CHAPTER 3
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 INTRODUCTION

Chapter 3 describes the affected environment that could be impacted by the implementation of the Alternatives. The chapter also addresses the potential environmental consequences of the Alternatives. Costs and benefits of the Alternatives are discussed in Chapter 4, Cost-Benefit Analysis.

The affected environment of the Alternatives covers the entire United States and is not site specific in nature. For that reason, several environmental resource topics are not analyzed in detail in this Draft GEIS. These environmental topics include: soils, land use, socioeconomics, environmental justice, historic and cultural resources, visual and scenic resources, and noise.

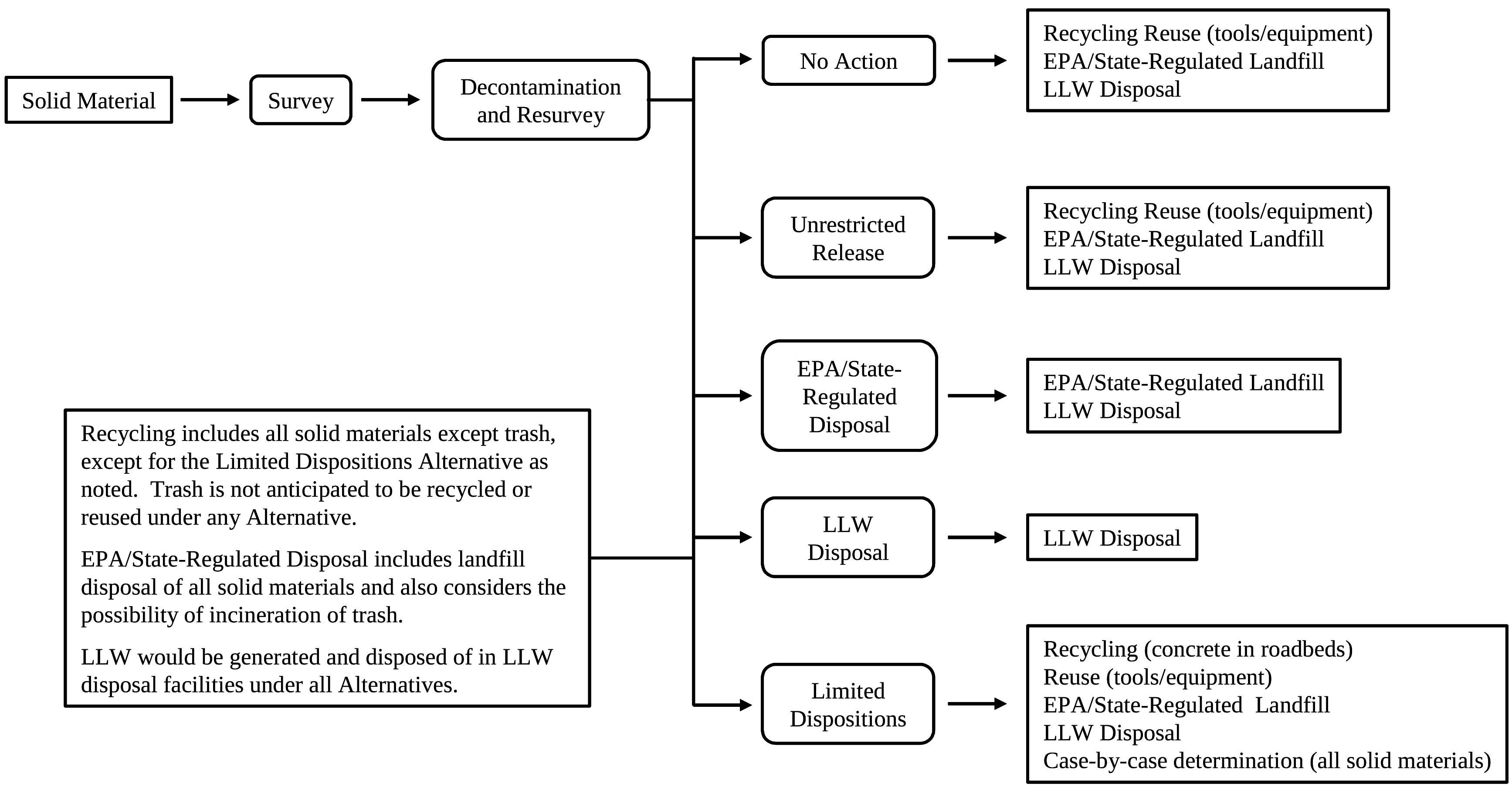
NRC does not anticipate construction activities that could have the potential to cause impacts to these environmental resources. In the event that there are construction activities associated with the disposition of solid material, any such construction activities would be subject to site-specific NEPA analysis conducted on a case-by-case basis. The affected environment of the Alternatives is limited to impacts associated with the transportation, recycling and disposal of solid materials and reuse of equipment and tools in their originally intended form and function.

The affected environment of the Alternatives does not include any solid materials left on site at licensee facilities after license termination. Solid materials remaining on site at facilities after license termination are subject to existing NRC regulations that would not be affected by the Proposed Action. When an NRC/Agreement State-licensed facility is decommissioned, the licensee must decontaminate the facility site to at least the minimum prescribed criterion prior to the NRC terminating the license (10 CFR Part 20 Subpart E). This limit pertains to both the facilities' remaining intrinsic structures (e.g., buildings) and site (e.g., soil). The potential impacts to the General Public, Non Licensed-Facility Workers, and Licensed-Facility Workers during decommissioning have already been analyzed through the NRC rulemaking for license termination.

The analysis of environmental consequences presented in this chapter evaluates the potential direct, indirect, and cumulative impacts that could occur with implementation of the Alternatives, including the No Action Alternative. As required by the Council on Environmental Quality (CEQ) regulations, this chapter also includes analysis of the potential adverse impacts on the environment associated with its short-term use and the potential adverse impacts on long-term productivity. In addition, this chapter includes a discussion of the irreversible and irretrievable commitment of resources associated with the Alternatives.

Figure 3-1 is a flowchart showing the disposition pathways for solid material under the Alternatives. Appendix F includes a description of licensees and the amounts of material and activity that could be released under each of the Alternatives.

Figure 3-1 Disposition Pathways



3.2 HUMAN HEALTH AND SAFETY

The Affected Environment is defined for the purposes of the Human Health and Safety Impact assessment as workers and the public potentially exposed to radiation dose from activities associated with generation, handling, processing, disposition, transportation, and disposal of the materials generated from licensed facilities under the Alternatives. Appendix G describes the affected General Public groups and the affected Non-Licensed Facility Worker groups and the radiological impact assessment methodology used for the collective dose assessment for the No Action, Unrestricted Use, EPA/State-Regulated Disposal, and Limited Disposition Alternatives for each solid material. This includes a description of the characteristics of each affected group and the assumed dispositions of each solid material under each Alternative upon which the collective dose assessment for each Alternative and solid material is based.

Occupational workers are defined in 10 CFR 20.1003 as only radiation workers, i.e., workers that work at LLW disposal facilities. Non-radiation workers are defined in 10 CFR 20.1003 as part of the public. For the purposes of the Draft GEIS, NRC has categorized potentially exposed individuals as (1) “Workers at Licensed Facilities,” (2) “Workers at Non-licensed Facilities,” and (3) “General Public,” as defined below. Affects on radiation workers (Workers at Licensed Facilities), non-radiation workers (Workers at Non-licensed Facilities), and the General Public are discussed in Section 3.2.3, 3.2.4, and 3.2.5 of the Draft GEIS.

Workers at Licensed Facilities - These workers are employed at NRC- or Agreement State-licensed sites, including licensee facilities and LLW disposal facilities. Their duties may involve exposure to radiation or to radioactive material which is potentially clearable. Doses to these workers could occur from surveying and decontaminating potentially clearable materials at licensed facilities or disposing of solid materials at licensed facilities.

Workers at Non-Licensed Facilities - These workers are members of the public who may experience work-related exposure while handling or otherwise encountering released material at their place of employment. Examples of these individuals include workers in scrap yards, iron and steel mills, EPA/State-regulated landfills, and EPA/State-regulated incinerators; truck drivers transporting released material; and building and road construction workers utilizing released material or byproducts of processing released material. Truck drivers transporting LLW to LLW disposal facilities are not workers situated at licensed facilities and are therefore categorized for the purposes of the Draft GEIS as Non-Licensed Facility Workers.

General Public - These individuals are members of the public who may experience non-work related exposures, i.e., exposures that occur outside their place of employment. For example, the General Public could be exposed to released materials utilized in automobiles, roadbeds, and buildings. Note that Workers are also members of the General Public when they are not working at their place of employment.

This section assesses the potential radiation exposures of workers at licensed facilities and non-licensed facilities, and the general public for each alternative. Detailed dose analyses were performed for concrete, ferrous metal, and trash generated from licensee facilities. Non-radiation impacts are discussed in Sections 3.3 (Transportation), 3.4 (Water Resources), 3.5 (Air Quality), and 3.6 (Ecological Impacts).

3.2.1 Background Radiation

Radiation is all around us, and it is naturally present in our environment. Consequently, life has evolved in an environment which has significant levels of ionizing radiation. It comes from outer space (cosmic), the ground (terrestrial), and even from within our own bodies. It is present in the air we breathe, the food we eat, the water we drink, and in the construction materials used to build our homes. Certain foods such as bananas and brazil nuts contain higher levels of naturally-occurring radiation than other foods. Brick and stone homes have higher natural radiation levels than homes made of other building materials such as wood. Furthermore, a lot of our natural exposure is due to radon, a gas from the Earth's crust, that is present in the air we breathe.

Background radiation is defined as radiation that comes from cosmic sources, naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the NRC. The typically quoted average individual exposure from background (natural and artificial) radiation is 360 millirem (3.6 mSv) per year (Table 3-1) (NCRP 1987a). Appendix E provides additional discussion of background radiation data.

Levels of natural or background radiation can vary greatly from one location to the next. For example, people residing in Colorado are exposed to more natural radiation than residents of the east or west coasts because Colorado has more cosmic radiation at a higher altitude and more terrestrial radiation from soils enriched in naturally occurring uranium. The average annual radiation exposure from natural sources that every individual in the United States receives is about 300 millirem (3 mSv) (Table 3-1). Radon gas accounts for two-thirds of this exposure, while cosmic, terrestrial, and internal radiation account for the remainder. No adverse health effects have been discerned from doses arising from these levels of natural radiation exposure (NCRP 1987a).

Man-made sources of radiation from medical, commercial, and industrial activities contribute another 60 mrem (0.6 mSv) to our annual radiation exposure. One of the largest of these sources of exposure is medical x-rays. Diagnostic medical procedures account for about 40 mrem (0.4 mSv) each year. In addition, some consumer products such as tobacco, fertilizer, welding rods, gas mantles, luminous watch dials, and smoke detectors contribute another 10 mrem (0.1 mSv) to our annual radiation exposure (NCRP 1987b).

A typical breakdown between natural background radiation and artificial sources of radiation is shown in Table 3-1. Natural radiation contributes about 82 percent of the annual dose to the population while medical procedures contribute most of the remaining 18 percent. Both natural radiation and artificial radiation affect people in the same way.

Table 3-1 Average Annual Effective Dose Equivalent of Ionizing Radiations to a Member of the U.S. Population

	Effective dose equivalent	
Source of Radiation	**mSv (mrem)**	**Percent**
Natural		
Radon[a]	2 (200)	55
Cosmic	0.27 (27)	8
Terrestrial	0.28 (28)	8
Internal	0.39 (39)	11
Total natural[b]	***3 (300)***	***82***
Artificial		
Medical		
X-Ray Diagnosis	0.39 (39)	11
Nuclear Medicine	0.14 (14)	4
Consumer Products	0.1 (10)	3
Other		
Occupational	less than 0.01 (less than 1)	less than 0.03
Nuclear Fuel Cycle	less than 0.01 (less than 1)	less than 0.03
Fallout	less than 0.01 (less than 1)	less than 0.03
Miscellaneous[c]	less than 0.01 (less than 1)	less than 0.03
Total artificial[b]	***0.63 (63)***	***18***
Total natural and artificial[b]	***3.6 (360)***	***100***

[a] Dose equivalent to bronchi from radon daughter products.
[b] Totals have been rounded and may not be numerically identical to the sum of the dose values shown.
[c] From Department of Energy facilities, smelters, transportation, etc.

Source: NCRP, 1987a.

3.2.2 Dose Assessment

The dose-based standards considered in this Draft GEIS express doses to an individual on a yearly basis, such as 1 mrem (0.01 mSv) per year. The dose modeling developed under NUREG-1640 is discussed in Appendix E. The IAEA RS-G-1.7 (IAEA 2004) radionuclide concentration levels are based on a dose of 1 mrem (0.01 mSv) per year. The differences between the radionuclide concentration levels in RS-G-1.7 and the levels derived for a dose of 1 mrem/yr from the modeling studies in NUREG-1640 are generally considered to be minor by modelers because of the uncertainties in making such estimates and taking into account, to the extent practicable, variations in modeling complex industrial processes. In part, the uncertainty and variability are attributed to differences in code models; scenarios and exposure pathways describing industrial practices; model assumptions and parameters; differences in dose coefficients between ICRP 26 and 60 (ICRP 1991) recommendations given their respective use by the NRC and IAEA; methods in incorporating radon and its decay products; adjustments of

IAEA clearance values with that of other exemptions to ensure compatibility; and the process used in rounding off IAEA values to the nearest power of ten. For each given disposition of released materials, this means that a dose of one mrem would be incurred annually by an individual, ignoring radioactive decay, if the material continued to be released year after year.

The sum of all individual doses for a group of individuals or a population is called the collective dose, which is expressed in person-rem or person-Sv. As a measure, collective dose provides a way of comparing the impacts to population groups against various activities. The annual background collective dose to the U.S. population due to natural sources of radiation and radioactivity is estimated to be about 84 million person-rem (840,000 person-Sv), assuming an annual average effective dose equivalent of 300 mrem (3 mSv). Appendix E presents a more detailed discussion of the concept and its application, including the limitations in the application of collective dose (Section E-III). For example, at low individual doses, the uncertainty in potential health risk includes the possibility of zero risk. Thus for populations where all members receive low doses, collective dose provides a very uncertain measure of risk, and there may be no significant impacts or risks to the population. However, NRC's regulatory analysis uses collective dose to a population because it enables a more direct comparison of the relative impacts of the different alternatives.

The collective dose results are inclusive of all exposure pathways. (See the analytical methods using the Monte Carlo technique and pathways described in Appendix D.) The collective dose results are inclusive of the sum of all doses over all exposure pathways and times specified for the analysis. Exposure pathways, dose receptors, and dose contributions are dynamic in that the dominance of each varies as a function of time. At first, facility workers and truck drivers are the first group to incur doses and later the dose contribution shifts to members of the general public. The pathways include doses associated with external radiation, ingestion, and inhalation exposures. The pathways can be further defined as whether they are workers or members of the public. For workers and truck drivers, doses are associated, in decreasing order of contribution, with the following exposure pathways: external radiation, inhalation, and incidental ingestion of dust containing residual levels of radioactivity. The exposures and doses occurring early in the front end of the process involve the release of materials (i.e., while materials are being generated by licensed facilities, during transportation, and during end-use or disposal in landfills). During transportation, members of the public are exposed to external radiation while vehicles are traveling on roads. Once materials are no longer generated, there are no additional doses to workers and dose contributions shift to the members of the public over a more protracted time. At this point, doses to the public are associated with the movement of radioactive materials through ground and surface water. The predominant exposure pathways, in decreasing order, are the consumption of water and food crops irrigated with surface or ground water. In terms of radionuclides contributing to doses, the following, in decreasing order of relative presence in the mix, contribute to external radiation: Co-60, Cs-137, Co-58, and Cs-134. For worker exposures associated with inhalation and incidental ingestion, the following radionuclides, in decreasing order of the mix, contribute to internal doses: Co-60, Fe-55, Cs-137, Ni-63, Co-58, and Cs-134. For members of the public where doses are associated with slow environmental transport, radionuclides with long half-lives dominate - in decreasing order of the mix, they include Cs-137, Ni-63, Sr-90, C-14, Pu-238, Pu-239, and I-129.

Although collective doses are used to compare the alternatives, the rule will be based on individual risk. The individual would not receive a dose of more than a specified dose limit (e.g. 1 mrem/yr (0.01 mSv/yr)). If the individual dose limit is low, then the population is protected as well since it is virtually impossible for everyone in any population group to receive the maximum dose. In fact, the great majority of individuals in the population group considered in the analysis are expected to receive doses that are a small fraction of the dose limit considered in this Draft GEIS (1 mrem/yr). The collective dose analysis is summarized in Appendix D.

The majority of the mass, activity and collective dose associated with licensed facilities is associated with solid materials released from commercial nuclear reactor licenses. For nuclear power plants, the radionuclide profile and relative fraction of each are based on site characterization results and selected low-level waste data. A single inventory was derived for all reactors, both operating and shutdown. The radioactivity profile assumed the presence of 17 radionuclides, as beta and gamma emitters, and transuranics. The most predominant radionuclides, comprising about 96% of expected residual radioactivity levels, are Mn-54, Co-58, Co-60, Ni-63, Fe-55, Cs-134, and Cs-137. For these radionuclides, the radioactive half-lives range from about 71 days to 100 years. The collective doses are based on the time period up to the point when the currently operating reactors will be decommissioned. The collective dose analysis considers the time period (50 years) during which solid materials will be generated and 200 years beyond in assessing long-term impacts. The analysis assumes that the decontamination and decommissioning and remediation work of all commercial nuclear power reactors effectively will be completed by 2050. The time period of this analysis is 250 years, which is the time when potentially clearable materials from existing licensees would result in significant contribution to collective dose. It should be noted that because most of the radioactivity is due to radionuclides with half-lives measured in years (a fraction of a year to about 30 years) rather than in thousands of years, the collective doses and impacts beyond 250 years become vanishingly small.

However, for the impacts associated with landfill disposals, the analysis was carried out to 1,000 years. In both cases, no specific distinction is made between the results associated with the 250 or 1,000-year analysis given that beyond 250 years, collective doses become negligible.

The collective dose analysis (SC&A 2003) considered Licensed Facility Workers involved in surveying and decontamination at licensed facilities generating solid material and at LLW disposal facility sites. The analysis considered the following scenarios for exposures to Non-Licensed Facility Workers and the General Public (Figure 3-1):

- The collective dose from recycled concrete analyzed in this Draft GEIS results only from its use for road bed construction. The selection of road bed construction as the single end use is based on the fact that approximately 85 percent of road construction is recycled concrete (Appendix G).

- The collective dose from ferrous metals is dominated by five scenarios depicting population exposures to finished ferrous metal products. These five end use products are office buildings, beds, automobiles, office furniture and home appliances.

- The end use for trash was disposal at EPA/State-regulated disposal facilities. Most of the trash from licensed facilities consists of items not likely to be reused (e.g., rubber gloves). Even if there were some recycling of this trash, its amount, compared to the much larger volumes of other materials intended for recycle would be insignificant in terms of collective dose. Also, current practice for trash from restricted/impacted areas at licensed facilities is that various trash items are mixed together and sent for disposal, not reuse or recycle.

