Waste Management Plan

TELLUS

PROPOSED CHANDLER FACILITY
DRAFT WASTE MANAGEMENT PLAN

Draft Report | September 2016

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ABBREVIATIONS

EPA	Environment Protection Authority
EPL	Environmental Protection Licence
ERA	Environmental Risk Assessment
ERP	Emergency Response Plan
MSDS	Materials Safety Data Sheet
NT	Northern Territory
WAC	Waste Acceptance Criteria
WAP	Waste Acceptance Policy
WAP	Waste Acceptance Procedure
WMP	Waste Management Plan
WZG	Waste Zoning Guide

1 INTRODUCTION

1.1 Purpose

The purpose of the Waste Management Plan (WMP) is to identify waste handling (transport, storage and isolation) processes that provide a framework for waste management associated with the proposed Chandler Facility (the Proposal).

This plan outlines legal requirements for the acceptance and management of wastes. It also defines waste categories, risks associated with key waste management activities and finally, waste management of hazardous substances including receipt, transport, storage, handling, re-use and permanent isolation.

1.2 Scope

This plan applies to all activities undertaken by employees and contractors at the Chandler Facility which includes the proposed Apirnta Facility and Chandler Facility.

This WMP is a requirement of the following Northern Territory (NT) legislation:

- *Waste Management Pollution Control Act.*
- *Waste Management Pollution Control Regulations.*
- *Work Health and Safety Act*.
- Work Health and Safety Regulations.
- *Dangerous Goods Act.*

Refer to Chapter 2 for more detail on how the above legislation is applicable to the Proposal and this WMP.

1.3 Objectives

The objective of this management plan is to prevent environmental impact from waste management by:

- Identifying and characterising wastes
- Explaining the procedures that will be applied for the safe receipt of wastes coming to the site
- Applying appropriate zoning, segregation and separation criteria.
- Ensuring appropriate methods and techniques are applied for certain waste materials.
- Ensuring appropriate level of responsibility is assigned.
- Preventing environmental risk by applying appropriate waste management policy and criteria.

1.4 Definitions

Table 1-1 outlines definitions to ensure all employees have the opportunity to read and understand various roles, responsibilities levels of waste.

Table 1-1: Definitions

Description	Definition
Competent person	A person assessed as competent by the site general manager for the tasks they shall perform and who has acquired, through training, qualification or experience or a combination of those things, the knowledge and skills required to perform the required task competently.
Dangerous goods	A dangerous good is any hazardous substance declared under Section 6 of the *Dangerous Goods Act 2012* (NT). They are classified on the basis of immediate physical or chemical hazards, such as fire, explosion, corrosion and toxicity that may affect life, health, property or the environment.
Deep Geological Repository	A deep salt facility used to permanently isolate waste. The geological barrier provides permanent isolation of wastes from the environment over the very long term in accordance with Environmentally Sound Management principles and also creates additional opportunities for the future recovery and recycling of valuable materials from the waste which can re-enter the circular economy.
Hazardous substance	A chemical, substance or material used in the workplace, which has the potential to cause injury or have an adverse effect on a person's health. Hazardous substances are listed in the Code of Practice for Managing Risks of Hazardous Chemicals in the Workplace (Appendix C) and are classified only on the basis of immediate or long term health effects.
Hazardous substances register	A comprehensive listing of the hazardous substances on site. Refer to Appendix A of this WMP.
Hierarchy of controls	A defined order which is based on effectiveness for implementing controls to mitigate risk (e.g. elimination, substitution, isolation, engineering, administration and personal protective equipment).
Hazardous Waste Landfill	A hazardous waste landfill, or hazardous waste containment facility (HWCF) is any landfill that accepts waste formally defined as ―hazardous waste‖ or ―listed waste‖ in statutory instruments. Siting, design, operation and monitoring requirements for landfills accepting hazardous waste will be considerably more stringent than for landfills accepting only municipal solid wastes[1].
NORM	Naturally Occurring Radioactive Material.
Risk	A function of the likelihood and severity of adverse impacts on public health, safety or the environment
Waste Acceptance Criteria	The criteria that will be applied for the exclusion or acceptance of certain types of wastes and the requirement for suitable packaging of wastes.

[1] *Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory*

Waste Acceptance Policy	The overall policy framework covering waste acceptance criteria, procedures and zoning
Waste Acceptance Procedure	The Procedure that will be used at the proposed Chandler Facility to determine if wastes meet all of the acceptance criteria
Waste Zoning	Procedure of waste segregation and zoning to physically separate reactive wastes during the transport, receipt, storage and during permanent isolation.

2 LEGISLATION, LICENCES AND PERMITS

2.1 Applicable legislation, regulation and guidelines

Table 2-1 provides a summary of relevant NT legislation applicable to this WMP as well as a brief summary of how it applies during construction and operation of the Proposal.

Table 2-1 Legislation applicable to waste management for the proposed Chandler Facility.

Applicable legislation, Regulation or guidance	Application
***Waste Management Pollution Control Act* and Regulations**	Provides for the protection of the environment by encouraging effective waste management and pollution prevention and control practices. The temporary storage and transfer of hazardous wastes is regulated by the NT Environment Protection Authority (EPA) under this Act. The proponent is required to obtain an Environmental Protection Approval for the Proposal and hold an Environmental Protection Licence (EPL) which is administered and regulated by the NT EPA. Locations at the proposed Apirnta Facility and Chandler Facility, which have potential to cause pollution, may be investigated and managed in accordance with the requirements of the contaminated land provisions of the Act.
***Work Health and Safety (National Uniform Legislation) Act* and Regulations**	The main object of this Act is to provide for a balanced and nationally consistent framework to secure the health and safety of workers and workplaces. This Act and its Regulations apply to the operation of the Proposal.
***Dangerous Goods Act* and Regulations**	This Act and its Regulations applies to the Proposal by providing provisions for the safe storage, handling and transport of certain dangerous goods.
***Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act* and Regulations**	This Act and its Regulations applies to the Proposal by providing provisions for the transport of dangerous goods by road or rail and for related purposes.
Australian Code Transportation of Dangerous Goods by Road and Rail	The model act sets out, in general terms, the legal requirements for transporting dangerous goods by road and rail.

2.2 Matters that do not apply

Whilst the proponent has assessed the following guideline, the NT *Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites* are not applicable to the Proposal.

The Proposal is not a landfill. It is a Deep Geological Repository (DGR). The definitions for a landfill and a DGR are contained in Table 2-1. The NT guidelines deal in large part with surface based facilities but provide important framework that Tellus believe can also be applied to deep geological disposal facilities, which are established in underground voids created by mining, i.e. into land. The guidelines, amongst other waste classifications, include listed waste which are defined as wastes that pose a threat or risk to public health, safety or the environment, and include substances which are toxic, infectious, mutagenic, carcinogenic, teratogenic, explosive, flammable, corrosive, oxidising and radioactive. The guidelines make clear that listed wastes are only to be disposed of at facilities that are licensed to receive listed waste, such as the proposed Facility

3 RESPONSIBILITIES

3.1 Company

- Develop policies and procedures.
- Hold necessary licences and approvals.
- Appoint sufficient competent persons.
- Train staff.
- Establish emergency procedures.

