Doses received through indirect pathways

In addition to the exposure of the drill crew, the impact on persons living near the site was evaluated. Water erosion of the mud pit, which delivers radionuclides to people primarily through the ingestion pathway, is ignored; in the arid region around the site, wind erosion is the dominant mechanism for the introduction of radionuclides into pathways leading to people. Such a pathway would deliver radionuclides principally through inhalation.

Details of the exposure calculations appear in Appendix K. Calculations of the airborne dispersion of radioactive material from the mud pit are based on measurements taken over 20 years at the GMX area of the Nevada Test Site (Healy, 1977). The air-suspension model parametrized for the Nevada Test Site observations and the climate at the WIPP site come from the NRC Reactor Safety Study (NRC, 1975).

Although at present there are no farms within several kilometers of the WIPP site, for this analysis it is assumed that a single-family farm exists 500 meters downwind from the mud pit. The farm is assumed to produce leafy green vegetables, dairy products, and beef. The people living on the farm are assumed to eat the food produced there and to breathe the air contaminated by the windborne particles from the pit.

Two drilling locations were assumed: (1) the 10-inch hole is drilled through the disposal area for remotely handled waste and (2) the 10-inch hole is drilled through the contact-handled-waste area. For each location, a 50-year dose commitment after 1 year of exposure is listed in Table 9-67; the exposure is assumed to occur either 100 or 1000 years after the closure of the repository.

For drilling through contact-handled TRU waste, the maximum calculated dose commitment is 2.2×10^{-4} rem to the bone 100 years after closure; the dominating pathway is inhalation, and the radionuclides dominating the dose are plutonium-239, plutonium-240, and americium-241. The results of drilling through remotely handled TRU waste are similar: the maximum dose commitment, 3.2×10^{-4} rem to the bone, occurs principally through the inhalation pathway at 100 years after closure, but the radionuclides dominating the dose are plutonium-239, strontium-90, and plutonium-240. The doses at 1000 years after closure are not radically different from the 100-year doses; at 1000 years the dominant radionuclides are plutonium-239 and plutonium-240.

9.7.1.6 Direct Access to WIPP Wastes by Solution Mining

Solution mining is one way by which some of the TRU waste contained in the WIPP could inadvertently be brought into contact with the biosphere after knowledge of the purpose and location of the WIPP had been lost. The techniques of solution mining are used to extract soluble minerals and also to create underground storage cavities for liquids and gases. The soluble minerals halite (NaCl) and sylvite (KCl), a form of potash, exist under the WIPP site and are of economic value. Only experimental extraction of potash minerals by solution mining has been attempted in the area, however, because the water supply in the arid Delaware basin is limited. Nevertheless, it is possible that solution-mining activity in the Delaware basin could increase in the future, given an increased water supply or an increased demand for potash or halite. There is also a small chance that underground storage cavities will be created in the vicinity of the WIPP; storage cavities in the salt domes of the southeastern states are being used to contain petroleum and natural gas, and these resources exist in the Delaware basin of New Mexico and Texas.

Table 9-67. Maximum Doses Received by a Person Through Indirect Pathways: Direct-Access Scenario

Pathway	50-year dose commitment after 1-year exposure (rem)		
	Organ	100 years	1000 years
	REMOTELY HANDLED TRU WASTE		
Inhalation	Bone	2.7-4[a]	1.7-4
	Lung	1.7-5	9.4-6
	Whole body	9.1-6	4.3-6
Ingestion			
Crops	Bone	4.3-5	6.9-6
	Whole body	1.7-6	1.8-7
Meat and milk	Bone	4.0-6	8.5-9
	Whole body	1.3-7	6.0-10
	CONTACT-HANDLED TRU WASTE		
Inhalation	Bone	2.2-4	1.9-4
	Lung	1.2-5	1.0-5
	Whole body	5.8-6	4.8-6
Ingestion			
Crops	Bone	9.4-6	7.7-6
	Whole body	2.8-7	2.0-7
Meat and milk	Bone	1.6-8	9.5-9
	Whole body	7.1-10	6.7-10

[a]2.7-4 = 2.7×10^{-4}.

Though each of the modes of intrusion mentioned above could, in theory, release waste to the biosphere, an analysis of their consequences has not been carried out for the present study, because intrusion into the WIPP repository by solution mining is considered to be an event of very low probability. The soluble evaporites whose presence would provide the motive for solution mining underlie at least 3.5 million acres of the Delaware basin. A random penetration of these evaporites for any reason would thus hit the 120-acre repository with a probability of 3.4×10^{-5} (or about 3 chances in 100,000). There are, moreover, site-specific reasons for believing that intrusion into the repository is unlikely. These reasons are outlined in the paragraphs that follow.

