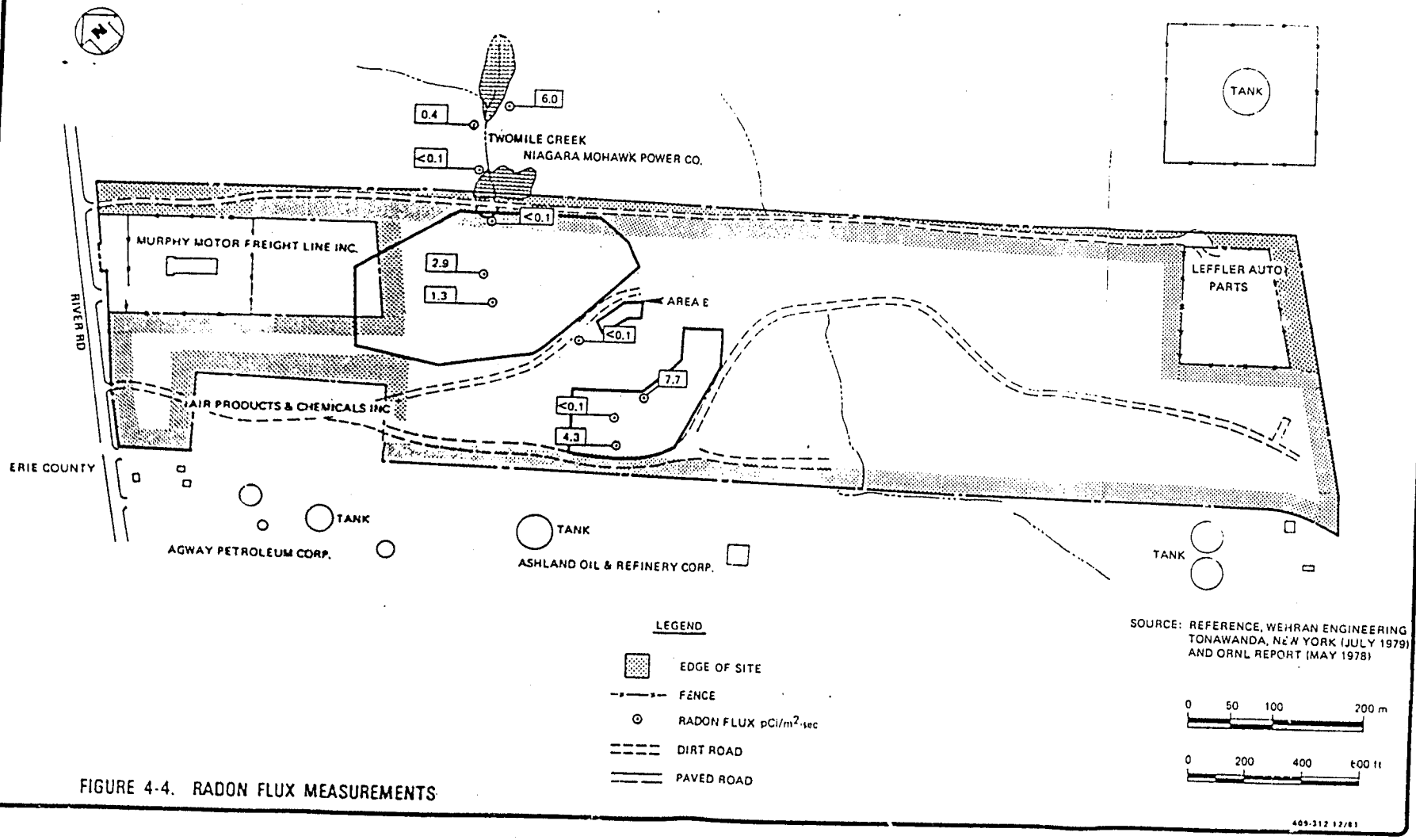

FIGURE 4-4. RADON FLUX MEASUREMENTS

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TABLE 4-1

PROPOSED SOIL CONTAMINATION LIMITS[3]

Radionuclide	Concentration (pCi/g)
^{137}Cs	80
^{90}Sr	100
^{238}U	40
^{230}Th	280
^{232}Th	20

TABLE 4-2

ACCEPTABLE SURFACE CONTAMINATION LEVELS(6)

NUCLIDES[a]	AVERAGE[b,c,f] (dpm/100 cm^2)	MAXIMUM[b,d,f] (dpm/100 cm^2)	REMOVABLE[b,e,f] (dpm/100 cm^2)
U-nat, U-235, U-238, and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90 Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above.	5,000	15,000	2,000

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each object.

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0 0 3 5 3 1

TABLE 4-2 (Cont)

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 mg/cm^2 of total absorber.

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0 0 3 5 3 2

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TABLE 4-3

SURFACE WATER SAMPLES*

Sample No.	^{226}Ra (pCi/l)	^{238}U (pCi/l)
SWS-1	<0.6	3.3
SWS-2	<0.6	3.3
SWS-3	<0.6	10.0
SWS-4	2.0	2.3
SWS-5	6.0	27.0
SWS-6	<0.6	17.0
SWS-7	<0.6	17.0
SWS-9	<0.6	3.3
SWS-10	<0.6	17.0
SWS-11	<0.6	3.3
SWS-12	<0.6	<3.3
SWS-13	<0.6	3.3
SWS-14	<0.6	50.0
SWS-15	<0.6	50.0
SWS-16	4.9	20.0

*See Figure 4-1 for location.

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TABLE 4-4

SOIL SAMPLE CONCENTRATIONS*

Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
1	DH-1	0-1	0.26	0.83
2		1-2	0.28	0.43
3		2-3	0.40	0.20
4		3-4	0.18	0.03
5		4-5	0.19	0.17
6		5-6	0.42	0.33
7		6-7	0.57	0.20
8		7-8	0.30	0.40
9		8-9	0.16	0.17
10		9-10	0.46	0.30
11		10-11	0.55	0.10
12	DH-2	0-1	0.44	1.03
13		1-2	0.30	1.2
14		2-3	0.37	0.47
15		3-4	0.55	2.3
16		4-5	0.45	0.20
17		5-6	0.51	2.6
18		6-7	0.32	0.33
19		7-8	0.15	1.2
20	DH-3	0-1	1.25	0.37
21		1-2	0.82	5.7
22		2-3	3.5	9.7
23		3-4	4.1	2.8
24		4-5	1.8	1.8
26	DH-4	0-1	1.5	2.2
27		1-2	2.0	2.3
28		2-3	1.6	3.7
29		3-4	1.7	1.2
30		4-5	0.95	0.60
31		5-6	0.25	0.13
32	DH-5	0-1	0.62	0.77
33		1-2	1.2	0.87
34		2-3	0.97	1.1
35		3-4	0.84	3.3
37	DH-6	0-1	5.6	5.7
38		1-2	2.3	13.0
39		2-3	4.2	6.7
40		3-4	15.0	6.3
42		5-6	5.3	9.3

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TABLE 4-4 (Cont)

Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
43	DH-7	0-1	0.74	0.77
44		1-2	1.4	0.90
45		2-3	8.2	5.7
46		3-4	22.0	13.0
47		4-5	3.6	4.3
48		5-6	1.9	2.1
49		6-7	0.56	1.3
50		7-8	1.6	1.7
51		8-9	2.9	1.7
52		9-10	0.72	2.1
53		10-11	0.29	1.0
54	DH-8	0-1	141.0	74.0
55		1-2	46.0	25.0
56		2-3	9.6	29.0
57		3-4	15.0	21.0
65	DH-9	0-1	4.8	26.0
66		1-2	22.0	21.0
67		2-3	5.8	8.0
68		3-4	4.1	4.0
69		4-5	6.9	17.0
70		5-6	10.4	12.0
71		6-7	<0.20	9.7
72	DH-10	0-1	0.79	19.0
73		1-2	5.5	5.7
74		2-3	3.0	1.8
75		3-4	0.12	0.87
76		4-5	1.6	0.67
77		5-6	0.40	1.2
78		6-7	0.32	0.63
79		7-8	0.50	0.40
80		8-9	0.60	0.33
81		9-10	0.20	0.67
82		10-11	0.57	0.33
83	DH-11	3-4	0.61	0.93
84		4-5	1.6	1.4
85		5-6	0.52	0.77
86		6-7	0.66	0.57
87		7-8	0.36	0.57
88		8-9	0.64	0.43
89		9-10	0.97	0.43
90		10-11	0.68	1.5

TABLE 4-4 (Cont) 137629

Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
SS-1		Surface	3.8	2.9
SS-2		Surface	1.2	1.3
SS-3		Surface	0.78	0.27
SS-4		Surface	1.04	0.43
SS-5		Surface	0.75	0.37
SS-6		Surface	0.60	0.27

*See Figure 4-2 for locations.

CHAPTER 4 REFERENCES

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CHAPTER 5

DESCRIPTION OF EXISTING ENVIRONMENT

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CHAPTER 5

DESCRIPTION OF EXISTING ENVIRONMENT

The information presented in this chapter describes the existing environment at the Seaway Industrial Park site and in the surrounding area. A broad scope of environmental information is needed to provide the basic data to evaluate current conditions accurately and thereby the potential impacts. This information, along with that given in previous chapters, is vital to reliable formulation of the remedial action options proposed in Chapter 6 and to the final evaluation of the proposed options in Chapter 7.

As noted in Chapter 3, the site is located in the Town of Tonawanda in western New York. A selected remedial action option could impact off-site properties as well as the areas on the site. It was decided that the environment would be evaluated out to a radius of 1 mi (1.6 km) from the contaminated area. This includes portions of the Town of Tonawanda, the Town of Grand Island and the City of Tonawanda, as shown in Figure 3-4. In addition, an even broader area would be evaluated for some environmental factors to ensure a clear understanding of the relationship between the site and site vicinity and the environment. This is a conservative approach given the low concentration of contaminants in the wastes, the relatively low health effects, and the site's location on an industrial landfill that discourages access to the general public. Access is discouraged by gates on the access road, the absence of other roads and the topography.

As a response to program directives, specific borrow sites, interim storage sites, and state or regional disposal sites have not been identified. In fact, the process for approval and development of a state or regional disposal site would require several years. Therefore, environmental descriptions of borrow sites and transportation routes have been limited to generic discussions. Borrow material probably would be obtained from existing commercial sites. Since commercial sites probably would be licensed and in compliance with regulations, there should be no new significant additional impacts on environmental factors.

Several categories of study were assessed in order to achieve the stated chapter objective and necessary understanding of the relationship between the environment and the site and site vicinity. Consequently, in the paragraphs that follow, the factors of land use, socioeconomics, cultural resources, climate and air quality, noise, geology and soils, water, and ecology are discussed in terms of the site and the site vicinity where appropriate.

5.1 LAND USE

5.1.1 Site

The present use of the land at the site is industrial, specifically a sanitary landfill.[1] Presently, municipal, commercial, industrial and construction solid wastes are disposed of in the landfill. Hazardous wastes, liquids, sewage sludges, insecticides, whole tires, trees, and explosives are presently excluded.

It has been reported that the landfill may have accepted a wide range of industrial wastes, some of which would be classified as hazardous.[2] Figure 3-3 shows where the radioactively contaminated materials are presently located. This waste, from the former Haist property (see Subsection 3.1.3), was deposited into the landfill in 1974; and according to the DOE the affected land could not be certified for unrestricted use until a cleanup was conducted.[2] Since this site is a landfill which also may contain hazardous wastes, it seems unlikely that it would be certified for unrestricted use in any case. The site shares fences with some of its neighbors. The only vehicular access to the site, which is via River Road, is through a gate that is locked after operating hours. While no additional fencing exists along the site perimeter, vehicular access is limited by topography and absence of roadways.

The Seaway Industrial Park Development Company has owned the site since 1964.[3] Before 1964, this company was known as the North Waterway Company, which also owned the site prior to 1964. Ownership prior to that of North Waterway Company is unknown. However, the site has been used to dispose of waste since at least 1930. Although the site is in a wet area, it is possible that at least some portions of the site were farmed in the past. Changes in land use at the site are not expected.

5.1.2 Site Vicinity

As shown in Figure 5-1, the area near the Seaway Industrial Park site is used for a mixture of industrial, commercial, public and residential purposes.[1,4,5,6] There is not much residential land and most of it is on Grand Island and in the City of Tonawanda. The brushland and vacant land within 1 mi (1.6 km) of the site is presently unutilized. Use of some of the unutilized land would be limited since it is classified as wetlands, as shown in Figure 5-2. This includes the area just north of the site. Nothing more than minor changes are foreseen to land use in the future. The town has no land use plan and the zoning board meets only to make individual modifications to the present zoning.[6] Possibly some areas now vacant and not classified as wetlands will be developed. There is a fly ash dump, a drive-in theatre, portions of three parks, another solid waste disposal area, a fire tower, two marinas, and a sewage

disposal facility within 1 mi (1.6 km) of the site, as shown in Figure 5-1.

5.1.3 Other Relative Land Use Data

When transportation routes to and from the site are chosen, residential areas will be avoided where possible and present land use patterns will not change. If possible, fill material will be obtained from existing commercial sources and will therefore be compatible with land use. If it becomes necessary to establish a borrow pit, it will be established in an area where it will be compatible with surrounding land use.

5.2 SOCIOECONOMICS

5.2.1 Population/Demography

The Town of Tonawanda, including the Village of Kenmore, has lost population in the past 10 yr. The 1970 population was 107,282 and the 1980 population was only 91,269. This represented a loss of 14.9%. The City of Tonawanda declined in population from 21,898 to 18,693, a loss of 14.6%. As Grand Island is rural in nature, it was not surprising that Grand Island's population increased from 13,977 to 16,770 from 1970 to 1980, an increase of 20%. Given this population gain in more rural areas, the overall loss of population for the past 10 yr for the county has not been so drastic, running only 8.8%. This great loss of population was not expected by state or local planners.[7,8,9] In fact, estimates of population made as late as 1980 predicted an increase over the 1970 population for the Town of Tonawanda and the Village of Kenmore.[7] Also, growth predictions for Grand Island were not met.

Using aerial photography and city block data from the 1980 census, it is estimated that 1,282 people live within 1 mi (1.6 km) of the contaminated area. As seen in Figure 5-2, which shows the residential population in 16 sectors at distances of 0.25 mi (0.4 km), 0.5 mi (0.8 km), 0.75 mi (1.2 km), and 1 mi (1.6 km), no people live within 0.5 mi (0.8 km) of the contaminated area. The closest residents are on Grand Island, 200 of which live between 0.5 and 0.75 mi (0.8 and 1.2 km) of the site. Of the total, only 45 or 3.5% of the people are Town of Tonawanda residents living to the southwest, and 474 or 37% are Grand Island residents living in the northwest quadrant. Therefore, 59.5% or 763 people are residents of the City of Tonawanda.

It seems likely that the trend of population loss in urban areas will continue. Thus, it is likely that the City of Tonawanda will continue to decrease in population. It is possible that the current downturn in population for the Town of Tonawanda may reverse itself in the future, or at least slow down. However, this increase would probably not be seen within 1 mi (1.6 km) of the site since there is not much land

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for residential development. If the population grows by predicted rates on Grand Island[7] perhaps as many as 1,600 people would live within 1 mi (1.6 km) of the site between now and the year 2005. If growth on Grand Island does not occur and population continues to drop in the City of Tonawanda, the population could drop perhaps to 1,100 by 1990. It seems unlikely that it would go below this by 2005. Most likely the population will be somewhere between these extremes. The population projections are shown in Figure 5-4.

5.2.2 Economy

Employment in the Town of Tonawanda is approximately 38,600 people.[10] Forecasts for 1985 predict a minor increase to about 38,800. While manufacturing has traditionally been the major employer for Erie and Niagara Counties, service oriented sources of employment have been increasing dramatically.[8] The same trend has occurred in the Town of Tonawanda, and presently the two groups probably hire about equal numbers of people.[10] This trend is expected to continue and service will become the major employment category.

Based on employment data for the census tracts,[11] it is estimated that approximately 7,150 people work within 1 mi (1.6 km) of the contaminated areas of the site. Future employment is unpredictable since the establishment of several large industrial or manufacturing businesses in the area could increase employment in the immediate area significantly. This could cause an increase of up to several thousand workers, even though a lot of growth is not expected for the town or county as a whole. Conversely, if several of the businesses were to migrate to some of the rural counties, or if a severe recession affected several industries in the area, a decrease in employment could occur. A decrease of 30% could be envisioned with the closing of one or two major employers. The true future employment would probably be between the upper and lower limits, as shown in Figure 5-4. Employment projections can be seen in Figure 5-4.

Approximately 13 people are employed on the site itself. Three of these are full-time and 10 are only part-time employees.

Unemployment in September 1981 for the Buffalo Standard Metropolitan Statistical Area (SMSA) included about 50,800 people.[12] Since construction workers amount to about 3% of the labor force in the area,[13] it is likely that at least 3% of the total unemployed or 1,700 individuals are construction workers.

There are numerous businesses which could provide materials for any remedial action necessary. For example, businesses that provide various kinds of machinery, concrete, and construction supplies are numerous in the Buffalo-Tonawanda area.

Values for the land around the site range from $628 to $2,850/acre.[14] The average value of the site itself is $961/acre.

5.2.3 Public Services

The trailer on site is served by municipal water, electricity, and telephone. These and other public services are well developed in the Buffalo metropolitan area. Schools, parks, recreation facilities, hospitals and clinics are scattered throughout the area.

5.2.4 Transportation

There is a well developed transportation system around the Buffalo-Tonawanda area. Major interstate highways connect the area with the rest of the country. Interstate 90 runs east through Albany to the Boston area and west toward Chicago and beyond. Interstate 190 runs north to Niagara Falls and eventually into Canada. These main roads are easily accessed from the site.

Conrail spur lines provide access to the site from the southwest. Truck transportation companies are numerous in the area. Air service is also available to the area; air transportation facilities exist at the Greater Buffalo International Airport, west of Buffalo, and the Niagara Falls International Airport. Lake Erie and the New York State Barge Canal (Erie Canal) provide water transportation to the area.

5.2.5 Public and Institutional Sentiment

This site is presently under license with the New York State Department of Environmental Conservation Division of Solid Waste Management. While state officials are aware of the low-level contamination at the site, there has been no adverse public sentiment in relation to the contamination discussed in this report.

5.3 CULTURAL RESOURCES

5.3.1 Historic Sites and Natural Landmarks

According to the New York State Department of Historic Preservation[15] and the New York State Museum's Cultural Education Center[16], preliminary review of the Seaway site area and on radii extending 1 mi (1.6 km) from the site, there are no natural landmarks or resources of historic significance that have National Registery status.

5.3.2 Archaeological Sites

Based on preliminary review of the Seaway site area and within 1 mi (1.6 km) in any direction of the site, the New

York State Archaeologist's Office considers the area of the site as sensitive.[17] However, the possibility of an archaeological find of any significance intact is remote.

New York State Division of Historical and Anthropological Services indicate two sites, one on the northeastern periphery of the 1 mi (1.6 km) radius of the site and another on the westernmost periphery of the 1 mi (1.6 km) radius. The northeast site is described as a multi-component Archaic and Iroquois site. The western site is unconfirmed but it provides a predictive model for archaeological sensitivity.[16]

5.3.3 Unique or Significant Structures

According to information supplied by the Landmark Society, an affiliate of the Buffalo and Erie County Historical Society, there are no significant or unique unregistered structures of historic interest within 1 mi (1.6 km) of the Seaway site.

5.3.4 Paleontological Resources

Presently there are no paleontological resources identified within 1 mi (1.6 km) of the Seaway site. The underlying Camillus Shale, which is far below the contamination, is not fossiliferous.

5.4 CLIMATE AND AIR QUALITY

5.4.1 Climate

The climate of western New York is moist and continental and is influenced by the presence of Lake Erie to the west and Lake Ontario to the north. Normal annual precipitation at the Seaway Industrial Park equals about 33 in. (840 mm) and is fairly evenly distributed throughout the year.[18]

Heavy lake-effect snow squalls occur frequently as a result of cold, relatively dry air crossing the unfrozen waters of the Great Lakes. Snowfall at the nearby Greater Buffalo International Airport averages about 93 in./yr (2360 mm/yr), two-thirds of which occurs during the months of December through February.[19] Annual snowfall at the Seaway site is approximately 10 in. (250 mm) less.[20]

Precipitation frequency data indicate that rainfall amounts at the Seaway site for events lasting 30 min can, on the average, be expected to equal or exceed 0.8 in. (20 mm) once every 2 yr, 1.3 in. (33 mm) once every 10 yr, and 1.9 in. (48 mm) once every 100 yr. Rainfall events with a duration of 6 hr can, on the average, be expected to equal or exceed 1.8 in. (46 mm), 2.7 in. (69 mm), and 3.7 in. (94 mm) once every 2, 10 and 100 yr, respectively. Twenty-four hour rainfall events of at least 2.5 in. (64 mm), 3.6 in. (91 mm), and 5.0 in. (130 mm) are expected once every 2, 10, and 100 yr, respectively.[21]

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Temperatures in the region are also moderated by the presence of the Great Lakes. Temperatures at the Seaway site average about 47° F (8° C) during the year, ranging generally from a mean January minimum of 18° F (-8° C) to a mean July maximum of 81° F (27° C). Recorded temperatures at the nearby Buffalo weather station have ranged from a low of -20° F (-29° C) to a high of 99° F (37° C) since data collection began in 1870.[19]

Prevailing winds at the nearby Greater Buffalo International Airport are out of the southwest and west-southwest, across Lake Erie. Wind speeds average approximately 12 mi/hr (19 km/hr), being slightly higher in the winter than during the remainder of the year.[19]

Records indicate that about three or four tornadoes strike limited, localized areas of New York State during most years, generally during the period of late May through late August.[20] The path of destruction is usually short and narrow. Because of the low frequency of occurrence and small area of destruction by tornadoes in the state, it is difficult to predict their occurrence at the Seaway site.

Hurricanes and tropical storms are very uncommon in western New York. Only one such storm has brought serious damage in recent years (October 1954) to the interior portions of the state.[20]

5.4.2 Air Quality

Total suspended particulates are monitored at five locations in the Town of Tonawanda by the New York State Department of Environmental Conservation, Air Quality Division.[22] During the period of April 1, 1979 through March 31, 1980, a total of 292 observations were made at these five locations. The geometric mean of these total suspended particulate data varied from a low of 48 $\mu g/m^3$ to a high of 62 $\mu g/m^3$. In all cases, these values were below the established air quality standard (65 to 75 $\mu g/m^3$, depending on the particular location).

5.5 Noise

Background noise level readings on the scale were taken at locations within the site and in adjacent areas[23]. The readings ranged from 55 to 60 dBA on-site and 60 to 85 dBA off site to the northwest along River Road. The noise levels are due to industrial activities at the nearby Ashland Oil Company and the highway systems. Noise levels from the Seaway landfill operations do not create contributive increases to these background levels.

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5.6 GEOLOGY AND SOILS

5.6.1 Topography

The Seaway Industrial Park is located in the Eastern lake section of the Central Lowland physiographic province.[24] The characteristic landscape of this section consists of dissected and glaciated lowlands and escarpments.

The Seaway site is situated on a broad lowland on the southeast bank of the Niagara River. The elevation of the site is approximately 600 ft (180 m) above mean sea level, as shown in Figure 3-5.

5.6.2 Soils

Native soils of the general area are shallow and typically saturated by a high water table.[25] Logs of holes drilled on site indicate that the sanitary landfill at the Seaway Industrial Park contains refuse that reaches heights of 50 to 60 ft (15 to 18 m) above the original ground surface.[2] The waste consists primarily of fly ash, demolition debris, and lesser amounts of municipal solid waste.

The waste fill at the Seaway site overlies recent alluvium and glacial till which is characteristically exposed over much of the area.[26] Drilling logs indicate that this alluvium and till consist predominantly of red clay and gravelly clay to a depth of approximately 95 ft (29 m). The lower portions of this till grade generally to sand and gravel.[2]

5.6.3 Geology

A map of regional bedrock geology is given in Figure 5-5. As noted previously, the Seaway site is situated on clayey alluvium and glacial till. At the Seaway site, this glacial till can be further subdivided into four units.[2] The Upper Clayey Glacial Till consists predominantly of clayey till with minor amounts of sand and gravel. The thickness of this unit at the site varies from 0 to 65 ft (0 to 20 m).

Uncomformably underlying the Upper Clayey Glacial Till is the Glaciolacustrine Clay Unit. This unit is continuous across the site although its thickness varies from 5 to 45 ft (1.5 to 14 m). The unit consists of laminations of silt and silty clay that were apparently deposited in a glacial lake.

The Basal Glaciolacustrine Unit consists of laminated clayey silt and sand. Its thickness varies from 0 to 7 ft (0 to 2 m) over the site.

The lowest unit of the glacial till at the Seaway site has been termed the Lower Sandy Glacial Till. This unit consists of sandy glacial till, with variable amounts of silt, clay, and

gravel. It also contains secondary gypsum in some locations from the underlying Camillus Shale. Its thickness varies over the site from 1 to 19 ft (0.3 to 6 m).

Underlying the glacial till at the Seaway site is the Camillus Shale of the Salina Group. This Upper Silurian formation is approximately 400 ft (120 m) thick in the area and consists predominantly of grey, red, and green thin-bedded shale and massive mudstone.[26] Interbedded with the shale and mudstone are relatively thin beds of gypsum, dolomite, and limestone.

The Camillus Shale dips southward at approximately 0.8%. However, the formation contains broad, low folds with amplitudes of a few feet and frequencies of a few hundred feet. The fold axes are generally oriented east-west.[26]

5.6.4 Mineral Resources

Erie County is a leading producer of stone, sand, and gravel in the State of New York.[27] Production of these minerals in the immediate vicinity of the Seaway site is severely limited, however, by the presence of a high water table.

