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THIS VERSION OF THE PATHWAYS ANALYSIS FOR THE SEAWAY INDUSTRIAL PARK AREAS A, B, AND C (MAY 1987) INCORPORATES COMMENTS RECEIVED SUBSEQUENT TO PUBLICATION OF THE VERSION PUBLISHED IN APRIL.

THIS VERSION SUPERCEDES THE DOCUMENT PUBLISHED IN APRIL.

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PATHWAYS ANALYSIS FOR THE SEAWAY INDUSTRIAL PARK

AREAS A, B, AND C

MAY 1987

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

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1.0 INTRODUCTION

1.1 OBJECTIVE AND SCOPE

This analysis was completed to assess the potential doses associated with leaving certain concentrations of low-level residual radioactive material buried in place at the Seaway Industrial Park and to compare the results of that action with the costs and benefits of removing the material. The report describes the methodology used to estimate potential doses from Areas A, B, and C at the Seaway site in Tonawanda, New York (Figure 1-1), and provides background information on the site. The report also compares the concentrations of residues at this site to those permitted under Nuclear Regulatory Commission (NRC) guidelines for disposal or on-site storage of thorium or uranium from past operations (Ref. 1). U.S. Department of Energy (DOE) protocol allows for the derivation of guidelines or limits or the application of alternative limits at sites where it is shown that DOE generic limits are not appropriate and the derived or alternative limits are more applicable and adequately protect the public and the environment. The exposure scenarios and pathways identified in this analysis are based on the radiological profile of the three areas as determined by surveys performed for DOE and the current or projected maintenance and use of the areas. Where site-specific information does not exist or is inadequate, the analysis uses generic parameters or assumptions that are generally conservative in nature.

1.2 BACKGROUND

The Seaway Industrial Park (Lot 94 of the Town of Tonawanda, Erie County, New York) covers nearly 100 acres. Most of the site has been used as a restricted access landfill for several years, and a portion of the site is designated by the New York State Department of Environmental Conservation (NYSDEC) as an inactive hazardous waste site. The site is located in a large

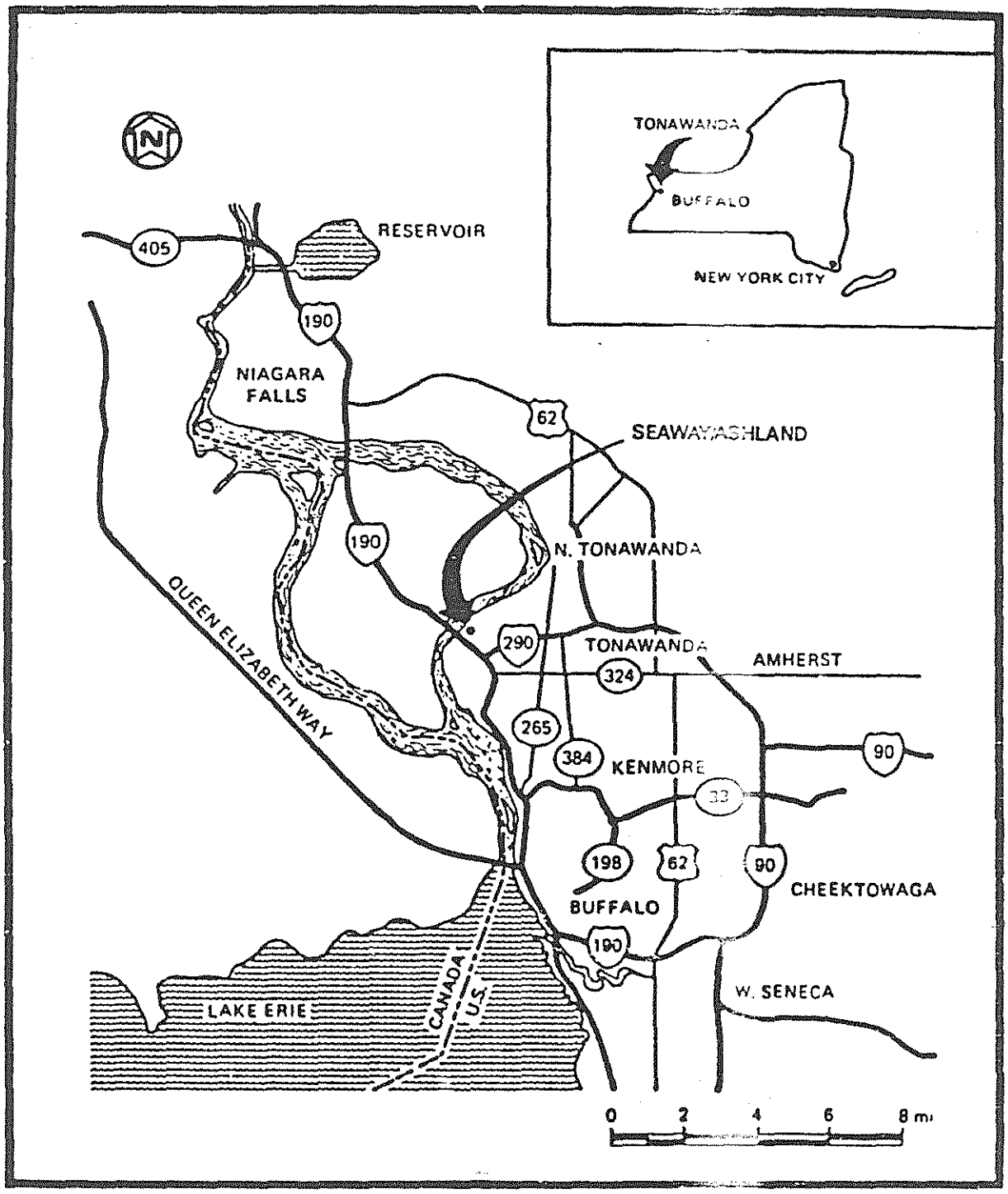

FIGURE 1-1 LOCATION OF THE SEAWAY/ASHLAND SITE

industrial area. The areas containing the radioactive residues are approximately 0.5 mi from the nearest house. The Seaway property is bounded by Ashland Oil, Inc.; Agway Fuel, Inc.; River Road; Murphy Trucking, Inc.; and property owned by Niagara Mohawk Power Corporation. There are no buildings and little vegetation on the radioactively contaminated portion of Seaway. Some parts of the site are at higher elevations than the surrounding terrain due to landfill operations. An aerial photograph of the Seaway Industrial Park and its vicinity is shown in Figure 1-2.

