ENVIRONMENTAL ASSESSMENT

FOR

BATTELLE COLUMBUS LABORATORIES

DECOMMISSIONING PROJECT

JUNE 1990

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ACRONYMS

R	-	Roentgen
mR	-	milliroentgen
dpm	-	disintegrations per minute
rem	-	roentgen equivalent man
mrem	-	milliroentgen equivalent man
ppm	-	parts per million
Ci	-	Curie
uCi/ml	-	micro Curies per milliliter

1.0 INTRODUCTION

This Environmental Assessment has been developed by the Department of Energy in accordance with the requirements of the National Environmental Policy Act of 1969 for the proposed decommissioning of contaminated areas at the Battelle Memorial Institute, Columbus, Ohio. The following discussions in this Section provide general background information on the proposed action. Section 2.0 describes the existing radiological and non-radiological condition of the Battelle Columbus Laboratories. Section 3.0 identifies the alternatives considered for the proposed action and describes in detail the proposed decommissioning project. Section 4.0 evaluates the potential risks the project poses to human health and the environment. Section 5.0 presents the Department of Energy's proposed action.

1.1 DESCRIPTION OF PROPOSED ACTION

Under provisions of the Surplus Facilities Management Program, the U.S. Department of Energy proposes to fund Battelle Memorial Institute to decommission fifteen facilities and associated premises belonging to Battelle Memorial Institute, Columbus, Ohio (see Figure 1-1). Nine of these buildings (A, 1, 2, 3, 4, 5, 6, 7, and 9) are located at Battelle Memorial Institute's Battelle Columbus Laboratories King Avenue Site, in Columbus (see Figure 1-2). The remaining six buildings (JN-1, JN-2, JN-3, JS-1, JS-10, and JS-12) are located at Battelle's West Jefferson Site, West Jefferson, Ohio (see Figure 1-3).

1.2 NEED FOR ACTION

Battelle Memorial Institute's facilities are operated under a Nuclear Regulatory Commission license (No. SNM-7) and in compliance with all applicable State and Federal regulations. As a result of nuclear research and development activities conducted over a period of approximately 43 years performed for the Department of Energy and its predecessor agencies--the Energy Research and Development Administration, the Atomic Energy Commission, the Manhattan Engineer District, and under commercial contracts, the 15 buildings became contaminated with varying amounts of radioactive material. The Department of Energy no longer has a need to utilize the facilities and is contractually obligated to remove that contamination such that they can be used by their owners without radiological restrictions. This Environmental Assessment for the Battelle Columbus Laboratories Decommissioning Project is consistent with the direction from the Secretary of Energy that public awareness and participation be considered in sensitive projects and is an appropriate document to determine action necessary to satisfy the requirements of the National Environmental Policy Act.

1.3 ENVIRONMENTAL SETTING

An 80 kilometer (50 mile) radius area map showing the King Avenue and West Jefferson sites is presented in Figure 1-1. The King Avenue facility is located in the West Central portion of the city of Columbus, Ohio, at a latitude of 39 degrees 59 minutes N, and longitude of 83 degrees 03 minutes W.

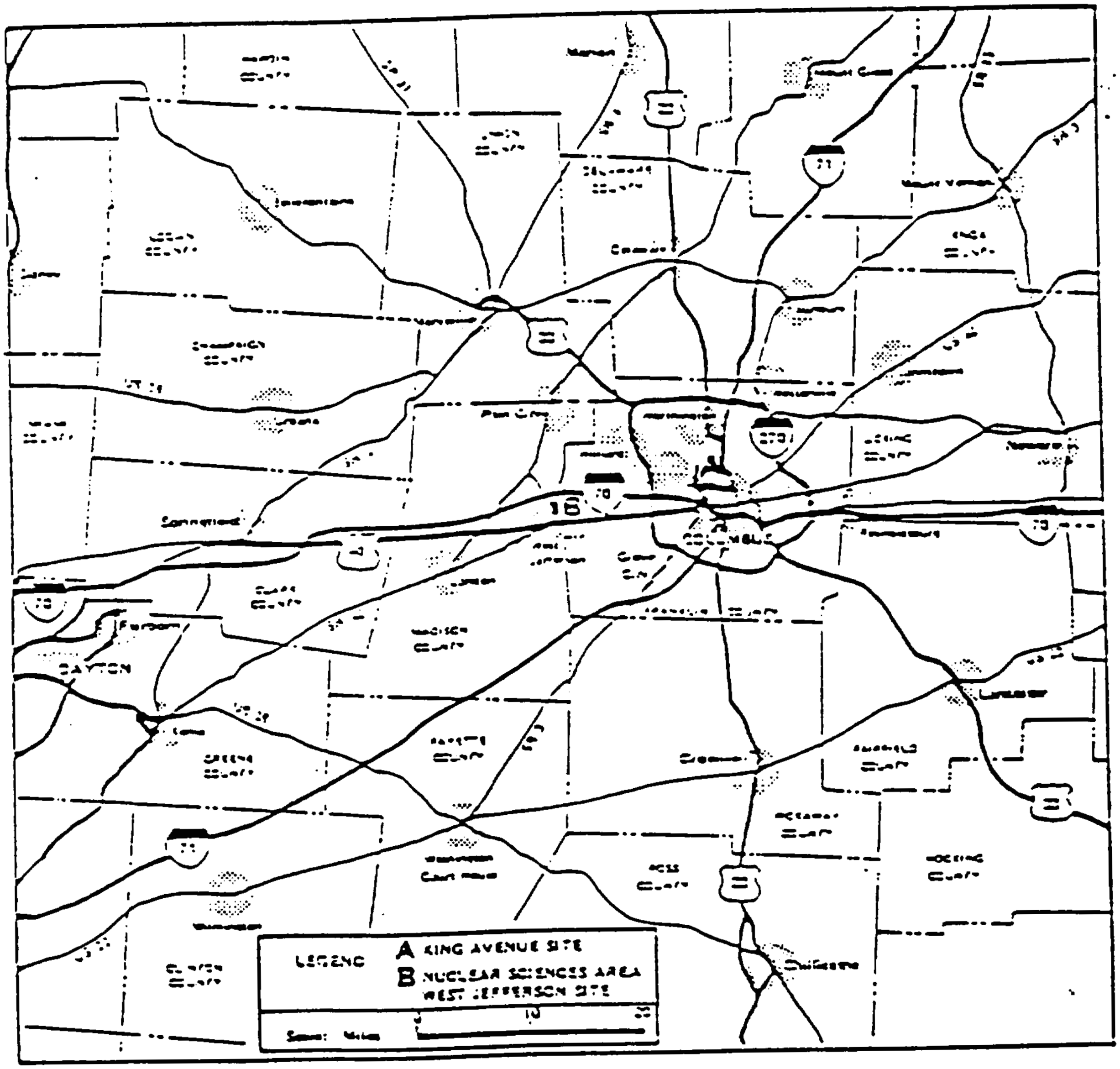


FIGURE 1-1. REGIONAL MAP FOR KING AVENUE AND WEST JEFFERSON SITES

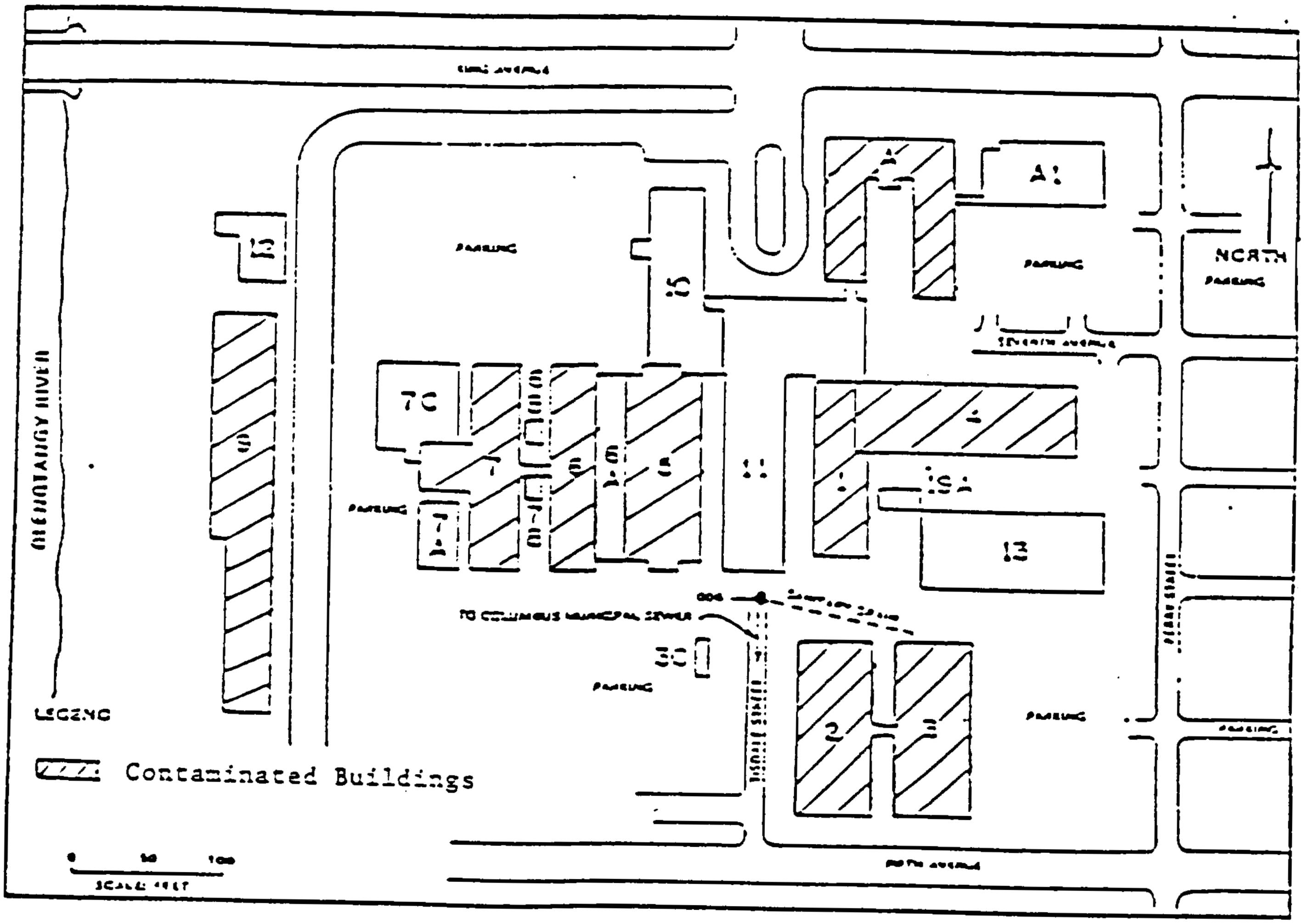
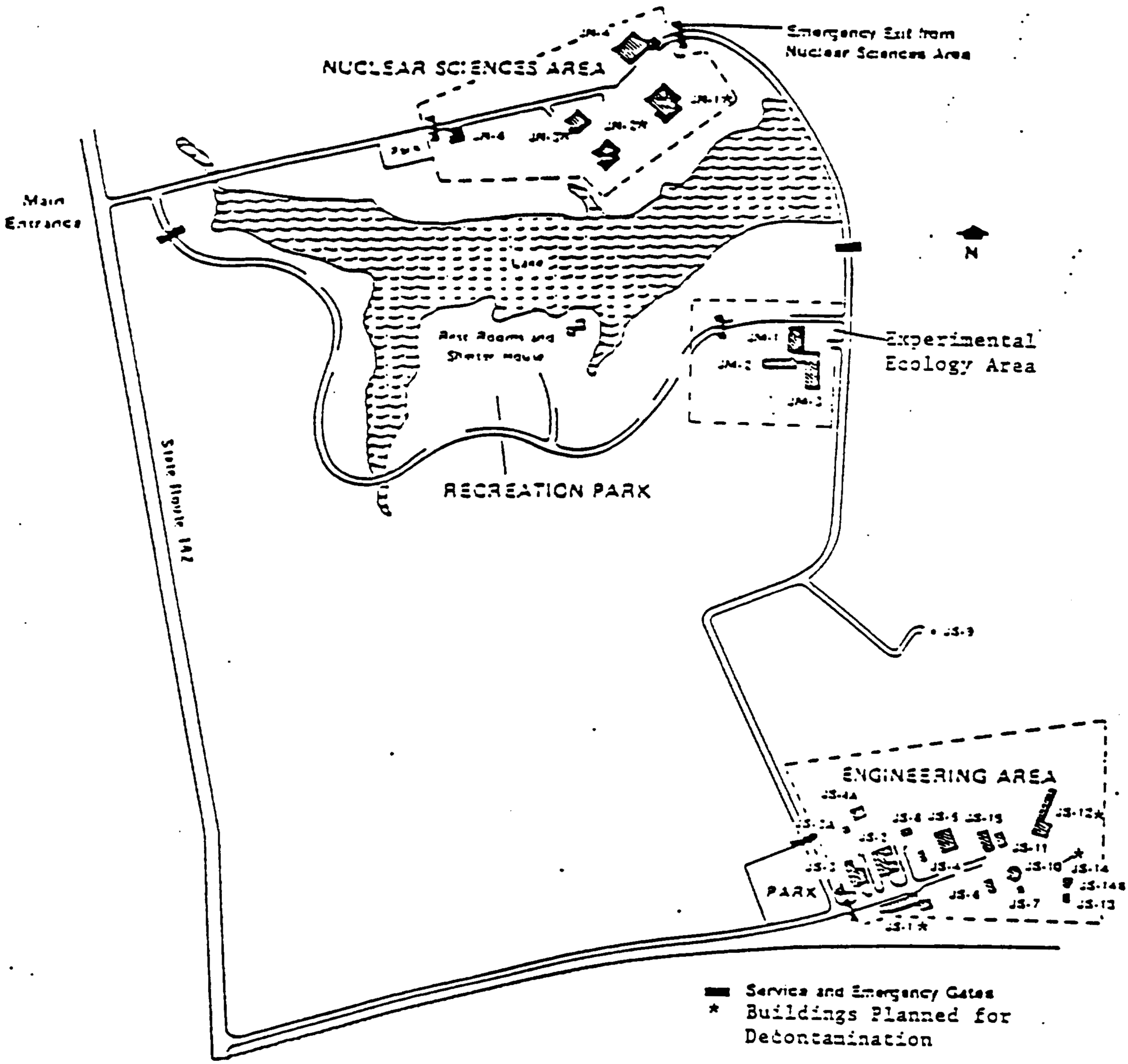


FIGURE 1-2. BATELLE COLUMBUS DIVISION KING AVENUE SITE



JN-1 Hot Cell Laboratory
JN-2 Administrative Building
JN-3 Decommissioned Research Reactor
JN-4 Hazardous Materials Laboratory
JN-6 Guardhouse
JM-1 Experimental Ecology and Health Services
JM-2 Greenhouse
JM-3 Medical Research and Evaluation Facility
JS-1 Hot Isostatic Processing Facility and Site Facilities
JS-2 Engineering and Pilot Plant Building, Gasification Laboratories
JS-3 General Engineering Building
JS-3A Rocket Laboratory
JS-4 High-Pressure Laboratory
JS-5 Pipe Research Facility
JS-6 High-Energy Fabrication Laboratory
JS-7 High-Energy Laboratory
JS-8 Pipe Research Facility
JS-8A Pipe Research Facility
JS-9 Storage
JS-10 High-Energy Containment Building
JS-11 Ballistics Shop Building
JS-12 High-Energy Ballistics Research Laboratory
JS-13 Ballistics Preparation Building
JS-14 Ballistics Preparation Building
JS-14B Ballistics Preparation Building
JS-15 Ballistics Assembly Building

FIGURE 1-3. BUILDING NUMBERS AND LOCATIONS - WEST JEFFERSON SITE

The ten-acre King Avenue facility comprising twenty-one buildings is bounded on the north by King Avenue, on the east by Perry Street, on the south by Fifth Avenue and on the West by the Olentangy River as shown in Figure 1-2. The areas surrounding the King Avenue site are high-density residential areas.

