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REMOVAL SITE EVALUATION REHABILITATION OF THE MAIN OUTFALL LINE JANUARY 1991

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REMOVAL SITE EVALUATION

REHABILITATION OF THE MAIN OUTFALL LINE

Feed Materials Production Center

U.S. Department of Energy

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1.0 Introduction

The FMPC discharge pipeline to the Great Miami River represents a National Pollutant Discharge Elimination System (NPDES) permitted outfall for the discharge of wastewater from the FMPC to the surface waters of the State. The NPDES regulated discharge system is monitored for compliance at Manhole 175 prior to the effluent leaving the site boundary. The wastewater effluent originates from primarily three sources: 1) treated effluent from the process wastewater treatment plants, 2) treated effluent from the sanitary wastewater treatment plant, and 3) storm water runoff from the storm water retention basins. The cast-iron effluent line, which is a total of 4,650 feet long with a diameter of 16 inches, was constructed in 1952. Seven concrete manholes are located along the line for access and maintenance purposes, and are numbered as 175 through 181. The pipeline is located at a depth of between 4 to 16 feet below grade, with a minimum and maximum slope of 0.1 and 12.9 percent, respectively.

The main effluent line extends through the southeast quadrant of the production area. The region of the outfall line between Manholes 179 and 180 resides off-site, see Figure 1, east of the site property boundary and west of State Route 128 and the Great Miami River. Pursuant to the State of Ohio Director's Findings and Orders (DFO), issued and effective on June 26, 1987, and the Consent Decree, signed in December 1988, the FMPC was required to ascertain the integrity of the outfall pipeline.

The outfall pipeline's integrity was investigated by two methods: soil testing of the gravel pack surrounding the pipeline to determine whether excessive amounts of contaminants were present; and pneumatic testing of the pipeline itself. The final report of the FMPC pipeline investigation was released on September 18, 1990 (FMPC, 1990). The pneumatic method was chosen because it was found to be the most adaptable to testing the pipeline's integrity on a section by section basis and at the same time was considered to be at least as accurate, in a qualitative manner, as the other methods evaluated. Based on a visual examination of the pipeline section using a video camera, several "dislocated" joints were noted. The dislocations were estimated to be 1/4" to 3/8". These dislocated joints are considered for the purposes of this investigation to be a potential source of leakage to the environment (FMPC, 1990).

The results of the pneumatic tests indicated that all sections of the pipeline passed except the section between Manholes 179 and 180; it therefore has the potential for leaking. Currently, activities under the FMPC RI/FS Work Plan are being initiated to perform sampling between Manholes 179 and 180 in order to characterize any contamination in this region. Upon the completion of sampling and analysis, an evaluation will be made as to the need for any additional removal action(s).

Access to the ground surface above Manholes 179 and 180 region is uncontrolled. The soils associated with the outfall pipeline have been identified as "suspect areas" to be addressed under the Operable Unit 3 RI/FS. The Operable Unit 3 RI/FS, which consists of the production area and other suspect areas outside the production area, is presently underway.

