DRC-2011-003709

ENERGY*SOLUTIONS*

pd #80,000.00
✓# 17823

April 7, 2011

CD11-0098

Mr. Rusty Lundberg
Executive Secretary
Utah Radiation Control Board
195 North 1950 West
Salt Lake City, UT 84114-5850

Re: Radioactive Material License #UT2300478: Response to Notice of Violation dated February 24, 2011

Dear Mr. Lundberg:

Under a cover letter dated February 24, 2011, the Utah Division of Radiation Control (DRC) issued a Notice of Violation (NOV) to Energy*Solutions*, LLC. The NOV, Section B, identifies violations relating to management of waste that exceeds the Class A limits. Section C identifies a violation of the requirement to immediately notify DRC of waste shipments where there may be a violation of applicable rules or license conditions.

Section D of the NOV finds that corrective actions to prevent recurrence of the receipt of waste that exceed the Class A limits are appropriate. These corrective actions were identified in our letter self-identifying this issue (CD10-0358, December 13, 2010) and have been implemented.

Section E, "Request for Additional Information" requires a response to include:

1) Dose estimates to radiation workers and the public if the waste is removed:
2) Calculations showing that if the waste is left in place does not impact the performance assessment of the Clive facility:
3) A plan detailing how the waste will be found and removed if the State of Utah requires the waste removal; and
4) A cost estimate and estimated timetable to remove the waste

Also, for the reporting violation, Section E requires that corrective actions be submitted.

Energy*Solutions* Response:
Energy*Solutions* does not dispute the violation. Enclosed please find check number 17823 for the assessed civil penalty. Also enclosed please find a report that provides the requested information in items 1-4 of Section E of the NOV.

Regarding the reporting violation, corrective actions have already been implemented. As correctly noted in the NOV, this is an issue that was cited in a Notice of Violation dated October

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19, 2010. As the timeline for these NOVs overlaps, corrective actions cited in our response to the October 19, 2010 NOV apply to the current situation as well. Namely, facility managers have been briefed on the importance of providing DRC notification within 24 hours of identifying shipments where there may be a possible violation of applicable rules or license conditions.

Energy*Solutions* does not request a hearing before the Utah Radiation Control Board at this time; however, Energy*Solutions* reserves its right to request a hearing before the Board.

Please contact me at 801-649-2151 with any questions concerning this issue.

Sincerely,

Sean McCandless

Sean McCandless
Director of Compliance and Permitting

enclosure

cc: John Hultquist, DRC (w/ encl.)

CLIVE FACILITY

RESPONSE TO NOTICE OF VIOLATION (24, FEBRUARY 2011)

FOR NON-CONFORMING WASTE DISPOSAL

April 7, 2011

For
Utah Division of Radiation Control
195 North 1950 West
Salt Lake City, UT 84114-4850

Energy*Solutions*, LLC
423 West 300 South, Suite 200
Salt Lake City, UT 84101

EXECUTIVE SUMMARY

As a result of a comprehensive internal audit, Energy*Solutions* notified the Utah Division of Radiation Control that it had inadvertent receipt and disposal of containers in their Class A and Mixed Waste cells that exceed the Class A limits. In response to their notification, the Division directed Energy*Solutions* to submit additional information justifying the position of not removing the waste that exceeds the Class A criteria from their Clive facility, including a dose estimate to facility workers and the general public if the waste is removed, estimates of the impacts to the Clive facility's ability to meet its performance objectives if left in-place, and a Waste Removal Management Plan. This Report is submitted in compliance with this Division directive, evaluating the methods, schedules, costs, and effects of doses to the general public and facility workers that would result from 1) the removal of Greater-Than-Class-A waste erroneously received and disposed of at Energy*Solutions*' Clive low level radioactive waste disposal facility, and 2) taking no further action (e.g., leaving the waste in-place).

The Extraction Alternative includes identification, removal, and return to generator of the Greater-Than-Class-A lifts, and models 9 exposure scenarios: 1) Survey/Staking of extraction footprint areas; 2) Survey of in-place waste lifts; 3) Removal and nearby stockpiling of radioactive wastes, clean soils, and CLSM fill materials located directly above the target lifts; 4) Location, excavation, and separate stockpiling of targeted lifts; 5) Packaging of the targeted lift materials; 7) Survey and release of package and vehicle from the restricted area; 8) Return of the targeted lift materials to the generator; and 9) Replacement and compaction of the short-term stockpiled materials into the Class A and Mixed Waste embankments.

Worker doses resulting from prolonged and close-proximity exposure to unshielded waste dominate the assessment of the Extraction Alternative. The cumulative projected exposure calculated from removal of all Greater-Than-Class-A Containers is 8 person rem (or an average 0.2 rem per person). The individual worker category for which the cumulative exposures are highest are the Truck Drivers, at 216 mrem per Truck Driver. Additionally, once located and excavated, returned wastes will be lower than the Class A limits and acceptable for disposal at Energy*Solutions*' Clive facility.

Since Tooele County Commission has zoned the Clive are as a "Hazardous Industrial District," no future residential housing will be authorized in the vicinity of the Clive site. Because of this, the Extraction Alternative models doses to a hazardous industrial worker located at the Clive facility boundary as representative of the general public. During extraction, dust is expected to be transported in the atmosphere. Airborne contaminants will be carried downwind into ambient air downwind of the Clive facility boundary by the wind and either inhaled directly by industrial worker or deposited onto the ground surface. External exposure from deposited dust blown off-site during excavation and replacement dominates the industrial worker dose at 1.2 mrem/year. The dose from inhalation of windblown dust is only 0.0001 mrem/year.

The No Action Alternative considers that the Greater-Than-Class-A waste will be allowed to remain disposed in the embankment. Actual worker exposures, tracked for the time periods of errant disposal, do not reveal appreciable worker exposures. Furthermore, since sufficient corrective action has been taken by Energy*Solutions* to correct the procedural errors, no further worker exposures will result from additional Greater-Than-Class-A wastes.

As part of their licensing and permitting efforts, Energy*Solutions* estimated limiting disposal concentrations necessary to comply with Clive's Radioactive Material License and Groundwater Discharge Permit. These models reveal that within the period of compliance, only water infiltration and groundwater migration of contaminants to a point of compliance is critical. Although the source term resulting from the Greater-Than-Class-A wastes is higher than those modeled, the cover performance will still prevent access of the waste to surface water and atmospheric. Because of this, only environmental impacts to groundwater are modeled for the No Action Alternative. Since the Greater-Than-Class-A wastes have been disposed at locations further from the compliance well than those originally modeled as part of licensing and permitting activities, the infiltrated-water travel times demonstrate that any contaminant leached from the Greater-Than-Class-A wastes will not reach the point of compliance within the required 500-year period. Additionally, no impact is projected for the Clive facility's ability to meet its performance objectives.

ALARA considerations suggest that attempts to excavate and recover the Greater-Than-Class-A materials be avoided. While standard controls to reduce worker doses would be applied to any recovery effort, incurring that dose should convey a corresponding benefit in terms of reducing public and environmental impacts. The overall situation does not compromise the facility's performance basis and therefore there is no benefit to accompany occupational doses received in excavating this material.

Comparison of the impacts to worker doses and general public exposures from these two Alternatives suggests that attempts to recover the errant waste be avoided. The additional worker doses and general population exposures from waste recovery far exceed the negligible projected doses from increases to the future groundwater concentrations (which are estimated as zero, since the groundwater is not potable or usable). Extraction conveys no corresponding benefit in terms of reducing general public and environmental impacts. Finally, selecting the No Action alternative does not compromise the Clive facility's ability to meet its performance objectives.

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1. PURPOSE AND NEED

As a result of a comprehensive internal audit, Energy*Solutions* notified the Utah Division of Radiation Control (the "Division") on 13 December 2010 of actions noncompliant with License Condition 9B of Radioactive Material License #UT 2300249 (Chalk, 2010). In this self-identified notification, Energy*Solutions* acknowledged inadvertent receipt and disposal of 23 containers (from 15 shipments) that exceed the Class A limits, as specified in Utah Radiation Control Rule 313-15-1009. Table 1-1 presents the 15 shipments within which the 23 containers that, as manifested, exceed the Class A limit. Those containers for which associated Bates numbers begin with "L" have been disposed of in the Class A cell. Conversely, those containers for which the assigned Bates number begins with "M" or "PM" are disposed in the Mixed Waste cell.

In response to their notification, Energy*Solutions* received a Notice of Violation on 24 February 2011 from the Division (Lundberg, 2011). As part of this Notice, the Division directed Energy*Solutions* to submit additional information justifying the position of not removing the waste that exceeds the Class A criteria from their Clive facility, including a dose estimate to facility workers and the general public if the waste is removed, estimates of the impacts to the Clive facility's ability to meet its performance objectives if left in-place, and a Waste Removal Management Plan (including detailed location and removal methods, associated costs, and required schedule).

1.1 Energy*Solutions*' ALARA Commitment

The objective of Energy*Solutions*' ALARA Program is to ensure that all reasonable actions are taken to reduce radiation exposures and effluent concentrations to levels that are considered as low as is reasonably achievable (ALARA) (ES, 2010a). Energy*Solutions* is committed to continuing its ALARA philosophy to all aspects of its operations, including the initial planning for waste disposal services, engineering, waste disposal and processing operations, and site decommissioning. Procedures included in this Report for each alternative evaluated employ ALARA's principles of time, distance and shielding in creation of engineering controls and administrative controls promoting worker safety.

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Table 1-1

Greater-Than-Class-A Containers

BATES #	ARRIVAL DATE	DISPOSAL DATE	SUM OF FRACTIONS FROM TABLE 1*	SUM OF FRACTIONS FROM TABLE 2*	SHIPMENT	CONTAINER IDENTIFIER	VOLUME (ft^3)
L37876	6/6/2001	7/17/2001		1.17	ZG038-01-0008	IT-117	106.0
L85036	6/6/2005	6/15/2005		1.15	8009-10-5262	BFLU000138	405.0
L85073	6/6/2005	6/14/2005		1.04	8009-10-5263	BFLU000314	540.0
L112300	2/26/2010	3/1/2010	1.00		8009-01-1020	X10C0506703	87.0
L112311	2/26/2010	3/2/2010	2.09	0.07	8009-01-1021	X10C0102456	90.0
L112311	2/26/2010	3/2/2010	1.91	0.07	8009-01-1021	X10C0012438	90.0
L112311	2/26/2010	3/2/2010	1.56	0.05	8009-01-1021	X10C0103790	90.0
L112311	2/26/2010	3/2/2010	1.24	0.06	8009-01-1021	X10X0301419	91.0
L112320	3/1/2010	3/3/2010	1.52	0.07	8009-01-1023	X10C0012435	90.0
L112320	3/1/2010	3/3/2010	1.63	0.04	8009-01-1023	X10C0103824	90.0
L112320	3/1/2010	3/3/2010	1.42	0.08	8009-01-1023	X10C0301420	91.0
L112381	3/8/2010	3/10/2010	2.41		8009-01-1035	X10C0506580	58.0
L112403	3/15/2001	3/16/2010	1.67	0.06	8009-01-1043	X10C0012439	90.0
L112405	3/15/2010	3/29/2010	1.81	0.05	8009-01-1053	X10C0012433	90.0
L112405	3/15/2010	3/29/2010	1.75	0.08	8009-01-1053	X10C0000107	90.0
L112409	3/15/2010	3/16/2010	2.01	0.06	8009-01-1050	X10C0400310	90.0
L112409	3/15/2010	3/16/2010	1.58	0.07	8009-01-1050	X10C0400310	90.0
L112409	3/15/2010	3/16/2010	1.45	0.08	8009-01-1050	X10C9901032	90.0
L112437	3/18/2008	3/19/2010	1.32	0.19	8009-01-1055	X10C0102820	90.0
M10392	3/10/2008	6/11/2008		1.00	9062-03-0001	1906-OJ-099	1.5
PM00151	12/16/2003	8/24/2004		1.04	0421-33-0001	18919	7.5
PM00804	8/20/2008	9/23/2008	1.10		9328-06-0002	C08197511	6.7
PM00976	9/16/2009	4/2/2010	1.16		9079-08-0001	RHZ-103-A16907	7.3
PM00976	9/16/2009	4/2/2010			9079-08-0001	RHZ-103-A16907	Dup
PM00976	9/16/2009	4/2/2010			9079-08-0001	RHZ-103-A16907	Dup

* Utah Division of Radiation Control Rule 313-15-1009

In addition to Energy*Solutions*' ALARA policies, this Report's waste location and removal procedures have been developed consistent with U.S. Occupational and Health Administration's Hazard Prevention and Control Strategy's engineering controls, administrative controls, and personal protective equipment policies. Engineering controls ensure that the location and removal tasks and their associated environments are designed to eliminate hazards or reduce exposure to hazards and include isolation of workers and the hazardous task conditions, such as standard dust control, restricted area access control, and (when deemed necessary by Energy*Solutions*' Director of Health Physics), deployment of interim soil cover over stockpiled wastes and the use of local ventilation for operators of extraction equipment. Furthermore, Energy*Solutions*' current policies of preventative maintenance to systems and equipment provide an additional layer of engineering controls. Similarly, Energy*Solutions*' administrative controls provide a solid framework describing safe work practices, including rotation of qualified workers through removal training and excavation activities, continued investigation and tracking of incidents and near-misses, refreshed HAZWOPER and respirator program training, and augmented emergency planning and training.

