Department of Resources, Energy and Tourism (DRET)

PROPOSED COMMONWEALTH
RADIOACTIVE WASTE MANAGEMENT
FACILITY, NORTHERN TERRITORY

Transport Assessment Report

PARSONS BRINCKERHOFF

Proposed Commonwealth Radioactive Waste Management Facility, Northern Territory

TRANSPORT ASSESSMENT REPORT

13 March 2009

Department of Resources, Energy and Tourism (DRET)

PREVIOUS ENGINEERING EXCELLENCE AWARD WINNER 2006, 2005, 2004, 2003, 2002, 2001

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Introduction

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

Three Commonwealth owned and Defence-managed sites were selected for the studies which formed part of a larger assessment process involving the collection, collating and provision of site suitability assessments. The studies will provide a basis from which the Commonwealth Government can consider the future project requirements. The three initial sites are listed below:

- Mount Everard – Approximately 25 km north-west of Alice Springs
- Harts Range – Approximately 100 km north-east of Alice Springs
- Fishers Ridge – Approximately 40 km south-east of Katherine.

During the investigations of these three sites, an additional fourth 'volunteer' site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa clan) and added to the scope of the investigations.

The assessment focused on consideration of the following site and logistics attributes:

- access to the respective sites from the adjoining NT regional road network by trucks carrying radioactive waste
- quantification of the logistics task of collection, conditioning, consolidation and transport of the accumulated radioactive waste to each repository site
- development of alternative logistics strategies for the transport of the waste by road and rail transport to the respective sites, having regard to security, safety and timeliness/reliability criteria
- estimation of logistics travel times, times to clear accumulated waste, and costs for the logistics tasks
- consideration of transport infrastructure upgrade requirements to enable the transport task to be safely and securely undertaken.

Findings

Site access

Access by road to each site can be made conveniently via the Stuart Highway, and thence via secondary rural arterial roads to each respective repository site. Construction of access roadways into each site

would be needed to provide reliable 'all weather' access. Of the four sites assessed, a repository at Fishers Ridge is likely to require more extensive access road improvements compared to the other four sites.

Background traffic volumes on the NT road network are relatively low. Additional heavy truck movements carrying waste containers would have low impact on other road users.

Logistics task

The task to transport the accumulated waste to a repository site in the NT is summarised in Table TE.1.

Table TE.1 Summary logistics task to be undertaken

Location of waste[2]	Conditioned waste[1]		Comments
	Volume (m^3)	Mass (t)	
Sydney	2,383	4,460	Mostly at Lucas Heights, plus small quantities collected from sites around Sydney and from Qld.
Bandiana (Vic)	14	24.1	Comprises Defence and Army waste
Melbourne	10	16.3	Consolidated from sites in and around Melbourne
Adelaide	180	324.4	Consolidated from sources in Adelaide, Salisbury and Mt. Gambier
Woomera	2,069	2,919	Low contaminated soil, not to be conditioned
Adelaide[3]	26	67.6	Reprocessed waste returned to Australia for storage

Source: DRET

(1) Assumed to be conditioned in standard 205 litre steel drums (or equivalent)
(2) Assumed locations at which waste is consolidated, conditioned and packaged for shipment to the repository sites
(3) Assumed to be shipped into Adelaide from Europe, and thence transported to the repository sites. Darwin could be an alternative port for receiving the waste shipment.

It is envisaged that this waste would be conditioned, and transported to the selected repository site encased within 200 litre drums, packed into 20 foot shipping containers. The estimated numbers of containers to be transported are shown in Table TE.2.

Table TE.2 Estimates of containers to be transported to the repository

Location of waste	No drums[1]	No of containers
Sydney[2]	15,000	230
Bandiana	50	1
Melbourne[3]	50	1
Adelaide[4]	1,080	17
Woomera	9,730	245[5]

(1) Equivalent 205l drums, assuming 300 kg mass of conditioned waste per drum.
(2) Includes waste from Lucas Heights plus other minor quantities from elsewhere in NSW and Queensland
(3) Includes waste from regional Victoria
(4) Includes regional SA waste, but excludes waste from Woomera.
(5) Assumes single level stacking only, to reduce logistics costs and to provide for faster container loading.

Logistics strategies

Alternative road and rail strategies for the processing and transport of the waste from the respective current storage locations were developed with the assistance of major freight logistics companies operating in Australia – TOLL Logistics, and Linfox. Both these companies routinely manage the movements of high flows of containerised freight across Australia, by road and rail transport.

The logistics strategies considered the following main elements:

- consolidation and conditioning of existing waste at key locations around Australia, into 200 litre drums
- packing of the drums into 20 foot shipping containers
- transport of these containers by road direct to each repository, or by rail with road freight components at each end of the rail task.

Alternative road routes were defined to utilise highest standard roads, while minimising impacts on intermediate towns and cities. Table T5.1 in the report describes the proposed routes.

Logistics travel times and costs

Elapsed times to clear the backlog of accumulated waste will be influenced by the nature of the logistics strategy, and by the level of cost for these strategies. Discussions with Linfox and TOLL suggest that the most cost effective strategies for transporting the waste by road would require elapsed times of 45–50 weeks. This would enable efficient use of trucks and trained drivers. Rail options could potentially deliver reduced elapsed clearance times, though the overall times would be influenced by the rate at which containers can be processed at the preferred repository.

Elapsed door-to-door times for transport will vary according to the location of the repository. For road options, travel times from Sydney are estimated to range between 3 days (Mount Everard and Harts Range) up to 4 days at Fishers Ridge. Rail options would require marginally longer travel times.

Estimated costs for road and rail transport options for each repository site are summarised in Tables T7.1 and T7.2 in the report. These are preliminary estimates, based on logistics arrangements and unit costs provided by Linfox and TOLL respectively. The costs are shown to vary between operators, reflecting differing assumptions. These costs will need to be refined and updated as part of the ongoing EIS assessment process. In summary, the costs are estimated to range as follows:

- TOLL road option: $6.6m (Mount Everard) to $7.6m (Fishers Ridge).
- Linfox road option: $4.6m (Mount Everard) to $6.2m (Fishers Ridge).
- Linfox road-rail option: $4.9m (Mount Everard) to $5.9m (Fishers Ridge).

Rail options become relatively less expensive as the haul distances increase.

Infrastructure upgrade requirements

Table T8.1 provides details of proposed access road upgrading requirements – lengths of each road, proposed construction standard – by repository site. Costs will vary location in response to differing length of road upgrades, availability of construction materials and availability of construction workforce. The details provide a basis for moving forward to more detailed investigations of a preferred site during the EIS stage of the process.

T1. Introduction

Parsons Brinckerhoff Australia Pty Ltd (PB) has been commissioned by the Department of Resources, Energy and Tourism (DRET) to undertake preliminary multi-disciplinary site assessments at four locations in the Northern Territory with regard to their suitability for use as a low to medium level radioactive waste management facility. The facility is to be known as the Commonwealth Radioactive Waste Management Facility (CRWF).

Three Commonwealth owned and Defence-managed sites were selected for the studies which formed part of a larger assessment process involving the collection, collating and provision of site suitability assessments. The studies will provide a basis from which the Commonwealth Government can consider the future project requirements. The three initial sites are listed below:

- Mount Everard – Approximately 25 km north-west of Alice Springs
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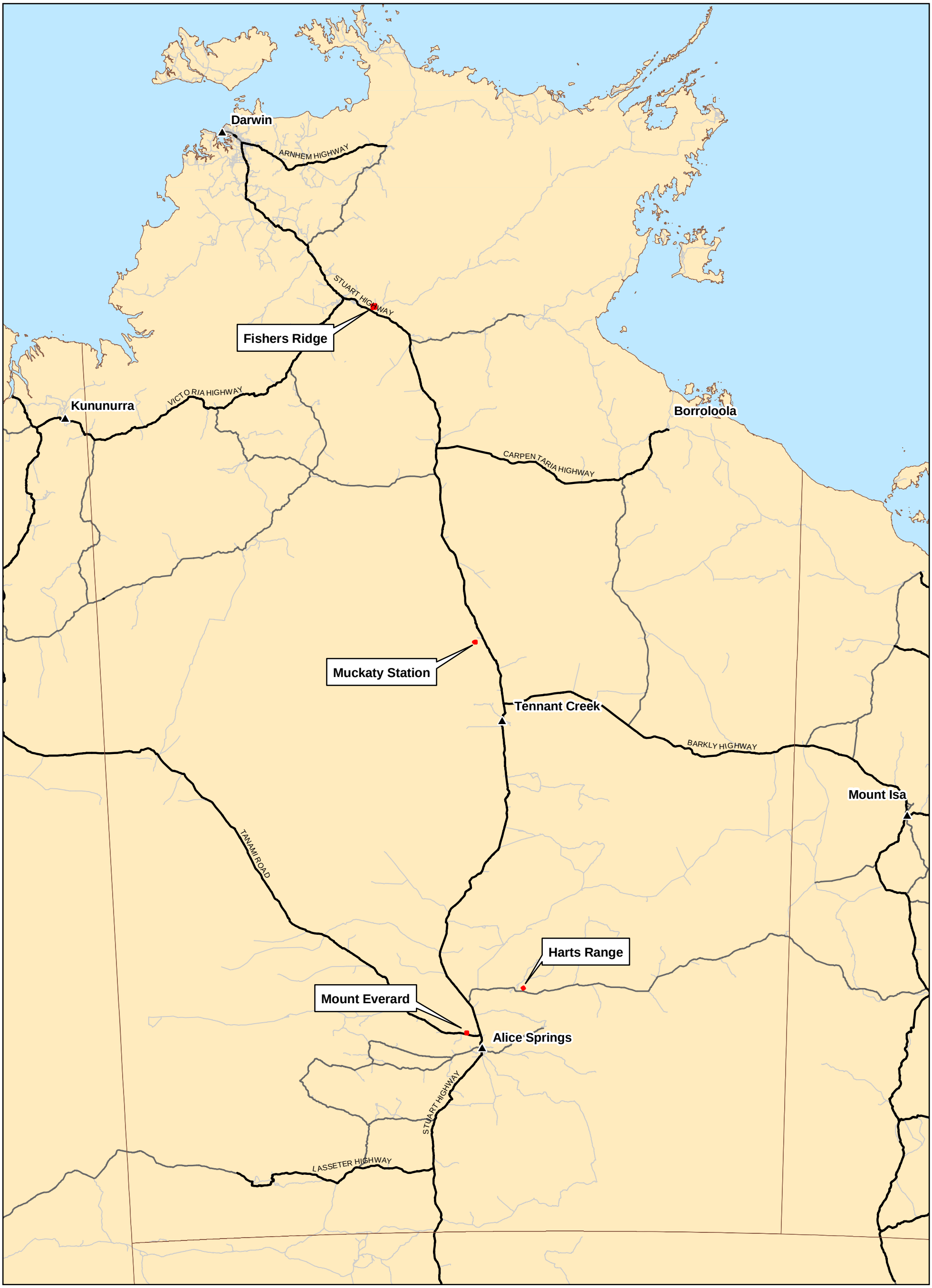
- Fishers Ridge – Approximately 40 km south-east of Katherine.

During the investigations of these three sites, an additional fourth 'volunteer' site – Muckaty Station (located approximately 110 km north of Tennant Creek) was nominated by the Traditional Owners (the Ngapa clan) and added to the scope of the investigations.

The four proposed sites are shown in Figure T1.1.

This component of the study addresses the logistics and practicalities of transporting radioactive waste to the four nominated sites. Realistically, there are only two transport modes that are practical: road and rail. The report examines the existing road networks linking the four sites to the current locations of radioactive waste storage sites, in terms of the characteristics of the roads, access to each site and on-site options for the use, up-grading or establishment of new roads. It also canvasses the practicality of inter-modal transport, where both road and rail networks could be used over part or all of the routes.

This report is not definitive and no preference is expressed for a particular site or sites.



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Commonwealth Radioactive Waste Management Facility Site Characterisation

Proposed repository sites

Figure T1.1

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T2. Context

Commonwealth owned and managed radioactive waste is currently located in many temporary stores. It comprises both low-level and intermediate level wastes, each requiring management solutions that reflect their degree of risk to the environment, including people.

This report (and other reports in this study) does not canvass the collection, conditioning, packaging and containerisation of the various wastes. It is assumed that such considerations will be the subject of more detailed studies in subsequent stages of this project.

For the purposes of this study, the following sections outline the types of radioactive wastes and the implications for road and rail transport.

T2.1 Bulk radioactive wastes

Bulk waste comprises most of the 'legacy' inventory in Australia. This includes: soils contaminated with radioactive elements; plastic, paper and glass used in the preparation of radiopharmaceuticals; and residues left over from research into mineral processing. This waste is currently stored in steel drums in a number of locations, principally: Lucas Heights (the Australian Nuclear Science and Technology Organisation's (ANSTO) facility, south of Sydney); and Woomera (where contaminated soils were taken for temporary storage). Lessor amounts (by bulk) are located at a number of Commonwealth Scientific and Industrial Research Organisation's (CSIRO) premises, and Department of Defence sites. Small quantities of additional wastes, principally encapsulated sources used in instruments or laboratories, are located in numerous facilities in many areas. All these wastes can be consolidated and placed in steel drums for transport and storage. Some will require 'conditioning' prior to transport, but it is envisaged that conditioning will be undertaken at a limited number of sites prior to transport to the waste facility.

It is considered that the bulk wastes will be conditioned, enclosed in steel drums, palletised and loaded into shipping containers (ISO containers) for transport by road or rail to the waste facility (store and repository). This is the basis for the transport and logistics study described in this report.