Seaway Industrial Park is adjacent to the former Haist property (now known as Ashland 1), which was used to receive residue from uranium processing during the period 1944 to 1946. In 1974, approximately 6,000 yd^3 of the residue, comprised essentially of low-grade uranium ore tailings, was excavated by Ashland Oil, Inc., the present owner of the former Haist property, and transported to the Seaway property (Ref. 2). This residue was dumped in the Areas A, B, and C indicated in Figure 1-3. Area A covers approximately 10 acres; Areas B and C together cover approximately 2 acres. The residue was left in small, isolated mounds in Areas B and C but was spread to a depth of less than 2 ft in most places in Area A. Although much of the residue was not originally covered, it has been mixed with clean soil because of the moving and spreading it has undergone since 1974.

The radioactive wastes originally deposited on Ashland Oil property and subsequently moved to Seaway were generated by wartime activities related to the Manhattan Engineer District. The site is included in DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP is a DOE effort to identify, decontaminate, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early days of the nation's atomic energy program. FUSRAP is currently being managed by DOE's Oak Ridge Operations Office. Bechtel National, Inc. (BNI) is the project management

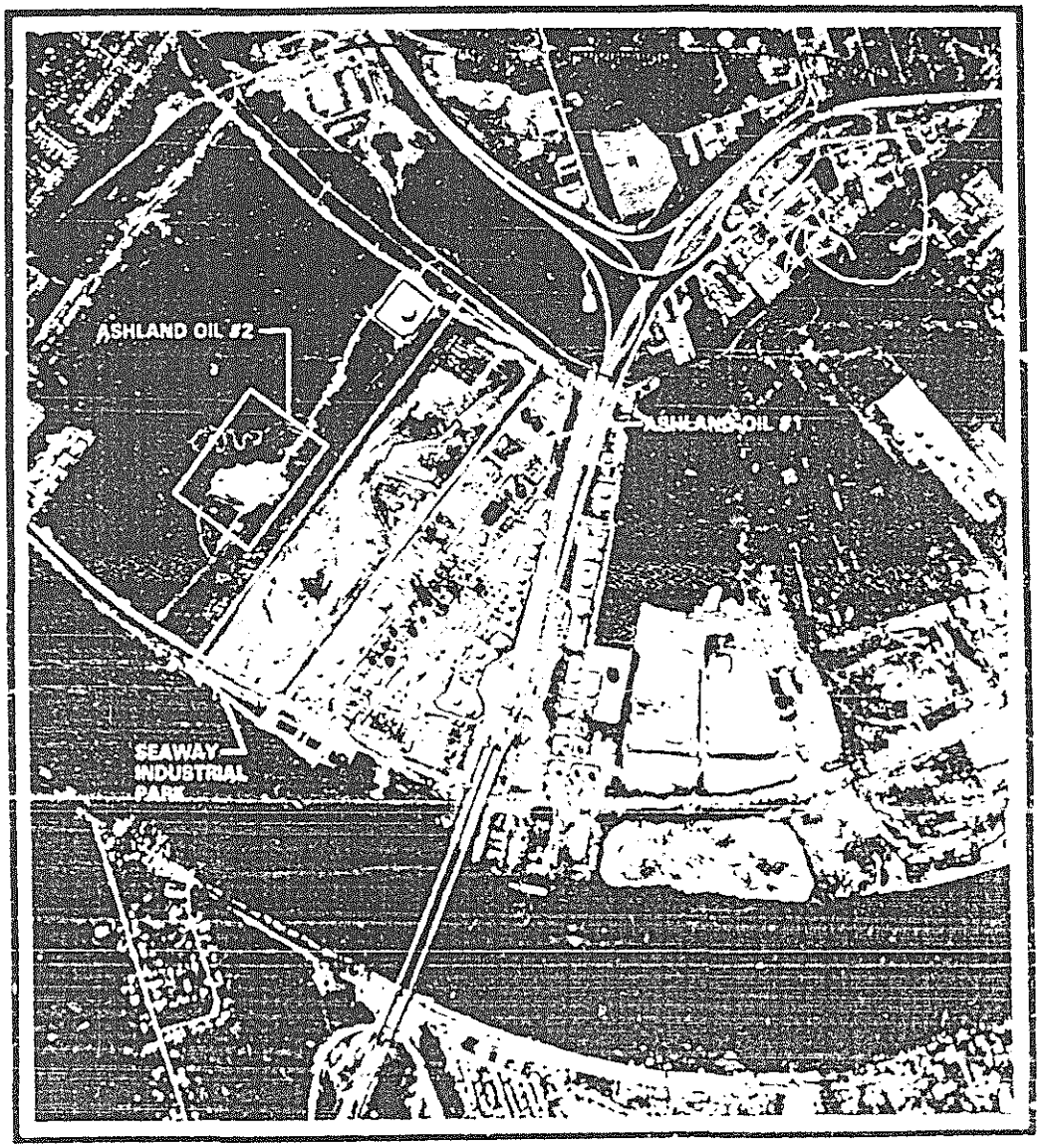

FIGURE 1-2 AERIAL VIEW OF SEAWAY INDUSTRIAL PARK AND ITS VICINITY

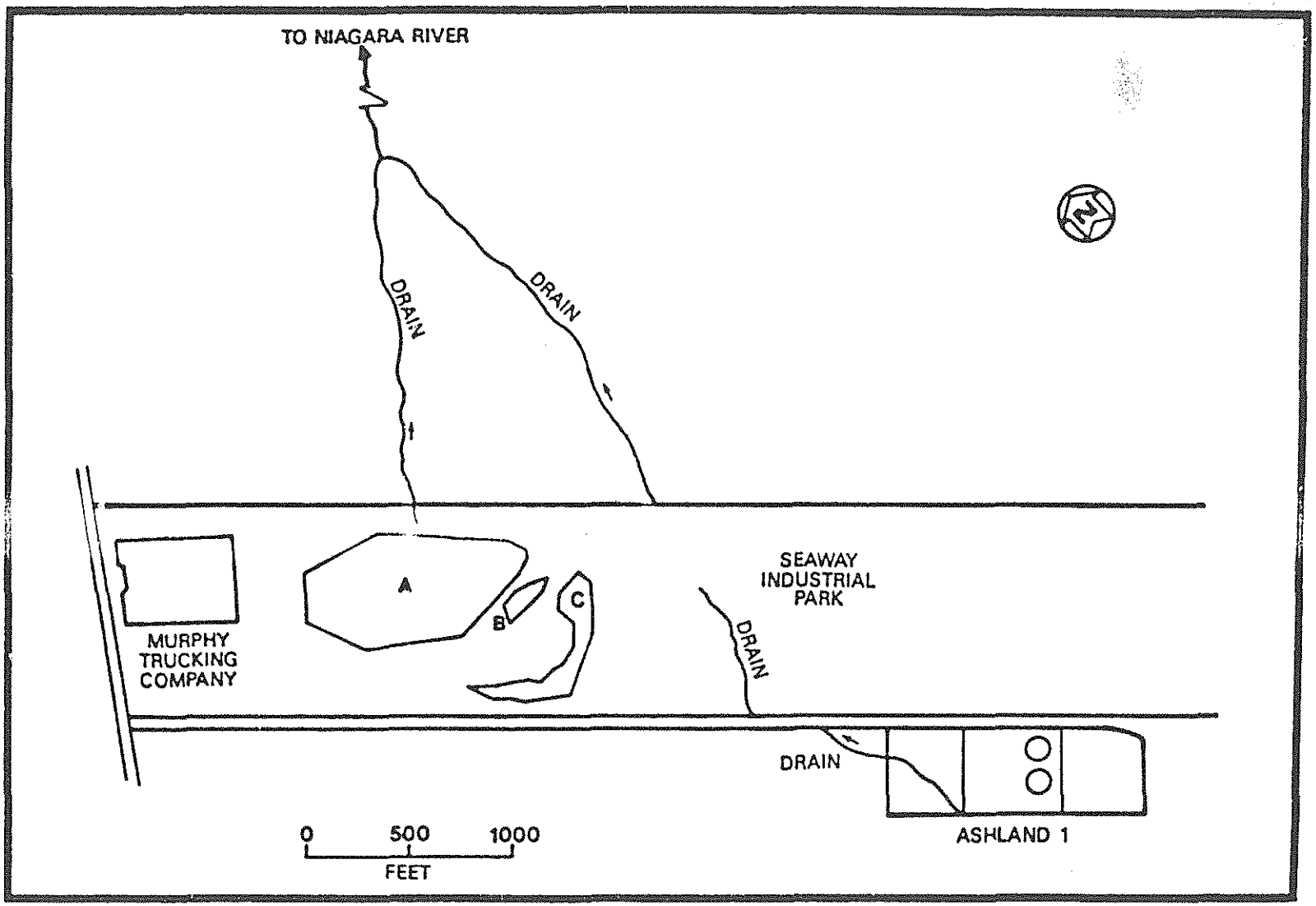