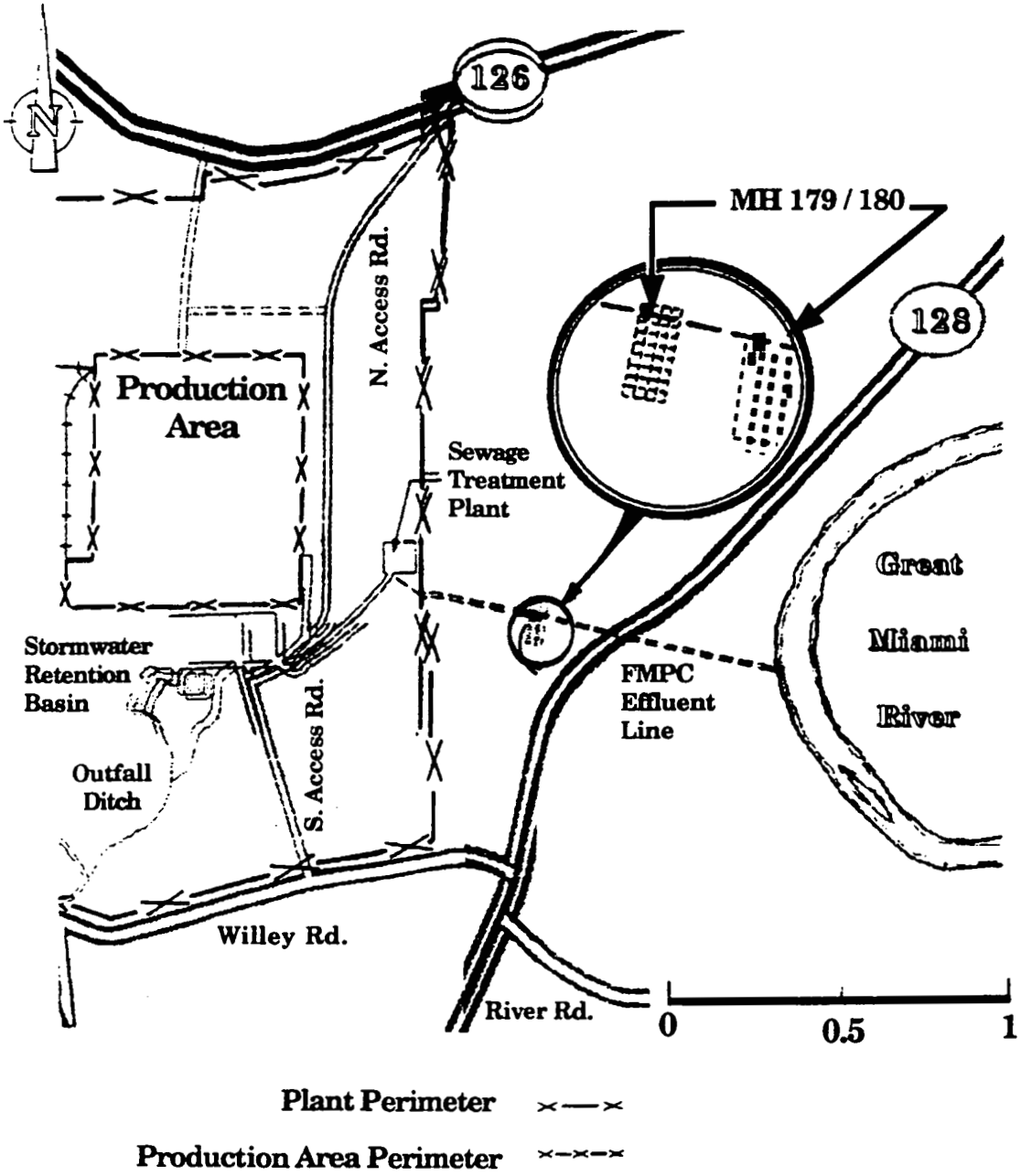

FIGURE I
LOCATION OF MANHOLE 179/180 REGION

This Removal Site Evaluation (RSE) has been completed by the DOE under authorities delegated by Executive Order 12580 under Section 104 of CERCLA and is consistent with Section 300 of the National Oil and Hazardous Substance Contingency Plan (NCP). This RSE addresses the potential leak identified in the effluent pipeline between Manholes 179 and 180 and has been completed to support the decision as to whether the present conditions warrant a removal action.

2.0 Source Term

The source term consists of those radionuclides present in the FMPC daily effluent. The source term describing the soil concentrations in the vicinity of Manhole 179 and 180 is currently being characterized. Based on weekly composites from 1986, the average concentration of total uranium in the FMPC effluent discharge was found to be 450 picocuries per liter (IT Inc., 1988). Soil samples taken down gradient from Manhole 179 and 180 show total uranium and total thorium concentrations below commonly accepted concentration based action levels, established as 35 picocuries per gram for depleted uranium and 10 picocuries per gram for total thorium, based on the NRC Branch Technical Position Guideline (USNRC, 1981). Nonradiological contaminants were also investigated, such as lead, chromium, and silver. Monitoring data from the NPDES discharge permit reports indicated that the concentrations for these contaminants are below the Toxicity Characteristic Leaching Procedure (TCLP) extract concentrations.