1.2 Alternatives Considered

In compliance with directives received in the Notice of Violation, this Report evaluates the methods, schedules, costs, and effects of doses to the general public and facility workers that would result from 1) the removal of Greater-Than-Class-A waste erroneously received and disposed of at Energy*Solutions*' Clive low level radioactive waste disposal facility, and 2) taking no further action (e.g., leaving the waste in-place). Activities considered herein are designed so that worker doses from waste removal are performed in compliance with and further continuance of Energy*Solutions*' ALARA policies.

The numbers given here are estimates based on several simplifying assumptions identified throughout this Report. Only whole body doses, including external gamma, inadvertent ingestion, and inhalation doses from waste removal and invasive sampling, are considered. As with all Clive facility operations, worker doses will be controlled through both administrative and engineering controls and will remain below Energy*Solutions*' administrative control limits for occupational radiation exposure.

2. EXTRACTION ALTERNATIVE

The Extraction Alternative includes identification, removal, and return to generator of the Greater-Than-Class-A lifts. Location and removal will be conducted according to the Waste Removal Management Plan and compliant with Energy*Solutions*' Health and Safety Policies and will include,

A. Review of disposal lift position records from Energy*Solutions*' Electronic Waste Information System (EWIS) for the targeted lifts;
B. Survey/Staking of extraction footprint areas;
C. Removal and nearby stockpiling of radioactive wastes, clean soils, and CLSM fill materials located directly above the target lifts;
D. Location, excavation, and separate stockpiling of targeted lifts;
E. Packaging of the targeted lift materials;
F. Survey and release of intermodal container and transport vehicle;
G. Return of the targeted lift materials to the generator; and
H. Replacement and compaction of the short-term stockpiled materials into the Class A and Mixed Waste embankments.

2.1 Waste Removal Management Plan

The location and extents of the target lifts have been identified from Quality Control lift records and are summarized in Table 2-1 and Figures 2-1 and 2-2. The Waste Removal Management Plan prioritizes retrieval of those lifts in active disposal areas, that are nearest the surface (i.e. lifts AWL01100407FF, AWI12100409MM-06, MW8B100419E-27, MW9A100419FF, and MW9A091014MV). However, the Waste Removal Management Plan recognizes that the remaining lifts will require considerable excavation to remove, due to the depth below the current surface. For those lifts requiring major excavation, the Waste Removal Management Plan considers development of individual retrieval strategies that address: 1) maintaining the segregation of each overlying lift during removal and replacement; 2) access for equipment (excavator and haul trucks) during the removal of the target lift; 3) access for equipment (haul trucks, dozer and compactor) during the replacement of overlying waste lifts; 4) excavation slope stability; 5) temporary stockpile locations and management; 6) maintaining other ongoing disposal operations; and 7) interim radiological cover and temporary cover removal and replacement.

Individual target lift retrieval strategies will be developed through the following steps.

1. The first step has already been completed, which is to identify the location, horizontal and vertical extents and volume of each target lift.
2. Define the horizontal and vertical limits and of each overlying waste lift that would need to be removed. It is important to note that not all of each overlying lift would need to be removed, only the minimum amount to allow access for equipment, provide a stable excavation wall and uncover the target lift.

Table 2-1

Greater-Than-Class-A Lifts

Embankment	Bates #	Shipment	Container No.	Location	Average Lift Elevation (ft)	Maximum Lift Elevation (ft)	Minimum Elevation (ft)	Maximum Depth (ft)	Minimum Depth (ft)	Excavation Volume to Lift Surface (ft^3)	Target Lift Volume (ft^3)
Class A	L112300	8009-01-1020	X10C0506703	AWJ01100305MM-06	4,282.6	4,295.0	4,283.0	12.40	0.40	0.00	34,121.03
Class A	L112311	8009-01-1021	X10C0102456	AWM01100920MM-02	4,269.9	4,278.0	4,270.0	8.10	0.10	28,922.71	11,992.86
Class A	L112311	8009-01-1021	X10C0012438	AWM01100920MM-02	4,269.9	4,278.0	4,270.0	8.10	0.10	28,922.71	11,992.86
Class A	L112311	8009-01-1021	X10C0103790	AWM01100920MM-02	4,269.9	4,278.0	4,270.0	8.10	0.10	28,922.71	11,992.86
Class A	L112311	8009-01-1021	X10C0301419	AWM01100920MM-02	4,269.9	4,278.0	4,270.0	8.10	0.10	28,922.71	11,992.86
Class A	L112320	8009-01-1023	X10C0012435	AWI07100921MM-02	4,291.5	4,305.0	4,292.0	13.50	0.50	39,962.08	9,135.90
Class A	L112320	8009-01-1023	X10C0103824	AWI07100921MM-02	4,291.5	4,305.0	4,292.0	13.50	0.50	17,127.61	83,102.47
Class A	L112320	8009-01-1023	X10C0301420	AWI07100921MM-02	4,291.5	4,305.0	4,292.0	13.50	0.50	17,127.61	83,102.47
Class A	L112381	8009-01-1035	X10C0506580	AWL01100407FF	4,283.4	4,288.0	4,283.0	4.60	0.00	17,127.61	83,102.47
Class A	L112403	8009-01-1043	X10C0012439	AWI12100409MM-06	4,317.7	4,319.0	4,318.0	1.30	0.30	21,044.01	26,305.90
Class A	L112409	8009-01-1050	X10C0012433	AWI01100429MM-25	4,309.4	4,310.0	4,309.0	0.60	0.00	13,356.01	44,521.20
Class A	L112409	8009-01-1050	X10C0000107	AWN23100430MM-19	4,289.1	4,298.0	4,290.0	8.90	0.90	63,778.29	24,730.86
Class A	L112409	8009-01-1050	X10C0400310	AWI01100429MM-25	4,309.4	4,310.0	4,309.0	0.60	0.00	63,778.29	24,730.86
Class A	L112405	8009-01-1053	X10C0000105	AWJ01100511DU-07	4,284.4	4,295.0	4,285.0	10.60	0.60	133,906.15	52,512.91
Class A	L112405	8009-01-1053	X10C9901032	AWN23100223MM-16	4,283.4	4,298.0	4,283.0	14.60	0.00	133,906.15	52,512.91
Class A	L112437	8009-01-1055	X10C0102820	AWL23100505MM-14	4,290.9	4,301.0	4,291.0	10.10	0.10	63,778.29	24,730.86
Class A	L85036	8009-10-5262	BFLUO00138	AWF11050609MM-00	4,280.5	4,309.0	4,288.0	28.50	7.50	645,121.27	35,840.86
Class A	L85073	8009-10-5263	BFLUO00314	AWL07051127MM-00	4,288.1	4,304.0	4,298.0	15.90	9.90	174,535.68	24,352.99
Class A	L37876	ZG038-01-0008	IT-117	AWC20010615M	4,276.8	4,301.0	4,281.0	24.20	4.20	312,400.60	19,800.93
Mixed Waste	M10392	9062-03-0001	1906-OJ-099	MW8A080812MV-01	4,296.3	4,310.0	4,296.3	13.70	0.00	150,700.00	1,314.00
Mixed Waste	PM00151	0421-33-0001	18919	MW6A040818SE	4,288.0	4,313.0	4,310.0	25.00	22.00	517,000.00	655.00
Mixed Waste	PM00804	9328-06-0002	C0819711	MW8A080923MV	4,300.3	4,306.0	4,300.3	5.70	0.00	62,700.00	619.00
Mixed Waste	PM00976	9079-08-0001	RHZ-103-A16907	MW9A091014MV	4,283.1	4,283.1	4,283.1	10.00	0.00	110,000.00	3,394.00
Mixed Waste	PM00976	9079-08-0001	RHZ-103-A16907	MW8B100419E-27	4,309.6	4,309.6	4,309.6	10.00	0.00	110,000.00	3,394.00
Mixed Waste	PM00976	9079-08-0001	RHZ-103-A16907	MW9A100419FF	4,283.8	4,283.8	4,283.8	10.00	0.00	110,000.00	3,394.00

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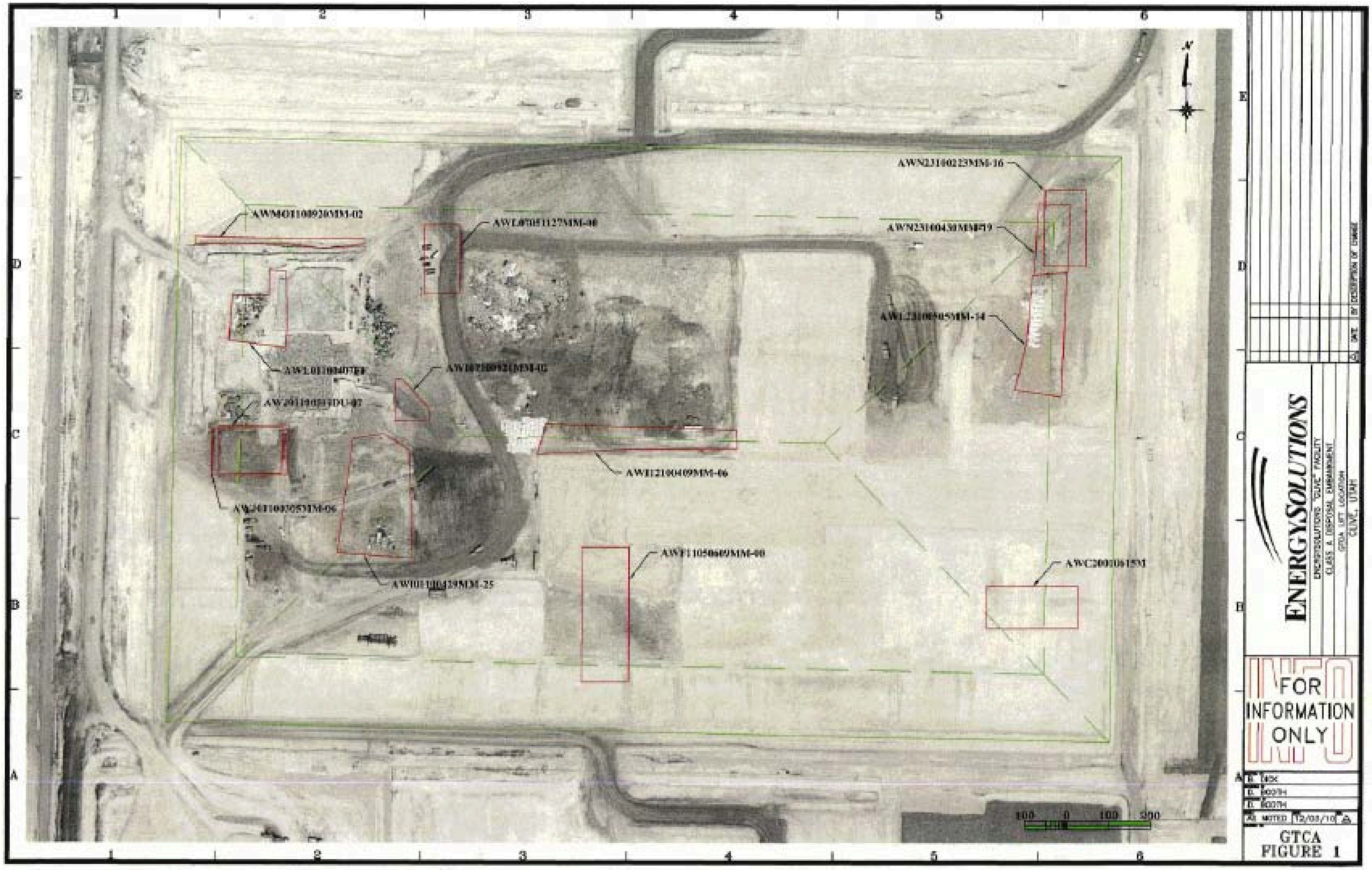