FIGURE 1-3 PLAN VIEW OF SEAWAY INDUSTRIAL PARK SHOWING THREE AREAS (A, B, C) WHERE RADIOACTIVE RESIDUES WERE DUMPED

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contractor for FUSRAP and acts as DOE's representative in planning, managing, and implementing FUSRAP.

A preliminary assessment of the current radiological and geological conditions of the Seaway/Ashland sites was performed from July 23 to August 12, 1986 (Ref. 3). The contamination on these sites was found primarily in the same locations identified by Oak Ridge National Laboratory (ORNL) in 1978 (Ref. 2). However, a substantial amount of fill material and garbage has been piled on a large portion of the contaminated area on Seaway, particularly on Areas B and C. Approximately 40 percent of Area A has also been covered by a layer of similar material. The cover over portions of Area A is much thinner than that over Areas B and C.

Surveys performed in August 1986 indicated that portions of Area A are now covered with soil/soil material that is not radioactively contaminated. This survey indicated that the radium-226 concentrations in soil in uncovered portions of Area A have not changed significantly since ORNL surveyed the Seaway site in 1978 (Ref. 2). On the basis of these data, it was determined that Area A should be evaluated by pathways analysis to determine if remedial actions are warranted. The option in lieu of remedial action would be to cover Area A with a minimum of 2 ft of clay or clayey material, then allow the owner/operator to use the area for refuse disposal provided he does not disturb the underlying radioactive contamination.