2.1 Soil Sampling Data

Table 1, taken from the Final Report for the FMPC Outfall Pipeline Investigation, lists the concentrations of total uranium for each sampling point for the region between Manhole 180 and the discharge at the Great Miami River. The location of these sampling points are illustrated in Figure 1. Note that the highest concentration of total uranium was observed to be approximately 21 picocuries per gram of soil by sample number 00536 which represented boring number 1532. This maximum observed concentration is below the NRC Branch Technical Position Guideline of 35 picocuries per gram of soil for depleted uranium (USNRC, 1981). Considering the steep gradient and the gravel packing surrounding the pipeline, these concentrations probably represent the maximum concentrations which would be observed in the region between Manholes 179 and 180.

Currently steps are being initiated as specified in the planned RI/FS Work Plan Addendum to perform a full radiological and hazardous substance list (HSL) sampling and analysis for the region between Manholes 179 and 180. The planned sampling plan outlines the completion of three soil borings and the installation of one (2000) series well. The Work Plan Addendum will be submitted to the USEPA for review and approval.

TABLE 1

BORING NUMBER	SAMPLE NUMBER	TOTAL THORIUM (1)	TOTAL URANIUM (1)	HNu READING (2)
1524	00452	5.0	11.6	0.0
	00455	11.0	10.1	0.0
	00459	3.0	9.3	0.0
	00462	3.0	6.3	0.0
	00465	7.0	9.6	0.0
	00468	5.0	7.2	0.0
	00472	<4.0	8.8	0.0
	00474	<5.0	9.5	0.0
1525	00400	6.0	13.9	0.0
	00403	<3.0	9.5	0.0
	00407	4.0	12.3	0.0
	00410	8.0	6.9	0.0
1526	00414	4.0	27.1	0.0
	00415	7.0	9.7	0.0
	00420	<4.0	18.1	0.0
	00421	2.0	8.4	0.0
1527	00426	6.0	6.9	0.0
	00428	7.0	11.1	0.0
	00432	6.0	9.2	0.0
	00435	<3.0	5.9	0.0
1528	00439	6.0	10.0	0.0
	00444	<4.0	7.8	0.0
	00445	<4.0	8.7	0.0
	00448	<4.0	7.0	0.0
1529	00478	7.0	9.9	0.0
	00481	4.0	9.4	0.0
	00484	5.0	8.9	0.0
	00488	3.0	10.8	0.0
1530	00491	7.0	11.8	0.0
	00494	6.0	15.6	0.0
	00494	8.0	6.3	0.0
	00501	3.0	8.4	0.0
1531	00505	<4.0	9.2	0.0
	00507	4.0	9.7	0.0
	00510	3.0	8.2	0.0
	00513	4.0	7.5	0.0
1532	00531	6.0	9.5	0.0
	00533	3.0	15.3	0.0
	00536	12.0	31.2	0.0
	00539	6.0	11.5	0.0
1533	00546	6.0	8.6	0.0
	00547	5.0	15.2	0.0
	00550	<4.0	7.7	0.0
	00552	<4.0	4.5	0.0
	00559	5.0	8.7	0.0
	00560	6.0	10.3	0.0
	00562	4.0	13.6	0.0
	00564	<4.0	6.5	0.0

(1) Units are in microgram per gram (ug/g).
(2) Units are in parts per million (ppm).