- Inventory information on other metals, besides ferrous metal, indicated these were primarily copper or aluminum, and there is a small amount of these materials generated as compared to ferrous metal. The results of a screening analysis indicated that collective doses for copper and aluminum are about one to two orders of magnitude lower than that of ferrous metals.

- The disposition for all materials could be LLW disposal.

- Collective doses were calculated for reuse of small and large pieces of equipment.

3.2.3 Licensed Facility Workers

This section describes the affected environment and environmental consequences associated with the Alternatives for Licensed Facility Workers.

3.2.3.1 Affected Environment

The affected environment with respect to Licensed Facility Worker collective dose includes survey workers and decontamination workers at licensed facilities generating solid material, and LLW disposal facility workers. Licensed Facility Worker activities contributing to collective dose include activities associated with surveying and decontaminating solid materials at licensed facilities and disposing of LLW at LLW disposal facility sites. Other solid material handling activities conducted at licensee facility sites, including management of solid material storage piles and loading of solid materials for transport to recycling or disposal facilities are assumed to be conducted by Licensed Facility Workers. Truck drivers within the impacted area during handling and loading operations would be considered Non-Licensed Facility Workers.

Activities conducted by Licensed Facility Workers in surveying and decontaminating the solid materials generated at licensed facilities are anticipated to be similar for all Alternatives. Licensed Facility Workers at LLW disposal facilities disposing of solid material as LLW are anticipated to be similar for all Alternatives. Therefore the affected environment for Licensed Facility Workers is similar for all Alternatives. These activities are described in this section and discussed in more detail in Appendix D.

<u>Survey Workers</u>

Survey workers are workers at licensed facilities who conduct radiation surveys of solid materials to assess their radiological characteristics. It is assumed for the purposes of the Draft GEIS that survey workers would conduct surveys specifically to characterize the solid materials in support of implementation of the proposed rule for the release of solid materials. Surveys of material expected to result in doses to members of the public ranging from 10 mrem/yr (0.1 mSv/yr) to 25 mrem/yr (0.25 mSv/yr) would be addressed as part of decommissioning activities under an NRC-approved license termination plan. Surveys conducted by survey workers in support of the decommissioning activities of licensed facilities for LLW disposal and to demonstrate compliance with the License Termination Rule, and that are not directly related to the release of solid materials, are not within the scope of the Proposed Action.

Decontamination Workers

Decontamination workers are workers at licensed facilities who decontaminate solid materials, mostly ferrous metal, to reduce the level of radioactivity of the solid materials. It is assumed for the purposes of the Draft GEIS that decontamination workers would conduct such activities specifically to decontaminate the solid materials in support of implementation of the proposed rule for release of solid materials. Decontamination activities conducted by workers in support of the decommissioning of licensed facilities and that are not related to the release of solid materials are not within the scope of the Proposed Action.

It is assumed that the Proposed Action would only apply to materials considered to be relatively free of both internal and external surface or volumetric contamination and with residual radioactivity levels close to or below the release criteria. In other words, the provisions of a proposed rule are not expected to change licensee practices in identifying and segregating materials with contamination levels that may warrant decontamination or disposal as LLW. Moreover, it is assumed that if decontamination were considered as a precursor to compliance with a proposed rule, the initial contamination levels would need to be such that release criteria could be readily achieved given the selection of an appropriate decontamination method. This recognizes that if contamination levels were too high and the decontamination factor were too low, it would be a futile exercise to spend time and resources on decontamination. In such a situation, disposal as LLW would be the most cost-effective course of action. The proposed action is not expected to impact this decision process, nor affect the related economic factors.

LLW Disposal Facility Workers

Under each alternative, different amounts of solid material would be disposed of as LLW at a LLW disposal facility. The quantity of solid material that would be disposed as LLW depends upon the Alternative and dose option selected and affects the collective dose to workers at these facilities.

The decision to dispose of useful material and equipment as LLW is driven by operational and economic considerations, taking into account replacement costs versus cost of repairs, lead time in procuring new equipment, amortization, and cost of money. These factors are expected to be different among facilities. The proposed action is not expected to impact this decision process, nor affect such economic factors.

3.2.3.2 Environmental Consequences

This section describes the environmental consequences associated with the Alternatives for Licensed Facility Workers. Environmental consequences are presented in terms of collective dose, in units of person-rem, for each alternative.

The collective doses to survey workers and decontamination workers at licensed facilities are assumed not to vary among the Alternatives and their associated dose options since all solid materials would be surveyed under each Alternative. However, it may be the case that for the 0.03 mrem/yr dose option for some of the Alternatives that the number of labor hours required to survey the material would be higher because the survey would be more difficult for the workers to conduct. Note that surveying materials at an actual "zero above background" dose option would not be feasible, because radiation survey equipment would be incapable of distinguishing the radiation content of the materials generated from ambient "background" radiation. Only sample collection followed by laboratory analysis are feasible, but at a much greater cost.

This analysis assumes that decontamination workers would decontaminate some of the ferrous metal generated from commercial nuclear reactor facilities in order to reduce the radionuclide concentration of the ferrous metal to below the dose option for the No Action, Unrestricted Release, EPA/State-Regulated Disposal and Limited Dispositions Alternatives. The analysis also assumed that some metals generated by commercial nuclear reactors would be decontaminated under all of the alternatives and over all dose options. The analysis assumed a representative decontamination factor of 15, with a range of 10 to 100 based on industry data. The resulting amount of steel is estimated to be about 40 tons per year per reactor and a total of 4,200 tons as additional material available for release. NRC has assumed that trash and concrete would not be decontaminated because it is not economical to do so.

Because the estimate of collective dose to decontamination workers is based on the decontamination of a fixed percentage of the ferrous metal generated, the collective dose to decontamination workers is assumed not to vary by Alternative. However, it may be the case for the 0.03 mrem/yr and 0.1 mrem/yr dose options for the Unrestricted Release Alternative and EPA/State-Regulated Disposal Alternative that decontamination of ferrous metals may not be feasible, based on economic considerations alone.

The collective doses are estimated to be about 290 person-rem (2.99 person-sievert) for survey workers and 308 person-rem (3.08 person-sievert) for decontamination workers for all dose options (Appendix D).

Under all the alternatives, solid material generated from licensed facilities that is within the scope of the alternatives but that does not meet the radiological criteria for release would be transported to a LLW disposal facility. Truck drivers transporting the solid material to the LLW disposal facility are classified as Non-Licensed Facility Workers. LLW disposal facility workers are classified as Licensed Facility Workers. The collective dose to workers at LLW disposal facilities does not vary significantly among the Alternatives and their associated dose options. The collective dose to LLW disposal facility workers for the Unrestricted Release Alternative and EPA/State-Regulated Disposal Alternative is 28 person-rem (0.28 person-sievert) for the 10 mrem/yr dose option and 35 person-rem (0.35 person-sievert) for the 0.03 mrem/yr dose option. The collective dose to LLW disposal facility workers is 34 person-rem (0.34 person-sievert) for the No Action Alternative and LLW Disposal Alternative (SC&A 2003).

3.2.3.2.1 No Action Alternative

Survey Workers

The estimate of collective dose to survey workers for the No Action Alternative is based on surveying all of the potentially clearable solid material. The collective dose to Licensed Facility Workers for surveying the entire inventory of ferrous metal, trash, and concrete generated from commercial nuclear reactor facilities would be about 290 person-rem (2.9 person-sievert), as shown in Table 3-2. The collective dose is dominated by the surveying of trash. This is because of the relatively low mass to surface area ratio of trash as compared to concrete and ferrous metal, which results in relatively large surface areas of trash to be surveyed compared to concrete and ferrous metal, and this increases the number of labor hours needed to conduct the surveys.

Table 3-2 No Action Alternative - Licensed Facility Worker Collective Dose from Surveying Materials Generated from Commercial Nuclear Reactor Facilities

Material	Exposure Rate (rem/hr)	Total Labor Hours	Collective Dose (person-rem)[1]
Trash	1.0E-04	27,400,000	274
Concrete and Ferrous Metal	5.0E-06	3,000,000	15
Total		31,400,000	289

[1] Source: SC&A 2003, Table 7.3.

Decontamination Workers

The collective dose to decontamination workers is estimated to be approximately 308 person-rem (3.08 person-sievert), as shown in Table 3-3.

Table 3-3 No Action Alternative - Licensed Facility Worker Collective Dose from Decontaminating Materials Generated from Commercial Nuclear Reactor Facilities (person-rem)

	Operating Ferrous metal	D&D Ferrous metal	Concrete	Trash	Total
Collective Dose	77	231	not applicable	not applicable	308

Source: SC&A 2003, Table 7.4.

LLW Disposal Facility Workers

Table 3-4 summarizes the collective dose to LLW disposal facility workers that would result from disposal of solid materials in LLW disposal facilities under the No Action Alternative.

Table 3-4 No Action Alternative - Licensed Facility Worker Collective Dose at LLW Disposal Facilities from Materials Generated from Commercial Nuclear Reactor Facilities

Total Radioactivity Generated (Ci)	Radioactivity in LLW (Ci)	Radioactivity Released (Ci)	Collective Dose (person-rem)
2,951	2,947	4	34

Source: SC&A 2003, Tables 8.6 and 8.7.

3.2.3.2.2 Unrestricted Release Alternative

The collective dose to survey workers and decontamination workers, for the Unrestricted Release Alternative is estimated to be 289 person-rem (2.89 person-sievert) for survey workers and 308 person-rem (3.08 person-sievert) for decontamination workers.

The collective dose to workers at LLW disposal facilities does not vary significantly among the dose options for the Unrestricted Release Alternative, as shown in Table 3-5. The total radioactivity generated is 2,951 Ci, as shown in Table 3-4. The collective dose to LLW disposal facility workers for the Unrestricted Release Alternative ranges from 28 person-rem (0.28 person-sievert) for the 10 mrem/yr dose option to 34 person-rem (0.34 person-sievert) for the other dose options.

Table 3-5 Unrestricted Release Alternative - Licensed Facility Worker Collective Dose at LLW Disposal Facilities from Materials Generated from Commercial Nuclear Reactor Facilities

Dose Option	Radioactivity in LLW (Ci)	Radioactivity Released (Ci)	Collective Dose (person-rem)
10 mrem/yr	2,413	538	28
1 mrem/yr	2,910	41	34
0.1 mrem/yr	2,948	3	34
0.03 mrem/yr	2,950	1	34

Source: SC&A 2003, Table 8.7.

3.2.3.2.3 EPA/State-Regulated Disposal Alternative

The collective dose to survey workers and decontamination workers for the EPA/State-Regulated Disposal alternative is estimated to be 289 person-rem (2.89 person-sievert) for survey workers and 308 person-rem (3.08 person-sievert) for decontamination workers.

The collective dose to workers at LLW disposal facilities does not vary significantly among the dose options for the EPA/State-Regulated Disposal Alternative, as shown in Table 3-6. The collective dose to LLW disposal facility workers for the EPA/State-Regulated Disposal Alternative ranges from 28 person-rem (0.28 person-sievert) for the 10 mrem/yr dose option to 34 person-rem (0.34 person-sievert) for the other dose options.

Table 3-6 EPA/State-Regulated Disposal Alternative - Licensed Facility Worker Collective Dose at LLW Disposal Facilities from Materials Generated from Commercial Nuclear Reactor Facilities

Dose Option	Radioactivity in LLW (Ci)	Radioactivity Released (Ci) to Landfills	Collective Dose (person-rem)
10 mrem/yr	2,402	549	28
1 mrem/yr	2,906	45	34
0.1 mrem/yr	2,946	5	34
0.03 mrem/yr	2,950	1	34

Source: SC&A 2003, Table 8.7.

3.2.3.2.4 Low-Level Waste Disposal Alternative

Under this Alternative, all the potentially clearable solid material would be disposed in LLW facilities. The collective dose to survey workers is estimated to be 289 person-rem (2.89 person-sievert). No decontamination is assumed for this Alternative. The collective dose to LLW disposal facility workers, as shown in Table 3-7, is 34 person-rem (0.34 person-sievert).

Table 3-7 Low-Level Waste Disposal Alternative - Licensed Facility Worker Collective Dose at LLW Disposal Facilities from Materials Generated from Commercial Nuclear Power Reactors

Total Radioactivity Generated (Ci)	Radioactivity in LLW (Ci)	Radioactivity Released (Ci)	Collective Dose (person-rem)
2,951	2,951	None	34

Source: SC&A 2003, Table 8.7.

3.2.3.2.5 Limited Dispositions Alternative

The environmental consequences for Workers at Licensed Facilities would be the same for the Limited Dispositions Alternative as for the No Action, Unrestricted Release and EPA/State-Regulated Disposal Alternatives described above. Solid material generated from licensed facilities under the Limited Dispositions Alternative would be subject to similar activities conducted by survey workers and decontamination workers as under the other Alternatives, resulting in similar collective doses to survey workers and decontamination workers. Solid materials not meeting the requirements under the Limited Dispositions Alternative would be disposed of in LLW disposal facilities, resulting in collective dose to LLW disposal facility workers. As shown above, the collective dose to LLW disposal facility workers does not vary significantly by Alternative, ranging from approximately 28 person-rem (0.28 person-sievert) to 34 person-rem (0.34 person-sievert). The collective dose to LLW disposal facility workers associated with the Limited Dispositions Alternative would be within the range of that for the other Alternatives.

3.2.3.2.6 Summary

Table 3-8 summarizes the collective dose for Licensed Facility workers for each of the alternatives. This table is derived from Tables 3-2 to 3-7 of this report. The total collective dose ranges from 323 person-rem (3.23 person-sievert) to 665 person-rem (6.65 person-sievert).

Table 3-8 Summary of Licensed Facility Worker Collective Dose Results (person-rem)

Alternative	Collective Dose			
	Survey Workers	Decontamination Workers	Workers at LLW Disposal Facilities	TOTAL
No Action	289	308	34	631
Unrestricted Release	289	308	28 - 34	625 - 631
EPA/State-Regulated Disposal	289	308	28 - 34	625 - 631
LLW Disposal	289	0	34	323
Limited Dispositions	289	308	34	631

3.2.4 Non-Licensed Facility Workers and the General Public

This section describes the affected environment and environmental consequences associated with the Alternatives for Non-Licensed Facility Workers and the General Public.

3.2.4.1 Affected Environment

This section describes the affected environment associated with the Alternatives for Non-Licensed Facility Workers and the General Public.

Non-Licensed Facility Workers

The affected environment for Non-Licensed Facility Workers for the No Action and Unrestricted Release Alternatives includes truck drivers transporting solid materials to recycling facilities and transporting products and byproducts from recycling facilities, and also includes workers at the recycling facilities. The categories of activities for affected Non-Licensed Facility Workers are:

- Material processing, including processes for recycling of materials into finished commodities and end use products;

- Materials disposition, including the installation of finished commodities (e.g., recycled concrete road building material) and end use products (e.g., metal products made from recycled ferrous metal);

- Byproducts disposition, including the application of products (e.g., furnace slag concrete) produced from byproducts of materials recycling processes;

- Waste disposal, including disposal of wastes (e.g., foundry dust) produced by materials recycling processes;

- Transportation, including transportation of generated materials, finished commodities and end use products made from recycled materials, and byproducts and wastes generated from materials processing activities.

The affected environment for all the Alternatives except the LLW Disposal Alternative includes truck drivers transporting solid material from licensed facilities to EPA/State-Regulated disposal facilities and workers at the EPA/State-Regulated disposal facilities, including EPA/State-Regulated landfills and incinerators.

The only Non Licensed-Facility Workers involved in the LLW Disposal Alternative are truck drivers or railroad workers transporting the LLW to the licensed disposal facility. The workers involved in surveying the LLW at the licensee facilities are categorized as Licensed-Facility Workers, and the workers involved in disposing of the LLW at licensed disposal facilities are also categorized as Licensed-Facility Workers.

Under the Limited Dispositions Alternative, the affected environment for concrete would be similar to that for the Unrestricted Release Alternative, which assumes recycling of concrete into road bed material. The affected environment for solid materials that would be disposed of in EPA/State-Regulated disposal facilities would be similar to that for the EPA/State-Regulated Disposal Alternative. The affected environment for reuse of equipment would be similar to that for the No Action and Unrestricted Release Alternatives for the reuse of furniture in office buildings and reuse of tools and other equipment in other workplace settings. The affected environment for equipment reuse would also include truck drivers driving trucks formerly used at licensed facilities.

<u>General Public</u>

The affected environment for the General Public for the No Action and Unrestricted Release Alternatives includes those individuals located in the vicinity of recycling facilities and along material transportation routes, and in locations where products produced from recycled materials are used. Products produced from recycled materials could be transported and utilized anywhere in the United States, and therefore the affected environment for the General Public for the No Action and Unrestricted Release Alternatives may encompass locations throughout the country.

Activities potentially contributing to General Public collective dose for the No Action Alternative and Unrestricted Release Alternatives are:

- Materials disposition, including direct radiation exposure from use of finished commodities (e.g., recycled concrete as road building material) and end use products (e.g., metal products made from recycled ferrous metal);

- Residuals disposition, including direct radiation exposure from the disposition of products (e.g., furnace slag concrete) produced from byproducts of materials recycling processes;

- Waste disposal, including ground-water discharges from disposal of wastes (e.g., concrete dust) produced by materials recycling processes; and

- Transportation of solid materials to recycling facilities and transportation of commodities from recycling facilities, including direct radiation exposure to finished commodities and end use products made of recycled solid materials, and byproducts and wastes generated from materials processing activities.

Under the No Action and Unrestricted Release Alternatives some material generated from licensed facilities would be disposed of as LLW, and byproducts from recycling activities would be disposed of in EPA/State-Regulated disposal facilities. Therefore the affected environment for the No Action and Unrestricted Release Alternatives also includes the General Public located in the vicinity of LLW disposal facilities and EPA/State-Regulated disposal facilities.

Under the EPA/State-Regulated Disposal Alternative some material generated from licensed facilities and covered under the Proposed Action would be disposed of as LLW. Therefore the affected environment for the EPA/State-Regulated Disposal Alternative also includes individuals located in the vicinity of LLW disposal facilities and along transportation routes.

Activities potentially contributing to radiation exposure to the General Public for the EPA/State-Regulated Disposal Alternative are:

- Transportation of solid materials for EPA/State-regulated disposal;
- Material disposal in EPA/State-regulated Subtitle D landfills;
- Trash disposal in EPA/State-regulated incinerators; and
- Landfill disposal of ash generated from trash incineration.

The affected environment for the General Public under the Limited Dispositions Alternative would be similar to that for the No Action, Unrestricted Release, EPA/State-Regulated Disposal, and LLW Disposal alternatives.

3.2.4.2 Environmental Consequences

This section describes the environmental consequences for Non-Licensed Facility Workers and the General Public associated with each Alternative. Environmental consequences are presented in terms of collective dose, in units of person-rem, for each Alternative.