Evaluations derived from topographic maps developed in 1976 and 1986 indicate that Areas B and C are presently buried beneath 10 to 40 ft of refuse and fill material. As a result, neither Area B nor Area C could be identified by surface scanning. On the basis of the average concentrations of radium-226 and uranium in Areas B and C (Ref. 2), it was determined that a pathways analysis should be performed to determine if removal of residual materials in Areas B and C is warranted.

The average concentrations of radium-226 are 10 pCi/g in Area A and 18 pCi/g in the combined Areas B and C, respectively (Areas B/C are considered to be one area in this evaluation). Portions of Area A are not presently covered with fill material, but this evaluation is based on site conditions that would result from the addition of 10 to 40 ft of cover by normal landfill operations. Preliminary discussions with the NYSDEC indicate that the State would apply restrictions to the use of Area A. These restrictions would specify that no additional excavation may take place in Area A, that a cover of 2 ft of clean fill be placed over the area prior to placing garbage there, and that future use of the area be limited to garbage disposal. The owner would have to guarantee that a minimum of 10 ft of fill material such as garbage would be permanently placed over Area A. The remedial action guideline for radium-226 in subsurface deposits more than 15 cm beneath the surface is 15 pCi/g. The disturbance of Areas B and C during the emplacement of refuse resulted in the dilution of the average concentration to less than 18 pCi/g and probably to less than the remedial action guideline value of 15 pCi/g. For conservatism, the 18 pCi/g value from the ORNL survey (Ref. 2) was used for the pathways analysis. Uranium concentrations in all areas are low but are included in dose calculations.

2.0 DESCRIPTION AND STATUS OF AREAS A, B, AND C

2.1 DESCRIPTIONS OF SEAWAY AREAS A, B, AND C

The Seaway site is located on an active landfill. The landfill operation has resulted in the disposal of refuse over the known radioactive materials. Radioactive materials in Areas B and C have been buried, but Area A has remained relatively undisturbed.

Area A consists of 10 acres at the northern end of the site. Area B is a small area, about one-half acre, laterally central on the site and directly south of Area A. Area C covers about 1.5 acres in a narrow arcuate configuration with one leg approximately parallel with the west site boundary and concave northwest (Figure 1-3).

The present topography of the Seaway site reflects the current use of the site by the present owner. A mound of refuse and fill material about 95 ft high has been constructed on a portion of the site. The mound is constructed of various types of industrial wastes and has slopes that drop steeply to either side and at the back (south) end of the site. At the front (north) end, the constructed mound slopes more gently and incorporates a series of ascending benches. The more gentle slope facilitates the maintenance of a road to the hilltop for access by trucks.

The site topography, before emplacement of the refuse, is estimated to have been nearly level at an elevation of about 585 ft mean sea level (m.s.l.). A stream channel several feet deep crossed the center of the site and was fed by smaller tributary stream channels which intersected the central stream course. It is not known whether the site surface was graded or otherwise modified before emplacement of the first refuse began. In 1983, a slurry cutoff wall was placed around the Seaway Industrial Park.

2.2 CURRENT RADIOLOGICAL STATUS OF SEAWAY AREAS A, B, AND C

A walkover scan of Seaway was performed from July 23 to August 12, 1986, by Thermo Analytical/Eberline (TMA/E) (Ref. 3). Area A was located, but Areas B and C could not be identified by this walkover scan because of overburden placed in the areas during landfill operations after emplacement of the radioactive materials some 10 years earlier. ORNL data (1978) (Ref. 2) indicate that concentrations of radium-226 in the contaminated portions of Area A ranged from 1 to 51 pCi/g with an average concentration of 10 pCi/g. Concentrations of uranium-238 ranged from 2 to 63 pCi/g with a sample average of 22 pCi/g. Concentrations of radium-226 in the contaminated Areas B/C ranged from 1 to 93 pCi/g with an average of 18 pCi/g. Concentrations of uranium-238 ranged from 2 to 102 pCi/g with a sample average of 27 pCi/g. External gamma radiation levels at 1 m above the surfaces of Areas A, B, and C ranged from 8 to 80 μR/h with a sample average of 36 μR/h, including the area background average of 11 μR/h. A survey performed by Ford, Bacon & Davis Utah, Inc. (FBDU) in 1981 failed to locate Area B (Ref. 4). It is assumed that Area B had been disturbed by landfill operations at the site prior to the survey.

Area-specific surface water data are limited. However, concentrations of uranium, radium, and thorium in water samples from Seaway and from drainage paths leading to the Niagara River were several orders of magnitude below the applicable concentration guide (Ref. 2). Data obtained from the present operation of the Seaway Industrial Park indicate an average gross alpha activity level of 5.4 pCi/l in leachate from the disposal facility.

The radon emanation rate prior to the emplacement of significant overburden was estimated by FBDU to be about 2 to 7 pCi/m^2/s (Ref. 4). This is roughly 10 times the average worldwide radon

emanation rate which is reported to be 0.43 $pCi/m^2/s$ (Ref. 5). The emanation rate through the current or expected overburden would be a factor of 4 lower due to radioactive decay of radon prior to reaching the surface of the overburden. Radon emanation rates should be less than 0.5 to 1.8 $pCi/m^2/s$ or less than 10 percent of the Uranium Mill Tailings Remedial Action Program (UMTRAP) criteria for disposal facility design.

3.0 RADIOLOGICAL ASSESSMENT

In evaluating the potential radiological exposure to the public from contaminated Areas A, B, and C of the Seaway Property, the exposure potential was based on actual soil concentrations of radionuclides measured in 1978 (Ref. 2) prior to the use of the property as a landfill. Under the present operation, Areas A, B, and C have been or will be covered with refuse and soil to a depth of 10 to 40 ft.