Solution mining for potash

The potash ores sylvite and langbeinite existing under the WIPP site are contained in 11 thin ore zones within the McNutt member of the Salado Formation. The base of the McNutt lies approximately 1740 feet below the surface, or about 400 feet above the level of the repository (Section 7.3). Only the sylvite component of the ore is extractable by solution mining.

Two methods for potash solution mining are currently possible. The first method uses a single well in which the same wellbore is used for both injection and production. This method usually produces deep cavities of limited areal extent and is therefore most suitable for thick ore bodies. The second method employs two or more wells; solvent circulates between pairs of wells after initial conduits between the wells have been formed by hydrofracture. The second method offers good control of cavity depth relative to cavity area and, for thin ore bodies, a more efficient use of solvent. The multiwell method has been used for the experimental solution mining of thinly bedded potash in the Carlsbad basin (Davis and Shock, 1970).

Because of the thinness of the potash ore zones and the limited supply of water near the WIPP site, future solution-mining efforts would probably use the multiwell method to extract potash under the site. The degree of control over cavity depth offered by the method suggests that there would be no direct contact with waste in the repository 400 feet below the lowest ore zone. The conditions favoring an eventual intrusion into the repository by water would, however, be enhanced because of the increased permeability of the mined-out ore zones. Although the long-term consequences of mining out the McNutt member have not been studied specifically, the consequences for the WIPP repository are not likely to be worse than those calculated for the bounding scenario (Section 9.7.1.4).

Solution mining for halite (salt)

Halite is the dominant constituent of the evaporites underlying the WIPP site. Evaporite formations within the site boundaries contain about 1.98×10^{11} tons of salt, the purest of which occurs in the Castile Formation below the level of the repository (Powers et al., 1978, Section 8.4.7). The mass of salt contained within the volume of the proposed 100-acre disposal area for contact-handled TRU waste is only about 3.61×10^{6} tons. This represents about one-sixth of the United States annual consumption of salt in the 1960s. Thus even if all the salt consumed in the United States at current rates were to be mined exclusively within the WIPP-site boundaries, a time on the order of 10,000 years would elapse before the actual repository would be reached with high probability. Furthermore, the presence of numerous beds of relatively impermeable anhydrite and polyhalite in the Salado makes this area unattractive for the solution mining of halite. The development of a reasonably sized mine cavity in the salt would be extremely difficult. Large masses of salt occur elsewhere in the Delaware basin, and adequate reserves of salt exist nearer to the continental centers of demand. These factors have led to the conclusion that it is highly unlikely that the repository will ever be breached in the process of mining halite.

Analyses of solution-mining release scenarios for domed-salt repositories containing high-level reprocessing waste and spent fuel (with larger inventories and concentrations of long-lived radionuclides than proposed for the WIPP repository) indicate that such events do not constitute significant societal risks (DOE, 1979b).

9.7.1.7 Summary of Calculated Doses

The following conclusions are drawn from the analysis of the five scenarios:

1. The greatest consequences from a liquid-breach scenario are for scenario 4. Under the assumptions made for that scenario, the greatest whole-body and organ doses are less than 0.02% of the whole-body dose from natural background radiation at the WIPP site.

2. The consequences of a liquid-breach scenario depend on the flow rate of water through the breached repository. A factor-of-4000 difference in the flow rates for the analyzed scenarios translates into a hundredfold difference in the maximum doses received by a person at Malaga Bend. The consequences of scenario 3, which involves transport only by diffusion, are directly proportional to the area of the communication that connects the repository with the Rustler aquifer.

3. Under the assumptions made concerning plutonium distribution coefficients, no plutonium enters the biosphere during the time considered for scenarios 1 through 4.

4. It is not considered likely that a drill crew would inadvertently drill into the repository only 100 years after sealing. If they did, however, the greatest external dose received by the drill crew is calculated to be about 1.5 x 10^{-3} rem to the whole body under the assumption that the drill has penetrated a canister of remotely handled TRU waste. The maximum external dose from drilling through contact-handled TRU waste would occur 80 years after repository closure; it would be 2.4 x 10^{-5} rem.

5. The 50-year dose commitment received through indirect pathways by a person living on a nearby farm 100 years after closure is conservatively estimated to be 2.2 x 10^{-4} rem to the bone if a drill penetrates the contact-handled TRU waste and 2.7 x 10^{-4} rem to the bone if it penetrates a canister of remotely handled TRU waste. These calculated dose commitments are upper bounds to the dose commitments that people might receive.