Figure 2-1. Class A Cell Disposal Location of Greater-Than-Class-A Lifts

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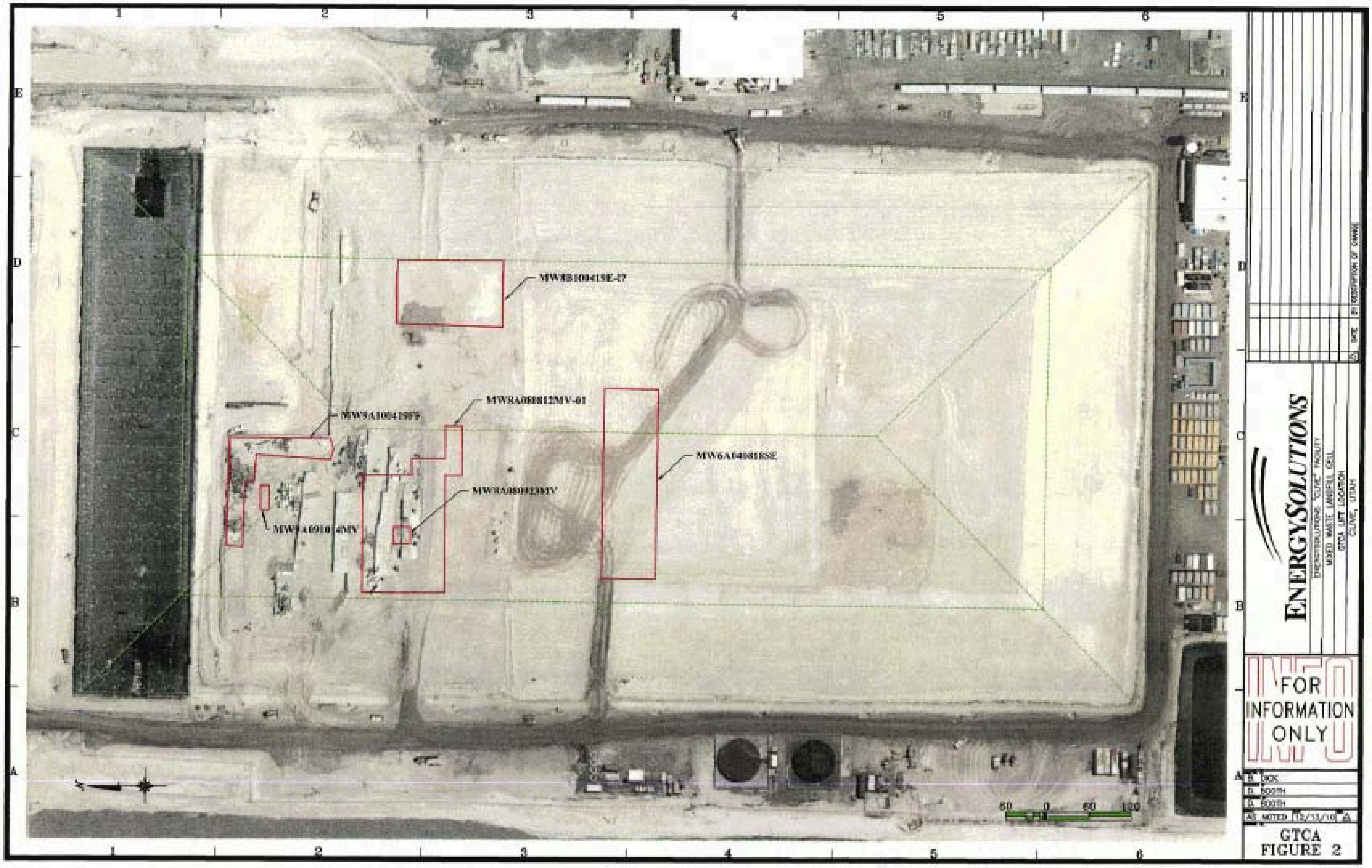

Figure 2-2. Mixed Waste Cell Disposal Location of Greater-Than-Class-A Lifts

3. Compile the information developed in Steps 1 and 2 into a comprehensive excavation plan that addresses access (haul route) to the retrieval area, access to the excavation by equipment, and the systematic removal of each overlying waste lift.
4. Indentify and prepare suitable locations for the temporary stockpiling of the overlying waste lifts. It is important to note that each lift would need to be maintained in a separate stockpile. For example, lift AWC20 would require as many as 24 separate stockpiles. Each stockpile/lift will need to be tracked from removal to replacement.
5. Identify a location for the staging and loading of the target material into shipping containers.
6. Indentify and define any unique conditions and associated CQA/QC specifications for the replacement of the overlying waste, for example the perimeter interface between existing lifts and replaced lifts.
7. Individual target waste retrieval strategies will also address daily cover/dust control for each stockpile, dust control for temporary haul routes; and dust/debris control during the loading of waste into shipping containers.

Once a retrieval strategy for a target waste lift is complete, the strategy will be reviewed, amended as applicable and approved by the Operations, HP, QA, QC and Safety groups. After a retrieval plan is approved, the physical work will be initiated.

1. The QC technicians will stake the extents of the first waste lift to be removed. This will include identifying the excavation depth for that lift.
2. If the lift area has interim radiological cover or temporary cover, the cover material will be removed and stockpiled for future use as fill material.
3. Operations will excavate and haul to a temporary stockpile the defined lift material. QC technicians will provide ongoing observation and survey control through the removal of the defined lift.
4. Steps 1 and 2 will be repeated until the target waste lift is uncovered.
5. The target lift will be removed and hauled to the staging area and loaded into shipping containers.
6. The material from each overlying waste lift removed will be replaced in accordance with applicable CQA/QC specifications.
7. If the lift area was previously covered with interim radiological cover, then new interim rad cover will be replaced.
8. If the lift area was previously covered with temporary cover, then additional waste/fill material will be placed to the waste limits, new temporary cover will be placed and settlement monitoring restarted for the affected area, subject to applicable CQA/QC specifications and approvals.

The Waste Removal Management Plan recognizes that this approach is subject to changes or additions as merited by field conditions, ALARA concerns, operational considerations and safety during the physical work.

2.1.1 Schedule

A tentative schedule for the completion of the work described in this Waste Removal Management Plan is at a minimum 399 shifts (days) or 1.6 years. This is based on the assumption that a single crew will be dedicated to the removal of the target lifts and the replacement of the overlying material. The production capability of the crew is estimated at 600 yd^3 per shift (day) for either removal or replacement. A total of 239,608 yd^3 of material will be handled, with at least 132,459 yd^3 removed and at a minimum 107,150 yd^3 replaced. It is recognized that enclimate weather or other events may result in extending this schedule.

2.1.2 Budget

As is summarized below, the total cost projected by this Waste Removal Management Plan is $1,916,507 (plus or minus 25%). The Waste Removal Management Plan includes current rates for the estimated 147,000 gallons of diesel fuel would be consumed over the course of the work.

Removal and stockpiling of target lifts and overlying material	$946,340
Replacement of overlying material	$970,167
TOTAL WASTE REMOVAL	$1,916,507

2.2 Source-Term

Once received and processed, Class A containers are placed into a lift area with other lower activity wastes, native soils, and other CLSM fill materials. Because of this, none of the errant containers remain in an isolated, concentrated unit within the disposal cell. Instead, the Waste Removal Management Plan assumes removal of the entire disposal lift in which the errant containers were placed. The volume of waste to be extracted represents 19 containers disposed in the Class A cell (less than 0.003% of the current Class A embankment volume) and 4 containers disposed in the Mixed Waste cell (less than 0.0001% of the current Mixed Waste embankment volume). Due to placement with other waste shipments, clean soils, and CLSM fill material, it is not considered feasible to locate and only recover specific contents from these 23 individual containers. The specific lifts in which these containers were disposed have combined volumes of 18,582 yd^3 (14,207 m^3) in the Class A cell and 9,432 yd^3 (7,211 m^3) in the Mixed Waste cell. Since the errant wastes were disposed in bulk waste and CLSM lifts with other containers from the same and from other shipments, uncontaminated soils, and CLSM fill material, the significant increase in recovered waste volume will contain dramatically lower average radionuclide concentrations than when initially received and disposed (as is illustrated in Table 2-2).

Table 2-2

Classification of Returned Wastes

LIFT	RETURNED SUM OF FRACTIONS FROM TABLE 1*	RETURNED SUM OF FRACTIONS FROM TABLE 2*
AWJ01100305MM-06	0.18	0.10
AWM01100920MM-02	< 0.01	0.01
AWI07100921MM-02	< 0.01	0.01
AWL01100407FF	0.88	0.34
AWI12100409MM-06	0.28	< 0.01
AWI01100429MM-25	0.17	< 0.01
AWN23100430MM-19	0.45	< 0.01
AWL23100505MM-14	0.34	< 0.01
AWL23101022MM-19	0.01	< 0.01
AWF11050609MM-00	0.76	0.03
AWL07051127MM-00	0.42	0.07
AWC20010615M	0.48	0.17
MW8A080812MV-01	0.00	< 0.01
MWGA040818SE	0.00	0.01
MW8A080923MV	0.01	0.00
MW9A091014MV	<0.01	0.00
MW8B100419E-27	<0.01	0.00
MW9A100419FF	<0.01	0.00

Since the targeted lifts are not at the respective cell surfaces, other lifts residing above the targeted lifts must first be removed and stockpiled prior to being able to extract the Greater-Than-Class-A lifts. The volume of waste, interim radiological cover, and temporary cover to be excavated and removed prior to being able to access the lifts with Greater-Than-Class-A containers is 56,820 yd^3 (43,442 m^3) from the Class A Cell and 21,636 yd^3 (16,542 m^3) from the Mixed Waste Cell. Once the targeted lifts have been successfully identified and removed, these wastes will be replaced and compacted in the respective embankments. Therefore, the total volume of waste, interim radiological cover, and temporary cover to be excavated and removed as part of the extraction of the Greater-Than-Class-A containers is 75,402 yd^3 (57,649 m^3) from the Class A Cell and 31,068 yd^3 (23,753 m^3) from the Mixed Waste Cell.