3.2 Supervisors

- Ensure that employees have the knowledge and proper training in handling of hazardous substances that will be encountered during the execution of work.
- Ensure that Materials Safety Data Sheets (MSDS) are available to workers (in the work area) throughout each shift.
- Update the MSDS Register on a needs basis
- Forward a copy of the updated register to the Health Safety and Environment (HSE) co- ordinator.

3.3 Health Safety and Environment Co-ordinator

- Provide guidance for the assessment of hazardous substances and recommendations for controls.
- Facilitate hazardous substances assessments as and when required.
- Periodically audit and verify the adequacy and effectiveness of implemented control measures.
- Site wide hazardous substances register custodian.

3.4 Employees and contractors

- Assess the workplace and work task for hazardous substances before commencing any work.
- Ensure that, when applicable, engineering and administrative controls and Personal Protective Equipment (PPE) shall be in place during handling of hazardous substances.

4 WASTE CATEGORIES

4.1 Hazardous waste

Hazardous wastes are wastes that pose a threat or risk to public health, safety or the environment. They are listed under the *Waste Management and Pollution Control Act*. They include substances which may be toxic, infectious, mutagenic, carcinogenic, explosive, flammable, corrosive, oxidising or radioactive. Hazardous wastes can include medical waste, excess or spent chemicals, contaminated scrap metals or drums, oily rags and absorbents, solvents, batteries, fluorescent tubes, oily sludge, paints and paint drums, oil filters, sewage and contaminated soil.

Tellus Waste Acceptance Policy establishes the context and importance of effective Waste Acceptance Procedures. The Policy states before waste can be accepted for storage or permanent isolation at the proposed Chandler Facility, Tellus must be satisfied that the waste meets agreed acceptance criteria, has been subject to the tests set out in the Waste Acceptance Procedure and that the waste can be accepted in accordance with Approvals and Licences issued by regulators.

WAC have been established to determine waste types which can and cannot be accepted when considering the characteristics and design of the site to achieve safe operation of the facility and to ensure long term environmental protection through containment of potential pollutants present within the wastes. In some cases the criteria used will lead to straightforward “go or no go” decisions based on compatibility with the site characteristics and WAC, and in other cases acceptance values and parameters will be used.

Whilst Tellus will ensure that waste generators are aware of the WAC for the Facility, it is recognised that on some occasions particular wastes presented will not conform to set criteria and re-evaluation of appropriate management techniques will be required so as to achieve the objective of safe storage or permanent isolation so that the threat to the receiving environment is minimised or prevented.

4.2 NEPM waste categories

The types and forms of chemical waste that are likely to be managed at the proposed Facility will generally be generated from industry. Examples of these wastes and their NEPM code are listed in Table 4-1 and a more comprehensive list including indicative volumes are presented in Appendix A.

Table 4-1: Example chemical wastes likely to be suitable[2] for permanent isolation at Chandler

NEPM code	Waste description
N205	Residues from industrial waste treatment/disposal operations
D110	Inorganic fluorine compounds excluding calcium fluoride
N120	Soils contaminated with a controlled waste
N220	Asbestos
J120	Waste oil/water, hydrocarbons/water mixtures or emulsions
D220	Lead; lead compounds
C100	Basic solutions or bases in solid form
D230	Zinc compounds
J100	Waste mineral oils unfit for their original intended use
D300	Non-toxic salts
B100	Acidic solutions or acids in solid form
N160	Encapsulated, chemically-fixed, solidified or polymerised wastes referred to in this list
F100	Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish
M100	Waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated napthalenes, polychlorinated terphenyls and/or polybrominated biphenyls
N100	Containers and drums that are contaminated with residues of substances referred to in this list
N190	Filter cake contaminated with residues of substances referred to in this list
G110	Organic solvents excluding halogenated solvents
M250	Surface active agents (surfactants), containing principally organic constituents and which may contain metals and inorganic materials
A100	Waste resulting from surface treatment of metals and plastics
N150	Fly ash, excluding fly ash generated from Australian coal fired power stations

Each potential waste will be subject to detailed screening using the Waste Acceptance Procedure to determine its suitability for permanent isolation at the Chandler Facility

4.3 Naturally Occurring Radioactive Material waste

The types and forms of radioactive waste that are likely to be managed at the proposed Facility would be generated from mining and processing of mineral ores or other material containing NORM, such as phosphate minerals, mineral sands, coal, some gold bearing rocks and hydrocarbons. These generally contain long lived radionuclides at relatively low concentrations. NORM such as scales arising in the oil and gas industry may have higher activity concentration levels but would need to meet the criteria set for the facility.

[2] In some cases following treatment

All wastes need to be characterised by means of collecting information about the waste in order to build up a picture of its properties. Data will be collected about the radiological, chemical and physical properties of the waste. This information helps to decide how the waste should be handled, packaged, stored and safely disposed of by the facility.

The National Directory for Radiation Protection, February 2014 (RPS 6) sets out to provide an overall framework for radiation safety, including both ionizing and non-ionizing radiation.

Tellus intends to only accept radioactive wastes up to exemption level as defined in Section 3.2 of RPS 6. The general criteria for granting an exemption are:

a) the health risks and the risks to the environment associated with the source, practice, or type of person using a source are sufficiently low as to be of no regulatory concern; and

b) radiation protection, including the cost of regulatory control, has been optimised.

The criteria to exempt radioactive material or practices from notification, registration and licensing are:

(a) the radioactive material has an <u>activity concentration</u> less than that prescribed in Schedule 4 of RPS 6 or consists of or contains less than the <u>activity</u> prescribed in Schedule 4 of RPS 6, or

(b) the radioactive material has an activity concentration greater than that prescribed in Schedule 4 of RPS 6 and consists of or contains greater than the activity prescribed in Schedule 4, but causes an annual effective dose to an individual member of the public of less than 10 μSv, and a collective effective dose to the critical group committed by one year of performance of the practice, as determined by the Authority, of less than 1 person.Sv, or

(c) in the case of a mixture of radioactive materials, where each of the radioactive materials present does not exceed the individual activity or activity concentration, the mixture is defined as exempt if the sum of the fractions obtained by dividing the activity of each material present by the appropriate activity value from Schedule 4 of RPS 6, or the sum of the fractions obtained by dividing the activity concentration of each material present by the appropriate activity concentration value from Schedule 4 of RPS 6, does not exceed 1.

(d) in the special case of exposure to naturally-occurring radon-222 in the workplace, the long-term average concentration of radon-222 is less than 1000 Bq/m3.

The Exempt activity concentrations and exempt activities of radionuclides are taken from the IAEA's International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series 115 [IAEA 1996], and is supplemented from NRPB Report R306, Exempt Concentrations and Quantities for Radionuclides not Included in the European Basic Safety Standards Directive [NRPB 1999].