3.2.4.2.1 No Action Alternative

This section summarizes the collective dose to Non-Licensed Facility Workers and the General Public for the No Action Alternative. A screening analysis conducted for the No Action Alternative and Unrestricted Release Alternatives indicates that the collective dose to Non-Licensed Facility Workers is negligible as compared to the collective dose to the General Public for the No Action Alternative. Therefore, quantitative collective dose results presented in this section for the No Action Alternative are primarily collective dose to the General Public.

Non-Licensed Facility Workers Collective Dose

A screening analysis was conducted (SC&A 2003) to illustrate the relative collective dose associated with the various activities conducted by Non-Licensed Facility Workers and the General Public for recycling of ferrous metal and concrete. The screening analysis is based on an evaluation of the collective dose experienced in the first year the solid material is released. The analysis indicates that the collective dose from recycling ferrous metal is dominated by five end use products manufactured from recycled ferrous metal: office buildings (i.e., structural ferrous metal); beds; automobiles; office furniture; and home appliances, all of which contribute to collective dose to the General Public. These five end use products manufactured from recycled ferrous metal and their associated collective dose to the General Public represent 99.8 percent of the total combined collective dose to the General Public and Non-Licensed Facility Workers. The collective dose to Non-Licensed Facility Workers involved in activities for recycling ferrous metal under the No Action and Unrestricted Release Alternatives represents less than 0.2 percent of the total collective dose. Thus the collective dose for ferrous metal for the No Action and Unrestricted Release Alternatives is dominated by the collective dose to the General Public.

The only end use of recycled concrete analyzed in the Draft GEIS is its use for roadbed construction (Appendix G). The amount of concrete dust that can become airborne depends mainly on its moisture content, physical properties, and engineered measures used to minimize such releases. The analysis assumed that the amounts of materials released via fugitive emissions are small, such releases are short-lived in duration, and long-term exposures associated with end uses are dominant in terms of collective doses. The collective dose from recycling of concrete is dominated by the collective dose to the General Public associated with this single disposition of recycled concrete: driving on roads built using recycled concrete. The collective dose to Non-Licensed Facility Workers involved in recycling concrete under the No Action Alternative represents less than 10 percent of the total first year collective dose. These Non-Licensed Facility Worker activities include transporting the concrete rubble, processing concrete rubble into road bed material, and building the road. More than 90 percent of the collective dose for concrete for the No Action and Unrestricted Release Alternatives is represented by collective dose to the General Public.

The use of concrete rubble is limited because reclaimed concrete is not pure Portland concrete, but rather a mixture of concrete, soil, some amounts of bituminous concrete, and other small size debris generated during demolition. The use of concrete with more than 15 percent reclaimed concrete has lead to problems in meeting material quality specifications, resulting in its difficult use and workability. Besides road construction, reclaimed concrete is being used in bulk fill applications on land and water, as riprap for shoreline protection, as trench backfill, as a mix in asphaltic concrete, and in revetments for fieldwork and mining. It is expected that such uses would result in much lower exposures and collective doses as compared to the construction and use of road bed made with reclaimed concrete.

General Public Collective Dose

Table 3-9 shows the collective dose to the General Public for the No Action Alternative. The total collective dose for the No Action Alternative is 3,996 person-rem (39.9 person-sievert). The collective dose is dominated by exposure of the General Public to products made from recycled ferrous metal. The primary exposure pathway for ferrous metal is external exposure (direct radiation) to products made from recycled ferrous metal, such as automobiles and appliances. Because Co-60 (with a 5-year half-life) is the primary radionuclide from the ferrous metal that partitions to the recycled metal (as opposed to partitioning to the furnace dust), the radiation exposure to the General Public rapidly decreases after the end of the period when there would be no additional nuclear reactors being decommissioned and when there would be no additional ferrous metal being generated from reactor decommissioning to be made into products. The other primary radionuclide considered in the collective dose assessment for the No Action Alternative, Cs-137, partitions primarily to the furnace dust at the mill. For the purposes of the collective dose assessment, the furnace dust is assumed to be disposed of in an EPA/State-Regulated landfill. Exposure pathways associated with landfill disposal of furnace dust include ground water and surface water discharges from the landfill and subsequent exposure of the General Public through drinking water and food ingestion, and direct radiation exposure of Non-Licensed Facility Workers (e.g., landfill workers, truck drivers) encountering the furnace dust. However, as discussed above, the collective dose to Non-Licensed Facility Workers from ferrous metal recycling is negligible as compared to the collective dose to the General Public.

Table 3-9 No Action Alternative - General Public Collective Dose for Materials Released from Commercial Nuclear Reactor Facilities (person-rem)[1]

Ferrous Metal	Concrete	Trash	Equipment Reuse	All Materials
3,920	3.91	0.006	72	3,996

[1] Source: SC&A 2003, Table 10.8.

Equipment Reuse

Table 3-10 describes the mean collective dose values to the General Public associated with the reuse of both large and small pieces of equipment for the Alternatives. The collective dose associated with equipment reuse for the No Action Alternative is 72 person-rem (0.72 person-sievert). The analysis of collective dose for equipment reuse is described in Section 12 of Appendix D.

Table 3-10 General Public Collective Doses Associated with Reuse of Large and Small Equipment from Commercial Nuclear Power Reactors

Dose Option	Collective Dose (person-rem) Small Equipment	Collective Dose (person-rem) Large Equipment	Total Collective Dose (person-rem) for Equipment Reuse
Unrestricted Release Alternative			
RS-G-1.7	5	56	61
10 mrem/yr	160	150	310
1 mrem/yr	16	15	31
0.1 mrem/yr	2	2	4
0.03 mrem/yr	<1	<1	<1
No Action Alternative	6	66	72

Note: Mean profile taken from Appendix D, Section 12 of this GEIS.
The IAEA volumetric criteria were converted to surficial limits using a mass-to-surface ratio of 5 g/cm^2, assuming that equipment consist of ferrous metals.

Collective doses to the General Public associated with the reuse of equipment were evaluated for two categories of equipment, large and small. The approach used in estimating collective doses relies on a scoping analysis because practices associated with the reuse of equipment are known to be highly variable. For example, it is known that different types of equipment and tools are used in radiologically controlled areas and later taken out of those areas. The type of equipment that could be potentially cleared from licensed facilities for reuse in an environment free of radiological controls ranges from small items, such as hand tools, to very large ones, such as mechanized equipment and industrial vehicles. The following are examples of potentially reusable equipment, tools, and miscellaneous items:

- small hand tools (wrenches, screw drivers, etc.) and power tools (drills, saws, etc.)
- electrical equipment, such as control panels, motors, pumps, and generators
- office furniture (desks, chairs, filing cabinets, etc.) and office equipment (copiers, computers, printers, fax machines, etc.)
- construction equipment, such as scaffolding, noise or dust-control barriers, wheelbarrows, etc.
- mechanized equipment, such as trucks, backhoes, bulldozers, and other vehicles
- materials and supplies for use in their original forms, but taken out as excess, such as piping, tubing, electrical wiring, floor covering, ductwork, sheet metal, pipe hangers, light fixtures, wall board, and sheet glass.

Table 3-10 describes the mean collective dose values to the General Public associated with the reuse of both large and small pieces of equipment.

3.2.4.2.2 Unrestricted Release Alternative

Non-Licensed Facility Workers and General Public

The screening analysis conducted for the collective dose to Non-Licensed Facility Workers for the No Action Alternative also applies to the Unrestricted Release Alternative as the same disposition of solid materials is assumed for both Alternatives in the screening analysis. The analysis indicates that the collective dose to Non-Licensed Facility Workers is negligible as compared to the collective dose to the General Public. Therefore, quantitative collective dose results are not presented separately for Non-Licensed Facility Workers for the Unrestricted Release Alternative.

Material-Specific and Material-Independent Collective Doses

Material-specific dose factors are developed for each radionuclide and each type of material. For example, the analysis for Co-60 in ferrous metal uses the dose factor for the scrap yard worker since it is the most limiting of all ferrous metal related scenarios that were evaluated (these scenarios include handling and processing, transportation, and product use). On the other hand, the material-independent dose factors consider the most conservative dose factor for each radionuclide, regardless of the type of material. For example, the presence of Co-60 in concrete (used in road building) results in the most limiting dose factor as compared to the presence of Co-60 in ferrous metal. More details can be found in Appendix D of the Draft GEIS for both cases - material-specific results (Case A) and material-independent results (Case B) (see Tables D-1 to D-3).

General Public Collective Dose

Table 3-11 shows the collective dose for the Unrestricted Release Alternative for concrete, ferrous metal, and trash for material specific and material independent dose factors. The collective dose is dominated by the exposure of the General Public to end-use products made from recycled ferrous metal. The primary exposure pathway for ferrous metal is external exposure (direct radiation) to products made from recycled ferrous metal. The total collective dose for concrete, ferrous metal, and trash ranges from 208 person-rem (2.08 person-sievert) for the 0.03 mrem/year dose option to 28,430 person-rem (284 person-sievert) for the 10 mrem/year dose option. Note that Table 3-11 presents collective dose results for material independent and material-specific cases, whereas Table 3-10 does not.

The collective dose for the RS-G-1.7 dose option is twice that of the 1 mrem/year dose option because the amount of activity anticipated to be released for this dose option is approximately twice that of the 1 mrem/year dose option, as shown in Table 3-11 (see Appendix D, Section 11).

Table 3-11 Unrestricted Release Alternative - General Public Mean Collective Dose Results (person-rem)[1]

Solid Material	Dose Option				
	0.03 mrem/yr	**0.1 mrem/yr**	**1 mrem/yr**	**10 mrem/yr**	**RS-G-1.7**
Unrestricted Release/ Material Specific					
Ferrous Metal	205	881	6,380	28,400	NA
Concrete	3	7	24	28	NA
Trash	<1	<1	<1	2	NA
TOTAL	208	887	6,404	28,430	NA
Unrestricted Release/Material Independent[2]					
Ferrous Metal	19	107	1,660	9,650	3,320
Concrete	3	7	24	28	48
Trash	<1	<1	<1	<1	<1
TOTAL	22	114	1,684	9,680	3,370

[1] Source: SC&A 2003, Table 10.8.
[2] For RS-G-1.7 results, see Appendix D, Section 11 of this report.

Inventory information on other metals, besides ferrous metal, indicated these were primarily copper or aluminum, and present in insignificant amounts as compared to ferrous metals. NUREG-1640 considers dose factors for both copper and aluminum for individual dose estimating purposes. However, regarding collective dose, the results were developed for ferrous metal and the small amounts of copper and aluminum inventory were evaluated using a screening analysis for the collective dose associated with the unrestricted release (recycling) of aluminum and copper generated from licensed facilities. A detailed collective dose assessment was not performed for aluminum and copper because of the small amount of these materials generated as compared to ferrous metal. The results indicate that collective doses for copper and aluminum are about one to two orders of magnitude lower than that of ferrous metal for all alternatives.

Table 3-10 describes the mean collective dose values to the General Public associated with the reuse of both large and small pieces of equipment for the Alternatives. The collective dose associated with equipment reuse for the Unrestricted Use Alternative is 61 person-rem.

3.2.4.2.3 EPA/State-Regulated Disposal Alternative

The collective dose to the Non-Licensed Facility Workers and the General Public for the EPA/State-Regulated Disposal Alternative is estimated for two scenarios, one assuming that the trash generated from licensed facilities is disposed of in EPA/State-Regulated landfills and one assuming that the trash generated from licensed facilities is disposed of in an EPA/State-Regulated incinerator, with subsequent disposal of the incinerator ash in an EPA/State-Regulated landfill. Concrete and metal solid materials are assumed not to be incinerated. Table 3-12 provides a summary of collective dose to Non-Licensed Facility Workers and the General Public for the EPA/State-Regulated Disposal Alternative for the trash landfill disposal and trash incineration disposal scenarios. The total collective dose for the EPA/State-Regulated Disposal Alternative without trash incineration ranges from 0.11 person-rem (0.0011 person-sievert) for

Table 3-12 EPA/State Regulated Disposal Alternative - General Public Mean Collective Dose Results (person-rem)

Solid Material	Dose Option				
	0.03 mrem/yr	0.1 mrem/yr	1 mrem/yr	10 mrem/yr	RS-G-1.7
EPA/State-Regulated Landfill					
Ferrous Metal	<1	<1	1	5	NA
Concrete	<1	<1	<1	<1	NA
Trash	0	<1	<1	2	NA
TOTAL	<1	<1	2	6	NA
EPA/State-Regulated Landfill with Trash Incineration					
Ferrous Metal	<1	<1	1	5	3
Concrete	<1	<1	<1	<1	<1
Trash	16	70	1,010	14,400	2,020
TOTAL	16	70	1,011	14,405	2,023

Source: SC&A 2003, Table 10.8.

the 0.03 mrem/year dose option to 6 person-rem (0.06 person-sievert) for the 10 mrem/year dose option. For the EPA/State-Regulated Disposal Alternative with trash incineration the total collective dose ranges from 16 person-rem (0.16 person-sievert) for the 0.03 mrem/year dose option to 14,400 person-rem (144 person-sievert) for the 10 mrem/year dose option. The collective dose assessment for trash for Non-Licensed Facility Workers and the General Public accounts for work activities involving truck drivers hauling trash, trash disposal in a landfill, trash incineration and ash disposal in a landfill, and a crane operator loading trash into an incinerator. Doses to offsite receptors consider the impacts associated with effluent discharges from landfill and incinerator operations. The collective dose associated with trash incineration is dominated by exposure of the General Public to airborne effluents.

The collective dose results in Table 3-12 are material specific. SC&A 2003 does not provide dose results for landfills evaluated for the material-independent case. It should be noted that such doses will be lower still than that shown for the material-specific case. This is because the material-independent case is based on the most limiting dose factors and corresponding lower release levels. Lower release levels yield lower collective doses.

The use of incineration at solid waste landfills has declined over the past decade (EPA, personal communication). In 2001, about 15 percent of all solid waste was incinerated, about 30 percent was recycled or composted, and the rest is sent to landfills. In the past, there was more emphasis on incineration when it was thought that landfill capacity would become scarce and expensive, but those concerns have not been borne out. In the near term, it seems likely that the percentage of waste incinerated will decline further. (See www.epa.gov/epaoswer/non-hw/muncpl/facts.htm for some basic information on solid waste.) However, even if all the trash is assumed to be incinerated, at the 1 mrem/yr dose option the collective dose is still less than for the No Action Alternative.

It is common practice for landfills to monitor incoming waste shipments for the presence of radioactivity. The radiation monitoring systems typically are installed at the scales where trucks are weighed before being sent to specific waste processing areas. The alarm set-points are set at varying levels, typically set at a multiple of ambient background levels. If a waste shipment were to set off an alarm, the shipment is set aside and the originator of the shipment is informed of the situation. Depending on operational procedures, landfill operators call the State agency responsible for radiation protection for guidance on how to proceed. In both cases, the originator of the shipment, at a minimum, is called upon to identify the type and quantities of radioactive materials present in the waste shipment, and demonstrate that the shipment complies with existing NRC or Agreement State regulations. In other instances, landfill operators do not accept any type of radioactive materials and the shipments are refused and returned to the originator.

Appendix J contains a discussion of RCRA facilities, including regulatory requirements, siting criteria, engineering design features, monitoring requirements, and exposure pathways. The evaluation of different RCRA Subtitle D landfills and their ability to affect environmental impacts supports the collective dose analysis. For municipal solid waste landfills the most important landfill parameters that affect the amount of radioactivity released are infiltration, waste thickness, and distribution coefficients (K_d).

3.2.4.2.4 Low-Level Waste Disposal Alternative

The only Non-Licensed Facility Workers that are associated with the LLW Disposal Alternative are truck drivers transporting the material to LLW disposal facilities. For the purposes of this analysis NRC has assumed that all of the potentially clearable material released from licensed facilities and transported to LLW disposal facilities under the LLW Disposal Alternative would be transported to the Envirocare facility in Utah. This is a reasonable assumption because little of the solid material would be eligible for disposal at the Barnwell and Hanford sites (Section 2.4.4). Also, this assumption would bound the analysis. Exposure time to truck drivers transporting the materials to the Envirocare facility under the LLW Disposal Alternative would be approximately a factor of eight higher than the exposure time for transport under the No Action and Unrestricted Release Alternatives, as calculated based on the vehicle miles traveled shown in Table 3-15. However, exposure time to truck drivers transporting the materials to the Envirocare facility would also depend on the curies transported to LLW disposal facilities. Under the No Action Alternative, 2,947 of a possible 2,951 curies of activity would be transported to LLW disposal facilities (Table 3-4). As shown in Tables 3-4 and 3-5, the collective dose to workers at LLW disposal facilities does not vary significantly among the alternatives and dose options.

Potential exposures for the General Public (which includes Non-Licensed Facility Workers) from the operation of LLW disposal facilities has been analyzed in the Final Environmental Impact Statement for 10 CFR Part 61 and in environmental reviews for licensing of existing LLW disposal facilities. The potential types of exposure mechanisms associated with the disposal of solid materials in LLW disposal facilities are similar to those for disposal in EPA/State-regulated landfills. Since materials that have been released have properties that are more like those found in the lower-most range of Class A wastes, it follows that potentially clearable materials can be safely disposed of in LLW sites without any further impacts to the public and environment. This aspect was addressed by comparing typical radioactive inventories of waste accepted by LLW disposal sites against that associated with releases (SC&A 2003, Section 8.1). A review of the data indicates that total receipts of radioactivity sent for disposal from 1986 to 2002 are about 9,300 curies, and 2 and 6.2 million curies at the Envirocare, Richland, and Barnwell disposal sites, respectively. These activity levels represent total curies without the contribution from H-3 and C-14, since these radionuclides contribute only minimally to exposures and doses. A review of the results presented earlier indicates that such inventories of radioactivity are lower by orders of magnitude. This comparison indicates that if LLW sites are authorized to receive several hundred thousands curies and be in compliance with Part 61 regulations, the small incremental amounts of radioactivity associated with potentially clearable materials will not adversely impact the site, nor compromise the health and safety of the public and workers. Therefore, no assessment of General Public or Non-Licensed Facility Worker collective dose is included in this Draft GEIS for the LLW Disposal Alternative.

3.2.4.2.5 Limited Dispositions Alternative

The Limited Dispositions Alternative involves different disposition pathways for different solid materials generated from licensed facilities. Tools and equipment released from licensed facilities could be reused in other locations. Recycling of concrete released from licensed facilities would be limited to recycling as road bed. Ferrous metals and trash released from licensed facilities would be limited to EPA/State-regulated disposal. Other dispositions could be approved on a case-by-case determination by NRC. The collective dose to Non-Licensed Facility Workers and the General Public resulting from the Limited Dispositions Alternative is anticipated to be similar to that for the Unrestricted Release Alternative for concrete and similar to that for the EPA/State-Regulated Disposal Alternative for other materials for ferrous metals and trash.