Based on disposal records, Energy*Solutions* estimates the current overall radioactive concentration in the Class A cell is less than 4% of the Class A limits. Similarly, the current radioactive concentrations in the Mixed Waste cell is less than 2% of the Class A limits. Current specific radionuclide concentrations for the targeted lifts (which must be removed and returned to the generator) and those residing above (which must be removed, stored, replaced, and compacted) are included in Appendix A. It is noted that generators do not uniformly manifest short-lived daughters (progeny in secular equilibrium) when shipping waste for disposal to Energy*Solutions*. However, gamma exposures evaluated using MicroShield® for each of the waste lifts include appropriate short-lived daughters based upon a review of parent radionuclides and their progeny in secular equilibrium (10 CFR 71). For those short-lived radionuclides for which the calculated concentrations from the parent's abundance are greater than those reported by the generator (as adjusted for decay since receipt), the higher value is reported in Appendix A and used in this analysis.

2.3 Worker Doses

The Extraction Alternative considers identification and removal of the Greater-Than-Class-A lifts. While location and removal activities will be conducted according to the Waste Removal Management Plan and compliant with Energy*Solutions*' Health and Safety Policies, they will include activities during which workers may be exposed, including:

A. STAKING (external): Workers will be involved in using lift locations and global positioning satellite coordinate records to survey and stake out target excavation locations.
B. EXCAVATION (external, inhalation, inadvertent ingestion): Workers operating heavy equipment will remove and stockpile waste, clean soils, and CLSM fill materials, including those located directly above the target lifts and the target lifts themselves;
C. TRANSFER (external, inhalation, inadvertent ingestion): Once identified and extracted, workers will transfer the target Greater-Than-Class-A lifts to a truck-mounted intermodal container for removal from the embankment;
D. RETURN (external): Workers will free-release the intermodal and then return of the targeted lift materials via truck to the generator;
E. REPLACEMENT (external, inhalation, inadvertent ingestion): Workers will replace excavated waste not returned to the generator; and

F. COMPACTION (external, inhalation, inadvertent ingestion): Workers will compact replaced waste not returned to the generator.

2.3.1 Methodology

Occupational exposures from materials containing gamma emitters are evaluated using Grove Engineering's MicroShield®, Version 8.03. MicroShield® is a comprehensive photon/gamma ray shielding and dose assessment program that is widely used for designing shields, estimating source strength from radiation measurements and as a part of Energy*Solutions*' ALARA planning. MicroShield® generates a hardcopy output describing the case model with a graphical representation of the source to receptor geometry. Effects of sky-shine or worker doses from energies less than 15 keV, extremity and lens of eye doses, or doses during accident scenarios are not included in this Report.

Energy*Solutions*' workers are thoroughly trained on the hazards presented by radioactive waste and the procedures prohibiting eating and smoking while in the restricted-access waste disposal unit. While prevented by administrative controls, if a disposal worker's hands do become contaminated with waste, it is possible that contaminants could be inadvertently ingested. Worker exposures to inadvertent soil ingestion assume the ingestion of a small quantity of bulk waste in the form of soil (consistent with EPA guidance for soil ingestion resulting from eating garden produce and from dirty hands contacting the mouth) (EPA, 2009). The methodology for calculating doses from soil ingestion is shown below.

$$Dose_{ingestion} = C_w / d_w \;\; U_w \;\; DCF_{ing} \qquad (2\text{-}1)$$

where,

$Dose_{ingestion}$	=	soil ingestion dose (mrem/year)
C_w	=	nuclide concentration in bulk waste (Ci/m^3)
d_w	=	density of bulk waste (kg/ m^3)
U_w	=	ingestion uptake of bulk waste (kg/year)
DCF_{ing}	=	ingestion dose conversion factor (mrem/Ci) (EPA, 1988)

When deemed necessary by the Director of Health Physics, inhalation doses to excavation workers will be reduced through enhanced control measures. In estimating worker inhalation doses, dust is assumed to be generated by mechanical and natural dust resuspension in the excavated stockpile and uncovered excavation pit, as is shown below.

$$Dose_{inhalation} = C_{air} \quad U_{air} \quad f \quad DCF_{inh} \qquad (2\text{-}2)$$

where,

$Dose_{inhalation}$	=	dust inhalation dose (mrem/year)
C_{air}	=	airborne nuclide concentration in bulk waste (Ci/m^3)
	=	C_{waste} x d x r (2-3)
C_{waste}	=	nuclide concentration in waste (Ci/m^3)
d	=	active soil depth for mechanical suspension occurs (m) (DOE, 1997)
r	=	resuspension factor (m^{-1}) (DOE, 1994)
U_{air}	=	inhalation rate (m^3/year)
f	=	fraction of year worker is exposed to dust (unitless)
DCF_{inh}	=	inhalation dose conversion factor (mrem/Ci) (EPA, 1988)

In estimating excavation worker inhalation doses, a resuspension factor is used to estimate the dust concentration for the worker (DOE, 1994). The dust resuspension factor accounts for mechanical disturbance of soil and is based on measurements taken in the cab of a tractor while operating. This factor provides a conservative estimate of the amount of dust resuspension expected at an arid site. Inhalation doses related to invasive waste sampling are considered negligible due to engineering controls (e.g., hoods), and personal protective equipment used in dedicated sampling rooms. Any increase in gas emanation through the finished cover once excavation activities have been completed is not considered here as it is applicable to the post-closure period.

2.3.2 Exposure Scenarios

Because of the uniqueness in time, distance, shielding, and geometry, assessment of worker exposures from the individual extraction tasks presented in the Waste Removal Management Plan are repeated for each of the 19 target lifts sought (because of the uniqueness in physical geometry and lift radiological characteristics). While a number of workers are involved in Clive's day-to-day operations, only a limited number will be involved in extraction activities and come into exposure proximity during waste extraction activities (see Table 2-3). Additionally, a list of heavy equipment to be used is given in Table 2-4.

Administrative and infrastructure support workers are not included in the dose assessment. This Report also does not address external alpha, beta or neutron dose contributions to Clive facility worker doses. Additionally, subsequent radioactive wastes generated on-site as part of identification and removal activities are not addressed in this Report, as all site wastes within regulatory limits are already managed in accordance with Radioactive Material License #UT 2300249. Other classes of personnel excluded from this dose assessment:

Table 2-3

Workers in Exposure Proximity to Excavated Waste

QTY	POSITION	RESPONSIBILITIES
1	Director of Engineering	Will generally be located in the Clive Administration Building. Will not have direct extracted waste responsibilities. Will provide engineering and stability support, including periodic walkabout inspections.
1	QC Manager	Generally working in the Clive Administration Building. Will periodically observe or participate in visual QC audits of extraction operations. Perform walkabout inspections. Oversees and supports QC Technicians.
1	Director of Health Physics	Generally working in the Clive Administration Building most of the time. Will periodically observe or participate in extraction operations, but is not expected to participate in them consistently as a work team member. Perform walkabout inspections.
1	Assistant Radiation Safety Officer	Oversee and support Radiation Technicians.
1	Operations Supervisor	Supervises equipment operators, riggers, and spotters
4	Heavy Equipment Operators	Heavy equipment operators account for waste excavation, move waste containers, participate in waste replacement, participate in equipment decontamination activities.
4	Riggers	Secure extracted waste loads.
8	Radiation Technicians	Performs non-destructive, non-invasive gamma spectroscopy of waste lifts, prior to excavation. Invasively collect samples from waste lifts, visually inspect excavated wastes. Performs soil density testing for replaced lifts.
12	Truck Drivers	Return extracted Greater-Than-Class-A wastes to generator, participate in equipment decontamination activities.
4	Operators	Operators of smaller equipment, supporting waste excavation, move waste containers, participate in waste replacement, participate in equipment decontamination activities.
4	QC Technicians	General QC extraction support, including supporting safe vehicle and load movements.

Table 2-4

List of Equipment For Use In Extraction Activities

1. Caterpillar 824C wheel-type rubber tire dozer tractor
2. Caterpillar D6 or smaller track-type tractors
3. Fiat Allis FD-20 dozer
4. Caterpillar 966C, wheel loader with a 3.25-yd3 bucket
5. Fiat Allis FR-15 loader
6. Caterpillar 977L track-type loader with a 3.25-yd3 bucket
7. Caterpillar 14G motor grader
8. John Deere 772A motor grader
9. Self-propelled smooth-drum compactors
10. 270 or smaller Hatachi excavator
11. John Deere 690 excavator
12. Highway-legal vehicles
13. Other smaller equipment

- Office administrative and other infrastructure support workers
- Utah Department of Environment Quality (UDEQ) resident staff
- Visitors, including over the road drivers delivering waste
- Laboratory technicians

2.3.2.1 STAKING: As is illustrated in Figure 2-3, workers will be involved in using lift locations and global positioning satellite coordinate records to survey and stake out target excavation locations. Since this scenario does not involve waste disturbance or removal, only external exposure to gamma radiation is considered. Other scenario parameters include:

- Operators (4) - exposed 0.5 hr/lift per person
- QC Technicians (4) - exposed 0.5 hr/lift per person

2.3.2.2 EXCAVATION As is illustrated in Figures 2-4 and 2-5, workers operating heavy equipment will remove and stockpile waste, clean soils, and CLSM fill materials, including those located directly above the target lifts and the target lifts themselves. This scenario considers external exposures from gamma radiation and internal exposure from inhalation and inadvertent ingestion of resuspended dust. Other scenario parameters include:

- Director of Engineering (1) - exposed 0.05 hr/lift per person
- QC Manager (1) - exposed 0.05 hr/lift per person
- Director of Health Physics (1) - exposed 0.05 hr/lift per person
- Assistant Radiation Safety Officer (1) - exposed 0.05 hr/lift per person
- Operations Supervisor (1) - exposed 0.5 hr/lift per person
- Heavy Equipment Operators (4) - exposed while removing 300 m^3 per person
- Operators (4) - exposed while removing 300 m^3 per person
- QC Technicians (4) - exposed while removing 300 m^3 per person
- Soil ingestion rate - 100 mg/year (EPA, 2009)
- Worker inhalation rate – 8,400 m^3/year (EPA, 2009)
- Mechanical resuspension factor – 1.7E-7 m^{-1} (EPA, 2009)
- Active soil depth for suspension – 1 mm (EPA, 2009)