T2.2 Conditioned nuclear fuel wastes

Australia operates a small nuclear research reactor (HIFAR recently replaced by OPAL) at its Lucas Heights facility. Fuel rods from HIFAR and Opal are sent to the United Kingdom and France for reprocessing. The reprocessing process results in radioactive wastes that are incorporated into concrete (United Kingdom) or glass (France) matrices to immobilise the products of nuclear fission that takes place in the reactor. The waste produced in the UK and France is placed inside shipping canisters that are designed in accordance with International Standards for nuclear waste. These canisters provide both radiation shielding and crash-resistance, and are designed to allow their transport as ISO container-shaped containers.

For the purposes of this report, conditioned nuclear fuel wastes are taken to be delivered to Australia by ship, at a port suitably equipped with cranes able to handle the weight of the shipping containers. Wastes will then be transported by road and/or rail to the chosen facility, and as such are treated in the same way as bulk wastes.

T2.3 Demolition wastes

HIFAR has recently ceased operations and has been replaced by the OPAL reactor. The HIFAR reactor generated neutrons which are exploited in various applications involving both the bombardment of targets (to produce secondary and tertiary radio-nuclides) and direct use of the neutron beams (for example in neutron radiography). The operation of HIFAR required that both the reactor itself and its beam lines are shielded to reduce the exposure of its operators from harmful ‘doses’ of ionising radiation. This inevitably involved the interaction of the neutrons with the fabric and shielding of the reactor and its associated beam line facilities. Bombardment of some materials by neutrons can induce radioactivity in the materials. The radio-nuclides produced by this bombardment have varying half-lives, but several have half-lives that require the activated materials to be treated as waste in the short and medium term.

Planning for the de-commissioning of HIFAR is currently underway by ANSTO, and it is not known how much radioactive waste, or the form and character of the waste will result from HIFAR’s demolition. Nevertheless, it is expected that some waste will require management in the radioactive waste facility planned by the Commonwealth.

It is possible that some demolition waste can be conditioned and packed into steel drums, palletised and transported in ISO containers. Waste that is not amenable to this treatment may have to be loaded into ISO containers without being placed in drums and palletised, nevertheless, it is assumed here that the waste will still be transported in ISO containers.

T3. Site location assessment

T3.1 Introduction

This chapter reports on the outcomes of a preliminary assessment of transport access issues associated with each of the three sites investigated from 1 May to 5 May 2006, and the fourth site investigated in October 2007. These were:

- Mount Everard
- Harts Range
- Fishers Ridge
- Muckaty Station.

The location of the four sites is shown in Figure T1.1.

The assessment has focused on road access to the respective sites. Alternative modal logistics strategies are reported on later in this report, but whatever these might be, access for waste to each proposed repository will be by truck – either directly from the waste assembly point (Lucas Heights, Woomera, other), from a rail intermodal facility, or from a port.

Following sections summarise the main findings for the four sites.

T3.2 Mount Everard site

T3.2.1 Location

The Mount Everard site is located on Commonwealth land abutting the Tanami Road, approximately 19 km west of the Stuart Highway. More generally the site is 17.5 km directly north-west of the Alice Springs Municipal boundary or approximately 30 km from the Alice Springs Municipal boundary via the Stuart Highway and the Tanami Road. It has bitumen road access to the main Department of Defence compound.

The main roads linking Alice Springs to the site are:

a) Stuart Highway

This is part of the national highway network, managed by the Northern Territory (NT) Government with Commonwealth funding. It links Alice Springs with Darwin to the north, and Adelaide to the South. It has been constructed to national highway standards, with dual 3.7 m lanes and sealed shoulders over the section north of Alice Springs (Photograph T3.1).

Much of the Stuart Highway to the Tanami Road turnoff has been constructed on rolling to hilly terrain through the MacDonnell Ranges to the north of Alice Springs.

Current daily traffic volumes along this section of the Stuart Highway are in the order of 1,100 vehicles.

The intersection of the Stuart Highway and Tanami Road has been designed to accommodate the turning movements of road trains (Photograph T3.2).

PHOTOGRAPH T3.1
Stuart Highway north of Alice Springs

PHOTOGRAPH T3.2
Intersection of Stuart Highway and Tanami Road

b) Tanami Road

The Tanami Road is classed as a rural arterial road by the NT Department of Planning and Infrastructure (DPI). It provides access from Alice Springs to station properties and aboriginal communities to the north west of Alice Springs, to the Tanami goldfields, and thence through the Tanami Desert to the Kimberley region of Western Australia. It is not considered to be a key tourist route in the NT.

The construction standard of the Tanami Road varies. Between the Stuart Highway and the site, the standard varies from dual lane sealed road with 3 m lanes, to a narrow single lane 3 m seal. Most of the length of road is of the latter standard, with minimal passing lane opportunities. The route distance between the Stuart Highway and the Mount Everard facility is 19 km. Photographs T3.3 and T3.4 illustrate typical road conditions.

The Tanami Road has been constructed on mostly flat terrain. There are limited waterway crossings of the road. These have been constructed using conventional floodways, given low frequency of storms and stream flows.

Current daily traffic volumes on the section of the Tanami Road to the site are in the order of 115 vehicles.

The narrow sections of seal between the Stuart Highway and the site are not expected to lead to an increased safety risk for the transport of radioactive waste material, mainly because of the low levels of traffic volumes prevailing along the Tanami Road. Other sections of the rural arterial road network have operated safely within the NT for many years as single lane seals, including the Tablelands Highway and the Barkly Highway (prior to upgrading). The major safety risk is considered to be the potential for collisions with stock crossing the Tanami Road.

PHOTOGRAPH T3.3
Tanami Road west of Stuart Highway – typical standard

PHOTOGRAPH T3.4
Tanami Road – short widened section

T3.2.2 Site access

There are three potential existing accesses to the site off the Tanami Road (Figure T3.1). These comprise:

- The main access road into the secure compound. This is a sealed road, with a width of approximately 3.5 m (Photograph T3.5). The intersection with the Tanami Road would need to be reconstructed to accommodate the turning movements of articulated trucks carrying the waste. The road pavement has likely been designed for low volumes of heavy truck movements, but should be adequate for the relatively low numbers of waste shipments.

PHOTOGRAPH T3.5
Sealed access road to secure compound

- Access road to the old compound on the site (Photograph T3.6). This is a wide, unsealed and unformed road; the running surface is the natural sandy clay material on the site. It could be readily upgraded with a formed surface to access a facility, either using natural materials or else sheeting with gravel to produce a more durable running surface. The intersection at the Tanami Road would also need to be constructed, with a culvert crossing of the verge drain. The road crosses an underground

PHOTOGRAPH T3.6
Access track from Tanami Road into old compound

Telstra cable approximately 20 m from the edge of the Tanami Road and the buried HV cable to the site.

- Firebreak along the eastern boundary of the site (Photograph T3.7). This functions as a wide unformed road with a sandy clay running surface. Due to previous grading, the roadway effectively functions as a surface drain during periods of rain. It could be cost effectively upgraded to serve as an access to a facility at this site, with a formed surface (possibly sheeted with gravel for the running surface), and with a reconstructed intersection at the Tanami Road to accommodate turning articulated trucks.

PHOTOGRAPH T3.7
Track along facility boundary firebreak

Alternatively, a new access road to a facility could be constructed off the Tanami Road, but this is probably not warranted. Sight lines for a new access road off Tanami Road appear adequate.

T3.3 Harts Range site

T3.3.1 Location

The proposed Harts Range site is located some 90 km east of the Stuart Highway on Commonwealth land, set back 2.6 km from the Plenty Highway. The intersection of the Plenty Highway with the Stuart Highway is approximately 80 km north of Alice Springs.

The roads linking Alice Springs to the site are:

a) Stuart Highway

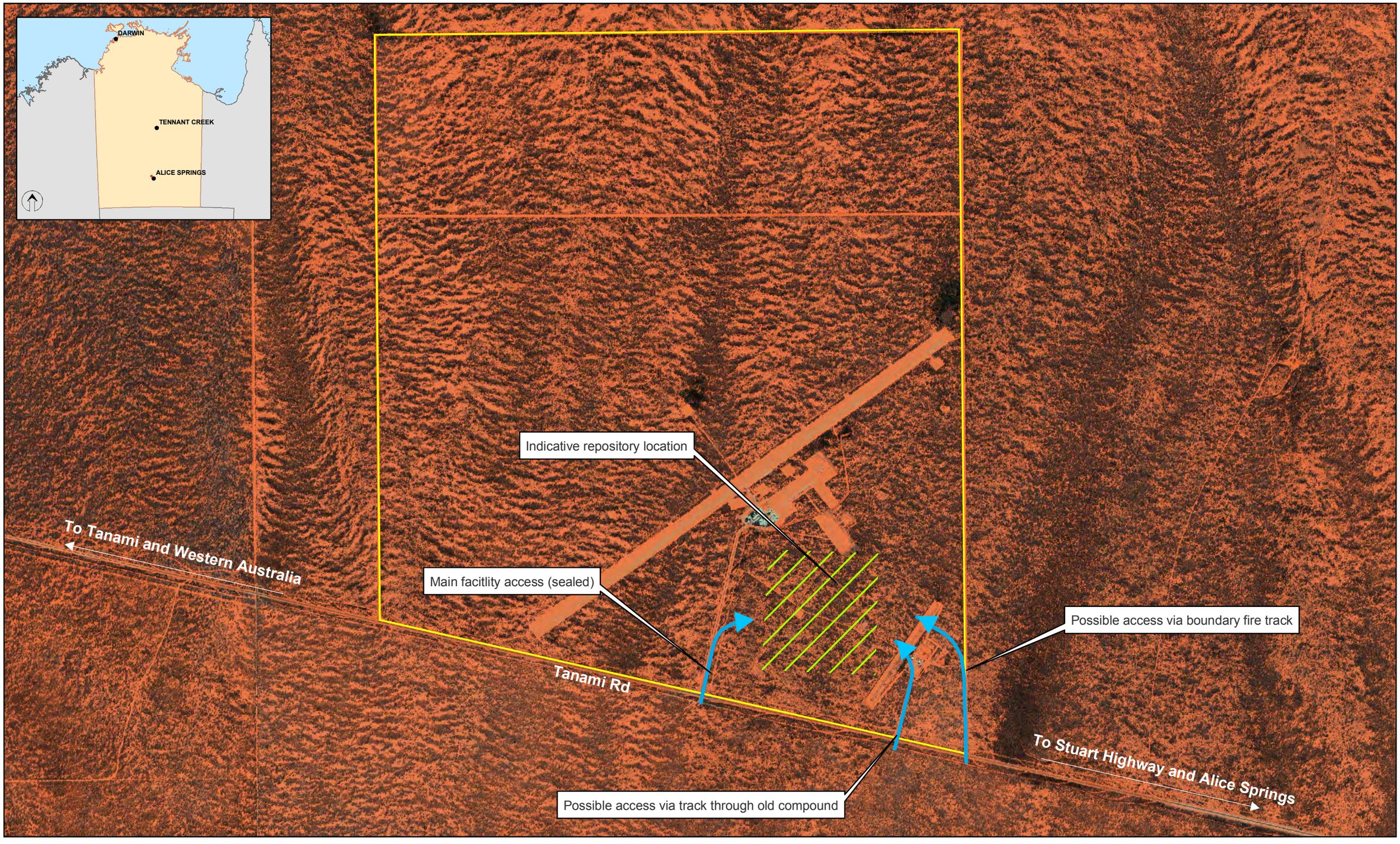
This is part of the national highway network, managed by the NT Government with Commonwealth funding. It links Alice Springs with Darwin to the north, and Adelaide to the South. It has been constructed to national highway standards, with dual 3.7 m lanes and sealed shoulders over the section north of Alice Springs (Photograph T3.8).

Much of the Stuart Highway to the Tanami Road turnoff (21 km north of Alice Springs) has been constructed on rolling to hilly terrain through the MacDonnell Ranges north of Alice Springs. From the Tanami Road to the Plenty Highway turnoff the terrain is generally flat.

Current daily traffic volumes along the Stuart Highway are in the order of:

- Alice Springs to Tanami Road: 1,100 vehicles
- Tanami Road to Plenty Highway: 960 vehicles.

The intersection of the Stuart Highway with the Plenty Highway has been designed to accommodate the safe turning movements of road trains (Photograph T3.9).



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Commonwealth Radioactive Waste Management Facility Site Characterisation

Possible access roads to Mt Everard repository site

Figure T3.1

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PHOTOGRAPH T3.8
Stuart Highway north of Alice Springs

PHOTOGRAPH T3.9
Intersection of Stuart Highway and Plenty Highway

b) Plenty Highway

The Plenty Highway is classed as a rural arterial road by the NT Department of Planning and Infrastructure (DPI). It provides access from Alice Springs to station properties and aboriginal communities to the north east of Alice Springs out to the Queensland border. The Plenty Highway also functions as a tourist route for travel between the Centre and the Mt Isa region of Queensland. Approximately 27 km east of the Stuart Highway turnoff the Sandover Highway runs north from the Plenty Highway and travels north-east to the Queensland border.

The construction standard of the Plenty Highway is generally consistent between the Stuart Highway and the turnoff into the Harts Range site. It has been constructed with a narrow single lane seal width varying between 3 m and 3.5 m, with formed gravel shoulders. The route distance between the Stuart Highway and the Harts Range site turnoff is 90 km. Photograph T3.10 illustrates typical road conditions.

The Plenty Highway has been constructed on mostly flat terrain. There are, however, numerous waterway crossings of the road. These have been constructed using conventional floodways, given low frequency of storms and stream flows (Photograph T3.11).

PHOTOGRAPH T3.10
Plenty Highway – typical standard of road

PHOTOGRAPH T3.11
Plenty Highway – typical floodway

Current daily traffic volumes on the section of the Plenty Highway to the site are in the order of 105 vehicles to the Sandover Highway, reducing to 75 vehicles per day over the section to Harts Range. These are mostly cars and light vehicles, with occasional road trains.