The collective dose for concrete under the Limited Dispositions Alternative would be similar to the Unrestricted Release Alternative, for which the collective dose assessment is based on concrete reuse as road bed (see Table 3-11). The collective dose for ferrous metals and trash would be similar to the EPA/State-Regulated Disposal Alternative (Table 3-12). The collective dose for reuse of tools and equipment would be similar to the Unrestricted Release Alternative.

The collective dose to the General Public associated with the Limited Dispositions Alternative is the sum of the following collective doses using the IAEA Safety Guide:

- concrete use in roadbeds (48 person-rem (0.48 person-sievert)) (Table 3-11);
- disposal of ferrous metal and trash in EPA/State-regulated disposal facilities (3 person-rem (0.03 person-sievert)) (Table 3-12); and
- reuse of tools and equipment (61 person-rem (0.61 person-sievert)) (Table 3-10).

3.2.4.2.6 Summary of Collective Doses for Non-Licensed Facility Workers and the General Public

Table 3-13 presents a summary of the collective doses to the General Public and Non-Licensed Facility Workers for the No Action, Unrestricted Use, EPA/State-Regulated Disposal, and Limited Dispositions Alternatives. This table is based on Tables 3-9 to 3-12 of this report. Results for the LLW Disposal Alternative are expected to be small (Section 3.2.4.2.4). For comparison purposes, the collective doses for the Unrestricted Release Alternative are material-independent and presented for the 1 mrem/yr dose option using the IAEA Safety Guide to be comparable to the Limited Dispositions Alternative. These collective dose results are for potentially clearable solid materials released from commercial nuclear reactor facilities.

Table 3-13 Summary of Non-Licensed Facility Workers and General Public Collective Dose Results (person-rem)

Alternative	Collective Dose				
	Concrete	Ferrous metal	Trash	Equipment Reuse	Total
No Action	4	3,920	<1	72	3,996
Unrestricted Use	48	3,320	<1	61	3,429
EPA/State-Regulated Disposal without Trash Incineration	<1	1	<1	0	2
EPA/State-Regulated Disposal with Trash Incineration	<1	1	1,010	0	1,011
Limited Dispositions	48	3	<1	61	112

3.2.5 Collective Dose from Materials Generated from Licensed Facilities Other Than Reactors

The collective dose values reported above include only solid materials generated from commercial nuclear reactor licensees. These materials constitute the majority of the mass, activity, and collective dose associated with material generated from licensed facilities. The other licensed facilities (which are described in Appendix F) include:

- Large medical centers: includes regional and university medical centers administering nuclear medicine.
- Fuel fabrication facilities: includes wastes generated from decontamination and decommissioning of licensed facilities that fabricate nuclear reactor fuel and daily operations (e.g., trash).
- Conversion plant: includes wastes generated from decontamination and decommissioning of licensed facilities that manufacture uranium hexafluoride.
- Non-power reactor: includes wastes generated from decontamination and decommissioning of research reactors and reactors other than commercial power reactors.

- Independent Spent Fuel Storage Installations (ISFSI): includes wastes generated from decontamination and decommissioning of ISFSI and daily operations (e.g., trash).

Other licensed facilities also generate trash from within radiation control areas during operations.

A screening analysis was conducted for materials generated from NRC-licensed facilities other than commercial reactors for the No Action and Unrestricted Release Alternatives. A screening analysis was used because the mass and activity of the reactor-generated solid materials is much greater than that of other licensed facilities. A screening analysis was not necessary for the other alternatives because the No Action and Unrestricted Release Alternatives would result in the greatest quantities of materials released. Table 3-14 summarizes the collective doses associated with solid materials released from NRC licensees other than commercial nuclear reactor facilities for the No Action and Unrestricted Release Alternatives.

Table 3-14 Summary of Collective Dose Scoping Calculations for Solid Materials Generated from Licensees other than Commercial Nuclear Reactors (person-rem)

Alternative	Large Medical Centers (person-rem)	Fuel Fab.	Conv. Plant	Non-power Reactor	ISFSI	Total Non- Reactor	Trash Generated from Other Licensees
No Action	6	<1	<1	<1	<1	6	<1
Unrestricted Release							
10 mrem/yr	1,020	4	1	2	38	1,066	<1
1 mrem/yr	71	<1	<1	<1	4	76	<1
0.1 mrem/yr	4	<1	<1	<1	<1	5	<1
0.03 mrem/yr	1	<1	<1	<1	<1	1	<1

Source: SC&A 2003, Table 5.31, and Tables 3-9 and 3-11 of this report.

The collective dose associated with release of materials from large medical centers was estimated for the No Action Alternative and for all the dose options under the Unrestricted Release Alternative. The dose is attributed to tritium and carbon-14, which are the major long-lived radionuclides contributing to the collective dose. Short-lived radionuclides used in routine nuclear diagnostic tests (Tc-99m) and therapy (I-131) are not considered since current practices manage these radionuclides using radioactive decay. The material associated with routine releases are assumed to consist of miscellaneous glass and plastic wares, absorbent pads, protective clothing, trays and racks, disposable equipment, and some parts of experimental apparatus, such as sampling and dispensing devices, fluid path tubing, pumps, filters, etc. It should be noted that waste volumes could be higher in a few instances, such as when gutting a room during facility refurbishment or after spills. However, in such instances, all materials would be disposed as LLW. Collective doses vary from about 1 to 1,000 person-rem (0.011 to 10 person-sievert) over all dose options and for the duration of the Proposed Action (46 years).

For the No Action Alternative, the collective dose is estimated to be nearly 6 person-rem (0.06 person-sievert). At 1 mrem/yr the collective dose for materials generated from licensees other than commercial reactor facilities is less than 5 percent of the collective dose associated with materials generated from commercial reactors for the Unrestricted Release Alternative.

The collective dose associated with materials generated from commercial reactor facilities, including concrete, ferrous metal, and trash for the Unrestricted Release Alternative is approximately 3,400 person-rem (34 person-sievert) for the 1 mrem/year dose option using the IAEA standard (IAEA 2004) (Table 3-11).

Unlike the detailed inventory information available for power reactors, and their very detailed analysis, the other licensed facilities inventory information was much more limited. Because the preponderance of contribution to the collective dose comes from the power reactor industry, and only a small percentage comes from the rest of the licensees, a screening analysis for bounding the collective dose contribution associated with these other facilities was considered appropriate. Consequently, the level of detail presented for collective dose breakouts in terms of contributions from concrete, ferrous metal, trash, etc. was not developed to the same degree as for the more detailed analysis of commercial nuclear power reactors. However, more details about inventory (type of material, amount, and curie content) for these licensed facilities is available from Appendix F. The trash volume is based on a total from all different categories of facilities, and its method of estimation is presented in Chapter 4 of the collective dose report (SC&A 2003), which is summarized in Appendix D.

3.2.6 Summary of Collective Doses

The human health and safety impacts are measured in this Draft GEIS in terms of collective dose. Table 3-8 summarizes the predicted collective doses for Licensed Facility Workers and Table 3-13 for Non-Licensed Facility Workers and the General Public. All of these doses are small when compared to the background collective dose to the U.S. population due to natural sources of radiation and radioactivity (Appendix E).

3.3 TRANSPORTATION

The affected environment and environmental consequences related to transportation of solid materials released from licensed facilities are related to:

- Radiation doses to Workers at Non-Licensed Facilities and to the General Public, as associated with the routine transportation of solid materials by truck; and

- Potential non-radiological consequences to Workers at Non-Licensed Facilities and to the General Public, as related to truck and rail transportation accidents as obtained from statistical highway and rail data.

Truck drivers transporting materials generated from licensed facilities are categorized as Workers at Non-licensed Facilities for the purposes of the Draft GEIS. Radiation dose to truck drivers is included in the collective dose assessment for Non Licensed-Facility Workers and the General

Public, as discussed in Section 3.2, and is not further discussed in this section. In addition, the radiological impacts from the transport of all licensed radioactive material has been generically evaluated in NUREG-0170, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (NRC 1977). This analysis considered radiation exposure of transport workers and members of the General Public along transportation routes from both normal transportation and accidents. Based on this analysis, radiological transportation impacts are expected to be small for all alternatives. As a result, only non-radiological impacts from transportation accidents are discussed below.

3.3.1 Affected Environment

The affected environment associated with non routine occurrences (transportation accidents) involving truck and rail transportation of solid materials are Workers at Non-Licensed Facilities (truck drivers and railroad workers) and the General Public (persons along a route) potentially affected by injuries or fatalities resulting from transportation accidents involving trucks or railcars. Such injuries or fatalities would be the result of accidents during transport (e.g., truck collisions, railcar derailments). The affected environment with respect to the General Public includes transportation routes throughout the United States. The locations of the licensed facilities that would generate solid materials affected by the Proposed Action are known; however, the specific transportation routes that would be used in transporting solid materials from licensed facilities to recycling facilities and disposal facilities cannot be fully determined. The affected environment therefore cannot be associated with specific transportation routes.

The affected environment for transportation is generally similar for all Alternatives except workers at Non-Licensed Facilities for the LLW Disposal Alternative would include both truck drivers and railroad workers. Transportation routes in the vicinity of recycling facilities would be primarily affected under the No Action and Unrestricted Release Alternatives. Transportation routes in the vicinity of EPA/State-regulated disposal facilities would be primarily affected under the EPA/State-Regulated Disposal Alternative. Transportation routes in the vicinity of LLW disposal facilities would be affected under the LLW Disposal Alternative. The Limited Dispositions Alternative would involve both recycling concrete and EPA/State-regulated disposal of solid material and would therefore affect transportation routes in the vicinity of both recycling and EPA/State-regulated disposal facilities.

3.3.2 Transportation Requirements

Transportation safety addresses the performance of rail or motor carriers, trucks or rail cars, and drivers or crews, and is often measured through accident rates. The Federal Motor Carrier Safety Administration and Federal Railroad Administration each enforce comprehensive safety standards and monitor carrier operations. Rail shipments involve compliance with regulations for track quality and condition, signal and control systems, freight car standards, operating practices, inspections, crew qualifications, etc.

Intrastate, interstate, and international shipments of hazardous materials (including hazardous wastes) by any mode of transport are covered by federal and international laws. These laws cover:

Proper identification and classification of hazardous materials;

- Required hazard communications, such as shipping papers, markings, labels, and placards; and
- Material-specific packaging requirements.

Transport of LLW is subject to all of the hazardous materials requirements above, and the U.S. Department of Transportation (DOT) (in consultation with NRC) establishes the applicable packaging standards. The disposal of LLW is conducted in accordance with the specific waste acceptance criteria of the recipient disposal site and Federal regulations. These requirements are addressed in NRC regulations in 10 CFR Part 61. The requirements of 10 CFR Part 61 are complemented with Subpart K (waste disposal) and Appendix G (shipping) to 10 CFR Part 20 and DOT regulations for radioactive materials in Subpart I to 49 CFR Part 173. Among others, the criteria address radiological and non-radiological profiles of waste, containerization and package labeling, shipping requirements, and use of shipping manifests. There are also RCRA exclusions that are applicable to the transportation of recycled scrap metal, which can relieve some of the requirements for packaging, shipping papers, marking, labeling, placarding, etc. for such materials. However, since the proposed release levels for the Limited Dispositions Alternative are less than or equal to the DOT activity concentrations for exempt material under 49 CFR Part 173.436, the solid materials are not regulated as radioactive material while in transport.

3.3.3 Environmental Consequences

This section describes the potential non-radiological environmental consequences to Workers at Non-Licensed Facilities and the General Public from potential transportation accidents associated with solid materials released from licensed facilities. In the transportation accident analysis in this section, for transportation by truck, the analysis is based on the total vehicle miles traveled for each Alternative. For transportation by rail, in the main analysis, railcar miles are assumed only for the LLW Disposal Alternative; however, a sensitivity study assumed that for all the alternatives the material would be shipped to LLW facilities by rail (Section 4.6). National accident rates for truck and rail transportation are applied to the total miles traveled. The national accident rates are independent of the material being transported. That is, the railcar accident rate, in units of the number of accidents per billion railcar miles traveled, applies equally to railcars containing solid materials released from licensed facilities and railcars containing salt, grain, or other materials.

The environmental consequences associated with non-routine occurrences (i.e., transportation accidents) do not include collective dose to Non-Licensed Facility Workers and the General Public. As discussed in Section 3.2, the collective dose to truck drivers for routine transportation of solid materials is included as part of the collective dose assessment. It is anticipated that any individual truck driver would experience no more than a single transportation accident and would therefore be exposed to no more than one incident of exposure. In addition, it should be pointed out that the occurrence of an accident does not necessarily result in an additional exposure. Any additional incremental exposure that did occur would not significantly increase the collective dose to Non Licensed Facility Workers and the General Public. Therefore, no collective dose assessment for potential radiation exposures related to transportation accidents is included in the Draft GEIS.

Table 3-15 summarizes the transportation characteristics for the No Action, Unrestricted Release, EPA/State-Regulated Disposal, and LLW Disposal Alternatives under the bounding dose options. The table shows the total amount of material that would be transported under each Alternative (SC&A 2003, Tables 10.3 and 10.7) as well as the total truck or rail car miles traveled. These distances are based on the distances between current nuclear power plants and recycling and disposal facilities (SC&A 2003, Table 9-62 and page K-25 of this report). The distances for non-reactors are assumed to be the same. Based on the assumed capacity of the trucks (25 tons), the number of miles trucks would needed to transport material to recycling or disposal facilities was calculated (Appendix K).

Table 3-15 Solid Materials Transported Under Alternatives

Solid Material	No Action		Unrestricted Release 10 mrem/yr dose option		Unrestricted Release 0.03 mrem/yr dose option	
	Tons	Vehicle Miles Traveled	Tons	Vehicle Miles Traveled	Tons	Vehicle Miles Traveled
Ferrous metal	2,059,800	22,163,448	2,450,961	26,372, 340	970,286	10,440,278
Concrete	16,213,364	128,409,843	19,772,249	156,596,212	15,038,234	119,102,813
Trash	20,408	326,528	66,102	1,057,632	13,643	218,288
Aluminum	173	1,861	211	2,270	192	2,066
Copper	5,362	57,695	6,539	70,360	4,255	45,784
Total Released	18,299,107	150,959,375	22,296,062	184,098,814	16,026,610	129,809,228
Total to LLW Disposal	4,406,964	272,174,097	410,009	25,322,156	6,679,461	412,523,511
TOTAL	**22,706,071**	**423,133,472**	**22,706,071**	**209,420,970**	**22,706,071**	**542,332,740**

Solid Material	EPA/State-Regulated Disposal 10 mrem/yr dose option		EPA/State-Regulated Disposal 0.03 mrem/yr dose option		LLW Disposal	
	Tons	Vehicle Miles Traveled	Tons	Vehicle Miles Traveled	Tons	Miles Traveled
Ferrous metal	2,480,000	5,753,600	1,570,000	3,642,400	2,498,911	19,791,375
Concrete	19,800,000	45,936,000	15,600,000	36,192,000	19,877,341	157,428,541
Trash	66,000	1,056,000	14,000	224,000	323,023	2,558,342
Aluminum	211	490	192	445	212	1,679
Copper	6,369	14,776	4,255	9,872	6,584	52,145
Total Released	22,352,580	52,760,866	17,188,447	40,068,717	22,706,071	-
Total to LLW Disposal	353,491	21,831,604	5,517,624	340,768,458	22,706,071	**318,710,669 by rail 1,402,326,945 by truck**
TOTAL	**22,706,071**	**74,592,470**	**22,706,071**	**380,837,175**	**22,706,071**	

Source: Materials tonnage based on SC&A 2003, Tables 4.7, 10.2 and 10.3.

The amount of potentially clearable solid material varies among the Alternatives, depending on (1) dose limits and (2) whether the material is transported to recycling facilities, EPA/State-regulated disposal facilities, or LLW disposal facilities. Separate quantitative analyses are provided for the 10 mrem/year dose option and the 0.03 mrem/year dose option for the Unrestricted Release and the EPA/State-Regulated Disposal Alternatives as lower and upper bounds for all the dose options. Note that some solid material is transported to LLW disposal facilities under each of the Alternatives. Only a single analysis is provided for the No Action Alternative and the LLW Disposal Alternative because there are no dose options for these Alternatives.

The fatal accident rate for large truck transportation is 3.2E-09 fatalities per vehicle mile traveled for truck occupants (Non-Licensed Facility Workers), and 2.0E-08 fatalities per vehicle mile for the occupants of other vehicles involved in an accident or for pedestrians (the General Public) as obtained from statistical highway data (FMCSA 2004). The accident rate for rail transportation is generally presented as an accident rate per train mile, or a combination of accident rates based on both train miles and rail car miles depending on the accident cause. In this instance an overall rate per rail car mile is desired as it is not known how many rail cars might be shipped per train.

Based on Federal Railroad Administration (FRA 2004) statistics, the accident rate for the crew (Non-Licensed Facility Workers) is 7.6E-10 fatalities per rail car mile traveled, and the rate for occupants of other vehicles and pedestrians (the General Public) is 2.0E-08 fatalities per rail car mile traveled.

Table 3-16 provides a summary of predicted transportation fatalities for each of the Alternatives over the period of the impacts (about 50 years). As shown, the fewest number of transportation accident fatalities, roughly 2 total fatalities for Non-Licensed Facility Workers and the General Public, is associated with the 1 mrem/year dose option under the EPA/State-Regulated Disposal Alternative. This result is because the largest amount of solid materials are transported the shortest distance under this Alternative and dose option. The highest number of transportation accident fatalities, approximately 32 fatalities, is associated with the LLW Disposal Alternative assuming truck transportation. This Alternative involves the highest vehicle miles traveled. For the LLW Disposal Alternative assuming rail transportation the number of transportation accidents is approximately 7. By comparison, there are approximately 10 fatalities from transportation accidents estimated for the No Action Alternative. For the Limited Dispositions Alternative, there are approximately 9 transportation fatalities.

3.3.3.1 No Action Alternative

The No Action Alternative is predicted to result in 1.4 fatalities for truck drivers (Non-Licensed Facility Workers) and 8.5 fatalities for the General Public over the time period of the Proposed Action.

Table 3-16 Summary of Transportation Impacts (Accident Fatalities) for Alternatives (Vehicle Miles are for Trucks, unless indicated)

Alternative	Dose Option (mrem/year)	Vehicle Miles Traveled	Fatalities NLFW[a]	Fatalities GP[b]	Total
No Action	not applicable	423,133,472	1.4	8.5	9.9
Unrestricted Release	10	209,420,970	0.7	4.2	4.9
	1	230,120,298	0.8	4.6	5.3
	0.03	542,332,740	1.7	10.9	12.6
EPA/State-Regulated Disposal	10	74,592,470	0.2	1.5	1.7
	1	87,624,470	0.3	1.8	2.1
	0.03	380,837,175	1.2	7.6	8.8
LLW Disposal	not applicable	1,402,326,945 (truck)	4.5	28	32.5
		318,710,669 (rail)	0.2	6.4	6.6
Limited Dispositions	RS-G-1.7	405,493,883	1.3	8.1	9.4

a - NLFW = Non-Licensed Facility Workers b - General Public

3.3.3.2 Unrestricted Release Alternative

The 10 mrem/yr and the 0.03 mrem/yr dose options provide a lower bound and upper bound for the vehicle miles traveled and number of transportation fatalities for the 1 mrem/year, 0.1 mrem/year, and RS-G-1.7 dose options. The fatalities to Non-Licensed Facility Workers are predicted to fall between 1 and 2 over the period of the Proposed Action, while for the General Public the range is 4 to 11 over the same period.