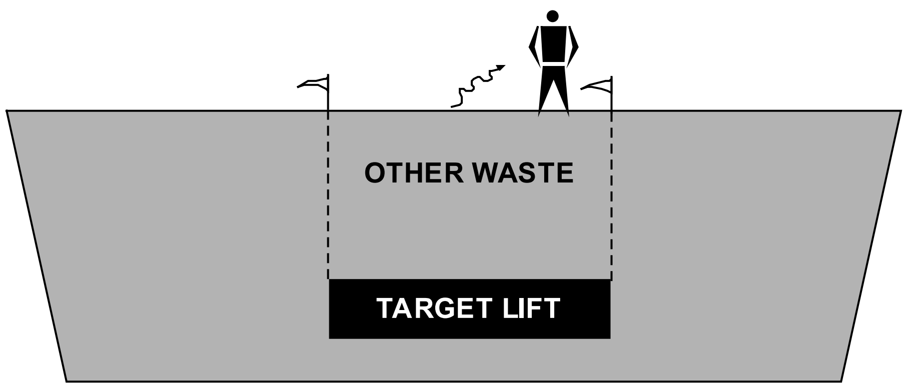

Figure 2-3. STAKING Exposure Scenario

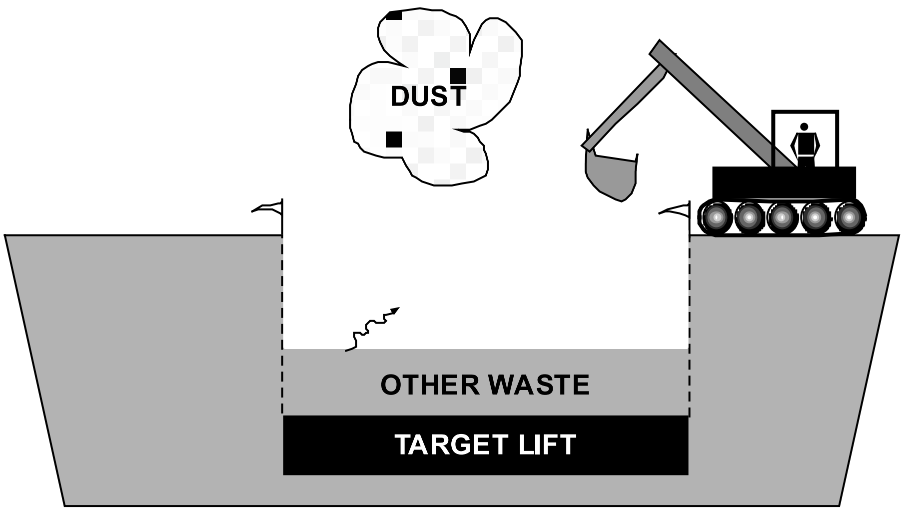

Figure 2-4. EXCAVATION Exposure Scenario

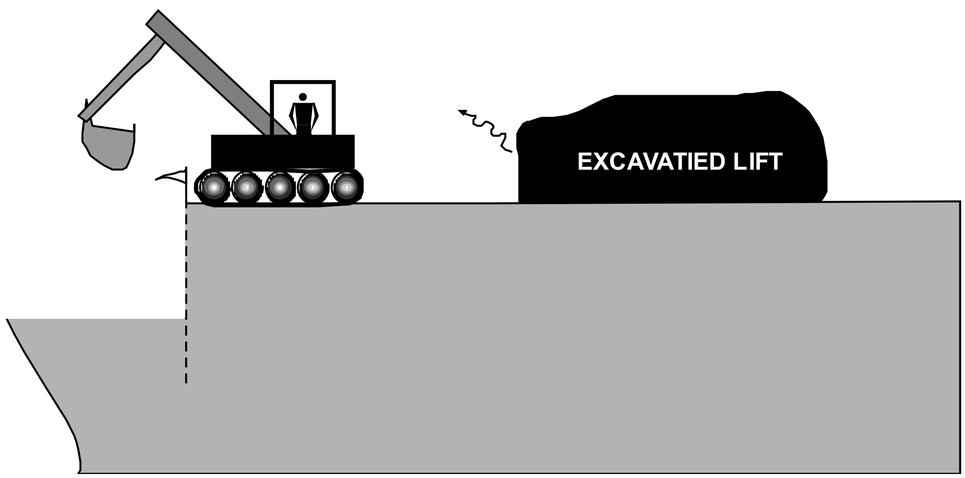

Figure 2-5. Secondary EXCAVATION Exposure Scenario

2.3.2.3 TRANSFER: As is presented in Figure 2-6, once removed from the embankment, workers will transfer the target lift to a top-loaded intermodal box, in preparation of return to the specific generator. This scenario considers external exposures from gamma radiation and internal exposure from inhalation of resuspended dust. Inadvertent soil ingestion is included in the EXCAVATION Scenario and not repeated in the TRANSFER Scenario. Other scenario parameters include:

- Director of Health Physics (1) - exposed 0.05 hr/lift per person
- Assistant Radiation Safety Officer (1) - exposed 0.1 hr/lift per person
- Heavy Equipment Operators (4) - exposed while transferring 300 m^3 per person
- Riggers (4) - exposed 1.0 hr/lift per person
- Radiation Technicians (8) - exposed 0.5 hr/lift per person
- Truck Drivers (12) - exposed 1.0 hr/lift per person
- Operators (4) - exposed while transferring 300 m^3 per person
- QC Technicians (4) - exposed while transferring 300 m^3 per person
- Worker inhalation rate – 8,400 m^3/year (EPA, 2009)
- Mechanical resuspension factor – 1.7E-7 m^{-1} (EPA, 2009)
- Active soil depth for suspension – 1 mm (EPA, 2009)

2.3.2.4 RETURN: As is illustrated in Figure 2-7, workers will then rig the intermodal, decontaminate and release the truck and container, and return the targeted lift materials via truck to the generator. This scenario considers external exposures from gamma radiation. Other scenario parameters include:

- Director of Health Physics (1) - exposed 0.1 hr/lift per person
- Assistant Radiation Safety Officer (1) - exposed 0.1 hr/lift per person
- Riggers (4) - exposed 1.0 hr/lift per person
- Radiation Technicians (8) - exposed 0.5 hr/lift per person
- Truck Drivers (12) - exposed 40 hr/lift per person

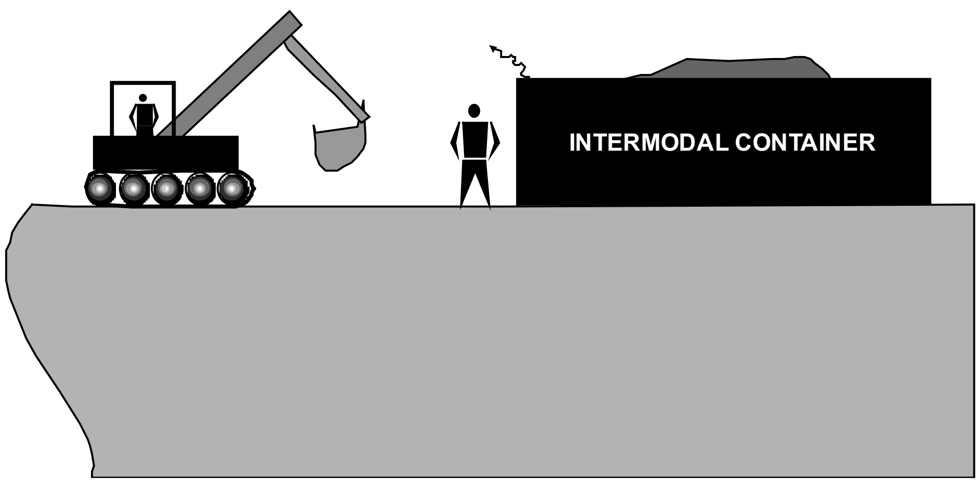

Figure 2-6. TRANSFER Exposure Scenario

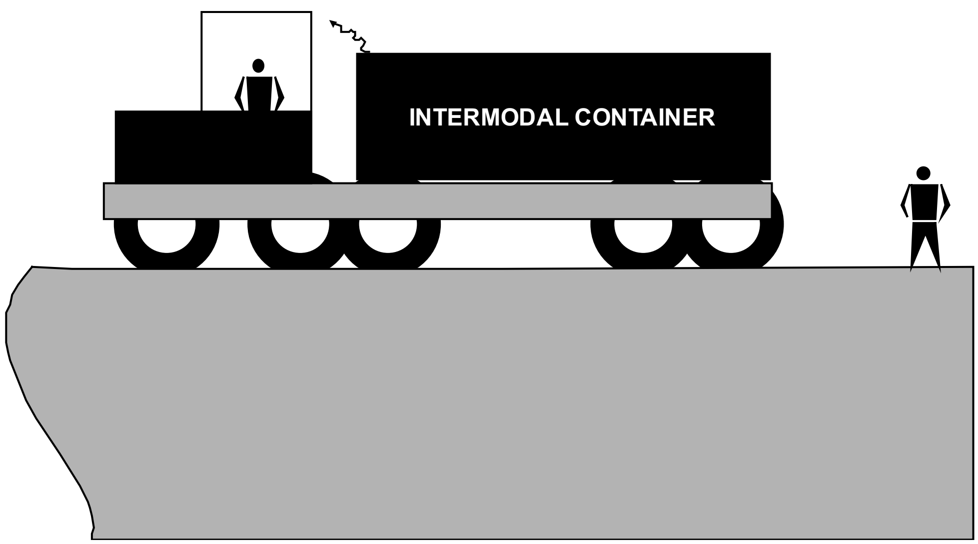

Figure 2-7. RETURN Exposure Scenario

2.3.2.5 REPLACEMENT: As is illustrated in Figure 2-8, workers operating heavy equipment will replace excavated materials previously stockpiled. This scenario considers external exposures from gamma radiation and internal exposure from inhalation and inadvertent ingestion of resuspended dust. Inadvertent soil ingestion is included in the EXCAVATION Scenario and not repeated in the TRANSFER Scenario. Other scenario parameters include:

- Director of Engineering (1) - exposed 0.05 hr/lift per person
- QC Manager (1) - exposed 0.05 hr/lift per person
- Director of Health Physics (1) - exposed 0.05 hr/lift per person
- Assistant Radiation Safety Officer (1) - exposed 0.05 hr/lift per person
- Operations Supervisor (1) - exposed 0.5 hr/lift per person
- Heavy Equipment Operators (4) - exposed while replacing 300 m^3 per person
- Operators (4) - exposed while replacing 300 m^3 per person
- QC Technicians (4) - exposed while replacing 300 m^3 per person
- Worker inhalation rate – 8,400 m^3/year (EPA, 2009)
- Mechanical resuspension factor – 1.7E-7 m^{-1} (EPA, 2009)
- Active soil depth for suspension – 1 mm (EPA, 2009)

2.3.2.6 COMPACTION: As is illustrated in Figure 2-9, workers operating compaction equipment will compact excavated materials previously replaced. This scenario considers external exposures from gamma radiation and internal exposure from inhalation and inadvertent ingestion of resuspended dust. Inadvertent soil ingestion is included in the EXCAVATION Scenario and not repeated in the TRANSFER Scenario. Other scenario parameters include:

- QC Manager (1) - exposed 0.05 hr/lift per person
- Operations Supervisor (1) - exposed 0.1 hr/lift per person
- Operators (4) – exposed while compacting 50 m^2 per person
- QC Technicians (4) - exposed while compacting 50 m^2 per person
- Worker inhalation rate – 8,400 m^3/year (EPA, 2009)
- Mechanical resuspension factor – 1.7E-7 m^{-1} (EPA, 2009)
- Active soil depth for suspension – 1 mm (EPA, 2009)

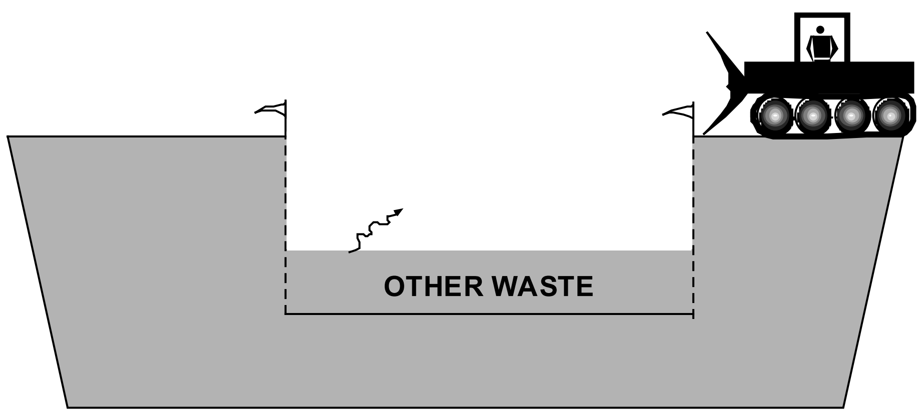

Figure 2-8. REPLACEMENT Exposure Scenario

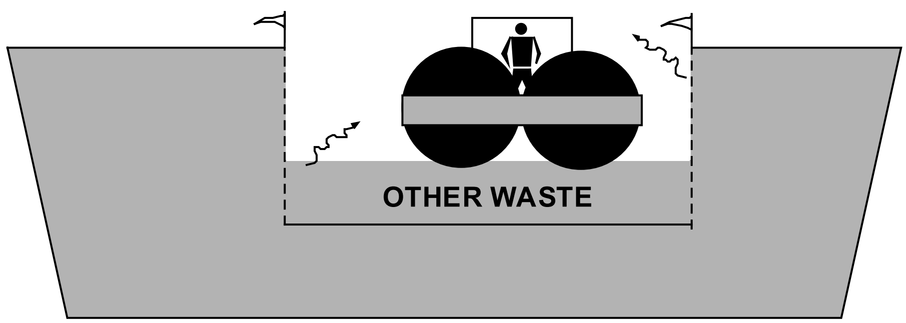

Figure 2-9. COMPACTION Exposure Scenario

2.3.3 Results

Individual MicroShield® results for the worker dose calculations are included in Appendix B. Analysis demonstrates that impacts resulting from prolonged and close-proximity exposure to unshielded waste dominate the assessment. As is summarized in Table 2-5, the worker categories for which the cumulative exposures are highest are the Truck Drivers (2,590 person mrem) and Equipment Operators (2,110 person mrem), due to length of exposure and lack of shielding. This is also reflected in the fact that the exposure scenarios for which the highest worker doses are calculated are EXCAVATION (1,760 person mrem) and RETURN (2,190 person mrem) with average exposures of 43 mrem per person and 54 mrem per person, respectively.