2.2 Radiological Pathway Assessment

Since radiological soil analysis has not been completed for the area between Manholes 179 and 180, the purpose of the following radiological pathway assessment is to estimate the upper limit on the health effects (maximum) for this region based on average total uranium concentration levels present in the wastewater in the effluent line. On the basis of the failure of the pneumatic tests, it is assumed for purposes of this assessment that the pipeline section is indeed leaking. Since the radionuclides would be released through a leak in the outfall line, the source characterization can be described as subsurface radionuclide contamination with potential future exposures occurring through the ingestion of contaminated groundwater. Because the radionuclides are potentially being released beneath the surface soil, the pathways of external radiation and inhalation of resuspended contaminated soil would represent negligible dose contributions since the soil cover would provide shielding as well as significantly reduce the availability for the atmospheric resuspension of contaminated soil particles. Calculations indicate that dose estimates resulting from the ingestion of crops or plants contribute insignificantly to the potential future exposure assessment of an individual residing in this region. Specifically, these food ingestion pathways are negligible for several reasons:

1) Low concentrations of the radionuclides exist in the root zone, since the pipeline is at a depth of between 4 and 16 feet.

2) Since the radionuclides were potentially released at a greater than 4 foot depth in the subsurface soil, atmospheric redistribution and subsequent foliar deposition and uptake, as a mechanism for plant uptake and accumulation, is eliminated.

3) Due to the steep gradient (approximately 13%) which occurs between Manholes 179 and 180, erosion, runoff, and subsurface transport of contaminants within the gravel packing of the effluent line would be enhanced which results in a lower concentration of radionuclides being available for uptake and accumulation.

The pathway assessment, summarized in Section 3.0, investigates a maximum dose and risk based on the potential future drinking water exposure route to an individual who is assumed to represent the reasonable maximum exposure (RME) for the Manhole 179/180 region. This RME individual's dose and risk assessments are based on exposure factors from the Environmental Protection Agency and the Nuclear Regulatory Commission's Regulatory Guide 1.109. Dose conversion factors were obtained from the Department of Energy (DOE, 1988); while effective dose equivalent risk coefficients were obtained from BEIR V (NAS, 1989). Appendix A contains the specific pathway equation as well as intermediate calculations.

The potential health effects from nonradiological contaminants were investigated using data from NPDES discharge permit reports (NPDES, 1990). Appendix B contains representative NPDES discharge permit data which details maximum observed concentrations of heavy metals for January through September of 1990. Since the concentrations for lead, chromium, and silver are below the quoted Toxicity Characteristic Leaching Procedure (TCLP) values, also shown in Appendix B, a nonradiological pathway assessment was not performed.

3.0 Evaluation of the Magnitude of the Potential Threat

The available data permits only a conservative pathway assessment, which is sufficient to justify consideration for removal action(s). Currently, additional soil sampling and analysis are planned to investigate residual contamination within the subsurface soils and groundwater in the area of the failed section. This conservative pathway assessment estimated an annual dose to an RME individual to be 9 millirem (mrem). Furthermore, this dose, using the risk coefficient of 5×10^{-7} risk per mrem (NAS, 1989), resulted in an annual risk of 5×10^{-6}. The lifetime risk to the RME individual was estimated to be approximately 3×10^{-4}, which equals approximately 3 chances in 10,000 of the RME individual developing a fatal cancer in his lifetime. The Environmental Protection Agency generally considers an acceptable lifetime risk of between 1×10^{-4} to 1×10^{-6} (NCP, 1989). It should be recognized that the RME individual does not represent a current exposure scenario, but a hypothetical maximum exposure scenario.

The nonradiological health impact from a potentially leaking effluent line are minimal considering the levels of toxic and carcinogenic chemicals observed in the effluent line under the NPDES permit. A comparison of observed NPDES discharge concentration levels with TCLP extract concentration levels is shown in Table B-1 of Appendix B.

4.0 Assessment of the Need for a Removal Action

Consistent with Section 40 CFR Part 300.410 of the National Contingency Plan, the Department of Energy (DOE) shall determine the appropriateness of a removal action. Eight factors to be considered in this determination are listed in 40 CFR 300.415 (b)(2). The following sections apply specifically to the Manhole 179 and 180 region.

- *Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.*

- *Actual or potential contamination of drinking water supplies or sensitive ecosystems.*

- *Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.*

These three factors are considered an appropriate result of the investigation which revealed the pipeline to be damaged and in need of repair. The drinking water pathway analyzed represents a hypothetical maximum human exposure route.