3.3.3.3 EPA/State-Regulated Disposal Alternative

The 10 mrem/year and the 0.03 mrem/yr dose options provide a lower bound and upper bound for the vehicle miles traveled and number of transportation fatalities for the 1 mrem/year, 0.1 mrem/year, and RS-G-1.7 dose options. The fatalities to Non-Licensed Facility Workers are predicted to fall between 0 and 1 over the period of the Proposed Action, while for the General Public the range is 2 to 8 over the same period.

3.3.3.4 Low-Level Waste Disposal Alternative

Transportation of solid material under the LLW Disposal Alternative could be conducted by truck, rail, or a combination of the two. The analyses in Table 3-16 are based on all of the solid material being transported either by rail or all of the solid material being transported by truck. Depending on the actual mix of rail and truck, the fatalities predicted would be expected to fall between 0 and 5 for Non-Licensed Facility Workers and between 6 and 28 for the General Public over the period of the Proposed Action.

3.3.3.5 Limited Dispositions Alternative

It is assumed that transportation impacts associated with reuse of tools and equipment are negligible. The fatalities are predicted to be 1 for Non-Licensed Facility Workers and 8 for the General Public over the period of the Proposed Action (about 50 years). NRC could allow solid material (e.g., metal) generated by a particular licensed facility to be recycled as a case-specific approval. Trash is not anticipated to be recycled. For these specific cases, the total amount of material that would be transported to recycling facilities and transported to disposal facilities under the Limited Dispositions Alternative and the associated vehicle miles traveled cannot be estimated. However, the case-by-case approval of a licensee’s application would include an environmental review.

3.3.4 Summary of Transportation Impacts

Transportation impacts are measured in this Draft GEIS in terms of fatal vehicle accidents and railcar incidents (e.g., derailments). Table 3-16 summarizes the predicted transportation fatalities for each of the alternatives. The Unrestricted Release, EPA/State-Regulated Disposal and Limited Dispositions alternatives have similar impacts compared to the No Action Alternative, and the transportation impacts associated with these Alternatives are small. However, the LLW Disposal Alternative assuming truck transportation has a higher number of transportation accident fatalities because this alternative involves the highest vehicle miles traveled. Thus, the transportation impacts associated with the LLW Disposal Alternative are small to moderate, depending on whether transportation is by rail or truck.

3.4 WATER RESOURCES

This section discusses the potential incremental exposures associated with non-radionuclide releases to surface water, ground water, and drinking water. Supplemental detailed information is in Appendix H. The potential radiological impacts in terms of collective dose associated with discharges to surface water, ground water, and drinking water are addressed in Section 3.2.

The significance of any exposure consequences depends on the presence, identity, and level of contaminants in the materials released from licensed facilities, and the ability of those contaminants to migrate to the waters which contact those materials. This section limits the discussion of the affected environment to populations potentially exposed to waterborne constituents, and does not address secondary paths involving waterborne constituents which transfer to other media, such as by adsorption onto soil particles, dispersion as airborne particulate matter, or conversion to a gaseous state. These secondary pathways are considered to have negligible exposure consequences. Inhalation pathways are specifically excluded from this section and covered in Section 3.5. Impacts from stormwater runoff along transportation routes are considered to be insignificant for all the Alternatives, and therefore are excluded from this discussion. The analysis begins at the point following release of the material, and does not address wastewater from decontamination activities. Potential exposure of decontamination workers to nonradiological constituents of wastewater is considered to be a negligible exposure pathway.

The incremental quantities of secondary aluminum and secondary copper under all the Alternatives will have negligible non-radiological impacts on water resources, and are excluded from further discussion in this section. The quantity of aluminum generated from commercial nuclear reactor facilities under the Proposed Action is less than 212 tons. The incremental impacts of this amount of aluminum, compared to the 1.1 million metric tons (USGS 2004) of secondary aluminum produced from old scrap in 2003, are negligible. The quantity of copper generated from commercial nuclear reactor facilities under the Proposed Action is less than 6,600 tons over the period of the Proposed Action. The annual release would be less than 700 tons per year. The incremental impacts of this amount of copper, compared to the 210,000 metric tons (USGS, 2004b) of secondary copper produced from old scrap in 2003, are negligible.

3.4.1 Regulatory Framework

The NRC recognizes, in 10 CFR 51.10(c), " ... that responsibility for Federal regulation of nonradiological pollutant discharges into receiving waters [from Licensed Facilities] rests by statute with the Environmental Protection Agency."

Surface Water

The National Pollutant Discharge Elimination System (NPDES) (40 CFR Part 122) requires permits for the discharge of pollutants from any point source into waters of the United States under authority of the Clean Water Act. The requirements for discharge permits cover, among other activities, process wastewater discharges and industrial stormwater discharges (including construction activities). Ground water generally does not meet the definition of a water of the United States and is not subject to NPDES requirements.

NPDES sets two types of discharge criteria: technology-based limits (based on the ability of dischargers in the same industrial category to treat wastewater) and water quality-based limits (if technology-based limits are not sufficient to provide protection of the water body). The effluent limits and conditions in an individual NPDES permit are unique to the permittee.

NPDES regulations apply to the discharge of industrial process water, wastewater and stormwater. The stormwater regulations define 11 industrial categories. For all the Alternatives, applicable industrial categories and the relevant covered industries or activities appear in Table 3-17.

Subtitle D of the Resource Conservation and Recovery Act (RCRA) of 1976 (42 USC 82, Subchapter IV) authorized regulation of State or regional solid waste plans. RCRA Subtitle D covers solid wastes, including hazardous wastes specifically excluded from RCRA Subtitle C. The promulgated solid waste regulations appear in 40 CFR Part 239 to 282, with Part 257 (Criteria For Classification Of Solid Waste Disposal Facilities And Practices) and Part 258 (Criteria For Municipal Solid Waste Landfills) specifying the siting, design, operational,

Table 3-17 NPDES Storm Water Discharges Associated with Relevant Industrial Activities

NPDES Industrial Category	Relevant Covered Industries or Activities
Category (I), 40 CFR Subchapter N	40 CFR 411 Cement manufacturing 40 CFR 420 Iron and steel manufacturing 40 CFR 421 Nonferrous metal manufacturing 40 CFR 433 Metal finishing 40 CFR 443 Paving and roofing materials 40 CFR 464 Metal molding and casting 40 CFR 467 Aluminum forming 40 CFR 468 Copper forming
Category (ii)	SIC Code 33 Primary metal industry SIC Code 3441 Fabricated structural steel SIC Code 373 Ship and boat building and repair
Category (iv) Hazardous waste	Subtitle C Hazardous waste disposal facilities
Category (v) Landfills	Industrial waste landfills Subtitle D landfills receiving industrial waste
Category (vi) Recycling Facilities	Metal scrap yards Salvage yards
Category (ix) Treatment Works	Domestic or municipal sewage treatment works or wastewater treatment system
Category (x) Construction	Clearing, grading, and excavation
Category (xi) Light Industry	SIC Code 34 Fabricated metal products SIC Code 35 Industrial machinery and equipment SIC Code 36 Electronic and other electric equipment SIC Code 37 Transportation equipment (except 373) SIC Code 38 Instruments and related products SIC Code 39 Miscellaneous manufacturing

Source: 40 CFR Part 122.

monitoring, and closure requirements. Subtitle D landfills that receive or have received any industrial waste from facilities requiring an NPDES discharge permit are themselves required to have an NPDES discharge permit. Subtitle D landfills have additional restrictions on run-on and run-off control, discharges to surface water bodies, and contamination of ground water.

The EPA regulations pertaining to incineration, 40 CFR Part 60 (Standards of Performance for New Stationary Sources), deal primarily with air emissions. 40 CFR Part 240 (Guidelines for the Thermal Processing of Solid Wastes), Section 240.204-1 additionally requires that all waters discharged by a solid waste thermal processing facility "shall be sufficiently treated to meet the most stringent of applicable water quality standards, established in accordance with or effective under the provisions of the Federal Water Pollution Control Act, as amended."

Ground Water

Federal laws provide for ground-water protection primarily by regulating potential sources of ground-water contamination. EPA oversees ground-water protection activities authorized by the laws listed in Table 3-18, but actual implementation and enforcement normally resides with individual States. All 50 States have some form of ground-water protection program.

Table 3-18 Federal Ground-water Protection Laws

Federal Laws	Summary Description
Safe Drinking Water Act	authorizes maximum contaminant levels in drinking water, regulates deep well disposal of wastes, designates single aquifer water supply areas, and encourages development of State wellhead protection programs
Resource Conservation and Recovery Act	regulates the storage, transportation, treatment, and disposal of solid and hazardous wastes to prevent contaminants from leaching into ground water from municipal landfills, underground storage tanks, surface impoundments, and hazardous waste disposal facilities
Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)	authorizes government clean up of contamination caused by chemical spills or hazardous waste sites that do or could pose threats to the environment
Federal Insecticide, Fungicide, and Rodenticide Act	controls the availability of pesticides that can leach into ground water
Toxic Substances Control Act	controls the manufacture, use, storage, distribution, or disposal of toxic chemicals that can leach into ground water
Clean Water Act	helps States develop ground-water protection strategies

NRC regulations for disposal facility performance objectives (10 CFR 61.41) address only radiological discharge restrictions. However, 10 CFR 51.10(c) states "In accordance with section 511(c)(2) of the Federal Water Pollution Control Act (86 Stat. 893, 33 U.S.C 1371(c)(2)) the NRC recognizes that responsibility for Federal regulation of nonradiological pollutant discharges into receiving waters rests by statute with the Environmental Protection Agency."

Drinking Water

The Safe Drinking Water Act regulates all public water supplies, defined as water systems with at least 15 service connections or regularly serving at least 25 persons. Under the National Primary Drinking Water regulations, 40 CFR Part 141, the EPA has set Maximum Contaminant Levels (MCLs) applicable to public water systems for organic chemicals, inorganic chemicals, radioactivity, turbidity, microbiological contaminants, and disinfection byproducts. EPA has also developed non-enforceable National Secondary Drinking Water Standards to regulate contaminants that may cause cosmetic or aesthetic effects in drinking water.

3.4.2 Affected Environment

Many of the activities associated with the generation, handling, processing, end use, and disposal of solid materials are common to two or more of the Alternatives. Under every Alternative, material handling, stockpiling and loading is expected to occur at the Licensed Facility; transportation of the material will occur; and some fraction of the material streams may be sent for direct disposal in LLW Disposal Facilities. Other activities only occur under some Alternatives. Table 3-19 indicates which activities occur under each Alternative.

Table 3-19 Water Resources Affected Environment for Alternatives

Activity	Alternatives Under Which Activity Occurs				
	No Action	Unrestricted Release	EPA/State -Regulated Disposal	Low-Level Waste Disposal	Limited Dispositions
Material handling, stockpiling, and loading at Licensee Facility	X	X	X	X	X
Material unloading, handling, stockpiling, and loading at recycling facility	X	X			X
Transportation	X	X	X	X	X
Recycling processing	X	X			X
Disposition to End Use for recycled material	X	X			X
Disposal in EPA/State-Regulated Landfill	X	X	X		X
Disposal in EPA/State-Regulated Incinerator	X	X	X		X
Disposal in LLW Disposal Facility	X	X	X	X	X

The affected environment for surface water is the surface water in the U.S. Workers at Licensed Facilities and Workers at Non-Licensed Facilities may potentially be exposed to wastewater, runoff, or collected leachate either created by direct contact with the materials released from a licensed site during the generation, handling, processing, usage, or disposal of the released materials; or created by direct contact with any byproducts, end use products, or waste products derived from the released materials. The General Public and Ecological Receptors may also potentially be exposed to surface water bodies into which wastewater, runoff, or collected leachate flows or is discharged, either directly or through a ground-water pathway.

The affected environment for ground water is all ground waters in the U.S. Workers at Licensed Facilities, Workers at Non-Licensed Facilities, the General Public, and Ecological Receptors may potentially be exposed to ground water compromised by process wastewater, surface runoff, or leachate which is not retained by or escapes barrier systems and subsequently seeps into the soil. The General Public faces potential non-drinking water exposures to affected ground water through dermal contact only. Ground water has little to no ecological influence until it is extracted from a well. Ground water extracted from a well and used for agricultural or residential irrigation is not considered a significant pathway for ecological impacts.

Ground water or surface water bodies may be used as sources for drinking water. Standard monitoring and treatment of public drinking water supplies, including wells on industrial properties serving more than 25 persons, limit the risk of exposure of Workers at Licensed Facilities and Workers at Non-Licensed Facilities to elevated levels of contaminants from the Proposed Action. Ingestion of drinking water by the General Public from private ground-water wells or private surface water supplies may lead to potential exposures.

3.4.3 Environmental Consequences

Environmental consequences for Workers at Licensed Facilities and Workers at Non Licensed Facilities are limited to dermal exposure to surface water in the form of process wastewater, runoff, and collected leachate. There are not anticipated to be any significant ground-water or drinking water impacts to workers.

The General Public does not face any significant environmental consequences from any of the Alternatives related to surface water. The General Public may experience impacts from dermal exposure to ground water extracted from a private well, or ingestion of drinking water from a private ground-water well or private ground-water fed surface water body. However, such exposure is expected to be minimal due to the low probability of the simultaneous occurrence of the combination of factors required.

Ecological receptors only face potential environmental consequences from surface water in ground-water fed surface water bodies. Ground water extracted from a well and used for agricultural or residential irrigation is not considered a significant pathway for ecological impacts.

Water quality effects are primarily associated with point source and area source water discharges from the storage, handling, and processing of solid materials. For the No Action and Unrestricted Release Alternatives, the effects are generated mostly by runoff discharges from rubblization of concrete and runoff and process wastewater discharges from recycling of ferrous metal. The incremental quantity of these discharges would be small as compared to the overall amount of discharges generated from the total amount of concrete and ferrous metal being recycled annually in the U.S. The impact on water quality would be proportionally small. Similarly, the quantity of additional leachate and potential effects on ground water associated with disposal of solid materials under the EPA/State-Regulated Disposal Alternative and the LLW Disposal Alternative would be small compared with the overall amount of leachate being generated annually by these facilities. Therefore, the overall effects on water quality associated with all of the alternatives would be small when compared with other sources of discharges. The quantities of materials released and therefore the volumes of surface water potentially impacted will differ among the alternatives. The contaminant concentrations in impacted waters may also be higher in scenarios in which greater volumes of material are released. Table 3-20 presents a summary of the potential environmental consequences to water resources.

Table 3-20 Summary of Potential Water Resources Environmental Consequences

	Workers	General Public	Ecological Receptors
Surface Water	Dermal exposure to process water, runoff, and leachate. Mitigated by avoidance of contact and use of personal protective equipment.	Direct discharge precluded by NPDES requirements. Low probability of indirect impacts from ground-water fed surface water bodies.	Direct discharge precluded by NPDES requirements. Low probability of indirect impacts from ground-water fed surface water bodies.
Ground Water	Limited potential for contact. Mitigated by avoidance of contact and use of personal protective equipment.	Low probability of dermal impacts from private wells.	None
Drinking Water	Limited by testing of onsite drinking water wells.	Low probability of ingestion impacts from private wells or ground-water fed surface water bodies.	N/A

3.4.4 Summary of Water Resources Impacts

This section assesses non-radiological impacts to surface water, ground water and drinking water. Radiological impacts are included in the dose assessments in Section 3.2.

The impacts to surface water described in Sections 3.4.2 and 3.4.3 are expected to be small because compliance with EPA and State permits (discussed in Section 3.4.1) would preclude significant impacts from direct discharges, the low probability of the simultaneous occurrence of the combination of factors required to affect surface water chemistry through ground-water flow limits the potential for impacts from indirect discharges, and the mild acidity of the majority of lakes and ponds provides natural protection against the most likely impact, an increase in pH level.

Ground water impacts are anticipated to be small due to limited opportunities for worker exposure to ground water and the use of personal protective equipment, and due to the low probability of the simultaneous occurrence of conditions required to cause dermal impacts to the General Public from the use of water from private wells.

The General Public may experience impacts from ingestion of drinking water from a private ground-water well or private ground-water fed surface water body. However such exposure is expected to be minimal due to the low probability of the simultaneous occurrence of the combination of factors required.

Furthermore, the incremental quantity of predicted discharges would be small as compared to the overall amount of discharges generated from the total amount of concrete and ferrous metal being recycled annually in the U.S. Similarly, the quantity of additional leachate and potential effects on ground water associated with disposal of solid materials under the EPA/State-Regulated Disposal Alternative and the LLW Disposal Alternative would be small compared with the overall amount of leachate being generated annually by these facilities. Therefore, the overall effects on water quality associated with all of the alternatives would be small when compared with other sources of discharges.

3.5 AIR QUALITY

The affected environment and potential environmental consequences discussed in this section address non radiological air pollutants emitted from activities associated with the release, handling, processing, transportation, and disposal of potentially clearable solid materials. Supplemental detailed information is in Appendix I. The affected environment and potential impacts associated with radionuclide air emissions are included in the collective dose analysis discussed in Section 3.2.

Activities associated with the Alternatives would occur at licensed facilities, along transportation routes, and at recycling facilities, EPA/State-regulated disposal facilities and LLW disposal facilities. The specific locations of recycling facilities, EPA/State-regulated disposal facilities, and transportation routes where activities would occur cannot be identified. Therefore the discussion of the affected environment in Section 3.5.2 is not site specific.

Air quality impacts are assessed in Section 3.5.3 through comparison of the air emissions associated with each Alternative with national air emissions trends. The emissions estimates are compared to the national emissions estimates for the processes that are involved on an average annual basis. In the analysis it is assumed that materials generated at the licensed facilities are released at a uniform rate over a 47 year period. Site-specific air quality impacts are not addressed, because the locations of activities emitting air pollutants cannot be identified.

3.5.1 Regulatory Framework

There are four broad categories of air pollutants associated with the processes and activities under the Alternatives. These include:

- Pollutants regulated as National Ambient Air Quality Standards (NAAQS) under Title 1 of the Clean Air Act (CAA) (EPA 2003b);

- Pollutants regulated by National Emissions Standards for Hazardous Air Pollutants (NESHAP) under Title 3 of the CAA (EPA 2003c);

- Pollutants regulated for the purposes of public welfare (e.g., acid rain, visibility); and

- Pollutants considered to be greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide).

NAAQS are pollutants that are emitted by or caused by emissions from a wide variety of air emissions sources and have been identified as contributing to human health effects. All States are required under the CAA to monitor these pollutants and develop State implementation plans (SIPs) to control the emissions of these pollutants to achieve and then maintain the concentration levels stipulated by the NAAQS. Table 3-21 lists the National Ambient Air Quality Standards.