2.3.3.1 STAKING: As are summarized in Table 2-6, worker doses were calculated for the STAKING scenario for target lifts in the Class A Cell and the Mixed Waste Cell. The target lift for which the highest cumulative worker doses are projected for the STAKING scenario is AWL01100407FF. Overall, a total cumulative worker dose for the STAKING scenario is projected at 1,200 person mrem and an average dose of 29 mrem per person.

2.3.3.2 EXCAVATION: As are summarized in Table 2-7, worker doses were calculated for the EXCAVATION scenario for target lifts in the Class A Cell and the Mixed Waste Cell. The target lift for which the highest cumulative worker doses are projected for the EXCAVATION scenario is AWL01100407FF. Overall, a total cumulative worker dose for the EXCAVATION scenario is projected at 1,760 person mrem and an average dose of 43 mrem per person.

Table 2-5

Worker Category Dose Summary

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	1.55E-04	2.34E+00	0.00E+00	**2.34E+00**	2.34E+00
QC Manager	2.32E-04	2.62E+00	0.00E+00	**2.62E+00**	2.62E+00
Director of Health Physics	2.32E-04	2.37E+00	0.00E+00	**2.37E+00**	2.37E+00
Assistant Radiation Safety Officer	3.10E-04	2.38E+00	0.00E+00	**2.39E+00**	2.39E+00
Operations Supervisor	1.70E-03	2.40E+01	0.00E+00	**2.40E+01**	2.40E+01
Heavy Equipment Operators	5.58E+00	7.94E+02	3.24E-01	**8.00E+02**	2.00E+02
Riggers	6.20E-03	1.62E+02	0.00E+00	**1.62E+02**	4.04E+01
Radiation Technicians	6.20E-03	1.62E+02	0.00E+00	**1.62E+02**	2.02E+01
Truck Drivers	1.86E-02	2.59E+03	0.00E+00	**2.59E+03**	2.16E+02
Operators	5.89E+00	2.11E+03	0.00E+00	**2.11E+03**	5.29E+02
QC Technicians	5.89E+00	2.11E+03	0.00E+00	**2.11E+03**	5.29E+02
TOTAL	**1.74E+01**	**7.95E+03**	**3.24E-01**	**7.97E+03**	**1.94E+02**

Table 2-6

STAKING Worker Dose Estimates

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE WORKER DOSE (mrem)
Director of Engineering	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
QC Manager	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Director of Health Physics	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Assistant Radiation Safety Officer	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Operations Supervisor	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Heavy Equipment Operators	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Riggers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Radiation Technicians	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Truck Drivers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Operators	0.00E+00	6.02E+02	0.00E+00	**6.02E+02**	1.50E+02
QC Technicians	0.00E+00	6.02E+02	0.00E+00	**6.02E+02**	1.50E+02
TOTAL	**0.00E+00**	**1.20E+03**	**0.00E+00**	**1.20E+03**	**2.94E+01**

Table 2-7

EXCAVATION Worker Dose Calculations

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	7.75E-05	2.07E+00	0.00E+00	**2.07E+00**	2.07E+00
QC Manager	7.75E-05	2.07E+00	0.00E+00	**2.07E+00**	2.07E+00
Director of Health Physics	7.75E-05	2.07E+00	0.00E+00	**2.07E+00**	2.07E+00
Assistant Radiation Safety Officer	7.75E-05	2.07E+00	0.00E+00	**2.07E+00**	2.07E+00
Operations Supervisor	7.75E-04	2.07E+01	0.00E+00	**2.07E+01**	2.07E+01
Heavy Equipment Operators	1.86E+00	5.76E+02	3.24E-01	**5.79E+02**	1.45E+02
Riggers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Radiation Technicians	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Truck Drivers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Operators	1.86E+00	5.76E+02	0.00E+00	**5.78E+02**	1.45E+02
QC Technicians	1.86E+00	5.76E+02	0.00E+00	**5.78E+02**	1.45E+02
TOTAL	**5.58E+00**	**1.76E+03**	**3.24E-01**	**1.76E+03**	**4.30E+01**

2.3.3.3 TRANSFER: Table 2-8 summarizes worker dose estimates for the TRANSFER scenario for lifts in the Class A Cell and the Mixed Waste Cell. The target lift for which the highest cumulative worker doses are projected for the TRANSFER scenario is AWL01100407FF. Overall, a total cumulative worker dose for the TRANSFER scenario is projected at 725 person mrem and an average dose of 18 mrem per person.

2.3.3.4 RETURN: Table 2-9 summarizes worker dose estimates for the RETURN scenario for lifts in the Class A Cell and the Mixed Waste Cell. The RETURN of target lift which results in the highest cumulative worker doses are projected for AWL01100407FF. Overall, a total cumulative worker dose for the RETURN scenario is projected at 2,190 person mrem and an average dose of 54 mrem per person.

2.3.3.5 REPLACEMENT: Table 2-10 summarizes worker dose estimates for the REPLACEMENT scenario for lifts in the Class A Cell and the Mixed Waste Cell. The lift replacement from which the highest cumulative worker doses are projected for the REPLACEMENT scenario is AWI07100921MM-02. Overall, a total cumulative worker dose for the REPLACEMENT scenario is projected at 662 person mrem and an average dose of 16 mrem per person.

2.3.3.6 COMPACTION: Table 2-11 summarizes worker dose estimates for the COMPACTION scenario for lifts in the Class A Cell and the Mixed Waste Cell. The lift from which the highest cumulative worker doses are projected for the COMPACTION scenario is AWI07100921MM-02. Overall, a total cumulative worker dose for the COMPACTION scenario is projected at 1,430 person mrem and an average dose of 35 mrem per person.

2.4 General Population Doses

The Tooele County Commission zoned the Clive site as a "Hazardous Industrial District," which falls within the West Desert Hazardous Industry Area, an area that prohibits future residential housing in the vicinity of the Clive site (NRC, 1993). The U.S. Nuclear Regulatory Commission further states that the area surrounding the Clive facility is used for cattle grazing purposes and recreation (NRC, 1993). While the Clive facility is zoned for hazardous waste disposal by Tooele County, the lack of potable water at this site makes the surrounding area an unlikely location for any residential, commercial, or industrial developments (Baird et al., 1990).

Table 2-8

TRANSFER Worker Dose Calculations

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
QC Manager	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Director of Health Physics	7.75E-05	1.80E-02	0.00E+00	**1.80E-02**	1.80E-02
Assistant Radiation Safety Officer	1.55E-04	3.59E-02	0.00E+00	**3.61E-02**	3.61E-02
Operations Supervisor	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Heavy Equipment Operators	1.86E+00	1.20E-01	0.00E+00	**1.98E+00**	4.95E-01
Riggers	6.20E-03	1.44E+02	0.00E+00	**1.44E+02**	3.59E+01
Radiation Technicians	6.20E-03	1.44E+02	0.00E+00	**1.44E+02**	1.80E+01
Truck Drivers	1.86E-02	4.31E+02	0.00E+00	**4.31E+02**	3.59E+01
Operators	1.86E+00	1.20E-01	0.00E+00	**1.98E+00**	4.95E-01
QC Technicians	1.86E+00	1.20E-01	0.00E+00	**1.98E+00**	4.95E-01
TOTAL	**5.61E+00**	**7.19E+02**	**0.00E+00**	**7.25E+02**	**1.77E+01**

Table 2-9

RETURN Worker Dose Calculations

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
QC Manager	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Director of Health Physics	0.00E+00	4.49E-03	0.00E+00	**4.49E-03**	4.49E-03
Assistant Radiation Safety Officer	0.00E+00	4.49E-03	0.00E+00	**4.49E-03**	4.49E-03
Operations Supervisor	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Heavy Equipment Operators	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Riggers	0.00E+00	1.80E+01	0.00E+00	**1.80E+01**	4.49E+00
Radiation Technicians	0.00E+00	1.80E+01	0.00E+00	**1.80E+01**	2.25E+00
Truck Drivers	0.00E+00	2.16E+03	0.00E+00	**2.16E+03**	1.80E+02
Operators	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
QC Technicians	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
TOTAL	**0.00E+00**	**2.19E+03**	**0.00E+00**	**2.19E+03**	**5.35E+01**

Table 2-10

REPLACEMENT Worker Dose Calculations

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	7.75E-05	2.74E-01	0.00E+00	**2.74E-01**	2.74E-01
QC Manager	7.75E-05	2.74E-01	0.00E+00	**2.74E-01**	2.74E-01
Director of Health Physics	7.75E-05	2.74E-01	0.00E+00	**2.74E-01**	2.74E-01
Assistant Radiation Safety Officer	7.75E-05	2.74E-01	0.00E+00	**2.74E-01**	2.74E-01
Operations Supervisor	7.75E-04	2.74E+00	0.00E+00	**2.74E+00**	2.74E+00
Heavy Equipment Operators	1.86E+00	2.18E+02	0.00E+00	**2.20E+02**	5.49E+01
Riggers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Radiation Technicians	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Truck Drivers	0.00E+00	0.00E+00	0.00E+00	**0.00E+00**	0.00E+00
Operators	1.86E+00	2.18E+02	0.00E+00	**2.20E+02**	5.49E+01
QC Technicians	1.86E+00	2.18E+02	0.00E+00	**2.20E+02**	5.49E+01
TOTAL	**5.58E+00**	**6.57E+02**	**0.00E+00**	**6.62E+02**	**1.62E+01**

Table 2-11

COMPACTION Worker Dose Calculations

WORKER	CUMULATIVE INHALATION DOSE (person mrem)	CUMULATIVE EXTERNAL DOSE (person mrem)	CUMULATIVE INGESTION DOSE (person mrem)	TOTAL CUMULATIVE DOSE (person mrem)	AVERAGE DOSE (mrem)
Director of Engineering	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
QC Manager	0.00E+00	2.74E-01	0.00E+00	2.74E-01	2.74E-01
Director of Health Physics	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Assistant Radiation Safety Officer	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Operations Supervisor	0.00E+00	5.48E-01	0.00E+00	5.48E-01	5.48E-01
Heavy Equipment Operators	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Riggers	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radiation Technicians	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Truck Drivers	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Operators	0.00E+00	7.12E+02	0.00E+00	7.12E+02	1.78E+02
QC Technicians	0.00E+00	7.12E+02	0.00E+00	7.12E+02	1.78E+02
TOTAL	**0.00E+00**	**1.43E+03**	**0.00E+00**	**1.43E+03**	**3.48E+01**

Extraction activities will be conducted compliant with Energy*Solutions*' existing procedures that limit water infiltration into uncovered cells, limit dust resuspension from embankment activities, and limit offsite contaminant transport due to erosion, runoff, and animal/plant intrusion. Additionally, since the lifts in which the Greater-Than-Class-A wastes have been placed more than 30 feet above the cell's liner, no negative impact is expected to the liner integrity. Because of this, no additional infiltration will be allowed to migrate downward to the aquifer or as increased runoff/erosion. Therefore, the current land uses restrict modeling of any increased exposure to the general population from the excavation and recovery of Greater-Than-Class-A wastes to the pathway of atmospheric dust transport.