The narrow sealed road section between the Stuart Highway and the site is not expected to lead to an increased safety risk for the transport of radioactive waste material, mainly because of the low traffic volumes on the Plenty Highway. Sections of the rural arterial road network have operated safely within the NT for many years as single lane sealed roads, examples include the Tablelands Highway and the Barkley Highway (prior to its upgrading). To the east of the site the Plenty Highway is configured as a gravel road.

T3.3.2 Site access

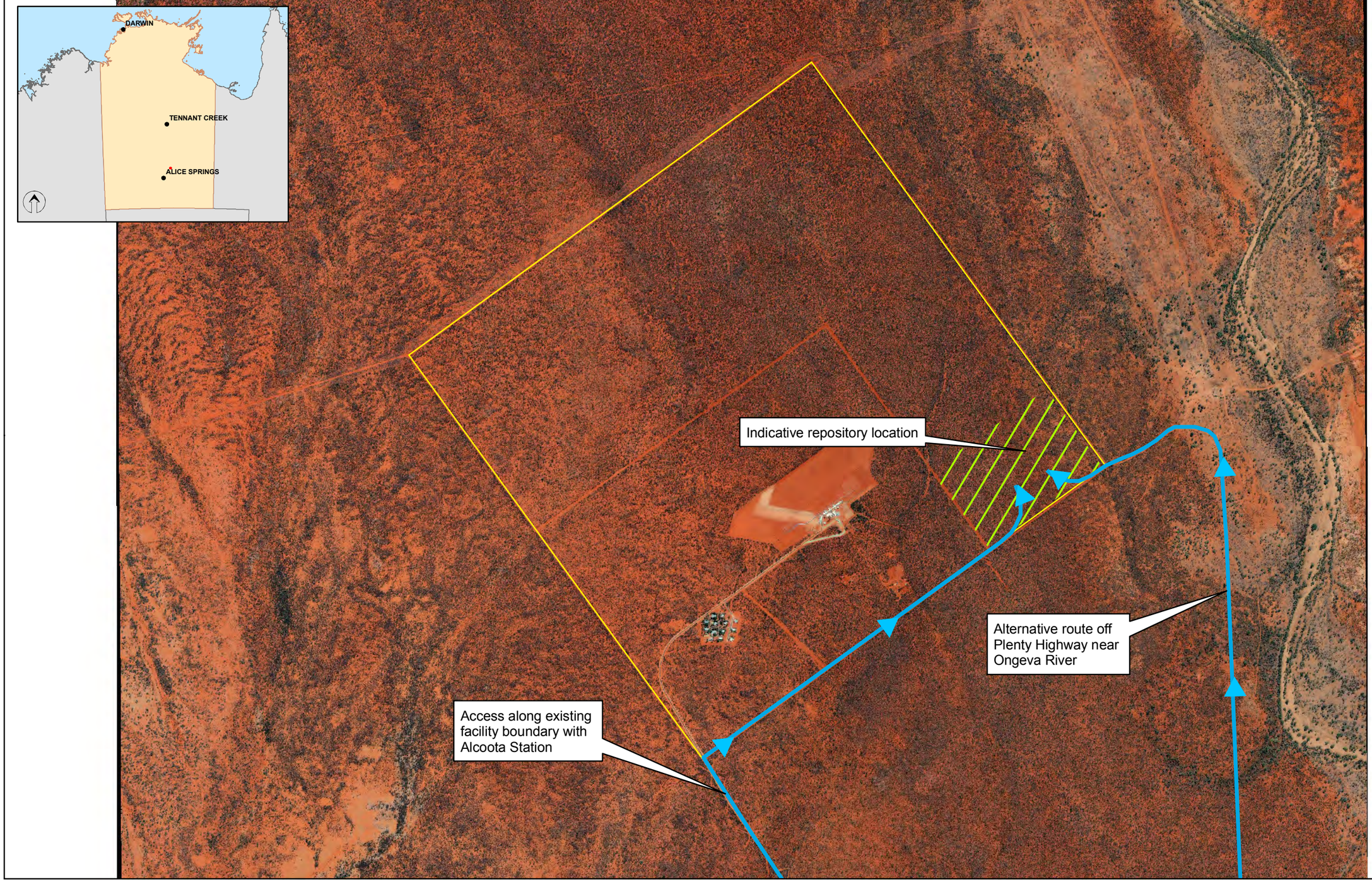
Preliminary investigations for a facility at this site suggest two feasible access strategies. These are illustrated in Figure T3.2 and are described as follows:

- Use the existing 3.5 m wide sealed facility access road as far as the entry point to the facility—a distance of 2.6 km from Plenty Highway. This entry point is located at the southern junction of the south western and south eastern boundary lines. The route would then follow the south eastern property line to directly link with the facility. This access point would be through the facility boundary line via an existing internal track located 2.4 km from the road. The route along the property line would be located within the Alcoota Station property which is currently used by cattle road trains and would require further improvement of the boundary track. Photograph T3.12 illustrates details of the facility access road, while Photographs T3.13 and T3.14 show views of the boundary line roadway.

PHOTOGRAPH T3.12
Sealed access road to Harts Range facility

PHOTOGRAPH T3.13
Gateway to Harts Range Defence facility

PHOTOGRAPH T3.14
View along south-eastern boundary line firebreak/access track



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Commonwealth Radioactive Waste Management Facility Site Characterisation

Possible access roads to Harts Range repository site

Figure T3.2

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- An alternative strategy would be for trucks to continue along the Plenty Highway to a point adjacent to the Ongeva River crossing—a distance of 3 km from the Defence Facility access road. At this location, there is a narrow unformed track that leads to a stockyard holding area about 1 km from the eastern corner of the Defence facility; the length of this track is 6.6 km. Cattle road-trains from Alcoota Station are understood to use this track from time to time, loading cattle at the holding area, then exiting to the Plenty Highway via the Defence facility boundary fence track. Photographs T3.15 to T3.17 show the standard of the route via the Alcoota holding area.

PHOTOGRAPH T3.15
Possible alternative access track – view 1

PHOTOGRAPH T3.16
Possible alternative access track – view 2

PHOTOGRAPH T3.17
Possible alternative access track – view 3

Comments on these alternative strategies are as follows:

Strategy 1: Use of existing Defence Facility access road

- The existing road is sealed with a width of 3.5 m. The road pavement has been designed for low volumes of heavy truck movements, including B-doubles carrying fuel and other equipment to the Defence Facility. It would be adequate for the relatively low numbers of waste shipments.

- Trucks carrying waste would not impact on the community or the function of the Defence Facility if they turned off the access road along the south eastern boundary line. The turnoff point would need some minor new road pavement works to ensure turning truck movements did not break up the existing edge of road seal.

- The track along the boundary line is approximately 2.4 km long, and would need to be upgraded for trucks carrying waste. It is currently about 4 m wide, on an unformed natural surface of sandy clay. The track can be difficult to traverse for up to a month following rains. Options for improvement include widening to a formed 7 m roadway, thus enabling heavy trucks to pass safely, and the possible construction of a gravel pavement. The latter would reduce the potential for road

closure due to rain, but this potential could be minimised by appropriate timing of waste shipments. A widened turning area would be required for entry to the site, with wide new gates. Within the facility site some further gravel pavement may be needed to link to the entry point.

Strategy 2: Use of Alcoota access track

- This track will need upgrading to permit the safe movement of articulated trucks carrying waste. Most of the work could be undertaken by bulldozer and grader, to provide a formed roadway. Sheeting with a gravel pavement may not be needed, as the terrain is generally sandy. The track does not cross any major water courses.
- The track is located across two station properties—Alcoota and Mt. Riddock. Agreement with the traditional owners of these properties would be needed to improve the existing tracks used by cattle road trains. A new cattle grid may be required to replace the existing gate between the two station properties.
- This access track joins the eastern corner of the Defence Facility. From there a section of the boundary roadway, approximately 1 km in length, would need to be upgraded as described above in Option 1.
- Overall this option would involve the upgrade of about 7.5 km of track.
- The net additional travel distance for this option is in the order of 5 km per truck movement, or 10 km per round trip.

T3.4 Fishers Ridge site

T3.4.1 Location

The proposed Fishers Ridge site is located on Commonwealth land off the Stuart Highway, some 40 km south-east of Katherine. The property boundary is approximately 2.6 km north of the Stuart Highway, and can be accessed via a local road which provides access to the region for the local pastoralist and aboriginal communities.

The site is approximately 5.7 km by 5.7 km. It is currently not being used for Defence or any other Commonwealth purposes. It is covered by native bushland.

T3.4.2 Access via Stuart Highway

The Stuart Highway forms part of the national highway network, managed by the NT Government with Commonwealth funding. It links Katherine with Darwin to the north, and Alice Springs and Adelaide to the South. It has been constructed to national highway standards, with dual 3.7 m lanes and sealed shoulders over this section (Photograph T3.18). The Stuart Highway passes the RAAF Tindal base some 10 km south of Katherine.

This section of the Stuart Highway has been constructed on flat to rolling terrain, with passing lanes to enable safe overtaking of slow vehicles.

Current traffic volumes along the Stuart Highway between Katherine and the site turnoff are in the order of 600 vehicles/ day.

PHOTOGRAPH T3.18
Stuart Highway south of Katherine

T3.4.3 Site access

Preliminary investigations for a facility at this site suggest a single feasible access strategy. This is illustrated in Figure T3.3, and is described in the following paragraphs.

The existing local access road off the Stuart Highway through the site would provide an appropriate level of accessibility to a waste management facility, irrespective of where the proposed facility is located on the site. A secondary access road would need to be constructed from this existing local access road into the facility.

Characteristics of the existing local access road are:

- The site has good dry weather road access, especially given that flooding had occurred only two weeks prior to the inspection. The road also provides access to an Aboriginal community further up Fishers Ridge Road.

- The initial section of the access road from the Stuart Highway to the pastoral property boundary (approx. 100 m) is unformed, with a running surface of natural sandy clay; it is 4 m wide (Photograph T3.19).

PHOTOGRAPH T3.19
Access road from Stuart Highway

- From the pastoral property gate to the site property line is approximately 5 km. This section of road has been formed with a high crown; the running surface comprises the natural sandy clay laterite soil. There are large verge drains, with side drains running off into the adjoining bush. The running surface typically varies from 5–6 m in width, though grading could provide a continuous surface width of 6 m.

- The access road through the site has generally similar characteristics to that as noted above from the pastoral property gate to the site boundary. There are several locations, however, where surface water flows across the road have caused some erosion of the road surface. Photographs T3.20 and T3.21 provide typical views of the access road.

PHOTOGRAPH T3.20
Access road through site – view 1

PHOTOGRAPH G3.21
Access road through site – view 2 showing erosion damage

T3.4.4 Access road upgrading requirements

The existing access road through the site has been formed, with a gravel pavement. Some minor reshaping work would be desirable to remove vegetation in some locations, and to repair several locations where surface water crossing the road has created some localised scouring. The short section of track from the Stuart Highway to the existing gate is unformed, and is simply a flat section of sandy track. Minor improvements with a formed gravel running surface would improve this section to a consistent standard for access, especially after rain.

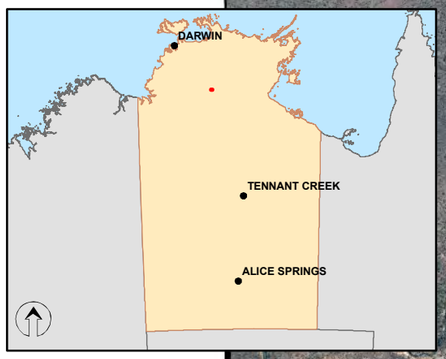
T3.5 Muckaty site

T3.5.1 Location

The nominated repository site on Muckaty Station is located approximately 110 km north of Tennant Creek. It directly abuts a sealed mine haul road linking the Bootu Creek manganese mine (located approximately 20 km east of the Stuart Highway) to a rail siding on the Alice Springs to Darwin rail line, 40 km to the west of the Stuart Highway. The repository site is approximately 10 km west of the Stuart Highway. A short access road would need to be constructed between the repository site and the haul road. Figure T3.4 illustrates the site location with respect to the Stuart Highway, the mine haul road, and the rail siding.

Access to the site could potentially be provided by road (off the Stuart Highway) or via rail, from the siding constructed by the Bootu Creek mine operator. We understand that the Commonwealth has not reached agreement for use of the mine haul road west of the nominated site, precluding the use of the rail siding. However, information on the rail option is included for completeness.

An overview of access arrangements by road and rail follow.