An underground gypsum mine once operated in the Camillus Shale at a location approximately 15 mi (24 km) northeast of the Seaway Industrial Park.[26] This mine has since been closed. The gypsum beds in the Camillus Shale apparently thin westward, precluding the production of gypsum in the immediate vicinity of the site.

5.6.5 Seismicity

The Seaway site is located in a Zone 3 seismic area where major destructive earthquakes may occur.[28] This is due to the close proximity of the Seaway site to the St. Lawrence River, a seismically active region.

Three major earthquakes (intensity VI or greater on the Modified Mercalli Scale) have been centered in the region surrounding the Seaway Industrial Park during recorded history.[28] An intensity VI earthquake occurred on October 23, 1857 about 15 mi (24 km) north of the Seaway site, causing minor damage in the region. On August 12, 1929, an earthquake of intensity VIII was centered approximately 30 mi (48 km) east of the site, near Attica, causing significant damage to chimneys and walls. An additional intensity VI earthquake occurred about 15 mi (24 km) south of the site on January 1, 1966.

5.7 WATER

5.7.1 Surface Water

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As discussed in Chapter 3, surface drainage at the Seaway site sanitary landfill flows primarily toward the north and northeast through small, unnamed channels. All Seaway site drainage eventually flows into the Niagara River.

Runoff from the Seaway site originates from high intensity precipitation events and snowmelt. Although a major portion of the volume of surface water draining from the site occurs as overland flow, leachate is also draining from the landfill through numerous seeps along the toe of the landfill slope.[2]

A freshwater wetland area covers approximately 310 acres (125 ha) of land immediately northeast of the Seaway site. Water that drains from the site to the northeast flows through this wetland. The wetland area is presumably caused by a locally high water table.

The Niagara River, which flows past the Seaway site between Lake Erie and Lake Ontario, is influenced by those Great Lakes which lie upstream from the river. The discharge of the river averages 203,000 ft^3/s (5,750 m^3/s) from Lake Erie.[29]

A limited number of surface water samples were collected from the area on and adjacent to the Seaway Industrial Park for radiologic analyses; these data are summarized in Section 4.2. Concentrations of the radionuclides examined were generally within NRC and EPA standards.

Several surface water samples were collected on and adjacent to the Seaway site for chemical analyses in conjection with a recent hydrogeologic investigation performed for Niagara Landfill, Inc., the operator of the Seaway Industiral Park landfill.[2] The results of the analyses, representing 2 samples collected at each of 10 sites in March and April of 1979, are presented in Table 5-1. Parameters with consistently elevated concentrations at the site included ammonia, chemical oxygen demand, sulfate, chloride, conductivity, total solids, and color. Trace amounts of halogenated organics (including PCB's) were also found on site. Surface water samples collected from channels on the northeast edge of the adjacent freshwater wetland area in conjunction with the previously mentioned hydrogeologic investigation showed significantly lower concentrations of most constituents.[2]

Samples collected near Niagara Falls indicate that the Niagara River is predominantly a calcium bicarbonate type of water with total dissolved solids contents varying from about 180 to 200 mg/l.[30] In past years, the Niagara River has carried a high pollution load due to the nutrient-laden waters of Lake Erie, wastes from the heavy industrial complex along the

tributary Buffalo River, and direct waste discharges from adjacent municipalities and industries.[29] However, with the closing of some major industrial polluters and upgrading of wastewater treatment facilities in the region within the past few years, pollution levels in the Niagara River have been lowered significantly. Although no routine water quality monitoring program is currently being conducted on the Niagara River by regulatory agencies, the quality of water in the river is considered to be within Federal and state standards at the present time.[31]

5.7.2 Ground Water

Ground water at the Seaway site occurs in one of three forms:[2]

(a) A ground-water table within the landfill and the immediately underlying recent alluvial deposits

(b) Largely immobilized, interstitial water within the underlying, relatively impermeable Upper Clayey Glacial Till and Glaciolacustrine Clay Unit

(c) Confined ground water within the Camillus Shale, which is hydraulically connected in some locations to the Basal Glaciolacustrine Unit and the Lower Sandy Glacial Till

Figure 5-6 presents the approximate configuration of the ground water table in the landfill as measured in April, 1979.[2] As indicated by this figure, ground water occurs throughout the landfill under unconfined conditions. Recharge by precipitation and discharge by seepage at the toe of the landfill slope has created ground-water mounds within the landfill, with the depth to ground water being 3 to 8 ft (0.9 to 2.4 m) over most of the site.

The base of the water-bearing zone within the landfill appears to correspond to the top of the underlying relatively impervious glacial till. Laboratory testing of samples of the clayey glacial till units collected at the site indicate that the hydraulic conductivity of the units is about 5.2×10^{-10} ft/s (1.6×10^{-8} cm/s).[2] The glacial till thus serves as an aquiclude in the immediate area.

The relatively impermeable nature of the clayey glacial units precludes significant downward percolation of water through the till into the underlying Camillus Shale. It has been estimated that the vertical seepage velocity of ground water through the clayey units below the site is approximately 0.04 ft/yr (0.01 m/yr). With the clayey units occupying a thickness of approximately 60 ft (18 m) of the glacial till, about 1,500 yr are required for ground water to pass through the aquiclude to an underlying aquifer.[2]

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The Camillus Shale is the most productive bedrock aquifer in the region. Water in this formation is produced primarily from solution cavities that have formed as the gypsum contained in the rock has dissolved. Yields from individual wells of greater than 1,000 gal/min (3,790 l/min) from the Camillus Shale are not unusual in the Buffalo/Tonawanda area.[26]

Ground water in the Camillus Shale generally exists under artesian conditions. Records of wells drilled near the Seaway site indicate that water rises to approximately 40 ft (12 m) below the ground surface in wells completed in the shale. Average hydraulic conductivities measured at these wells are in excess of 1×10^{-3} ft/s (3×10^{-2} cm/s).[26] These relatively high hydraulic conductivities can be attributed almost entirely to the gypsum solution cavities.

A summary of the quality of ground water within the landfill is presented in Table 5-2. Parameters with excessive concentrations at the site included cadmium, iron, and manganese. Elevated concentrations of these metals are not unexpected considering the types of wastes that are known to have been received at the landfill. All other constituents listed in Table 5-2 generally meet or are below existing ground-water quality standards at the time of sampling.[2] Only minute concentrations of halogenated organics (including PCB's) were detected at the site.

During the hydrogeologic investigation, ground water samples were collected from wells completed in recent alluvial deposits. These alluvial deposits occur with two stream channels that carry drainage water from the site to the northeast. Analyses of these samples indicated that the quality of water in these alluvial deposits closely resembled that contained in the saturated zone of the landfill. It is apparent from these data that leachate from the landfill has migrated into the alluvial deposits.

Although the Camillus Shale is the most productive bedrock aquifer in the region, it also contains the poorest quality water. Typically, in the area of the Seaway site, water from wells completed in the Camillus Shale has total dissolved solids concentrations ranging from 2,000 to 6,000 mg/l, sulfate concentrations of 1,000 to 1,500 mg/l, and chloride concentrations of 1,500 to 2,000 mg/l.[26] This high level of salinity precludes development of this water for domestic consumption without extensive and costly treatment. Use of this water is restricted to certain industries that can tolerate highly saline water.

5.7.3 Other Relevant Information

The Town of Tonawanda, wherein the Seaway Industrial Park is located, obtains its water supply from the Niagara River. The intake point is located approximately 3.4 mi (5.4 km)

upstream from the site. A water treatment plant at the intake provides chlorination, clarification, and rapid sand filtration.[32]

5.8 ECOLOGY

There are no known Federal- or state-listed endangered, threatened, or sensitive animal or plant species found on or near the Seaway landfill facility. However, because of the site's proximity to the Niagara River, the bald eagle (Haliaeetus leucocephalus) and osprey (Pandion haliaetus), both completely protected wildlife species, according to the New York State Division of Wildlife Conservation,[33] may be seen periodically as migratory transients near the site. There are no documented nesting areas on or near the site and the site has no features that would tend to attract either of these species or support establishment of their habitats.

5.8.1 Flora

Sparse vegetation with indigenous shrubs and grasses is the only floral growth found on the site as a result of the overall activities associated with a landfill operation.

New York State Regulations relating to solid waste management facilities on landfill closure and post-closure require seeding of such facilities with native grasses to promote evapotranspiration.[34] There are no impacts on floral species due to the site's present condition, its location, and the type of operations at this site. Potential impacts from inadequate vegetation would be created only in terms of erosion.

Vegetation from the site was collected and identified as follows:

Scientific Name	Common Name
Chrysanthemum leucanthemum	field daisy
Asclepias spp.	milkweed
Vicia spp.	vetch
Hordium jubatum	foxtail grass
Melilotus officinalis	yellow clover
Trifolium praetense	red clover
Rumex acetosella	sorrel, dock
Typha spp.	cattail

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5.8.2 FAUNA

Landfill operations at the site and industrial activities in the surrounding area have restricted wildlife activity. The natural wildlife habitats at the site and its immediate vicinity apparently have been altered or eliminated as a result of industrial usage of the area. Transitory faunal species which may occupy the site include seagulls (Pagophila eburnea), crows (Corvus brachyrhynchos), and rodents, especially rats and mice.

No mammal or bird inventories were performed because the Seaway landfill site is a recently highly disturbed site and only early successional biota are present. Since the animal life is strongly dependent upon the existing plant life, significant animal populations have not yet become established.

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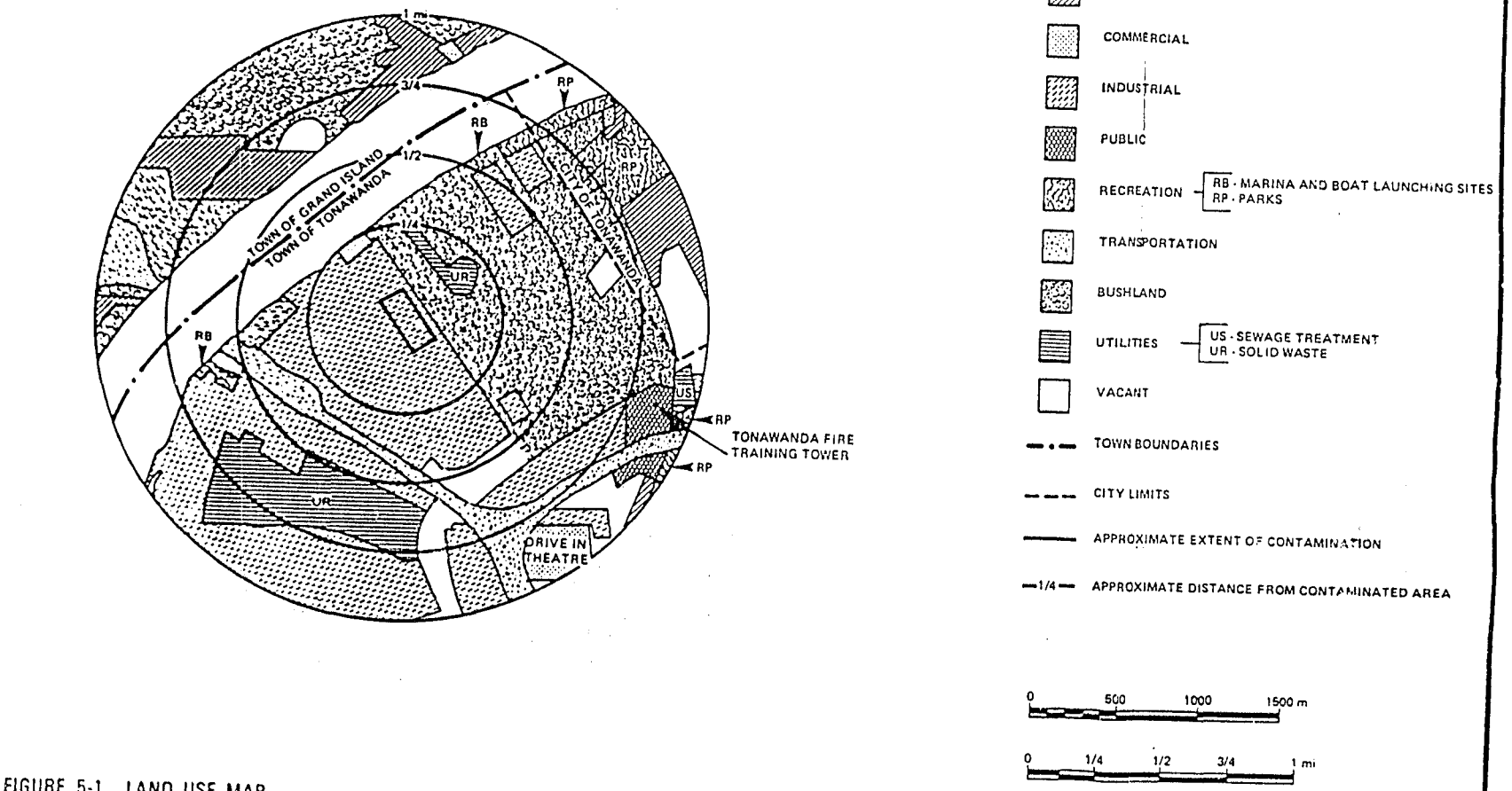
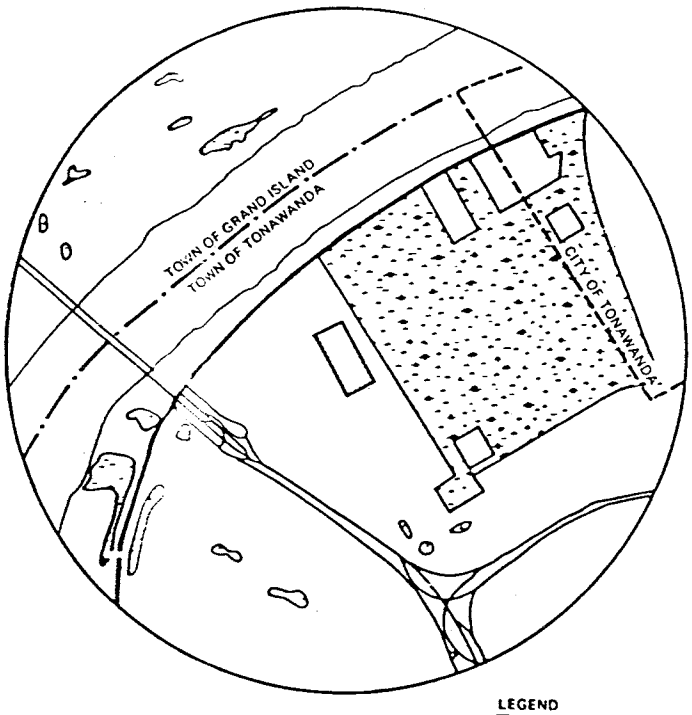


FIGURE 5-1. LAND USE MAP



LEGEND

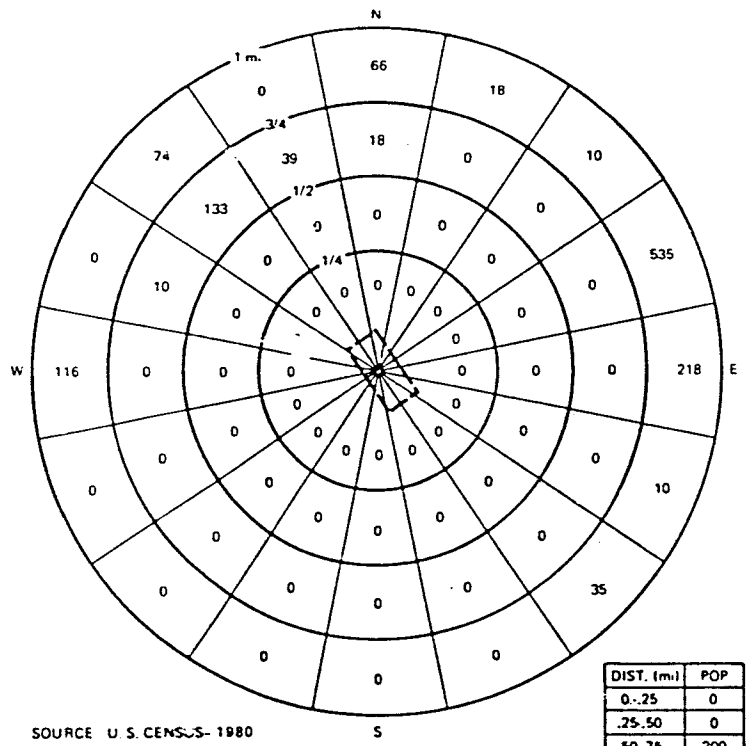
CONTAMINATION AREA

WET LANDS

TOWN BOUNDARIES

CITY LIMITS

FIGURE 5-2. WETLANDS AREAS



SOURCE U.S. CENSUS- 1980

DIST. (mi)	POP
0-.25	0
.25-.50	0
.50-.75	200
.75-1.00	1082
0-1.00 (TOTAL)	1282

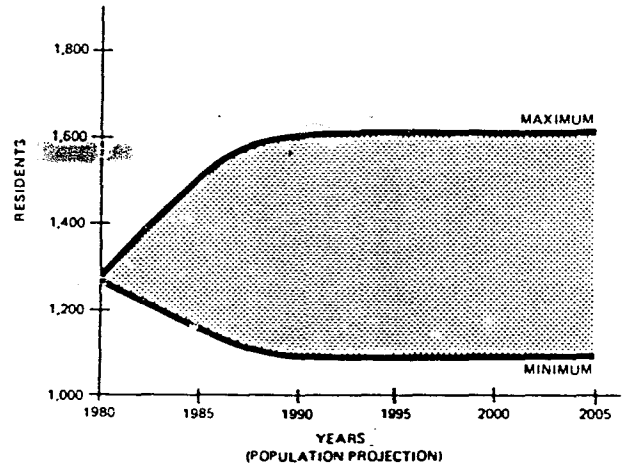
0 500 1000 1500 m

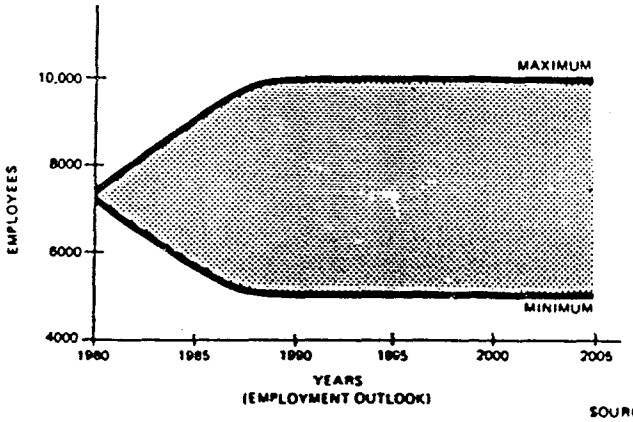
0 1000 2000 3000 4000 5000 ft

LEGEND

APPROXIMATE BOUNDARY OF CONTAMINATED AREAS

FIGURE 5-3. POPULATION DISTRIBUTION WITHIN 1 MI OF SITE





SOURCE
REFERENCE 7.11

FIGURE 5-4. POPULATION AND EMPLOYMENT OUTLOOK FOR AREA WITHIN 1 MILE OF SITE

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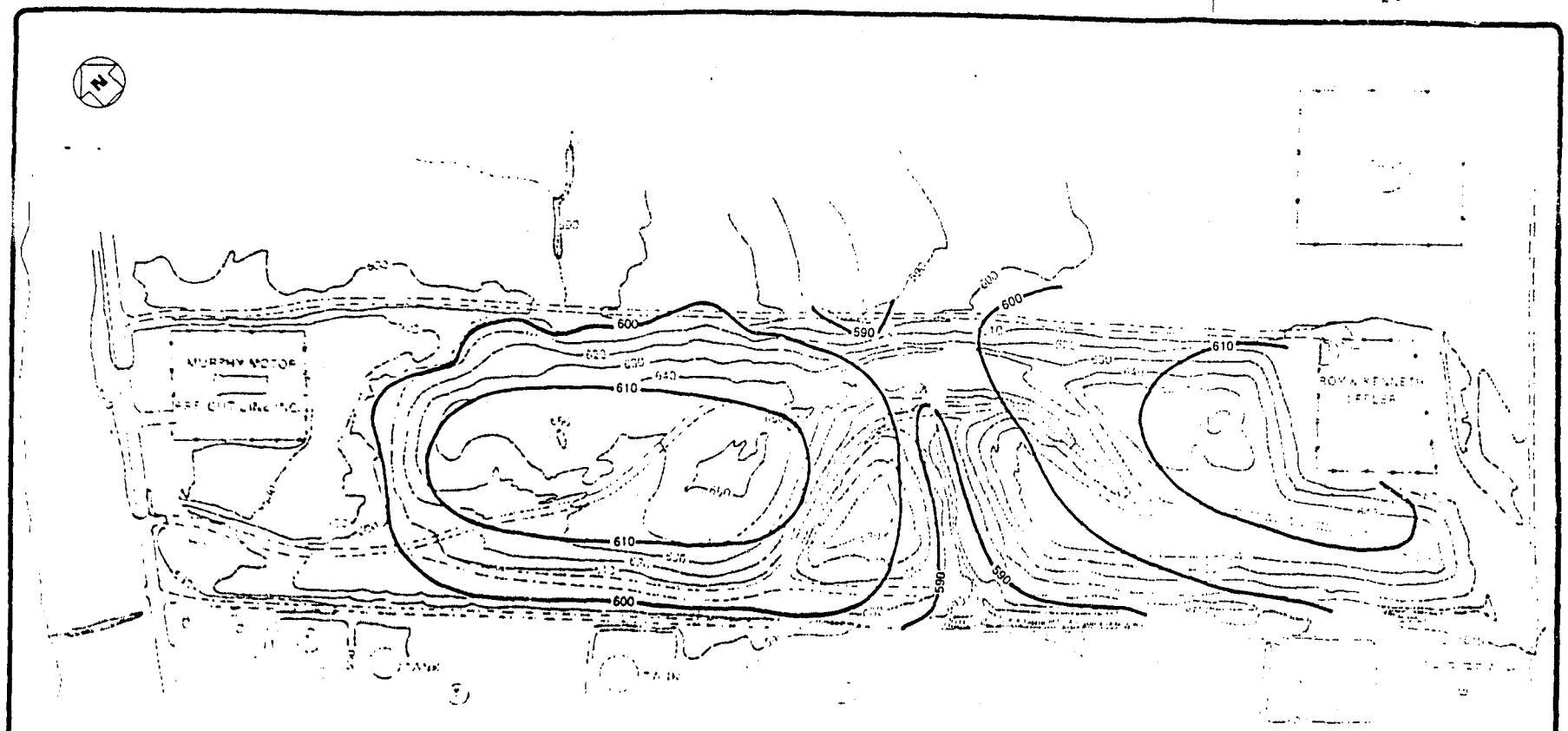
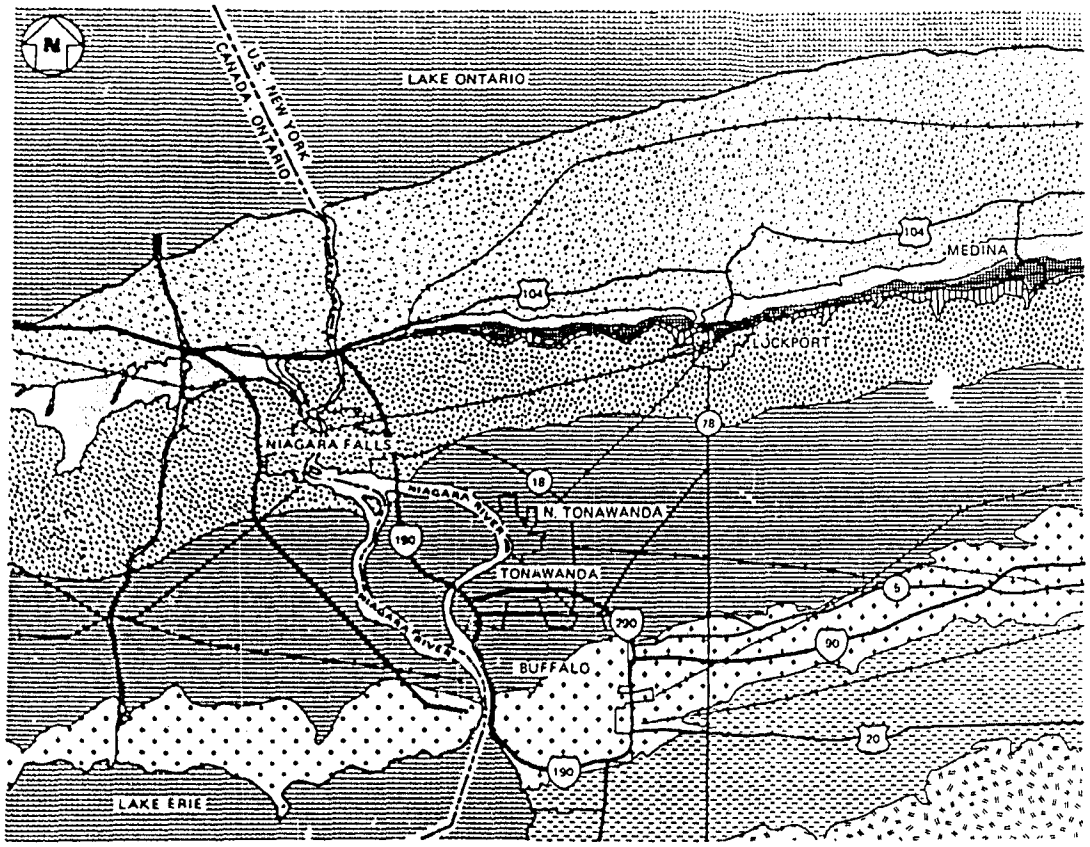


FIGURE 5-6. GROUND WATER CONTOUR MAP



LEGEND

MEDINA GROUP AND QUEENSTON FORMATION (800 FT)

QUEENSTON SHALE.