The West Jefferson site is approximately 15 statute miles west of the King Avenue facility and is located at a latitude of 39 degrees 58 minutes N, and longitude of 83 degrees 15 minutes W. The northern boundary of the West Jefferson site extends from the Plain City-Georgesville Road eastward to Big Darby Creek and is approximately one mile south of Interstate Highway 70. On the southern boundary are Conrail tracks. The eastern boundary of the site is parallel to Big Darby Creek. The western boundary is defined by the Plain City-Georgesville Road (See Figure 1-4). The site consists of a 1000-acre tract including the following three areas: (1) the Engineering Area in the southeastern portion, (2) the Experimental Ecology Area in the east central portion, and (3) the Nuclear Sciences Area in the northern portion. The areas immediately surrounding the site have a low population density and are primarily agricultural. Battelle Lake, the result of the damming of Silver Ditch, is located south of the Nuclear Sciences Area on the facility. The glaciated tills found at the surface of site are saturated but exhibit low permeability and yield. The principal aquifer is the unglaciated bedrock, which is 80 to 100 feet deep at the site.

As noted previously, nine of the buildings involved in the decommissioning action are located at the King Avenue Site in Columbus, Ohio. The nuclear research performed in these buildings included processing and machining of enriched, natural, and depleted uranium, thorium fuel fabrication, radiotracer studies, radiochemical analyses, and powder metallurgy studies. In addition, secure vault storage for nuclear material was provided in one of the buildings.

The remaining six buildings included in the decommissioning project are located at the West Jefferson site in West Jefferson, Ohio. Research was performed at two areas on the West Jefferson site: the Nuclear Sciences area (three buildings) in the northern portion, and (2) the Engineering area (three buildings) in the southeastern portion. The oldest and most highly contaminated building in the Nuclear Sciences area is the Hot Cell Building (JN-1). This building began operation in 1955 and has been used continuously for nuclear research studies. Work conducted there included examinations and evaluations of power and research reactor fuels; post irradiation examination of fissile control rod, source, and structural materials and components; and examinations of irradiation surveillance capsules. In addition, this building has been the site of radiation source encapsulation, and physical and mechanical property studies of irradiated materials and structures. The two other buildings at the Nuclear Sciences area are the old Critical Assembly Laboratory (JN-2) and the partially dismantled Research Reactor Building (JN-3). The Critical Assembly Laboratory was used for reactor critical assembly experiments, direct energy conversion experiments, experiment assembly, special nuclear materials handling, and plutonium research activities. Active nuclear experimentation was terminated in this building in 1970. Since then it has been used for administration offices. However, it still houses a special nuclear materials vault, although all special nuclear materials have

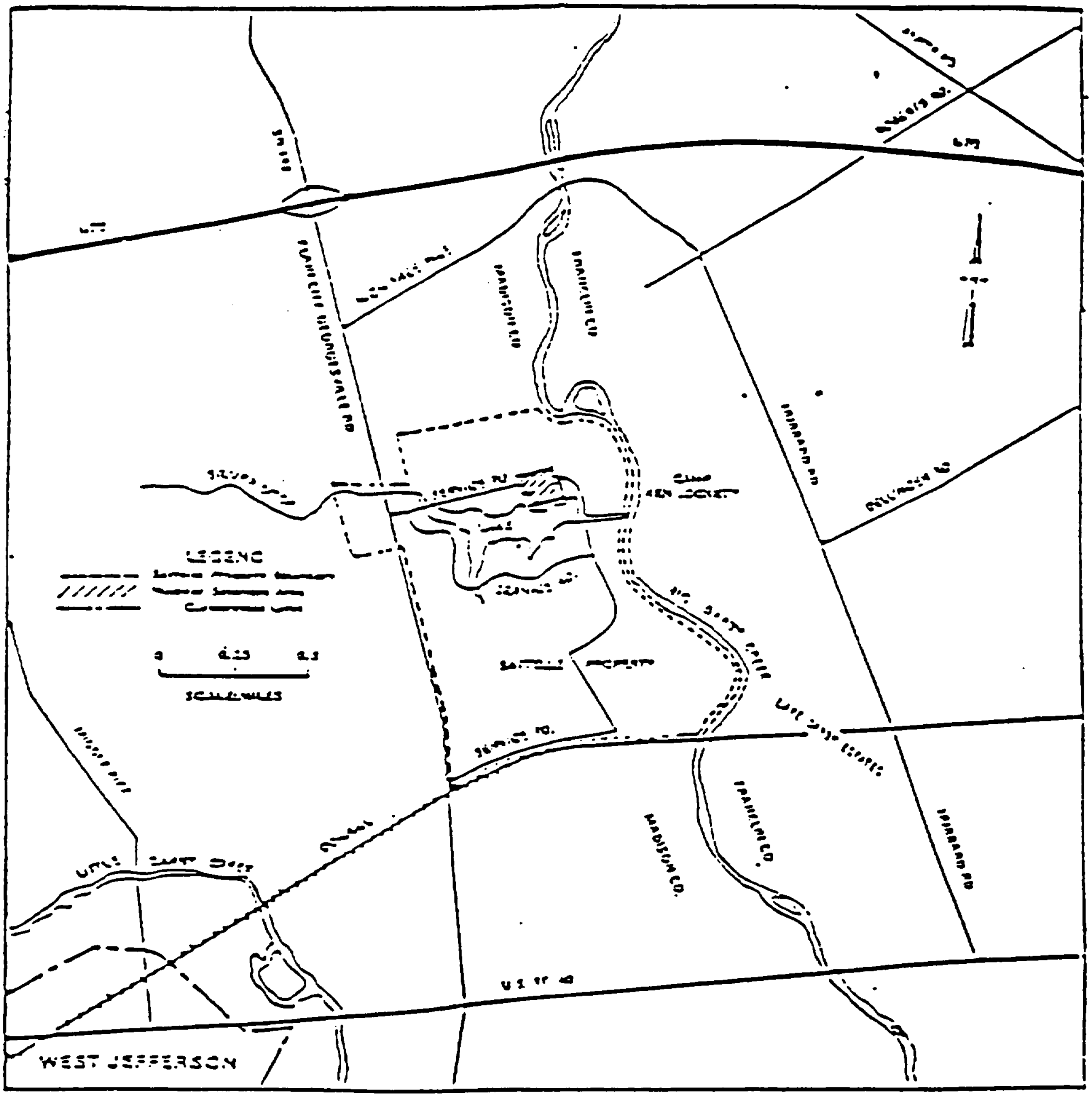


FIGURE 1-4. LOCAL VICINITY MAP OF NUCLEAR SCIENCES AREA WEST JEFFERSON SITE

been removed, and a radiochemistry laboratory which supports health physics and site environmental activities. The Research Reactor Building contains the Battelle Research Reactor which was actively used from 1956 until 1974. It was partially dismantled in 1974 and its license was changed to a possession only under SNM-7. Since then it has been used for short term waste storage. The three buildings in the Engineering area were used for fuel element fabrication and ballistics studies.

Further details on each facility's environmental setting can be found in the Site Characterization Plan (July 1989)[19].

2.0 CURRENT STATUS

This Section describes the existing radiological and non-radiological condition of the Battelle facilities. Section 2.1 describes the condition of the buildings, their contents at both facilities, and any interim actions that have been taken. Section 2.2 describes soil contamination at the West Jefferson facility.

2.1 BUILDING CONTAMINATION

Existing monitoring data and historical information indicate that building contamination consists of fission products, activation products, uranium, thorium, and suspect transuranics. There is no spent nuclear fuel or special nuclear material present at the sites except for those deposited on the surface of the Hot Cell and Hot Cell equipment at West Jefferson. The contamination is contained and fixed within the buildings and is monitored under an extensive surveillance and maintenance program. All operational materials, fuel remnants, special nuclear material, and stored operational wastes were removed during the phase-out of operations in the buildings. There have been no radioactive releases outside the buildings reportable under the Battelle Nuclear Regulatory Commission license and under 10 CFR Part 21 during the entire operation of the facility. There are, however, two areas of soil with slightly elevated radiation levels at the West Jefferson facility. This soil contamination is discussed in the next section.

The radioactive substances which have been processed in these Battelle facilities include fission products, activation products, uranium (natural, enriched, depleted), thorium, cobalt-60, carbon-14, and a few other individual nuclides. An estimated 6,055 Ci of radioactive contamination are present in the facilities. The following is an estimate of the distribution of this contamination among the facilities:

- Hot Cell Laboratory (JN-1 at West Jefferson) - Approximately 6,000 Ci, primarily fission products, activation products, uranium, and suspect transuranics.
- Battelle Research Reactor (JN-3 at West Jefferson) - Approximately 15 Ci, primarily fission products and activation products.
- Remaining Facilities - Approximately 40 Ci, primarily uranium and thorium.

Existing monitoring data indicate the general locations and types of surface contamination and contaminated systems. The Hot Cell Laboratory (Building JN-1) contains high radiation fields in the hot cells themselves (on the order of hundreds of R/hr), with lower levels in the operating areas (less than 2 mR/hr). Within the hot cells, surface contamination (as listed above) is as high as 1.2 x 10^6 dpm/100 cm^2 has been measured.[6] The remainder of the facilities contain contaminated floors, walls, ceilings, equipment, and/or interior drains. The contamination consists primarily of uranium and thorium. Surveys by Battelle and Argonne National Laboratory[6] have shown maximum surface contamination levels (basically uranium and thorium) of 357,000 dpm/100 cm^2 taken in the reactor building of JN-3. By comparison, U. S. NRC Regulatory Guide 1.86 and the Department of Energy guidelines[2] specify maximum acceptable surface contamination levels of 15,000 dpm/100 cm^2 (5,000 dpm/100 cm^2 average) for uranium and 3,000 dpm/100 cm^2 (1,000 dpm/100 cm^2 average) for thorium. The annual radiological reports indicate that safety controls and the location of the contamination have resulted in total doses to workers occupying the buildings full time of less than 100 mrem/yr.

Interim actions were initiated in the contaminated buildings at the West Jefferson and King Avenue sites in December 1989. These actions involve the removal of low levels of contamination from small areas of the floor in buildings JS-1 and JS-12. It was determined that these activities clearly had no significant impact on the environment and did not impact or limit the choice of reasonable alternatives for the rest of the project in accordance with 40 CFR 1506.1. This finding was documented in a memorandum to the file dated December 13, 1989, that describes the levels of contamination, decontamination activities, health impacts, waste volumes, and restraints.

Twenty sumps exist at the King Avenue site that contain sludge. The sludge from nineteen sumps (one was empty) was analyzed to determine whether it was a RCRA hazardous waste, and whether it contained pesticides, PCBs, or radioactive materials.[29] Figure 2-1 provides the location of these sumps. The results of these analyses are as follows:

- Neither pesticides nor characteristically hazardous metals were found at levels which would result in the sludge being classified as a EP toxic RCRA hazardous waste in any of the sumps.
- Three (3) sumps contain sludge which contains neither radioactive materials, nor PCBs in concentrations greater than 50 ppm.
- Three (3) sumps contain sludge with PCB concentrations greater than 500 ppm (i.e., 2300, 2900, and 880 ppm) but no radioactive material.
- Ten (10) sumps contain sludge with radioactive materials and PCBs at concentrations less than 50 ppm.
- Two (2) sumps contain sludge with radioactive materials and PCB concentrations greater than 50 ppm but less than 500 ppm.