Table 3-21 National Ambient Air Quality Standards

Parameter	Standard	National Standard	Average Period
Ozone*	Primary and Secondary	0.12 ppm (235 μg/m³) 0.08 ppm (150 μg/m³)	1-hour average 8-hour average
Particulate matter (PM_{10})	Primary	150 μg/m³ 50* μg/m³	24-hour average Annual average
Fine particulate matter ($PM_{2.5}$)*	Primary	65 μg/m³	24-hour average
	Primary and Secondary	15 μg/m³	Annual average
Nitrogen dioxide	Primary and Secondary	0.053 ppm (100 μg/m³)	Annual average
Sulfur dioxide	Secondary	0.50 ppm (1,300 μg/m³)	3-hour average
	Primary	0.14 ppm (365 μg/m³) 0.03 ppm (80 μg/m³)	24-hour average Annual average
Carbon monoxide	Primary	35 ppm (40 mg/m³) 9 ppm (10 mg/m³)	1-hour average 8-hour average
Lead	Primary and Secondary	1.5 μg/m³	3-month average

ppm Parts per million

μg/m³ Micrograms per cubic meter.

* The revised ozone standard of 0.08 parts per million (ppm) for an 8-hour averaging period, and the standards for particulate matter of 2.5 microns in diameter (PM2.5) became effective in September 1997. However, due to legal challenges EPA has just recently completed designating attainment or nonattainment areas; and SIP plans to achieve these standards are currently in development.

Source: 40 CFR Part 50.

Hazardous air pollutants (HAPs), frequently referred to as air toxics, have been linked to human health effects. These pollutants are generally associated with specific types of air emissions sources and activities and, therefore, affect primarily specific local areas. Since these pollutants are emitted by specific types of air emissions sources, they are not regulated under the NAAQS provisions of the CAA, but are regulated under the source-specific National Emissions Standards for Hazardous Air Pollutants (NESHAP). Sources of these pollutants are required to apply Maximum Achievable Control Technology (MACT) to control releases of the HAP pollutants. A list of NESHAP regulations applicable to source categories related to the Alternatives is provided in Table 3-22.

Pollutants identified in the CAA associated with public welfare effects include precursors of acid rain and regional haze. Acid rain is produced by sulfur and nitrogen-containing air pollutants that react in the atmosphere to create acidic compounds that are then deposited through precipitation or dry deposition processes onto the surface of the Earth. The accumulation of these acid compounds over time can damage sensitive aquatic, agricultural, and forest ecosystems resulting in reduced productivity and reduced biodiversity. Regional haze results from the same precursors of acid rain, plus organic compounds, and soils that are suspended in the atmosphere by mechanical processes. The largest stationary sources of sulfur compounds and a major source of nitrogen compounds are coal-fired power plants. The precursor pollutants of acid rain and regional haze are also emitted by highway and off road mobile sources, ferrous metal mills, other secondary metals processes, incinerators, and the processes used to reduce concrete into smaller pieces that can be hauled away and used as road bed aggregate. These sources, however,

Table 3-22 Potential Relevant Source Categories Covered by NESHAP MACT Regulations

Source Category	Federal Register Citation	Pollutants Regulated	Date of Implementation
Hazardous Waste Combustion	64 FR 52827	dioxins, furans, mercury, cadmium, lead, antimony, arsenic, beryllium, chromium, acid gases and chlorine gas	9/20/01
Ferroalloys Production	64 FR 27450	particulate matter	5/20/01
Secondary Aluminum Production	65 FR 15689	metals, dioxins, furans, polycyclic organic matter, HCl, and chlorine gas	3/24/03
Integrated Iron and Steel Production	68 FR 27645	particulate matter	5/20/06
Iron and Steel Foundries	signed 8/29/03	HAP Metals and HAP Organics	
Subtitle D Landfills	68 FR 2227	Represented as total PM and Total Organics	11/16/03
Offsite Waste Recovery Operations[1]	61 FR 34140	Removal of HAP Materials Before Treatment	7/10/06

[1] Includes non RCRA exempt hazardous waste landfills and incinerators (EPA 2003c).

represent only a small fraction of the emissions resulting from power plants, existing mobile sources and existing activities of the type related to the Alternatives. Acid rain is regulated largely by the emissions trading program implemented under Title 4 of the CAA which restricts the collective emissions of sulfur dioxide and oxides of nitrogen from the largest coal-fired power plants. Regional haze precursor pollutants are regulated in conjunction with PM2.5 programs and most States are just beginning to implement plans to achieve the visibility objectives.

Sources associated with the Alternatives emit long lasting air contaminants that absorb heat energy and are thought to be capable of causing changes in the Earth's climate. These compounds act like the panes of glass in a greenhouse to trap heat and, therefore, have become known as greenhouse gases (GHGs). The primary GHGs are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Carbon dioxide is the dominant gaseous byproduct of fossil and biomass fuel combustion, and any such combustion source (e.g., industrial furnaces, solid waste incinerators, gasoline engines, diesel engines) releases CO_2. Methane and N_2O are also released by fuel combustion sources, although at very small levels, and also by other industrial processes. EPA prepares an annual assessment of emissions of GHGs in the U.S[1] (EPA 2003d): Greenhouse gases are not currently regulated under the CAA, although there are many voluntary programs that are being implemented to reduce the amount of these gases that are released in the

[1] http://yosemite.epa.gov.oar/globalwarming.nsf/ResourceCenterPublicationsGHGEmissions.html.

U.S. The contribution of the activities associated with the Alternatives to total GHG loading is negligible in comparison to power generation and total mobile source activities.

3.5.2 Affected Environment

The affected environment, as defined for the purposes of the air quality impact assessment, includes the ambient air affected by non radiological air pollutants emitted from activities associated with the release, handling, processing, transportation, and disposal of solid materials generated from licensed facilities under the Alternatives, and the General Public potentially exposed to such non radiological air pollutants. The affected environment also includes environmental receptors potentially affected by air emissions from activities associated with the Alternatives.

3.5.3 Environmental Consequences

Total national air emissions (in units of tons per year) from processes and activities associated with the Alternatives are estimated using emission factors. For example, the total amount of particulate matter (PM) associated with the recycling of ferrous metal under the Unrestricted Release Alternative is estimated by multiplying the total amount of ferrous metal generated from licensed facilities that is recycled in ferrous metal mills (in units of tons per year) by a factor for the amount of particulate matter emitted per ton of ferrous metal recycled (in units of mass PM per ton ferrous metal processed). Emission factors (EPA 2004a) are applied to appropriate estimates of the material flow through each process to estimate the incremental effects on air quality associated with each Alternative. A summary of the total air emissions expected to result from each of the Alternatives is provided in Table 3-23.

Table 3-23 Summary Table – Total Air Emissions from Alternatives (metric tons)

No Action and Unrestricted Release Alternatives	**PM_{10}**	**SO_2**	**NO_x**	**VOC**	**CO**
Concrete	1,219	Neg.	4,654	1,132	910
Ferrous Metal	8,362	2,905	7,248	4,614	--
Trash (landfill disposal)	67	Neg.	186	94	94
TOTAL	9,648	2,905	12,124	5,839	1,004
EPA/State-Regulated Disposal Alternative	**PM_{10}**	**SO_2**	**NO_x**	**VOC**	**CO**
Concrete (landfill disposal)	1,210	Neg.	3	1,132	910
Ferrous metal (landfill disposal)	36	Neg.	772	60	326
Trash (landfill disposal)	10	Neg.	186	94	94
Trash (incineration)	171	117	337	94	157
TOTAL	1,417	117	5,696	1,285	1,393
LLW Disposal Alternative	**PM_{10}**	**SO_2**	**NO_x**	**VOC**	**CO**
All Materials total	93	7	889	94	94
Limited Dispositions Alternative	**PM_{10}**	**SO_2**	**NO_x**	**VOC**	**CO**
All Materials	205	62	258	123	21

Note: Neg. means negligible.

Approximately 19.8 million metric tons of concrete and 2.4 million tons of ferrous metal would be released from licensed commercial nuclear reactor facilities under any of the Alternatives (SC&A 2003, Table 10.3). This amount of ferrous metal is compared to approximately 82 million metric tons per year in the United States. Conversely, approximately 6,600 metric tons of copper and 200 metric tons of aluminum are anticipated to be released from commercial nuclear reactor facilities. Due to the relatively small quantities, air quality impacts associated with recycling and disposal of aluminum and copper are not discussed quantitatively in the Draft GEIS. Approximately 0.066 million metric tons of trash would be released from licensed nuclear reactor facilities, with an additional 0.886 million tons of trash released from licensed facilities other than commercial nuclear reactors. This compares with estimates of approximately 209 million metric tons per year of municipal solid waste. The air quality impact analysis for trash is based on the disposal of trash in either EPA/State-regulated landfills, EPA/State-regulated incinerators, or LLW disposal facilities. Trash is not assumed to be recycled or reused under any of the Alternatives.

Sources and activities associated with the Alternatives to which NESHAP standards apply are described in Appendix I. Process emissions of hazardous air pollutants (HAPs) would be generated from the recycling of ferrous metal under the No Action and Unrestricted Release Alternatives. The emission factors for HAPs for ferrous metal recycling are small compared to the emission factors for the criteria (NAAQS) air pollutants for ferrous metal recycling, in terms of emissions per ton of ferrous metal recycled. Therefore, the HAP emissions from ferrous metal recycling would be small as compared to the total inventory of HAPs emitted on a national basis. Similarly, the HAP emissions associated with disposal of licensee-generated material in Subtitle D landfills or EPA/State-regulated incinerators would also be small as compared to the total inventory of HAPs emitted from landfill disposal and incineration of solid waste. In addition, the facilities where these materials would be processed are already subject to HAP emissions limitation standards whether or not the materials from licensed facilities are processed. Therefore, HAP emissions from ferrous metal recycling and landfill disposal and incineration of solid waste are not discussed quantitatively in the Draft GEIS.

The preceding analysis has been completed based on material quantity estimates for commercial reactor licensees. There are a variety of other types of activities that release materials that could be included in the various alternatives. With the exception of trash, the total quantities of the other materials from these non reactor facilities are extremely low and will not add to the air quality impacts. The quantity of trash generated from these other licensed facilities is estimated to be 883,000 tons (SC&A 2003, Tale 5.6). The emissions totals for trash incineration assume incineration of only the 66,000 tons (SC&A 2003, Table 10.7) generated from commercial nuclear reactor facilities. These totals remain in the range of less than one percent of existing emissions represented in the annual national emissions inventory.

3.5.4 Summary of Air Quality Impacts

This section assesses non-radiological impacts to air quality. Radiological impacts are included in the dose assessments in Section 3.2.

Non-radiological air emissions associated with processes and activities associated with the Alternatives are summarized in Table 3-23. These emissions will take place over a large geographical area, and at various times depending on when individual sites are decommissioned and the materials are released. Some of these emissions will also occur over the operating life of the facility. The potential impacts on any individual community will be intermittent and short lived. Therefore, it is concluded that incremental impacts on ambient air quality and human exposure to non-radiological air pollutants in individual communities will be inconsequential for all of the alternatives.

Furthermore, the incremental quantity of predicted air emissions would be small as compared to the overall amount of air emissions generated from the total amount of concrete and ferrous metal, being recycled annually in the U.S. The overall effects on air quality associated with all of the alternatives would be small when compared with other sources of emissions.

3.6 ECOLOGICAL IMPACTS

Section 3.4 concludes the potential non-radiological impacts to surface water, ground water and drinking water are expected to be small because compliance with EPA and State permits would preclude significant impacts. Furthermore, ecological receptors only face potential environmental consequences from surface water in ground-water fed surface water bodies. Leachate or runoff that seeps into ground water and ultimately reaches a surface water body, especially a small pond, could alter the pH of or introduce organic and inorganic compounds into the surface water body. Since the non-radiological impacts to surface water, ground water and drinking water described in Section 3.4 are expected to be small, then non-radiological impacts to ecological receptors are also expected to be small.

Radiological impacts to environmental receptors are considered to be insignificant. The current position of the International Commission on Radiological Protection (ICRP 1991) is that "the standard of environmental control needed to protect man to the degree currently thought desirable will ensure that other species are not put at risk." Recently, ICRP has stated that the ICRP "system for protection of human beings has indirectly provided a fairly good level of protection of the human habitat." (ICRP 2003, page 201) However, the ICRP has decided to develop a framework for the assessment of radiation effects in non-human species. "The primary purpose of developing such a framework is to fill a conceptual gap in radiological protection; it does not reflect any particular concern over environmental radiation hazards." (ICRP 2003, page 207) Since a dose rate of 1 mrem/yr is a small fraction of background radiation, there would be no significant radiological impact to ecological resources associated with the Alternatives.

The DOE standard *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002, July 2002, p. xxi) (DOE 2002a) states:

> “The technical standard assumes a threshold of protection for plants and animals at the following doses: for aquatic animals, 1 rad/d (10 mGy/d); for terrestrial plants, 1 rad/d (10 mGy/d); and for terrestrial animals, 0.1 rad/d (1 mGy/d). Available data indicate that dose rates below these limits cause no measurable adverse effects to populations of plants and animals.”

These exposure thresholds are consistent with the values in the Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to the General Assembly - "Effects of Radiation on the Environment" (UNSCEAR 1996). The units associated with exposure and dose to non-human species, and value of the relative biological effectiveness is currently the subject of international debate. It should be noted that the annual dose rate thresholds identified by these agencies are orders of magnitude above any of the dose limits being considered under the alternatives. As a result, it is impossible under the provisions of the proposed rule to attain such high dose rates. Consequently, the rule provides ample protection to biota.

3.7 WASTE MANAGEMENT

Under the five proposed Alternatives, materials generated from licensee facilities can be released to one or more of the following dispositions: use in general commerce (including recycling into consumer products or industrial and construction uses); reuse; disposal in EPA/State-regulated facilities[2]; or disposal at Low-Level Radioactive Waste (LLW) disposal facilities. The waste management discussion below describes the affected environment and analyzes potential environmental consequences of the Alternatives with respect to disposal of materials in EPA/State-regulated landfills and LLW disposal facilities. Section 3.7.1 provides a discussion of the affected environment with respect to waste management, and Section 3.7.2 provides a discussion of the potential environmental consequences with respect to waste management.

3.7.1 Affected Environment

The affected environment for the Proposed Action includes EPA/State-regulated disposal facilities (landfills and incinerators) and LLW disposal facilities where licensees would dispose released solid material. Under each of the Alternatives some amount of potentially clearable material would be disposed of at LLW disposal facilities; the amount of material disposed of as LLW varies by Alternative. For the LLW Disposal Alternative all of the potentially clearable material released would be disposed of as LLW. For the other Alternatives a smaller amount of the material which is below the release criteria would be disposed of as LLW. Under the EPA/State-Regulated Disposal Alternative almost all of the potentially clearable solid material would be disposed of in EPA/State-regulated disposal facilities, with the remainder disposed of in LLW disposal facilities.[3] Under the No Action and Unrestricted Release Alternatives licensees could dispose of solid materials in EPA/State-regulated disposal facilities or recycle the materials. Under the Limited Dispositions Alternative, ferrous metals and trash could be

[2] Disposal in EPA/State-regulated Subtitle C disposal facilities is not being considered as an Alternative in the Draft GEIS. Please see the discussion on Subtitle C disposal facilities in Chapter 2, Section 2.4.3.

[3] Note that under the No Action, Unrestricted Release, and Limited Dispositions Alternatives byproducts of solid material recycling processes (e.g., furnace slag) are anticipated to be disposed of in EPA/State-regulated landfills. Such disposal is not quantitatively evaluated in the waste management consequences analysis in Section 3.7.2., because these quantities are much lower quantities than the quantities of solid materials that would be disposed of under the Alternatives.

disposed of in EPA/State-regulated disposal facilities, while concrete could either be recycled into roadbed material or disposed of in EPA/State-regulated landfills.

The environment in the vicinity of the EPA/State-regulated disposal facilities and LLW disposal facilities may be affected by disposal in terms of consumption of the existing disposal capacity of these facilities and associated consumption of available land area. The environmental consequences analysis for disposal of solid materials in EPA/State-regulated disposal facilities or in LLW disposal facilities evaluates the effects of such disposal on the existing disposal capacities of these waste disposal facilities and the potential need for additional facility capacity and the associated utilization of land. There are three licensed LLW disposal facilities - Barnwell, South Carolina, Hanford, Washington, and Clive, Utah. These three facilities and their environs represent the affected environment with respect to LLW disposal conducted under any of the Alternatives. Under the EPA/State-Regulated Disposal Alternative, NRC would authorize the disposal of solid materials at any EPA/State-regulated landfill or incinerator (for trash only) in the United States. The affected environment with respect to EPA/State-regulated disposal potentially includes any RCRA Subtitle D landfill or incinerator facility in the United States and the environs of such facilities. However, no site-specific analyses are conducted for EPA/State-regulated disposal because the specific facilities that may accept solid materials for disposal cannot be identified, and therefore no site-specific discussion of the affected environment is provided in this section.

3.7.1.1 EPA/State-Regulated Disposal Facilities

As discussed in Section 2.4.3, the EPA/State-regulated facilities are RCRA Subtitle D landfills.

Capacity data for Subtitle D landfills was obtained from "The State of Garbage in America", a report on municipal solid waste published annually in *BioCycle* (BioCycle 2002). The methodology and a full discussion of these data can be found in Attachment 2 of Appendix J. The remaining Subtitle D landfill capacity reported in 2001 is 6,584,885,975 tons. Although capacity expanded between 1998 and 2000 as a result of the addition of new landfills or expansion of existing landfills, NRC assumes that the amount of remaining capacity would remain equal to the 2001 value for the purposes of this environmental consequences analysis.

The actual cubic yards of disposal capacity remaining in the Subtitle D landfills depends on what assumption is made concerning how tightly the waste is compacted. Using low, middle, and high end conversion factors (see Table 3-24) gives the following range of the remaining volume of disposal capacity.

Regional disposal capacity, regional waste generation, and remaining years of capacity have been calculated as part of Appendix J. In general, the Mountain region of the U.S. has much more disposal capacity than it needs to dispose of the solid waste generated in that region, while the New England and the Mid Atlantic regions have the lowest amount of disposal capacity (out of seven regions) as compared to the amount of solid waste generated in those regions. However, exporting solid waste to different regions alleviates some of the disparity in capacity. For the assessment of environmental consequences with respect to Subtitle D landfills in Section 3.7.2, the national low and high capacity estimates from 2001 in Table 3-24 were used.

Table 3-24 Remaining Disposal Capacity for Subtitle D Landfills, 2001

Remaining Capacity in 2001 (million tons)	Cubic Yards per Ton	Cubic Yards of Remaining Capacity (million cubic yards)
6,584	1.66 (low)	10,970
6,584	4.33 (medium)	28,513
6,584	7 (high)	46,094

Source: Online searches and interviews with randomly chosen landfill operators were used to find standard "tons to cubic yards" conversions. Conversions ranged from 1.66 cubic yards per ton to 7 cubic yards per ton, depending on the compaction rate and density of waste.