Indicative repository location 1

Possible route to a repository site from access road

Indicative repository location 2

Possible route to a repository site from access road

Existing formed road through site

Department of Resources, Energy and Tourism

1:27,000 at A3

0 500 1,000 metres

Data Source: Geoscience Australia, DoD, PB

Coord. Sys.: GDA94 MGA53

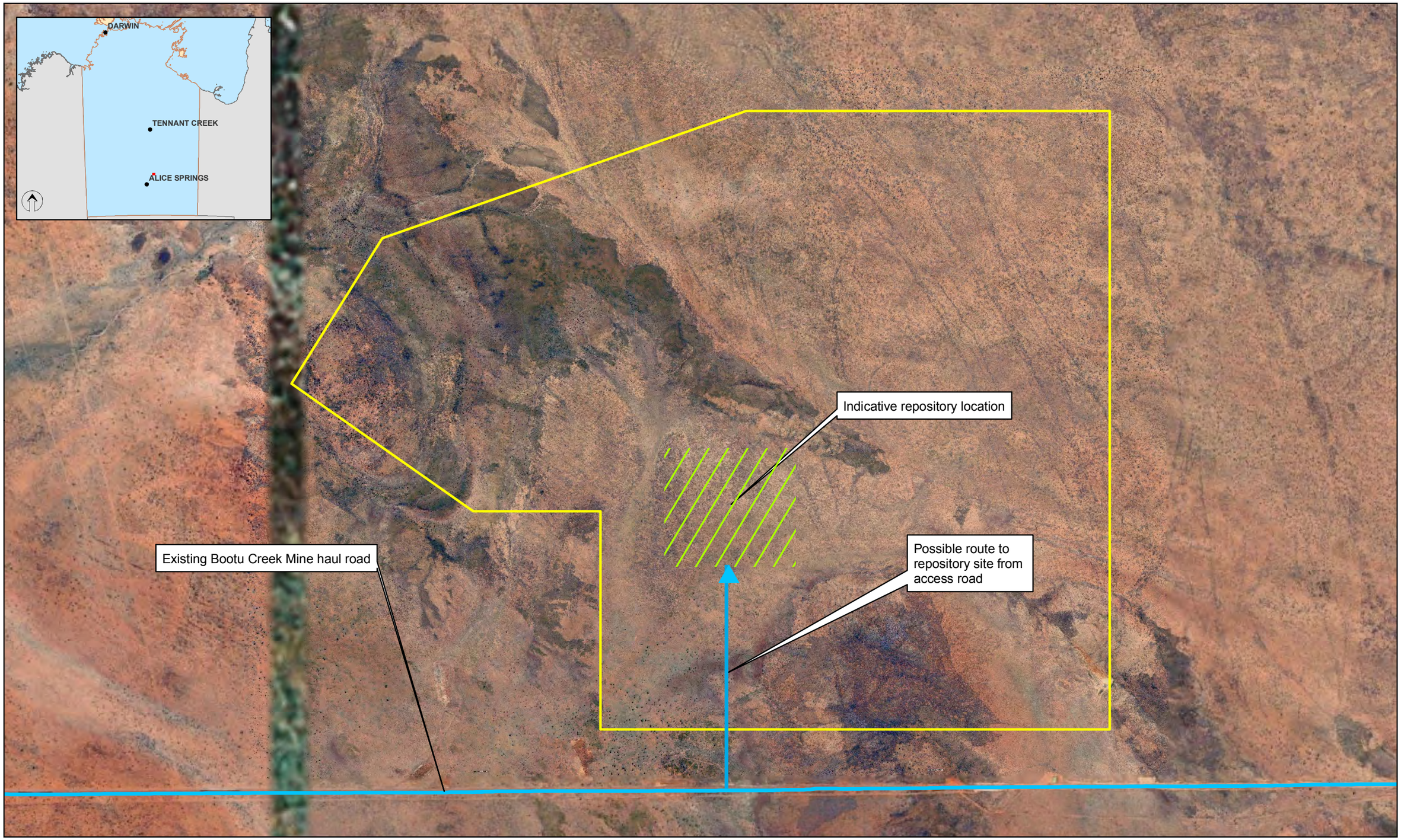
Drawing No.:		**2102701A_GIS_F086**	
Revision:	**B**	**Date:**	**15/07/2008**
Drawn By:	**BHB**	**Checked by:**	**GB**
Client Ref:		**RADWASTE**	

Commonwealth Radioactive Waste Management Facility Site Characterisation

Possible access roads to Fishers Ridge repository site

Figure T3.3

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\2102701A_GIS_F086_B.mxd



Department of Resources, Energy and Tourism

1:20,000 at A3

0 250 500
metres

Data Source: Geoscience Australia, DoD

Coord. Sys.: GDA94 MGA53

Drawing No.:		**2102701A_GIS_F048**	
Revision:	**B**	**Date:**	**15/07/2008**
Drawn By:	**RP**	**Checked by:**	**GB**
Client Ref:		**RADWASTE**	

Commonwealth Radioactive Waste Management Facility Site Characterisation

Possible access roads to Muckaty Station repository site

Figure T3.4

GIS File: J:\A303-ENVPLN\PROJ\2102701A_Radwaste_2\10_GIS\Projects\2102701A_GIS_F048_B.mxd

T3.5.2 Transport access

The main road network providing access to the repository site from southern Australia comprise:

a) Stuart Highway

The Stuart Highway would form the main likely access route for the transport of conditioned waste from southern Australia to the repository site by road. The highway forms part of the national highway network, managed by the NT Government with Commonwealth funding. It links Alice Springs via Tennant Creek to Darwin to the north, and Adelaide to the South. It has been constructed to national highway standards, with dual 3.7 m lanes and sealed shoulders. Photograph T3.22 shows typical details of the Stuart Highway at the Bootu mine turnoff.

The Stuart Highway has largely been constructed on flat terrain, north from Tennant Creek to the Bootu Creek mine haul road, and south towards Alice Springs.

Current average daily traffic volumes along the Stuart Highway are in the order of:

- Alice Springs to Tanami Road: 1,100 vehicles
- Tanami Road to Plenty Highway: 960 vehicles
- Plenty Highway to Tennant Creek: 325 vehicles
- Tennant Creek to Threeways: 2,960 vehicles (includes some intra-Tennant Creek traffic)
- Threeways to Bootu Creek mine haul road: 350 vehicles.

The intersection of the Stuart Highway with the Bootu Creek mine haul road access has been designed and constructed to accommodate the safe turning movements of road trains (Photograph T3.23).

PHOTOGRAPH T3.22
Stuart Highway near Bootu Creek Mine turnoff

PHOTOGRAPH T3.23
Intersection of Stuart Highway and Bootu Creek Mine access road

b) Bootu Creek Mine Haul Road

This road was constructed by the mine operators for the transport of ore from the mine to a rail siding on the Alice Springs to Darwin rail link. It is a private road, comprising two main sections:

- A dual lane sealed road extending 20 km east from the Stuart Highway to the mine; seal width is 6.5 m. This road is linked to the Stuart Highway via a looped connection.

- West of the loop to the Stuart Highway, the haul road reduces to a 4 m single lane sealed road with 2 x 1 m unsealed shoulders. It is located in an underpass of the Stuart Highway, then extending some 40 km west to the rail siding.

Traffic movements along the haul road comprise:

- Stuart Highway to Bootu Creek mine: General traffic to the mine (employees, operating supplies and equipment), plus the road trains transporting ore to the rail siding. Movements of the latter trucks are in the order of 24 (total two way) per day, with trucks operating 2 hour cycles, 24 hours per day. Volumes of employee and other mine-related traffic along the road are relatively low.

- Stuart Highway to rail siding: Movements are generally confined to the road trains carrying ore from the mine, totalling in the order of some 24 movements (two way) per day. The road trains have absolute priority of use of this road at all times, with any other traffic being required to pull off the road to enable the heavy trucks to pass.

Photographs T3.24 and T3.25 respectively illustrate the haul road in the Stuart Highway underpass, and in the vicinity of the repository site. Photograph T3.26 provides a view of the road trains used to haul ore to the rail siding; these are side tipping trucks.

PHOTOGRAPH T3.24
Bootu Creek Mine haul road at Stuart Highway underpass

PHOTOGRAPH T3.25
Bootu Creek Mine haul road near repository site

T3.5.3 Rail access

The transport of waste to the site by rail could be achieved as follows:

- via the standard gauge rail line from Adelaide via Alice Springs to the Bootu Creek mine siding; and
- via truck along the mine haul road to the repository site, a distance of 30 km.

PHOTOGRAPH T3.26
Bootu Creek Mine ore road trains using haul road

Trucks carrying waste from the rail siding to the proposed repository site would need to share the haul road with mine trucks, as noted above.

Photographs T3.27 to T3.29 show views along the rail siding. The first and second of these photographs showing views along the siding to the east, including the stockpiling of ore along the alignment of the siding, ready for loading by front end loader onto ore trains. The third photo shows a view along the siding to the turnouts from the mainline. Photograph T3.30 shows one of the turnouts from the mainline into the siding.

The length of the rail siding is approximately 650 m.

PHOTOGRAPH T3.27
View along Bootu Creek rail siding

PHOTOGRAPH T3.28
View along Bootu Creek rail siding

PHOTOGRAPH T3.29
View along Bootu Creek rail siding

PHOTOGRAPH T3.30
Rail turnout from mainline into Bootu Creek siding

T3.5.4 Site access

Access to the proposed repository from the mine haul road would be via a new direct road link. The location and length of this new link will depend on the final repository location within the designated site. The intersection of the link with the haul road would need to be located to meet safe sight distance requirements for trucks exiting from the repository.

T3.6 Summary findings

The field inspections have showed that:

- All sites have sealed road access:
  - Mount Everard directly from the Tanami Road
  - Harts Range off the sealed access road into the Defence facility
  - Fishers Ridge from a much longer formed natural surface track off the Stuart Highway
  - Muckaty Station site off the sealed Bootu Creek mine haul road.
- All sites are accessible by the various truck configurations that might be considered for transport of waste to the repository:
  - Single unit trucks that might carry a single container from a rail intermodal facility at Alice Springs or Katherine (road-rail logistics strategy)
  - Semi-trailers (potentially carrying waste from Woomera)
  - B-double trucks carrying two containers of waste per truck
  - A-trains (potentially carrying waste from Woomera).
- Minor upgrading works would be required at the Mount Everard and Harts Range sites, in the form of:
  - Gravel sheeting of the agreed access road into the repository site. This is desirable given a potentially long elapsed time for clearance of the waste backlog from Lucas Heights (Section T6.1). Trucks will arrive regularly during the campaign, and there is potential for wet weather. Gravel sheeting will reduce the risk for closure of the access roads for long periods.
  - Construction of the intersections of the access roads with the respective sealed roads to the respective sites. These will need to be constructed to accommodate the pavement stress of heavy turning vehicles.
  - Some minor upgrading/realignment of internal tracks within the facility sites may be needed to accommodate the swept paths of the articulated trucks, with adequate turnaround provision for the trucks after unloading of the containers. The need for this will be subject to more detailed consideration after a preferred site is identified, and the position of the repository determined.
- A repository at the Fishers Ridge site would be accessed via the existing formed, natural surface road off the Stuart Highway. This is generally in good condition, though is narrow in sections, and the formation is subject to erosion by cross flows of stormwater in wet seasons. Some upgrading of the road would be needed to provide an all weather track (through the wet season), with some widening.

  A new dedicated repository access track would need to be constructed off the main access road. A gravelled all weather pavement would be needed to accommodate the heavy truck movements.
- A repository at Muckaty Station could be accessed via a new road link directly off the Bootu Creek mine haul road onto the site. This link will need to be engineered to provide a low maintenance, all weather access. Either road or rail transport to this proposed site offers feasible logistics options for consideration.

Of the four sites, a repository at Fishers Ridge is likely to require more extensive access road improvements, mainly due to the need to provide all weather access over a wet season.

T4. Logistics task

The scope of the logistics task to be performed was derived from the waste inventory data as provided by the DRET. This data was summarised, and aggregated to provide a sound basis for development of the logistics strategy; it is reported in Table T4.1.

Table T4.1 Summary logistics task to be undertaken

Location of waste[2]	Conditioned waste[1]		Comments
	Volume (m^3)	Mass (t)	
Sydney	2,383	4,460	Mostly at Lucas Heights, plus small quantities collected from sites around Sydney and from Qld.
Bandiana (Vic)	14	24.1	Comprises Defence and Army waste
Melbourne	10	16.3	Consolidated from sites in and around Melbourne
Adelaide	180	324.4	Consolidated from sources in Adelaide, Salisbury and Mt. Gambier
Woomera	2,069	2,919	Low contaminated soil, not to be conditioned
Adelaide[3]	26	67.6	Reprocessed waste returned to Australia for storage

Source: DRET

(1) Assumed to be conditioned in standard 205 litre steel drums (or equivalent)

(2) Assumed locations at which waste is consolidated, conditioned and packaged for shipment to the repository sites

(3) Assumed to be shipped into Adelaide from Europe, and thence transported to the repository sites. Darwin could be an alternative port for receiving the waste shipment.

Comments on the data in the table:

- The volumes of waste from sites around Sydney (other than Lucas Heights) and from regional Queensland are very minor in absolute terms.
- The accumulated waste at Bandiana was assumed to include Army waste, as advised by DRET.
- Volumes of waste accumulated in and around Melbourne are all relatively small.

- The volume of waste in SA from Mt. Gambier is minor. The main sources of waste are from CSIRO (Adelaide) and Defence (Salisbury).

- The waste at Woomera is low grade contaminated soil previously transported and stored at Woomera in the early 1990s. This waste will be transported directly from Woomera to the selected repository site without the need for conditioning.

Estimates of the numbers of 20 foot containers needed to transport the above logistics task were prepared, based on the following assumptions:

- All waste other than from Woomera is to be conditioned. It would be packed onto standard pallets, four drums per pallet. A total of 16 pallets will be stored in each container (10 on base level and six above the base level); this total reflects axle load limits for trucks carrying the containers (either long haul to the selected repository or to/from a rail head).

- Waste from Woomera is not to be conditioned, and would be simply loaded onto semi-trailers for shipment to the NT, else packed into 20 foot containers on a single level for shipment by rail. It is assumed that 40 drums can be accommodated per container, with appropriate packing, for the latter case.

The resulting numbers of containers to be shipped are summarised in Table T4.2. These numbers are appropriate for planning purposes.

Table T4.2 Estimates of containers to be transported to the repository

Location of waste	No drums[1]	No of containers
Sydney[2]	15,000	230
Bandiana	50	1
Melbourne[3]	50	1
Adelaide[4]	1,080	17
Woomera	9,730	245[5]

(1) Equivalent 205l drums, assuming 300 kg mass of conditioned waste per drum.
(2) Includes waste from Lucas Heights plus other minor quantities from elsewhere in NSW and Queensland
(3) Includes waste from regional Victoria
(4) Includes regional SA waste, but excludes waste from Woomera.
(5) Assumes single level stacking only, to reduce logistics costs and to provide for faster container loading.

T5. Development of alternative logistics strategies

Input to the identification of key issues impacting on logistics strategies, and in developing alternative strategies, has been provided by two of Australia's largest and most respected freight logistics companies – TOLL Logistics and Linfox. Both companies routinely manage the movements of very high flows of containerised freight across Australia by road and rail. They have commercial reputations for developing cost-effective logistics solutions for movements of widely varying types of freight.