THOROLD SANDSTONE; GRIMSBY FORMATION–SANDSTONE, SHALE; POWER GLEN AND CABOT HEAD SHALES, WHIRLPOOL SANDSTONE.

CLINTON GROUP (100-150 FT)

DECEW DOLOSTONE; ROCHESTER SHALE; IRONDEQUOIT AND MERRITON LIMESTONE.

IRONDEQUOIT LIMESTONE; ROCKWAY DOLOSTONE; HICKORY CORNERS LIMESTONE; NEAHGA SHALE; KODAK SANDSTONE.

LOCKPORT GROUP (150-200 FT)

GUELPH, OAK ORCHARD, ERAMOSA, AND GOAT ISLAND DOLOSTONES; GASPORT LIMESTONE–LOCAL BIOHERMS.

AKRON DOLOSTONE AND SALINA GROUP (400-700 FT)

AKRON DOLOSTONE, BERTIE FORMATION–DOLOSTONE, SHALE CAMILLUS, SYRACUSE, AND VERNON FORMATIONS–SHALE, DOLOSTONE, SALT, AND GYPSUM.

ONONDAGA AND BOIS BLANC LIMESTONES (150 FT)

ONONDAGA LIMESTONE–SENECA, MOREHOUSE (CHERTY), AND CLARENCE LIMESTONE MEMBERS. EDGECLIFF CHERTY LIMESTONE MEMBER, LOCAL CORAL BIOHERMS. BOIS BLANC LIMESTONE–SANDY, THIN, DISCONTINUOUS.

HAMILTON GROUP (200-500 FT)

MOSCOW FORMATION–WIDOM AND KASHONG SHALES, MENTETH LIMESTONE MEMBERS
LUDLOWVILLE FORMATION–DEEP RUN SHALE, TICHENOR LIMESTONE, WANAKAH AND LEDYARD SHALES, CENTERFIELD LIMESTONE MEMBERS
SKANEATELES FORMATION–LEVANNA SHALE, STAFFORD LIMESTONE MEMBERS.
MARCELLUS FORMATION–OATKA CREEK SHALE MEMBER

WEST FALLS GROUP (400-950 FT)

ANGOLA AND RHINESTREET SHALES.

0 10 20 km

0 5 10 15 mi

SOURCE:
NY STATE MUSEUM OF SCIENCE

409-312 12/81

FIGURE 5-5. GEOLOGIC MAP OF BUFFALO-TONAWANDA AREA

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TABLE 5-1

SURFACE WATER QUALITY AT THE SEAWAY LANDFILL[2]

Parameter	Units	Min.	Mean	Max.
Ammonia (as N)	mg/l	0.6	22.5	85.4
COD	mg/l	41.0	447.0	4420.0
BOD	mg/l	<2.0	137.0	1230.0
Sulfate	mg/l	51.1	868.0	7670.0
Chloride	mg/l	45.8	678.0	1810.0
Fluoride	mg/l	0.324	0.765	2.63
Conductance (@ 25°C)	μmhos/cm	1120	3010	5990
Total Organic Carbon	mg/l	17.0	166.0	1370.0
pH	Std. Units	7.53	8.28	9.39
Total Solids (103°C)	mg/l	834.0	2940.0	10,100.0
Color	Pt-Co Units	19	134	750
Phenols	mg/l	<0.01	0.27	2.6
Total Oil & Grease	mg/l	<1.0	8.4	22.0
Polar Oil & Grease	mg/l	<1.0	5.4	18.3
Hydrocarbon Oil & Grease	mg/l	<1.0	3.0	9.6
Diss. Aluminum	mg/l	0.4	0.5	0.8
Diss. Arsenic	μg/l	<1.0	6.6	71.0
Diss. Selenium	μg/l	<1.0	1.1	6.8
Diss. Chromium (Total)	mg/l	<0.001	0.024	0.184
Diss. Copper	mg/l	<0.003	0.010	0.027
Diss. Lead	mg/l	<0.02	<0.02	0.05

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TABLE 5-1 (Cont)

Parameter	Units	Min.	Mean	Max.
Diss. Mercury	μ g/l	<0.5	<0.5	<0.5
Diss. Nickel	mg/l	<0.02	0.03	0.11
Diss. Cadmium	mg/l	<0.002	0.007	0.020
Diss. Iron	mg/l	<0.02	0.31	1.83
Diss. Manganese	mg/l	0.03	0.51	2.90

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TABLE 5-2

QUALITY OF GROUND WATER IN THE SEAWAY LANDFILL(2)

Parameter	Units	Min.	Mean	Max.
Ammonia (as N)	mg/l	<0.1	3.2	11.9
COD	mg/l	30.0	242.0	490.0
Sulfate	mg/l	13.4	633.0	1410.0
Chloride	mg/l	10.6	362.0	610.0
Fluoride	mg/l	0.177	0.954	2.44
Conductance (@ 25°C)	µmhos/cm	1000	2540	4000
Total Organic Carbon	mg/l	71.8	152.0	270.0
pH	Std. Units	7.24	7.79	8.16
Total Solids (103°C)	mg/l	1230	2430	3550
Color	Pt-Co Units	12.5	100.0	500.0
Phenols	mg/l	<0.001	0.018	0.066
Total Oil & Grease	mg/l	1.3	9.6	26.0
Polar Oil & Grease	mg/l	<0.1	7.3	20.0
Hydrocarbon Oil & Grease	mg/l	<0.1	2.3	6.0
Diss. Aluminum	mg/l	0.4	1.8	3.4
Diss. Arsenic	µg/l	<1.0	8.9	48.0
Diss. Selenium	µg/l	<2.0	<2.0	2.8
Diss. Chromium (Total)	mg/l	<0.003	0.003	0.010
Diss. Copper	mg/l	<0.002	0.010	0.028
Diss. Lead	mg/l	<0.02	0.02	0.05

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TABLE 5-2 (Cont)

Parameter	Units	Min.	Mean	Max.
Diss. Mercury	µg/l	<1.0	<1.0	<1.0
Diss. Nickel	mg/l	<0.03	<0.03	0.03
Diss. Cadmium	mg/l	<0.002	0.050	0.280
Diss. Iron	mg/l	<0.02	0.72	3.60
Diss. Manganese	mg/l	0.05	1.41	3.90

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CHAPTER 6

BASIC REMEDIAL ACTION ALTERNATIVES AND PROPOSED OPTIONS

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BASIC REMEDIAL ACTION ALTERNATIVES AND PROPOSED OPTIONS

To comply with a stated objective of the FUSRAP Program Management Plan,[1] the proposed remedial action approach will be composed of a sequence of events "designed to preclude any future radiological problems at the sites formerly utilized by MED/AEC." Consequently, the options proposed in this chapter for remedial action associated with the open areas located at the Seaway Industrial Park have been structured to meet this objective.

6.1 MECHANISM FOR DEVELOPMENT OF PROPOSED REMEDIAL ACTION ALTERNATIVES

The remedial action options proposed specifically for the Seaway site have been developed within the framework of five basic remedial action alternatives:

(a) No Action

(b) Minimal Action

(c) Stabilization/Entombment

(d) Partial Decontamination

(e) Decontamination and Restoration

These five basic alternatives are effective mechanisms for proposing remedial action options for MED/AEC sites. When all available data pertinent to a specific site are evaluated, the basic alternatives that best fit the data and the FUSRAP program goals are selected as the parent categories within which site-specific options can be formulated.

The kinds of pertinent data that are considered both in selecting the appropriate basic alternatives and in formulating the site-specific proposed options include, for example, the following:

(a) Radiological and other regulatory criteria

(b) Time and scheduling limitations

(c) Disposal site problems

(d) Interim storage versus immediate disposal

(e) Transportation problems

(f) Necessity of institutional controls (e.g., Federal or agency control or ownership) 137629

(g) Environmental impacts (short- and long-term)

(h) Costs and risks

(i) Programmatic considerations

6.1.1 Description of Basic Remedial Action Alternatives

The guidelines governing the five basic remedial action alternatives are explained in the following paragraphs.

6.1.1.1 Basic Alternative I - No Action

No action means that no remedial actions are implemented; consequently, the current levels of radioactivity and the contaminated property remain unchanged. This basic alternative is one of the possible courses of action that requires consideration based on the Council on Environmental Quality guidelines. From this alternative comes the proposed option which serves as the base case against which health effect analyses and environmental impacts of the remaining proposed options, if implemented, can be compared.

6.1.1.2 Basic Alternative II - Minimal Action

Minimal action implies that no remedial actions are taken to remove surface or subsurface radioactive contaminants from the site for disposal. Minimal action involves only those measures which effectively limit public exposure to radioactive sources, such as restricting public access to and use of a contaminated property. Generally, this basic alternative requires that the property be purchased by a government agency and held in perpetuity, fenced, posted with appropriate warning signs, maintained, and radiologically monitored periodically for water, soil, and air contamination.

6.1.1.3 Basic Alternative III - Stabilization/Entombment

Stabilization in this basic alternative requires covering a contaminated area with a specific amount of compacted clean soil. Entombment requires total encapsulation of the contaminated materials and area with a permanent casing, such as concrete. Access to a site and use of the site could be restricted. Periodic radiological monitoring of the site normally would be required, as would periodic maintenance.

6.1.1.4 Basic Alternative IV - Partial Decontamination

Partial decontamination involves remedial actions formulated to remove or contain the easily accessible active or

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potentially active sources of radiation above criteria to prevent the spread of contamination and to reduce or eliminate immediate health effects. Complete decontamination is accomplished at a later, more appropriate time. In buildings, for example, transferable alpha contamination could be cleaned up and removed off site for disposal, or left in place and covered over with an epoxy film to check its spread. Radon gas and radon daughter concentrations could be reduced by using various methods of control, such as by ventilation and filtration. Contaminated drainage systems could be removed to prevent further spread of radioactive contamination. Access to the partially decontaminated areas of the site would be restricted. A program of periodic surveillance, radiological monitoring, and maintenance normally would be required to ensure containment of contamination.

6.1.1.5 Basic Alternative V - Decontamination and Restoration

Decontamination and restoration require that all contamination above criteria be removed from a property to make it available for unrestricted use. Contaminated soils are excavated to the extent needed to meet the appropriate decontamination criteria. All contaminated debris from buildings and contaminated soils are transported safely to an appropriate disposal site. Restoration of the property follows after completion of decontamination efforts. Certification by the DOE of decontamination then allows unrestricted use of the property.

6.1.2 Feasibility of Basic Remedial Action Alternatives

The five basic alternatives discussed above were analyzed to determine if they were feasible mechanisms for development of practicable options for the Seaway Industrial Park site. As a result of this analysis, Basic Alternatives II and IV were found to be unacceptable.

Basic Alternative II, the minimal action alternative, was rejected on the basis that contamination could not be adequately stabilized under present conditions nor under the proposed manner of maintaining the landfill, which includes covering the landfill with a layer of clay, vegetating the cover, and monitoring the local ground water for leachates. Workers would continue to be exposed to direct gamma radiation, and radon flux rates would not be reduced to a level which is attainable under other basic alternatives.

Basic Alternative IV, the partial decontamination alternative, is not justified because the Seaway site does not pose an immediate health or environmental hazard. The main objectives of the partial decontamination option is to remove immediate health hazards and leave the less hazardous material for future consideration. Also, soil contamination is fairly uniform,

which would result in little immediate gain from partial decontamination.

6.2 PROPOSED OPTIONS

Ten options considered as feasible for the Seaway Industrial Park site have been developed from three of the basic alternatives discussed above: Option A from Basic Alternative I; Option B from Basic Alternative III; and Options C1, C2, C3, D1, D2, D3, E1, and E2 from Basic Alternative V. Synopses of these proposed options follow.

6.2.1 Option A - No Action

No remedial action options would be implemented to clean up, mitigate, or stabilize the waste. However, contamination would be somewhat stabilized and radiological conditions partially mitigated through continuing the normal landfilling operation.

6.2.2 Option B - On-Site Stabilization

The stabilization option involves burial of the contaminated residues on site with engineered ground water control and radon gas encapsulation. An area would be chosen which the total volume of residues could occupy. A 3-ft (1-m) layer of locally obtained clay would act as a liner to the stockpiling area. Once the residues have been stockpiled, a 3-ft (1-m) "cap" of the local clay would be applied along with 7 ft (2 m) of additional top soil. The use of clay has been studied at the St. Louis Airport site by Weston, Inc.[2] as a possible method of diverting ground water around buried radioactive waste and reducing rain water percolation into buried radioactive waste. The Weston study also looked at encapsulation of uranium mill tailings piles for controlling radon flux rates and found that 2 ft (0.6 m) of moist cover soil would be sufficient to reduce flux rates down to 2 pCi/m^2-s above background. However, 10 ft (3 m) is required to meet the NRC limits for a 1,000-yr stabilization.

The stabilization option also involves periodic monitoring of the site for migration of radionuclides and would require that the U.S. Government purchase the Seaway Industrial Park. A major drawback to this option is that the U.S. Government, being the new owner, would have to assume liability for the site. Any future problems with any of the landfill's pollutants would be the U.S. Government's responsibility.

6.2.3 Option C - Decontamination and Restoration with Interim On-Site Storage before Disposal

Contaminated areas would be excavated and contaminated materials would be stockpiled in a remote area of the landfill. A plastic cover would be placed over the stockpiled material.

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Radiological monitoring of the excavation process would be needed to define the limits of contamination. Monitoring also would be performed at the stockpiling locations. Soil samples would be taken in the excavation areas to confirm cleanup.

6.2.3.1 Option C1 - Interim On-Site Storage with Final Disposal at a State or Regional Disposal Facility

The decontamination and restoration procedures described in Section 6.2.3 would be performed. The stockpiled material would be loaded in trucks, and final disposal would take place at a state or regional disposal facility within 500 mi (800 km) of the Seaway site.

6.2.3.2 Option C2 - Interim On-Site Storage with Final Seabed Disposal under Relaxed Regulatory Controls

The decontamination and restoration procedures described in Section 6.2.3 would be performed. The contaminated material would be loaded in trucks and transportation from the on-site storage to a seabed disposal embarkation point 500 mi (800 km) from the site.

6.2.3.3 Option C3 - Interim On-Site Storage with Final Seabed Disposal under Strict Regulatory Controls

The decontamination and restoration procedures described in Section 6.2.3 would be performed. The waste would eventually be removed from the interim storage site, packaged in plywood boxes to meet strict regulatory controls, and hauled by truck to a seabed disposal embarkation point 500 mi (800 km) from the site.

6.2.4 Option D - Decontamination and Restoration with Interim Off-Site Storage before Disposal

Decontamination and restoration would proceed as in Section 6.2.3; however, instead of on-site storage, the contaminated material would be taken by truck to a 150-mi (240-km) distant interim storage location. The contaminated material would then be stockpiled at the interim storage site and covered with plastic.

6.2.4.1 Option D1 - Interim Off-Site Storage with Final Disposal at a Moderately Distant Disposal Facility

Decontamination and restoration would be performed as in Section 6.2.3. The contaminated material would eventually be transported by truck for final disposal to a state or regional disposal facility 500 mi (800 km) from the site.

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6.2.4.2 Option D2 - Interim Off-Site Storage with Final Seabed Disposal under Relaxed Regulatory Controls

Decontamination and restoration would be performed as in Section 6.2.3. The contaminated material would eventually be taken from the interim off-site storage by truck to a seabed disposal embarkation point 500 mi (800 km) from the site.

6.2.4.3 Option D3 - Interim Off-Site Storage with Final Seabed Disposal under Strict Regulatory Controls

Decontamination and restoration would be performed as in Section 6.2.3. The contaminated material would eventually be repackaged in plywood boxes to meet strict regulatory controls. The repackaged residues would then be transported by truck to a seabed disposal embarkation point 500 mi (800 km) from the site.

6.2.5 Option E - Decontamination and Restoration with Direct Disposal at an Existing Disposal Facility

Decontamination and restoration would be performed as in Section 6.2.3. The contaminated material would be transported in bulk form to an existing disposal facility.

6.2.5.1 Option E1 - Decontamination and Restoration at an Existing Moderately Distant Disposal Facility

Contaminated soils would be loaded onto trucks and transported in bulk form to an existing moderately distant disposal facility located at an assumed distance of 1,000 mi (1,600 km) from the site.

6.2.5.2 Option E2 - Decontamination and Restoration at an Existing Distant Disposal Facility

Contaminated soils would be loaded into sealed railroad hopper cars in bulk form for shipment to an existing distant disposal facility located at an assumed distance of 2,300 mi (3,700 km) from the site.

6.3 ENGINEERING EFFORTS OF PROPOSED OPTIONS

The cost estimates developed for the proposed options are based on projected engineering considerations, and therefore should be regarded as preliminary. These preliminary costs are provided for comparison between options. Major cost components include labor, material, equipment, excavation, transportation, storage and disposal, health physics coverage, radiological monitoring, site maintenance, and engineering. Other costs include overhead, engineering, contractor's fees, and estimated contingencies. Contingencies cover uncertainties and unpredictable expenses such as strikes, bad weather delays, and

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procurement delays. A conservative 6% interest rate is used for the monitoring and samples fund. All costs are presented in constant 1981 dollars.

A summary of the estimated costs for the proposed options is given in Section 6.3.11. Selected unit costs used in developing the cost estimates are summarized in Table 6-1. A summary of estimated working days and crew sizes for each option is listed in Table 6-2. Specific contractors would use equipment, crew sizes, and schedules to meet their own individual requirements, and Table 6-2 is valid only for the preliminary estimates of this report. Table 6-3 lists the options with estimated itemized and total costs. These costs have been rounded to the nearest thousand dollars on an individual line basis, and consequently may not match exactly the line item costs given in the body of this section. Totals, however, match to the closest thousand dollars. The information presented in previous sections and the unit cost information presented in this chapter have been used to develop the costs for each option.

The soil volumes used in the costs presented in this section are the resultant "loose" or "bulk" volumes that occur from expansion when soils are handled. Clay was not considered to swell. These are the volumes applicable to pricing, loading, and disposal of contaminated materials. In other sections, volumes are given as "in-place" without engineering contingency. The swell factor used was 25%; this factor can be used to transpose the volume numbers from in-place to bulk. The weight after swell is estimated to be 100 lb/ft^3 (600 kg/m^3) for cohesionless soils. The same density has been used for clay.

The transportation costs in this section have the same price for truck or railroad haulage up to 500 mi (800 km). Beyond that distance, rail haulage is less expensive and is therefore used. The only options that have more than a 500-mi (800-km) shipment at one time are Options E1 and E2. These options consider direct disposal at existing disposal facilities, where the distances are 1,000 mi (1,600 km) and 2,300 mi (3,700 km), respectively. Truck haulage figures are based on one driver per truck. Rail haulage is not assumed as requiring additional costs for manpower.

For all options, loading-unloading manpower, equipment, and health physics coverage at the disposal sites are considered to be part of disposal charges. Bulk shipment by train includes plastic sheet sealing of the bottom and fiberglass bolt-down covers. Bulk shipment by truck is based on 12-yd^3 (9-m^3) capacity dump trucks, also sealed and covered. Material containerized in plywood boxes would be transported in either boxcars or enclosed highway trailers.

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6.3.1 Option A - No Action

Since no remedial action would be performed, no expenses would be incurred. The option is required for possible future NEPA processing and also provides the base case against which other option costs and health effects can be compared.

6.3.2 Option B - On-Site Stabilization

Stabilization would be accomplished by excavating the 61,700 yd^3 (47,200 m^3) of contaminated soils and stockpiling them in an existing flat, relatively low-elevation, well-drained area at the site. A 3.3-ft (1-m) clay base would be placed below the stack, and a 3.3-ft (1-m) clay cap would be placed over the stack. The clay would totally enclose the contamination. Normal backfill operations at the site would then be utilized to cover over the contaminated soil and clay. After the site has been filled to final grade, a security fence would be installed around the contaminated soil area. Ground water monitoring samples would be taken using existing wells.

The areas with contaminated material and the stockpile would be surveyed and marked with small red flags. The base of the stockpile would be about 375 x 375 ft (115 x 115 m). Fencing would extend about 50 ft (15 m) beyond each side. The stockpile would have sides sloped 30 degrees to the horizontal. The overall stack height would be about 23 ft (7 m).

The clay base would be hauled by truck to the site from a local quarry. It would be placed and spread at the stockpile location. The contaminated soil would be excavated and loaded on 12-yd^3 (9-m^3) dump trucks and hauled approximately 0.5 mi (0.8 km) to the stockpile site, where it would be dumped on the clay base. Bulldozers would spread and shape the stockpile. Sheepsfoot compactors would also be used to compress the contaminated soil. When the contaminated soil has been compacted and shaped, the clay cap would be hauled in and placed over the stockpile. This work is expected to take an average 20-worker crew 88 days to complete.

The costs associated with this option are as follows:

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Base clay, in place, 15,800 yd^3 (12,000 m^3)	189,000
c.	Excavate and load contaminated soil, 61,700 yd^3 (47,200 m^3)	620,000
d.	Haul contaminated soil 0.5 mi (0.8 km)	61,700
e.	Place and compact contaminated soil	61,700

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Item	Cost $
f. Cap clay, in place, 17,800 yd^3 (13,600 m^3)	213,600
g. Security fence, 1,700 ft (520 m)	25,500
h. 1,500 samples	187,500
i. Monitoring and sampling fund of $25,000 @ 6% interest = $1,500/yr	25,000
j. Health physics and radiological monitoring, 4 workers	88,000
SUBTOTAL	$1,473,600
k. Engineering, 15%	221,000
l. Contingency, 30%	442,100
ROUNDED TOTAL	$2,137,000

6.3.3 Option C1 - Decontamination and Restoration with Interim On-Site Storage and Final Disposal at a State or Regional Disposal Facility

Decontamination and restoration would be accomplished by excavating the 61,700 yd^3 (47,120 m^3) of contaminated soils and stacking them on the site in an area central to the three main contamination areas. For this interim storage, the contaminated soils would be stacked as explained in Section 6.3.2, except that a 2-ft (0.6-m) thick clay base would underlie the pile. The pile would be covered with a durable plastic sheet (EPDM) bonded into a continuous overlay and weighted. An earthen dike would surround the pile to divert water. Wooden boards, diagonally cut with the sheet compressed between the cut, would hold the sheet in place. The boards in turn would be secured by bolting through to a concrete footing all around the pile. It is assumed that a maximum of 6 in. (15 cm) of the base clay could become contaminated. This clay volume is included in the final disposal volume. Clay and soil handling as well as fencing would be as explained in Section 6.3.2.

At some time in the future, when a state or regional disposal facility becomes available, the contaminated materials would be hauled by truck an assumed distance of 500 mi (800 km) to this final disposal site. This work is expected to take an average 69-worker crew 363 days to complete.

The costs associated with this option are as follows:

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Base clay, in place, 9,550 yd^3 (7,300 m^3)	114,600
c.	Excavate and load contaminated soil, 61,700 yd^3 (47,200 m^3)	620,000
d.	Haul contaminated soil 0.25 mi (0.4 km)	30,850
e.	Place and compact contaminated soil	61,700
f.	Install EPDM sheet, dike, and anchorage, 15,200 yd^2 (11,600 m^2)	53,200
g.	Load and haul contaminated soils and clay, 64,100 yd^3 (49,000 m^3), 500 mi (800 km)	8,653,500
h.	Security fence, 1,700 ft (520 m)	25,500
i.	1,500 samples	187,500
j.	Monitoring and sampling fund of $25,000 @ 6% interest = $1,500/yr	25,000
k.	Disposal charges, 64,100 yd^3 (49,000 m^3)	25,960,500
l.	Health physics and radiological monitoring, 4 workers	363,000
	SUBTOTAL	$36,096,950
m.	Engineering, 15%	5,414,500
n.	Contingency, 30%	10,829,100
	ROUNDED TOTAL	$52,341,000

6.3.4 Option C2 - Decontamination and Restoration with Interim On-Site Storage and Final Seabed Disposal, Relaxed Regulatory Controls

This option would have the same bulk handling volumes, haul distances, work sequences, project duration, work force, and cost estimate line items as Option C1 above, except that final disposal charges would differ. This option is therefore estimated to require a 69-worker crew 363 days to complete.