3.1 METHODOLOGY AND PARAMETERS USED IN DOSE CALCULATIONS

Potential exposure pathways to the resident assuming that institutional controls remain in effect are internal exposure to radionuclides ingested in vegetables, meat, and milk produced on the site following irrigation and from the ingestion of water from wells drilled near the site. Potential exposure pathways to an inadvertent intruder following loss of institutional controls would include the pathways listed above plus exposure to external radiation and radon gas.

The methodology and parameters used in the calculation of internal dose are discussed in detail by Gilbert, et al. (Ref. 6). Dose conversion factors (Ref. 6) are based on data in ICRP Publication 30 (Ref. 7) and taken directly from ORNL/ICRP data files at ORNL. The dietary parameters are based on data from Nelson and Young (Refs. 8 and 9). The transfer factors are based on values recommended by NRC (Ref. 10) which have been updated with more recent information.

Other dose calculation information and parameters are shown in Appendix A.

3.2 COMPARISON OF SITE CONTAMINATION LEVELS TO DOE GUIDELINES FOR RESIDUAL CONCENTRATIONS

The comparison of the measured concentrations of radionuclides in the soil of Areas A, B, and C to the DOE remedial action guidelines for residual concentrations (Ref. 11) is shown in Table 3-1. The radium-226 concentration of 18 pCi/g at Areas B/C is slightly higher than the appropriate DOE remedial action guideline of 15 pCi/g, while that of Area A is about 67 percent of the guideline value. The average of the concentrations at Areas B/C and Area A would be less than the guideline value for unrestricted use at the site. Additionally, it is highly unlikely that the future use of either Areas B/C or Area A would not result in dilution of the soil radionuclide concentration by uncontaminated soil cover, thereby decreasing the radium-226 concentration to well below the guideline value. The concentrations of thorium-230 in the soil at both areas are well below the guideline value of 15 pCi/g. In fact the highest soil concentration of 2.4 pCi/g is only 16 percent of the guideline value.

At the present time, no action guideline value for soil concentration has been derived for natural uranium. It is considered very likely that the guideline will fall in the range from 50 to 100 pCi/g. If this is the case, then the natural uranium concentrations as shown in Table 3-1 are approximately 50 percent of the lowest estimated guideline value of 50 pCi/g.

As noted previously, an uncontaminated soil cover over the sites would likely result in dilution of the radionuclide concentrations to well below the estimated remedial action guideline value. On the basis of past experience at other FUSRAP sites, the removal of several feet of cover over the contaminated soil and the subsequent mixing of the soils would reduce the concentration of radium-226 and uranium by a factor of 5 to 50 times. For the analyses presented, a dilution factor

TABLE 3-1

COMPARISON OF SITE SOIL CONTAMINATION LEVELS TO U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL CONCENTRATIONS OF RADIONUCLIDES IN SOIL MATERIALS AND RADON-222 EMANATION RATE

Radionuclides[a]	Measured Concentration in Soil of Area A (pCi/g)	Measured Concentration in Soil of Areas B/C (pCi/g)	DOE Remedial Action Guidelines[b] (pCi/g)
Radium-226	10	18	15
Natural Uranium	22	27	50-100
Thorium-230	1.3	2.4	15
Radon-222[c]	1.8 $pCi/m^2/s$	1.8 $pCi/m^2/s$	20 $pCi/m^2/s$[d]

[a]Only uranium-238 and radium-226 concentrations were measured. The total uranium and thorium-230 radionuclides were calculated based on concentration ratios found in the surface water.

[b]The action guidelines for radium-226 and thorium-230 are based on an average over a 15-cm-thick layer of soil more than 15 cm below the surface. Derivation of an action guideline for natural uranium is currently under consideration. It is considered probable that the guideline will fall in the range of 50 to 100 pCi/g. The total natural uranium values are based on the total of soil concentrations of uranium-234, uranium-235, and uranium-238.

[c]Average emanation rate over Areas A, B, and C.

[d]This value is a design criteria for UMTRAP disposal facilities and is not a remedial action guideline. It is provided, however, for comparison purposes.

of 5 has been applied. The concentrations in the disturbed soil that would result are presented in Table 3-2. Under this scenario, the concentrations of radium-226 and uranium in soil would be less than the applicable DOE remedial action guidelines. On the basis of the concentrations presented in Tables 3-1 and 3-2, remedial action guidelines would be met. While institutional controls are in force, contaminated soils will be buried beneath 10 to 40 ft of fill material. In this scenario, remedial action guidelines for subsurface contamination will apply (15 pCi/g for radium-226). If the areas are disturbed after institutional controls have lapsed, contamination brought to the surface would have to meet remedial action guidelines for surface contamination (5 pCi/g for radium-226).

On the basis of the site conditions described above, the resulting concentrations of uranium and radium-226 in Areas A, B, and C presently meet or will meet the subsurface remedial action guidelines for radium-226. This assumes that Area A will be buried beneath 10 to 40 ft of fill material. Once all materials in the three areas are buried, any excavation of the materials or removal of cover materials would result in dilution of the contamination to levels less than the applicable remedial action guidelines for surface soil contamination.

Close coordination with the NYSDEC will be required to ensure the proper covering of Area A and to maximize the duration of institutional controls over Areas A, B, and C. Controls would be provided through amendments to the facility operating license. These amendments would provide the controls necessary to ensure the timely and proper covering of Area A. The license coupled with possible covenants to the deed for the site would be the instruments used to maximize the duration of institutional controls.

TABLE 3-2

CONCENTRATION OF RADIONUCLIDES IN THE SOIL OF AREA A AND AREAS B/C FOLLOWING DILUTION BY MIXING WITH UNCONTAMINATED SOIL COVER

Radionuclides[a]	Concentration in Soil (pCi/g)[a] Area A (pCi/g)	Areas B/C (pCi/g)	DOE Remedial Action Guidelines[b] (pCi/g)
Radium-226	2.0	3.6	15
Natural Uranium	4.4	5.4	50-100
Thorium-230	0.26	0.48	15

[a]A dilution factor of 5 was assumed for the mixture of the contaminated soil with the uncontaminated soil cover.