2.4.1 Methodology

Transport of contaminants in the atmosphere can occur through resuspension and movement of wind borne contaminated soil particles. Wastes that are excavated and stockpiled serve as sources for atmospheric transport. As these contaminants accumulate on the ground surface they undergo resuspension into the atmosphere, leading to airborne transport. Airborne contaminants will be carried into ambient air by the wind and either inhaled directly by receptor populations or deposited onto soils in the vicinity.

The Clive facility is sited in an exposed area, with little around it to protect from the winds. Wind dispersion is a likely mechanism of airborne transport. Contaminants deposited over or adsorbed onto soil may migrate from this area source as airborne particulates. Depending on the particle-size distribution and associated settling rates, these particulates may be deposited downwind or remain suspended, resulting in contamination of surface soils and/or exposure of regional receptors through inhalation, immersion, or external irradiation pathways.

Doses resulting from the atmospheric transport of surface materials have been modeled previously, as part of Energy*Solutions*' Radioactive Material License Renewal Application (Streamline, 2005). In these previous efforts, the offsite point of maximum atmospheric concentration was identified using site-specific climatological and meteorological data. The airborne dust concentration at the offsite point of maximum concentration (Clive facility boundary) is based on a simple Gaussian plume atmospheric dispersion and transport model. The atmospheric dispersion is quantified in terms of the standard X/Q' dispersion factor. The dust suspension at the source is based on a resuspension rate, as opposed to the resuspension factor used for the on-site worker dust doses. The resuspension rate characterizes a mass transfer rate at which dust is resuspended from the ground surface into the air. Inhalation doses to a rancher located at this maximum offsite exposure location, from dust assumed to be generated by mechanical and natural dust resuspension during the excavated stockpile and uncovered excavation pit, as is shown below.

$$Dose_{offsite\ inhalation} = C_{air} \quad U_i \quad f \quad DCF_{inh} \tag{2-5}$$

where,

$Dose_{offsite\ inhalation}$	=	dust inhalation dose (mrem/year)
C_{air}	=	airborne nuclide concentration at receptor location (Ci/m^3)
	=	$Q\ (X/Q')$ (2-6)
Q	=	resuspended dust source (Ci/s)
	=	$C_{waste}\ d\ \alpha\ A$ (2-7)
d	=	active soil depth for dust suspension (m) (DOE, 1997)
α	=	resuspension rate (s^{-1}) (DOE, 1994)
A	=	exposed area of excavated waste (m^2)
X/Q'	=	atmospheric dispersion factor (Ci/m^3 at facility boundary per Ci/s at source)
U_i	=	inhalation rate (m^3/year)
f	=	fraction of year rancher is exposed to dust
DCF_{inh}	=	inhalation dose conversion factor (mrem/Ci) (EPA, 1988)

Ranchers located at the Clive facility boundary will also be exposed to external radiation from wind-deposited excavation dust. A temporary cover is placed on excavated waste at the end of each day to reduce potential airborne dust releases. Dust from excavated waste that becomes airborne and is transported to the point of maximum concentration offsite can deposit on the vegetation and the ground surface. At the rancher location (Clive facility boundary) dust deposition onto the ground surface is calculated using a simple deposition model.

$$C_{ground\ surface} = C_{air} \quad v_d \quad T \tag{2-8}$$

where,

$C_{ground\ surface}$	=	ground surface concentration of deposited dust (Ci/m^2)
v_d	=	dust deposition velocity (m/s)
T	=	accumulation time for dust deposition (seconds)

The dust deposition is accumulated over a period of one year. Seasonal snow and rains will likely wash away deposited dust each year or cause it to become diluted with uncontaminated surface materials. Similarly, contaminated dust is likely to be co-deposited with uncontaminated dust from other sources. This analysis does not account for dilution of radionuclides with uncontaminated dust. The external radiation dose from deposited dust is calculated from the following equation:

$$\text{Dose}_{\text{offiste external}} = C_{\text{ground surface}} \; f \;\; DCF_{ext} \qquad (2\text{-}9)$$

where,

$\text{Dose}_{\text{offsite external}}$	=	dose from external radiation (mrem/year)
$C_{\text{ground surface}}$	=	ground surface concentration of deposited dust (Ci/m^2)
f	=	fraction of year rancher is exposed
DCF_{ext}	=	external dose conversion factor (mrem/yr per Ci/m^2) (EPA, 1993)

2.4.2 Exposure Scenarios

The land surrounding the Clive facility is currently utilized for cattle and sheep grazing (BLM, 2010). Livestock apparently utilize the area more during winter periods when snow is present and when puddles exist during wet periods (NRC, 1993). The Bureau of Land Management (BLM) currently issues leases for 6 months of the year (November 1 to April 30; BLM, 2010, personal communication: Salt Lake Field Office). The Ranchers activities include herding, maintenance of fencing and other infrastructure, and assistance in calving and weaning. In addition to local ranchers, other industrial facilities are located near the Energy*Solutions* Clive facility.

As a highest credible exposure scenario, the atmospheric dispersion during excavation of the target lifts is modeled for a receptor located at the Clive facility boundary. Exposure to individuals at those off-site locations are expected to be minimal due to either the large distance from the site (Interstate-80 rest areas and Knolls OHV area) or because the exposure time for any individual will be very brief (travelers on road, rail, and highway). Unlike industrial workers and ranching receptors that may be adjacent to the Clive site, these off-site receptors will likely only be exposed to highly-dispersed contamination, for which inhalation exposures dominate.

The industrial worker will be exposed at the maximally-exposed Clive facilty boundary location (A-21) for 1/50 year (175 hours per year from ES, 2010b). Since this scenario does not close proximity to the waste embankment, only exposure to dust inhalation and external exposure to dust deposited at the receptor location are considered. Other scenario parameters include:

- Inhalation Rate (8,400 m^3/year)
- Resuspension factor (1.7E-7 m^{-1})
- Active soil depth for mechanical resuspension (1 mm)
- Resuspension rate (2.07e-7 s^{-1}, Streamline, 2005)
- Chi/Q (2.08E-6 Ci/m^3 per Ci/s, Streamline, 2005)
- Fraction of year exposed (0.02)
- Fraction of year wind blows towards A-21 (0.13, Streamline, 2005)
- Dust deposition velocity (0.00274 m/s)

2.4.3 Results

Figure 2-10 summarizes the projected doses to the industrial worker (as included in Appendix C), who is assumed to be exposed 2% of the year at location A-21 adjacent to the Clive Facility fence line. External exposure from deposited dust blown off-site during excavation and replacement dominates the dose at 1.2 mrem/year. Conversely, the dose from inhalation of windblown dust is 1.3E-4 mrem/year.

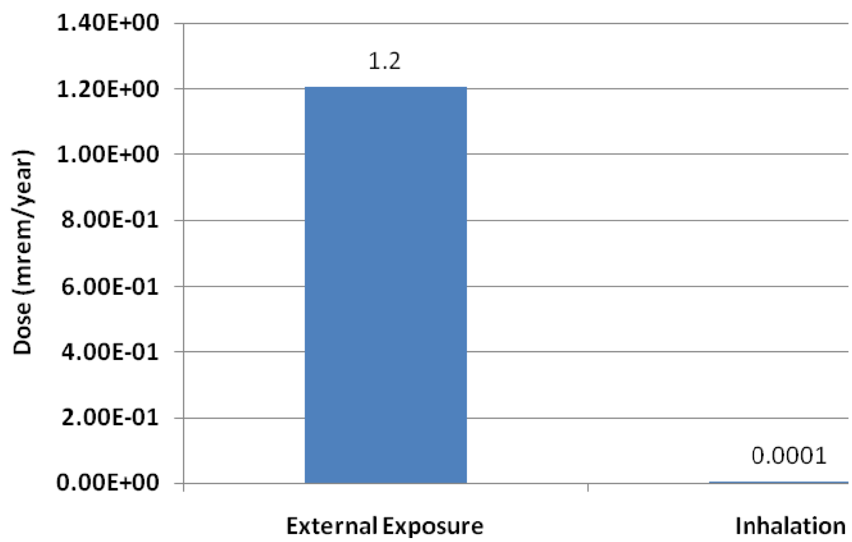

Figure 2-10. Maximally-Credible Exposures to the General Public

3. NO ACTION ALTERNATIVE

Since corrective actions have been taken to avoid further erroneous disposal of Greater-Than-Class-A waste, the No Action Alternative considers continuing Energy*Solutions*' current disposal operations. Greater-Than-Class-A waste will be allowed to remain disposed in the embankment. Resulting doses from the fate and transport of the higher activity wastes are projected for the general public. Exposures shown on worker dose monitors (TLDs) for the time periods of disposal are examined. No further changes to Energy*Solutions*' Health and Safety or Environmental Monitoring programs are considered.

3.1 Management Plan

At the time of discovery, corrective action was taken to prevent recurrence of disposal of Greater-Than-Class-A waste. The corrective action prevents recurrence through ongoing application of the updated waste classification algorithm, implemented on 13 August 2010. An additional component of the corrective action is the added administrative control requiring Director of Health Physics review and approval before accepting wastes within 75% of the Class A limit. Finally, a quarterly consistency check is required to verify that ongoing modifications to the Electronic Waste Information System do not inadvertently affect function of the Waste Classification System.

Energy*Solutions*' Environmental Monitoring Program already samples groundwater, surface water, and surface soils to ascertain unexpected contaminant transport away from the facility. No further modifications are expected to this Program.

3.2 Source-term

Sum of fraction waste concentrations from the inadvertent received and disposed 23 containers (from 15 shipments) that exceed the Class A limits are identified in Table 3-1.

3.3 Worker Doses

Since the No Action Alternative considers no further contact by Energy*Solutions*' staff with the errant waste, no additional worker doses are projected. Worker exposures for the time periods of disposal of the errant wastes have been examined and demonstrate no statistically-significant increase in comparison to exposures during the facilities normal operations.

Table 3-1

No Action Source Term

BATES #	ARRIVAL DATE	DISPOSAL DATE	SUM OF FRACTIONS FROM TABLE 1*	SUM OF FRACTIONS FROM TABLE 2*	SHIPMENT
L37876	6/6/2001	7/17/2001		1.17	ZG038-01-0008
L85036	6/6/2005	6/15/2005		1.15	8009-10-5262
L85073	6/6/2005	6/14/2005		1.04	8009-10-5263
L112300	2/26/2010	3/1/2010	1.00		8009-01-1020
L112311	2/26/2010	3/2/2010	2.09	0.07	8009-01-1021
L112311	2/26/2010	3/2/2010	1.91	0.07	8009-01-1021
L112311	2/26/2010	3/2/2010	1.56	0.05	8009-01-1021
L112311	2/26/2010	3/2/2010	1.24	0.06	8009-01-1021
L112320	3/1/2010	3/3/2010	1.52	0.07	8009-01-1023
L112320	3/1/2010	3/3/2010	1.63	0.04	8009-01-1023
L112320	3/1/2010	3/3/2010	1.42	0.08	8009-01-1023
L112381	3/8/2010	3/10/2010	2.41		8009-01-1035
L112403	3/15/2001	3/16/2010	1.67	0.06	8009-01-1043
L112405	3/15/2010	3/29/2010	1.81	0.05	8009-01-1053
L112405	3/15/2010	3/29/2010	1.75	0.08	8009-01-1053
L112409	3/15/2010	3/16/2010	2.01	0.06	8009-01-1050
L112409	3/15/2010	3/16/2010	1.58	0.07	8009-01-1050
L112409	3/15/2010	3/16/2010	1.45	0.08	8009-01-1050
L112437	3/18/2008	3/19/2010	1.32	0.19	8009-01-1055
M10392	3/10/2008	6/11/2008		1.00	9062-03-0001
PM00151	12/16/2003	8/24/2004		1.04	0421-33-0001
PM00804	8/20/2008	9/23/2008	1.10		9328-06-0002
PM00976	9/16/2009	4/2/2010	1.16		9079-08-0001
PM00976	9/16/2009	4/2/2010			9079-08-0001
PM00976	9/16/2009	4/2/2010			9079-08-0001

* Utah Division of Radiation Control Rule 313-15-1009

3.4 General Population Doses

Since the No Action Alternative considers leaving the errant waste in-place, impacts to the General Population from the transport of contaminant away from the Clive facility are estimated. As part of normal operations, Energy*Solutions*' staff will continue to implement existing design features and administrative procedures intended to limit water infiltration cells and subsequent offsite contaminant transport.