5 CONCEPTUAL SITE MODEL

8.1.1 Introduction

A site conceptual model is a simplified representation of the physical hydrological and hydrogeological setting and understanding of the system. This includes the identification and description of the geologic and hydrologic frameworks, recharge to the system, groundwater flow dynamics and surface-groundwater interaction processes.

8.1.2 Surface water and groundwater connectivity

The widespread absence of permanent surface water features across the Proposal area means that the groundwater and surface water systems are not connected in the vicinity of the Chandler Facility or the Apirnta Facility. Shallow groundwater levels and gradients within the alluvium groundwater system indicate some potential for connectivity to the south-east along the Finke River about 20 kilometres from the Chandler Facility.

There are no groundwater monitoring bores located directly adjacent to the Finke River and screened within the deeper groundwater systems (i.e. Idracowra Sandstone, Horseshoe Bend Shale or Langra Formation). Therefore, it is difficult to gain a comprehensive understanding of connectivity in areas along the Finke River directly down hydraulic gradient of the Chandler Facility. Characterisation of the water type of the springs located along the Finke River to the south and south-east of the Chandler Facility suggest the source of water from these springs is likely to be derived from the perched shallow alluvial sediment and not the deeper groundwater system connected to the Chandler Facility approximately 50 kilometres away.

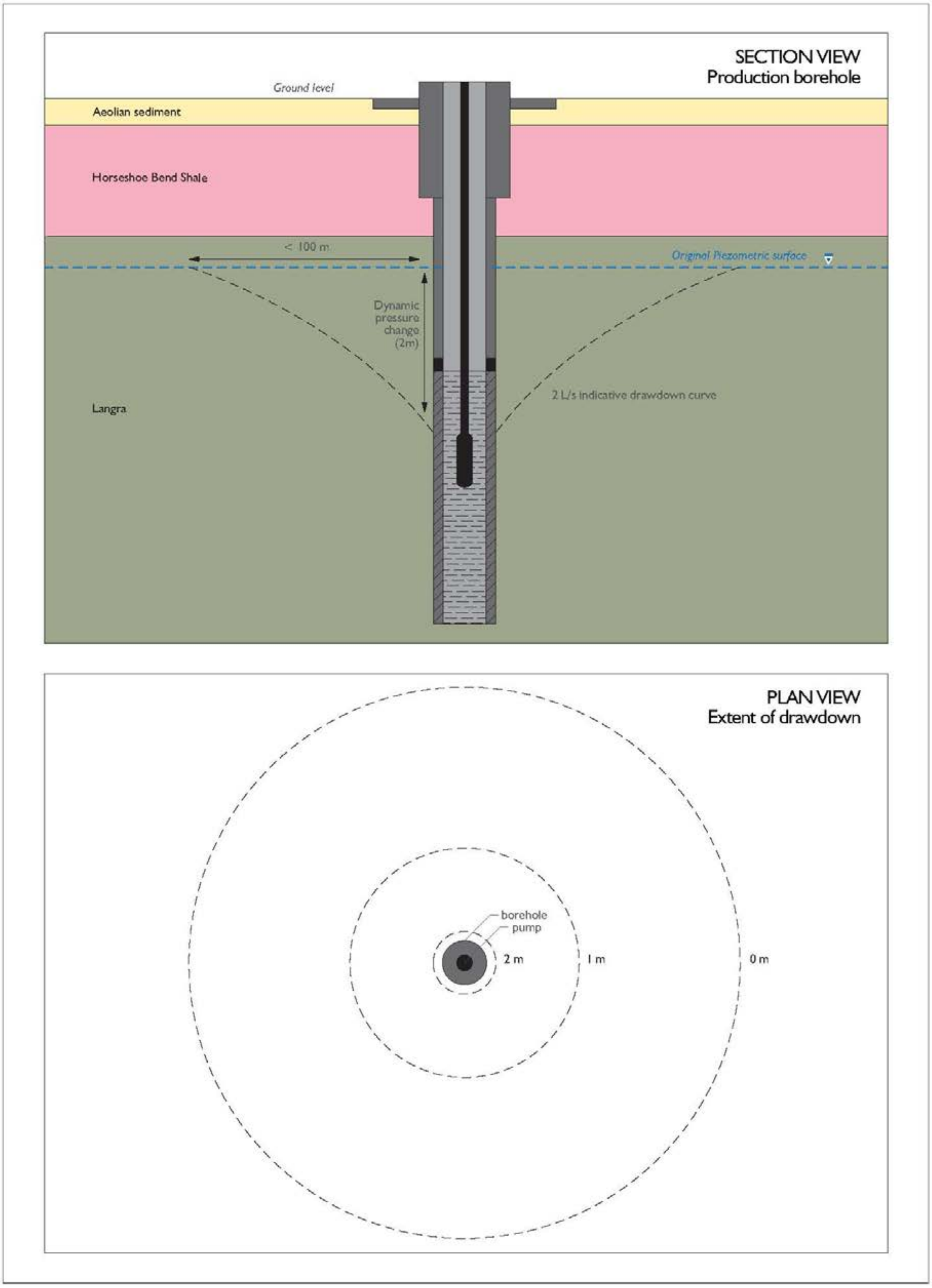
This implies a lack of connectivity, which would mean that any potential drawdown impacts in the deeper groundwater systems arising from Proposal dewatering through abstraction or mining activities would not impact surface water resources.

It should also be noted that the drawdown impacts arising from the Proposal would be of such low magnitude and extent that they would not reach the spring areas. This is due to the low rate of groundwater pumping throughout the Proposal life (1.7 L/s, which is broadly consistent with stock and domestic rates), and also the limited extent of drawdown due to the relatively low permeability aquifer units, and the intervening aquitard units.

An indicative pumping and drawdown relationship has been conceptualised in Figure 5-1. This schematic assumes that the extent of drawdown generated through consistent pumping of the Langra groundwater system at a rate of 1.7 L/s is constrained to a 100 metre radius.

The potential impacts of groundwater dewatering at depths between 160 metres below ground level to 220 metres below ground would be modelled following the completion of detailed design and further drilling campaigns expected to commence in March 2017. In addition, any potential impacts of drawdown would be further discussed and illustrated through supplementary material to this EIS.

Figure 5-1 Conceptual groundwater drawdown within the Langra groundwater system



8.1.3 Groundwater systems

The Proposal area is within the Chandler Syncline, itself within the south-eastern extent of the Amadeus Basin. The Chandler Syncline hosts various local groundwater systems, all of which have minor confining layers and permeability barriers to groundwater flow. The basal unit overlying the Chandler Formation and target salt resource is the Giles Creek Dolostone Formation, comprising predominantly dolomitic calcareous shales and sand and silt sediment. Overlying the Giles Creek Dolostone Formation is the Jay Creek Limestone Formation, comprising predominantly of marine shale, silt and sand sediments and thin beds of dolomite.