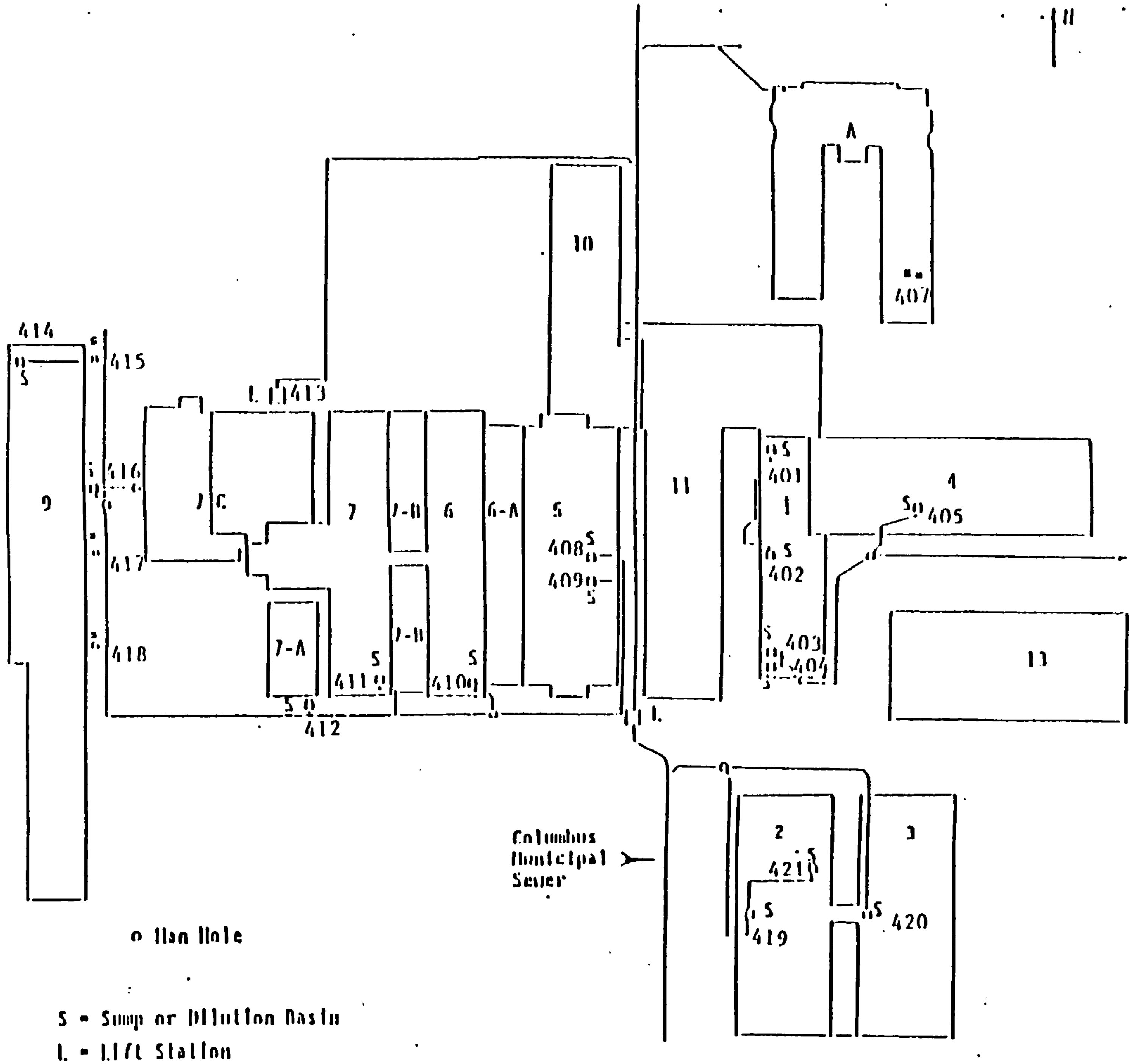


Figure 2-1. KING AVENUE SUMP SAMPLING LOCATIONS

- One (1) sump contains sludge with radioactive materials and a PCB concentration greater than 500 ppm (i.e., 1100 ppm).

- One (1) sump contained insufficient sludge to sample.

Table 2-1 summarizes the sludge sampling results and Table 2-2 the gamma spectroscopy results.

The Hot-Cell Laboratory at the West Jefferson facility includes a storage and transfer pool which contains approximately 125,000 gallons of slightly contaminated water. Recent analysis of the pool water shows the gross beta-gamma activity excluding tritium to be about $6x10^{-6}$ uCi/ml. Predominant source of activity is Cs-137, which was measured at $2.7x10^{-6}$ uCi/ml. Tritium and Carbon-14 concentrations were also measured and the results were $2.9x10^{-4}$ uCi/ml and $8x10^{-12}$ uCi/ml, respectively. For the pool water volume of 125,000 gallons (473,000 liters) the total activity of the three nuclides present is estimated to be $1.3x10^{-3}$ Ci of Cs-137, 0.14 Ci of tritium, and $4x10^{-9}$ Ci of Carbon-14.

In addition to the monitoring data, historical records indicate the types of activities carried out in these facilities. The combination of monitoring data and historical records provides a preliminary basis for estimating exposures that may be expected during decontamination operations. Estimates of radiological exposure and conclusions about potential impacts discussed in Section 4.0 are based on these data.

2.2 SOIL CONTAMINATION

There are two areas of soil with slightly elevated radiation levels at the West Jefferson facility. This contamination is a result of years of activities performed for the Department of Energy at the site. There have been no radioactive releases outside the buildings reportable under the Battelle Nuclear Regulatory Commission license (No. SNM-7) and under 10 CFR Part 21.

The first area is a storm sewer outfall that collects storm water runoff from the roofs of buildings JN-1 and JN-4 and surface drains in the area at the West Jefferson-Nuclear Sciences Area. Low levels of radionuclides have accumulated at the outfall point for over thirty years. The soil at the outfall point has acted as a collection sump concentrating the radionuclides in a relatively small area at the outfall point. No residual radioactivity is expected in the sewer pipe itself because the nuclides were carried to the outlet point in the runoff water.

The contaminated area (approximately 210 feet by 70 feet) is adjacent to the service road leading to JN-4 and northwest of the Battelle Lake dam (Figure 2-2). Recent sampling data of the area indicate that the elevated levels are restricted to the top 6 inches or less of soil with the higher concentrations

TABLE 2-1. ANALYSIS OF KING AVENUE SUMP SLUDGE SAMPLES

Sample No.	Bldg No.	Sludge Depth in.	Gross Alpha pCi/g	Gross Beta pCi/g	EP Tox mg/L	PCBs ppm	Pest. ppm	Sludge Vol. ft^3
401	1	4	102	106	(a)	250	(c)	5
402	1	6	77	50	(a)	(b)	(c)	8
403	1	10	379	252	(a)	(b)	(c)	16
404	1	15	99	105	(a)	(b)	(c)	24
405	4	11	155	153	(a)	1100	(c)	18
407	A	12	27	21	(a)	(b)	(c)	12
408	5	12	1013	823	(a)	5	(c)	16
409	5	24	665	925	(a)	3	(c)	29
410	6	36	431	156	(a)	(b)	(c)	48
411	7	36	36	201	(a)	10	(c)	60
412 *	7A	72	18	11	(a)	(b)	(c)	54
413 *	7C	13	10	7	(a)	(b)	(c)	20
415 *	9	13	13	25	(a)	2300	(c)	19
416 *	9	36	15	13	(a)	2900	(c)	39
417 *	9	12	8	11	(a)	880	(c)	13
418 *	9	12	8	9	(a)	(b)	(c)	13
419	2	30	287	794	(a)	150	(c)	40
420	3	13	1295	532	(a)	11	(c)	24
421	2	4	44	65	(a)	18	(c)	3
Background (d)			29	41				

* These sumps are located outside the building.
(a) Below Extraction Procedure Toxicity Limit
(b) Below Lower Limit of Detection for PCBs
(c) Below Lower Limit of Detection for Pesticides
(d) Average of 2 soil samples taken at Worthington and Columbus, Ohio.

TABLE 2-2. GAMMA SPECTROSCOPY RESULTS

Sample No.	Bldg No.	Gamma Spectroscopy Results, pCi/g					
		Co-60	Cs-137	Pb-212	Ra-226[a]	Th-232[a]	U-238[a]
401	1	(b)	(b)	4.8	11	4.5	20
402	1	(b)	(b)	7.4	(b)	6.4	4
403	1	(b)	(b)	52	1.5	47	50
404	1	(b)	(b)	4.9	13	5	10
405	4	1.7	5.2	2.3	2.8	2.3	80
407	A	1.7	(b)	1.1	1.7	0.7	(b)
408	5	(b)	(b)	5.5	1.2	5.5	360
409	5	6.4	(b)	10	(b)	15	450
410	6	8.2	(b)	56	8.7	(b)	15
411	7	(b)	(b)	(b)	(b)	(b)	(b)
412 *	7A	(b)	(b)	(b)	(b)	(b)	(b)
413 *	7C	(b)	(b)	1.1	0.7	(b)	(b)
415 *	9	(b)	(b)	(b)	1.4	(b)	(b)
416 *	9	(b)	(b)	(b)	(b)	(b)	(b)
417 *	9	(b)	(b)	(b)	(b)	(b)	(b)
418 *	9	(b)	(b)	(b)	(b)	(b)	(b)
419	2	(b)	(b)	7.9	(b)	7.2	350
420	3	8.9	1.6	30	0.8	32	290
421	2	(b)	0.5	1.2	(b)	(b)	25

* These sumps are located outside the building.
(a) Inferred from presence of daughters products.
(b) Not detected.

found in a small area closest to the outfall pipe, approximately 10 feet wide by 60 feet long. Sampling indicates that all the contamination is isolated in the area of the outfall and no contamination has been identified in the immediate vicinity of Battelle Lake. Elevated levels of four isotopes have been measured in this area; Cs-137, Co-60, Am-241, and Pu-239. Table 2-3 provides the average concentrations found at depth, the maximum concentration measured, the estimated number of Curies, and the CERCLA reportable quantity limit for each isotope. The estimated number of Curies for each isotope is conservative because it is based on the average concentration of each isotope and double the area identified as contaminated. All isotopes are below the CERCLA reportable quantity limit.

Table 2-3. Concentrations of Radionuclides in Soil at Storm Sewer (pCi/g)

Const.	Avg. 0-6 in.	Avg. 6-12 in.	Max.	Curies (10^{-4})	CERCLA Reportable Quantity (Ci)
Cs-137	1.27	0.327	4.9	10.55	1
Co-60	1.02	0.25	11.2	8.39	10
Am-241	0.575	0.275	5.1	5.62	0.01
Pu-239	1.5	0.071	5.9	10.39	0.01

In addition, pathway analyses (using RESRAD[30]) indicate that the maximum dose to a family living at the outfall, farming and consuming their crops (a very conservative assumption), would be 71 mrem/yr at time zero. The total dose decreases with time. The Department of Energy's criterion for release without radiological restrictions is 100 mrem/yr (from all sources) plus "As Low As Reasonably Achievable" (ALARA). Any remediation of the storm sewer area, therefore, will be conducted to meet the Department's ALARA policy. Based on these results, CERCLA is not applicable to this portion of project.

Elevated levels of radioactivity have also been identified in two retired filter beds on the West Jefferson facility (Figure 2-2). The two filter beds were constructed as a secondary control to filter particulates from the sanitary sewer effluent water. The filter beds were designed to accumulate radionuclides. The nuclides in these filter beds accumulated over a period of about twenty years. Continued routine monitoring of liquid effluent from the filter beds shows no release of radioactivity in this stream.

There is a large filter bed, approximately 105 feet by 60 feet, and a small filter bed, approximately 75 feet by 35 feet. The filter beds are located between the service road to JN-4 and Big Darby Creek. Both beds are approximately 10 feet deep. In 1980, portions of the bed media were removed, packaged as low-level radioactive wastes, and shipped to an approved

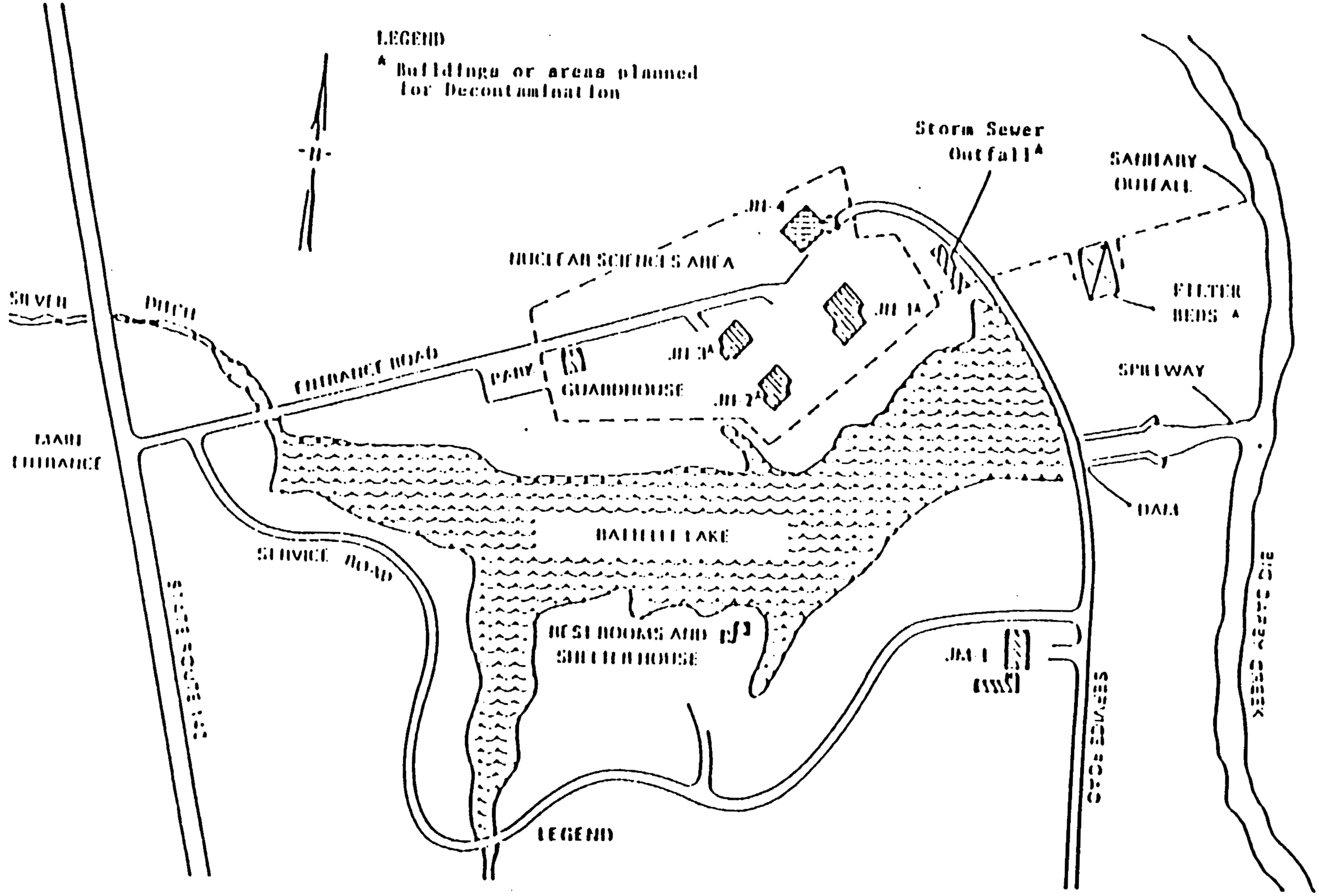


FIGURE 2-2. NUCLEAR SCIENCES AREA, WEST JEFFERSON

radioactive waste disposal site. Based on analyses of samples taken from the remaining filter media, the Nuclear Regulatory Commission (NRC) authorized Battelle to backfill the beds with clean sand, blend the sand with the remaining filter bed media, and cover the blended material with three feet of soil. This was completed in 1982. Recent samples from the large filter bed exhibited average concentrations of 20 pCi/g for Cs-137, 0.3 pCi/g for Co-60, and 1.5 pCi/g for Am-241. The highest level of concentrations of 223 pCi/g for Cs-137, 1.3 pCi/g for Co-60, and 7.6 pCi/g for Am-241 are at a depth of approximately four feet in an area of approximately 60 feet by 30 feet concentrated in the southwest corner of the large filter bed. Similar data from the small filter bed exhibited average concentrations of 8.3 pCi/g for Cs-137, 0.4 pCi/g for Co-60, and 0.2 pCi/g for Am-241. The highest level of concentrations of 32 pCi/g for Cs-137, 0.6 pCi/g for Co-60, and 0.5 pCi/g for Am-241 are a depth of approximately six feet in an area of approximately 45 feet by 20 feet. The two filter bed areas total approximately 9,000 square feet. As with the storm sewer outfall area, total calculated Curie content for the filter beds (i.e., Co-60, $10.1x10^{-4}$; Cs-137, $5.5x10^{-4}$; Am-241, $10.6x10^{-4}$) is also below CERCLA reportable quantities. Any further remediation of the filter beds will also be conducted to meet the Department's ALARA policy because the original closure of the beds was conducted under the direction of the NRC. Because of the low amounts of radionuclides present and the NRC approved closure, CERCLA is not applicable to this portion of the project.