Linfox has current expertise in the movement of radioactive material – it has had a long term contract with BHP Billiton (and formerly WMC) for the transport of uranium oxide from Roxby Downs to Outer Harbor in Adelaide for export. These transport services have been performed in a low key manner (in terms of public perception) without incident, over a number of years.

T5.1 Key issues

Transport of radioactive waste material is a very emotive issue, and one which needs to reflect the sensitivity of the community, and the need to meet defined Australian and international standards. The key issues considered in developing a preferred strategy are described in the following sections.

For the purposes of this assessment, two broad logistics arrangements were considered feasible:

- A road only option, with waste being shipped directly between the points of conditioning/ consolidation and the repository sites, by truck.
- A road/rail arrangement, whereby rail is used for the longer line haul sectors of the routes to the NT, with trucks being used for the local transfers to/from rail.

A combination of coastal shipping combined with road/rail is not considered a feasible option, excepting for the reprocessed waste from the UK and France, which will be shipped into a designated Australian port by charter vessel, then carried by truck or train/truck to the final preferred repository site.

T5.1.1 Security

Maintaining tight security of the waste during transport to the repository is a critical requirement for Government. Security issues will be similar for the four proposed repository sites, but will vary between logistics options. These are overviewed as follows:

T5.1.1.1 Road transport options

Transport of the conditioned waste by road potentially offers the highest level of security (compared to rail). Once trucks have departed from waste conditioning pick up points, safety provisions are expected to include:

- Trucks travelling in convoy, with overnight stops in recognised towns/areas where truck security is not considered to be a security risk. Alternatively trucks have a second driver, and drive continuously between origins and destinations.
- Constant monitoring of truck progress/location via GPS transponder beacons in all trucks. Thus the location of each truck is known at all times, with continuous chain of custody being maintained.
- Satellite phones in each truck, enabling regular contact calls plus an instant call-in should any security or emergency matter arise.
- Trucks would travel on national and state highways as far as possible, as these offer higher standards for the safe movement of the waste (compared to secondary routes).

T5.1.1.2 Road/rail options

Rail is regarded as offering a feasible option for line haul shipments between the respective consolidation/ conditioning centres and the NT repository sites, with trucks being used for transport to/from the respective rail heads. There are several potential shortcomings with rail, however, that need to be considered:

- Given the current structure of rail freight operators, waste from Sydney, Bandiana (Vic) and Melbourne would need to be transhipped through Adelaide. Containers would need to be transferred between differing operators' wagons (unless special arrangements could be put in place between the Commonwealth and rail operators to avoid such transfers). A full time security guard may be needed during this transfer process, to ensure continuous chain of custody. If container transfer can be avoided, then overall transit times can be reduced, whilst at the same time minimising the need for loaded wagons to be left unattended in rail marshalling yards (it may then not be necessary to provide security monitoring of wagons and containers).
- Continuous monitoring of the location of shipments via rail will be more difficult and GPS transponders may need to be located on each container.
- Containers must be transferred twice between rail wagons and truck, adding to terminal costs, potentially giving rise to security concerns, and creating the potential for container damage during the transfer process.

T5.1.2 Safety

Whilst personnel handling the waste containers (drivers, forklift operators etc) would be trained in safe handling of the conditioned materials, there is nevertheless potential for safety incidents during the transport of the waste to the repository. Such incidents could arise from a combination of:

- poor handling of waste at the point of loading
- potential for truck accidents en route
- potential for train derailments en route
- poor handling practices at the repository receivals processing and storage of the waste containers in the repository; and
- poor handling of inter-modal transfers between road and rail sectors.

The potential for safety incidents can be minimised through rigorous training and management practices. Truck-only options for waste shipment will mean least handling of containers of waste, but are expected to have higher risk potential for accidents en route to the repository.

All shipments of waste would be undertaken in accordance with the ARPANSA code of practice for the transport of hazardous and nuclear materials, and with reference to respective state regulations as appropriate.

A more detailed assessment of the crash risk potential for truck movements to the selected repository site (truck strategy) will be required as part of a later EIS. This assessment will need to consider the probability of truck crashes along the nominated routes to the selected repository.

T5.1.3 Timeliness and reliability

Door-to-door travel times for truck-only options can be estimated reliably, given a set of basic logistics assumptions. There is always potential for truck breakdowns, but years of trucking operations has demonstrated a high degree of reliability in the industry. If there is a major crash on a designated route to the repository, then subsequent trucks could be directed to an approved backup route during the period of disruption. The position of trucks can be monitored at all times by means of GPS tracking devices.

Rail freight services are also considered reliable, though there is potential for wagons to be left stranded in marshalling yards, in unsecured conditions (this potential may be minimised as noted above in Section T5.1.1 if transfers of containers between operator wagons can be avoided). Derailments of rollingstock can also result in several weeks of delay before schedules can be restored to normal operating conditions. A major derailment would result in containers being delayed en route, again potentially outside of secure conditions.

T5.2 Strategy overview

T5.2.1 Linfox approach

Linfox has considered two alternative logistics strategies. These are:

- a road-based strategy, in which all waste would be transported to an NT repository site using truck transport
- a road/rail strategy where rail freight would be used for the longer distance line haul components of the transport task between the southern states and the NT, with trucks being used to transport the waste to the rail heads in the southern states, and thence from an NT railhead to the preferred repository.

Whilst two alternative options have been developed, Linfox has stated a preference for the road-only strategy, for reasons as outlined in Section T5.5. This preference reflects past experience in long distance haulage of sensitive freight by rail. Overall a road-only solution would offer a lower risk arrangement to Linfox in terms of being able to transport the waste within expected conditions likely to be imposed by a contract with DRET for the task.

Notwithstanding this preference, Linfox developed two strategies with associated costs for comparison.

T5.2.2 TOLL approach

TOLL has recommended adoption of a truck-based logistics solution for carrying the waste to the preferred repository. This is a reflection of past experience with the reliability of rail transport, and in particular having consideration of the following issues:

- the inability to continuously monitor location of the containers. Shipments would be considered less secure by rail
- significantly longer overall door-to-door travel times to the repository sites, (but depending on the need to transfer containers between differing rail operators in Adelaide)
- multiple handling of containers, with increased cost and risk of damage to containers; and
- less certainty in travel times.

Overall a road-only solution would offer potentially a lower risk arrangement to TOLL in terms of being able to transport the waste reliably, safely, and within the constraints of operational terms and conditions that would be imposed by the Commonwealth.

T5.2.3 Logistics considerations for Muckaty site

The repository site on Muckaty Station is readily accessible by truck off the Stuart Highway via the Bootu Creek mine haul road. Access by rail would also be convenient, with the nominated site being only 30 km from the existing rail siding operated by the Bootu Creek mine, and linked by a sealed haul road past the site.

The closeness and convenience of the rail siding compared to the more remote rail access arrangements for the three alternative sites suggests that rail transport may be a logistically efficient and cost effective option if a site at Muckaty is selected. (It is noted that there are no communities located near to the siding, nor between the siding and the Muckaty site. The fact that the Bootu Creek mine haul road is a private road would also assist in providing more secure road transport from the siding to the proposed southern repository site.)

The rail option for this site would also have the benefit of not requiring unloading of containers in a major NT centre (Alice Springs for either the Mount Everard or Harts Range sites, or Katherine for the Fishers Ridge site) as the existing rail siding near Muckaty would be used for the unloading of containers as noted above. This arrangement would effectively avoid the need for the evocative movement of containers through urban and regional areas in NSW, Victoria, and South Australia, and thence via long sections of the NT road network to the other sites.

It is understood that BHP Billiton is likely to construct a rail spur into Olympic Dam as part of the proposed Olympic Dam Mine expansion. Such a link would provide a convenient facility to load the accumulated waste currently stored at Woomera onto dedicated trains for shipment to the Muckaty repository site, via the Bootu Creek mine siding. This would avoid the need for any truck movements between Woomera and the repository along the Stuart Highway, (particularly though Alice Springs and Tennant Creek). Coordinating the loading of trains with containers packed with waste would need to be managed between the Commonwealth and BHP Billiton.

Use of rail transport to the Muckaty site will have some impact on the handling of containers at the repository receiving station. Compared to truck transport, where transport can be scheduled to ensure a steady arrival rate of trucks and containers at the repository, a more limited number of trains would carry the waste. Initial calculations suggest that the number of trains may be of the following order, based on a maximum available length train of 650 m at the Bootu Creek siding:

- Waste from NSW/Queensland: 4 trains
- Waste from Bandiana, Victoria and SA: 1 train (or part train)
- Waste from Woomera: 4 trains

A temporary secure storage facility adjacent to the rail siding would be needed to store containers as they are unloaded from the trains, with containers then being progressively transported by truck to the repository. There is land adjacent to the western end of the siding that may be suitable for this purpose.

Coordinating use of the Bootu Creek mine siding with the mine operators (McMahon) will require careful planning and negotiation by the Commonwealth. The key logistics considerations for McMahon comprise:

- trains use the siding every 2–3 days to load manganese ore from Bootu Creek
- stockpiles of ore are located along the length of the siding, on each side of the line, set back sufficiently for a high capacity front end loader to load the ore onto trains.

Joint usage of the siding will require:

- construction of an improved flat surface adjacent to one side of the rail siding, to provide a suitable platform for operation of a forklift to unload containers from

trains, and to thence shift the containers to the proposed temporary secure storage area

- while containers are being unloaded, mine trucks would need to travel along the outside of the ore storage mounds as they unload the ore. This would prevent conflict between mine trucks and the waste forklift

- management of mine truck movements to minimise potential conflict with the movement of the forklift during train unloading, and movements of container trucks into/out of the siding area.

T5.2.4 Logistics approaches investigated

In keeping with the Brief, both road and road-rail logistics options have been investigated as part of this project. Having regard to these two approaches, various operational arrangements might be put into place by differing transport companies, and this is illustrated below for the road strategy. The Commonwealth will need to carefully assess alternative strategies when tenders are finally called to transport the current waste backlog.

T5.3 Developing a road strategy

Linfox and TOLL have developed road-based strategies with differing logistics approaches for the Lucas Heights to NT shipments, but with similar approaches for transport of other accumulated waste. Both approaches have merit, with similar overall elapsed times for transport of the waste to the NT. They are both outlined in following sections for consideration.

T5.3.1 Linfox approach

The proposed Linfox logistics road transport strategy envisages the following main elements:

1. Conditioned waste from Sydney (Lucas Heights) would be transported in 20 foot containers by B-double trucks direct to the preferred repository site in the NT.

2. Containerised waste from Bandiana would be transported to Melbourne in a single 20 foot container using a side loader hired for loading palletised waste into the container. This loaded container would then be trucked from Melbourne to Adelaide on a B-double truck, together with the 20 foot container of Victorian waste. These containers would then be shipped from Adelaide to the NT, as an integral part of waste shipments from SA.

3. Waste from SA would loaded into 20 foot containers, with all containers from Adelaide (plus those from Bandiana and Melbourne), being shipped by B-double trucks (2 containers per truck) to the NT repository site.

4. Separate single unit semi-trailers would pick up the waste presently stored at Woomera, and transport this to the repository site as a secondary transport task.

Such shipments could be undertaken in parallel to the shipments from Sydney and Adelaide.

5. Reprocessed waste from Europe would be landed by ship at Adelaide (Outer Harbor), then trucked to the repository site using single unit semi-trailers.

More details of the process are provided as follows:

- Collection of the low volume sources of waste from regional and urban locations, followed by delivery of these to four key centres for consolidation with other major sources of waste. Conditioning would then be undertaken prior to shipment. This process envisages:
  - waste from Queensland and other regional sites in NSW and in/around Sydney would be collected, and taken to the ANSTO facility at Lucas Heights
  - waste from Army sources in the Wodonga area to be consolidated with existing waste stored at Bandiana defence facility
  - waste from Geelong and at other locations in/around Melbourne to be consolidated with waste currently stored at Broadmeadows
  - waste from Mount Gambier and Adelaide to be consolidated with waste at a location within the Salisbury (Edinburgh Parks) Defence precinct.

  For planning purposes, it was assumed that the regional/other urban waste would be placed into sealed steel drums, with these drums then being collected by light truck for delivery to the consolidation/conditioning centres. Drivers of these trucks would need to be trained and accredited to undertake this task. Pre-approved routes would be followed for these regional pickups.

- For planning purposes, it was assumed that conditioning of the waste at the four main sites, Lucas Heights, Bandiana, Melbourne and Adelaide (Salisbury) would be undertaken by ANSTO in a sequential operation, using a mobile conditioning facility. This facility would be used to complete all conditioning at Lucas Heights, then transported progressively to Bandiana, Melbourne and finally to Adelaide. (Note that actual conditioning arrangements would be made at a later time; the above assumption was made in building up a possible logistics arrangement for planning and costing purposes.)

- Waste would be palletised, with four 205 litre drums per pallet, and shrink-wrapped onto the pallets.

- Pallets would then be loaded into 20 foot containers with the following attributes:
  - Width to allow two pallets to be placed side by side across the container.
  - The containers would contain 10 pallets to be stored on the floor of the containers, with a further four pallets stacked on top and tied down using approved methods. Allowing for the weight of the container, this arrangement would just fall within axle load limits for the proposed truck transport.
  - The pallets would be loaded via the standard rear container door, and manoeuvred into place within the container.
  - Internal tie down and restraint of pallets would be required, especially those stacked on top of the base pallets.
  - Pallets would be hired, and reused after each trip after the drums are unloaded at the repository site and placed in their underground storage facility.

This arrangement is considered by Linfox to represent an efficient form to store the waste in containers for shipment.