Overlying the Jay Creek Limestone Formation is the Stairway Sandstone Formation, a thick geological sequence comprising predominantly continental coarse to medium grained sandstone within interbedded minor silt and shale beds.

Overlying the Stairway Sandstone Formation is the Langra Formation, a geological unit subdivided into three member units, represented at depth by interbedded silt and shale beds, gradually transitioning into extensive fine to medium grained sand.

Overlying the Langra Formation is the Horseshoe Bend Shale Formation, a massive siltstone and quartzitic sandstone deposit. Directly above the Horseshoe Bend Shale Formation and partially eroded at surface across the Proposal area is the Idracowra Sandstone, a kaolinitic sandstone represented across the Maryvale Hills and discontinuous across the Proposal area.

Locally in the vicinity of the Proposal area, there is limited recharge from direct rainfall and minor recharge is expected to occur via infiltration from overlying alluvial systems during major flooding events. Minor direct rainfall recharge may occur locally, but the low rainfall and high evaporation means this volume would be minimal and the presence of stratified low permeability clays and silts in the middle and lower members of the Langra Formation is likely to result in the formation of perched localised groundwater systems in the upper Langra Formation and Horseshoe Bend Shale Formation.

Consistent with topographic gradients, hydraulic gradients are very gentle in the south-eastern extent of the Amadeus Basin, and the broad flow direction in all groundwater systems is generally from northwest to southeast.

Two cross sections were drawn across the Chandler Facility (see Figure 5-2). The basement structure (typically associated with folding) influences the groundwater flow direction in certain areas across the Proposal area and allows a conceptual understanding of how the site's hydrology and hydrogeology performs (see Figure 5-3, Figure 5-4 and Figure 5-5). The horizontal hydraulic conductivity in geological units is likely to be highly variable, due to the depositional environments and volume of clay; substantial lateral flow through Formations is therefore not expected.

There is an upwards hydraulic gradient from the Langra Formation to the Horseshoe Bend Shale Formation based on pressure head differences observed through groundwater monitoring, but there is no evidence of substantial flow volumes between these units. Elsewhere, within the 25 kilometres spatial buffer around the Chandler Facility, landholder bores located within the shallow alluvium report shallow groundwater levels which are likely to be perched systems, with very little vertical leakage to the underlying Idracowra Sandstone Formation and Horseshoe Bend Shale Formation.

The saline groundwater quality within the Chandler Syncline is differs markedly from the potable water quality reported for the Mereenie Aquifer System about 100 kilometres north within the Northern Amadeus Basin.

The Chandler Syncline system is considered to be a separate groundwater system entirely and therefore, not connected to the groundwater sources utilised for the Alice Springs Water Supply. The evidence confirms that the Chandler Syncline system is distinct and separate from the Mereenie Aquifer System in terms of geological structure, lithological units, groundwater flow properties, hydraulic gradients and hydro-geochemistry.

Water quality within shallow alluvial groundwater accessed by landholder bores to the north and west of the Chandler Facility, particularly at Titjikala, is potable. By comparison, groundwater quality observed within the Horseshoe Bend Shale and Langra local groundwater systems at the Chandler Facility is poor and saline. Salts originating from the marine depositional environment, and the enhanced climatic nature of the environment (i.e. low precipitation/high evaporation), coupled with long groundwater residence times is likely to contribute to the poor groundwater quality observed within the Chandler Syncline.