3.0 DISCUSSION OF ALTERNATIVES

The project generally consists of disposition of radioactively contaminated buildings at the King Avenue and West Jefferson facilities and disposition of contaminated soil at the West Jefferson facility. Sections 3.1 and 3.2 describe and screen the alternatives for each of these activities. The remainder of the Section describes how the viable alternatives would be implemented including discussions of safety and waste management.

3.1 DISPOSITION OF RADIOACTIVE AND NON-RADIOACTIVE CONTAMINATION

Alternatives have been evaluated for disposition of the radioactively contaminated buildings at the West Jefferson and King Avenue facilities and slightly elevated radioactive contaminated soil at the West Jefferson facility. The alternatives are: 1) no action, which consists of continued surveillance and maintenance and 2) decommissioning of the facilities. The alternatives and alternate approaches to the action alternative are evaluated below.

3.1.1 No Action

The no action alternative is to continue surveillance and maintenance of the contaminated facilities. The surveillance and maintenance activities include a continued environmental monitoring program to maintain assurance that radioactive contamination has not escaped to the environment. Regularly scheduled inspection and maintenance of health, safety, and radiation protection equipment and instrumentation calibration are performed and documented. A program of health physics surveillance monitoring and personnel dosimetry has been established, and emergency planning, training and drills have been conducted. All surveillance and maintenance activities are conducted under an existing nuclear quality assurance program consistent with DOE Order 5820.2A (NQA-1) and 10 CFR 50 Subpart B.

The Department of Energy elected to discontinue nuclear materials research and development at Battelle Columbus under contract W-7405-ENG-92 in 1985. Battelle plans to maintain their active NRC license (No. SNM-7). These facilities are an integral part of the Battelle Columbus operations and the Department of Energy is contractually obligated, in a timely manner, to make them available for Battelle's use without radiological restrictions. Accordingly, perpetual surveillance and maintenance is not a viable option.

3.1.2 Decommissioning of the Facilities

This action involves removal from the buildings of fluids (i.e., water and hydraulic oil), including the 125,000 gallons of pool water at the West Jefferson Hot Cell, piping, equipment, components, structures, and waste having radioactivity levels greater than those permitted for release of the property. The decontamination will reduce contamination to levels consistent with use of the facilities without radiological restrictions.[2] Wastes generated during the operation would be managed in accordance with all applicable Federal and State requirements and Department of Energy guidelines. Decommissioning would be conducted in a manner that no uncontrolled releases of radionuclides or hazardous materials to the surrounding environment would occur. There are a number of approaches to accomplishing this task which are discussed below. An analysis of the risks associated with the decommissioning alternative and its approaches is provided in Section 4.0.

For the contaminated soils this action involves leaving the soil in place with additional institutional controls or removing the soil. The approach to accomplish this task is discussed below. A brief analysis of the risks associated with these alternatives is also provided in Section 4.0.

3.1.2.1 Approach to Decommissioning

The approach for decommissioning these facilities is to decontaminate and remove radioactive or contaminated (PCB or asbestos) equipment/materials/soil from the facilities on site to permit reuse of the property.[1] For the facilities in question this will generally involve dismantlement and/or removal of equipment; decontamination of building structures; and appropriate restoration of the buildings; treatment and disposal of the Hot Cell Pool Water; implementing additional institutional controls for the contaminated soil or removing and disposing of the soil as a low-level radioactive waste.

The decontamination operations are similar to activities undertaken as part of routine nuclear research and development at the Battelle facilities and at other facilities around the country over the past 45 years. The general decontamination approach will be the same for all fifteen buildings.

3.1.2.2 General Building Decommissioning Plan

The general decommissioning plan for the buildings involves the following sequence of operations:

- Perform a comprehensive radiological survey to further define the extent and location of contamination for purposes of scoping and planning the decontamination and decommissioning effort.
- Relocate non-nuclear operations and staff (as required).
- Isolate the area to be decontaminated and install access control.
- Cap all floor drains.
- Survey and remove uncontaminated equipment; package contaminated equipment for disposal.
- Remove pipes, ducts, and drains; survey and package contaminated material for disposal.
- Decontaminate ceilings, walls, and floors consistent with the Department of Energy Guidelines.[2]
- Survey for residual contamination and continue the decontamination as necessary.
- Release individual buildings for reuse as independent verification is completed.
- Implement certification procedures for eventual development of a certification docket for the entire site.

All of the decontamination and decommissioning operations will be carried out with suitable technical and administrative controls to minimize the risks of inadvertent exposure and contamination. Such controls include:

- protective clothing for workers
- tents, bags, or other containment to isolate operations area
- HEPA filter systems with monitors and alarms
- emergency air, power, and other supplies
- radiation monitors, area and personnel dosimetry, etc.
- isolation of workers

These controls will also be instrumental in preventing the spread of contamination outside the facilities during decontamination.

be disposed of as low-level radioactive waste or managed as suspect TRU waste at Hanford, an approved Department of Energy site.

- o Ultrasonic Cleaning - The ultrasonic cleaning process uses intense sound and water vibration to remove surface contamination from metal surfaces. The process generates a liquid waste that consists of surface contamination and water. The liquid, if radioactive, will be filtered and evaporated on site at West Jefferson. The remaining sludge will be solidified in concrete or other solidification agents (such as LIQUI-SET), and packaged in approved containers for disposal as low-level radioactive waste or managed as suspect TRU waste at Hanford, an approved Department of Energy site.

- o Electropolishing - In-situ electropolishing will be used to clean stubborn "hot" spots from metal surfaces. This nonmechanical method will involve cleaning the metal surface via an electrolytic circuit. The process will generate a small amount of waste electrolyte solution (i.e., RADIAC, a mild detergent) through rinsing. The liquid, if radioactive will be filtered and evaporated on site at West Jefferson. The waste will be packaged in approved containers for disposal as low-level radioactive waste or managed as suspect TRU waste at Hanford, an approved Department of Energy site.

- o Concrete Cutting - Concrete cutting will be employed to remove contamination that has penetrated a crack. Dust and debris will be controlled with a water spray. The water, if radioactive will be filtered and evaporated at West Jefferson. The contaminated concrete will be packaged directly into approved waste drums for disposal as low-level radioactive waste or managed as suspect TRU waste at Hanford, an approved Department of Energy site.

The volumes of estimated waste generated in each building using the above methods are discussed in Section 3.2 (See Table 3-1).

In addition to the methods described above, special safety requirements will be applied to the Hot Cell Laboratory in JN-1 which include remote operations and radiation protection provisions for workers. The contaminated materials from the Hot Cell will be packaged in approved containers for temporary storage as a suspect TRU waste at Hanford, an approved Department of Energy site until the Department's Waste Isolation Pilot Plant in New Mexico is ready to accept waste. Some mixed waste, in the form of lead shielding may be generated. It will be properly packaged and sent to Hanford for temporary storage.

There are nineteen sumps with sludge for this project. The sludge will be pumped from the sump using a slurry pump and filter press to remove excess liquid. Measurements indicate that there is approximately 17 yds^3 of wet sludge in all sumps (see Tables 2-1 and 2-2). No action is necessary for the three (3) sumps containing non-radioactive and non-PCB containing sludge (approximately 3 yds^3). Sludge that contains PCBs in concentrations greater than 500 ppm and no radioactive materials (3 sumps, approximately 3 yds^3) will be incinerated at a permitted PCB incinerator. Sludge with PCB concentrations less than 50 ppm and containing radioactive materials (10 sumps, approximately 9 yds^3) will be packaged in approved containers for disposal as low-level radioactive waste at Hanford, an approved Department of Energy site. The remaining sludge (3 sumps, approximately 2 yds^3), with PCB concentrations greater than 50 ppm and containing radioactive materials, will be properly packaged and sent to the Department's Oak Ridge Reservation for storage and incineration in the PCB/radioactive waste incinerator expected to be permitted soon or to Hanford for storage and eventual incineration. No commercial PCB/radioactive waste incinerators or treatment facilities are currently available.(29) The transportation and generator requirements of the Toxic Substance Control Act will be followed whenever PCB contaminated sludge is shipped.

3.1.2.4 Decontamination Methods for Hot Cell Pool Water

Two options for the treatment and disposal of the 125,000 gallons of hot cell pool water were reviewed on the basis of allowable 10 CFR 20 release limits. The options are discussed below.

- <u>Evaporation</u> - Under this option, the pool water will be evaporated and released as steam while the radioactive contaminants will be concentrated in the evaporator. Prior to the start of the evaporation process, the pool water will be pumped through a filter and ion exchange system to reduce the radioactivity significantly (below 10^{-7} uCi/ml beta-gamma). The process will be conducted on-site by a qualified and licensed contractor. The process will concentrate most of the radionuclides except tritium in the sludge. A small amount of radionuclides may be released in the water droplets entrained in the exhaust steam. For cesium this is estimated at less than 10^{-13} uCi/ml which is insignificant compared to the allowable release limit of 6×10^{-8} uCi/ml (10 CFR 20 Appendix B). Ion-exchange processing will not reduce the tritium in the water. When the water is evaporated, the concentration of tritium in the vapor would be 2.4×10^{-7} uCi/ml at the exhaust point of the evaporator. With an additional dilution factor of 10^{-4} from the exhaust point to the site boundary, the discharge rate of tritium will be $<10^{-11}$ uCi/ml. This value is significantly less than the allowable release limit of 2×10^{-7} uCi/ml specified in 10 CFR 20 Appendix B. Evaporation will result in the concentration of Cs-137 in the sludge which will be solidified. Less than 2.7 cubic yards of waste of relatively low activity is expected to be generated. The entire evaporation process will be largely automated resulting in very low radiation exposures to workers.

- <u>Direct Discharge into Effluent Streams</u> - In this option, the pool water will be pumped through the ion exchange demineralizer system until the activity is reduced to $<10^{-8}$ uCi/ml (Beta-Gamma) prior to discharge. The process will be conducted on-site by a qualified and licensed contractor. The pool water concentrations for Cs-137 (2.7×10^{-6} uCi/ml), tritium (2.9×10^{-4} uCi/ml), and C-14 (8×10^{-12} uCi/ml) are currently significantly lower than the 10 CFR 20 limits for discharge of these species, i.e., 4×10^{-4}, 0.1, and 2×10^{-2} uCi/ml above background, respectively. Direct discharge of the treated pool water would be to the effluent systems storm sewer. The site has a National Pollutant Discharge Elimination System permit. This process would result in low radiation exposures to workers and reduced volumes of radioactive waste.

Based on the above discussion, pool water management by either evaporation or direct discharge appear to be viable and environmentally acceptable options.

3.1.2.5 Disposition of Contaminated Soils

As stated in Section 2.2, any remedial action taken with contaminated soils at the West Jefferson site will be based on the Department of Energy's ALARA policy because there is no radiologic threat to the public from the storm sewer and filter bed area. ALARA guidelines will be developed for the project. There are three possible approaches for handling the slightly elevated radioactive contaminated soil that can be incorporated into these guidelines.

The first approach, no action, is continued surveillance and maintenance and is discussed in Section 3.1.1 for the contaminated buildings.

The second approach is to leave the soil in place and add additional institutional controls to ensure that the public is not exposed to the radioactivity. The type of control will depend upon the level of exposure, type of radionuclide, and exposure pathways. The controls could include: 1) fencing, 2) surveillance by Battelle security staff, 3) capping with soil or non-earthen materials, 4) deed restrictions, and 5) restrictions on use of resources (e.g., ground water).

The steps necessary to implement this option will depend on the institutional controls selected. In general, however, they will follow the following sequence: 1) characterization of the area to define the extent of the area to be placed under institutional control, 2) implementation of the selected method, 3) surveillance and maintenance (if necessary) until the area may be released, 4) verification that the area may be released for use without radiological restriction by an Independent Verification Contractor, and 5) preparation of the certification docket.

The third approach is the removal and disposal of the soil as a low-level radioactive waste. The Am-241 in the soil is not a TRU waste because the quantity present, a maximum estimate of 6.9×10^{-3} nanocuries per gram, is less than the 100 nanocuries per gram TRU waste criteria. If soil removal is selected, less than 300 cubic feet of soil is expected to be removed from the storm sewer discharge area and approximately 3,000 cubic yards of soil is expected from the filter bed areas. Both these estimates are based on the most severe contamination scenarios and, therefore, are maximum values. Implementation steps are generally as follows:

- o Perform a radiological survey to establish type and extent of contamination for purposes of planning the effort.
- o Isolate the contaminated area and control access to prevent contaminated soil from being carried/trucked off-site.
- o Implement administrative controls (i.e., radiation work permit) to minimize the risks of inadvertent exposure and contamination.

- Excavate contaminated soils and properly package in certified LSA boxes for shipment to Hanford, an approved Department of Energy low-level disposal site.

- Perform verification survey (by Independent Verification Contractor) to determine if area can be released for use without radiological restriction.

- Prepare certification docket.

Dust formation will be prevented by maintaining the soil in a dampened condition to preclude airborne contamination but not soaked to cause the contamination to migrate deeper into the soil.

All three approaches are environmentally viable for this project. The impacts and risks posed by these options are analyzed in Section 4.0. The Department's conclusions regarding a preferred alternative are presented in Section 5.0.

3.2 WASTE MANAGEMENT

Approximately 227,000 $ft.^3$ of low-level radioactive waste and approximately 8,000 $ft.^3$ of suspect TRU waste (once packaged for contact handling, volume will be 59,700 $ft.^3$), in the form of decontamination debris contaminated with daughter products, is expected to be generated from the buildings. This includes approximately 81,675 cubic feet of low-level radioactive contaminated soil which may be generated. The estimated volumes of waste for each building and the soil is provided in Table 3-1. These volumes are based on a radiologic survey of each building and contaminated soil area.

All radioactive waste will be characterized and classified in detail and will be packaged in containers approved for each specific waste classification in accordance with the Department of Energy Orders 1540.1, 1540.2, 5480.3, and 5820.2A, and with the disposal site's acceptance criteria. Certification plans for low-level and suspect TRU waste will be prepared and submitted to the Department of Energy for approval to ensure that acceptance criteria are met.