5.0 Appropriateness of a Response

If it is determined that a response action is appropriate due to both the level of contamination found in the soils and groundwater, after sampling has been completed and the potential for contamination migration exists, removal action(s) beyond the repair of the pipeline may be required to address the situation.

The analysis contained in this Removal Site Evaluation is based on current operating flow conditions. Currently, a proposal is underway to utilize the main outfall pipeline, starting from Manhole 177, to pump effluent from the South Plume Removal Action to the Great Miami River. A future total flow rate of approximately 3600 gallons per minute (gpm) is expected with the additional effluent generated by the South Plume Removal Project.

If a planning period of less than six months exists prior to the initiation of a response action, DOE will issue an Action Memorandum. The Action Memorandum will describe the selected response and provide supporting documentation for the decision.

If it is determined that there is a planning period greater than six months before a response is initiated, DOE will issue an Engineering Evaluation / Cost Analysis (EE/CA) Approval Memorandum. This memorandum is to be used to document the threat of public health and the environment and to evaluate viable alternative response actions. It will also serve as a decision document to be included in the Administrative Record.

Appendix A

Estimating Doses and Risks for Potential Contamination at Manhole 179/180 Region Determined using a Pathway Assessment Methodology

Introduction

The purpose of this pathway assessment is to estimate the maximum potential health effects resulting from possible radionuclide contamination of the ground water in the region between Manholes 179 and 180. The methodology consists of using the average total uranium concentrations reported in the effluent of the main outfall pipeline for 1986 to predict a resulting drinking water intake and dose. Several assumptions were made in order to conservatively quantify a steady state leak rate for the pipeline. Using a mixture model, total uranium levels in the pipeline were used to estimate the resulting groundwater concentration levels which would be available for ingestion. This assessment is considered to be conservative for several reasons:

1) Due to the relatively short transport times for the radionuclides within the gravel pack region surrounding the effluent line, suspect radionuclides would most likely migrate out of the assessment region.

2) Only a fraction of the uranium present in the effluent line has been or is being released to the soil and water media surrounding the outfall pipeline based upon the flow capacity and the slope of the effluent line. Furthermore, a portion of the uranium released will be absorbed onto the soil particles lying between the pipeline and the aquifer.

3) The pathway analysis methodology used conservatively assumes that an individual will ingest 2 liters or 0.53 gallons of the assessment region water each day (USEPA, 1989).

This pathway assessment attempts to identify the reasonable maximum exposure route through the ingestion of contaminated groundwater from the Manhole 179/180 region. Health effects are based on committed effective dose equivalents and lifetime risk of contracting a fatal cancer.

Assessment Region

The assessment region is defined as the groundwater bearing region lying between Manholes 179 and 180 of the main outfall line. Furthermore, it is assumed that a drinking water well will be installed within 1.4 meters (4.5 feet) on each side of the pipeline. The pipeline section between Manholes 179 and 180 is approximately 85.3 meters (280 feet) long. Using 2.74 meters (9 feet) as the width and 85.3 meters as the length of the pipeline region, the area of the rectangular aquifer region under investigation was determined to be approximately 234 square meters (2,520 square feet).

Methodology

The procedure for performing this assessment consists of four components: 1) estimate the quantity of water released through the leaking pipeline, 2) use the average total uranium concentration for 1986 (IT Inc., 1988) to determine the quantity of uranium released from the pipeline, 3) use a total mix model to predict the effect of dilution between the leaking effluent line and the assessment region of the buried valley aquifer, and 4) characterize the doses and risks based on the assumptions of the Reasonable Maximum Exposure (RME) scenario.

Estimate the Effluent Leak Release Rate

In 1986 the average rate of discharge through the outfall line was 0.78 cubic feet per second (0.78 ft^3/s) as reported in the Environmental Monitoring Report (WMCO, 1987). Conversely, the minimum flow rate during 1986 was 0.31 ft^3/s. Based on a visual examination of the pipeline section using a video camera, the overall integrity of the line appears to be good, no cracks, breaks, or crushed areas; however, several "dislocated" joints were noted. The dislocations were estimated to be 1/4" to 3/8". The leaking release rate for the pipeline was conservatively estimated to be approximately 1 %. The following assumptions were used to substantiate the 1 % since the pneumatic tests did not reveal an actual leak rate. The discharge data from 1986 was utilized since it corresponded to the document, "Hydrogeological Study of FMPC Discharge to the Great Miami River, Final Report," which was used to model the mixture equation and the data also represented a more realistic historical picture of the FMPC total uranium discharge concentrations than more recent environmental monitoring data indicates. These values also represent a more conservative pathway assessment.