Solid Waste Incinerator Capacity

The existing solid waste incinerator capacity was evaluated with respect to disposal of trash for the EPA/State-Regulated Disposal Alternative. Solid materials other than trash (concrete and metal) are assumed not to be incinerated. The incinerator capacity data were derived from *BioCycle's* (BioCycle 2002) annual report. The methodology is described in Appendix J. The existing solid waste incinerator capacity for the 2001 study year is 33,791,899 tons/year. For the purposes of the capacity analysis, the analysis assumed that the incineration capacity would remain equal to the capacity reported in 2001.

3.7.1.2 LLW Disposal Facilities

Three facilities in the country currently accept LLW for disposal. Their total remaining capacity is roughly 10.4 million cubic yards, as summarized in Table 3-25.

The Hanford LLW disposal facility accepts waste from the Northwest and Rocky Mountain compacts. Hanford is licensed by the State of Washington to receive wastes in Classes A-C. The "compact States" include Washington, Oregon, Idaho, Montana, Utah, Wyoming, Nevada, Colorado, New Mexico, Alaska, and Hawaii. The only power reactors in these compact States are the four "Energy Northwest" units at Hanford. The Barnwell LLW disposal facility currently accepts waste from all U.S. generators except those in Rocky Mountain and Northwest compacts. Beginning in 2008, Barnwell will only accept waste from the Atlantic Compact States (Connecticut, New Jersey, and South Carolina). The Barnwell facility is licensed by the State of South Carolina to receive wastes in Classes A-C. Therefore, the existing LLW disposal capacity is reported in the following section with and without consideration of the capacity at the Barnwell and Hanford facilities, as most commercial nuclear reactor facilities would be precluded from disposing of LLW at the Hanford and Barnwell facilities during the period of the Proposed Action.

Table 3-25 NRC-Licensed LLW Disposal Facility Capacity, 2002

Facility	Remaining Volume (million cubic yards)	Notes
Envirocare - Clive, UT	2.7	Remaining capacity as of 12/02
Barnwell Disposal Facility - Barnwell, SC	0.008	Reported as 230,000 cubic feet. This only accounts for non-regional* waste. Barnwell will stop accepting non-regional waste in 2008.
Hanford Off-Site LLW Disposal Facility - Hanford, WA	7.7	Excluding facilities for wastes generated at the Hanford Site.
Total	10.4	Not including Barnwell.

* Non-regional waste is anything generated outside the Atlantic Compact, which includes South Carolina, New Jersey, and Connecticut.

3.7.2 Environmental Consequences

Environmental consequences could affect EPA/State-regulated disposal facilities and LLW disposal facilities. Potential environmental consequences to RCRA Subtitle D facilities under each Alternative are discussed in Section 3.7.2.1. Potential environmental consequences to LLW disposal facilities under each Alternative are discussed in Section 3.7.2.2.

3.7.2.1 EPA/State-Regulated Disposal Facilities

Under four of the five Alternatives, some amount of solid material released from licensed facilities could be disposed of in EPA/State-regulated licensed landfills. For the Unrestricted Release Alternative and the EPA/State-Regulated Disposal Alternative, the amount of material that could be disposed of at EPA/State-regulated landfills would depend upon the specific dose option for the Alternative. For the No Action and the Limited Dispositions Alternatives the amount of material that could be disposed of in EPA/State-regulated landfills would be determined by case-by-case assessment by NRC, and therefore the amount of material that would be disposed of cannot be estimated. However, the No Action and Limited Dispositions Alternatives would be bounded by the Unrestricted Release and EPA/State-Regulated Disposal Alternatives.

The environmental consequences of disposal of solid materials in EPA/State-regulated landfills relates to the consumption of disposal capacity of the existing population of landfills, displacement of materials from other sources that would normally have been disposed of in EPA/State-regulated landfills, and potential exceedance of available disposal capacity. If only a small percentage of the overall existing landfill disposal capacity would be utilized under a particular Alternative, then neither exceedance of capacity nor displacement of materials would occur. The following evaluation of environmental consequences is based on the projected amount of material released for disposal and the remaining capacity of EPA/State-regulated landfills. The analysis demonstrates that the existing capacity of Subtitle D landfills is adequate for disposal of all potentially clearable solid materials that could be released under any of the alternatives.

3.7.2.1.1 No Action Alternative

Solid materials can currently be released for unrestricted use or disposal. Any future changes in the proportion of those dispositions would be covered by the impacts of the Unrestricted Release and EPA/State Regulated Disposal Alternatives. The EPA/State-regulated landfill capacity discussed in Section 3.7.1 would be adequate to accommodate the disposal of solid material in RCRA Subtitle D landfills under the No Action Alternative.

3.7.2.1.2 Unrestricted Release Alternative

Under the Unrestricted Release Alternative five dose options are considered for the release of solid materials. For purposes of this analysis, it is assumed that all of the ferrous metal, concrete, and trash[4] released for each dose option would be disposed of in EPA/State-regulated landfills. This assumption would represent the maximum amount of material that would be disposed of in Subtitle D landfills under any of the Alternatives and would include solid material that could otherwise be recycled under the Unrestricted Release Alternative. Under this assumption, the amount of material that would be disposed of in EPA/State-regulated landfills under the Unrestricted Release Alternative is approximately the same as the amount that would be disposed of in EPA/State-regulated landfills under the EPA/State-Regulated Disposal Alternative. This also bounds the amount from the Limited Dispositions Alternative.

Figure 3-2 shows the amount of total material released and the amounts of ferrous metal, concrete, and trash under each dose option. The amount of material released under each dose option is: 8.4 million cubic yards for the 0.03 mrem/yr dose option; 9.9 million cubic yards for the 0.1 mrem/yr dose option; 11.1 million cubic yards for the 1 mrem/yr dose option, and 11.3 million cubic yards for the 10 mrem/yr dose option. The amount of material that would be released under the Unrestricted Release Alternative RS-G-1.7 dose option would be approximately the same as the 1 mrem/yr dose option.

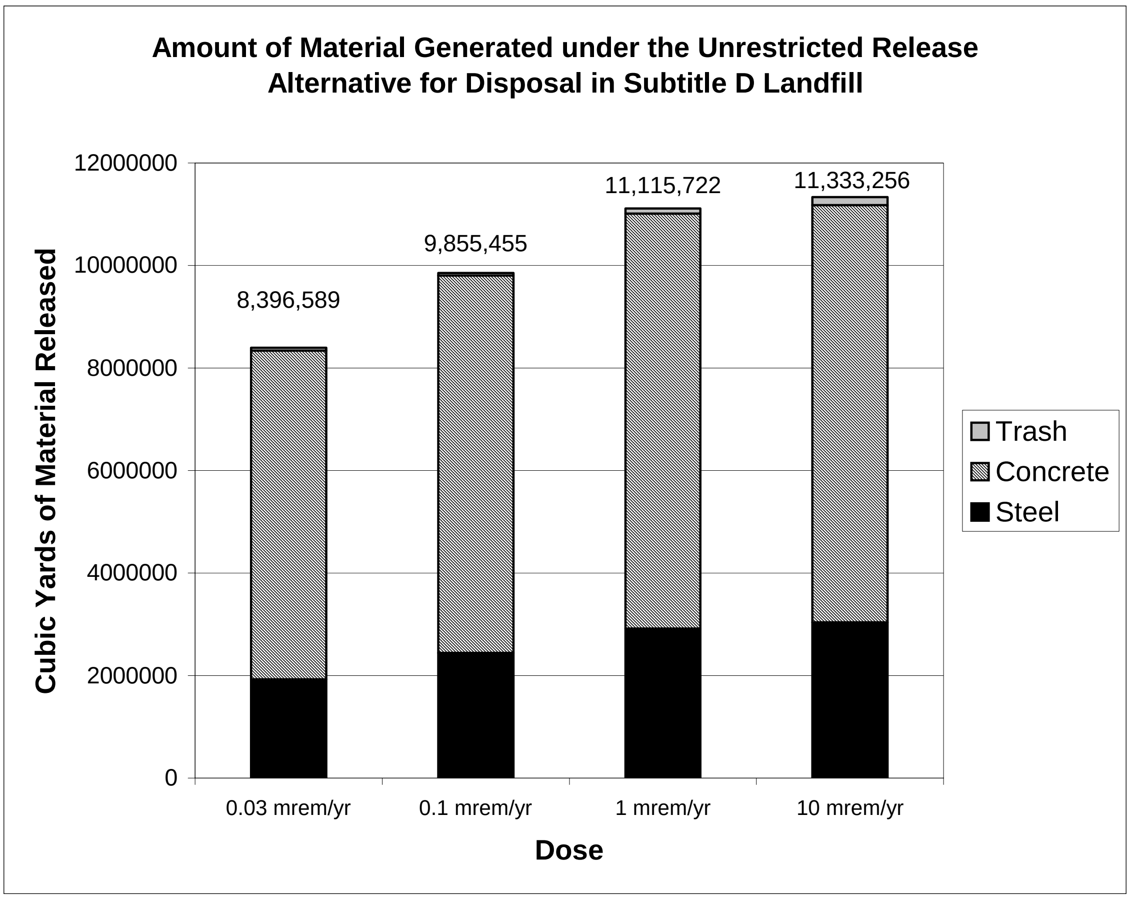
Table 3-26 provides a comparison of the estimated remaining Subtitle D landfill capacity and the maximum estimated amount of material anticipated to be released under the Unrestricted Release Alternative that could be disposed of in EPA/State-regulated landfills.

By 2049 an estimated 6.4 million cubic yards of concrete and 1.9 million cubic yards of ferrous metal is anticipated to be released under the 0.03 mrem/yr dose option for the Unrestricted Release Alternative. This 8.3 million cubic yards of material represents 0.08 percent of the

[4] These figures represent the total amount of concrete, ferrous metal, and trash. Note that aluminum, and copper are not included in this capacity analysis.

remaining capacity of Subtitle D landfills in the United States. For the 10 mrem/yr dose option an estimated 11.3 million cubic yards of concrete, ferrous metal, and trash would be released. This represents 0.10 percent of the remaining Subtitle D landfill capacity. Thus, the existing capacity of Subtitle D landfills would be adequate for the disposal of all of the potentially clearable materials that would be released under the Unrestricted Release Alternative under all dose options. There will therefore be no additional environmental consequences from the release of materials for disposal in Subtitle D landfills under the Unrestricted Release Alternative.

Figure 3-2



Note: Volumes of materials for the 1 mrem/yr and RS-G-1.7 dose options are the same.

Table 3-26 Estimated Remaining Subtitle D Disposal Capacity and Projected Materials Released under the Unrestricted Release Alternative

Subtitle D Landfill	Estimated Remaining Disposal Capacity (million cubic yards)	Projected Material Released (million cubic yards and percent of remaining capacity)*							
		.03 mrem/yr		.1 mrem/yr		1 mrem/yr		10 mrem/yr	
Low Capacity Estimate	10,970	8.4	0.08%	9.9	0.09%	11.1	0.10%	11.3	0.10%
High Capacity Estimate	46,094	8.4	0.02%	9.9	0.02%	11.1	0.02%	11.3	0.02%

* Figures for "projected material released" apply to the period of 2003 to 2049.

3.7.2.1.3 EPA/State-Regulated Disposal Alternative

The EPA/State-Regulated Disposal Alternative would require that all potentially clearable materials released from licensed facilities be disposed of in EPA/State-regulated landfills or incinerators (for trash only). The same five dose options evaluated under the Unrestricted Release Alternative apply to the release of materials for disposal in EPA/State-regulated landfills under this Alternative. Each dose option represents a different amount of material released, as shown in Figure 3-2. Under the EPA/State-Regulated Disposal Alternative, all solid material would be prohibited from general commerce (recycling into consumer products and industrial and construction uses). The maximum amounts of materials assumed to be disposed of in EPA/State-regulated landfills under the EPA/State-Regulated Disposal Alternative under each dose option are the same as for the Unrestricted Release Alternative in Section 3.7.2.1.2.

The estimated remaining Subtitle D landfill disposal capacity under the EPA/State-Regulated Disposal Alternative is the same as shown in Table 3-26. The maximum amount of remaining Subtitle D landfill capacity that would be utilized under the EPA/State-Regulated Disposal Alternative is approximately 0.10 percent. There will therefore be no additional environmental waste management impacts from the release of materials for disposal in Subtitle D landfills under the EPA/State-Regulated Disposal Alternative.

3.7.2.1.4 Low-Level Waste Disposal Alternative

No solid material would be disposed of in Subtitle D disposal facilities under the LLW Disposal Alternative.

3.7.2.1.5 Limited Dispositions Alternative

Under the Limited Dispositions Alternative concrete could be recycled only into roadbed material. Other materials would be required to be disposed of in EPA/State-regulated disposal facilities, except for those materials released in a case-by-case assessment by NRC. Tools and other equipment could be reused under this Alternative. Therefore the amount of solid material anticipated to be disposed of in EPA/State-regulated landfills under this Alternative would be less than that anticipated to be disposed under the EPA/State-Regulated Disposal Alternative described in Section 3.7.2.1.3 above.

3.7.2.2 LLW Disposal Facilities

Similar to the discussions above for environmental consequences to EPA/State-regulated disposal facilities, environmental consequences associated with waste management at LLW facilities can be categorized in two main groups: potential exceedance of capacity of the current population of LLW facilities or displacement of materials from other sources that would normally have been disposed of in a LLW facility. Exceedance of capacity or displacement of materials would most likely precipitate construction of new LLW facilities or expansion of existing facilities. The impacts associated with construction of new facilities or expansion of existing facilities are outside of the scope of the Proposed Action, but are discussed qualitatively in Section 3.7.3 below.

The total amount of potentially clearable solid material anticipated to be released from commercial nuclear reactor facilities is summarized in Table 3-27. Under the LLW Disposal Alternative all of this material would be disposed of in LLW disposal facilities. The amount of solid material that would be disposed of as LLW under the other four Alternatives will be less. Table 3-28 lists the estimated amount of material to be disposed of as LLW under each of the Alternatives.

Table 3-27 Mass of Potentially Clearable Materials from Commercial Nuclear Reactor Facilities

Material	Total Mass (tons)
Ferrous Metal	2,498,911
Concrete	19,877,341
Trash	323,023
Aluminum	212
Copper	6,584
Total	22,706,071
Total Cubic Yards	**11.5 Million Cubic Yards**

Source: SC&A 2003, Table 10.3.

Table 3-28 Projected Material Released to LLW Disposal* and Estimated Remaining Disposal Capacity Under Each Alternative

			Percent of Estimated Remaining LLW Disposal Capacity	
Alternative		Projected Material Released (million cubic yards)	Hanford, Barnwell and Envirocare (10.4 Mil cubic yards)	Envirocare Only (2.7 Mil cubic yards)
No Action		2.27	21.9	84.5
Unrestricted Release	0.03 mrem/yr	3.4	32.5	125
	1.0 mrem/yr	0.41	4	15.2
	10 mrem/yr	0.21	2.1	7.9
EPA/State-Regulated Disposal	0.03 mrem/yr	2.8	26.9	103
	1.0 mrem/yr	0.29	2.8	10.9
	10 mrem/yr	0.18	1.7	6.6
LLW Disposal		11.5	111.6	425.9
Limited Dispositions	RS-G-1.7	0.41	4	15.2

* Figures for "projected material released" apply to the period 2003 to 2049.

Source: Volume of materials based on Table 10.3 SC&A 2003 and Tables 3-15 and 3-27 of this report. Tonnage to cubic yard conversions assume a density of 0.51 cubic yard per ton.

The estimated remaining LLW disposal capacity for each alternative is shown in Table 3-28. It is anticipated that because of waste acceptance restrictions on the Hanford and Barnwell facilities the only licensed facility that would be available to accept LLW generated under the Proposed Action would be the Envirocare facility in Utah. As shown above, several of the "projected material released" scenarios exceed the current capacity of the Envirocare LLW facility. Under the No Action Alternative the amount of solid material anticipated to be disposed as LLW would utilize 84 percent of the available Envirocare facility disposal capacity or 22 percent of the available capacity of all three of the currently licensed LLW disposal facilities. The amount of solid material anticipated to be disposed of as LLW under the LLW Disposal Alternative is equivalent to 426 percent of the LLW disposal capacity of the Envirocare facility, or 112 percent of the disposal capacity of all three of the currently licensed LLW disposal facilities.

Note that these disposal capacity utilization estimates include only the solid materials that would be generated from commercial nuclear reactors under the Proposed Action. Given the anticipated rate of generation of LLW from all facilities under the Proposed Action, the existing LLW disposal capacity at the Envirocare disposal facility may be either completely utilized or come close to capacity for at least one dose option under each of the Alternatives. This is even without considering the fact that facilities that are not reactors would also continue to generate LLW during the time frame of the Proposed Action. The 1 mrem/yr dose option under the Unrestricted Release and EPA/State-Regulated Disposal Alternatives, however, would not exceed the current

LLW disposal capacity, but would utilize only 11 to 15 percent of Envirocare's total available disposal capacity.

If the existing LLW disposal capacity is completely utilized within the time frame of the Proposed Action, then either other material will need to be displaced from LLW disposal, waste acceptance restrictions on the Hanford and Barnwell facilities will need to be lifted, or LLW facilities will need to be constructed or expanded to accommodate the LLW disposal. Note however that under the LLW Disposal Alternative, even if all the waste acceptance restrictions were lifted from the Hanford and Barnwell facilities, the total capacity of the three licensed LLW disposal facilities would not be sufficient to accommodate all of the LLW that would be generated. Potential construction of new LLW disposal facilities or expansion of LLW disposal facilities is discussed in Section 3.7.3, however quantitative evaluation of construction impacts is not within the scope of the Draft GEIS.

3.7.3 Potential Impacts from Construction of Additional Facilities

There will be no need for construction of additional RCRA Subtitle D disposal facilities as a direct result of any of the Alternatives described in Section 3.7.1 above. The existing Subtitle D landfill capacity will not be adversely affected under any of the Alternatives and associated dose options and therefore no land-take for future construction would occur related to these Alternatives in the time period analyzed. Because there will be no new construction, there are no associated waste management consequences from disposal in current landfills. If in the future, a need for constructing new Subtitle D landfills arises in response to any site-specific conditions, then a site-specific environmental review would be conducted for that Proposed Action as it falls outside of the scope of this analysis.

The need for construction of additional LLW disposal facilities or expansion of existing facility capacity may result from any of the Alternatives described in Section 3.7.2. This would depend upon the specific dose option. The LLW Disposal Alternative would result in utilization of more than 100 percent of the available LLW disposal capacity. The availability of LLW disposal facility capacity could potentially be adversely affected by several of the proposed Alternatives, and therefore land-take for future construction of new facilities or expansion of existing facilities may be necessary. Potential environmental consequences related to new construction or expansion of LLW facilities are outside of the scope of this Draft GEIS, however. If, in the future, new LLW disposal facilities are proposed to be constructed or existing facilities expanded, then site-specific environmental reviews would be conducted that would evaluate all related environmental consequences.