Figure 5-2 Location of conceptual cross section lines

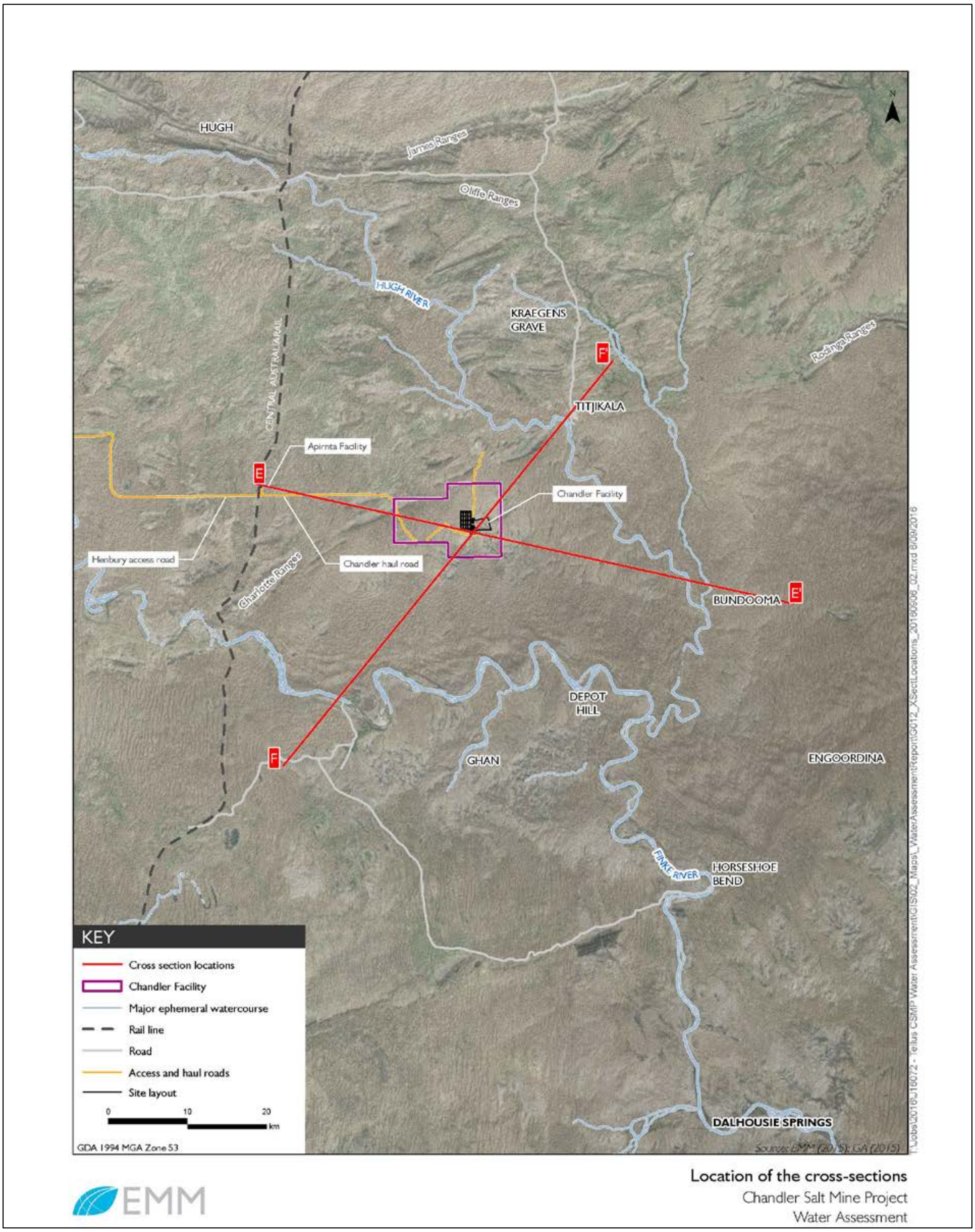


Figure 5-3 Cross section D-D[1] conceptual hydrogeological cross section

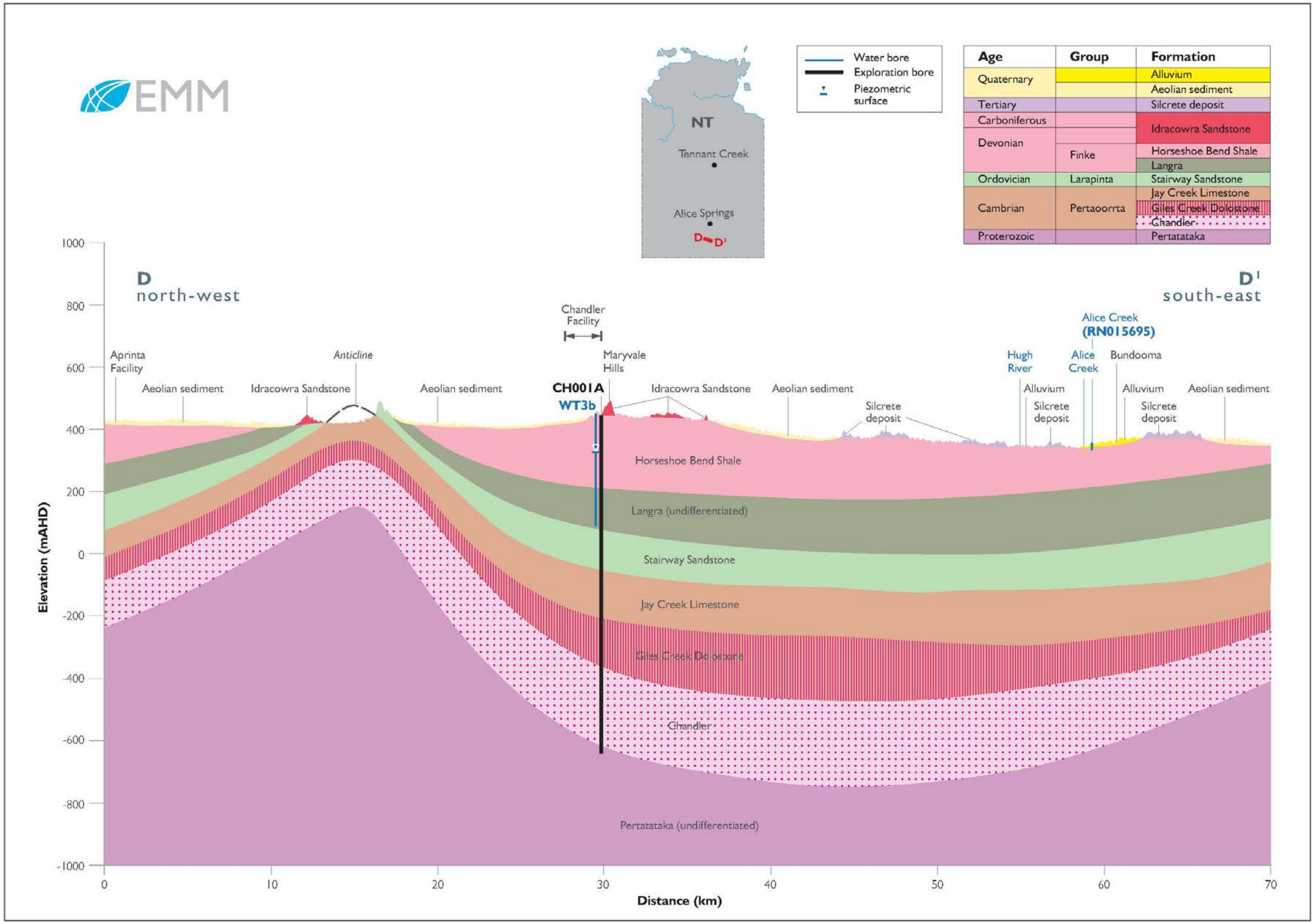


Figure 5-4 Conceptual site model

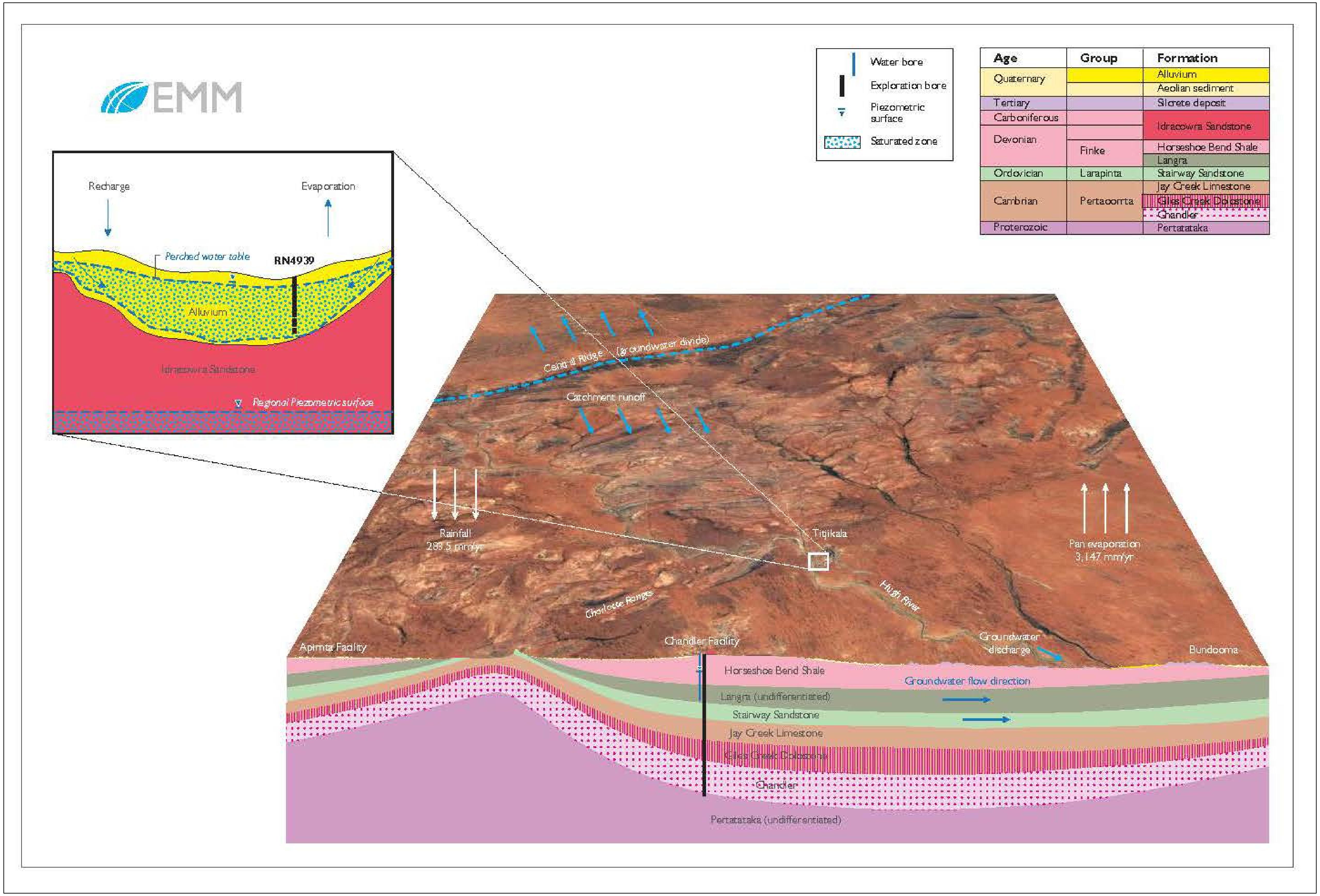
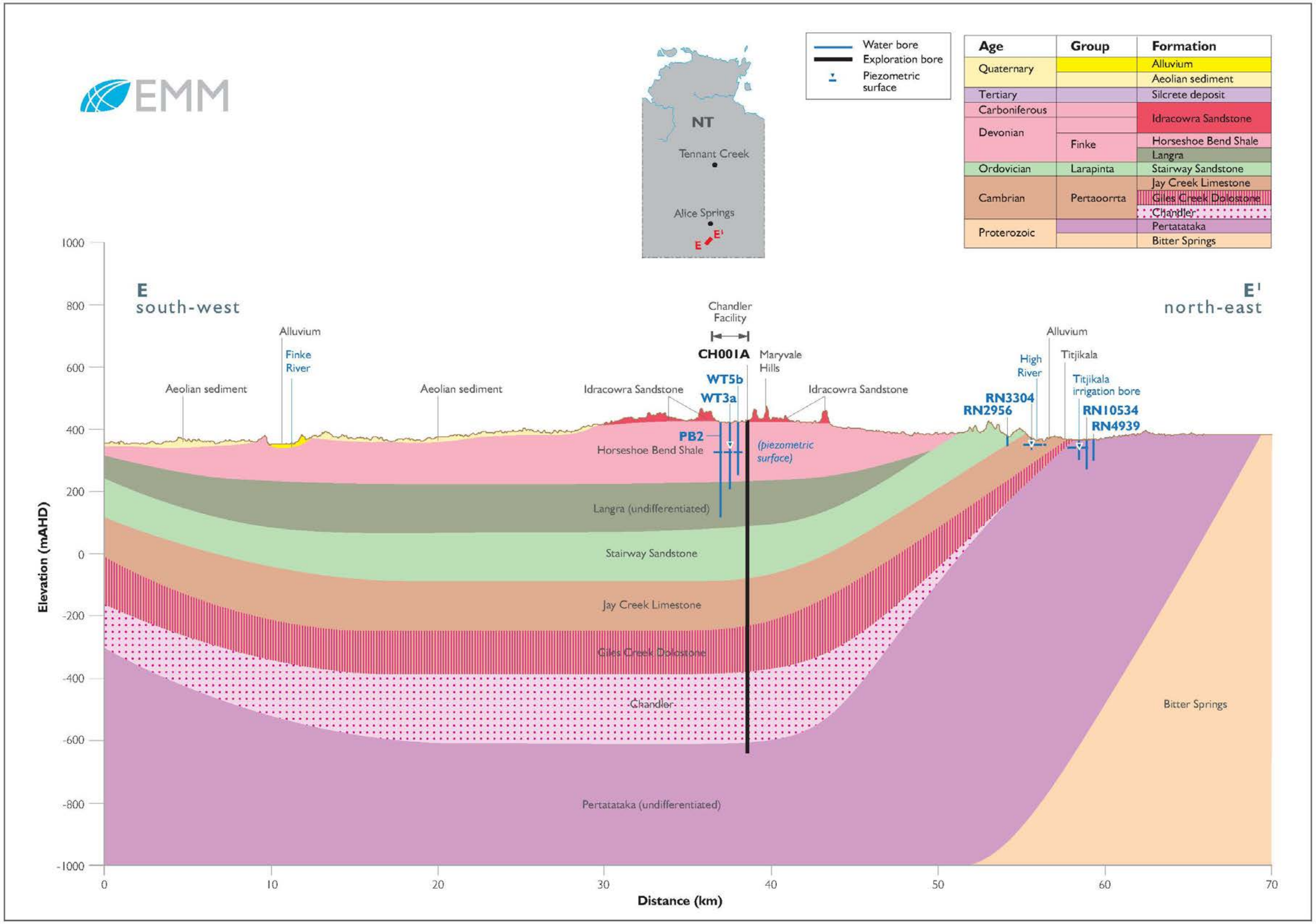


Figure 5-5 Cross section E-E[1]



8.1.4 Water balance

A water balance involves the estimation of the storage and flow of water in a defined area, during a given timeframe. A mass balance equation is used in which the change of water stored within an open (natural) hydrological system is equal to the inputs to the system minus the outputs from the system (Todd and Mays 2005):

$$\text{Change in storage } (\Delta S) = \text{Inflows} - \text{Outflows}$$

A water balance combining the mine water management system, abstracted saline and potable groundwater, and saline water intercepted during construction has been prepared for the construction and operations phases.

The water balance is based on the conceptual mine plan and would be updated following the completion of detailed design. The results of the updated water balance would be carried through into the Proposal's Water Management Plan.

The conceptual water balance is presented in Figure 5-6 below and indicates marginal net change in total site water inventory during the operation phase.