Disposal of low-level waste will be at the Department of Energy-Hanford burial site under an on-going agreement. Suspect TRU waste will be shipped to the Department of Energy-Hanford site for certification to the Department of Energy's Waste Isolation Pilot Plant waste criteria. The packaged waste will be transported to the burial site by an approved transporter. Approximately 116 truck shipments of suspect TRU waste and 409 shipments of non-transuranic waste are anticipated.

Wastes which are not radioactively contaminated will be so certified by the Health Physics staff prior to final disposition. Approximately 13,000 $ft.^3$ of primarily concrete rubble is expected to be generated at the King Avenue site and between one and four times that volume at the West Jefferson site. Non-radioactive waste from the King Avenue site will be disposed of via local landfills or removed as scrap. The volume generated will result in approximately one dump truck load a month leaving the site. Numerous landfills are available in the area to handle this material. Non-contaminated rubble at the West Jefferson site will be used as fill material on-site. No permit is required, in Ohio, for on-site rubble fills.

Table 3-1. Estimated Radioactive Waste Volumes (Cubic Feet)

Building or Location	Suspect TRU	Low-Level
A	0	400
1	0	2,400
2	0	775
3	0	6,900
4	0	930
5	0	1,300
6	0	500
7	0	300
9	0	100
JS-1	0	800
JS-10	0	800
JS-12	0	800
JN-1	59,700	104,000
JN-2	0	100
JN-3	0	25,500
Outfall	0	300
Filter Beds	0	81,375
Total	59,700	227,280
Minimum Number of 55 Gallon Drums	8,144	30,304

No hazardous wastes have been identified in the 15 buildings nor is any expected to be generated. Decontamination methods will be selected that do not use hazardous chemicals (i.e., solvents) which will avoid generation of mixed waste. Radioactive mixed waste, in the form of contaminated lead shielding, may be generated during decommissioning of JN-1. This material will be managed in accordance with RCRA and sent to Hanford for ultimate disposal.

PCB wastes will be sent to a licensed PCB facility. Asbestos may be encountered which will be appropriately packaged prior to disposal. Radioactively contaminated asbestos will be disposed of as low-level radioactive waste.

3.3 RADIATION SAFETY

Radiation protection for both decontamination workers and the general public will be emphasized. Staff familiar with the activities conducted at these facilities and with the radiation hazards that exist will be available to participate in the decontamination and decommissioning efforts. These staff are experienced in radiological health, safety requirements, and procedures. However, good operating practices dictate refresher training for all involved staff. Staff turnover can be anticipated over the course of the decontamination and decommissioning effort and all workers will receive radiation safety training prior to beginning decontamination activities. This training will include biological effects of radiation, protective clothing requirements, use of respirators, and external and internal exposure control methods specific to the activity being performed. Health physics staff will be assigned to each work crew to review procedures and proposed activities, monitor activities to enforce as low as reasonable achievable principles, survey radiation levels, and maintain personnel exposure.

Health physics staff will have authority to stop any operations which they believe may involve unusual, unnecessary, or excessive radiological risk to workers, the public, or the environment.

Areas within buildings being decontaminated will be isolated and maintained as closed systems under negative pressure relative to atmospheric pressure to prevent the release of radioactive contamination outside the work areas during decontamination operations. All radioactive wastes generated will be collected and packaged in approved containers and the outside of containers will be decontaminated prior to removal to clean areas. Air releases will be prevented by: 1) a system of air locks at entrances, 2) a negative pressure work area, 3) HEPA filtration systems on equipment exhaust pickups and the room exhaust, 4) use of water sprays where feasible to reduce dust, and 5) closure of ducts, vents, and passages. Water releases will be prevented by sealing all effluent outlets from the enclosed work areas. In addition, an environmental monitoring program will continue throughout the decontamination operations to assure early detection of any releases. This monitoring program is designed to meet the requirements of the Battelle's Nuclear Regulatory Commission license and to assure compliance with Department of Energy Order 5480.1. This program consists of regular surveys at King Avenue augmented by water effluent measurements and air monitors as appropriate. At the West Jefferson site, continuous air monitors are located throughout the site and are set to alarm if derived air concentration levels are exceeded. Additionally, environmental samples are taken on a regular basis. These include soil, water, sediment, grass, food crops, and fish specimens.

Decontamination operations which could lead to airborne contamination (primarily scabbling) will employ multiple-stage filtration systems to protect both workers and the public. The decontamination equipment will be equipped with a rough filter and a HEPA filter, in series, and will exhaust to the intake of the exhaust system for the area being decontaminated (see next paragraph). This will assure local pickup of particulates as they are generated and will preclude the build-up of airborne contamination in the area being decontaminated. The HEPA filter will be equipped with a pressure gauge to monitor filter performance. If the pressure drop moves outside a preset range -- too low signifying filter malfunction and too high signifying the need to change filters -- operations will be stopped and the filters will be replaced. As an additional safeguard, constant air monitors will be employed in the area being decontaminated to monitor for buildup of airborne radioactive contamination.

Air exhaust for the area being decontaminated will pass through a rough filter and 2 HEPA filters in series. Both HEPA filters will be equipped with pressure gauges to monitor filter performance, as described above. In the event of an out-of-range pressure drop across either HEPA filter, operations will be suspended and the filter will be replaced. The presence of a triple-filter system, together with monitoring of HEPA filter performance, will prevent the release of airborne particulate contamination from the area being decontaminated. Battelle's experience shows that approximately 97 percent of radioactive particulates are captured in the rough filter, with HEPA filters removing 99.97 percent of the remaining particulates. Therefore, the combination of a rough filter and 2 HEPA filters in a series limits particulate release to less than 3×10^{-7} percent of the airborne particulate contamination in the area being decontaminated, and this is already low because decontamination equipment will capture and filter out particulates as they are generated.

In summary, the use of HEPA filtered decontamination equipment prevents exposure of workers to airborne particulate contamination. The use of redundant HEPA filters for air exhaust from the decontamination area prevents release to the public. Monitoring of filter performance assures that operations which could generate airborne contamination are stopped in the unlikely event of a HEPA filter failure. HEPA filter failure is extremely rare, and the simultaneous failure of three filters in series is even more improbable.

3.4 CONFIRMATORY SURVEY AND RESTORATION

Following the decontamination of each facility and soil area, a confirmatory survey performed by an independent verification contractor will be conducted to assure that the facility or area has been decontaminated to levels consistent with the Department of Energy's guidelines for use without radiological restriction.[2,5] Because some of the contamination is under Nuclear Regulatory Commission license, the Department of Energy will coordinate review of the confirmatory survey results with Nuclear Regulatory Commission to assure that the requirements of U.S. NRC Regulatory Guide 1.86 are satisfied.

3.5 SCHEDULE AND COST

The decommissioning alternative is scheduled to take over 8 years beginning in 1990. The estimated cost is $94.4 million in constant FY 89 dollars exclusive of planning costs. The no action alternative costs were approximately $1.4 million for FY 89.

4.0 ENVIRONMENTAL CONSEQUENCES AND MITIGATION

Potential environmental consequences and mitigation measures associated with the proposed action and alternatives are discussed in this section. Potential impacts are divided under the major headings of Radiological Impacts (Section 4.1) and Non-Radiological Impacts (Section 4.2).

4.1 RADIOLOGICAL IMPACTS

The potential radiological impacts of the decontamination and decommissioning alternative and No Action alternative associated with the project are divided into impacts on human health (both workers and the public) and impacts on biota. Estimates of both occupational and public radiological exposures were estimated and compared with applicable Department of Energy standards.[7,8] The associated risk estimates reflect the potential mortality from cancer in the exposed population (or individual) and of significant genetic defects in progeny as a consequence of the exposures. A risk coefficient expresses the numerical relationship between exposures (i.e., doses) and their potential health effects. The risk coefficient used here is 600 health effects per million person-rem. The value is based on information provided by the National Academy of Sciences (i.e., The BEIR IV[26] report and preliminary review of the BEIR V[27] report), EPA[28], and other sources.

4.1.1 Human Health

The radiological impact for no action alternative is documented by Battelle's Environmental Health Physics Group's ongoing monitoring program. Battelle submits an annual Environmental Report on Radiological Parameters based on a range of environmental samples including air, water, grass, soil, and food crops to the Department.[10,11] Since the initial report submitted over twenty years ago, the data continues to indicate no significant radionuclide releases to the environment. Furthermore, data collected through 1987 suggest that there is no major site contamination. The annual report of radiation exposure for Battelle Columbus Laboratories pertains specifically to those staff that engage in the surveillance and maintenance program.[20] The total person-rem for visitors is 0.1 person-rem. This total dose represents a health risk of 6 x 10^{-5}. The radiological exposure to the general public is less that 0.1 person-rem, which is clearly insignificant. The total person-rem for the facilities are shown in Table 4-1.

Table 4-1 Total Person-rem Data for Battelle-Columbus Laboratories[a]

	Total Person-rem
Hot Laboratory	5.870
Services Groups	0.480
Visitors	0.100

(a) Risk Coefficient 6 x 10^{-4} per person-rem

For the decontamination and decommissioning alternatives, workers will be in direct contact with contaminated equipment, demolition materials, and possibly radioactive aerosols. Suitable precautions and protective equipment will be utilized to maintain exposures below occupational limits and ALARA principles will be implemented.

The risk of exposure for the general public has been estimated for two sub-groups: Battelle staff, not involved in decommissioning work, and the general public in areas around the Battelle sites. Non-involved Battelle staff include staff working in offices, laboratories, or shops near the facilities where decontamination will take place. At the King Avenue site, nearly all buildings are connected by hallways or service tunnels. Thus, there are credible indoor transfer pathways from contaminated sites to locations where Battelle staff will be present. These passageways, however, will be temporarily blocked with appropriate barriers as necessary to prevent contamination transfer.

There are approximately 1,000 Battelle staff assigned to the nine buildings at the King Avenue site and 40 Battelle staff assigned to the six buildings at the West Jefferson site that are scheduled for decontamination and decommissioning. These figures represent upper limits for the number of Battelle staff who will be located in close proximity to decommissioning operations. Many staff will be relocated from the buildings or away from the contaminated areas during the project. The primary potential exposure route for non-involved Battelle staff is expected to be the respiratory route. External irradiation is assessed as being minimal.

The other sub-group of the general public are persons residing or working near the King Avenue or West Jefferson sites. There are approximately 31,000 persons residing within 1 mile of the King Avenue site and 1,710,000 persons located within 50 miles. For the West Jefferson site these figures are 1,200 persons and 1,730,000 persons for the 1 mile and 50 mile radius, respectively. The general population is not expected to be exposed to decommissioning contaminants.

The following two sections discuss the radiological risks to these groups in greater detail.

4.1.1.1 Decommissioning Workers

For decommissioning workers, the total dose during building decommissioning was estimated and compared to the Department of Energy occupational guidelines.(7) Estimated radiation doses to decommissioning workers are shown in Table 4-2.

The highest exposure is less than 60 percent of the occupational guideline, and the mean exposure is less than 20 percent of the guideline. These individual dose estimates lead to a collective dose estimate for decontamination and decommissioning workers of 520 person-rem. Knowing the actual number of workers and the amount of time they will be in contaminated areas, allows the collective dose to be presented in person-rem (see Attachment A). Actual exposures are expected to be less than these estimates as a result of the implementation of ALARA principles during decommissioning operations. These estimates are consistent with Nuclear Regulatory Commission's conclusions that the dose impact of the decommissioning of nuclear facilities is small, particularly in comparison with operation of the facility over its lifetime.(9)

Worker exposure for both soil disposition options is expected to be insignificant. The activities observed to date are near concentrations derived as standards via pathways analyses.

Table 4-2 Estimated Exposures for Decontamination and Decommissioning Workers[a][d]

	Individual Exposure, Rem/yr[b]
Maximum	2.9
Mean	0.92
Guideline[c]	5.0

Collective Exposure 520 person-rem[b]

(a) Internal and external doses for the Hot Cell Laboratory based on operating experience. External doses in other facilities based on monitoring data. Internal doses in other facilities based on the inventory of predominant species to be removed.

(b) See attachment A. (Battelle's Radiological Exposure Estimates)

(c) See reference 7.

(d) Risk Coefficient 6×10^{-4} per person-rem

4.1.1.2 General Public

Estimated radiological doses from building decontamination activities for non-involved Battelle staff are presented separately from the remainder of the general public because the staff represent the individual "at the point of maximum annual concentration."[8] Non-involved Battelle staff will be relocated from buildings planned for decommissioning.

Estimated doses for non-involved Battelle staff are shown in Table 4-3. The maximum dose is approximately 0.04 percent of the Department of Energy guidelines, and the mean dose is still lower. These individual dose estimates lead to a collective dose estimate for non-involved Battelle staff of 0.01 person-rem. Again, knowledge of the number of non-involved staff and the amount of time they will be near contaminated areas allows the collective dose to be presented in person-rem. This translates to a health risk of 6×10^{-6}.

Table 4-3. Estimated Exposures for Non-involved Battelle Staff[a][d]

	Individual Exposure, mrem/yr[b]
Maximum	0.10
Mean	0.03
Guideline[c]	25.0

Collective Exposure 0.01 person-rem[b]

(a) Assumes no external dose above background. Internal dose via inhalation; estimate based on inventory of predominant radioactive species to be removed.

(b) See attachment A.(Battelle's Radiological Exposure Estimates)

(c) See reference 8.

(d) Risk Coefficient 6×10^{-4} per person-rem

Estimated doses to the general public from building decontamination activities are shown in Table 4.4.

These conservative results indicate individual exposures are several orders of magnitude below the Department of Energy guidelines of 25 mrem/yr for air pathway only, whole body dose equivalent exposure to the general population. These individual dose estimates lead to collective dose estimates for the general public of 1.9×10^{-4} person-rem/yr and 4.6×10^{-3} person-rem/yr for the King Avenue and West Jefferson sites, respectively, which are clearly below guidelines. Collective dose estimates for the general public are presented in person-rem/yr because of uncertainties in how long any person will stay in the area. The project is expected to last eight years. A conservative risk estimate, assuming full exposure over the life of the project, presented by these doses are 9×10^{-7} and 2×10^{-5} for the King Avenue and West Jefferson sites respectively. In all cases the estimated doses to the general public are far below the Department of Energy guidelines for exposure to the general population.