The costs associated with this option are as follows:

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	Item	Cost $
a.	Survey and mark areas	1,600
b.	Base clay, in place, 9,550 yd^3 (7,300 m^3)	114,600
c.	Excavate and load contaminated soil, 61,700 yd^3 (47,200 m^3)	620,000
d.	Haul contaminated soils 0.25 mi (0.4 km)	30,850
e.	Place and compact contaminated soil	61,700
f.	Install EPDM sheet, dike, and anchorage, 15,200 yd^2 (11,600 m^2)	53,200
g.	Load and haul contaminated soils and clay, 64,100 yd^3 (49,000 m^3), 500 mi (800 km)	8,653,500
h.	Security fence, 1,700 ft (520 m)	25,500
i.	1,500 samples	187,500
j.	Monitoring and sampling fund of $25,000 @ 6% interest = $1,500/yr	25,000
k.	Disposal charges, 64,100 yd^3 (49,000 m^3)	5,192,100
l.	Health physics and radiological monitoring, 4 workers	363,000
	SUBTOTAL	$15,328,550
m.	Engineering, 15%	2,299,300
n.	Contingency, 30%	4,598,600
	ROUNDED TOTAL	$22,226,000

6.3.5 Option C3 - Decontamination and Restoration with Interim On-Site Storage and Final Seabed Disposal, Strict Regulatory Controls

This option would have the same remedial action activities as Option C2 except that packaging of contaminated materials would be required; consequently, disposal volumes and charges would be higher. The packaging containers would be plywood boxes, 4 x 7 x 4 ft (1.2 x 2.1 x 1.2 m), with plastic sheet liners. Large forklifts or a crane would be required to lift these boxes, which would weigh about 5 tons (4.6 MT) when filled. Small front-end loaders would be used to fill the boxes. It is assumed that the boxes would be filled to 90% of their total volume capacity before sealing. The boxes would

then be inventoried and appropriately marked for the contained material. Disposal charges are based on the total volume capacity of the boxes and are therefore 10% higher than bulk disposal charges. The boxes would be placed on a clay base to isolate them from surface water and covered with a plastic sheet to protect them from precipitation. The clay would not become contaminated as with the previous options, and would be left at the site. A security fence would be installed around the boxes. This option is expected to take an average 69-worker crew 393 days to complete.

The costs associated with this option are as follows:

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Base clay in place, 11,400 yd^3 (8,740 m^3)	137,200
c.	Purchase boxes, 16,530 each	3,719,300
d.	Excavate and load contaminated soil in boxes, 61,700 yd^3 (47,200 m^3)	620,000
e.	Load and haul 16,530 boxes, 0.28 mi (0.4 km)	30,800
f.	Inventory and mark boxes	20,700
g.	Stack boxes	62,100
h.	Cover boxes with EPDM sheet, dike, and anchor	53,200
i.	Load and haul boxes, 64,100 yd^3 (49,000 m^3), 500 mi (800 km)	8,653,500
j.	Security fence 1,770 ft (540 m)	26,600
k.	1,500 samples	187,500
l.	Monitoring and sampling fund of $25,500 @ 6% interest = $1,500/yr	25,000
m.	Final disposal charges, 16,530 boxes, 112 ft^3 (3 m^3) each = 1,851,000 ft^3 (52,400 m^3)	37,027,200
n.	Health physics and radiological monitoring, 4 workers	393,000
	SUBTOTAL	$50,957,700
o.	Engineering, 15%	7,643,700

Item	Cost $
p. Contingency, 30%	15,287,300
ROUNDED TOTAL	$73,889,000

6.3.6 Option D1 - Decontamination and Restoration with Interim Off-Site Storage and Final Disposal at a State or Regional Disposal Facility

This option would include the same remedial action activities as Option C1 (Section 6.3.3) except that interim storage would be off site at an assumed distance of 150 mi (240 km) from the Seaway site. For this interim storage, asphalt concrete (paving) would be used for the base pad. Unloading and handling at the interim site are assumed to be part of the disposal charge; however, the plastic cover sheet and base asphalt are not. The base material is assumed to become contaminated from the contaminated material stockpiled on top of it, and the volume of base material would be added to the contaminated volume for final disposal. This work is expected to take an average 69-worker crew 440 days to complete.

The costs associated with this option are as follows:

Item	Cost $
a. Survey and mark areas	1,600
b. Excavate and load contaminated soil in boxes, 61,700 yd^3 (47,200 m^3)	620,000
c. Haul contaminated soil 150 mi (240 km)	2,498,900
d. Asphaltic concrete at interim site 450 x 450 ft (140 x 140 m) = 22,500 yd^2 (18,800 m^2)	326,300
e. Place and compact contaminated soil	61,700
f. Disposal charges, interim site 61,700 yd^3 (47,200 m^3)	5,830,700
g. Install EPDM sheet, dike, and anchorage 15,200 yd^2 (12,700 m^2)	53,200
h. Load and haul contaminated soil and asphalt 65,500 yd^3 (50,000 m^3), 500 mi (800 km)	8,835,800
i. Final disposal charges, 65,500 yd^3 (50,000 m^3)	26,507,300
j. 1,500 samples	187,500

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	Item	Cost $
k.	Health physics and radiological monitoring, 4 workers	440,000
	SUBTOTAL	$45,363,000
o.	Engineering, 15%	6,804,500
p.	Contingency, 30%	13,608,900
	ROUNDED TOTAL	$65,776,000

6.3.7 Option D2 - Decontamination and Restoration with Interim Off-Site Storage and Final Seabed Disposal, Relaxed Regulatory Controls

This option would have the same bulk handling volumes, haul distances, work sequences, project duration, work force, and cost estimate line items as Option D1 except that final disposal charges would differ. This option is therefore also estimated to require an average 69-worker crew 440 days to complete.

The costs associated with this option are as follows:

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Excavate and load contaminated soil in boxes, 61,700 yd^3 (47,200 m^3)	620,000
c.	Haul contaminated soil 150 mi (240 km)	2,498,900
d.	Asphaltic concrete at interim site 450 x 450 ft (140 x 140 m) = 22,500 yd^2 (18,800 m^2)	326,300
e.	Place and compact contaminated soil	61,700
f.	Disposal charges, interim site 61,700 yd^3 (47,200 m^3)	5,830,700
g.	Install EPDM sheet, dike, and anchorage 15,200 yd^2 (12,700 m^2)	53,200
h.	Load and haul contaminated soil and asphalt 65,500 yd^3 (50,000 m^3), 500 mi (800 km)	8,835,800
i.	Final disposal charges, 65,500 yd^3 (50,000 m^3)	5,301,450
j.	1,500 samples	187,500

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Item	Cost $
k. Health physics and radiological monitoring, 4 workers	440,000
SUBTOTAL	$24,157,150
l. Engineering, 15%	3,623,600
m. Contingency, 30%	7,247,150
ROUNDED TOTAL	$35,028,000

6.3.8 Option D3 - Decontamination and Restoration with Interim Off-Site Storage and Final Seabed Disposal, Strict Regulatory Controls

This option would have the same remedial action activities as Option D2 except that packaging would be required. Disposal charges would also be higher with this option. The packaging containers would be the plywood boxes described under Option C3, Section 6.3.5. The loading, handling and volumes involved with the use of these boxes are also as described for Option C3, except that asphaltic concrete instead of clay would be used for a base pad. This option is expected to take an average 69-worker crew 470 days to complete.

The costs associated with this option are as follows:

Item	Cost $
a. Survey and mark areas	1,600
b. Purchase boxes, 16,530 each	3,719,300
c. Excavate and load contaminated soil in boxes, 61,700 yd^3 (47,200 m^3)	620,000
d. Haul boxes 150 mi (240 km)	2,498,900
e. Inventory, number, and mark boxes	20,700
f. Asphaltic concrete at interim site for boxes stacked 3 high, 450 x 450 ft (140 x 140 m) = 22,500 yd^2 (18,800 m^2)	326,300
g. Install EPDM sheet, dike, and anchorage 15,200 yd^2 (12,700 m^2)	53,200
h. Disposal charges at interim site, 16,530 boxes, 1,851,000 ft^3 (52,400 m^3)	6,479,800
i. Load and haul boxes, 64,100 yd^3 (49,000 m^3), 500 mi (800 km)	8,653,500

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	Item	Cost $
j.	Final disposal charges, 1,851,000 ft^3 (52,400 m^3)	37,027,200
k.	1,500 samples	187,500
l.	Health physics and radiological monitoring, 4 workers	470,000
m.	Stack boxes	62,100
	SUBTOTAL	$60,120,100
n.	Engineering, 15%	9,018,000
o.	Contingency, 30%	18,036,000
	ROUNDED TOTAL	$87,174,000

6.3.9 Option E1 - Decontamination and Restoration with Direct Disposal at an Existing Moderately Distant Disposal Facility

This option provides for immediate direct disposal at an existing, moderately-distant disposal facility, which is assumed to be 1,000 mi (1,600 km) from the Seaway site. During remedial action, the contaminated soil would be excavated with front-end loaders, placed in trucks, and hauled an estimated 5 mi (8 km) to a railcar loading site. At this location, the trucks would dump the contaminated soil in a pile. The soil would then be loaded from this pile onto railcars using front-end loaders. The contaminated soil would then be transported by rail to an existing, moderately-distant disposal facility. This option is expected to take a 35-worker crew 40 days to complete. The man-days for this rail-haul option are lower than the other options that use truck haulage because of the differences in labor requirements for rail haulage compared to truck haulage.

The costs associated with this option are as follows:

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Excavate and load contaminated soil, in boxes, 61,700 yd^3 (47,200 m^3)	620,000
c.	Haul to railroad and dump, 5 mi (8 km)	616,400
d.	Load from dump pile onto train cars	61,700

	Item	Cost $
e.	Train shipment, 1,000 mi (1,600 km)	14,160,200
f.	1,500 samples	187,500
g.	Health physics and radiological monitoring, 4 workers	40,000
h.	Disposal charges, 61,700 yd^3 (47,200 m^3)	13,327,200
	SUBTOTAL	$29,014,600
i.	Engineering, 15%	4,352,200
j.	Contingency, 30%	8,704,100
	ROUNDED TOTAL	$42,071,000

6.3.10 Option E2 - Decontamination and Restoration with Direct Disposal at an Existing Distant Disposal Facility

This option has the same elements as Option E1 above except that the haul distance to disposal is assumed to be 2,300 mi (3,700 km) instead of 1,000 mi (1,600 km). The extra distance adds a few man-days to the train crew. Disposal charges are also assumed to be different at this disposal site (see also Table 6-1). This option is therefore expected to take an average 35-worker crew 45 days to complete.

	Item	Cost $
a.	Survey and mark areas	1,600
b.	Excavate and load contaminated soil, in boxes, 61,700 yd^3 (47,200 m^3)	620,000
c.	Haul to railroad and dump, 5 mi (8 km)	616,400
d.	Load from dump pile onto train cars	61,700
e.	1,500 samples	187,500
f.	Train shipment, 2,300 mi (3,700 km)	32,568,300
g.	Disposal charges, 61,700 yd^3 (47,200 m^3)	3,331,800
h.	Health physics and radiological monitoring, 4 workers	45,000
	SUBTOTAL	$37,432,300
i.	Engineering, 15%	5,614,800

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j. Contingency, 30%		11,229,700
ROUNDED TOTAL		$54,277,000

6.3.11 Cost Summary

The estimated total cost of each option is summarized as follows:

	OPTIONS	TOTAL ESTIMATED COST $
A	No Action	-0-
B	On-Site Stabilization	2,137,000
C1	Decontamination and Restoration, Interim On-Site Storage, Final Disposal at a State or Regional Disposal Facility	52,341,000
C2	Decontamination and Restoration, Interim On-Site Storage, Final Seabed Disposal under Relaxed Regulatory Controls	22,226,000
C3	Decontamination and Restoration, Interim On-Site Storage, Final Seabed Disposal under Strict Regulatory Controls	73,889,000
D1	Decontamination and Restoration, Interim Off-Site Storage, Final Disposal at a State or Regional Disposal Facility	65,776,000
D2	Decontamination and Restoration, Interim Off-Site Storage, Final Seabed Disposal under Relaxed Regulatory Controls	35,028,000
D3	Decontamination and Restoration, Interim Off-Site Storage, Final Seabed Disposal under Strict Regulatory Controls	87,174,000
E1	Decontamination and Restoration, Direct Disposal at an Existing Moderately Distant Disposal Facility	42,071,000
E2	Decontamination and Restoration, Direct Disposal at an Existing Distant Disposal Facility	54,277,000

6.4 ENVIRONMENTAL IMPACTS OF PROPOSED OPTIONS 137629

This section describes the environmental impacts expected to result from each of the proposed actions. The environmental parameters determined from the preliminary activities are presented. Each of these parameters is discussed along with the potential environmental impacts and mitigating measures associated with each of the options. The following parameters are evaluated:

a) Radiological Health Effects

b) Remedial Action Accidents

c) Transportation Accidents

d) Transportation Fatalities

e) Ambient Radiation

f) Air Quality

g) Water Quality

h) Soils and Erosion

i) Nonrenewable Resources

j) Ecology

k) Public Sentiment and Socioeconomics

l) Land Use and Land Value

m) Noise

6.4.1 Parameters Not Impacted by Any Proposed Option

No identifiable cultural resources exist at the site. The options would therefore produce no impact upon this parameter.

6.4.2 Potential Impacts of Option A

Since no action would be taken, all existing impacts described in this section would continue unmitigated indefinitely. There also is concern that the contamination would spread beyond its current location, thereby possibly increasing environmental impacts.

Of the parameters listed in Section 6.4, parameters b, c, d, i, j, k, and m are not affected in Option A, and therefore are not discussed in the following subsections.

6.4.2.1 Radiological Health Effects, Option A

Health effects were calculated for exposure to radon daughters and to external gamma radiation of three full-time workers and to 10 part-time employees at the Seaway Industrial Park. It was conservatively assumed that the maximum gamma exposure rate of 72 μR/hr above background applied continuously to all workers. It was also assumed conservatively that the maximum observed radon flux (at surface levels), of 7.7 pCi/m^2-s could give a radon daughter equivalent working level (at breathing zone levels) of 0.06 WL, assuming 25% of equilibrium. With these assumptions, the total annual health effect risk to workers on site from radon daughter inhalation is about 2×10^{-3}, and from gamma exposure is 1×10^{-4}. Given the number of conservative assumptions made, these numbers are accurate to no more than one order of magnitude.

Without remedial action, the contamination at this site would continue to emit gamma radiation for many millennia. Consequently, the associated health effects of the contamination also would persist at this level as long as the contamination remains in its present condition and location and the site continues to be occupied by workers. These levels of contamination thus constitute a slightly negative health impact.

Gamma radiation and radon concentrations at site boundaries were at or near background. Health effects calculations were too low to be meaningful.

6.4.2.2 Ambient Radiation, Option A

As discussed in Chapter 4, elevated levels of direct gamma radiation and surface beta-gamma contamination are found at several locations on Area A, and on Area C and down the slope south of Area C. Because of these elevated radiation levels, Option A has a slightly negative environmental impact.

6.4.2.3 Air Quality, Option A

Radon daughters have only a minimal adverse effect on air quality at the Seaway site due to the absence of buildings in the contaminated areas. Under Option A, this minimal impact will continue.

Radon flux levels were slightly elevated in some locations at the Seaway site, particularly in contaminated Area C. As a result, the overall impact of implementing Option A will be slightly negative.

6.4.2.4 Water Quality, Option A

All but one water sample collected during the site surveys showed concentrations of radionuclides to be within guidelines. However, only surface water samples were collected. Although

the relatively impermeable nature of the clayey glacial till underlying the site should prevent future contamination of important ground water supplies, locally perched bodies of ground water within the landfill may become contaminated with radioactive constituents. Hence, Option A may have a slightly negative impact on water quality.

6.4.2.5 Soils and Erosion, Option A

By implementing Option A, soils on site would remain contaminated. Leaching of contaminants, although not proceeding at a rate rapid enough to affect important ground water supplies, will slowly increase the volume of contaminated soil at the site, resulting in a slight negative impact.

Erosion of the contaminated areas of the landfill may occur in the future if Option A is implemented, spreading contaminated soil both on- and off-site. Dilution of contaminated material in formerly clean soils should minimize the adverse effects of this erosion, however. The overall impact, therefore, would only be slightly negative.

6.4.2.6 Land Use and Land Value, Option A

The presence of the contamination limits the use of certain areas of the site in the sense that the land cannot be recovered until the radiation problem is resolved. There has been no effect on land use in the surrounding area. While an effect on land values is not evident, it is possible that if an attempt were made to sell the property, its classification as a FUSRAP site might adversely affect the market value. Since this site is already a landfill dump, this would be a minor adverse impact.

6.4.3 Potential Impacts of Option B

This option involves on-site stabilization and is described in detail in Section 6.3.2. Potential impacts of Option B are described in Subsections 6.4.3.1 through 6.4.3.13 that follow.

6.4.3.1 Radiological Health Effects, Option B

There would be a slight negative impact to workers during transfer of contaminated materials to the stabilization/entombment location. As an example, if the 20 workers estimated for this operation were to be exposed to radon daughter concentrations of 0.06 WL (the maximum expected concentration for the entire 88 working days estimated to complete the work), the total annual health effect risk to this entire group of workers would be about 1.7×10^{-3}. The health effect risk from gamma radiation exposure during this time period was calculated to be so low as to be meaningless.

After completion of the stabilization/entombment operations, direct gamma radiation and radon emanation would be reduced to near background levels. This would result in a slight positive impact to the worker population.

6.4.3.2 Remedial Action Accidents, Option B

The probability of a remedial accident occurring while implementing this option is based on U.S. construction industry accident statistics.(3) These statistics indicate a rate of 0.052 accidents/man-yr. Considering an average crew size of 20, 88 days for completion of the work, and 250 working days/yr, Option B will require 7 man-yr. This calculates to be 7 man-yr x 0.052 accidents/man-yr, or a statistical projection of 0.4 accidents, which is a slight adverse impact. No accident-related disabling injuries are projected for after implementation of these options.

6.4.3.3 Transportation Accidents, Option B

The Interstate Commerce Commission (ICC) figures for 1976 for regulated motor freight carrier traffic(4) show an accident frequency of .24 x 10^{-8}/ton-mi (3.59 x 10^{-8}/MT-km). Based on this statistic, the probability for similar incidents in transporting the contaminated materials and backfill is 5.24 x 10^{-8} x 350,500 ton-mi, or 0.02 transportation accidents. This number represents a negligible probability that a transportation accident would occur, which would be a no adverse impact situation. No transportation-related impacts are projected for after implementation of these options.

6.4.3.4 Transportation Fatalities, Option B

The ICC figures for 1976(4) show a fatality frequency of 5.14 x 10^{-9} fatalities/ton-mi (3.52 x 10^{-9} fatalities/MT-km). Based on this statistic, the probability for similar fatalities occurring during transport of the contaminated materials and backfill is 5.14 x 10^{-9} x 350,500 ton-mi, or 0.002 transportation fatalities. This number represents a negligible probability a transportation fatality would occur, which would be a no-impact situation. No transportation-related impacts are projected for after implementation of these options.

6.4.3.5 Ambient Radiation, Option B

Stabilization would expose decontamination workers to elevated levels of gamma radiation and to increased radon emanation, both during transfer of the radioactive materials to the clay-lined storage area and during placement of the clay cap over the stored materials. This would be a slight negative impact. Following stabilization completion, radiation and radon emission levels would be reduced to near background levels. This would be a slight positive impact on environmental quality for workers at the landfill.

6.4.3.6 Air Quality, Option B

During excavation and backfilling, total suspended particulates and radon daughter concentrations are expected to increase slightly above ambient conditions. However, following final stabilization of the contaminated material, long-term air quality should be slightly improved due to encapsulation of the radon sources.

6.4.3.7 Water Quality, Option B

Providing an engineered barrier to the movement of ground water through the contaminated material should prevent future contamination of local ground water supplies. In addition, since ground water at the Seaway site seeps to the surface and enters surface water supplies (see Section 5.7), provision of an adequate ground water barrier should further reduce the potential for contamination of surface water supplies. Thus, the overall impact of this option should be slightly beneficial to water quality.

6.4.3.8 Soils and Erosion, Option B

The spread of contaminants by leaching should be reduced following consolidation and stabilization of the radiologically contaminated materials on site. Although soil erosion may increase slightly during excavation operations, this increase should be insignificant with the implementation of standard erosion control practices. In addition, through the use of proper stabilization measures, erosion and subsequent transport of contaminated material to both on- and off-site areas should be reduced. However, because these processes are currently proceeding at a relatively slow rate, the resultant overall impact would be only slightly beneficial.

6.4.3.9 Nonrenewable Resources, Option B

Stabilization would result in a minor adverse impact due to the use of fuel and fill. The impact on other nonrenewable resources would be much less. Most of the work would involve earthmoving, which would consume fuel and fill. The fuel and fill consumed would be insignificant compared to the total amounts of these resources used in the Buffalo metropolitan area. This option would require the smallest amount of nonrenewable resources of all the proposed options.

6.4.3.10 Ecology, Option B

Option B would have a slight short-term adverse impact upon the ecology of the area. Additional soil would be brought in to increase the depth of cover material. This additional fill material would require several years for vegetation to stabilize and mature to provide habitat and carrying capacity for immigrating animal life. After biotic elements of the

ecosystem have become established, Option B would not produce any detectable ecological impacts at the site. Fill material could be obtained from existing commercial borrow sites so as to avoid any new areas of disturbance or additional ecological impacts.

6.4.3.11 Public Sentiment and Socioeconomics, Option B

It is likely that the public would approve of the stabilization of the contamination. This option would also bring a short-term economic benefit to the local economy, since the work force could be obtained locally. Some adverse economic impact could result if the ongoing operations of the landfill were disturbed by the cleanup. Efforts could be made to avoid this, however.

Existing transportation patterns, population, and public services should not be affected. Overall, public sentiment and socioeconomics would experience minor beneficial impacts due to implementing on-site stabilization.

6.4.3.12 Land Use and Land Value, Option B

This option would still require the use of part of the site which might limit land use to a small extent in the future. There would be no value to any part of the site on which the stabilized waste is located. However, due to consolidation, less of an area would be impacted than if it were left in its present dispersed condition. Because of this, this option could result in a slight adverse impact.

6.4.3.13 Noise, Option B

Option B would produce only slight impacts during the time that stabilization is being effected. Since this action would require the same types of diesel equipment currently in use, only slight and insignificant adverse noise impacts are expected.

6.4.4 Potential Impacts of Options C1 - C3

These options, described in detail in Sections 6.3.3 through 6.3.5, consider interim on-site storage of the contaminated materials before final disposal. Potential impacts of these options are described in Subsections 6.4.4.1 through 6.4.4.13 that follow.

6.4.4.1 Radiological Health Effects, Options C1 - C3

Radiological health effects on workers during decontamination operations would be very low. In quantifying the risk, it was assumed that a crew of 69 workers would be involved for 363 working days, that radon daugher concentrations would be at 0.6 WL (the maximum expected annual concentration), and that gamma

exposures would be at the average level of 72 μR/hr for the entire time. Under these highly conservative assumptions, the annual risk from radon daughter exposure would be about 2×10^{-2} health effects/yr and would be about 1×10^{-3} health effects/yr from gamma radiation. Since workers would be exposed during cleanup, the operation itself is judged to have a slight negative impact.

Proper control procedures during the on-site storage period would reduce the already low health effect risk, but could not completely eliminate this risk. For this reason, this option is considered to have a slight negative impact until the contaminated material is removed from the site for final disposal.

The radiological health impacts during transport were judged to be negligible. Gamma exposures to the public would be so small that they could not be calculated with any degree of accuracy. Exposure to truck drivers would produce a health effect risk too low to be meaningful. For these reasons it was assumed that cleanup of the waste would result in a slight beneficial impact.

Eventual disposal at a state or regional disposal facility would not result in a significant radiological health effect risk to populations, since standards for siting and control would preclude the exposure of these populations to radiation from the facility. Seabed disposal, either under relaxed or strict regulatory controls, would have a minimal impact on radiological health effects because the wastes would be isolated and shielded from populations.

Since all populations would be protected from radiation, either by disposal at a state or regional facility or by disposal at sea, these options would result in a slight beneficial impact.

6.4.4.2 Remedial Action Accidents, Options C1 - C3

The remedial action accident statistics are based on U.S. construction industry data.(3) The construction accident potential of this option assumes 69 workers, 363 days for completion, and 250 working days/yr, which amounts to 100 man-yr. Multiplying this times the stated accident rate translates to a statistical projection of five accidents during completion of the C options. This would be a minor adverse impact. No remedial action accidents after implementation are projected for these options.

6.4.4.3 Transportation Accidents, Options C1 - C3

The transportation accident potentials of these options also are based on the ICC frequency for motor freight traffic for 1976.(4) The frequency is 5.24×10^{-8} accidents/ton-mi

(3.59×10^{-8} accidents/MT-km). Therefore, for these options, 5.24×10^{-8} accidents/ton-mi x 5.66×10^{7} ton-mi, or 3.0 transportation accidents, would statistically occur. This number represents a minor adverse impact.

6.4.4.4 Transportation Fatalities, Options C1 - C3

The transportation fataility potential for these options is based on the ICC frequency for 1976 of 5.14×10^{-9} fatalities/ton-mi (3.52×10^{-9} fatalities/MT-km).(4) Therefore, for these options, 5.14×10^{-9} fatalities/ton-mi x 5.66×10^{7} ton-mi, or 0.29 transportation-related fatalities, statistically would occur. This number represents a low probability that such a fatality would occur, and consequently a slight adverse impact.

6.4.4.5 Ambient Radiation, Options C1 - C3

Complete decontamination of the site to the criteria described in Chapter 4 would give an increase in radiation exposure to a small number of workers during remedial action operations. However, the work would result in a decrease in radiation exposure to near-background levels for site workers and for nearby populations after completion of the decontamination effort. This would be a slight benefit.

The on-site interim storage stockpile would result in a slightly negative impact at the site until the contaminated material was finally moved. At that time there would be a slight benefit.

The contaminated soils and materials delivered to the state or regional disposal facility (Option C1) would result in a negative impact at that facility. However, such a facility would be designed to accept the contaminants and to mitigate the impact.

Very low concentrations of radioactive materials are found naturally in seawater. Seabed disposal under relaxed regulatory controls (Option C2) probably would result eventually in localized increases in concentrations of radioactive contaminants in the ocean. The increase in radiation levels after dispersion by ocean currents would be insignificant. The same impacts would occur under strict regulatory controls (Option C3), which would require packaging of the contaminated materials. However, the radioactive materials would escape from the plywood containers at a slow rate, and this would result in a milder total adverse impact than that under Option C2.