[b]The action guidelines for radium-226 and thorium-230 are based on an average over a 15-cm-thick layer of soil more than 15 cm below the surface. Derivation of an action guideline for natural uranium is currently under consideration. It is considered probable that the guideline will fall in the range of 50 to 100 pCi/g. The natural uranium values are based on the soil concentrations of uranium-234, uranium-235, and uranium-238.

3.3 DOSE FROM DRINKING WELL WATER

A cutoff wall has been constructed around the entire industrial site by the owner/operator to intercept groundwater or leachate moving to the unconfined aquifer. The groundwater is directed to a single manhole where samples are collected (Ref. 12). Data obtained from the present operator of the Seaway Industrial Park indicated an average concentration of 5.4 pCi/l of gross alpha activity in the groundwater. It is assumed that this concentration of contamination would be found in the water of a site well. Because only gross alpha activity was measured in the leachate, it is conservatively assumed that all of the activity results from radium-226, the most hazardous radionuclide present in the contaminated soil. No dilution effect by the flow of the aquifer was considered.

Assuming that the resident would draw all of his drinking water (730 l/yr) from the contaminated well, the total dose would be 5.2 mrem/yr as shown in Table 3-3. This dose, based on conservative assumptions, is well below the DOE guideline of 100 mrem/yr (Ref. 13). A comparison of the radionuclide concentration in area well water with the DOE Derived Concentration Guide (DCG) (Ref. 13) for concentrations of radionuclides in drinking water is shown in Table 3-4. The concentration of radium-226 in well water is only 5.4 percent of the DOE DCG.

It should be pointed out that preliminary geological survey data (Ref. 12) indicated that the groundwater located above the low permeability clay stratum that covers the area is so shallow that utilization of this water for any purpose is unlikely (Ref. 12). The survey also shows that the groundwater below this clay stratum has a naturally occurring high content of degrading material such as chlorides and sulphates so that its use as a household water supply is unlikely.

TABLE 3-3

DOSE FROM DRINKING WATER FROM AN ON-SITE WELL

Radionuclide[a]	Concentration in Well Water[a] (pCi/l)	Dose from Drinking Water[c] (mrem/yr)
Radium-226	5.4	5.2

[a]Since only gross alpha activity was measured, it was assumed that all of the activity was due to the radium-226, the most hazardous radionuclide present in the contaminated soil.

[b]Based on the average concentration measured in the site groundwater (leachate) for years 1985 and 1986.

[c]Committed effective dose equivalent. Assumes an annual water intake of 730 liters taken from the well.

TABLE 3-4

COMPARISON OF RADIONUCLIDE CONCENTRATION IN WELL WATER WITH THE DOE DERIVED CONCENTRATION GUIDES (DCG) FOR CONCENTRATIONS OF RADIONUCLIDE IN DRINKING WATER[a]

Radionuclide	DOE Derived Concentration Guide for Drinking Water (μCi/l)	Concentration in Area Well Water (μCi/l)	Percentage of DCG for Area Well Water
Radium-226	1×10^{-4}	5.4×10^{-6}	5.4

[a]Based on concentration in water that could be continuously consumed (730 l/yr) and not exceed an effective dose equivalent of 100 mrem/yr.

3.4 DOSE FROM IRRIGATION OF CROPS

Contamination of groundwater can contribute to the food pathways as well as to the drinking water pathway when the contaminated water is used for irrigating crops. Reliance on natural rainfall is the usual practice in the area, but the effects of some irrigation on food crops was examined. It was assumed that the top 15 cm of soil would be irrigated with 15 in. (38.1 cm) per year of overhead irrigation water. A soil density of 1.5 g/cm^3 was assumed. The radionuclide concentration in soil is shown in Table 3-5.

It was assumed that in addition to vegetables, grains, and fruit that grazing land for beef and dairy cattle would also be irrigated. The doses to the resident from the ingestion of food crops, meat, and milk produced on the irrigated land are shown in Table 3-6. The total dose of 2.8×10^{-3} mrem/yr from all three sources of food is only a small fraction of the DOE limit of 100 mrem/yr (Ref. 14).

3.5 POTENTIAL DOSE TO WORKERS REMOVING CONTAMINATED SOIL

Should a decision be made to remove the contaminated soil from Area A and Areas B/C, the workers involved would be exposed to low-level beta-gamma activity primarily from the radium-226 in the soil. A survey was made of these areas in 1978 (Ref. 2) prior to the landfill operator covering Areas B and C. An average gamma exposure rate of 42 μR/h was measured on Area A and 37 μR/h on Areas B/C at 1 m above the ground. Since Areas B and C have already been covered with 10 to 40 ft of fill material, the expected exposure rate would be significantly lower than that measured. Exposure rates would be on the order of 20 μR/h if the contaminated zone were uncovered. It was assumed that it would take 6 weeks to remove contaminated soils from Area A and 3 weeks to remove the contaminated soils buried in Areas B and C. It was assumed in each case that two loader

TABLE 3-5

AVERAGE CONCENTRATION OF RADIONUCLIDE IN SOIL FOLLOWING IRRIGATION OF SOIL WITH GROUNDWATER

Radionuclide[a]	Concentration in Groundwater[b] (pCi/cm^3)	Concentration in Soil after Irrigation[c] (pCi/g)
Radium-226	5.4×10^{-3}	9.1×10^{-3}

[a]Only total alpha activity in the groundwater was measured. It was assumed that the activity was due to radium-226, the most hazardous radionuclide in the contaminated soil.