For the contaminated soil at the storm sewer outfall area of the West Jefferson facility an analysis was performed to determine potential public exposure assuming a puff release of the entire inventory of radioactive contaminants to the atmosphere occurred[21]. The results of this analysis indicated a maximum exposure of 0.12 mrem/yr to the public. This maximum

Table 4-4. Estimated Exposures for the General Public[c]

	Individual Exposure, mrem/yr[a]	
	King Avenue	West Jefferson
Maximum	1.22×10^{-5}	1.09×10^{-3}
Mean	1.23×10^{-7}	3.13×10^{-6}
Guideline[b]	25	25
Collective Dose (person-rem/yr.)	1.9×10^{-4}	4.6×10^{-3}

(a) See Attachment A. (Battelle's Radiological Exposure Estimates)

(b) See reference 8.

(c) Risk Coefficient 6×10^{-4} per person-rem

exposure was at the site boundary and declined with distance outside the boundary. Compared to the guideline of 25 mrem/yr[8] this exposure is much below the guidelines. Public exposure from either of the soil disposition alternatives would be expected to be less than this worst case scenario for the storm sewer outfall area which assumes all the contamination is released in the air all at once.

For the contaminated soil at the two filter bed areas of the West Jefferson facility, a preliminary analysis indicates that the average concentration of radioactivity is one order of magnitude greater than of the storm sewer outfall area and hence using similar analysis indicate a maximum exposure of 1.2 mrem/yr to the public. Compared to the guideline of 25 mrem/yr[8] this exposure is below guidelines. The contamination is contained within the filter beds which were covered by 3 feet of uncontaminated soil. Exposures are expected to be less for the filter beds then for the outfall area because the contamination in the filterbeds are covered by 3 feet of uncontaminated soil thus reducing the airpath exposure route.

4.1.2 Biota

No threatened or endangered species occur on either site nor are there wetlands or scenic waterways. Monitoring data demonstrate that there have been no releases of radionuclides from operation of the King Avenue and West

Jefferson facilities (i.e., no action) that could have an effect on the terrestrial and aquatic biota in the areas.[10,11]

The preceding sections describe the mitigative measures to prevent releases outside of the site during the planned decontamination and decommissioning activities. Terrestrial and aquatic biota exposure to contaminants from the operations, therefore, is expected to be minimal (if any). All material that is trapped in filters or is removed in liquid waste resulting from the decommissioning will be disposed of as described in Section 3.2. Environmental monitoring will continue at both sites to detect any releases or their impact on the biota.

4.1.3 Transportation of Waste

Based on the estimated volume of waste (see Section 3.2), it is anticipated that approximately 525 shipments will be required which will consist of 409 shipments of low-level waste and 116 shipments of suspect transuranic waste. This assumes that each shipment will include 70 55-gallon drums or 10 boxes 4 ft.x 7.5 ft. x 2 ft. At the peak, one truck shipment per week is expected.

For the purpose of calculating radiation exposure during transportation, an analysis was performed assuming suspect transuranic waste is shipped to Hanford for subsequent shipment to the Waste Isolation Pilot Plant in New Mexico and that low-level waste was shipped to Hanford for disposal. Based on these assumptions, potential radiation exposure to truck drivers (2 per shipment, 48 hours driving time, and a maximum of 2 mrem/hr radiation field in the cab) is estimated to be 100.8 person-rem. On the assumption that no individual driver participates in more than two shipments per month (a conservative assumption because of the driving time), the maximum exposure to any individual driver is less than 2.5 rem/yr (less than 50 percent of the Department of Energy occupational guidelines of 5 rem/yr). In addition, the carrier is required to maintain control of exposure to the driver below limits. Environmental issues and consequences relating to shipment of radioactive materials are treated in existing documents.[12,13,14]

4.1.4 Disposal of Waste

The Hanford site in Washington is fully approved and qualified to accept and dispose of the low-level wastes from decommissioning activities at BCL.[15,16] The volume of low-level waste generated will equal approximately 4% of the volume annually accepted at the Hanford site for the life of the project but an insignificant percentage of the total volume of the site. It is expected that any TRU waste will go to the Waste Isolation Pilot Plant (WIPP) for disposal once the WIPP is authorized to accept such wastes. In the interim, this waste will be stored at Hanford. The BCLDP suspect TRU waste is estimated to be approximately 0.06% of the waste expected to be received at the WIPP.

4.2 NON-RADIOLOGICAL IMPACTS

No adverse non-radiological environmental impacts from no action are expected as supported by annual Environment Reports on non-radiological parameters based on a range of samples including air and water, grass, soil, and food crop.[10,11]

No adverse non-radiological environmental impacts from the proposed action are expected. Potential impacts are discussed as they relate to decommissioning activities or transportation of waste. No non-radiological impacts are predicted for disposal of waste at the two Department of Energy waste sites.

There are no identified Resource Conservation and Recovery Act hazardous wastes in the 15 buildings or in the contaminated soil areas nor is any expected to be generated.

It can be anticipated that asbestos will be encountered either with or without radioactive contamination. Appropriate disposal shall occur in both cases using certified contractors. The disposal of the PCB contaminated sludge from the King Avenue sumps is discussed in Section 3.1 and will be carried out in accordance with TSCA requirements and regulations.

4.2.1 Decommissioning Activities

Non-radiological impacts associated with decommissioning activities or removal activities could be due to the presence of toxic substances, noise from decommissioning equipment, and socioeconomic changes. Mixed wastes may be generated in the form of contaminated lead shield from the Hot Cells. A pre-decommissioning survey of the area will be conducted and the decontamination procedures will be appropriately modified as necessary.

Noise levels that could adversely affect workers and staff will be mitigated by providing ear protection for workers and relocation of staff to areas away from the decommissioning activities. The public is located far enough from Battelle facilities that noise inside the buildings is not expected to cause any impacts.

The proposed action will result in a small net increase in employment and economic activity. Battelle employs approximately 3,000 people with a payroll on the order of $150,000,000/yr. At its peak, the decontamination program could employ approximately 150 people at a cost of $20,000,000/yr.

4.2.2 Transportation of Waste

There is a certain potential for non-radiological injury or death as a result of a truck accident. The overall accident rate for truck transport is 1.06×10^{-6} per kilometer, and there are 0.51 injuries and 0.03 fatalities per truck accident.[4] Based on these rates, it is estimated that waste shipments might lead to 1.26 accidents, 0.6 injuries, and 0.04 fatalities. The number of trucks used to transport waste is not expected to have any significant impact yon traffic at either site. During maximum transport activity, it is estimated that a total of six truck shipments will originate during 1993 from the King Avenue site and 40 truck shipments during 1996 from the West Jefferson site. This maximum transport activity would be equivalent to a common 18-wheel, tractor-trailer rig leaving the King Avenue site every 2 months and slightly less than once a week from the West Jefferson site.

4.3 ENVIRONMENTAL CONSULTATIONS AND PERMITS

Potential requirements for the proposed action are evaluated in regard to their relationship to the location of the action, the contaminants involved, and specific action components.

These relationships are summarized and evaluated in Table 4-5.

The Battelle Columbus Laboratories Decommissioning Project has implemented the "BCLDP Public Information Plan."[18] This active public awareness information program provides information about the decommissioning project to individuals and groups who are potentially affected by or interested in the program. The program builds internal and external awareness of the decommissioning project. The program is directed at Federal, State, and Local Government officials, community groups, environmental groups, business leaders, and the media. The Federal Government includes appropriate members of the U.S. Senate and U.S. House of Representatives. The State and local government include State legislators, elected state, county and city officials, and potentially interested state, county and city agencies for both Columbus and West Jefferson, Ohio. The community groups include civic, community and residents associations in the vicinity of Battelle facilities at Columbus and West Jefferson.

The Department of Energy will distribute this assessment or notice of this assessment to interested persons as appropriate and the following agencies as a minimum.

> Ohio Environmental Protection Agency
> 1800 Watermark Drive
> Columbus, OH 43215

> U.S. Environmental Protection Agency
> Region V
> 230 South Dearborn Street
> Chicago, IL 60604

Battelle currently has an Nuclear Regulatory Commission license (No SNM-7) and a National Pollutant Discharge Elimination System permit (Number N404*CD) for the West Jefferson facility.

Battelle has an operator identification number (F OH007901598 3D) under the Resource Conservation Recovery Act and has interim status for waste storage. Any hazardous wastes generated during the project will comply with the Resource Conservation and Recovery Act.

4.4 ACCIDENT RISKS

As discussed in Section 3.0, all workers involved in the project will be properly trained and will be subject to the authority of the health physics staff. The project will have a Spill Prevention, Control, and Countermeasures (SPCC) Plan to address emergency situations. Spills and accidents, therefore, will receive immediate response to prevent or minimize exposure to workers and

Table 4-5
Applicability of Related Federal Environmental Statutes and Regulations

Statute/Regulation	Evaluation	Required?
Endangered Species Act[22, 23, 24]	No critical habitats exist in the affected area, and no adverse impacts to threatened or endangered species are expected to result from the proposed action.	No
Floodplain/Wetlands Regulations[22]	The proposed action is not located within a wetland or in a floodplain area.	No
Fish and Wildlife Coordination Act	The proposed action does not modify or impact fish or wildlife in any way or modify any bodies of water more than 10 acres in surface area.	No
Coastal Zone Management Act	The proposed action does not involve a coastal zone.	No
Farmland Protection Policy Act[25]	The proposed action does not affect prime or unique farmlands.	No
National Historic Preservation Act	There are no historical sites or areas in the location of the proposed action.	No

Table 4-5 (Continued)
Applicability of Related Federal Environmental Statutes and Regulations

Statute/Regulation	Evaluation	Required?
American Indian Religious Freedom Act	The proposed action does not interfere with the right of Native Americans to exercise their traditional religions.	No
Wild and Scenic Rivers Act	The proposed action does not involve waterways designated as wild and scenic rivers.	No
Resource Conservation and Recovery Act	The proposed action may include the generation, packaging, and transportation of mixed hazardous waste.	Possible
Comprehensive Environmental Response, Compensation and Liability Act (Superfund)	There have been no reportable releases in excess of reportable quantities and analysis indicates that no threat to human health or the environment exists from contaminated areas.	No
Federal Insecticide, Fungicide and Rodenticide Act	The proposed action is not involved in distribution, use, or disposal of any insecticides, fungicides, or rodenticides.	No

Table 4-5 (Continued)
Applicability of Related Federal Environmental Statutes and Regulations

Statute/Regulation	Evaluation	Required?
Toxic Substance Control Act	The proposed action will include the generation of PCB sludge waste which will be disposed of at a PCB licensed facility. Asbestos may also be encountered during the project which will be properly packaged and disposed of in accordance with the Toxic Substance Control Act requirements.	Yes
Clean Air Act	The facilities have a National Emissions Standard for Hazardous Air Pollutants permit. Asbestos may be encountered during the project which will be contained in enclosed spaces, properly packaged, and disposed of.	Yes
Clean Water and Safe Drinking Water Act	The proposed action is not expected to affect surface water bodies or water supplies.	No

Table 4-5 (Concluded)
Applicability of Related Federal Environmental Statutes and Regulations

Statute/Regulation	Evaluation	Required?
Noise Control Act	Noise levels that could adversely affect workers and staff will be mitigated by providing ear protection for workers and relocation of staff to areas away from the activities. The public is not expected to be impacted from the noise inside the buildings.	Yes
Hazardous Materials Transportation Act	The proposed actions will require shipment of PCB's and asbestos. All waste will be packaged and shipped in appropriate containers and disposed of at licensed facilities.	Yes
Transportation Requirements for Low Specific Activity Radioactive Materials	The proposed action will require the shipment of radioactive materials. All radioactive waste will be packaged and shipped in approved containers and vehicles and vehicle loading will conform to the Department of Transportation regulations.	Yes

the public. In addition, the physical nature of the materials that will be generated during the project that could be released (i.e., particulates, water droplets) allow for relatively easy control. The following paragraphs qualitatively discuss probable accidents that could occur during the project and their potential impact on workers and the public.

All work areas will be equipped with HEPA filters to control the release of airborne contaminants during the project. Failure of a HEPA filter would result in a minimal, if any, release of contaminants for two reasons. First, all work areas will be maintained under negative atmospheric pressure, precluding the escape of particulates from the area. Second, the HEPA filters are set in series (see Section 3.3) providing back-up in the event of failure. Potential risk of exposure from HEPA filter failure is considered low.

Failure of the work-area containment system (e.g., shrouds, temporary walls) has the potential to result in the release of contaminants during the project. Such failure could occur, for example, if a lift truck were to accidently collide with the containment structure. Releases from such an event would be minimal because; (1) work areas will maintain negative atmospheric pressure, precluding release, and (2) the work areas and the buildings are equipped with HEPA filters which will control any release. Potential risk of exposure from containment system failure, therefore, is considered low.

Rupture of waste containers during handling and movement to the loading areas, either through dropping the container or spearing with a lift truck, has the potential to release contaminants. Such spills would be addressed by procedures established by the SPCC Plan and would be immediately cleaned up. All drains in the work area will sealed to prevent the release of liquids in the event of a spill. Because all container handling will be inside the buildings, the maintenance of the negative atmospheric pressure and HEPA filters will prevent any potential particulate releases. Potential risk of exposure from waste container rupture, therefore, is considered low.

Risk of exposure from a general power failure is also considered low. In such an event all decontamination and decommissioning activities, including the evaporator, would shut down. The primary release control systems (i.e., HEPA filters) are passive and would prevent any releases until power is restored. Although the negative atmospheric pressure would slowly increase to atmospheric conditions, its presence would also control releases until power is restored. In addition, back-up power systems will be available and power will be restored as quickly as possible.

The above scenarios are the most likely to occur during project activities at the site. Accidents that could occur during off-site transportation are addressed in Sections 4.1 and 4.2. Risks that could result during waste disposal are addressed in the disposal sites' environmental documentation.[15,16]

5.0 CONCLUSIONS

The no action alternative does not allow the Department to release the facilities to Battelle for future use without radiological restrictions and therefore is not considered viable. The decommissioning alternative, therefore, is the proposed action. For the facilities in question this will generally involve dismantlement and/or removal of equipment; decontamination of building structures; treatment and evaporation or discharge of the Hot Cell Pool Water; and removal of contaminated soil in accordance with the Department's ALARA policy. The facility will be made available for future use without radiological restrictions.

All required state and Federal permits, and the Nuclear Regulatory Commission license are current and will be retained.

If actions are subsequently identified outside the proposed scope of work outlined in this Environmental Assessment, a supplemental National Environmental Policy Act evaluation will be performed.

6.0 REFERENCES

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3. Environmental Impact Assessment for Decontaminating the Battelle Columbus Plutonium Facility. Battelle Columbus Laboratories (prepared for U.S. Department of Energy), 1978.

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19. BCLDP Site Characterization Plan. Battelle, July 1989.