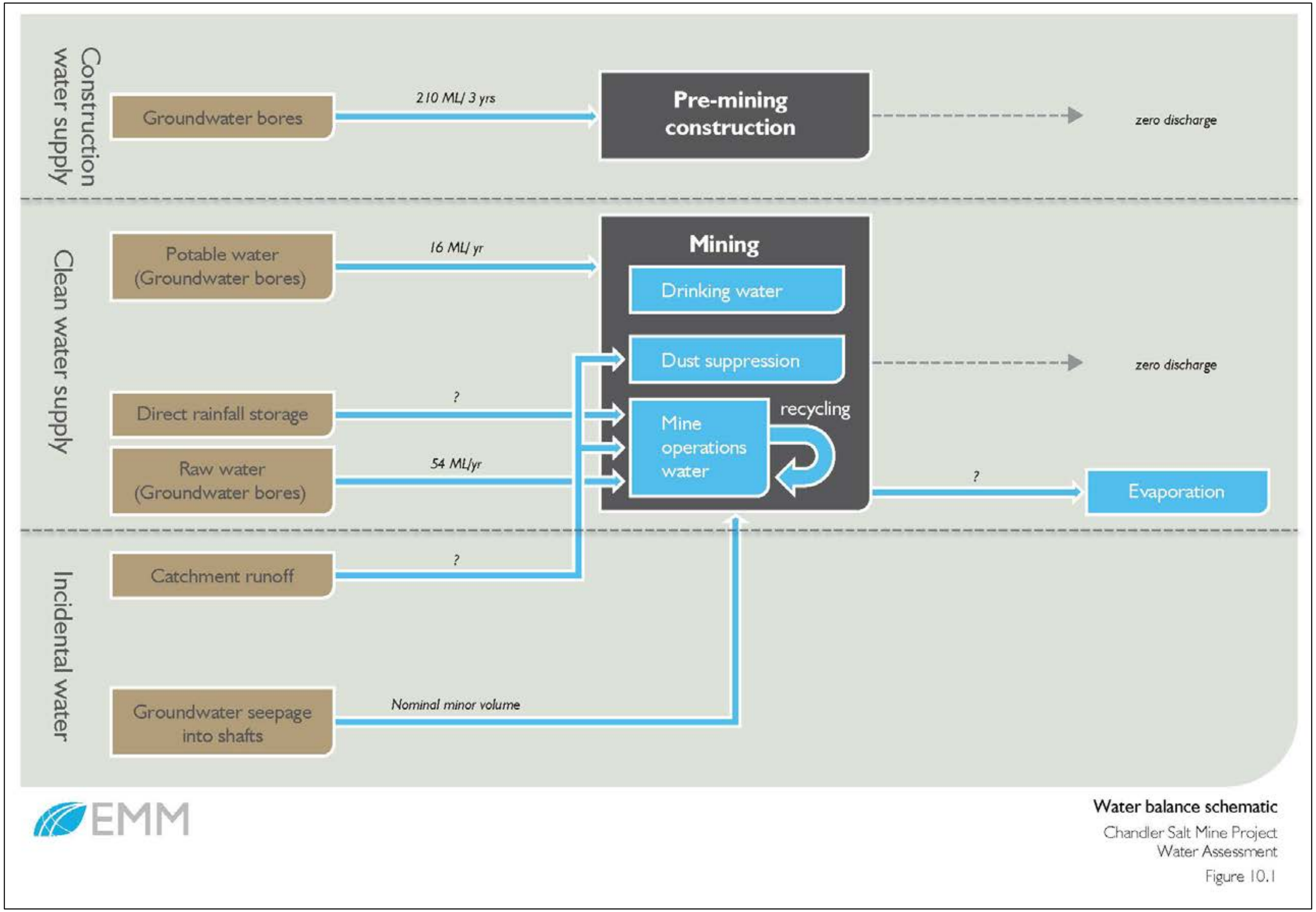
Table 8-1 Water balance (average rainfall year)

Parameter	Construction (ML/year)	Operation – Year 1 (ML/year)
Inflows to water management system		
Groundwater inflow to shafts	0	0
Catchment runoff	203	203
Direct rainfall on water storages	143	143
Raw water supply for processing/dust suppression activities	54	54
Potable water supply	16	12
Total inflows	*416*	*412*
Outflows from water management system		
Net site water management system	70	66
Uncontrolled releases	0	0
Evaporation	346	346
Total outflows	*416*	*412*
Net change in total site water inventory	**0**	**0**

Notes: 1. ML/year = megalitres per year.

The water management system maximises the capture and reuse of mine affected water. The majority of water will be sourced from groundwater abstraction with make-up water supplied via on-site sources (i.e. rainfall runoff). Mine affected water will be reused to the supply the processing plant and water dust suppression demands in addition to groundwater abstraction.

Figure 5-6 Water balance schematic



6 RISK ASSESSMENT

6.1 Methodology

Environmental Risk Assessment (ERA) is the process undertaken to identify, evaluate and mitigate potential environmental impacts and risks to human health and the environment associated with the Proposal. The design for the Proposal included input from a wide range of technical disciplines, and therefore, a Project based ERA was undertaken to ensure consistency in determining the level of risks.

A standardised approach to evaluating significance of risks does not replace the methodologies used by technical disciplines to identify or assess impacts, nor does it replace methods of impact assessment prescribed by existing guidance. Rather, it adds to the impact assessment by providing clear, more readily comparable conclusions regarding the significance of impacts. The risk assessment methodology has been devised by the proponent based upon the broad definitions and methodology and principles outlined in AS/NZS ISO 31000:2009.

The standardised risk assessment for the proposed Facility involved the following steps:

- **Hazard Identification**
    - The identification of potential environmental hazards associated with various components ('aspects') of the Proposal.
    - Identifying the nature of the identified hazards (defined as "beneficial", "neutral" or "adverse").
- **Pre-Mitigation Risk**
    - Assessing the *'likelihood'* of an identified hazard occurring.
    - Defining the *'consequence'* of the hazard occurring, as described by impacts of health & safety, environmental, financial, project delivery or social impacts.
    - As a product of the *likelihood* and *consequence*, determining the pre-mitigation composite risk index i.e. '*risk*' (CRI = likelihood x consequence).
- **Identifying Required Mitigation**
    - Identifying the mitigation required to control the risk as a consequence of likelihood of the hazard; and/or
    - Identifying the mitigation required to control the risk as a consequence of consequence of the hazard.
    - Documenting the owner of those mitigation actions, the time and cost implications and detailing a review date.

Post-Mitigation Risk

- Reassessing the *'likelihood'* of an identified hazard occurring in light of the implemented mitigation.
- Reassessing the *'consequence'* of the hazard occurring in light of the implemented mitigation.
- As a product of the mitigated *likelihood* and *consequence*, determining the post-mitigation composite risk index i.e. '*risk*'. This is often termed as 'residual risk' or occasionally 'current risk'.

6.1.1 The nature of an identified hazard

By definition, a 'hazard' is described as a source of potential harm, but as the risk assessment methodology may be used to identify beneficial impacts in this context a 'hazard' is identified as impact of the Proposal of whatever nature. For the purposes of this WMP the following descriptors are used:

- **Beneficial:** The hazard has a potential beneficial impact upon the environment.
- **Neutral**: The hazard has neither a beneficial or adverse impact on the environment. Occasionally, the term 'benign' is used. Typically, a hazard will be categorised as having a neutral nature post-mitigation.
- **Adverse:** The hazard has a potentially adverse impact on the environment.

6.1.2 Evaluating likelihood

The likelihood of a hazard and an impact occurring can be described in terms of probability. Overlaying this is the need to recognise that uncertainty may be associated with potential risks occurring, particularly during the initial risk assessment process. Where scientific uncertainty exists, a precautionary approach was taken which identified a higher level of risk. Each identifiable impact can be assigned a likelihood of occurring, ranging from rare to almost certain.

In simplifying the potential impacts for the purpose of a risk assessment, an element of subjectivity is introduced. The purpose of the risk assessment is not necessarily to agree on the probability of any particular impact, but to facilitate an understanding of the relative probability of different impacts.