6.4.4.6 Air Quality, Options C1 - C3

During removal and interim storage operations, total suspended particulates and radon daughter concentrations are expected to increase slightly above ambient concentrations. During storage, impacts to air quality should be negligible.

Over the long term, following final disposal of the contaminated materials, air quality should be slightly improved over present conditions due to the removal of the radon sources.

6.4.4.7 Water Quality, Options C1 - C3

Protection of the stockpiled contaminated materials during interim storage should prevent future contamination of surface water supplies. The relatively impermeable nature of the clayey glacial till underlying the site also serve to prevent contamination of important ground water supplies.

As a result of final disposal, water quality at the site should be slightly improved. All potential sources of contamination will have been removed, thus preventing long-term future impacts to water quality. Hence, the overall result of implementing any of Options C1 through C3 should be a slight benefit to water quality.

6.4.4.8 Soils and Erosion, Options C1 - C3

Decontamination of the site will prevent additional spreading of contaminants through leaching and erosion. Although soil erosion may increase slightly during excavation operations, this increase should be insignificant with the implementation of standard erosion control practices. Hence, implementation of any of Options C1 through C3 should result in a slightly beneficial impact to soils and erosion.

6.4.4.9 Nonrenewable Resources, Options C1 - C3

These options involve basically the same material handling volumes and remedial actions as Options B, D1 through D3, E1, and E2, described in foregoing sections. Options C1 through C3, however, require an additional handling step. This extra handling would consume additional fuel, although the additional amount would be insignificant compared with the total fuel consumption in the Buffalo metropolitan area.

6.4.4.10 Ecology, Options C1 - C3

Options C1 through C3 would produce only a slight short-term adverse impact upon the ecology at the site of remedial action activities. Only the existing annual weeds and the habitat of rodents would be disturbed by removal of the contaminated materials. On-site storage of recovered wastes would also be placed upon annual weeds and the habitat of rodents. This area again would be disturbed when the stored materials were picked up for shipment prior to final disposal. Since the ecology at this site is not considered important, only a slight adverse impact would occur.

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6.4.4.11 Public Sentiment and Socioeconomics, Options C1 - C3

Public sentiment in the Tonawanda, New York area should be favorable to the cleanup of contamination on the site, resulting in a minor beneficial impact. Favorable local sentiment would probably be offset somewhat by unfavorable public sentiment along transportation routes and near disposal sites. It seems likely that Option C2, the relaxed seabed disposal option, should be the option least well received by the general public.

Since the work force would be obtained locally, a short-term beneficial impact would result to the economy of the surrounding area. Option C3 would provide a greater amount of money for a local contractor than Options C1 or C2 as a result of the packaging requirement. Adverse economic impacts could result if the ongoing operations of the landfill were disturbed by the cleanup operations, and efforts could be made to avoid this.

Transportation patterns in the area would be adversely affected over the short term, especially during final disposal. The impacts would be the same for all three suboptions. Population and public services should not be affected.

6.4.4.12 Land Use and Land Value, Options C1 - C3

Land use and land value would be beneficially impacted by these options. Following remedial action, any use restrictions because of radiological conditions would be removed. The potential for negatively impacting land value of the site due to radiological conditions would be removed. This would result in a minor long-term beneficial impact for Options C1 through C3.

6.4.4.13 Noise, Options C1 - C3

Options C1 through C3 would produce only slight impacts during the on-site stockpiling of the contaminated material. If the stockpiled material is removed to a final disposal site while the landfill is in operation, similar diesel-powered equipment as in current use would be used to load and transport the material from the site, the impact on noise would still be slight.

6.4.5 Potential Impacts of Options D1 - D3

These options, described in detail in Sections 6.3.6 through 6.3.8, all specify interim off-site storage of the contaminated materials before final disposal. Potential impacts of these options are described in Subsections 6.4.5.1 through 6.4.5.13 that follow.

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6.4.5.1 Radiological Health Effects, Options D1 - D3

The rationale for calculating radiological health effects for these options would be exactly the same as described for Options C1 through C3. Consequently, the radiological health effects on workers during remedial action would be very low.

The radiological health impacts during transport were judged to be negligible. Gamma exposures to the public would be so small that they could not be calculated with any degree of accuracy. Exposure to truck drivers would produce a health effect risk too low to be meaningful. For these reasons it was assumed that cleanup of the waste would result in a slightly beneficial impact.

The effects due to disposal at a state or regional disposal facility or at a seabed location would have a minimal adverse impact during disposal operations, but a slight beneficial impact at the Seaway site after disposal.

6.4.5.2 Remedial Action Accidents, Options D1 - D3

The remedial action accident potential for these options is based on the U.S. construction industry data.(3) The construction accident potential for these options is calculated based on 116.8 man-yr x 0.052/man-yr, resulting in a statistical projection of 6.1 accidents. This indicates a minor adverse impact.

6.4.5.3 Transportation Accidents, Options D1 - D3

The mileage used in the ton-mile computation is 650 mi (1,100 km), which is the combined distance to the interim storage site and the state or regional disposal facility. The transportation accident potential of these options also is based on the ICC frequency for motor freight traffic for 1976.(4) The frequency is 5.24×10^{-8} accidents/ton-mi (3.59×10^{-8} accidents/MT-km). Therefore, for these options, 5.24×10^{-8} accidents/ton-mi x 4.20×10^{7} ton-mi, or a statistical projection of 3.9 accidents would occur. This number represents a minor adverse impact for these options.

6.4.5.4 Transportation Fatalities, Options D1 - D3

The transportation fatality potential for these options is based on the ICC frequency for 1976 of 5.14×10^{-9} fatalities/ton-mi (3.52×10^{-9} fatalities/MT-km).(4) Therefore, for these options, 5.14×10^{-9} fatalities/ton-mi x 42,000,000 ton-mi, or a statistical projection of 0.38 fatalities, would occur. This number represents a slight adverse impact for these options.

6.4.5.5 Ambient Radiation, Options D1 - D3

Complete decontamination of the site to the criteria described in Chapter 4 would have a increase in radiation exposure to a small number of workers during remedial action operations. However, the decontamination of the site would result in a decrease in radiation exposure to near-background levels for site workers and for nearby populations. This would be a slight benefit.

There would be a negative impact at the off-site interim storage facility due to increased radiation levels at that location until final disposal is completed. Radiation levels along the transfer route to the interim storage facility would increase only by a very small amount during transfer. Radiation exposure to the truck driver would increase only slightly, resulting in a slight negative impact.

The contaminated soils and materials delivered to the state or regional disposal facility would technically result in a negative impact at that facility. However, such a facility would be designed to accept the contaminants and to mitigate the impacts.

Very low concentrations of radioactive materials are found naturally in seawater. Seabed disposal under relaxed regulatory controls (Option D2) probably would result eventually in localized increases in concentrations of radioactive contaminants in the ocean. The increase in radiation levels after dispersion by ocean currents would be insignificant. The same impacts would occur with strict regulatory controls (Option D3), which would require packaging of the contaminated materials. However, the radioactive materials would escape from the plywood containers at a slow rate and thus would have a milder total adverse impact than Option D2.

6.4.5.6 Air Quality, Options D1 - D3

Impacts to air quality under Options D1 through D3 will be the same as those discussed for Options C1 through C3. A short-term negative impact will result during cleanup operations. The long-term impact following decontamination and disposal, however, will be slightly beneficial.

6.4.5.7 Water Quality, Options D1 - D3

Impacts to water quality will be similar to those discussed for Options C1 through C3. Under Options D1 through D3, all potential sources of contamination will be removed. The overall impact on water quality of implementing these options is expected to be slightly beneficial.

6.4.5.8 Soils and Erosion, Options D1 - D3

Impacts to soils and erosion will be similar to those discussed for Options C1 through C3. The quality of on-site soils will be improved by removing the radiologically contaminated materials. Although erosion may increase slightly during decontamination operations, implementation of standard erosion control practices would minimize this increase. Over the long term, removal of the contaminated materials would be prevented by removing the source. Radiologically contaminated materials should result in a slightly beneficial impact on soils and erosion.

6.4.5.9 Nonrenewable Resources, Options D1 - D3

These options would require the same material-handling volumes and remedial actions as Options C1 through C3 as described in Section 6.4.4.9. However, Options D1 - D3 specify 650 mi (about 1,053 km) of haul distance compared with 500 mi (800 km) with Options C1 through C3. Consequently, more fuel would be used in Options D1 through D3, although the amount would be insignificant compared with the total fuel consumption in the Buffalo metropolitan area.

6.4.5.10 Ecology, Options D1 - D3

The ecological impacts of Options D1 through D3 will be similar to those described for Options C1 through C3 in Section 6.4.4.10. Interim off-site storage locations that do not have any important ecological features and that would thereby minimize any adverse impacts can be selected.

6.4.5.11 Public Sentiment and Socioeconomics, Options D1 - D3

Impacts of this option would be similar to those described for Options C1 through C3 in Section 6.4.4.11. However, public opinion may not favor the establishment of an off-site storage facility included in Option D1. For this reason, this option would be only slightly beneficial. Benefits to the local economy would be somewhat greater due to the additional haulage to the interim storage location.

6.4.5.12 Land Use and Land Value, Options D1 - D3

These impacts would be the same as those described for Option C in Section 6.4.4.12.

6.4.5.13 Noise, Options D1 - D3

Interim off-site storage would have a minimal impact on noise because a type of diesel-powered equipment similar to that currently used on site would be used.

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6.4.6 Potential Impacts of Options E1 and E2

These options are described in detail in Sections 6.3.9 and 6.3.10. Option E1 involves an effort to decontaminate and restore the site and to dispose of the contaminated soils and materials directly to an existing moderately distant (1,000-mi, 1,600-km) disposal facility. Option E2 is the same except disposal would occur at an existing distant (2,300-mi, 3,700-km) disposal facility. This difference in haulage miles has been considered in the impacts discussed in the following subsections.

6.4.6.1 Radiological Health Effects, Options E1 and E2

Decontamination and restoration with direct disposal, either at an existing moderately distant disposal facility or at an existing distant disposal facility, would have approximately the same very low radiological health effects as would Options C1 through C3, and Options D1 through D3. However, Options E1 and E2 would involve rail haulage rather than truck haulage. The wastes would be transported by rail and exposures to the public or to railroad workers would be so small that they could not be calculated accurately. This impact would be negligible in comparison with health effects impacts for other portions of the cleanup work, which were also considered small. For these reasons it was assumed that cleanup and disposal of the waste under Options E1 and E2 would result in a slight beneficial impact.

6.4.6.2 Remedial Action Accidents, Options E1 and E2

The remedial action accident potential for these options is based on the U.S. construction industry data.[3] The construction accident potential for both of these options is calculated based on 6.1 man-yr x 0.052/man-yr, resulting in a statistical projection of 0.32 accidents. This indicates a slight adverse impact.

6.4.6.3 Transportation Accidents, Options E1 and E2

The mileage used in the ton-mi computation for Option E1 is 1,000 mi (1,600 km), which is the assumed distance to an existing moderately distant disposal facility. According to the Department of Transportation (DOT), the railroad accident frequency for 1980[5] was 1.07×10^{-9} accidents/ton-mi (7.32×10^{-9} accidents/MT-km). The transportation accident potential of Option E1 would be 1.07×10^{-8} accidents/ton-mi x 108,900,000 ton-mi, resulting in a statistical projection of 1.2 accidents. This number represents a slight adverse impact.

The mileage used in the ton-miles computation for Option E2 is 2,300 mi (3,680 km), which is the assumed distance to an existing distant disposal facility. According to the DOT, railroad accident frequency for 1980[5] was 1.07 x 10-8 accidents/

ton-mi (7.32×10^{-9} accidents/MT-km). The transportation accident potential of Option E2 would be 1.07×10^{-8} accidents/ton-mi x 250,500,000 ton-mi, resulting in a statistical projection of 2.7 accidents. This number represents a minor adverse impact.

6.4.6.4 Transportation Fatalities, Options E1 and E2

The transportation fatalities potential for Option E1 is also based on the 1980 DOT railroad fatality rate of 9.92×10^{-10} fatalities/ton-mi (6.8×10^{-10} fatalities/MT-km). Therefore, for this option, 9.92×10^{-10} fatalities/ton-mi x 108,900,000 ton-mi, or a statistical projection of 0.12 fatalities, would occur. This number represents no adverse impact.

The transportation fatalities potential for this Option E2 is also based on the 1980 DOT railroad fatality rate of 9.92×10^{-10} fatalities/ton-mi (6.8×10^{-10} fatalities/MT-km). Therefore, for this option, 9.92×10^{-10} fatalities/ton-mi x 250,500,000 ton-mi, or a statistical projection of 0.25 fatalities, would occur. This number represents a slight adverse impact.

6.4.6.5 Ambient Radiation, Options E1 and E2

Ambient radiation at the site would be reduced to near-background levels following decontamination and restoration. This would be a benefit for site workers and nearby populations. Radiation along the transportation route would be increased by an amount too low to be quantified during each shipment. Radiation exposures to the truck driver would result in a slight negative impact. The existing storage facility, whether moderately distant or distant, would technically incur a negative adverse impact. However, the facility would be designed to accept these shipments and to mitigate such an impact.

6.4.6.6 Air Quality, Options E1 and E2

Impacts to air quality under Options E1 and E2 will be the same as those discussed for Options C1 through C3. A short-term negative impact will result from cleanup operations. The long-term impact following decontamination and disposal, however, will be slightly beneficial.

6.4.6.7 Water Quality, Options E1 and E2

Impacts to water quality will be similar to those discussed for Options C1 through C3. Under Options E1 and E2, all potential sources of contamination will be removed. The overall impact on water quality of implementing these options is expected to be slightly beneficial.

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6.4.6.8 Soils and Erosion, Options E1 and E2

Impacts to soils and erosion will be similar to those discussed for Options C1 through C3. The quality of on-site soils will be improved by removing the radiologically contaminated materials. Although erosion may increase slightly during decontamination operations, implementation of standard erosion control practices will minimize this increase. Over the long term, removal of the radiologically contaminated materials should result in a slightly beneficial impact on soils and erosion.

6.4.6.9 Nonrenewable Resources, Options E1 and E2

These options would involve basically the same material-handling volumes and remedial actions as Options C1 through C3, as described in foregoing sections. However, Options E1 and E2 specify 1,000 mi (1,600 km) and 2,300 mi (3,700 km) of haul distance respectively compared with a 500 mi (800 km) haul distance for Options C1 through C3. Consequently, more fuel would be used in Options E1 and E2, although the additional amount would be insignificant compared with the total fuel consumption in the Buffalo metropolitan area. These options would require more fuel than the other options.

6.4.6.10 Ecology, Options E1 and E2

Options E1 and E2 would produce only slight adverse ecological impacts such as those described for Options C1 through C3 in Section 6.4.4.10. Options E1 and E2 have the slight benefit of not impacting the ecology at the interim storage site.

6.4.6.11 Public Sentiment and Socioeconomics, Options E1 and E2

Impacts of this option would be similar to those described for Options C1 through C3 in Section 6.4.4.11. Public sentiment may favor the immediate cleanup of all contamination. Economic benefits to the local economy would be greater under Option E2 than under Option E1 due to the greater haul distances. However, the public in general would probably favor the shorter haul distances mostly because of fewer expected transportation accidents.

6.4.6.12 Land Use and Land Value, Options E1 and E2

These impacts would be the same as those described for Options C and D in foregoing sections.

6.4.6.13 Noise, Options E1 and E2

This option would produce only slight adverse impacts during excavation. Since this action would require the same types of diesel-powered equipment currently in use at the

landfill, only slight and insignificant noise impacts are expected.

6.4.7 Mitigating Measures

The environmental impacts associated with each of the 13 environmental issues have been presented in Sections 6.4.2 through 6.4.6. This section discusses measures that could be taken to mitigate adverse impats created during the remedial actions.

6.4.7.1 Radiological Health Effects

A radiation monitoring program should be designed to measure radon and gamma exposure to workers in the contaminated area. Previous gamma radiation surveys have determined the gamma levels both on and off the contaminated area and can be used to provide baseline data. Each worker would be issued a radiation exposure badge to ensure that individual exposures do not exceed the limits prescribed for workers. At the conclusion of the operations, surveys of the contaminated area for alpha, beta, and gamma radiation should be performed to confirm that the operation objectives have been achieved. Bioassay monitoring should also be provided.

Industrial health and safety protection procedures have been developed for workers performing decontamination activities. These activities include various types of monitoring, surveillance, and supervision to ensure that exposures are maintained at acceptable levels. The decontamination contractor may be required to establish and comply with an approved radiological health program.

6.4.7.2 Remedial Action Accidents, Transportation Accidents, and Transportation Fatalities

The mitigating measures to control remedial action accidents would rely primarily on a well designed safety program that includes proper training of workers and supervisory insistence on safe work practices. Correct protective clothing and proper equipment operations and maintenance would help minimize accident potential. Earthmoving accident potential could be minimized by correct procedures and constant surveillance by a field engineer able to detect problems before an accident occurred. Problems could be mitigated through correct construction procedures, adequate supervision, and strict adherence to Federal, state, and local safety requirements. Approved eye protection would be required with adequate supervision to ensure adherence to all safety requirements.

Mitigation of transportation accidents and fatalities would be accomplished through development of a comprehensive transportation plan that included safety regulations, training requirements, accident investigation, and adequate supervision.

To reduce impacts, transportation routes would be specified in the transportation plan.

6.4.7.3 Ambient Radiation

Several practical measures could be used to mitigate any adverse effects on ambient radiation during remedial action. For example, decontamination would be performed by experienced personnel using proper decontamination equipment and techniques. Personnel should be supervised to ensure that proper procedures are followed. Decontamination activities should be monitored and frequent quality assurance checks made to assure that the decontamination process is being conducted properly.

6.4.7.4 Air Quality

Air quality sampling should be initiated at appropriate on- and off-site areas before conducting remedial actions to establish a more definitive air quality baseline. The monitoring program should include sampling for radon, radiological particulates, and conventional dust before and during decontamination operations. Monitoring equipment should be placed at strategic locations near operation areas and at more distant locations.

Increases in air particulate concentrations during decontamination operations could be limited by keeping the working areas small, sprinkling with water, and curtailing operations during adverse weather conditions. Workers performing the decontamination activities may be required to wear approved protective gear to prevent inhalation of both radioactive particulates and dust.

6.4.7.5 Water Quality

Many of the mitigating measures applied to minimize erosion, as discussed in the following section, also apply to water quality. A monitoring program should be established to gauge impacts of the remedial actions on local surface and ground waters. Surface water samples for radiological analysis should be periodically collected from drainages leaving the site. Ground water samples should be collected from existing on-site monitoring wells.

6.4.7.6 Soils and Erosion

Standard construction practices should be used to isolate work areas and limit the total area of active disturbance. Sedimentation control measures (i.e., mulching, straw bale dikes, diversion ditches, and sedimentation basins) should be used to minimize erosion of contaminated soils to both on- and off-site areas. Periodic maintenance of erosion control structures will be required to ensure proper functioning.

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6.4.7.7 Nonrenewable Resources

Nonrenewable resources that would be used are primarily fill and fuel. Impacts on fill could be minimized by using poor-quality material rather than higher-quality topsoil. Minimizing the quantities of surface soil obtained by accurate excavation control could help to mitigate the quantity of fill used. Haul trucks could be carefully loaded to prevent spillage.

Fuel consumption could be mitigated by using properly tuned equipment driven at the most efficient speeds. Equipment could be carefully chosen and properly sized to minimize energy waste. Routes could be selected to minimize travel distances. Proper gear-shifting and reasonable acceleration are also mitigating measures in fuel use. Supervision to ensure adherence to such guidelines would contribute in minimizing impacts.

6.4.7.8 Ecology

Mitigation of ecological impacts from remedial actions at the Seaway site will be easy to effect because of the absence of endangered species and their habitats at the site. Proper contouring of the site should be accomplished. The disturbed areas should also be reseeded with grasses or other vegetation that will provide a rapid growth and a stabilizing effect on the soil. No other measures will be required.

6.4.7.9 Public Sentiment and Socioeconomics

A public relations program to inform the public and any special interest groups about the chosen remedial action and its impacts would help mitigate adverse public sentiment. Appropriate selection of transportation routes also would help minimize impacts to present transportation patterns.

Care would be taken to minimize interference with ongoing operations at the site, thereby helping to mitigate any economic impacts.

6.4.7.10 Land Use and Land Value

Care would be taken to minimize impacts on the site and surrounding area during the remedial action operations.

6.4.7.11 Noise

Appropriate measurements should be taken and standard safety equipment for worker protection provided. Noise levels are additive; consequently, reducing the number of loud equipment units would reduce noise levels. Contracts could require a decibel check of all equipment to ensure that noise levels meet Office of Safety and Health Administration (OSHA) standards. The OSHA standards allow longer exposure to lower decibel

sound. Also, it may be possible to locate loud equipment (i.e., compressors) at a distance to reduce noise. Supervisory personnel should be well versed on OSHA requirements and instructed to enforce them.

6.5 NONENVIRONMENTAL IMPACTS OF PROPOSED OPTIONS

In this section, the impacts on nonenvironmental factors from implementation of the proposed options are described. These factors are cost, future liability, and fulfillment of FUSRAP objectives.

6.5.1 Cost

There are no costs attributable to Option A since no remedial actions are implemented; consequently, no adverse impact results. Option B would be the least expensive due to low transportation costs and no disposal fees. Options C1, C2, D2, E1, and E2 represent a range of approximately $22,000,000 to $54,000,000, representing minor to moderately adverse impacts. Costs of Options D1, C3, and D3, ranging from approximately $65,000,000 to $87,000,000 were considered as severe impacts.

6.5.2 Future Liability

A minor adverse impact on future liability would result if Option A, the no action option, were implemented. On-site stabilization, Option B, would result in a moderately adverse impact on liability because following purchase of the site, the U.S. Government would be responsible for all hazards - radioactive and chemical - that are associated with the landfill. All decontamination and restoration options with interim storage, C1 through C3 and D1 through D3, would cause a slightly adverse impact on liability due to the interim storage. Direct disposal options E1 and E2 would be slightly beneficial due to immediate removal of any hazard from the site.

6.5.3 Fulfillment of FUSRAP Objectives

The FUSRAP objectives would not be fulfilled with Option A because the contamination would not be stabilized. The stabilization option, B, would not meet the requirement for unrestricted use and therefore is rated as moderately beneficial. All of the decontamination and restoration options (C1 through C3, D1 through D3, E1, and E2) meet the FUSRAP objectives and are considered as significantly beneficial.

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TABLE 6-1

SELECTED UNIT COSTS FOR SEAWAY REMEDIAL ACTIONS

Item	Unit	Cost ($)
Excavate and load contamination	yd^3 (0.76 m^3)	10.00
Security fence	ft (0.3 m)	15.00
Paving, asphaltic concrete	yd^2 (0.84 m^2)	14.50
Clay	yd^3 (0.76 m^3)	12.00
Sample analysis	each	125.00
Disposal charges, existing moderately distant facility	ft^3 (0.03 m^3)	8.00
Disposal charges, interim storage	ft^3 (0.03 m^3)	3.50
Disposal charges, existing distant facility	ft^3 (0.03 m^3)	2.00
Disposal charges, future state or regional facility	ft^3 (0.03 m^3)	15.00
Disposal charges, relaxed seabed	ft^3 (0.03 m^3)	3.00
Disposal charges, strict seabed	ft^3 (0.03 m^3)	20.00
Truck shipment/500 mi (800 km)	cwt (45 kg)	5.00
Rail haulage/1,000 mi (1,600 km)	cwt (45 kg)	8.50
Grade, compact, anchor, and place EPDM plastic sheet cover	yd^2 (0.84 m^2)	3.50
Plywood boxes, 4 x 7 x 4 ft (1 x 2 x 1 m)	each	225.00
Inventory, number, and mark boxes	each	1.25

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TABLE 6-2

ESTIMATED REQUIRED WORKING DAYS AND CREW SIZES

OPTION	NUMBER OF WORKING DAYS	AVERAGE CREW SIZE
A	-0-	-0-
B	88	20
C1	363	69
C2	363	69
C3	393	69
D1	440	69
D2	440	69
D3	470	69
E1	40	35
E2	45	35

TABLE 6-3

COST ESTIMATES (IN HUNDRED THOUSANDS OF DOLLARS - 1981)

Remedial Action Item	Remedial Action Option									
	A[a]	B	C1	C2	C3	D1	D2	D3	E1	E2
Survey and Mark Areas		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Base Clay, in Place		1.89	1.15	1.15	1.37					
Excavate and Load Contaminated Soil		6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
Haul Contaminated Soil, Final		0.62	86.85	86.85		88.36	88.36			
Place and Compact Contaminated Soil		0.62	0.62	0.62		0.62	0.62			
Cap Clay, in Place		2.14								
Security Fence		0.25	0.25	0.25	0.27					
Samples		1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88
Monitor and Sampling Fund		0.25	0.25	0.25	0.25					
Health Physics and Radiological Monitoring		0.88	3.63	3.63	3.93	4.40	4.40	4.70	0.40	0.45
Install EPDM Sheet			0.53	0.53	0.53	0.53	0.53	0.53		
Disposal Charges, Interim						58.31	58.31	64.80		

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TABLE 6-3 (Cont)

Remedial Action Item	Remedial Action Option									
	A[a]	B	C1	C2	C3	D1	D2	D3	E1	E2
Disposal Charges Final			259.61	51.92	370.27	265.07	53.01	370.27	133.27	33.32
Purchase Plywood Boxes					37.19			37.19		
Load and Haul Boxes, Total					86.84			86.54		
Stack Boxes					0.62			0.62		
Asphalt Concrete						3.26	3.26	3.26		
Haul Contaminated Soil, Interim						24.99	24.99	24.99		
Inventory, Number, and Mark Boxes					0.21			0.21		
Haul to Railroad and Dump									6.16	6.16
Load Train Cars									0.62	0.62
Train Shipment									141.60	325.68
Engineering		2.21	54.14	22.99	76.44	68.04	36.24	90.18	43.52	56.15
Contingency		4.41	108.28	45.98	152.87	136.08	72.47	180.36	87.04	112.30
TOTAL		21.37	523.41	222.26	738.89	657.76	350.28	871.74	420.71	542.77

(a) No action

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0 0 3 6 0 8

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CHAPTER 6 REFERENCES

1. "Program Management Plan"; Draft Report; Formerly Utilized Sites Remedial Action Program; Department of Energy; Oct 1980.