20. Fiscal Year 1988 Radiation Exposure Report. Battelle Columbus Division (prepared for U.S. Department of Energy), 1988

21. Annual Reports of Radiation Exposure - Fiscal Year 1988. Battelle, 1988

22. An Environmental and Ecological Assessment of the Proposed Upper Darby Water Supply Project. Battelle Columbus Division. 1975 (Prepared for Burgess and Niple, Ltd., Columbus Ohio)

23. Ohio's Endangered Wild Animals. Division of Natural Resources. 1987a

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25. 2010 Land Use Estimate for Geographic Zones, 1117, 1118, 1119, 1120 and 1121, Columbus, Ohio. Mid-Ohio Regional Planning Commission, 1985a.

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27. Health Effects of Exposure to Low Levels of Ionizing Radiation, National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiations. (BEIR V). 1989

28. Risk Assessments, Environmental Impact Statement, NESHAPS for Radionuclides, Background Information Document - Volume I. EPA/520/1-89-006-1, U.S. Environmental Protection Agency, September 1989.

29. Analysis and Evaluation of Sludge in King Avenue Sumps. Battelle Columbus Division, December, 1989.

30. A Manual for Implementing Residual Radioactive Material Guidelines, ANL/ES-160, DOE/CH/8901. Argonne National Laboratory, June 1989.

Attachment A

Radiological Exposure Estimates

Surveys taken by Battelle and Argonne National Laboratories[1,2] indicate the general locations of surface contamination and contaminated systems. Historical records indicate the types of activities carried out in these facilities. There is information available on the specific inventory of contamination at each location, which is the basis for establishing exposures that may be expected during decontamination operations. Best estimates of radiological exposures and impacts on human health are presented to the extent possible with the information.

Human Health

The paramount considerations of the proposed action is the prevention of human radiological exposures to the maximum practical extent. Further consideration dictates that all anticipated operations within the scope of the proposed action will be carefully evaluated for the potential for human exposure and impact on human health. Anticipated operations for which the limitation of radiological exposures to acceptable levels cannot be ensured with reasonable certainty will be modified to permit such insurance or will be eliminated. Additionally, any exposures which cannot be prevented will be maintained as low as achievable within the prescribed limits.

Populations at Risk

Three groups of persons will be potentially at risk of exposure to radionuclides during decontamination operations. The first group includes workers who will perform decommissioning activities and will be in direct contact with contaminated equipment and demolition materials, and radioactive aerosols. It has been estimated that decommissioning in the low-level contamination areas will require a work force of approximately 50 persons and approximately 15 workers will be required for the Hot Cell facility. Decommissioning activities in these facilities may take only 12 months in many instances, but some operations may occur over an 8-year period.

The second group of persons who could be exposed to lower levels of radiation or airborne materials include Battelle staff working in offices, laboratories, or shops near the facilities where decontamination will take place. The total number of Battelle staff at King Avenue is slightly less than 2,800 and there are approximately 120 persons located at various buildings at the West Jefferson site. The primary exposure for Battelle staff is believed to be by the respiratory route. External irradiation is considered to be minimal.

The final group of persons who could be exposed to low levels of radiation are the persons residing or working near the King Avenue or West Jefferson sites. There are approximately 31,000 persons residing within 1 mile of the King Avenue site and 1,700,000 located within 50 miles. Approximately 1,200 persons reside within 1 mile of the West Jefferson facilities and 1,700,000 people are located within 50 miles. The general population could conceivably be exposed to contaminants generated by decontamination activities and dispersed by atmospheric transport.

External Dose Considerations--Normal Operations

Estimates of external doses expected to be experienced by decontamination workers, other Battelle staff and the public are based on exposure rate measurements recently made in certain of the facilities and the ambient exposure rates (most are background) known in other facilities. Exposure rate in virtually all parts of the facilities are at, or very near ambient natural background rates and the doses to workers in these facilities will be low.

External doses to other Battelle staff, (Battelle staff who are not involved in decontamination operations, but who may work in areas near those being decontaminated) will certainly be much lower than those of decontamination workers. Other Battelle staff will be relocated from buildings during decontamination activities.

External doses to the public are expected to be negligible for normal operating conditions.

Decommissioning Workers

Some of the previous radiological surveys of the contaminated facilities included exposure rate measurements taken at 1 m above the floor in the vicinity of contaminated areas. Where these readings are available, they are considered to be the best data to use for estimating external doses to workers involved in decontamination and decommissioning. These measurements range from background levels to microRoentgen (uR) levels at King Avenue. Table A-1 summarizes estimated external doses to decontamination and decommissioning workers. For buildings where measurements have been reported as background levels, the principal radioactive contaminant inventory is embedded in building surfaces and will not add significantly to external doses, but must be considered as potentially significant in contributing to a whole body dose via inhalation and internal pathways.

Battelle Staff

For the areas being decontaminated, the external dose to non-involved staff in adjacent areas is expected to be below Department of Energy guidelines or indistinguishable from background. The reasons for this are:

(a) The doses to non-involved staff who may remain in areas adjacent to decontamination operations are expected to be substantially lower than the doses to workers. The external dose to workers discussed previously is expected to be indistinguishable from general background, except for six locations (Buildings 1, 3, 5, JN-1, JN-2, and JN-3) where workers exposures will be above background, but well below the Department of Energy (1981) exposure guidelines. Thus, non-involved staff are expected to receive doses that are either indistinguishable from background or well below the Department of Energy exposure guidelines.

TABLE A-1. Estimated External Dose to Decontamination and Decommissioning Workers

Building	Estimated Performance Period[a]	Estimated Exposure Data[b]	Estimated Level of Effort[c]	Estimated External Dose to D&D Workers[d]
Building A	12 months	Background Levels	4 Workers; 8,000 worker hours	Indistinguishable from background
Building 1	18 months	1.2×10^{-5} R/hr including background	6 workers; 18,000 worker hours	0.22 person-rem
Building 2	12 months	Background levels	4 workers; 8,000 worker hours	Indistinguishable from background
Building 3	72 months	2.5×10^{-4} R/hr including background	10 workers; 120,000 worker hours	30.0 person-rem
Building 4	12 months	Background levels	4 workers; 8,000 worker hours	Indistinguishable from background
Building 5	15 months	2.0×10^{-5} R/hr including background	7 workers; 17,500 worker hours	0.35 person-rem
Building 6	12 months	Background levels	5 workers; 10,000 worker hours	Indistinguishable from background
Building 7	14 months	Background levels	4 workers; 9,300 worker hours	Indistiguishable from background
Building 9	12 months	Background levels	4 workers; 8,000 worker hours	Indistinguishable from background
Building JS-1	12 months	Background levels	5 workers; 10,000 worker hours	Indistinguishable from background
Building JS-10	12 months	Background levels	4 workers; 8,000 worker hours	Indistinguishable from background
Building JS-12	12 months	Background levels	4 workers; 8,000 worker hours	Indistinguishable from background
Building JH-1	96 months	1.46×10^{-3} R/hr	15 workers; 240,000 worker hours	350 person-rem[e]

TABLE A-1. Estimated External Dose Decontamination and Decommissioning Workers (Continued)

Building JN-2	16 months	2.4 x 10^{-5} R/hr	4 workers; 10,600 worker hours	0.25 peson-rem
Building JN-3	60 months	2.4 x10^{-5} R/hr	3 workers; 100,000 worker hours	2.4 person-rem

(a) Data from Figure A-4.

(b) Average exposure values are based on limited measurements taken at 1 m above the floor in the vicinity of contaminated areas except for JN-1 where hot cells have fields of 100's of R/hr(Battelle, 1984).

(c) Battelle estimate of level of effort.

(d) Estimates of external doses for Building 3 and JN-1 are considered to be worst-case estimates. The estimates for other facilities are considered average.

(e) The value is considered the total dose for decontamination of JN-1, external plus, internal, and is based on prior operating experience.

(b) For the heavily contaminated areas, staff in adjacent areas will be relocated while decontamination activities are ongoing. Relocation may also be necessary for non-radiological reasons, such as noise, clutter, access, etc.

(c) Exposure rates will be monitored at the periphery of areas undergoing decontamination and in the adjacent areas where staff may remain during decontamination. Decontamination operations or occupation of adjacent areas, or both, will be modified as necessary to maintain exposure and doses as low as practical within the guidelines.

The basis for this conclusion is explained below for each of the buildings proposed for decontamination and decommissioning.

Building A. Dose to workers is indistinguishable from background and, therefore, dose to non-involved staff in adjacent areas will certainly be negligible. Staff in adjacent areas may be relocated because of noise and dust. Areas being decontaminated will essentially be converted to closed systems (vents and outlets being closed). These measures will be employed as appropriate to prevent releases of contaminants and dust to the environment outside the confines of the area being contaminated.

Building 1. The foundry area where a major part of the decontamination work will occur has very limited office space and a very small work force. Relocation of staff and isolation of work areas will preclude any measurable doses to Battelle staff.

Building 2. The layout of the building is such that there are no heavily and frequently occupied areas adjacent to the areas proposed for decontamination and decommissioning. The dose to Battelle staff should be negligible when all appropriate mitigative measures described above are in place.

Building 3. All staff not involved in decontamination activities will be relocated to other areas. Areas being decontaminated will be isolated and treated as restricted areas. External doses to staff should be indistinguishable from background.

Building 4. The dose to non-involved staff should be zero, based on the dose to workers presented in Table A-1.

Buildings 5, 6, 7, and 9. Staff not involved in decontamination activities will be relocated from adjacent rooms to other areas. The decontamination area will be an isolated, restricted area, and dose to staff will, therefore, be indistinguishable from background.

Buildings JS-1, JS-10, and JS-12. With all mitigative measures in place during decontamination, dose to non-involved staff is expected to be zero, based on the fact that worker external doses are estimated to be indistinguishable from background.

Buildings JN-1, JN-2, and JN-3. A majority of the staff on-site in these buildings are associated with operations of these facilities and no non-involved staff are expected to be present. The nearest non-involved Battelle staff are located in JN-4 which is at least 100 feet away from JN-1. The dose to all JN-4 staff is likely to be no more than 0.035 person-rem, if all the mitigative measures are in place. Such exposures are well below the whole body exposure guideline to the general population.

Public

As evident from the description above, the doses to Battelle staff not involved in decontamination and decommissioning within the King Avenue facility are expected to be negligible (.10 mrem/yr), except under upset condition where all the mitigative measures fail. The external doses to public outside the 10-acre King Avenue facility are expected to be negligible (1.22×10^{-3} mrem/yr maximum), because of the limited access to public, distance, and the low radioactivity inventory. External doses to the public at the West Jefferson site are expected to be negligible (1.09×10^{-3} mrem/yr maximum), because of limited access to public, distance, and the low radioactivity inventory.

Internal Dose Considerations--Normal Operations

Internal doses to decontamination workers, other Battelle staff, and public persons are determined by several fundamental parameters specific to the uptake mode which, in this case, is principally inhalation. Although there is some potential for contamination of cuts and abrasions, these can be readily decontaminated, if they occur, and are expected to be of minor radiological consequence except in certain major upset conditions.

The fundamental parameters that determine internal doses from inhalation intake are:

- o Particle size distribution of aerosols,
- o Radionuclides in the aerosols,
- o Chemical and other physical properties of the aerosols,
- o Quantity of aerosols inhaled.

These parameters are determined by several factors which can be monitored and controlled within certain limits, and thus, permit control of intake and internal dose. The factors which determine internal dose were identified and evaluated to the extent possible in deriving the internal dose estimates listed in Table A-2. The factors considered in the exposure scenarios and the assumptions that were made for these factors are listed:

TABLE A-2. Estimated Internal Dose to Decontamination and Decommissioning Workers and Non-Involved Staff

Building	Estimated Total Contaminant Inventory[a]	Estimated Potential Airborne Inventory[b]	Estimated Internal Dose to D&D Workers[c]	Estimated Internal Dose to Non-Involved Battelle Staff[d]
Building A	2.0×10^{-6} Ci, U	1.0×10^{-6} Ci	1.5×10^{-5} person-rem	3.4×10^{-9} person-rem
Building 1	2.39 Ci, U	0.63 Ci	9.8 preson-rem	1.2×10^{-3} person-rem
Building 2	7.0×10^{-3} Ci, U+Th	4.0×10^{-3} Ci	0.062 person-rem	4.8×10^{-6} person-rem
Building 3	8 Ci, U+Th	3.25 Ci U	103 person-rem	All staff relocated, 0
Building 4	1.8 Ci, U+Th	0.03 Ci U 0.001 Ci Th	0.68 person-rem	1.7×10^{-4} person-rem
Building 5	6.8 Ci, U+Th+MFP	0.6 MFP 0.65 Ci U 0.005 Ci Th	11.1 person-rem	6.9×10^{-4} person-rem
Building 6	2.5 Ci, U	0.05 Ci	0.78 person-rem	6.8×10^{-4} person-rem
Building 7	5 Ci, U+Th	0.5 Ci	7.8 person-rem	2.4×10^{-3} person-rem
Building 9	<5 Ci, U+Th	0.25 Ci	3.9 person-rem	1.0×10^{-3} person-rem
Building JS-1	0.75 Ci, U	0.25 Ci	3.9 person-rem	3.6×10^{-4} person-rem
Building JS-10	0.2 Ci, U+Th	0.19 Ci U 0.01 Ci Th	5.1 person-rem	No non-involved staff
Building JS-12	0.2 Ci, U	0.2 Ci	3.12 person-rem	No non-involved staff
Building JN-1	[e]	6000 Ci	350 person-rem[e]	No non-involved staff

TABLE A-2. Estimated Internal Dose To Decontamination and Decommissioning Workers and Non-Involved Battelle Staff (Continued)

Building JN-2	<6 Ci, U+Th+MFP+AP	5.0×10^{-3} person-rem	1.04 person-rem	$6.4\ 10^{-5}$ 0.25 peson-rem
Building JN-3	15 Ci, MFP+AP	15 Ci MFP	2.55 person-rem	No non-involved staff

(a) Dervied from data in Battelle (1984). MFP = Mixed fission product; AP = Activation Products.

(b) Professional judgement on the amount impregnated into building surfaces likely to become airborne during the destructive removal process.

(c) Doses are considered to be worst-case estimates.

(d) This value is considered the total worker's dose for decontamination of J-1, external plus internal, and is based on prior operating experience.

(e) <u>BCLDP Site Characterization Plan,</u> Battelle, July 1989.

Factor 1: Potential Airborne Inventory. In each facility, some portion of the total contaminant inventory is present as surface contamination. Methods for removal of surface contamination may, of necessity, destructively remove a portion of the structural element surface and may generate dusts or aerosols in the process. The aerosol can become airborne in the work area and a small portion can be conveyed into adjacent areas and smaller quantities may find their way into the public domain. The portion of the total contaminant inventory which must be removed by methods which may generate aerosols is considered the potential airborne inventory. The remainder of the total contaminant inventory in a facility is considered to reside within the confines of elements of systems or in configurations which can be removed with very little risk of generating aerosols. Estimates of the amount of potential airborne inventory in a facility are made with best professional judgement and are presented in column 3 of Table A-2.