1) This segment of the pipeline is a gravity drain. The effluent is not normally under pressure in this segment.

2) The pipeline was designed to transport more capacity than the current flow.

3) Pressure difference between the pipeline and the surrounding soil is relatively small, therefore the path of least resistance would still be the pipeline itself and not the surrounding soil matrix, especially considering the steep slope of this segment.

Equation (A-1) illustrates the calculation for determining the effluent leak release rate based on the leak representing 1 percent of the outfall pipeline's discharge rate. This corresponds to a release rate of 0.22 liters per second or 0.058 gallons per second.

$$\textit{Leak Release Rate} = 0.78\ (\frac{ft^3}{s})\ x\ .01 = 0.0078\ (\frac{ft^3}{s}) \qquad (A\text{-}1)$$

Calculate Aquifer Flow Rate

Equation (A-2) describes a general formula for determining the flow rate in a groundwater medium. This simplified equation assumes a homogeneous isotopic medium in which the gradient is constant over the horizontal increment, delta x.

$$V = -k \times \frac{\Delta H}{\Delta X} \qquad (A\text{-}2)$$

V = Groundwater flow rate with units of meters per day, (0.675 m/day) (Equation from: Till, 1983).

-k = Hydraulic Conductivity with units of meters per day, (250 m/day) (GeoTrans Inc., 1985).

ΔH / ΔX = Hydraulic Gradient in the direction of flow. The hydraulic gradient was determined from twelve groundwater isopleths for the months of September 1986 to August 1987 (IT Inc., 1988). The average hydraulic gradient was determined to be 0.0027.

Equation (A-3) was used to determine the total groundwater flow rate, with units of cubic meters per day. Recall the assessment region beneath Manhole 179/180 was defined as a rectangle 85.3 meters long by 2.7 meters wide or a total area of 234 square meters.

$$Volumetric\ Flow\ Rate,\ Q = 0.675\ m/day \times 234\ m^2 \qquad (A\text{-}3)$$

$$Q = 158\ \frac{m^3}{day}$$

The total flow rate in the groundwater region beneath Manholes 179 and 180 equals approximately 158 m^3/day or approximately 1.8 liters per second.

Characterize the Extent of Dilution between the Aquifer and the Effluent Line

A complete mix model was utilized to determine the resulting groundwater concentration (pCi/L) of the assessment region after mixing with the effluent release. The basic assumption of the model is that the total mass flux of uranium mixes completely and instantaneously with the background mass flux of uranium in the groundwater. Since the mass flux can be described by the product of the flow rate and uranium concentration, the concentration in the groundwater after mixing is defined by Equation (A-4) (IT Inc., 1988). The extent of soil absorption is not included in the analysis.

$$C_{GRND} = \frac{(Q_p \times C_{effluent} + Q_{GRND} \times C_{Bkg})}{Q_p + Q_{GRND}} \qquad (A\text{-}4)$$

$$49\ pCi/L = \frac{(0.22\ L/sec \times 450\ pCi/L + 1.8\ L/sec \times 1.2\ pCi/L)}{0.22\ L/s + 1.8\ L/s}$$

C_{GRND} = Resulting concentration of uranium in groundwater after mixing (49 pCi/L).

Q_p = Leak rate of the effluent from the pipeline (0.22 L/sec).

Q_{GRND} = Flow rate in groundwater of the assessment region (1.8 L/sec).

$C_{effluent}$ = Concentration of total uranium in effluent (450 pCi/L) (IT Inc., 1988).

C_{Bkg} = Background concentration of uranium in the groundwater (1.2 pCi/L).