2. "Stability Concept and Method Tests Project, St. Louis Airport, St. Louis, Missouri"; Progress Report prepared for ORNL by Weston, Inc., West Chester, PA.

3. "Accident Facts - 1979"; National Safety Council; p. 23, 1980.

4. U.S. Department of Transportation, 10th Annual Report, Fiscal Year 1976; Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; (Stock No. 05-000-00137070).

5. Accident/Incident Bulletin No. 148 - Calendar Year 1979; U.S. Department of Transportation, Federal Railroad Administration, Office of Safety; July 1980.

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CHAPTER 7

EVALUATION OF PROPOSED OPTIONS

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EVALUATION OF PROPOSED OPTIONS

7.1 MATRIX COMPARISON

A matrix was developed to evaluate each of the proposed options by comparing the environmental and nonenvironmental parameters of each option. As shown in the matrix, Figure 7-1, the 16 individual parameters to be evaluated were placed horizontally above the columns of the matrix and the 10 proposed options were placed vertically beside the rows. The three nonenvironmental parameters (cost, future liability, fulfillment of FUSRAP objectives) were grouped into a block separate from the other parameters. The particular matrix in Figure 7-1 was designed to evaluate proposed options for the Seaway Industrial Park site and is uniquely applicable to this site. Therefore, no comparison should be made between this matrix and that of any other site.

7.1.1 Weighting Values

Weighting values have been assigned to each parameter. The weighting values provide a means by which the paramters are compared. Weighting values for the parameters represent a subjective evaluation, on a scale of 1 to 10, of the significance each parameter has compared with the other parameters.

Radiological health effects and transportation fatalities were assigned a weighting value of 10, indicating that an occurrence of cancer or an accidental fatality were judged to be the most serious potential environmental consequences. Fulfillment of FUSRAP objectives, a nonenvironmental parameter, also was judged highly important, and therefore was assigned a weighting value of 10.

Cost, public sentiment and socioeconomics, and future liability were each assigned a weighting value of 5. The significance of each of these parameters was considered major, but of less significance than parameters related to human life.

Remedial action accidents, transportation accidents, and ecology were assigned a weighting value of 4. Potential injuries and accidents were judged to be of lesser significance than the foregoing parameters.

Air quality, water quality, and soils and erosion were assigned a weighting value of 3 since the impacts of these parameters would tend not to be as severe as accidents.

Ambient radiation was assigned a weighting value of 2, as was land use and land value since the impacts of these parameters would tend to be limited to the site and immediate site

area. Finally, noise and nonrenewable resources were each assigned a weighting value of 1.

7.1.2 Parameter Ratings

A rating specific to each option was assigned to each of the parameters. This parameter rating was derived as follows: A parameter that was not impacted by a particular option was assigned a rating of zero. Benefits were designated by a positive sign (+) and adverse impacts were designated by a negative sign (-). The degree of the benefit or impact was indicated by numbers of from 1 to 4. The parameter ratings used were as follows:

(+4) Significant Benefit

(+3) Moderate Benefit

(+2) Minor Benefit

(+1) Slight Benefit

(0) No Impact

(-1) Slight Adverse Impact

(-2) Minor Adverse Impact

(-3) Moderate Adverse Impact

(-4) Significant Adverse Impact

7.1.2.1 Radiological Health Effects

A comparison of radiological health effects for various proposed options shows that the greatest negative impact is for Option A, No Action, where the risk could be as high as 2×10^{-3} health effects/yr. This slight adverse impact was given a rating of -1. Health effects of cleanup operations for all other options were so low as to be negligible. Cleanup would eliminate the radiological health effects and therefore would have a slight positive impact, or a rating of +1.

7.1.2.2 Remedial Action Accident

Incidents of possible accidents from remedial action construction work were calculated in Section 6.4. These potentials for all active options were considered as slight or minor. Options B, E1, and E2 were each assigned a rating of -1, and Options C1, C2, C3, D1, D2, and D3 were each assigned a rating of -2. Option A would have no accident potential and therefore was assigned a rating of zero.

7.1.2.3 Transportation Accidents

Matrix ratings were assigned to the transportation accidents parameter on the basis of the ton-mile (MT-km) of transportation. Option A would not involve transportation and was assigned a rating of zero. All the active options were considered as having adverse impacts, as explained in Section 6.4. Options C1, C2, C3, D1, D2, D3, and E2 were assigned a rating of -2. Option E1 was rated at a -1 since the shorter rail haul distance would result in fewer accidents than the longer rail haul distance of Option E2. Option B was assigned a rating of zero.

7.1.2.4 Transportation Fatalities

Zero ratings were assigned to the transportation fatalities parameter in Options A, B, and E1 because the analysis showed impacts were negligible in these cases. The remaining options were assigned a -1 rating because there were only 0.11 up to 0.38 statistically projected transportation fatalities.

7.1.2.5 Ambient Radiation

Ambient radiation in Option A would have a slight adverse impact that would last for many years. Option A therefore was assigned a rating of -1. Cleanup operations in the remaining proposed options would increase the ambient radiation in the immediate vicinity for a short time, but after completion of remedial actions ambient radiation would be reduced to natural background levels. This would be a slight positive impact at the site. Therefore, a rating of +1 was assigned to all options except Option A.

7.1.2.6 Air Quality

Air quality is currently slightly adversely impacted by the presence of contaminated materials. Therefore, air quality under Option A was assigned a rating of -1. There would be a small adverse impact during actual cleanup operations. This adverse impact, however, would be temporary. After cleanup, air quality would return to the condition that existed prior to site contamination by radioactive materials. Therefore, over the long term, the impact of remedial action measures would be slightly beneficial. Consequently, all options except Option A were assigned a rating of +1.

7.1.2.7 Water Quality

No measurable impact on water quality is currently detectable at the site. However, contamination of locally perched bodies of ground water may be occurring. This condition probably would continue under Option A, resulting in a slightly adverse impact. Water quality under Option A therefore was assigned a rating of -1. Implementation of the remaining

options would result in the removal of all potential for off-site contamination. Removing this potential for contamination may result in a slightly beneficial impact on water quality. Therefore, for all options exept Option A a rating of +1 was assigned.

7.1.2.8 Soils and Erosion

The volume of contaminated soil is increasing at a very slow rate through the mechanisms of leaching and erosion. These processes should continue in the future under Option A, resulting in a slightly adverse impact. Thus a rating of -1 was assigned to Option A. Implementation of the remaining options would result in removal of all potential for future off-site contamination. Consequently, this slightly beneficial impact on soils and erosion was assigned a +1 rating for all options except Option A.

7.1.2.9 Nonrenewable Resources

Option A would consume no resources and therefore would create no impacts. A zero rating therefore was assigned to Option A.

Fill amounts and fill haul distances would be the same for all active options. Fuel consumption, however, would not be equal because of the different haul distances. Options C1 - C3 would have similar minor adverse haul distances, and were assigned a rating of -2. Options D1, D2 and D3 would have longer haul distances, and therefore were assigned a rating of -3. Fuel consumption has been used as the discriminator since the other nonrenewable required resources would be about equal for all options.

Options E1 and E2 involve significantly greater distances than the other options, and rail haulage is projected. Rail haul uses less fuel per ton-mile. Option E1 therefore was assigned a rating of -2. The greater distance of 2,300 mi (3,700 km) in Option E2, however, was assigned a rating of -4.

7.1.2.10 Ecology

Option A was assigned a rating of zero because it would produce negligible impacts. There would be slight adverse ecological impacts in the short term with the remaining options. These options, therefore, were assigned a rating of -1.

7.1.2.11 Public Sentiment and Socioeconomics

Since the site likely would remain restricted as a result of nonradiological health hazards associated with the sanitary landfill, the no action option A was assigned a rating of zero. Since public opinion probably would favor a cleanup of

radiological materials at the site. Options B, C1, D1, D1, and E2 were given positive ratings. Option D1 was assigned a rating of +1 since public opinion could be opposed to the establishment of a new interim storage facility, especially near a chosen storage location. Options B and C1 were assigned a slightly higher rating of +2, since off-site interim storage would not be involved. Option E2 was assigned a higher rating (+3) than B and C1 because it would not require the establishment of a state or regional disposal facility, which would probably be viewed negatively by the public. Option E1, involving immediate cleanup of all contamination on the site, would not require the establishment of a state or regional disposal facility, nor would it require transportation of contaminated soils as far as in Option E2. Option E1, therefore, was rated +4.

Options C2, C3, D2, and D3 probably would be viewed negatively judging by past public sentiment. Also, seabed disposal would have international political ramifications. For these reasons, these options were assigned negative ratings. Options C2 and D2 were assigned a -4. Options C3 and D3 were assigned -3 rating since seabed disposal under strict regulatory controls probably would be viewed somewhat more positively.

In arriving at the matrix ratings it was felt that variability in benefits to the local economy would be far outweighed by the effects of public sentiment, and that long-term impacts would outweigh the short-term impact on the socioeconomic climate.

7.1.2.12 Land Use and Land Value

The current condition of the site has a minor adverse effect on the potential land use and has the potential of similarly affecting land value at the site. Consequently, Option A was assigned a minor adverse impact rating of -2. Under Option B, the contamination would be consolidated, resulting in smaller areas of the site being affected; therefore, this option was assigned a slight adverse impact rating of -1. Although there might be some short-term adverse impacts during the remedial actions, all options would result finally in complete release of the site for any future use and the elimination of the potential of adverse effects on land value. For this reason the remaining options were viewed as resulting in a minor beneficial impact and were each assigned a rating of +2.

7.1.2.13 Noise

Since there is no noise impact created by the contamination, Option A was rated zero. While there would be no adverse impact at the close of operations, there would be some short-term adverse impacts during operations. This could lead to the long-term impairment of someone's hearing. With proper mitigation of noise it was felt that there would be no more than

a slight potential adverse impact, and a rating of -1 was assigned all options except Option A.

7.1.2.14 Cost of Options

There would be no costs attributable to Option A since no remedial actions would be implemented; consequently, Option A was assigned a rating of zero. Option B would be the least expensive ($2,137,000) active option as a result of transportation costs and no disposal fees, and was therefore rated -1. Option C2 ($22,226,000) was rated -2 because it would be more than a slightly adverse impact. Options C1, D2, E1, and E2 were rated -3 because they were in the middle of the cost range. Options D1, D3, and C3 reflected the high end of the range and were rated -4.

7.1.2.15 Future Liability

Option A was rated -2 because of the minor chance that a future problem could result from the contaminated materials not being stabilized. Option B was rated -3 because the Federal Government would have to assume liability for any toxic substances (chemical or radiological) migrating from the site. The decontamination and restoration options utilizing interim storage (C1, C2, C3, D1, D2 and D3) could entail liability for the interim time period, and therefore were rated -1. The direct disposal Options E1 and E2 would result in removal of future liability, and therefore were rated +1.

7.1.2.16 Fulfillment of FUSRAP Objectives

Option A would not meet any of the FUSRAP objectives and consequently was rated zero. Option B would meet most objectives but would not allow future unrestricted use. Therefore, Option B was assigned a +3 rating. All decontamination and restoration options (C1, C2, C3, D1, D2, D3, E1, and E2) would meet FUSRAP objectives and were assigned a +4 rating.

7.1.3 Weighted Points

The weighted points for each parameter were obtained by multiplying the weighted value at the top of each column by the parameter rating.

7.1.4 Total Weighted Points

The weighted points total and the environmental weighted points are shown in the two rightmost columns in Figure 7-1, and are given below in descending order with the most beneficial options listed first.

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Options	Weighted Points	Options	Environmental Weighted Points
E1	+60	E1	+30
E2	+39	B	+18
B	+28	E2	+9
C1	+22	C1	+2
D1	+11	D1	-4
C2	-3	C3	-23
C3	-8	D3	-24
D2	-9	A	-25
D3	-9	C2	-28
A	-35	D2	-29

It should be recognized that the totals represent subjective as well as objective evaluations, and consequently cannot be regarded as "absolute" values. For example, a weighted points total of -50 should not be assumed to have negative impacts 5 times more severe than a weighted points total of -10.

7.2 SELECTION OF RECOMMENDED OPTION

The degree to which the environmental and nonenvironmental parameters were either adversely affected or benefited at the Seaway Industrial Park site was numerically evaluated in the matrix shown in Figure 7-1. The weighted points total and the environmental weighted points total values shown in the matrix, and noted in Subsection 7.1.4, were used in a relative comparison between the ten proposed options.

7.2.1 Recommended Option

A case could be made for selection of Option B, based on considerations in addition to parameters evaluated in the matrix. For example, the stabilization plan proposed in Option B incorporates engineering specifications adequate to ensure stabilization of high specific activity uranium tailings. However, since the residues measured at the Seaway Industrial Park site are characterized by low specific activity, the engineering plans for the stabilization option may be overly conservative. Despite the adequacy of stabilization the public probably would continue to view Option B more negatively than

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Option E1, which proposes direct disposal at an existing moderately distant facility. Also, Option B would result in greater restrictions on land use than Option E1, because structures could not be built on the stabilized residues. However, structures most likely would be restricted from being built on the site since it is a sanitary landfill. Therefore, restrictions on the use of site land are not as severely impacted in the stabilization Option B as the fulfillment of future FUSRAP objectives parameter rating indicates.

All parameters considered, the recommended option is Option E1, Decontamination and Restoration with Direct Disposal at an Existing Moderately Distant Facility.

7.2.2 Environmentally Preferred Option

Based on the overall evaluation of the 13 environmental parameters shown in the matrix in Figure 7-1, Option E1 is the environmentally preferred option. As explained in Subsection 7.2.1, this option also is the recommended option. The greatest advantages of Option E1 over the options (considering only environmental parameters) are the lesser adverse public sentiment and the fewer land use restrictions offered by Option E1.

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Remedial Action Option	Weighting Value	10	4	4	10	2	3	3	3	1	4	5	2	1	5	5	10		
	Parameter	Public Health & Safety	Regional Social Attitudes	Transport Accident	Transport Facilities	Ambient Radiation	Air Quality	Water Quality	Soils Erosion	Maintenance Requirements	Reliability	Public Statement and Political Impacts	Feasible and Constructible	Noise	Cost	Future Liability	Enforcement Schedule Implications		
A No Action		(-1) -10	(0) 0	(0) 0	(0) 0	(-1) -2	(-1) -3	(-1) -3	(-1) -3	(0) 0	(0) 0	(0) 0	(-2) -4	(0) 0	(0) 0	(-2) -10	(0) 0	-35	-25
B On Site Stabilization		(+1) 10	(-1) -4	(0) 0	(0) 0	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-2) -2	(-1) -4	(+2) +10	(-1) -2	(-1) -1	(-1) -5	(-3) -15	(+3) +30	+28	+18
C1 Decontamination and Restoration Interim On Site Storage Final Disposal at a State or Regional Facility		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-2) -2	(-1) -4	(+2) +10	(+2) +4	(-1) -1	(-3) -15	(-1) -5	(+4) +40	+22	+2
C2 Decontamination and Restoration Interim On Site Storage Final Disposal at Relaxed Seaway		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-2) -2	(-1) -4	(-4) -20	(+2) +4	(-1) -1	(-2) -10	(-1) -5	(+4) +40	-3	-28
C3 Decontamination and Restoration Interim On Site Storage Final Disposal at Stringent Seaway		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-2) -2	(-1) -4	(-3) -15	(+2) +4	(-1) -1	(-4) -20	(-1) -5	(+4) +40	-8	-23
D1 Decontamination and Restoration Interim Off Site Storage Final Disposal at a State or Regional Facility		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-3) -3	(-1) -4	(+1) +5	(+2) +4	(-1) -1	(-4) -20	(-1) -5	(+4) +40	+11	-4
D2 Decontamination and Restoration Interim Off Site Storage Final Disposal at Relaxed Seaway		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-3) -3	(-1) -4	(-4) -20	(+2) +4	(-1) -1	(-3) -15	(-1) -5	(+4) +40	-9	-29
D3 Decontamination and Restoration Interim Off Site Storage Final at Stringent Seaway		(+1) 10	(-2) -8	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-3) -3	(-1) -4	(-3) -15	(+2) +4	(-1) -1	(-4) -20	(-1) -5	(+4) +40	-9	-24
E1 Decontamination and Restoration with Direct Disposal at a Moderately Distant Facility		(+1) 10	(-1) -4	(-1) -4	(0) 0	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-2) -2	(-1) -4	(+4) +20	(+2) +4	(-1) -1	(-3) -15	(+1) +5	(+4) +40	+60	+30
E2 Decontamination and Restoration with Direct Disposal at a Distant Facility		(+1) 10	(-1) -4	(-2) -8	(-1) -10	(+1) +2	(+1) +3	(+1) +3	(+1) +3	(-4) -4	(-1) -4	(+3) +15	(+2) +4	(-1) -1	(-3) -15	(+1) +5	(+4) +40	+39	+9

LEGEND

(+1) — PARAMETER RATING
+20 — WEIGHTED POINTS (PARAMETER RATING x WEIGHTING VALUE)

-4 SIGNIFICANT ADVERSE IMPACT
-3 MODERATE ADVERSE IMPACT
-2 MINOR ADVERSE IMPACT
-1 SLIGHT ADVERSE IMPACT

0 NO IMPACT
+1 SLIGHT BENEFIT
+2 MINOR BENEFIT
+3 MODERATE BENEFIT
+4 SIGNIFICANT BENEFIT

*TOTALS ARE PROVIDED ONLY FOR A RELATIVE COMPARISON OF OPTIONS. DIFFERENCES BETWEEN TOTALS ARE NOT INTENDED TO BE ABSOLUTE.

FIGURE 7-1. SEAWAY INDUSTRIAL PARK SITE EVALUATION MATRIX

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SEAWAY INDUSTRIAL PARK SITE

GLOSSARY

SEAWAY INDUSTRIAL PARK SITE 137629

GLOSSARY

Abbreviations/Terms	Definitions
AEC	Atomic Energy Commission
alpha particle (α)	A positively charged particle emitted from certain radioactive material. It consists of two protons and two neutrons, hence is identical with the nucleus of the helium atom. It is the least penetrating of the common radiation (α, β, γ), hence is not dangerous unless alpha-emitting substances have entered the body.
aquiclude	A formation that will not transmit water fast enough to furnish enough supply for a well or spring.
aquifer	A water-bearing formation below the surface of the earth; the source of wells
ASEV	Assistant Secretary for Environment
ASNE	Assistant Secretary for Nuclear Energy
background radiation	Naturally occurring low-level radiation to which all life is exposed. Background radiation levels vary from place to place on the earth.
BAQS	Bureau of Air Quality Surveillance
beta particle (β)	A particle emitted from some atoms undergoing radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation can

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	cause skin burns and beta emitters are harmful if they enter the body.
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Ci	Curie (the unit of radioactivity of any nuclide, defined as precisely equal to 3.7×10^{10} disintegrations/second)
C-T ore	Columbian (niobium) - tantalum ore
cwt	Hundred weight; 100 pounds, or 45.36 kilograms
daughter product	The nuclide remaining after a radioactive atom (parent) has undergone radiaoctive decay. A daughter atom also may be radioactive, producing further daughter products.
dBA	Sound pressure level weighting in a given frequency range; a measure of hearing damage potential, annoyance, and other factors associated with noise exposure.
DOE	Department of Energy
DOT	Department of Transportation
dpm	Disintegrations per minute
EGR	External gamma radiation (gamma radiation emitted from a source(s) external to the body, as opposed to internal gamma radiation emitted from ingested or inhaled sources)
EPA	Environmental Protection Agency

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EPDM	Ethylene Propoylene Dienemonomer: a heavy gauge synthetic liner used in resevoirs.
ERDA	Energy Research and Development Administration
exposure	Magnitude of radiation to which a person is subjected. It is defined and measured by electrical charge produced per unit mass of air.
FACE	Federally Assisted Code Enforcement
FB&DU	Ford, Bacon & Davis Utah Inc.
FUSRAP	Formerly Utilized MED/AEC Sites Remedial Action Program
gamma background	Natural gamma ray activity everywhere present, originating from two sources: (1) cosmic radiation, bombarding the earth's atmosphere continually, and (2) terrestrial radiation. Whole body absorbed dose equivalent in the U.S. due to natural gamma background ranges from about 60 to about 125 mrem/yr.
gamma ray (γ)	High energy electromagnetic radiation emitted from the nucleus of a radioactive atom, with specific energies for the atoms of different elements and having high penetrating power
ground water	Subsurface water in the zone of full saturation which supplies wells and springs
ha	Hectare; 10,000 square meters. A hectare is equal to 2.471 acres.

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half-life	The period of time required for one half of the original amount of a radioisotope to decay into a daughter product.
health effect	Adverse physiological response to pollutants from radioactive materials. In this report, one health effect is defined as one death resulting from cancer caused by exposure to radiation.
ICC	Interstate Commerce Commission
kg	Kilogram (10^3 grams), which is equal to 2.2046 pounds
km	Kilometer (10^3 meters), which is equal to 0.62137 miles
l	Liter, which is equal to 1.0567 quarts
LANL	Los Alamos National Laboratory
m	Meter, which is equal to 39.37 inches or 1.09 yards
m^2	Square meter, which is equal to 1.196 square yards, or 10.764 square feet
m^3	Cubic meter, which is equal to 1.3079 cubic yards, or 35.314 cubic feet
μR/hr	Microroentgen per hour (10^{-6} μR/hr)
mR/hr	Milliroentgen per hour (10^{-3} μR/hr)
MED	Manhattan Engineering District

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mg	Milligram (10^{-3} grams), which is equal to 0.0154 grains
mi	Mile, which is equal to 1.6 kilometers
MPC	Maximum permissible concentration (the highest concentration in air or water of a particular radionuclide permissible for occupational or general exposure without taking steps to reduce exposure)
MSD	Metropolitan St. Louis Sewer District
MT	Metric ton, which is equal to 2204.6 pounds or 1.1 tons
National Interim Primary Drinking Water Regulations	Title No. 40 of the Code of Federal Regulations, EPA Chapter 1, Part 141, dated July 9, 1976.
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
nuclide	A general term applicable to all atomic forms of the elements; nuclides comprise all the isotopic forms of all the elements. Nuclides are distinguished by their atomic number, atomic mass, and energy state.
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
pCi/l	Picocurie per liter (10^{-12} Ci/l)
R	Roentgen (a unit of exposure to ionizing radiation. It

is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of electrical charge, either positive or negative, in 1 cm^3 of dry air under standard conditions numerically equal to 2.58×10^{-4} coulombs/kg)

rad — The basic unit of absorbed dose of ionizing radiation. A dose of one rad means the absorption of 100 ergs of radiation energy per gram of absorbing material.

radioactivity — The spontaneous decay or disintegration of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation

radioactive decay chain — A succession of nuclides, each of which transforms by radioactive disintegration into the next, until a stable nuclide results. The first member is called the parent, the intermediate members are called daughters, and the final stable member is called the end product.

radium — A radioactive element chemically similar to barium, formed as a daughter product of uranium (^{238}U). The most common isotope of radium, ^{226}Ra, has a half-life of 1,600 yr. Radium is present in all uranium-bearing ores. Trace quantities of both uranium and radium are found in all areas, contributing to the gamma background.

radon — A radioactive, chemically inert gas, having a half-life of 3.8 days (^{222}Rn); formed as a

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	daughter product of radium (^{226}Ra)
radon background	Low levels of radon gas found in an area, due to the presence of uranium or radium in the soil
radon daughter	One of several short-lived radioactive daughter products of radon (Several of the daughters emit alpha particles.)
RAPO	Remedial Action Programs Office; also "ORAP"
RDC	Radon daughter concentration (the concentration in air of short-lived radon daughters, expressed usually in pCi/l; also measured in terms of working level (WL))
rem	Roentgen equivalent man. The unit of dose for any ionizing radiation which produces the same biological effect as a unit of absorbed dose of ordinary X-rays, numerically equal to the absorbed dose in rads multiplied by the appropriate quality factor for the type of radiation. The rem is the basic recorded unit of accumulated dose to personnel.
SMSA	Standard Metropolitan Statistical Area
SPC	State Planning Council
WL	Working level. A unit of radon daughter exposure, equal to any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy based on 170 hr of exposure per man. This level is equivalent to the

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energy produced in the decay of the daughter products that are present under equilibrium conditions in a liter of air containing 100 pCi of ^{222}Rn. It does not include decay of ^{210}Pb (22 yr half-life) and subsequent daughter products.