- Adelaide would be used as a transport hub for shipments of waste from Bandiana, Melbourne and SA, via the following process:
  - The container from Bandiana would be transported by side loader to Melbourne, as noted above. A single B-double truck would then be used to transport the containers of Bandiana and Victorian waste from Melbourne to Adelaide.
  - Consolidated/conditioned waste from SA would be containerised in Adelaide, and shipped by B-double truck to the nominated NT repository site.

  Some short term storage of the containers from Bandiana and Melbourne may be required in Adelaide, but this would take place under secure conditions.

- Waste to be transported from Woomera to the NT is low level contaminated soil. It is understood that it will not need to be conditioned, but that the drums will be checked and resealed. Linfox proposes to simply load these drums onto enclosed A-trains, not into containers. The drums would then be transported to the repository site in a shuttle type of operation.

- It is proposed that the reprocessed waste (in the TN81 containers) from the UK be shipped into Outer Harbor (Adelaide), then secured into enclosed semi-trailers and transported to the repository site. The unloading process would be similar (in reverse) to the current arrangements for the handling of yellowcake containers from Roxby Downs onto ships for export.

The strategy envisages that Linfox take the responsibility at the consolidation facilities for providing a side loader and operator, whose task would be to palletise the drums, shrink wrap the pallets, and then load the pallets directly into the containers on B-double trailers. It is proposed that the side loader would travel from Lucas Heights (on completion of the shipments from there) down to Bandiana, and thence to Melbourne to complete the loading process.

Linfox would also provide a side loader and operator at the repository facility to unload the pallets, and after checking by ANSTO staff, place the drums into designated locations within the repository. Pallets would then be stored and returned to Lucas Heights (or Adelaide) for the next shipment.

Training and accreditation of all staff involved in the operation would be provided, as required by the standards for the handling and shipment of radioactive material.

T5.3.2 TOLL approach

The proposed TOLL logistics road transport-based strategy envisages four main sets of logistics tasks:

1. Waste from Sydney (Lucas Heights), Bandiana and Melbourne to be trucked in 20 foot containers to Adelaide on single unit semi-trailers. This arrangement would avoid the emotive movement of waste through the Blue Mountains.

2. Containers then to be transferred to B-doubles for transport north to the NT repository site. Waste from Adelaide would be stored in 20 foot containers, with these containers also being shipped via the B-doubles.

3. Separate single unit semi-trailers would pick up the waste presently stored at Woomera, and transport this to the repository site as a secondary transport task.

4. Reprocessed waste from Europe would be landed by ship at Darwin, then trucked down to the repository site using single unit semi-trailers.

Item 1 varies from the strategy proposed by Linfox, in that all waste from Lucas Heights would be transported to Adelaide, with all containers then being shipped north to the NT repository from Adelaide in B-double trucks. Other elements of the TOLL strategy are essentially similar to those as proposed by Linfox, with some differences as noted below.

The proposed TOLL strategy reflects logistics handling facilities available in Adelaide. These include the availability of forklifts to tranship containers, and security for temporary storage of containers en route to the NT.

The strategy of waste shipments from Sydney to Adelaide has a benefit in that movements can better be restricted to national and state highways, with reduced impacts on regional centres in NSW and South Australia, but with increased impacts on travel through the Adelaide metropolitan area (along sections of the national urban road network).

TOLL also proposes an innovative approach to the design of the proposed 20' containers to be used for waste shipments. These are proposed to have the following attributes:

- Width to allow two pallets to be loaded side by side.
- The containers would have mezzanine floors, enabling 10 pallets to be stored on the lower level, and 6 pallets on the upper level. Allowing for the weight of the container, this arrangement would just fall within axle load limits for the proposed truck transport.
- The containers would have wide opening side doors, to facilitate rapid loading by forklift, without the need to remove the containers from trailers prior to loading of the palletised drums of waste.
- Internal tie down and restraint of pallets would be required, especially those on the mezzanine floor. Fixing of the pallets on the mezzanine floor is envisaged to be a simpler process that on top of pallets on the lower level.

T5.3.3 Comments on the alternative road strategies

The key difference between the logistics strategies proposed by TOLL and Linfox relates to the transport of the waste from Lucas Heights in Sydney to the NT. The former envisages waste being hubbed through Adelaide, while the latter sees more direct shipments to the preferred repository site via Queensland. There will be some cost implications, but the main difference relates to the route options that would be employed. At this preliminary stage, route selection comes down to a trade off between:

- transport through numerous regional centres in NSW, and South Australia (along the River Murray), along a combination of national and state highways with the use of some local roads for connectivity; and

- transport along national and state highways, through Adelaide on national links to a consolidation point at Islington in Adelaide.

There will clearly be a number of political sensitivities associated with each option. A value judgement will be needed at a later time as to which option should be carried forward for more detailed investigation as part of a later planning stage. This issue is essentially independent of which repository site is finally selected in the NT.

T5.3.4 Indicative transport routes

Indicative routes for the TOLL and Linfox logistics options are presented in Table T5.1. More detailed assessment will be required as part of the later EIS process, including identification of route alternatives in the case of temporary road closures.

Where possible routes will be located along roads according to the following hierarchy:

- National Highways
- State Highways
- Other primary rural arterial roads.

The objective would be to use highest standard roads, minimising impacts on intermediate towns and cities.

Table T5.1 Indicative transport routes

Route sector	Route to repository
TOLL Strategy	
Sydney to Adelaide	Hume Highway, Sturt Highway, then the route from Balranald across the River Murray at Tooleybuk via Ouyen and Pinnaroo to Tailem Bend, then via the Princes Highway to Adelaide. Within Adelaide trucks would follow the national urban route and thence Churchill Road to the TOLL inter-modal facility at Islington.
Bandiana to Adelaide	Hume Highway, then Sturt Highway and via the route to Adelaide as for the waste from Sydney.
Melbourne to Adelaide	The Dukes Highway to Tailem Bend, the Princes Highway to Adelaide then through Adelaide as for the waste from Sydney.
Adelaide to Repository Sites	Via the national highway routes - Port Wakefield Road and Stuart Highway, with local access to the respective sites.
Woomera to Repository Sites	Via the Stuart Highway, with local access to the respective sites.
Darwin to Repository Sites(1)	Via the Stuart Highway, with local access to the respective sites.

	Route to repository
Linfox Strategy[2]	
Sydney to the NT[3]	Hume Highway, Sturt Highway to Renmark, then via Morgan and Burra to the Port Wakefield Road (national highway) north of Port Pirie, and thence via the Port Wakefield Road and Stuart Highway to the NT. Linfox have also noted the potential to transport containers through northern NSW and thence through Queensland to the NT, depending on the location of the selected repository site. More detailed route investigations would be required once a preferred repository site is chosen by the Commonwealth.
Bandiana to Melbourne	Via the Hume Highway.
Adelaide to Repository Sites[1]	Via the Port River Expressway, Port Wakefield Road and Stuart Highway to the NT.

(1) Reprocessed waste in TN81 containers shipped in from the UK.
(2) Route elements differing from those of the TOLL strategy.
(3) An alternative route from Lucas Heights to a Fishers Ridge site might be considered. This would be located through NSW into Queensland, linking into the NT via Mt Isa and the Barkly Highway to the Stuart Highway just north of Tennant Creek. Such a route needs more detailed investigation.

The TOLL strategy would require a single crossing of the River Murray at Tooleybuk, over a single lane bridge. A speed restriction on trucks crossing would be specified for safety reasons, supplemented with traffic control.

The Linfox strategy envisages two crossings of the River Murray, at Mildura and at Renmark.

T5.4 Road-rail strategy

This strategy proposed by Linfox envisages the following elements:

- Sydney: Containers from Lucas Heights would be trucked to the rail head at Cronulla, then transported by train via Adelaide to the NT; containers would be transhipped from Pacific National trains at the Islington intermodal facility in Adelaide to Freightlink trains for onwards travel to the NT.
  - for the Mount Everard and Harts Range sites, the containers would be offloaded at the Alice Springs intermodal facility
  - containers bound for a repository at Fishers Ridge would be transported to the Katherine intermodal facility
  - containers bound for the fourth site at Muckaty would be offloaded at the Bootu Creek mine siding.
- Loading of the conditioned waste onto pallets and then into 20' containers would be undertaken at Lucas Heights via a similar process as for the road option described above. The main exception being that single unit trucks would transport the containers to the Cronulla rail head. Consolidation of waste from Queensland and regional NSW would also take place via small local truck pickup as described above.
- Bandiana and Melbourne: The single 20 foot container packed in each of these two locations would be transported to Adelaide (Islington intermodal facility) by

single unit semi-trailers. Local arrangements for waste consolidation in Bandiana and Melbourne would also be as described above in Section T5.3.1.

- Adelaide: Waste would be containerised at DSTO Salisbury (indicatively), and trucked to the Islington intermodal facility for shipment by train to Alice Springs, Katherine or Muckaty depending on the repository site (as noted above for waste from Sydney).

- Waste from Woomera and the TN81 containers from Europe would be transported by truck to the preferred repository site by truck (refer Section T5.3.1) for the Mount Everard, Harts Range and Fishers Ridge site. Shipments to the site at Muckaty could take place by truck or alternatively by rail if a siding is constructed by BHP Billiton. The transport of the TN81 containers to a site at Muckaty may be most efficiently undertaken by truck.

  The way in which TN81 containers are transported, irrespective of the selected site, will be influenced by the availability of suitable cranes for lifting the containers. A large factor of safety is required for the lifting capacity.

Some variations to the arrangements as outlined above might evolve once detailed planning is undertaken.

T5.5 Issues impacting on the choice of road-only or road-rail logistics strategies

As noted in Section T5.2, both Linfox and TOLL have clear preferences for adoption of a road-only transport logistics arrangement. The main reasons for this preference are:

- The difficulty in continuously monitoring the location of containers on trains. Thus shipments may be considered less secure by rail unless logistics contractors are able to offer a cost effective system for doing so.

- Reduced overall door-to-door travel times to the repository sites by road, in the order of three days less from Sydney, and one day less from Adelaide (Section T6.2).

- Multiple handling of containers for rail transport, with increased cost and risk of damage to containers. (Potentially an interline rail transfer in Adelaide might be avoided by special arrangement with rail operators, as noted earlier in this report.)

Other benefits for the road option include:

- Containers will require less lifts for road options compared to road-rail. From Sydney four lifts would be expected for road transport (assuming an intermodal transfer in Adelaide) compared with up to seven lifts for rail options.

- As single containers would only be shipped to rail heads on single unit trucks, there would be some 296 road trip from the pick up point to the rail heads (through metro areas). The road only option would be done using a combination of B-doubles and single unit semi-trailers (depending on the logistics strategy out of Sydney), taking the most direct route out of the populated areas. Therefore

there will be approximately 150 trips through metro areas, a significant reduction in truck movements.

- The rail option will likely require the set up of temporary storage areas at the respective rail facilities in Sydney and Adelaide, where containers can be stored for short periods as part of a consolidation process prior to loading onto trains. Such facilities would not be needed for road only options; containers would be transported by truck as they were packed. A rail storage facility would also be required at the Bootu Creek mine siding near Muckaty. This would enable all containers to be rapidly unloaded from trains, then progressively transported to the Muckaty repository site at a steady rate which could be managed by the inwards processing staff.

- Only one company gets involved in the road transport process and therefore only one set of permits is required. A road and rail operation will need to have a minimum of four sets of permits – road shuttle to rail head, rail to Adelaide, rail to NT, road shuttle from NT rail head to the repository site.

- The road routes are variable and contingency routes can be made in the event of emergencies, as opposed to rail where there is only one route.

- There may be a need for additional security, together with related costs, at the rail intermodal facilities.

The rail options have several benefits compared to road, and these need to be noted:

- Rail options minimise the extent of transport of waste through towns and cities, and in the case of NSW, transport of waste through the Blue Mountains. Transport of waste through these areas is emotive.

- There is lower likelihood of serious crash risk with rail compared to road.

The final decision as to whether a road or a road-rail option is selected by the Commonwealth may not necessarily be made on purely cost grounds. From a political perspective, a road-rail option may be seen as a less emotive option, with reduced accident potential.

T6. Logistics travel times

T6.1 Elapsed waste clearance times

Shipment of the waste from Lucas Heights will be the factor determining the overall timeframe for clearing the backlog of accumulated waste, depending on the adopted logistics strategy. For a road-only option, an elapsed time of some 45–50 weeks to transport all conditioned waste from to the repository is envisaged, whether the logistics strategy takes the form of that proposed either by Linfox or TOLL. For a rail option, the waste may potentially be cleared in a shorter timeframe through the following process:

- accelerated conditioning/packing into containers at Lucas Heights
- progressively transporting containers to an intermodal loading facility in Sydney, with temporary secure storage being provided
- loading stored containers onto special trains when warranted by accumulated numbers of containers, and thence shipping the containers to the NT.

This rail arrangement might potentially enable the clearance time to be reduced by several months.

After the completion of the shipments from Lucas Heights, single shipments from Bandiana and Melbourne to Adelaide would be arranged, using road transport. Onwards shipment of the Bandiana/Victorian containers from Adelaide to the NT repository would then take place in conjunction with conditioned waste from SA; this could occur either by rail or by truck (using B-doubles). The waste from SA would be shipped to the NT after the mobile ANSTO conditioning facility has completed its task respectively at Lucas Heights, Bandiana and Melbourne, and moved on to Adelaide for the conditioning process. This can occur while the transport of conditioned waste from Lucas Heights is still taking place. (It is noted that the conditioning process could be commenced by ANSTO well in advance of a contract actually being let for the transport task.) The waste from Woomera would be transported in parallel with that from Lucas Heights and Adelaide, using a different set of trucks and drivers, or by rail.

Transport of the conditioned waste by road is expected to result in the steady arrival of shipments at the repository site, to enable processing and storage of the drums without the need for any extensive temporary storage of waste within the repository. More detailed logistics planning would need to be undertaken to ensure an optimum delivery rate of waste at the repository that can best be accommodated by repository staff. This planning should take place as part of the wider operational planning and

design for the repository, feeding into later tender documents for transport of the waste.