3.4.1 Methodology

Prior waste cell infiltration and transport modeling, conducted in support of Energy*Solutions*' 2008 Radioactive Material License Renewal Application, calculated limiting disposal concentrations necessary to comply with Clive's groundwater discharge permit. This Permit requires that environmental impacts to groundwater be kept within tolerable risk levels. In order to assess these risks, the infiltration of water and transport of constituents from the nearest edge of the Class A and Mixed Waste disposal cells to a compliance-point are projected for a period of 500 years after closure (Whetstone, 2000a,b).

These models, developed to support the Class A and Mixed Waste permit and license, represent waste as if it is only disposed of at the cell's nearest respective edge to a compliance well (located 250 feet from the northern edge of the Class A embankment's top slope and 240 feet from the northern edge of the Mixed Waste embankment's top slope). The distance from the bottom of waste to the aquifer in the Class A cell is measured at 14.54 ft (4.43 m). Water leaving the Mixed Waste cell must travel 24.3 ft (7.4 m) downward, before reaching the aquifer.

The velocity of water moving vertically downward through the liner (below waste) to the aquifer has been previously modeled as 0.092 ft/yr (0.028 m/yr) for the Class A cell and 0.082 ft/yr (0.025 m/yr) for the Mixed Waste cell (Whetstone, 2000a,b). The horizontal velocity of water moving within the aquifer from below the Class A and Mixed Waste cells northward towards the compliance-point wells has been previously modeled as 1.0 ft/yr (0.834 m/yr) (Whetstone, 2000a,b).

Using the velocities and relative distances between the nearest waste edges for the waste cells and the compliance points, the water travel times are calculated as,

$$\text{Travel Time}_{\text{Total}} = \text{Travel Time}_{\text{Vertical}} + \text{Travel Time}_{\text{Horizontal}} \qquad (3\text{-}1)$$

where,

Travel $Time_{Total}$ = Cumulative time required for water leaving waste to arrive at the compliance well (yr).

Tavel $Time_{Vertical}$ = Time required for water leaving wastes to travel downward through the liner and vadose zone to the aquifer (yr).

$$= v_{vadose}/d_{vadose} \quad (3\text{-}2)$$

v_{vadose} = Vertical water velocity through effective material region between the waste and the aquifer (m/yr).

d_{vadose} = Distance from beneath the waste and the aquifer (m).

Tavel $Time_{Horizontal}$ = Time required for water arriving at the aquifer beneath waste to travel horizontally through the aquifer to the compliance well (yr).

$$= v_{aquifer}/d_{aquifer} \quad (3\text{-}3)$$

$v_{aquifer}$ = Horizontal aquifer water velocity from northern edge of waste to the compliance well (m/yr).

$d_{aquifer}$ = Distance from northern most edge of waste beneath the cell top slope to the compliance well (m).

Accordingly, the cumulative travel times required for water to leave waste and arrive at compliance wells, as included in the models developed in support of the license and permit are calculated as 250 years for the Class A cell and 384 years for Mixed Waste cell.

Since the Greater-Than-Class-A wastes have been disposed at locations further from the compliance well than the embankment's edge and at depths far above the cell liner, the same methodology is used to calculate revised travel times required for water to leave the Greater-Than-Class-A wastes and arrive at the compliance wells.

$$\text{Travel Time}_{\text{Revised Total}} = \Delta T_{\text{Vertical}} + \Delta T_{\text{Horizontal}} + \text{Travel Time}_{\text{Total}} \quad (3\text{-}4)$$

where,

Travel $Time_{Revised\ Total}$ = Revised cumulative time required for water leaving Greater-Than-Class A waste to arrive at the compliance well (yr).

$\Delta T_{Vertical}$	=	Increase in time required for water leaving wastes to travel downward through the Greater-Than-Class-A waste to the liner (yr).	
	=	$v_{vadose}/d_{vertical}$	(3-5)
$d_{vertical}$	=	Distance from beneath the Greater-Than-Class A waste and the liner surface (m).	
$\Delta T_{Horizontal}$	=	Increase in time required for water entering the aquifer beneath the Greater-Than-Class-A waste to travel to the compliance well (yr).	
	=	$v_{aquifer}/d_{horizontal}$	(3-6)
$d_{horizontal}$	=	Distance from northern most edge of the Greater-Than-Class A waste to the northern edge of the Top Slope's waste toe (m).	

Revised compliant well-water concentrations must then be projected for any water travel paths whose associated travel times are less than 500 years. It is noted that this methodology is used to calculate water travel times, as a boundary for calculating contaminant travel. In general, contaminant travel is slower than the advective water, due to particle absorption (as designated by nuclide-specific k_d values). Additionally, these same models also demonstrated that contaminant transport will not result in exposures that exceed the dose limits to the general public via any other pathway, due to the limited erosion, infiltration, and naturally poor classification of the area's groundwater.

3.4.2 Exposure Scenario

Since disposal of the errant wastes has not affected the geo-hydrology of the Clive facility system, the volume and velocity of infiltration and subsequent migration of water into the Class A and Mixed Waste disposal cells as previously estimated in prior Radioactive Material License Application efforts will not require revision (Whetstone, 2000a and 2000b). However, the amount of time required for water to infiltrate through the Greater-Than-Class-A wastes downward to the aquifer and then horizontally to the compliance well must be calculated. Revised well-water concentrations are then projected for any travel paths whose associated travel times are less than 500 years.

3.4.3 Results

Table 3-2 summarizes the location of the Greater-Than-Class-A containers beneath the top slope from the Class A and Mixed Waste cell boundaries and associated travel times. As is illustrated, at the soonest time, water infiltrating through container BLFU000314 in lift AWL07051127MM-00 will arrive at the compliance-point 664 years after infiltrated water modeled at the edge of the Class A cell's top slope. By comparison, water infiltrating through container RHZ-103-A16907 will arrive at the compliance-point 1,031 years after infiltrated water modeled at the edge of the Mixed Waste cell's top slope. Therefore, no Greater-Than-Class-A contaminants will be measurable within the compliance-point well water before the required 500-year time limit promulgated as part of the groundwater discharge permit.

In all cases, it is important to note that travel times for radionuclides leached from the containers will be much slower than the infiltrated water, due to retardation via sorption onto soil particles in the soil region beneath the waste and the aquifer. Therefore, compliance-point well concentrations before year 500 (already modeled in support for the Class A and Mixed Wastes Radioactive Material License and Groundwater Discharge Permit) are unaffected by the errant disposal of the Greater-Than-Class-A containers.

Table 3-2

Increases in Container-Specific Infiltrated-Water Travel Times

CONTAINER #	LOCATION NAME	INCREASED DISTANCE FROM CELL EDGE (ft)	INCREASED DISTANCE FROM CELL LINER (ft)	INCREASE IN VERTICAL TRAVEL TIME (yr)	INCREASE IN HORIZONTAL TRAVEL TIME (yr)	ADJUSTED TRAVEL TIME FROM WASTE TO WELL (yr)
IT-117	AWC20010615M	1,025	31	335	375	959
BFLU000138	AWF11050609MM-00	950	27	294	347	891
BFLU000314	AWL07051127MM-00	200	32	349	73	672
X10C0506703	AWJ01100305MM-06	700	39	420	256	926
X10C0102456	AWM01100920MM-02	225	41	445	82	777
X10C0012438	AWM01100920MM-02	225	41	445	82	777
X10C0103790	AWM01100920MM-02	225	41	445	82	777
X10X0301419	AWM01100920MM-02	225	41	445	82	777
X10C0012435	AWI07100921MM-02	550	38	414	201	864
X10C0103824	AWI07100921MM-02	550	38	414	201	864
X10C0301420	AWI07100921MM-02	550	38	414	201	864
X10C0506580	AWL01100407FF	300	43	465	110	824
X10C0012439	AWI12100409MM-06	650	44	481	238	968
X10C0012433	AWJ01100511DU-07	700	39	429	256	934
X10C0000107	AWN23100223MM-16	100	38	410	37	697
X10C0400310	AWI01100429MM-25	100	45	487	37	773
X10C0400310	AWN23100430MM-19	120	40	437	44	730
X10C9901032	AWI01100429MM-25	700	45	487	256	992
X10C0102820	AWL23100505MM-14	275	40	434	101	784
1906-OJ-099	MW8A080812MV-01	240	38	465	88	937
18919	MWGA040818SE	600	22	262	219	865
C08197511	MW8A080923MV	285	42	514	104	1,002
RHZ-103-A16907	MW9A091014MV	90	45	549	33	965
RHZ-103-A16907	MW8B100419E-27	270	45	549	99	1,031
RHZ-103-A16907	MW9A100419FF	60	45	549	22	954

4. CONCLUSIONS AND RECOMMENDATIONS

In compliance with directives received in the Notice of Violation, this Report evaluates the methods, schedules, costs, and effects of doses to the general public and facility workers that would result from 1) the removal of Greater-Than-Class-A waste erroneously received and disposed of at Energy*Solutions*' Clive low level radioactive waste disposal facility, and 2) taking no further action (e.g., leaving the waste in-place).

The analysis project significant impacts for the Extraction Alternative to radiation workers, with projected cumulative exposures of 8 person rem and an average exposure of 194 mrem per person. Exposures to the general public from deposited dust blown off-site during excavation and replacement are projected at 1.2 mrem/year. Additionally, once located and excavated, returned wastes will be lower than the Class A limits and acceptable for disposal at Energy*Solutions*' Clive facility.

Since corrective actions have been taken to avoid further erroneous disposal of Greater-Than-Class-A waste, the No Action Alternative considers no further disposal of Greater-Than-Class-A wastes. Clive facility records for worker exposures for the time periods of disposal of the Greater-Than-Class-A Containers do not show distinguishable impact from compliant disposal operations. Similarly, resulting doses from the higher activity wastes left in-place to the general public are negligible. Finally, no impact is projected for the Clive facility's ability to meet its performance objectives.

ALARA considerations suggest that attempts to excavate and recover the Greater-Than-Class-A materials be avoided. While standard controls to reduce worker doses would be applied to any recovery effort, incurring that dose should convey a corresponding benefit in terms of reducing public and environmental impacts. The overall situation does not compromise the facility's performance basis and therefore there is no benefit to accompany occupational doses received in excavating this material.

Comparison of the impacts to worker doses and general public exposures from these two Alternatives suggests that attempts to recover the errant waste be avoided. The additional worker doses and general population exposures from waste recovery far exceed the negligible projected doses from increases to the future groundwater concentrations (which are estimated as zero, since the groundwater is not potable or usable). Extraction conveys no corresponding benefit in terms of reducing general public and environmental impacts. Finally, selecting the No Action alternative does not compromise the Clive facility's ability to meet its performance objectives.

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APPENDIX A

LIFT EXCAVATION SOURCE-TERM

APPENDIX B

MICROSHIELD® OUTPUT

APPENDIX C

GENERAL PUBLIC AND NON MICROSHIELD® DOSE CALCULATIONS