Estimate Doses and Risks

An exposure scenario was outlined for a reasonable maximum exposure individual who ingests two liters of water each day for 365 days each year for the rest of his life. The assumptions for this pathway are as follows:

Drinking Water Pathway Assumptions

1) No dilution or filtering of groundwater assumed.

2) Exposure is 2 liters (0.53 gallons) per day and 365 days per year.

3) Committed effective dose equivalent conversion factors were used in the analysis (USDOE, 1988.)

4) Uranium concentrations exist in the effluent line which provide for the assumption of a continuous and uniform source within the groundwater beneath the assessment region.

Equation (A-5) describes the calculation of dose equivalents for the drinking water pathway using the average source term concentration for the ith radionuclide.

$$Dose\left(\frac{mrem}{year}\right) = S\left(\frac{pCi}{L}\right) \times DF\left(\frac{L}{day}\right) \times EF\left(365\frac{day}{year}\right) \times DCF\left(\frac{mrem}{pCi}\right) \quad (A\text{-}5)$$

The terms of Equation (A-5) are defined as follows:

Dose = Annual contribution to the committed effective dose equivalent with units of millirem of dose per year.

$\mathbf{S_i}$ = Source concentration for the ith radionuclide with units of picocuries per liter of water (found to be 49 pCi/L from Equation A-4).

DF = Dietary factor for the ingestion of drinking water on an average daily basis (2 liters per day).

$\mathbf{DCF_i}$ = Dose conversion factor for i^{th} radionuclide with units of dose equivalent (millirem) per picocurie of radionuclide ingested. A total uranium DCF, based on a natural isotopic activity distribution, is 2.53×10^{-4} mrem per year.

EF = Exposure Frequency with units of days of exposures per year (365 days per year).

The annual dose commitment using the previous equations and assumptions was found to be:

Annual Dose Equivalent = 9 mrem

Equation (A-6) illustrates the calculation of annual risk from the drinking water pathway based on a dose equivalent. The risk coefficient employed is from BEIR V (NAS, 1989) and represents the most recent findings of the Scientific Community.

$$Risk(Annual) = Dose\ Equivalent\left(\frac{millirem}{year}\right) \times Risk\ Coefficient\left(\frac{risk}{millirem}\right) \quad (A\text{-}6)$$

The terms of Equation (A-6) are defined as follows:

Risk = Annual risk to RME individual for the drinking water pathway.

Dose Equivalent = Annual dose equivalent to RME individual with units of millirem per year.

Risk Coefficient = Annual Risk of developing a fatal cancer based on the BEIR V risk estimate with units of risk per mrem (5×10^{-7} risk per mrem).

The annual risk using Equation (A-6) was found to be: **5×10^{-6} Risk / Year**

Equation (A-7) illustrates the calculation of lifetime risk based on the annual risk multiplied by the standard lifetime defined by the Environmental Protection Agency of 70 years.

$$Lifetime\ Risk\ \left(\frac{risk}{70}years\right) = Annual\ Risk \times 70\ years \quad (A\text{-}7)$$

The lifetime risk was found to be: **3×10^{-4} Risk**

Appendix B

Evaluating the Health Impact from Non-Radiological Contaminants for the Manhole 179 and 180 Region

Introduction

The purpose of this appendix is to investigate the possible nonradiological health effects associated with the potentially leaking effluent line between Manholes 179 and 180. The evaluation of nonradiological contaminants in the effluent line consisted of comparing the observed concentration levels, obtained from the NPDES permit discharge reports, with the TCLP extract concentration levels. Table B-1 below illustrates this comparison. The NPDES data were taken from discharge reports for 1990. The TCLP concentration levels are usually reported in terms of milligrams per liter, for comparison purposes these values were converted to micrograms per liter.

Table B-1

Comparison of Maximum Observed Concentrations from the NPDES Permit Discharge Reports with the TCLP Extract Concentration Levels

Contaminant	NPDES Level (micrograms/Liter)	TCLP Level (micrograms/Liter)
Chromium, Total	70	1,000
Lead	30	5,000
Silver	2.9	5,000