Waste shipments by rail could be undertaken in a much shorter overall elapsed time once waste is containerised on site and transported to designated rail loading facilities. But rail is also expected to require interim storage facilities at rail intermodal facilities in Sydney and Adelaide, with additional storage facilities in the NT. A storage facility at the Bootu Creek mine siding is expected to be less expensive to construct compared to options in Alice Springs or Katherine.

The TN81 containers would be transported from Outer Harbor or Darwin to the repository by special arrangement when shipping details are known. It is likely that such shipments will take place some time after the transport of the current waste inventory.

The long elapsed time for transport of the waste by road has four major logistics benefits:

- It will enable a smaller logistics operation by the appointed transport company. A smaller number of trucks, containers, drivers and other staff can be used for the task. This will require less training of drivers in the standards for safe transport of radioactive waste, and reduced overall costs.
- The volumes of heavy trucks transporting the containers will be low at all times, reducing public perception of the scale of the task.
- The mobile ANSTO conditioning plant can be used for waste processing in each of the four major centres, reducing the cost for additional conditioning equipment. (It is noted, nevertheless, that processing of the accumulated waste could be completed well in advance of a transport contract being issued.)
- It is understood from discussions with ANSTO that operation of the repository can be most efficiently managed with a steady arrival of waste containers. An accelerated transport schedule would require significant temporary storage of drums on site, likely under cover; double handling of the drums would be necessitated.

The reduced clearance time for rail shipments has the advantage of less exposure of waste shipments to the public, with movements at the terminal ends by road being relatively short.

T6.2 Door-to-door travel times

T6.2.1 Road option

T6.2.1.1 Linfox strategy

Based on the logistics strategy as described in Section T5.3.1, door-to-door travel times are estimated (one way trips) as:

- Lucas Heights to Mount Everard/Harts Range: 2 days
- Lucas Heights to Fishers Ridge: 3 days

- Lucas Heights to Muckaty: 2.5 days
- Bandiana to Melbourne: 1 day
- Melbourne to Adelaide: 1 day
- Adelaide to Mount Everard/Harts Range: 1.5 days
- Adelaide to Fishers Ridge: 2.5 days
- Adelaide to Muckaty: 2 days
- Woomera to the Mount Everard and Harts Range sites: 1 day
- Woomera to the Fishers Ridge site: 2 days
- Woomera to the Muckaty site: 1.5 days.

Travel times for the respective line haul elements of the proposed logistical arrangements. Times for the local collections in Queensland, NSW, Victoria and SA are not critical, and would be organised in the most cost-effective way possible, taking up to several days in each state.

Transhipment times in Adelaide for the containers from Bandiana and Melbourne would be negligible.

T6.2.1.2 TOLL strategy

Travel times for the respective line haul elements of the proposed logistical arrangements (Section T5.3.2) are summarised below. Again, times for the local collections in Queensland, NSW, Victoria and SA are not critical, and would be organised in the most cost-effective way possible, taking up to several days in each state.

- Sydney (Lucas Heights) to Adelaide: 1.5 days
- Bandiana to Adelaide: 1.5 days
- Melbourne to Adelaide: 1 day.

Approximately one day would be required in the TOLL Adelaide depot for transhipping the containers from Sydney, Bandiana and Melbourne onto the B-doubles for the journey to the NT repository site.

Travel times to the NT would be in the order of:

- Adelaide to repository sites near Alice Springs (Mount Everard, Harts Range): 1.5 days
- Adelaide to the Fishers Ridge site: 2.5 days
- Adelaide to the Muckaty site: 2 days
- Woomera to the Mount Everard and Harts Range sites: 1 day
- Woomera to the Fishers Ridge site: 2 days
- Woomera to the Muckaty site: 1.5 days.

The times above are indicative, but are representative of possible overall travel times.

T6.2.2 Road-rail option

Very approximate one way door to door times by a road-rail option are summarised in Table T6.1.

Table T6.1 Estimated transit times by road/rail

Transport Element	Road Access (days)[1]	Rail Component (days)	Total Time in Transit (days)
Sydney to Mount Everard/ Harts Range	1	4[2]	5
Sydney to Fishers Ridge	1	5[2]	6
Sydney to Muckaty	1	4.5[2]	5.5
Adelaide to Mount Everard/ Harts Range	1	2	3
Adelaide to Fishers Ridge	1	3	4
Adelaide to Muckaty	<1 day	2.5	< 3.5

(1) 0.5 days at each end of the trip – respectively in Sydney, Adelaide and for travel to the respective NT repository sites

(2) Assumes containers do not need to be transhipped between differing rail operator wagons in Adelaide.

Note: Train movements to the Mount Everard and Harts Range sites would be to the Alice Springs intermodal facility. Movements to Fishers Ridge would be to the Katherine intermodal facility. Train movements to the Muckaty site would be to the Bootu Creek mine siding.

These times are marginally longer than the comparable times by the road-only option.

T7. Transport and logistics costs

Preliminary estimates of costs were prepared in conjunction with Linfox and TOLL for their respective proposed logistics strategies, for shipments to repository sites at Mount Everard, Harts Range and Fishers Ridge; cost estimates for the Muckaty site were derived by the consultants based on data from Linfox. These estimates include allowances for the elements in the logistics chains as summarised in Sections T5.3.1 and T5.3.2 respectively. The costs should be considered as indicative, and would be influenced by more detailed requirements as may be specified in later tender documentation by DRET.

The costs are in 2006 prices, and would be subject to normal escalation over time.

T7.1 Costs for Linfox strategies

Summary costs are detailed in Table T7.1. Costs are not broken down into detailed elements for reasons of commercial sensitivity.

Table T7.1 Summary logistics costs – Linfox (2006 Prices)

Cost Component	Cost by Repository Location ($m)			
	Mount Everard	Harts Range	Fishers Ridge	Muckaty
Road Option	$4.62m	$4.80m	$6.22m	$5.29m
Road-Rail Option	$4.85m	$5.09m	$5.87m	$5.07m

Source: Linfox

The costs by the road-rail options to Fishers Ridge and Muckaty sites is significantly lower than the comparable road options given the relatively marginal additional cost for rail haulage from Alice Springs to Katherine or Bootu Creek, compared to the rate for transport by road. Thus as the haul becomes longer, the road-rail options become more cost effective, notwithstanding other logistics issues.

Actual costs for the logistics strategies as noted above will be influenced by a range of external factors:

- For all movements, the waste product will be packaged to a standard that can be shipped with ease and is compliant with the state and federal regulations for this type of product.
- Government authorities will be required to give approval for specific gazetted routes for the waste containers, similar to the process of moving U308 from Roxby Downs.
- All packing of containers and the provisions for packing containers will be handled by third party approved suppliers. These costs have not been factored into these estimations.
- All containers will be returned to the original sending port.
- No costings have been allowed in relation to container clean out in the event of high radiation readings.
- Costs associated with getting approved routes and/or specific licensing for the moving of the waste materials have not been factored into the above estimates.
- All vehicles and transport operators will comply with the relevant Australian standards for the cartage of bulk and packaged dangerous goods.
- Standard twenty foot two pallet-wide containers will need to be used for consolidation purposes.
- Prices are indicative and assume the project will be completed progressively over a 12 month period.

T7.2 Costs for TOLL strategy

Summary costs are detailed in Table T7.2. Costs are not broken down into detailed elements for reasons of commercial sensitivity.

Table T7.2 Summary logistics costs – TOLL (2006 Prices)

Cost Component	Cost by Repository Location ($m)			
	Mount Everard	Harts Range	Fishers Ridge	Muckaty
Logistics Costs ex Adelaide(1)	5.43	5.72	6.46	6.16
Costs ex Woomera	0.72	0.79	0.92	0.86
Costs ex Darwin(2)	0.27	0.24	0.07	0.14
Costs at repository	0.13	0.13	0.13	0.13
Total Costs	**$6.55m**	**$6.88m**	**$7.58m**	**$7.29m**

(1) Handling and transport costs, include transport of containers from Lucas Heights, Bandiana and Melbourne to Adelaide, and then onwards shipments to the repository.

(2) TN81 containers of reprocessed waste from Europe

The table shows a consistent outcome as for the Linfox strategy (Table T7.1), with costs increasing as haul distances increase. Costs are marginally higher than those

presented for Linfox, and this may be a reflection of the level of detail inherent in the cost estimation process by Linfox.

The costs in Table T7.2 include allowance for the packing of containers in Lucas Heights, Bandiana, Melbourne and Adelaide. Comments on the costs include:

- costs for the Woomera to repository shipments could be reduced if shipments of drums packed in trucks without using shipping containers is adopted
- no costs have been allowed in relation to container clean out in the event of high radiation readings
- costs associated with getting approved routes and/or specific licensing for the moving of the waste materials have not been factored into the above estimates
- costs for training in the safe handling of the radioactive waste have not been allowed for
- prices are indicative and assume the project would be completed progressively over a 12 month period.

T8. Transport infrastructure upgrades

A series of road network improvements will be needed to transport the waste backlog to the respective repository sites in the NT, irrespective of whether the final logistics strategy is a roads-only arrangement or a combination road-rail strategy. If rail is to form part of the final logistics strategy, then further upgrades of rail intermodal facilities in the NT may also be required.

Following sections overview the extent of upgrades expected to be needed.

T8.1 Road infrastructure improvements

The focus of proposed road improvements to provide access to the respective repository sites will be the linkages from the NT national/rural arterial road network to each respective repository. Road improvements elsewhere along the routes between the major waste sources in Sydney, Bandiana, Melbourne, Adelaide and Woomera are not likely to be needed, with trucks using existing national and state highway infrastructure.

Note that the required extent of access roads will be very similar for road only, and road:rail logistics options.

T8.1.1 Alternative road standards

A key design issue to be addressed in development of the repository is the standard of the site access road, as this will impact on costs (capital and recurring costs), and potentially on logistical and licensing arrangements if the access road is closed due to wet weather. Further, desirable access road standards may vary by repository site.

Three alternative basic types of access road might be considered:

- Natural surface road, no special drainage provisions. This standard of road would ideally have 10 m clear width. Access over roads of this type would be very susceptible to wet weather. Such roads at the three repository sites would likely be unusable for many days/weeks after substantial rainfall. Levels of maintenance could be expected to be high.

- Formed road with gravel pavement, side cut off drains and transverse drainage, raised above the adjoining landscape. Depending on the repository site this type of road might vary between 7 and 9 m in width, including gravel shoulders. These roads offer improved access during wet weather, but the roads would still be subject to potential scour. Reduced levels of maintenance would be required relative to natural surface roads, but still higher than for a sealed road. This type of road might typically have a pavement of 200–300 mm of crushed rock.

- Formed and sealed road, with side cut off drains and transverse drainage, raised above the adjoining landscape. Seal width will vary between 4 and 6 m depending on the site, with constructed 1.5 m gravel shoulders. This type of road is more expensive to construct, but would provide the most durable 'all weather' access road, least impacted by wet weather, and with least ongoing maintenance costs. These roads would be similar to a formed road, with a spray seal surface.

For the formed and the sealed road options, connections to sealed Defence or NT Government roads would need to be constructed to accommodate turning movements of B-double trucks. Connections to unformed tracks would lead to accelerated failure of existing sealed road pavements and shoulders where trucks turn.

Following sections consider alternative road standard options for each site, identifying logistical impacts, and presenting preferred access arrangements for each site.

T8.1.2 Logistics issues impacting on access road type

For road-based options, it is expected that the initial campaign to clear the current waste backlog will take place over a 12 month period, as described in Section T5. The logistics strategy for this process envisages transport of waste via regularly scheduled truck movements. This will enable efficient operation of the repository, (processing and storage of the waste), without the need for extensive under cover interim storage. On average, it is estimated that some six trucks per week would deliver consolidated waste to the repository. Each truck would have high axle loads, but within load limits for travel on national and state highways.

The main implication of the logistics strategy would be the need for continuous access to the repository. If access is prevented for any significant length of time, for example due to access road unserviceability (wet weather), then a number of trucks (potentially in the order 4+ vehicles) en route to the repository will need to either park with their loads in secure areas or else unload their waste containers in secure areas until access is restored. (Once access to the repository site is prevented by wet weather, further shipments of waste from Sydney or Adelaide would need to be put on hold until access was restored.) This strategy will have several important implications:

- A secure location will be needed for temporary storage of trucks or containers for the southern (Mount Everard and Harts Range sites) and the northern Fishers Ridge site. Ideally such sites would need to be in the NT to avoid backtracking of truck movements, and on Commonwealth land. A storage for Fishers Ridge could probably be sourced within the RAAF Tindal Base; a storage area notionally in the Alice Springs area would be required for the Mount Everard and Harts Range sites. A temporary storage facility for a Muckaty repository site could probably sourced within the environs of Tennant Creek.

- It would not be cost effective to maintain container handling equipment at such locations. There would be delays in bringing in equipment to unload containers, or significant costs for holding trucks for potentially long periods of time.

- Interim storage facilities would need to be secure, and would need to be licensed by ARPANSA.

These implications clearly point to the desirability of providing 'all weather' repository access. Either a well designed formed access road with a gravel pavement, or else a sealed road is needed to provide certainty of access. This would obviate the need for interim storage facilities.

Road-rail options will have differing logistics impacts, however, particularly for the repository site at Muckaty. There is potential for more extended interim storage of waste containers at railway unloading sites should there be extended wet conditions interrupting truck access to the preferred repository. The cost for such storage provision would likely be higher at Alice Springs (for Mount Everard, Harts Range), marginally less at Katherine (Fishers Ridge), and minor at the Bootu Creek rail siding (for the Muckaty site). The provision of interim storage near to rail facilities may enable a cheaper, lower standard repository access road to be constructed. For example, it may be feasible to construct formed roads using natural material at Muckaty with low levels of gravel sheeting, avoiding the need to construct more expensive road pavements. Higher rainfall conditions at Fishers Ridge, nevertheless, are still likely to require construction of an engineered road pavement.