[b]Based on measured average alpha activity in the groundwater (leachate).

[c]Calculated based on irrigating the top 15 cm of soil with 15 in. (38.1 cm) per year of overhead irrigation water. A soil density of 1.5 g/cm^3 was assumed.

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TABLE 3-6

DOSE TO RESIDENT FROM INGESTION OF FOODS[a] PRODUCED ON IRRIGATED LAND

Radionuclide[b]	Ingestion Dose (mrem/yr)			
	Vegetables	Meat	Milk	Total Dose
Radium-226	2.7×10^{-3}	5.3×10^{-5}	1.5×10^{-5}	2.8×10^{-3}

[a]Based on an intake of 1.6×10^5 g/yr of vegetables, grain, and fruit; 92 l/yr of milk; and 63 kg/yr of meat.

[b]Since only gross alpha activity in the groundwater was measured, it was assumed that the activity was due to radium-226, the most hazardous radionuclide in the contaminated soil.

operators and four truck drivers would be required for these operations. It was assumed that the two loader operators would spend 40 h/wk engaged in loading the soil on trucks for removal. During this time, they would be seated 1 m from the site surface (no reduction of the dose rate as a result of the shielding provided by the vehicle was considered). The doses are shown in Table 3-7. The highest individual annual dose, 4 mrem, is a small fraction of the 5,000 mrem/yr DOE limit (Ref. 15).

Doses were also estimated for the truck drivers involved in removing the contaminated soil from the area. It was assumed that each driver would move four loads per day with each trip taking 2 hours. The truck would be empty on the return trip; therefore, the driver would spend 20 h/wk exposed to the contaminated soil (no reduction of the dose rate as a result of the shielding provided by the truck was considered). The doses are shown in Table 3-7. The doses to the truck drivers would be about one-half of the doses to the loader operators and are only about 0.04 percent of the DOE limit of 5,000 mrem/yr (Ref. 15).

The calculated dose to workers removing contaminated soils from Area A is 0.02 manrem; the calculated dose to workers removing contaminated soils from Areas B/C is 0.004 manrem.

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TABLE 3-7

DOSE TO INDIVIDUAL WORKERS REMOVING THE CONTAMINATED SOILS FROM AREA A AND AREAS B/C

Location	External Gamma Dose Rate (mrem/h)[a]	Dose (mrem)[b]	
		Loader[c]	Truck Driver[d]
Area A (10 acres)	3.4×10^{-2}	4	2
Areas B/C (2 acres)	1.5×10^{-2}	2	1

[a]Measured dose rate at 1 m above the surface of the ground. A factor of 0.8 is used for direct conversion from the measured exposure, mR/h, to the effective dose equivalent in mrem/h (Ref. 6).

[b]Dose to the individual operators.

[c]It was assumed that the loader operator would be located 1 m above the ground and would spend 40 h/wk working on the site.

[d]The driver was assumed to move four loads per day with each trip taking 2 hours. The truck would be empty on the return trip; therefore, he would spend 20 h/wk exposed to the contaminated soil.

4.0 DISCUSSION AND CONCLUSIONS

Areas A, B, and C of the Seaway property present minimal hazard to the public. A radiological survey performed in August 1986 (Ref. 3) indicated that shielding provided by the landfill cover has reduced the gamma radiation at the surface of the soil to background levels. FBDU measured radon emanation at the soil surface in each of the three areas. The emanation rates varied from 2 to 7 $pCi/m^2/s$. The depth and composition of cover material on Areas B and C reduced these emanations to background levels. Similar reduction in emanation of radon from Area A will be achieved when it is also covered with 10 to 40 ft of cover material. Geological reviews made in 1986 (Ref. 12) reveal that the groundwater is not likely to be used for public consumption because the groundwater in the upper aquifer is too shallow and that in the deeper aquifer is degraded by naturally occurring chemicals. Under present site restrictions, the only significant exposure pathway is groundwater migration from the site. Under this conservative scenario, the dose to a resident using the well for domestic purposes would be 5 mrem/yr. This dose is well below the radiation protection standard, 100 mrem/yr.

It was assumed that the site would be used for construction of a family dwelling after administrative controls have lapsed. The remaining radioactive contaminants were assumed to be further diluted during construction, by a factor of 5 to 50. Using the lower dilution factor (5), the concentration in the disturbed soils would be less than the remedial action guideline value for surface soil contamination. Thus, it was determined that expected dose to any inadvertent intruder would be less than 100 mrem/yr.

The existing concentrations of radioactive contamination in Areas A, B, and C of the Seaway Industrial Park are approximately equal to DOE soil guidelines (DOE Residual Radioactivity Guidelines); however, this contamination is well

isolated (in the case of Areas B and C) from the public and environment. On the basis of evaluations of the site conditions and existing site restrictions, it was determined that potential dose to persons presently using the site or to individuals who might live adjacent to the site would be well below DOE dose limits.

Unrestricted use of the site would not result in doses to members of the general public in excess of the dose limits, because of the relatively low exposure levels, limited volume of residual radioactive material in Areas B and C, and the thick layer of cover over the contamination. The realistic scenario estimates indicate possible doses of approximately 5 percent of the dose limit. If Area A were covered to a level equivalent to the other two areas, the combined potential doses to a future site user would be equal to or less than that calculated for Areas B/C.

The remedial action costs, including excavation, transportation to a disposal site 100 mi from Seaway, and final disposal (at a location to be determined) of contaminated soil/rubble now on the Seaway Industrial Park were evaluated. This evaluation included three options: leave-in-place; complete remediation of Areas A, B, and C; and remediation of Area A only.