Factor 2: Release Fraction. Only a small fraction of the potential airborne inventory will become airborne in the removal process due to many of the particles being too large to become or remain airborne. The fraction which may become airborne can be controlled to some extent by proper selection of the contamination removal methods and techniques. For example, for drilling holes in contaminated concrete, the fraction released is reported on the order of 10% (Battelle Pacific Northwest Laboratories, 1977). Certain types of scabbling devices (Funakawa, et al., 1987) improve removal rates and reduce airborne dust. Use of fixative coatings or wetting sprays further reduce the fraction released as an aerosol. Wet blasting with a grit or high pressure water reduce the fraction released over dry methods. The fraction which may become airborne is taken as 5% for this evaluation.

Factor 3a: Local Pickup Fraction. A local exhaust or vacuum pickup at the point of aerosol generation is employed for many surface contamination removal procedures. Certain grit blasting devices employ vacuum pickup as an integral feature of the system. Recently developed scabbling devices provide a shroud enclosing the area being chipped. The shroud is connected to a vacuum or exhaust air source capable of maintaining capture velocities and carrying away a major portion of the generated aerosol. The material captured by this system is passed through a separator, roughing filter, and HEPA filter in series and the effluent air is discharged into the intake side of an area exhaust ventilation system. The capture efficiency of this local pickup system is assumed to be 90% (Battelle Pacific Northwest Laboratories, 1977) of the release aerosol. The filter transmission fraction of the system is assumed to be 3×10^{-4}.

Factor 3b: Room Exhaust Collection Fraction. The enclosed decontamination work area will be provided with a filtered-exhaust ventilation system to maintain the work area negative with respect to surrounding areas and to capture and retain a substantial portion of the contaminated aerosol which escapes the local vacuum pickup. The material captured by this system is taken as the source term for estimating the internal dose to Battelle staff in adjacent areas who are not involved in the decontamination. This system is assumed to capture 75% of the aerosol that escapes the local vacuum pickup. The overall transmission fraction of the roughing filter/2 HEPA filter series arrangement in this system is assumed to be 8×10^{-8}.

Factor 4: Dilution of Ventilation Effluent in Surrounding Area. Small quantities of aerosols are assumed to be discharged from the ventilation system of the work area into adjacent areas where other Battelle staff may work. Staff in adjacent areas in building 3 and certain other buildings will be relocated during decontamination activities. No non-involved staff will be present in buildings JN-1, JN-3, JN-10, or JS-12 except possibly for authorized observers who will be present for only short periods of time and will be provided protective gear appropriate for ambient conditions. The effluent from the work area ventilation system is discharged into the larger volume of the surrounding areas which reduce the volume concentration of the aerosol. The dilution is assumed to be 0.033.

Factor 5: Respiratory Fraction. Particle size, density, and air current velocity are among the parameters which determine the portion of a finely divided material that will become airborne and may be retained in the human respiratory system. Data collected while using a milling cutter as a decontamination tool on concrete (Funakawa et al., 1987) showed particle size populations as follows:

- o 90% in the range of 10 um to 1 mm,
- o 7% were greater than 1 mm, and
- o Less than 3% were less than 10 um.

International Commission for Radiation Protection (1978) reports that the deposition in the pulmonary region of the lung for particle size of 10 um to 0.1 um ranges from about 5% to 60%; the deposition for 1 um particles is on the order of 25%. A respiratory fraction of 0.10 is assumed.

Factor 6: Respiratory Protection Factor. Where the control of contaminated aerosols in the work area cannot be ensured by preventative means, decontamination workers will be provided respiratory protective devices. Air sampling data will be collected to evaluate aerosol concentrations and determine when respiratory protection is necessary. Respirator protection factors range from 10 for half mask filter units to 5000 or greater for airline or self contained, full face, pressure demand units (NRC, 1987; ANSI, 1980: and Pritchard, 1977). Specific devices will be selected and used as appropriate for contaminant concentrations and working conditions. Workers will be fitted with the specific device to be used and trained in its use. No work will be done in atmospheres that are immediately hazardous to life. Very little activity is anticipated in high concentrations of high hazard radionuclides. Virtually all operations with elevated concentrations of high hazard radionuclides or with elevated external exposure rates will be done remotely where at all practical. For internal dose estimates, a respiratory protection factor of 2000 is assumed.

Factor 7: Estimated Internal Dose to Decontamination and Decommissioning Workers. The dose estimated to be received after inhalation of radionuclides is the 50 year effective committed dose calculated with conversion factors expressed in rem per Curie (rem/Ci). The conversion factors for nuclides at Battelle facilities are as follows:

Uranium-238 plus daughters = 1.2×10^{8} rem/Ci
Thorium-232 plus daughters = 1.6×10^{9} rem/Ci
Strontium-90 (as an index of old fission products) = 1.3×10^{6} rem/Ci

The effective committed dose estimates for decontamination workers (Dw) in Table A-2 have been calculated using the following formula:

Dw (dose in rem) = (potential airborne inventory) (release fraction) (1- local pickup fraction)(1- room exhaust collection fraction) (1/ respirator protection factor) (respirability fraction) (dose factor)
= (potential airborne inventory) (0.1) (0.1)(0.25)(0.0005)(0.10) (dose factor)
= 1.3×10^{-7} (potential airborne inventory) (dose factor)

A similar formula was used to calculate internal doses for non-involved Battelle staff with the following exceptions:

(1) A factor is developed to relate the internal dose to non-involved staff in adjacent areas to the contaminant released in the work enclosure during decontamination. This factor is developed by assuming the contaminants available for inhalation by Battelle staff are the same contaminants that become airborne within the work enclosure by decontamination activities and leak into surrounding areas through the HEPA filters of the system exhausting the work enclosure. In general, the intake by non-involved staff depends upon the contaminant concentration in the areas they occupy. The concentration in their areas is related to the amount of contaminant released from the work enclosure, and the volume of the larger surrounding areas occupied by non-involved staff. The amount of contaminant inhaled by non-involved staff should be related to the amount of contaminant within the work enclosure by the product of the volume ratio and the exhaust filter leakage fraction.

(2) Since decontamination workers will use respiratory protection during the decontamination operations, but persons in adjacent areas will not, the respirator protection factor of 2,000 was removed. Thus, the formula for calculating Battelle staff dosages (Ds) was as follows:

Ds (dose in rem) = (potential airborne inventory) (release fraction) (transmission fraction for 2 HEPA filters) [(local pickup fraction) (transmission fraction for 1 HEPA filter) + (1- local pickup fraction) (room exhaust collection fraction)] (dilution fraction) (dose factor)

= (potential airborne inventory) (0.1) $(8 \times 10^{-8}$ $[(0.9)(3 \times 10^{-4}) + (0.1)(0.75)]$ (0.33) (dose factor) (respirability fraction)

= 2×10^{-12} (potential airborne inventory) (dose factor)

Decontamination and Decommissioning Workers

Estimated internal doses for decontamination workers are provided in Table A-2. These doses range from 1.5×10^{-5} to 133 person-rem in decontamination low level buildings and 350 person-rem in decontaminating the Hot Cell facility. These values are predicted for worst case scenarios.

Battelle Staff

Estimated internal doses for Battelle staff not involved in decontamination operations are provide in Table A-2. Estimated internal doses to non-involved staff range from 3.4×10^{-9} to 2.4×10^{-3} person-rem. The values are worst case scenarios. Aerosol concentrations will be determined by sampling or monitoring the areas of interest. Decontamination operations or the use of adjacent areas, or both will be modified as necessary to maintain aerosol concentrations and exposures at the lowest practical level.

Public

Security arrangements at Battelle prevent public access to the interior of facilities and operations involving radioactive materials. Environmental monitoring data (Battelle, 1987) indicate no significant releases of radionuclides from either of the Battelle sites. Also, the small inventory of radionuclides at the King Avenue facilities and the mitigative measures in place will limit emissions of radionuclides and public exposure. At the West Jefferson site, the distance to major population centers limit the internal dose to public persons to natural background levels. Aerosol concentrations will be sampled or monitored in effluent airstream and in the external vicinity to confirm adequate containment.

Estimates of the internal dose to the general public were calculated separately for the King Avenue site and West Jefferson site as 70-year committed doses using the AIRDOS-EPA/RADRISK model (Department of Energy, 1985b). The following assumptions were made for the King Avenue Site:

(1) The initial source term is the sum of the inventories subject to release.

(2) The release fraction is assumed to be 0.55 of the total inventory.

(3) The fraction picked up at the point of origin by the local exhaust or vacuum is assumed to be 0.90. The filters on the pickup equipment are assumed to have a transmission factor of 3×10^{-4} to the general room exhaust ventilation system.

(4) The capture fraction for the room general exhaust ventilation system is 0.75 of the aerosol released in the decontamination room. The filters on the decontamination room are assumed to have a transmission factor of 8×10^{-8}.

(5) The activity is expected to be released from the center of the King Avenue campus, at an average height of 12 meters, over a period of seven years, and at the following rates: U-238 = 5.6×10^{-9} Ci/yr, MFP (Sr-90) = 6.1×10^{-10} Ci/yr, and Th-232 = 2.6×10^{-10} Ci/yr.

The following predicted internal doses to the public for the King Avenue site were calculated as 70-year committed doses with the AIRDOS model using the above assumptions:

(1) The weighted sum, effective dose equivalent for the individual receiving the maximum dose (individual within 250 meters of the release point in the downwind, northeasterly direction), is 1.22×10^{-5} mrem/yr.

(2) The weighted sum, effective dose equivalent for the mean individual, within a 45-mile radius, is 1.23×10^{-7} mrem/yr.

(3) The collective population dose for 1×10^{6} persons is 1.88×10^{-4} person-rem/yr.

In all the cases the public doses estimated for the King Avenue site are far below the Department of Energy (1985) guideline of 25 mrem/yr for air pathway only, whole body dose equivalent exposure to the general public.

Predicted internal doses to the public from the West Jefferson facilities using the AIRDOS model are based on stack release data from the Hot Cell Laboratory. The radionuclide inventories from the other West Jefferson facilities are so small they would make no real contribution to the public dose in addition to that from the Hot Cell Laboratory. Also, it is estimated that the overall time to decontaminate all West Jefferson facilities is about 9 years. The following predicted internal doses to the public for West Jefferson site were calculated as 70-year committed doses with the AIRDOS model:

(1) The weighted sum, effective dose equivalent for the individual receiving the maximum dose (individual within 250 meters of the release point in the predominantly downwind, northeasterly direction), is 1.09×10^{-3} mrem/yr.

(2) The weighted sum, effective dose equivalent for the mean individual, within a 45 mile radius, is 3.13×10^{-6} mrem/yr.

(3) The collective population dose for 1.48 x 10^6 persons is 4.64 x 10^{-3} rem/yr.

In all cases the public doses estimated for the West Jefferson site are far below the Department of Energy (1985b) guideline of 25 mrem/yr for air pathway only, whole body dose equivalent exposure to the general population.

Total Doses - Normal Operation

The sum of the estimated internal and external doses to the decontamination and decommissioning workers in all buildings is substantially below the occupational exposure guidelines of 5 rem/yr set by the Department of Energy. Table A-3 sums the doses projected for the decontamination workers from external and internal exposures. The doses are expressed in total person-rem for the entire work crew and the individual doses. Table A-4 presents the occupational standards observed by the Department of Energy, which may be used to assess the significance of the total doses. Estimated doses for decontamination and decommissioning activities in all buildings are well below the guideline. The projected for average annual whole-body dose to an individual exceeds 50% of the annual whole-body guidelines only in the Hot Cell Laboratory and this would be only under worst-case conditions. Although dose calculations are preliminary, the estimated levels are well below the guidelines and, thus, no impacts to human health are expected.

References

1. Cursory Radiological Assessment, Battelle Columbus Laboratory Decommissioning and Decontamination Project Report. Argonne National Laboratory, 1988.

2. Battelle Columbus Surplus Facilities Surveillance and Maintenance Program Plan. Battelle, May 1989.

Table A-3. Estimated Total Dose to Decontamination and Decommissioning Workers, Normal Operations

Building	External Estimated Dose[a] (person-rem)	External Estimated Dose (rem per year per person)	Internal Estimated Dose[b] (person-rem)	Internal Estimated Dose (rem per year per person)	Total Dose (person-rem)	Total Dose (rem per year per person)
A	Neg	Neg	$1.5x10^{-5}$	$3.8x10^{-6}$	$1.5x10^{-5}$	$3.8x10^{-6}$
1	0.22	0.024	9.8	1.1	10.0	1.11
2	Neg	Neg	0.062	0.016	0.062	0.016
3	30	0.50	103	1.72	133	2.22
4	Neg	Neg	0.68	0.170	0.680	0.170
5	0.35	0.040	11.1	1.27	11.45	1.31
6	Neg	Neg	0.78	0.16	0.78	0.16
7	Neg	Neg	7.8	1.7	7.8	1.7
9	Neg	Neg	3.9	0.98	3.9	0.98
JS-1	Neg	Neg	3.9	0.78	3.9	0.78
JS-10	Neg	Neg	5.1	1.3	5.1	1.3
JS-12	Neg	Neg	3.1	0.78	3.1	0.78

TABLE 3-A. Estimated Total Dose to Decontamination and Decommissioning Workers, Normal Operations (continued)

JN-1	—[c]	2.9	—[c]	—[c]	350	2.9
JN-2	0.25	0.04	1.04	0.196	1.30	0.240
JN-3	2.4	0.048	2.55	0.057	5.0	0.105
Grand Total	33.2[d]	(Average 0.047 of all[d])	153[d]	(Average 0.731 of all[d])	536[e]	(Average 0.918 of all[d])

(a) Based on information in Table A-1.
(b) Based on information in Table A-2.
(c) Internal and external doses were not estimated separately for JN-1, the estimated dose is internal plus external.
(d) Exclusive of JN-1.
(e) Including JN-1.

TABLE A-4. Department of Energy Guidelines for Workers, Individuals, and General Public[a]

Occupational:	
Whole body, head, trunks, gonads, lens of eye, red bone marrow, active blood-forming organs	5 rem/year 3 rem/quarter
Skin, other organs, tissues and organ systems other bones	15 rem/year 5 rem/quarter
Individual:	
Whole body, gonads, bone marrow (dose as point of maximum exposure)	0.5 rem/year
Other organs	1.5 rem/year
General Population:	
Whole body, gonads, bone marrow	0.12 rem/year
Other organs	0.5 rem/year

(a) Source: U.S. Department of Energy, 1981.