T8.1.3 Preferred access road arrangements

Having accepted the argument that 'all weather' access should be provided to the repository, but having regard to possible road-rail options requiring a lower standard of access road, the decision then comes down to a choice between unsealed or sealed road options. We incline to the view that a sealed road is preferred, given reduced ongoing maintenance requirements, less susceptibility to severe wet weather conditions, and reduced dust nuisance (particularly the repository sites near Alice Springs). It will not be cost effective to have road plant on hand to grade and maintain unsealed roads; maintenance would need to be undertaken by contractor from Alice Springs (Mount Everard or Harts Range), Katherine (Fishers Ridge) or Tennant Creek (Muckaty).

Sealed roads are more expensive to initially construct than a gravel sheeted formed road, but the reduction in maintenance requirements and associated costs are expected to outweigh the initial capital cost, and to reduce the inconvenience of having to manage maintenance from time to time. Further, a sealed road could be expected to be available for subsequent campaigns without the need for any extensive road maintenance/improvements.

Based on the foregoing discussion, we propose that a sealed access road be provided to the final repository site. The discussion then focuses on the standard of sealed road recommended for each of the repository sites. Distinction in this process is made between a short 'driveway' and a longer access road:

- Mount Everard: Travel distances to a repository at this location from the Tanami Road (Figure T3.1) are relatively short. A 4 m wide sealed road with 1.5 m gravel shoulders for passing is considered adequate.

- Harts Range: An access road (off the Defence site entry road), along the site boundary, would be approximately 2.5 km long (Figure T3.2). Given flat terrain, with no sight distance issues, a similar standard sealed road 4 m wide sealed road with 1.5 m gravel shoulders is proposed as per the Mount Everard site.

- Fishers Ridge: Access into a repository site at this location would come off the existing road through the site (Figure T3.3). This existing road varies in standard and width, and at places has restricted sight distances with impacts on safety. Our recommendations for access comprise:

  - Upgrade the existing through road to a 6 m sealed standard to allow for safe vehicle passing. This upgrade would only take place between the Stuart Highway and the access 'driveway' to the repository site.

  - Construct a new 4 m sealed 'driveway' from the through road to the repository. This road would require 1.5 m gravel shoulders for passing, and would need to be built up above the surrounding terrain given the more frequent incidence of wet weather at Fishers Ridge, and the nature of the prevailing soil characteristics.

- Muckaty Station: Access to the nominated site would come directly off the sealed Bootu Creek mine haul road. This will require construction of a new road link approximately 2 m in length to the repository.

In all cases, adequate drainage is required to suit the local conditions.

Pavement thicknesses may vary between sites. These will need to be designed to accommodate the expected axle loads, but rather than being based on the normal 'pavement fatigue' method for more frequently trafficked roads, an alternative 'pavement shear" design approach will be needed to reflect the much less frequent truck loadings – both during the initial waste campaign and then in the future for later campaigns. Pavement thicknesses at Fishers Ridge are expected to be more substantial due to the nature of the local soil conditions, and the need to raise the road above the surrounding terrain for drainage purposes.

Table T8.1 summarises proposed access arrangements for the three sites.

T8.2 Rail infrastructure upgrades

Good standard rail intermodal facilities are in place at Alice Springs and Katherine. These facilities would be used for transfer of waste containers from railway wagons to trucks for onwards shipment to a repository, the former for a repository at Mount Everard or Harts Range or the latter for a repository at Fishers Ridge.

For a road:rail logistics strategy, there is expected to be a need for secure temporary storage facilities at one or other of the above intermodal facilities. This need might be for overnight storage of containers, or for longer term storage if delivery of containers to the repository is delayed due to very severe storms and floods. Should this occur, then a secured storage area adjacent to the intermodal facility will likely be needed. To provide for this eventuality, it would be necessary to purchase or lease of a land parcel adjacent to the intermodal facility, with construction of a hard stand area, secure fencing and potentially a separate access point.

There is a relatively new intermodal facility constructed by the Bootu Creek mining operation near to the Muckaty site. The rail infrastructure is in good condition, enabling trains up to approximately 650 m in length to operate. For use as a terminal point for radioactive waste shipments, it is proposed that an improved hard surface area be provided along the southern side of the rail track, to provide a firm base for the unloading of containers from trains, followed by temporary storage in an adjoining purpose-built interim storage facility. (The hard surface area would need to be extended to the interim containers storage area.) The storage facility would need to accommodate a trainload of containers at any time, prior to the containers being transported to the appropriate nearby Muckaty repository. Provision for the storage of returned empty containers would also need to be made, with these containers then being back loaded onto the next arriving train carrying waste for shipment back to either Sydney, Adelaide or Woomera ready for the next shipment.

Table T8.1 Proposed access road standards

	Repository sites				Comments
	Mount Everard	Harts Range	Fishers Ridge	Muckaty	
Road Length	▪ Existing sealed Defence access from Tanami Road: 370 m ▪ New sealed access 'driveway' to repository: 550 m	▪ Existing sealed Defence access from Plenty Highway: 2.6 km ▪ New sealed access along site boundary: 2.7 km(2) ▪ New sealed access from site boundary to repository: 270 m	▪ Upgrade existing formed road through Fishers Ridge: ‣ North site: 10.2 km ‣ South site: 7.0 km ▪ New sealed access from through road to repository: ‣ North site: 1.65 km ‣ South site: 1.25 km	Construct new access road from Bootu Creek mine haul road: Length 2 km. No other road upgrades required, apart from an upgrade of the intersection of the access road with the Bootu Creek haul road.	Access option at Mount Everard assumes use of current sealed Defence access road. Two other alternative route options could also be considered (Figure T3.1).
Proposed Sealed Road Standards	▪ Existing sealed Defence access from Tanami Road: Retain current 3.5 m seal+shoulders(1) ▪ New sealed access to repository: 4 m seal+1.5 m shoulders	▪ Existing sealed Defence access from Plenty Highway: Retain current 3.5 m seal+shoulders(1) ▪ New sealed access to repository: 4 m seal+1.5 m shoulders	▪ Upgrade existing road through Fishers Ridge to 6 m+shoulders ▪ New sealed access to repository: 4 m seal+1.5 m shoulders	New formed road with gravel pavement from the haul road. To comprise 6m pavement, with gravel shoulders.	Adequate drainage to be provided for each road. A 4 m wide seal at Harts Range is recommended, given flat terrain and good sight distances.

(1) Pavement may need to be strengthened.
(2) The existing cattle grid at the Defence site entrance (Photograph T3.14) will need to be reconstructed to provide for trucks to turn along the proposed new access road on the site boundary.

Notes:
1. The intersection of the existing sealed access road at Mount Everard and the Tanami Road will need to be upgraded to accommodate turning truck movements.
2. The intersection of the existing sealed access road at Harts Range and the Plenty Highway will need to be upgraded to accommodate turning truck movements.
3. No improvements are needed at the intersection of the Stuart Highway with the Tanami Road (access to Mount Everard) or the Plenty Highway (access to Harts Range). These intersections have already been constructed to accommodate the movements of heavy trucks (B-doubles and road trains).
4. The intersection of the Stuart Highway with the Fishers Ridge road would require major upgrading works to enable the safe turning of heavy trucks, and to prevent breakup of the existing Stuart Highway pavement at the intersection.

T9. Summary

This section provides a summary of key transport and site issues, in a form that enables a simple comparison of relative attributes for inclusion in an overall assessment of site impacts. The issues are summarised in Table T9.1. They draw on findings/observations made in preceding chapters, supplemented with observations of road construction and maintenance impacts as derived from the geotechnical assessment.

Table T9.1 Summary key transport and site indicators

Aspect		Repository Site				Comments
		Mount Everard	Harts Range	Fishers Ridge	Muckaty Station	
1.	**Transport logistics costs ($m)**[1] ▪ **Road only option** ▪ **Road/rail option**	$4.6-7.1m $4.9m	$4.8-7.4m $5.1m	$6.2-7.7m $5.9m	$5.3-7.3m $5.1m	Costs are preliminary estimates only, providing broad expectations of costs. These are subject to more refined estimates at time of tender.
2.	**Routes to site**	▪ National/state highways in NSW, Vic and SA ▪ National Hwy in NT plus Tanami Road (NT rural arterial road)[3]	▪ National/state highways in NSW, Vic and SA ▪ National Hwy in NT plus Plenty Hwy (NT rural arterial road)[2]	▪ National/state highways in NSW, Vic and SA ▪ National Hwy in NT[4]	▪ National/state highways in NSW, Vic and SA ▪ National Hwy in NT[4] Bootu Creek mine haul road	Various route combinations possible in southern states, to be addressed in detail in the EIS. Routes from Lucas Heights to Fishers Ridge could travel via NSW/Queensland and thence via the Barkly Highway to the Stuart Highway
3.	**Access disruption due to flooding**	Low potential for flooding of Tanami Road	Higher potential for flooding of Plenty Highway compared to Tanami Road	Access direct from national highway; lowest flood potential	Low potential disruption for rail option. Increased potential for road option (underpass of Stuart Highway by Bootu Creek mine haul road)	Flooding potential for roads within site at Fishers Ridge potentially higher than other sites
4.	**Traffic flows on roads near site**	Approx. 115 vpd on the Tanami Road	Approx. 105 vpd on the Plenty Highway	In order of 600 vpd on Stuart Highway past the site access	About 350 vpd on the Stuart Highway, minimal truck traffic on Bootu Creek mine haul road.	Passing traffic flows are very low for the Mount Everard, Harts Range and Muckaty South sites, offering much reduced crash potential for trucks travelling to/from a repository at these locations.

Aspect		Mount Everard	Harts Range	Fishers Ridge	Muckaty Station	Comments
5.	**Access to repository**					
5.1	Access road distances	▪ Sealed access road from Tanami Rd to repository T/O: 370 m ▪ Site access: 550 m	▪ Sealed access road from Plenty Hwy to repository T/O: 2.6 km ▪ Site access: 3 km	▪ Fishers Ridge access road: 7-10.2 km[5] ▪ Site access: 1.3-1.7 km	▪ Bootu Creek mine haul road: ▪ Rail siding 40 km to west ▪ Stuart Highway 10 km to east Site access about 1km	Mount Everard site has the shortest (and hence lowest cost) access route from the NT road network. The longest access route (and associated cost) is for a repository at Fishers Ridge. The Muckaty site is close to Stuart Highway, but not accessible by public road.
5.2	Intersection upgrade from adjoining highway	Upgrade to existing sealed road access for B-double truck turning movements	Upgrade to existing sealed road access for B-double truck turning movements	Major upgrade of existing access road; full intersection construction for B-doubles	None required	Upgrade required for Fishers Ridge access road significantly more extensive compared to other three sites.
5.3	Access road standards	▪ Retain current access off Tanami Road ▪ Repository access road: new 4 m seal+1.5 m shoulders	▪ Retain current access off Plenty Highway ▪ Repository access road: new 4 m seal+1.5 m shoulders	▪ Upgrade site access road: to 6 m seal + shoulders ▪ Repository access road: new 4 m seal + 1.5 m shoulders	Repository access road: new 6 m formed gravel road with 1.5 m shoulders	Highest cost site access road to Fishers Ridge location (upgrade to 6 m seal width to enable safe passing where sight distances are poor).
6.	**Construction of access to repository**					
6.1	Road construction – commercial quarry location	Lowest cost, with shortest length of road, and with commercial quarries in/near to Alice Springs.	Not close to commercial quarry location.	Commercial quarry expected to be in Katherine region, providing cost of material similar to Alice Springs.	Low cost with short length of road (1 km). Suitable construction material expected in area.	Mount Everard expected to have lowest cost for road construction materials (close to quarry, and with shortest length of road to construct). The Muckaty site is also expected to have low access road costs.
6.2	Road construction – on site borrow pits	Limited potential for on-site borrow pits.	Potential for borrow pits in the Harts Range region.	Limited potential for on-site borrow pits.	Potential for on-site borrow pit.	Harts Range site likely to have road construction materials within easy haul distance. Offers cheaper on-site material sourcing.

Aspect						Comments
					Muckaty Station	
6.3	Indicative construction costs	Potentially least cost option due to proximity of site to a large population centre (Alice Springs) and least length of access road to be constructed.	Higher cost option compared to Mount Everard, with much longer distances for construction workforce. A construction camp would have to be created.	Workforce available in Katherine, but construction costs higher than Mount Everard due to the road length to be constructed. The repository access road from the Fishers Ridge road will need to be more substantial, and elevated above the surrounding natural surface level, due to the poor black soil conditions.	Workforce available in Tennant Creek. Low to moderate cost option.	Mount Everard offers the lowest construction cost option, though with the Muckaty sites only marginally higher. The sandy clay soil provides a good base for road construction at these three sites.
7.	**Internal road maintenance**	Potentially the lowest road maintenance cost site, with shortest length road, and least expected road damage due to rain/storm damage.	Higher compared to Mount Everard, with significant potential road damage if Ongeva Creek floods across the site.	High potential maintenance cost, due to road length, prevailing soil; conditions, and regular wet season with higher flood potential.	Considered medium-low, low rainfall area. Could be reduced if access road is sealed.	Mount Everard offers the most likely least cost maintenance option for access roads, with Fishers Ridge expected to be the most expensive.

(1) Based on estimates as reported in chapter 7.

(2) Mostly a single lane sealed road off the Stuart Highway, about 80 km north of Alice Springs

(3) Mostly a single lane seal road off the Stuart Highway, approximately 30 km north of Alice Springs

(4) Access approximately 45 km south of Katherine

(5) Depends on location of repository site within Fishers Ridge