3.8 CUMULATIVE IMPACTS

Cumulative impact is defined in 40 CFR 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." CEQ guidelines (CEQ 1997) describe those attributes that should be considered when analyzing cumulative impacts of a proposed action (such as this rulemaking), including:

- Determining which resources are affected by the proposed action;

- Identifying other past, present, and reasonably foreseeable future actions that either have or might affect those resources;

- Identifying and evaluating potential impacts, but focusing on the most important cumulative impact issues; and

- Determining the magnitude and significance of the proposed action in the context of the cumulative impacts of other past, present and future actions.

The environmental consequences we considered were doses to the public and LLW disposal capacity. The cumulative impacts considered in this section are (1) exposure of individuals to multiple sources, (2) disposition of DOE scrap metals, (3) industrial activities involving naturally-occurring radioactive materials (NORM), and (4) the proposed NRC licensing of facilities with significant quantities of LLW.

Individuals could be exposed to very low levels of radioactivity from more than one source, for example from a vehicle's engine block and recycled concrete in a roadbed. Appendix E considers the possible frequency of multiple scenarios affecting the same individual. There could be multiple radionuclides involved, or multiple kinds of materials released, or multiple concurrent scenarios (such as multiple facilities releasing materials, or processing released materials while using consumer products made from released materials). Appendix E concludes the likelihood of such multiple concurrent exposures becomes vanishingly small as the number of potential concurrent scenarios increases. While it is difficult to estimate the actual probability of a particular scenario, with each additional scenario, the potential for all the scenarios occurring together becomes smaller. Even with only a few scenarios, this potential is very small.

Another source of potentially clearable solid materials is the decommissioning of DOE facilities. DOE is developing an environmental impact statement (EIS) related to the disposition of DOE scrap metals with small amounts of radioactivity. At this time, because DOE has not yet published its EIS, NRC has found insufficient information in the published literature to quantitatively characterize DOE facilities. Although the relative contribution of DOE materials to public doses cannot be estimated, the release of DOE scrap metal could contribute to cumulative impacts if the material leaves DOE sites.

Most Department of Defense facilities using potentially clearable materials are licensed by the NRC and are thus captured by the licensed facilities analyzed in this GEIS.

Other sources of potentially clearable solid materials are commercial industries not licensed by NRC that use or process materials that contain NORM, which because of their operations create higher concentrations of radioactivity than that associated with an undisturbed natural setting. This material is defined as technologically enhanced NORM (TENORM). The following industries generate TENORM - petroleum production, uranium mining, phosphate and phosphate fertilizer production, fossil fuel combustion, drinking water treatment, metal mining and processing, and geothermal energy production. Radioactive species associated with TENORM are typically uranium, thorium and their decay products. Contaminated equipment could be decontaminated and reused, disposed of, or sold as scrap. Limited information was uncovered in the published literature to quantitatively characterize potential cumulative impacts (DOE 1996).

Investigation of the recycle of scrap metal contaminated with NORM has found that the NORM goes into the slag rather than the metal products. Because the same NORM species present as contamination are present in the ore or raw materials that initially contain the metals, and these species go to the slag during processing, recycle of metals from these industries has been performed for decades and gives no cause for concern. Although NORM use is not federally regulated, many States have promulgated regulations to control exposure from TENORM. In 2004, the States published model State regulations and Implementation Guidance for TENORM (Part N of the Suggested State Regulations for Control of Radiation), which were developed working through the Conference of Radiation Control Program Directors, Inc. Adoption of State regulations equivalent to Part N provide basic radiation protection standards for TENORM that are the same as the basic standards for radiation protection in NRC's 10 CFR Part 20. Although the industries mentioned above are not licensed by NRC, some States may amend their TENORM regulations in response to an NRC rulemaking on controlling the disposition of solids.

When considering cumulative impacts related to LLW disposal capacity, the analysis considered proposed NRC-licensed facilities that would generate large quantities of solid materials that would be classified as LLW. There are two proposed new uranium enrichment plants, one proposed by the USEC, Inc. for construction in Portsmouth, Ohio and one proposed by Louisiana Energy Services (LES) for construction in Lea County, New Mexico, that would generate LLW. In the event that NRC does not license a new enrichment plant, the existing USEC enrichment plant in Paducah, Kentucky is anticipated to remain in operation. (The Paducah plant is anticipated to cease operations if a new USEC plant is licensed.) Each proposed enrichment plant and also the existing USEC Paducah plant, if it continues to operate, would generate depleted uranium hexafluoride (DUF_6) that under current DOE requirements would be converted to uranium oxide (DU_3O_8) in a DUF_6 conversion plant. DOE is proposing to construct and operate two conversion facilities for converting DUF_6 at Portsmouth, OH and Paducah, KY. These facilities would convert DOE's inventory of DUF_6 to a more stable chemical form suitable for beneficial use or disposal. For the proposed USEC enrichment plant, LLW would be generated from site preparation activities including D&D of existing USEC-controlled buildings and structures at the USEC Portsmouth and Paducah plants. For the proposed USEC and LES enrichment plants, additional LLW would be generated from D&D of the enrichment plants at the end of their operating life. The amount of such D&D waste that would be classified as LLW would depend upon what Alternative NRC selects for the Proposed Action.

The license application processes for the proposed USEC and LES enrichment facilities are in their early stages and quantitative estimates of the amount of LLW that would be generated from these proposed facilities are not available. In the event that no new commercial LLW disposal capacity is constructed in the U.S. during the time frame of the Proposed Action, the Proposed

Action itself would have a small to large (significant) impact on existing LLW disposal capacity. The combined amount of LLW generated from the Proposed Action and the two proposed uranium enrichment plants would have a greater impact on existing LLW disposal capacity than the Proposed Action alone.

When considering past, present, and foreseeable future actions and the impacts from the proposed rulemaking, cumulative impacts to doses to the public are expected to be small due to the low doses considered in the NRC rulemaking. In considering cumulative impacts on LLW disposal capacity, NRC will continue to follow DOE's environmental review of the recycling of DOE scrap metals and the licensing of the USEC and LES enrichment facilities. NRC considers the cumulative impacts on LLW disposal capacity to be potentially small to large (significant), depending on the Alternative considered under this Proposed Action.

3.9 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS, SHORT-TERM USES OF THE ENVIRONMENT, AND LONG-TERM PRODUCTIVITY

The radiation doses that would occur as a result of the proposed action are well below NRC regulatory limits and represent a small fraction of the existing background levels of radiation. Unavoidable adverse environmental impacts, short-term uses of the environment, and long-term productivity were previously considered under the activities expected during operation and decommissioning of licensed facilities.

3.10 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

For all but the LLW Disposal Alternative, no resources would be lost because the Proposed Action falls within the activities expected during operation and decommissioning of licensed facilities. For the LLW Disposal Alternative, no solid material would be released and all the potentially clearable material would be disposed of in LLW disposal facilities. This amount of LLW would be more than four times the available LLW disposal capacity at Envirocare and more than the disposal capacity at Hanford, Barnwell and Envirocare combined (Table 3-28). The LLW Disposal Alternative would result in the commitment of land for additional LLW facilities or the expansion of current LLW facilities.

The Proposed Action would also commit energy resources related to transportation of the solid material to either recycling or disposal facilities. For the No Action Alternative, approximately 475 million vehicle miles would be traveled transporting the solid materials to recycling facilities and licensed LLW disposal facilities (Table 3-15). By comparison, under the LLW Disposal Alternative, approximately 1.4 billion vehicle miles would be traveled transporting by truck all of the solid materials released to licensed LLW disposal facilities. The LLW Disposal Alternative represents approximately a 350 percent increase in energy expended for transportation as compared to the No Action Alternative.

The No Action and Unrestricted Release Alternatives would result in recycling of concrete, ferrous metal, aluminum and copper. The Limited Dispositions Alternative would result in recycling of concrete but not metals, except by case-by-case determination by NRC. For the No Action Alternative 18.3 million tons of solid material, including 16.2 million tons of concrete and 2.06 million tons of ferrous metal, would be recycled (Table 3-15). The recycled ferrous metal could displace the need for production of more than 2 million tons of new ferrous metal. Production of one ton of recycled ferrous metal requires less energy and materials than production of one ton of new ferrous metal using virgin materials. Therefore the No Action Alternative and Unrestricted Release Alternative, under which ferrous metal would be recycled, would commit fewer resources towards steelmaking than would the EPA/State-Regulated Disposal Alternative or LLW Disposal Alternative, under which no recycling would be conducted. The amount of ferrous metal that would be recycled under the Limited Dispositions Alternative cannot be estimated but would likely be much lower than the amount for the No Action or Unrestricted Release Alternatives.

3.11 MITIGATION MEASURES AND MONITORING

All radioactive materials used, possessed, or stored onsite are required to be periodically monitored and inventoried. The monitoring includes the conduct of external radiation and surface contamination surveys. The inventory addresses quantities of radioactive materials as to their physical and chemical forms, uses, and dispositions, including radioactive decay. These requirements are stated in 10 CFR Part 20 and as license conditions stipulated in each license. Accordingly, the radiological status and locations of materials, before being designated for release, fall under the full control of the radiation safety program of each licensee. As a result, no additional mitigation measures are anticipated as a result of implementing any of the alternatives. The implementation of the rule will be monitored through inspections, similar to those for releases to sewers.

3.12 COMPARISON OF PREDICTED ENVIRONMENTAL IMPACTS

NEPA regulations require a comparison of the environmental impacts of the alternatives, in order to define the issues and provide a clear basis for choice among the alternatives. This section presents a comparison of the environmental impacts of the alternatives described in Section 2.4 of this Draft GEIS, based on information and analysis presented in Chapter 3, Affected Environment and Environmental Consequences. Table 2-1 provides a summary of the impacts.

Some environmental issues are not analyzed in detail in this Draft GEIS because NRC does not anticipate activities that could have the potential to impact these environmental resources. These environmental resources and issues include soils, noise, ecological resources, socioeconomics, historic and cultural resources, environmental justice, visual and scenic resources, and land use. In the event that there are site-specific construction activities associated with the disposition of solid material, any such activities would be subject to site-specific NEPA analysis conducted on a case-by-case basis.

3.12.1 Human Health and Safety

The radiological effects to the General Public, Non-Licensed Facility Workers, and Licensed Facility Workers are assessed in this Draft GEIS in terms of collective dose, in units of person-rem. Even using the highest dose option (10 mrem/year), the effects of exposure on all three categories of exposed groups would be small when compared with background exposure coming from other sources (Appendix E). However, there is a variation between alternatives.

Table 3-29 presents a summary of the collective dose results discussed in Section 3.2. For the Unrestricted Release Alternative, the dose option chosen for the comparison is the IAEA Safety Guide RS-G-1.7, which is also part of the Limited Dispositions Alternative. For Licensed Facility Workers, the collective doses associated with all of the alternatives are similar, except that for the LLW Disposal Alternative the collective dose is lower because there is no decontamination of the solid materials.

Table 3-29 Summary of Collective Dose Results (person-rem)

	Collective Dose	
Alternative	**Licensed Workers**	**Non-Licensed Facility Workers and General Public**
No Action	631	3,996
Unrestricted Release	631	3,429
EPA/State-Regulated Disposal without Trash Incineration	631	2
EPA/State-Regulated Disposal with Trash Incineration	631	1,011
LLW Disposal	323	-
Limited Dispositions	631	112

For Non-Licensed Facility Workers and the General Public, the highest collective doses are for the No Action and Unrestricted Release Alternatives because for these alternatives the collective dose is dominated by exposure of the General Public to products made from recycled ferrous metal. The lowest collective dose to Non-Licensed Facility Workers and the General Public is for the EPA/State-Regulated Disposal Alternative without incineration. Collective dose was not calculated for the LLW Disposal Alternative for Non-Licensed Facility Workers and the General Public, but is assumed to be low, similar to the collective dose for the EPA/State-Regulated Disposal Alternative. The collective dose for the Limited Dispositions Alternative is smaller than for the No Action and Unrestricted Release Alternatives.

3.12.2 Transportation

Transportation effects are measured in this Draft GEIS in terms of fatal vehicle accidents and railcar incidents (e.g., derailments). These effects are based on statistical information on non-radiological accidents. The effects are highest for the LLW Disposal Alternative, with an estimated 32 fatal accidents over the 250 year period of the analysis if the material is transported by truck, or approximately 7 accidents if it is transported by rail (Table 3-16). This results from the fact that the analysis for the LLW Disposal Alternative assumes that all materials must be transported to a single LLW disposal site in Utah, which is an average trip of 1,544 miles. Transport distances associated with all the other alternatives are significantly shorter, resulting in significantly lower transportation effects. The number of fatal accidents under the No Action Alternative is estimated at 11, which is about double the effect associated with the Unrestricted Release Alternative at 1 mrem/yr. For the EPA/State-Regulated Disposal Alternative, the effect would be even lower due to the large number of Subtitle D landfills located throughout the country resulting in short transportation distances, typically less than 100 miles. For the Limited Dispositions Alternative, there are approximately 9 fatalities.

3.12.3 Water Quality

As discussed in Section 3.4, impacts to water quality are expected to be small because compliance with EPA and State permits would preclude significant impacts. Water quality effects are primarily associated with point source and area source water discharges from the storage, handling, and processing of solid materials. For the No Action and Unrestricted Release Alternatives, the effects are generated mostly by runoff discharges from rubblization of concrete and runoff and process wastewater discharges from recycling of ferrous metal. The incremental quantity of these discharges generated would be small as compared to the overall amount of discharges generated from the total amount of concrete and ferrous metal being recycled annually in the U.S., and the impact on water quality would be equally small. Similarly, the quantity of additional leachate and potential effects on ground water associated with disposal of solid materials under the EPA/State-Regulated Disposal Alternative and the LLW Disposal Alternative would be small compared with the overall amount of leachate being generated annually by these facilities. Therefore the overall effects on water quality associated with all of the alternatives would be small when compared with other sources of discharges.

3.12.4 Air Quality

Air quality effects are primarily associated with mobile source emissions from transportation of solid materials to recycling and disposal facilities, fugitive dust emissions from rubblization of concrete, process emissions from recycling of ferrous metal, and emissions from the incineration of trash (Section 3.5). The effects on air quality would be greatest for the EPA/State-Regulated Disposal Alternative trash incineration variation. The air quality effects associated with all other alternatives would be negligible. However, the overall effects on air quality associated with all of the alternatives are small when compared with other sources of emissions (Table 3-23).

3.12.5 Waste Management

The resource being evaluated for waste management is disposal capacity. The EPA/State-regulated disposal facilities considered were RCRA Subtitle D landfills. The analysis in Section 3.7 demonstrates that the existing capacity of Subtitle D landfills would be adequate for the disposal of all of the potentially clearable materials that could be released under any of the alternatives.

Section 3.7 also discusses the analysis of disposal capacity at LLW disposal sites for all the alternatives. A summary of the LLW disposal capacity analysis is shown in Table 3-30. For the Unrestricted Release and EPA/State Regulated Disposal Alternatives, the dose option chosen for the comparison is IAEA Safety Guide RS-G-1.7, which is also part of the Limited Dispositions

Alternative. For small impacts, there is currently sufficient LLW disposal capacity and the need to expand existing LLW storage is small. For moderate impacts, there is currently insufficient LLW disposal capacity and expansion of existing LLW storage capacity would be needed. For large impacts, the amount of additional LLW disposal capacity needed is of such a magnitude that this impact should be avoided.

Table 3-30 Summary of LLW Disposal Capacity Analysis

Alternative	Percent of Estimated Remaining LLW Disposal Capacity	
	Hanford, Barnwell and Envirocare	Envirocare Only
No Action	22	84
Unrestricted Release	4[1]	15
EPA/State-Regulated Disposal	3[1]	11
LLW Disposal	112	426
Limited Dispositions	4	15

[1] Percentage presented is based on the 1 mrem/yr dose option. See Table 3-28.

The effects associated with the LLW Disposal Alternative are considered large. Under this alternative, the amount of solid material projected to be disposed of in the Envirocare LLW facility totals more than four times the existing capacity of the facility under its current State licenses and permits. Under the No Action Alternative, the amount of solid material that would be sent to the Envirocare LLW disposal site is approximately 84 percent of the existing capacity of the site; this is considered a moderate impact. For the other Alternatives, the impacts are small. Under the Unrestricted Release and Limited Dispositions Alternatives the amount of potentially clearable solid material that would be disposed of at the Envirocare LLW disposal site, would total approximately 15 percent of the existing LLW disposal capacity of the Envirocare facility for the 1 mrem/year dose option. Similarly, for the EPA/State-Regulated Disposal Alternative, the amount of potentially clearable solid material that would not be disposed in an EPA/State-regulated landfill, but would be disposed at the Envirocare LLW disposal site, would correspond to approximately 11 percent of the existing LLW disposal capacity of the Envirocare facility.

3.12.6 Cost/Benefit

The cost/benefit analysis is discussed in Chapter 4 and summarized in Table 3-31 for the dose limit of 1 mrem/yr. The No Action Alternative is the baseline and by definition there are no incremental costs or benefits associated with this alternative. Incremental costs for the other alternatives are those costs above the No Action Alternative costs. In Table 3-31 only the most significant attributes are shown. Public and Occupational Health (Routine) includes collective doses to the public and licensed workers and represents less than 0.5 percent of the total incremental benefit or cost of each alternative. Public and Occupational Health (Accident) includes traffic accidents and represents about 1 percent of the total. Industry Operations includes the cost of surveys, disposal fees, and transportation costs and represents about 99 percent of the total. Environmental considerations include air emissions and reductions in the use of virgin materials due to recycling and represent less than 1 percent of the total. Transportation and disposal costs are the most significant sub-attributes when considering costs and benefits.

Table 3-31 Summary of Net Incremental Benefit (Cost) Associated with Major Attributes by Alternative

	Benefit (Cost) in Millions of Dollars				
Alternative	**Public and Occupational Health (Routine)**	**Public and Occupational Health (Accident)**	**Industry Operations**	**Environmental Considerations**	**Total**
No Action	-	-	-	-	-
Unrestricted Release	<1	0	246	1	247
EPA/State-Regulated Disposal	1	0	181	(1)	181
LLW Disposal	1	(13)	(1,378)	(13)	(1,404)
Limited Dispositions	1	0	258	(2)	257

The incremental costs and benefits associated with the various alternatives vary greatly. The highest incremental costs are associated with the LLW Disposal Alternative and are estimated to exceed $1.4 billion, primarily from transportation and disposal costs. For the Unrestricted Use and EPA/State-Regulated Disposal Alternatives, the incremental costs and benefits are highly dependent on the dose option selected. For both, benefits are associated with the 1 mrem/yr and 10 mrem/yr dose options, but costs are associated with the 0.03 mrem/yr and 0.1 mrem/yr dose options due to the fact that under these smaller dose options, smaller amounts of solid material are cleared, and larger amounts must be transported and disposed of in LLW disposal sites. For the comparison of the Unrestricted Release, EPA/State-Regulated Disposal and Limited Disposition Alternatives in Table 3-31, the 1 mrem/yr dose option was chosen. For these three alternatives, the total benefits are similar.

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