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APPENDIX A

FIGURES AND TABLES
FROM THE ORNL
RADIOLOGICAL SURVEY OF THE
SEAWAY INDUSTRIAL PARK, TONAWANDA, NEW YORK

HEALTH AND SAFETY RESEARCH DIVISION
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

Table 1. Results[a] of water sample analyses

Sample	^{226}Ra	^{234}U	^{235}U	^{238}U	^{228}Th	^{230}Th	^{232}Th
W1	4.0×10^{-4}	2.8×10^{-2}	1.5×10^{-3}	2.8×10^{-2}	3.9×10^{-4}	1.8×10^{-4}	7.2×10^{-5}
W2	1.0×10^{-3}	2.0×10^{-2}	1.0×10^{-3}	2.0×10^{-2}	3.7×10^{-4}	9.0×10^{-5}	$\leq4.0\times10^{-5}$
W3	6.3×10^{-3}	4.1×10^{-3}	3.4×10^{-4}	4.2×10^{-3}	3.6×10^{-4}	7.6×10^{-5}	1.1×10^{-4}
W6	1.6×10^{-3}	4.1×10^{-2}	1.3×10^{-2}	5.3×10^{-2}	3.2×10^{-4}	9.0×10^{-4}	6.8×10^{-5}
W7	9.0×10^{-4}	1.0×10^{-2}	4.4×10^{-4}	1.0×10^{-2}	3.0×10^{-4}	1.4×10^{-4}	$\leq3.0\times10^{-5}$
W8	5.8×10^{-4}	4.0×10^{-2}	1.4×10^{-3}	3.9×10^{-2}	3.7×10^{-4}	1.1×10^{-4}	4.1×10^{-5}
W9	8.0×10^{-4}	5.0×10^{-2}	2.1×10^{-3}	5.0×10^{-2}	3.2×10^{-4}	8.6×10^{-5}	$\leq3.0\times10^{-5}$
W10	1.1×10^{-3}	1.4×10^{-2}	7.6×10^{-4}	1.1×10^{-2}	3.2×10^{-4}	7.2×10^{-5}	$<3.0\times10^{-5}$
MPC[a] (Soluble)	3×10^{-2}	30	30	40	7	2	2

[a]Concentrations given in μCi/ml.

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Table 2. Radium concentrations[a] in the soil

Sample[b]	Depth (ft)	^{226}Ra	Sample	Depth (ft)	^{226}Ra
2-1	0-1	16.2	13-1	0-1	12.4
2-2	1-2	8.2	13-2	1-2	17.3
2-3	2-4	12.8	13-3	2-3	30.6
2-4	4.5-5.5	1.1	13-4	3-4	20.8
2-5	5.5-6.5	0.8	14-1	0-2	9.9
3-1	0-1	27.8	14-2	2-3	1.7
3-2	1-2	9.0	15-1	0-1	1.0
3-3	2-4	1.3	15-2	1-2	0.8
4-1	0-1	3.3	16-1	0-1	17.9
4-2	1-2	3.0	16-2	1-2	1.4
4-3	2-4	8.2	17-1	0-1	40.5
5-1	0-2	1.6	17-2	1-2	1.0
6-2	1-2	1.0	18-1	0-1	15.0
6-3	2-4	7.3	18-2	1-2	1.9
9-1	0-1	32.0	19-1	0-1	11.5
9-2	1-2	1.5	19-2	1-2	1.3
10-1	0-1	40.9	22-1	0-1	1.2
10-2	1-2	1.2	24-1	0-1	1.3
11-1	0-2	20.5	24-4	4-4.5	1.8
11-2	2-3	1.3	25-1	0-1	3.3
12-1	0-2	6.3	25-3	2-3	4.4
			25-7	Surface	8.0

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Table 2. (cont'd.) Radium concentrations[a] in the soil

Sample[b]	Depth (ft)	^{226}Ra	Sample	Depth (ft)	^{226}Ra
26-1	0-1.5	7.8	45-1	0-1	18.0
28-1	0-1	1.4	45-2	Surface	5.2
29-1	0-2	7.5	47-1	0-1	5.4
30-1	0-1	21.2	47-2	1-2	6.1
30-2	1-2	1.3	47-3	2-3	3.6
31-1	0-1	50.8	47-4	3-4	2.6
31-2	1-2	50.2	47-5	4-5	3.5
32-1		17.8	47-6	5-6	4.5
32-2	1-2	2.9	48-1	0-1.5	32.3
33-1	0-1	4.8	52-1	0-1	8.8
33-2	1-2	0.43	52-2	1-2	4.5
34-1	0-1	2.0	53-1	0-1	32.6
34-2	1-2	7.4	53-2	1-2	1.5
36-1	0-1	1.3	54-1	0-1	10.7
37-1	0-0.5	6.0	54-1	1-2	7.8
38-1	0-0.5	9.4	55-1	0-1	5.6
39-1	0-1	20.2	55-2	1-2	8.2
40-1	0-0.5	22.5	61-1	0-1	11.1
40-2	0.5-1.0	1.8	61-2	1-2	2.5
41-1	0-0.5	3.7	62-1	0-1	4.1
43-1	0-0.5	9.9	63-1	0-1	20.8
44-1	0-0.5	18.7	64A-1	0-1	11.7
			64A-2	1-2	15.1
			64P	0-2	35.6

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Table 2. (cont'd.) Radium concentrations[a] in the soil

Sample	Depth (ft)	^{226}Ra	Sample	Depth (ft)	^{226}Ra
65P	0-1	23.1	77-1	0-1	1.0
66-1	0-1.5	13.0	77-2	1-2	1.0
67-1	0-1	7.2	79-1	0-1	22.2
68-1	0-1	5.8	80-1	0-0.5	3.6
70-1	0-0.5	2.6	80-P1	0-1	92.6
72-1	0-1	3.4	80-P2	1-2	71.7
72-2	1-2	1.9	81-2	1-2	1.0
75-1	0-1	24.6	82-1	0-1	6.5
76P	Surface	5.9	82-2	1-2	1.1
			82-3	2-3	40.0

[a]Measurements given in pCi/g.

[b]The first number in the sample designation refers to the sample location (see Figs. 4 and 5).

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Table 3. Concentrations[a] of ^{238}U in selected samples

Sample[b]	^{238}U (pCi/g)
3-1	63.0
5-1	2.9
11-1	17.0
13-1	40.0
28-1	2.5
30-2	2.8
31-2	56.0
33-1	2.4
34-1	4.3
36-1	4.2
47-3	3.5
48-1	44.0
53-1	46.0
63-1	34.0
65P	21.0
66-1	12.0
68-1	12.0
77-1	2.5
79-1	N.F.
80-P2	102
82-3	59.0

[a]Radium concentrations and depth of these samples are given in Table 2.

[b]The first number in the sample name refers to the sample location (see Figs. 4 and 5).

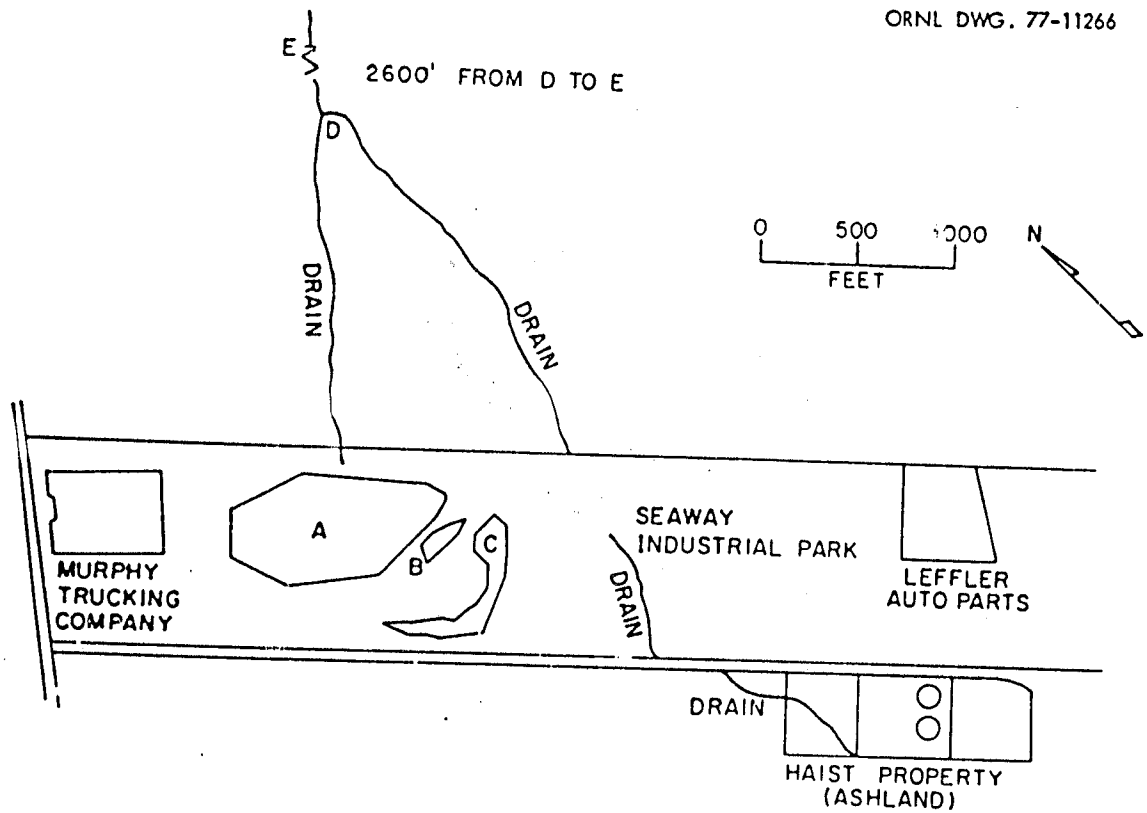

Fig. 1. Plan view of Seaway Industrial Park showing three areas (A, B, C) where radioactive residues were dumped.

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0 0 3 6 3 6

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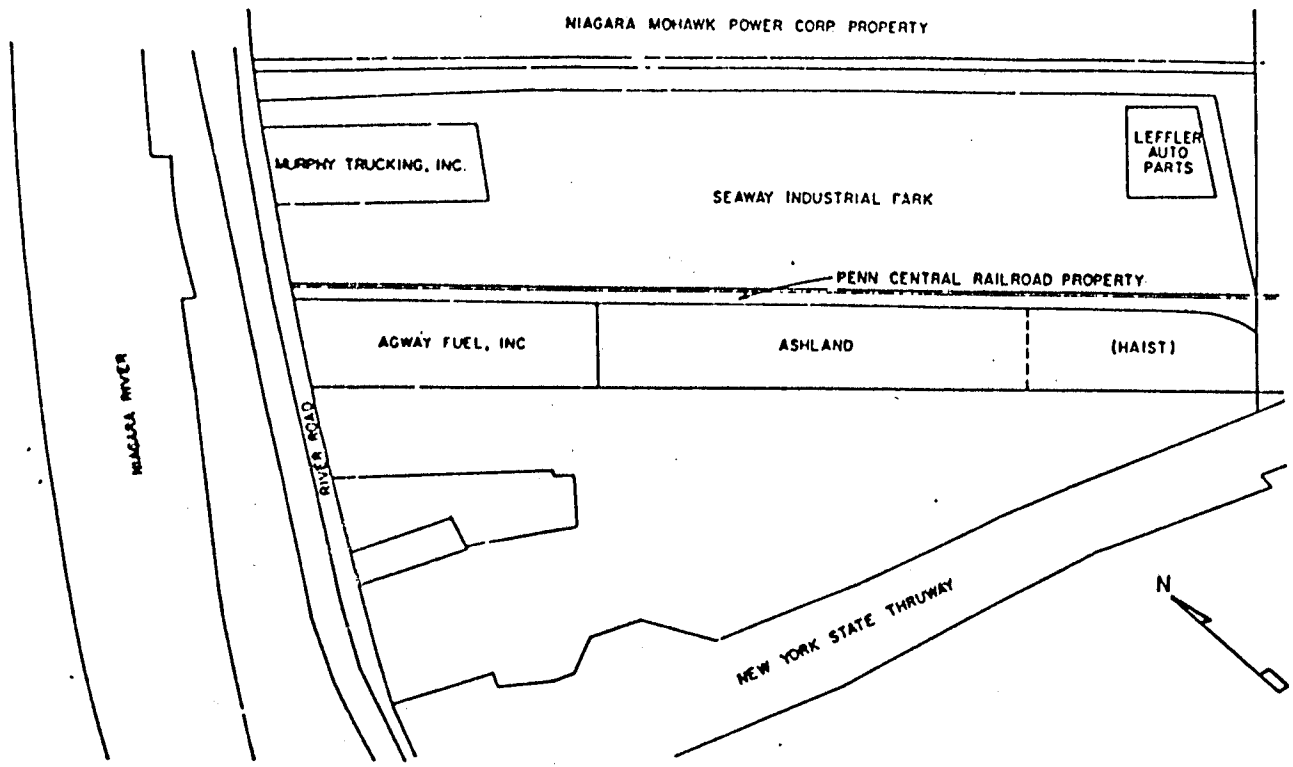

Fig. 2. Seaway Industrial Park and surrounding area.

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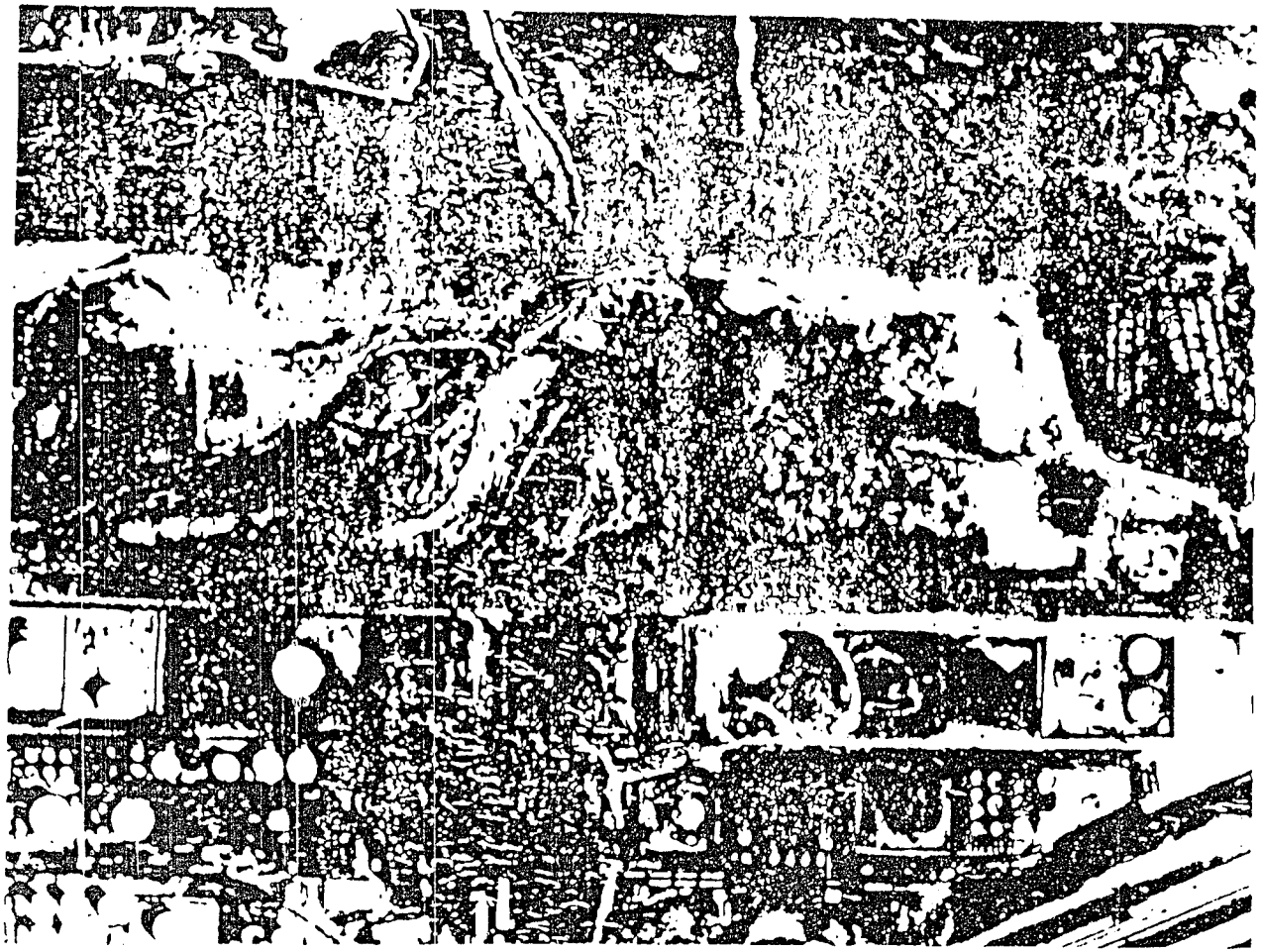

Fig. 3. Aerial photograph of Seasay and surrounding area.

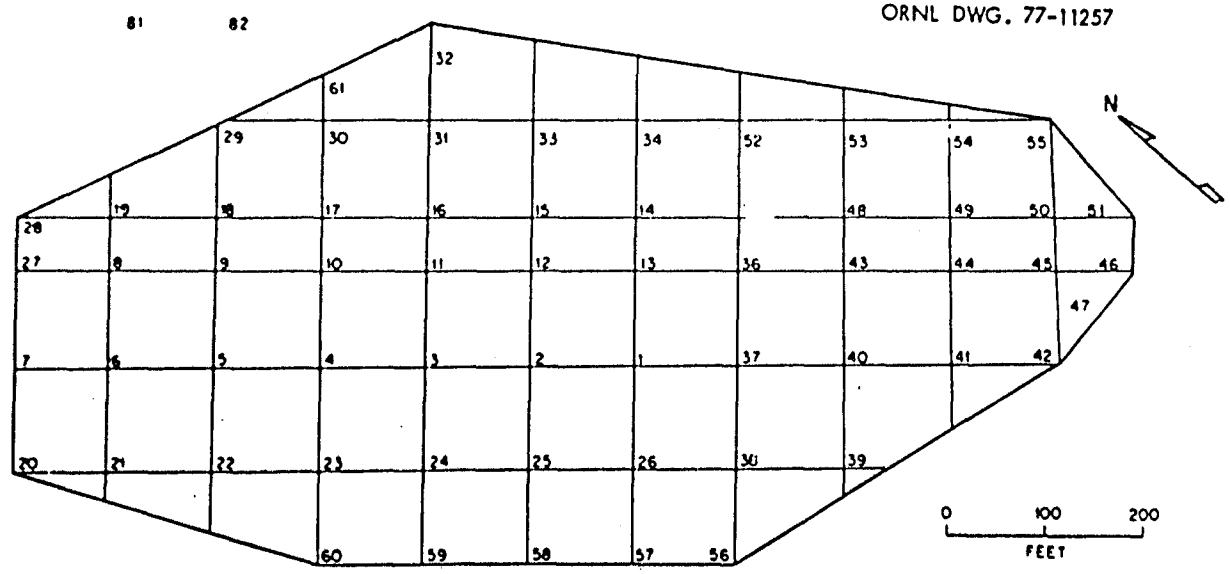

Fig. 4. Points on and near area of known contamination at which measurements were taken (Area A).

1 3 7 5 2 9

0 0 3 6 3 9

ORNL-DWG 76-19879

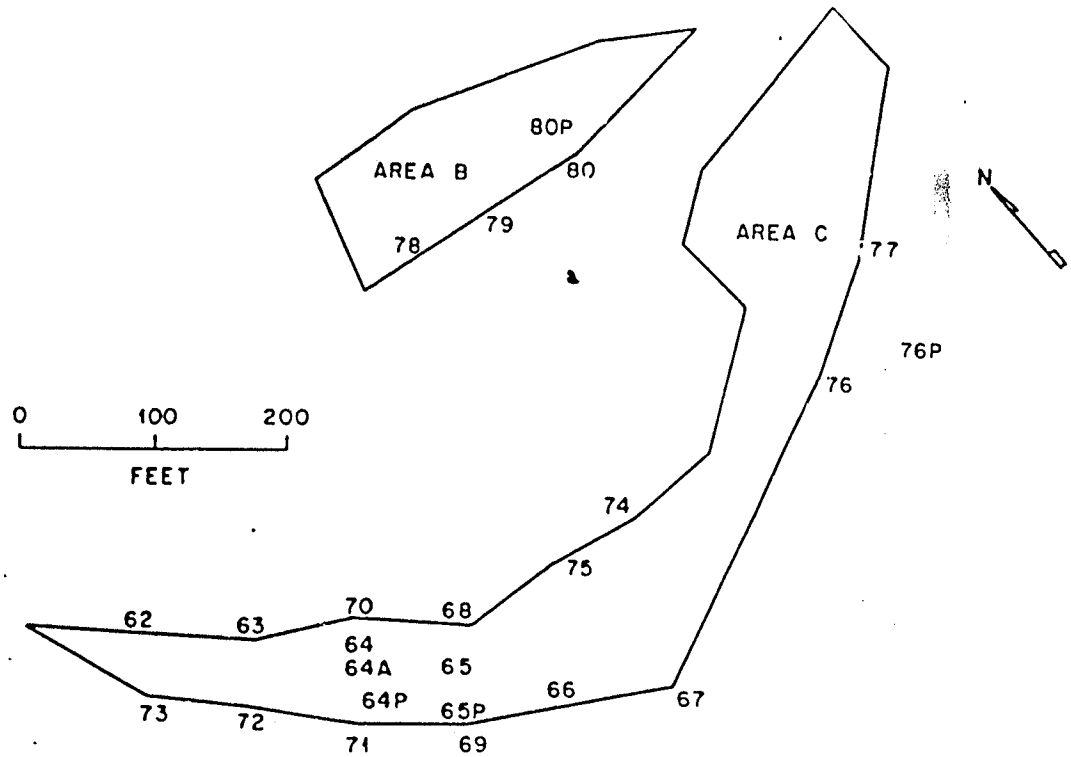

Fig. 5. Points on and near area of known contamination at which measurements were taken (Areas B and C).

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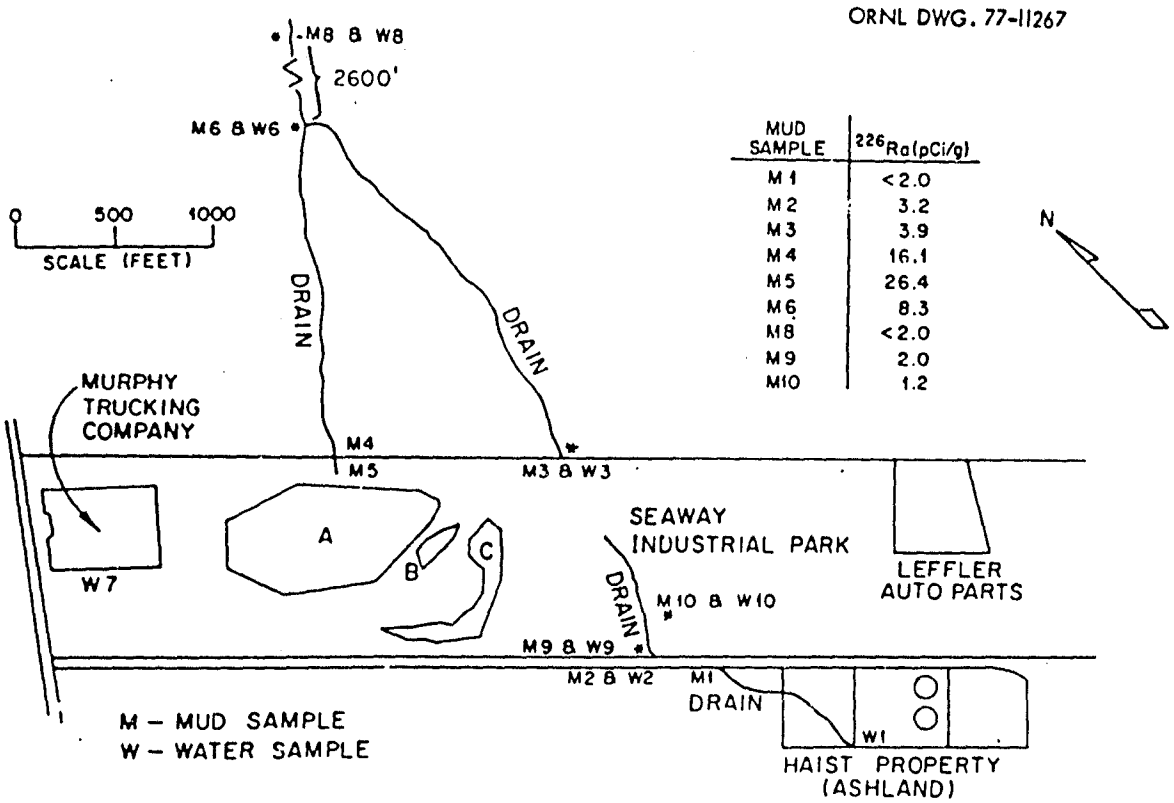
0 0 3 6 4 0



MUD SAMPLE	^{226}Ra (pCi/g)
M1	<2.0
M2	3.2
M3	3.9
M4	16.1
M5	26.4
M6	8.3
M8	<2.0
M9	2.0
M10	1.2

Fig. 6. Locations of water and mud samples and concentrations of ^{226}Ra in mud samples (pCi/g).