Cost estimates assume that a New York disposal site will be available in 1996 and that excavation and removal of soil/rubble on Seaway would occur in 1996 and 1997. All cost estimates are in year-of-expenditure dollars (1996). The disposal site is assumed to be 100 mi from the site. The volume of contaminated soil/rubble includes 33,000 yd^3 on Area A and 15,000 yd^3 on Areas B and C. In addition, 48,000 yd^3 of uncontaminated soil/rubble must be removed from Areas B and C to gain access to the contaminated materials.

For the leave-in-place option, it is assumed that Areas B and C would remain in their present condition, buried beneath 10 to 40 ft of soil/rubble and that Area A would be similarly buried. For Areas A, B, and C, agreements would be developed between DOE, the NYSDEC, and the owner/operator to ensure that the materials remain in place; that Areas A, B, and C not be disturbed; and that Area A be covered by 2 ft of clay and used only for garbage disposal. Assurances would be provided that 10 to 40 ft of garbage would be placed over Area A. Provisions for the monitoring of site conditions would be included in the site license with the NYSDEC. The owner/operator presently conducts this type of monitoring.

Costs to DOE associated with the leave-in-place option would be limited to administrative costs associated with obtaining the necessary agreements with the NYSDEC and the owner/operator. The total cost is estimated to be $500,000 over a period of 5 years.

The cost associated with the removal of contaminated materials from Areas A, B, and C including transportation and disposal is $23 million. This cost includes $10 million for on-site remedial action, $3 million for transportation, and $10 million for disposal.

The cost associated with the removal of contaminated materials from Area A including transportation and disposal is $13 million. This cost includes $4 million for on-site remedial action, $2 million for transportation, and $7 million for disposal.

On the basis of the dose assessments presented in Section 3.0, risks to the public from the leave-in-place option are low. The costs associated with remedial action of these areas is estimated to be $13 million to $23 million. The benefits to be derived from the removal of low-level contamination on Areas A, B, or C do not justify the remediation cost.

The concentrations of radium-226 at the Seaway Industrial Park were reviewed against NRC interim guidance on disposal or on-site storage of thorium or uranium wastes from past operations (Ref. 1). As stated in this Branch Technical Position, five options for disposal or on-site storage of uranium-contaminated waste exist. Under present and predicted future land use, two of these options are applicable to Seaway.

One applicable option permits the on-site disposal of materials having concentrations of up to 20 pCi/g of radium-226, provided that the burial depth is greater than 4 ft, the property is zoned for industrial use only, and in the case of Seaway, that radiation dose rates are less than 100 mrem/yr.

The other applicable option permits the on-site disposal of materials having concentrations of up to 100 pCi/g of radium-226 but requires that land use be limited. The radium-226 concentration is based on a limited exposure of 2.4 h/day to limit the radon dose to less than 0.5 working level (WL) month, which is equivalent to continuous exposure to the 0.02 WL exposure guideline implemented by the Environmental Protection Agency (EPA).

Clearly, these areas of the Seaway Industrial Park meet the requirements of either option in terms of the average concentration of radium-226 and future land use. The proposed option for the disposal of uranium and radium-226 at Seaway, in situ stabilization by burial beneath 10 to 40 ft of rubble, is clearly a viable alternative and is compatible with NRC regulations and published Branch Technical Positions.

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APPENDIX A

METHODOLOGY AND PARAMETERS

Parameters

1. Concéntration Factors for Plants

   Ra - 1.4×10^{3}
   U - 2.5×10^{-3}
   Th - 4.2×10^{-3}

2. Fraction of radionuclide transfer to Milk, Fm (d/L)

   Ra - 2.0×10^{-4}
   U - 6.0×10^{-4}
   Th - 2.5×10^{-6}

3. Fraction radionuclide transfer to Beef, Ff (d/kg)

   Ra - 9.9×10^{-4}
   U - 5.0×10^{-3}
   Th - 5.0×10^{-3}

4. Dose Conversion factors (mrem/pCi) for Ingestion

   Ra-226 - 1.32×10^{-3}
   U-234 - 2.83×10^{-4}
   U-235 - 2.66×10^{-4}
   U-238 - 2.55×10^{-4}
   Th-230 - 5.48×10^{-4}

5. Dietary factors for Adult

   Vegetable, Grain and Fruit - 160 kg/yr
   Milk - 92 l/yr
   Meat - 63 kg/yr
   Water - 730 l/yr

6. Gross intake by Beef and Dairy Cattle - 50 kg/d

Methodology

1. Dose from Eating Vegetables

   [Concentration of radionuclide in soil (pCi/g)] x [1.40×10^{3} (Concentration Factor for Vegetable)] x 1.6×10^{5} g/yr (Vegetable intake)] x [Dose Conversion Factor (mrem/pCi)] = mrem/yr

2. Dose from Drinking Milk

[Concentration of Radionuclide in Soil (pCi/g)] x [1.4 x 10^{-3} (Concentration Factor for Grass)] x [5 x 10^{4}g/d (Grass Intake for Cow)] x [2 x 10^{-4} d/l/Transfer Factor] x [0.25 kg/d (Milk Intake by Adult)] x 365 d/yr x [Dose Conversion Factor (mrem/pCi)] = mrem/yr.

3. Dose from Eating Beef

[Concentration of Radionuclide in Soil (pCi/g)] x [1.4 x 10^{-3} (Concentration Factor for Grass)] x [5 x 10^{4} g/d (Grass Intake by Cow)] x (9.9 x 10^{-4} d/kg (Transfer Factor)] x [0.173 kg/d (Beef Intake by Adult)] x 365 d/yr x [Dose Conversion Factor (mrem/pCi)] = mrem/yr.

4. Dose from Drinking Water

[Concentration in Water (pCi/l)] x [730 L/yr (Water Intake by Adult)] x [Dose Conversion Factor (mrem/pCi)] = mrem/yr.