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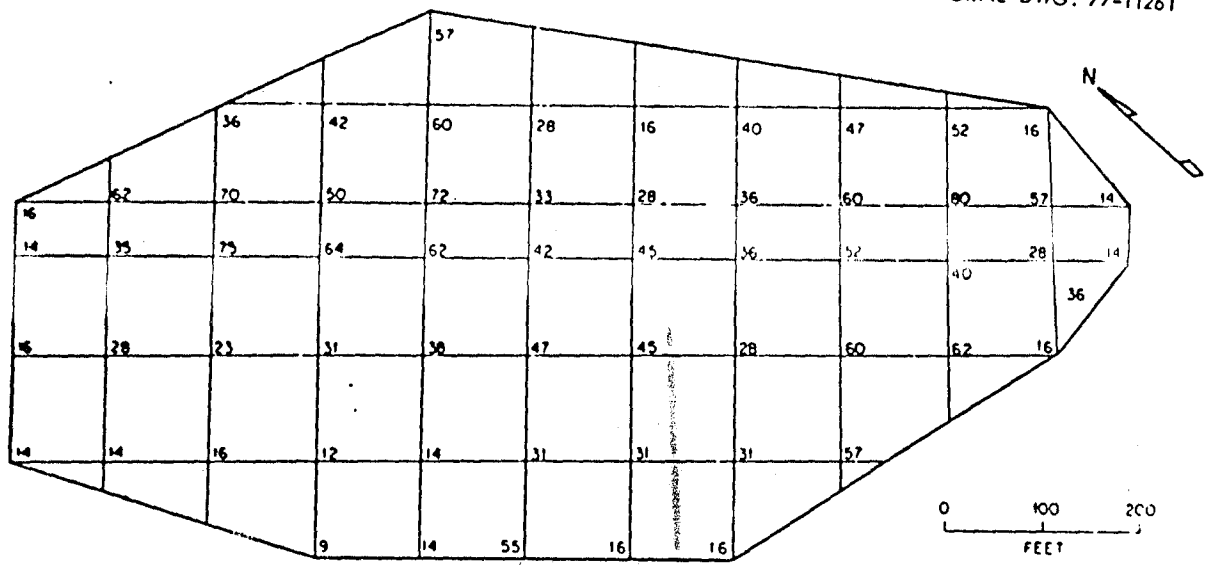

Fig. 7. External gamma radiation levels (in μR/hr) at 1 m above surface (Area A).

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0 0 3 6 4 2

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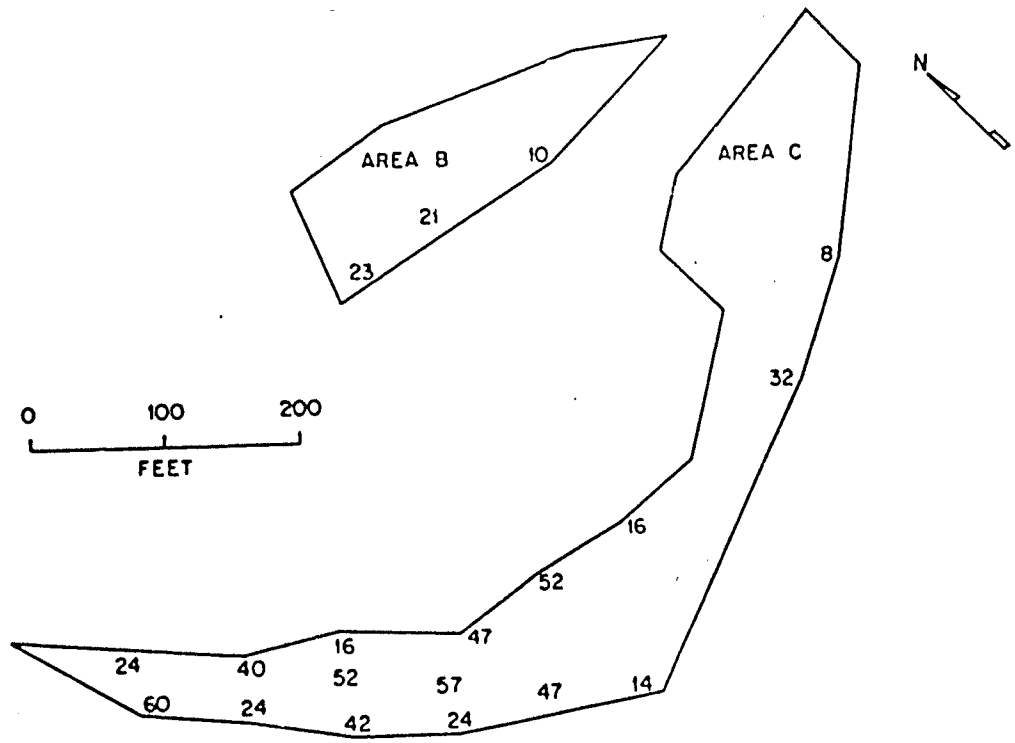

Fig. 8. External gamma radiation levels (in μR/hr) at 1 m above surface (Areas B and C).

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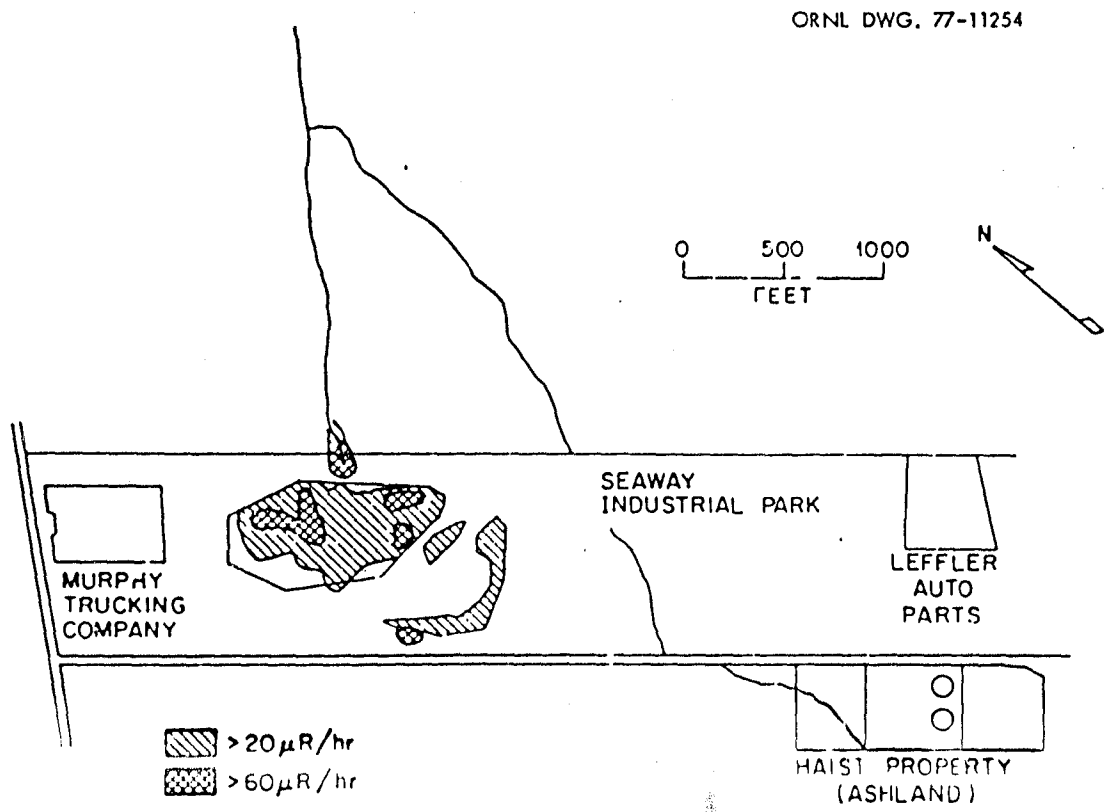

Fig. 9. Area of elevated external gamma radiation.

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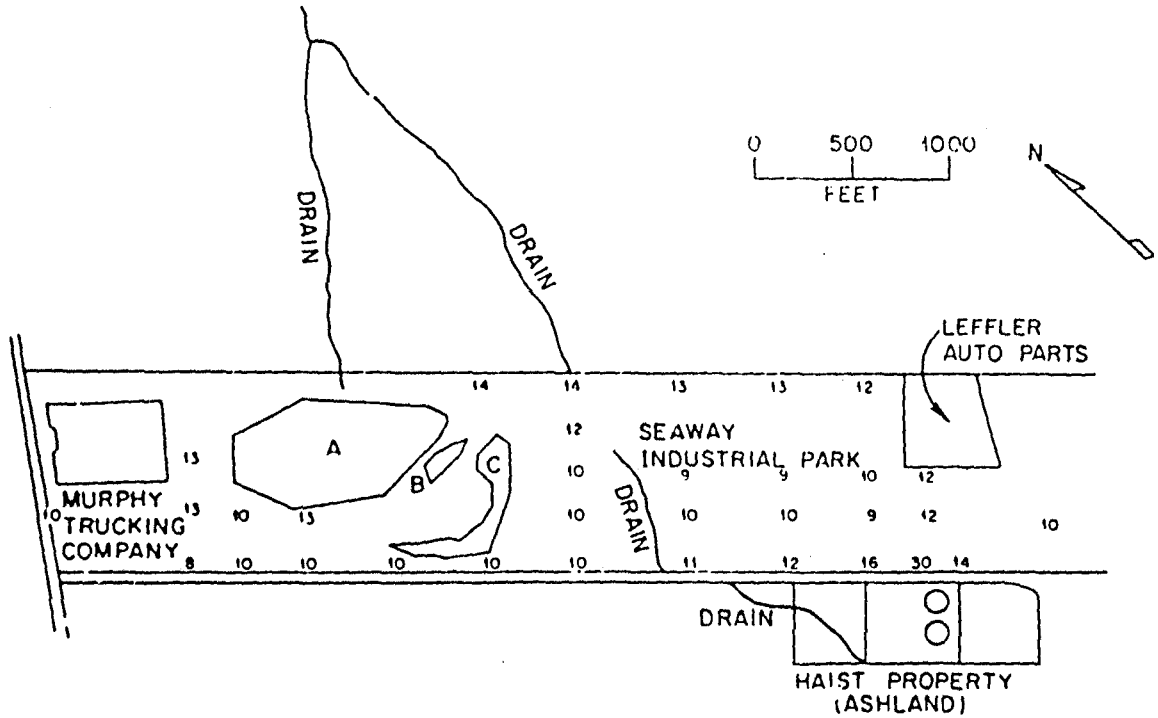

Fig. 10. External gamma radiation levels (in μR/hr) at 1 m above surface on 400-ft grid.

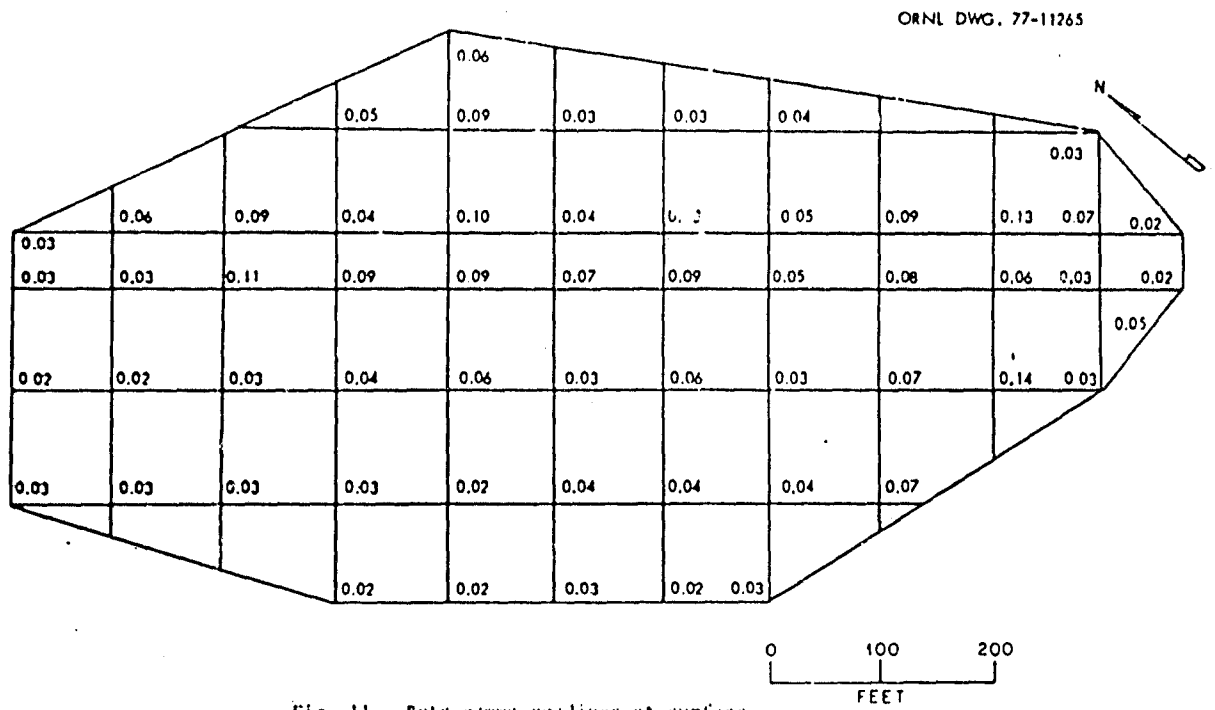

Fig. 11. Beta-gamma readings at surface (in mrad/hr).

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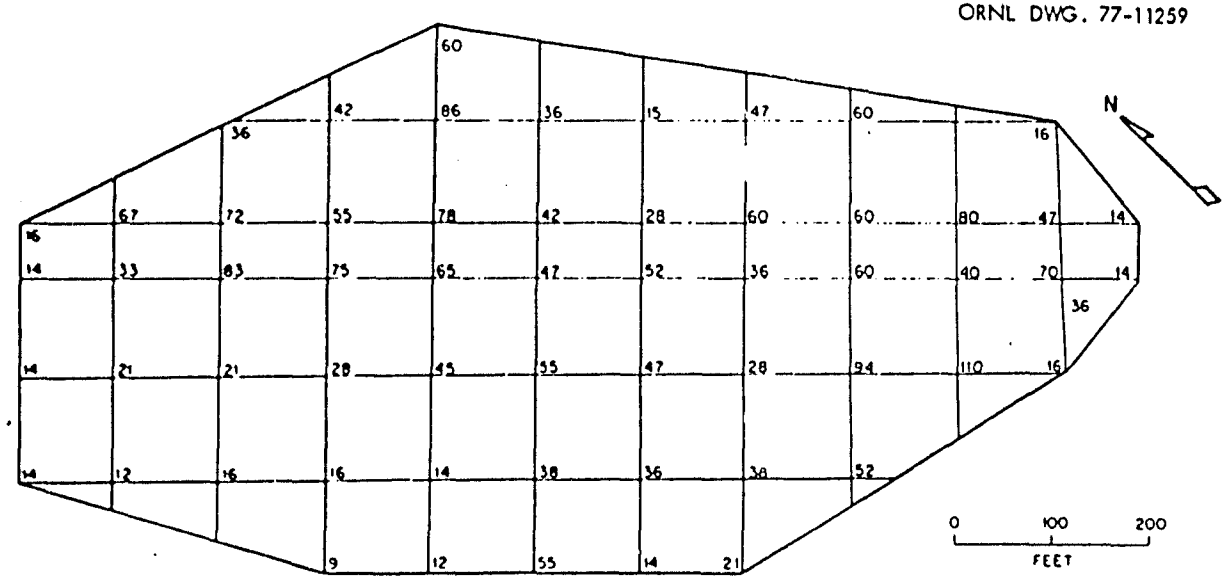

Fig. 12. External gamma radiation (in μR/hr) at the surface on Area A.

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0 0 3 0 4 7

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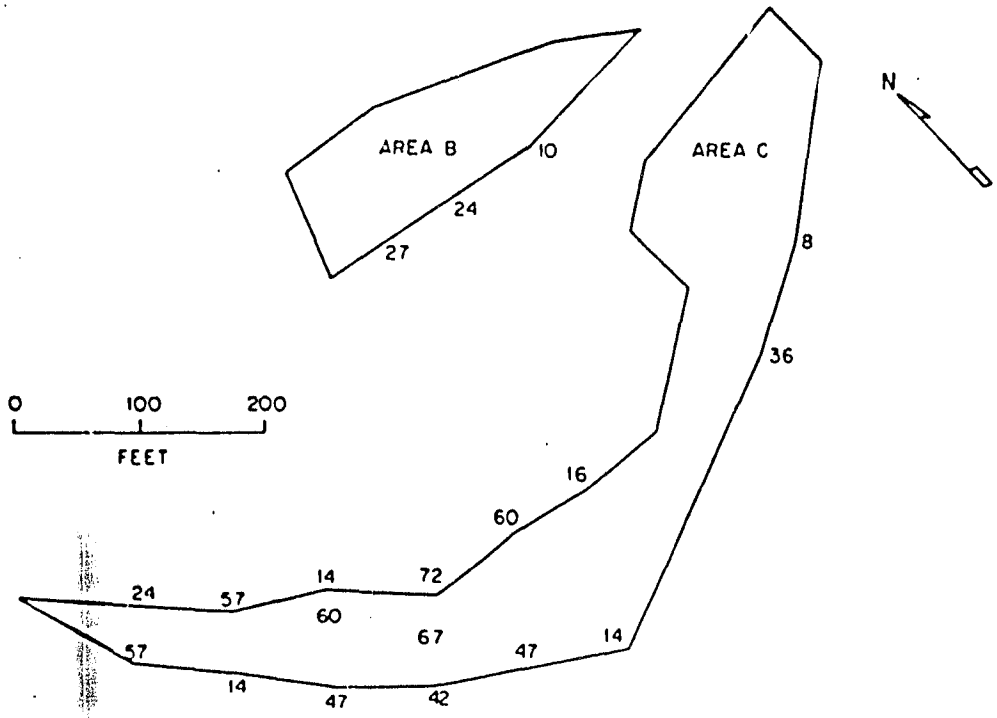

Fig. 13. External gamma radiation levels (in μR/hr) at the surface on and near Areas B and C.

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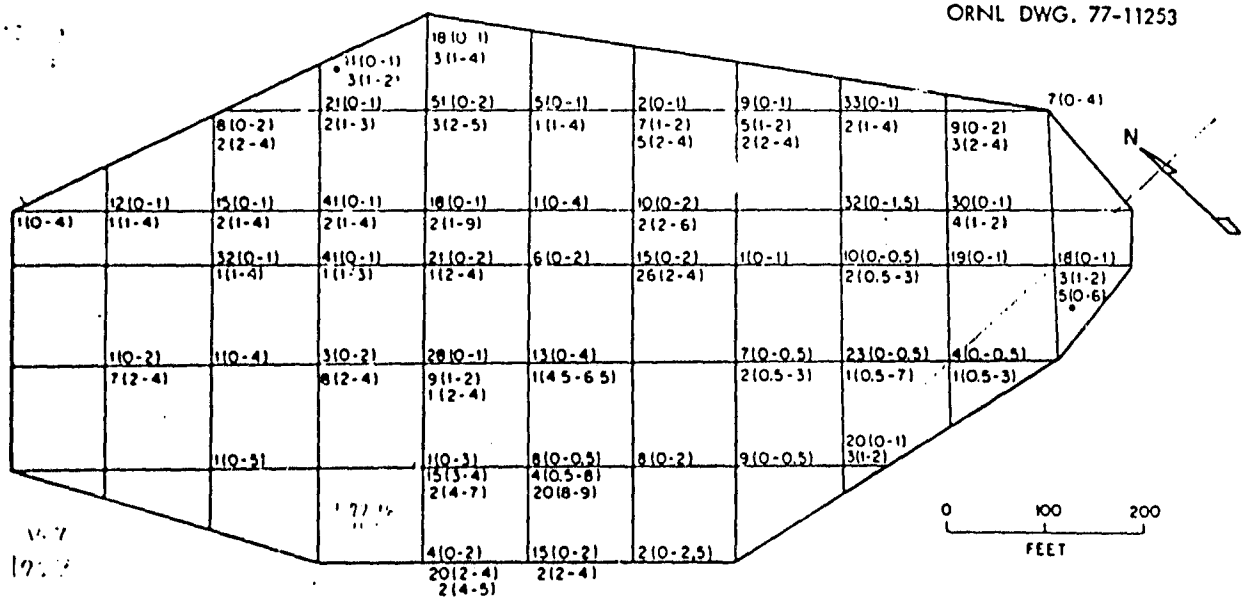

Fig. 14. Radium concentrations in Area A estimated from loggings and soil sample analyses [legend u(v-w) indicates u pCi/g from a depth of v ft to a depth of w ft].

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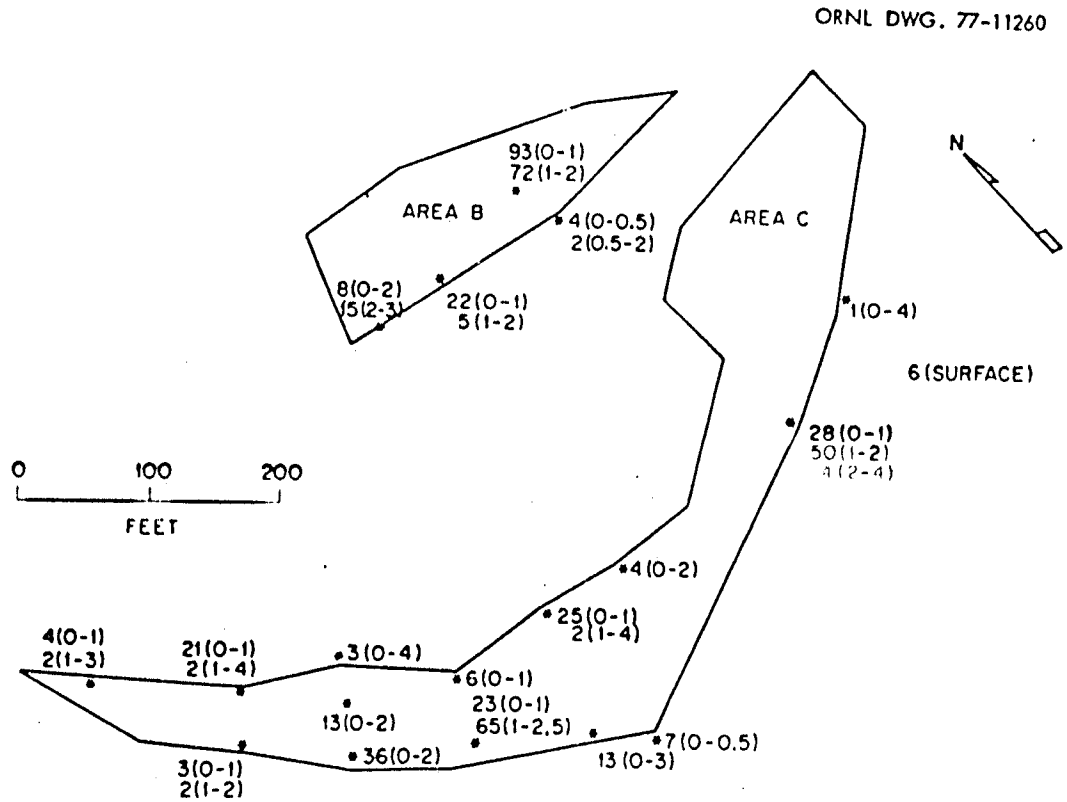

Fig. 15. Radium concentrations in Areas B and C estimated from logging and soil sample analyses [legend u(v-w) indicates u pCi/g from a depth of v ft to a depth of w ft].

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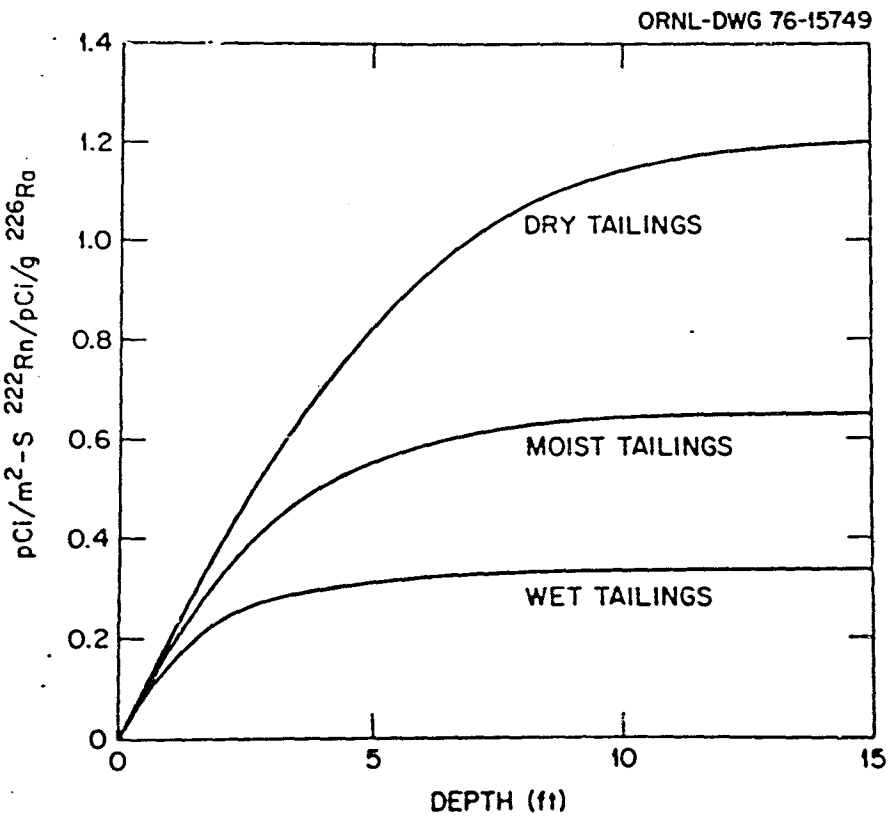

Fig. 16. Relationship of radium concentration and radon emanation.