The pre-mitigation assessment of likelihood needs to account for the probability of an identified hazard occurring, assuming the incorporation of 'designed-in' mitigation that would be required to comply with legislation, relevant guidance, or otherwise which is intrinsic to the design specification upon which the development proposal has been based.

Columns two to four in Table 6-1 give descriptions that elaborate on the possible likelihood categories. These are presented to help view the impact from different perspectives.

Table 6-1 Likelihood of a hazard

Likelihood	Description	Probability	Mid-Interval	Community outlook
Almost certain	Is expected to occur in most circumstances	0.91<P<1.00	0.95	Almost everyone affected
Likely	Will probably occur in most circumstances	0.61<P<0.90	0.75	Most people affected
Possible	Might occur at some time	0.41<P<0.60	0.50	Many people affected
Unlikely	Could occur at some time	0.11<P<0.40	0.25	Some people affected
Rare	May occur only in exceptional circumstances	0.01<P<0.10	0.05	Few or no people affected or interested

6.1.3 Evaluating consequence

To determine the consequence of potential impacts, clearly described thresholds were developed which included the scale of impact, its geographic extent, duration, ecological and social sensitivity, reversibility, cumulative effects and likelihood of occurrence.

In simplifying the potential impacts for the purpose of a risk assessment, an element of subjectivity is introduced. The purpose of the risk assessment is not necessarily to agree on the defined consequence of any particular hazard, but to facilitate an understanding of the relative impacts.

The pre-mitigation assessment of consequence needs to address the severity of an identified hazard occurring, assuming the incorporation of 'designed-in' mitigation that would be required to comply with legislation, relevant guidance, or otherwise which is intrinsic to the design specification upon which the development proposal has been based.

Table 6-2 give descriptions that elaborate on the possible consequence categories. These are presented to help view the impact from different perspectives.

Table 6-2 Consequence of a hazard

Descriptor	Description (examples)				
	Health	Environmental	Financial Loss	Project Delivery	Social
Catastrophic	Death	Toxic release off-site with detrimental effect	Cessation of production capability / Huge financial loss	Project incapable of completion / Unviable	No social licence to operate
Major	Extensive injuries	Off-site release with no detrimental effects	Loss of production capability Major financial loss	Project can only be completed with major changes (redesign)	Reactive media plan, recovery plan, working committees
Moderate	Medical treatment required	On-site release contained with outside assistance	High financial loss	Project can be completed with moderate changes	Additional meetings.
Minor	First aid treatment	On-site release immediately contained	Medium financial loss	Project can be completed with changes	Additional local engagement
Insignificant	No injuries	None	Low financial loss	Trivial	Insignificant

6.1.4 Evaluating risk

The risk of an identified hazard (sometimes also called the 'significance') was determined as a product of the likelihood of the hazard and its consequence on the environment, resource, social value or receptor that it would potentially impact, or as a consequence to the delivery of the Proposal, assuming that the mitigation required to comply with legislation, relevant guidance and the design specifications for the Proposal have been implemented.

In order to standardise the significance rating assigned to potential environmental impacts, a matrix was developed and two multi-disciplinary workshops were held by key members of the EIA team in May 2015 and again in March 2016.

A generic set of risk criteria is defined (refer to Table 6-3) and enables a consistent description of both adverse and beneficial impacts. In each chapter, the significance criteria are made relevant to the topic being considered.

Table 6-3 Generic significance criteria

Significance	Criteria
Extreme	These impacts are considered critical to the decision making process. They tend to be permanent, or irreversible, or otherwise long term, and can occur over large scale areas. These effects are generally but not exclusively associated with sites and features of and/or the impacts of national importance. Typically, mitigation measures are unlikely to remove such effects.
High	These impacts are likely to be of importance in the decision making process. They tend to be permanent, or otherwise long to medium term, and can occur over large or medium scale areas. Environmental receptors are high to moderately sensitive, and/or the impacts are of state significance.
Medium	These impacts are relevant to decision making, particularly for determination of environmental management requirements. These impacts tend to range from long to short term, and occur over medium scale areas or focused within a localised area. Environmental receptors are moderately sensitive, and/or the impacts are of regional or local significance.
Low	These impacts are recognisable, but acceptable within the decision making process. They are still important in the determination of environmental management requirements. These impacts tend to be short term, or temporary and at the local scale.
Eliminated	As a consequence of mitigation, the likelihood and/or the consequence has been removed.

6.1.5 Risk assessment matrix

Based on the assessment of likelihood and consequence, any foreseeable impact can be assigned a risk rating. The EIA is at this point intended to focus on potentially significant environmental risks and impacts.

Table 6-4 is to be read as a matrix, with increased consequence across the top and increased likelihood on the far left column. Any potential impacts that fall in the top left of the matrix are therefore addressed as *key environmental issues requiring detailed environmental assessment* in the EIS. Impacts that fall into the bottom right of the matrix are addressed as *other issues* in the EIS

Table 6-4 Risk matrix

Consequence / Likelihood	eliminated	insignificant	minor	moderate	major	catastrophic
almost certain	eliminated	high	high	high	extreme	extreme
likely	eliminated	medium	medium	high	high	extreme
possible	eliminated	low	medium	medium	high	high
unlikely	eliminated	low	low	medium	medium	high
remote	eliminated	low	low	low	medium	medium
eliminated	eliminated	eliminated	eliminated	eliminated	eliminated	eliminated

6.1.6 Duration

This assessment also requires consideration of the duration of the impact (refer to Table 6-5).

Table 6-5 Relative duration of environmental effects

Duration of environmental effects	Period
Temporary	Days to months
Short-term	Up to 1 year
Medium-term	From 1 to 5 years
Long-term	From 5 to 50 years
Permanent/irreversible	Over multiple generations

6.1.7 Uncertainty

The uncertainty of risk is evaluated according to the following descriptors:

- **Low:** the risk has been determined through quantitative assessment procedures, or is determined to a high degree by a person with adequate skill and experience to make the assessment.
- **Medium:** the risk has been evaluated through qualitative assessment and represents a reasonable estimate of risk under normal circumstances.
- **High:** the risk is largely unknown

6.2 Key activities

The key activities that may give rise to risk on the receiving environment and/or human health include:

- Transport of hazardous waste
- Handling of dangerous goods or hazardous waste
- The action of emplacing and isolating hazardous wastes
- Accidental spills or leaks that contain hazardous or dangerous wastes.

6.3 Identified risks

Detailed Proposal risk assessments were undertaken by the proponent at various stages of design and in the preparation of the EIS. The full risk assessment is contained in the EIS.

Risks that apply to this WMP include risks associated with transporting, handling and storing wastes at the Apirnta and Chandler Facilities. Table 6-6 provides a summary of those risks associated with operation of the above Facilities.

Table 6-6 Identified risks associated with managing hazardous wastes

Hazard	Aspect / Descriptor
Human Health / safety	exposure from dry waste
Human Health / safety	exposure from waste wet
Human Health / safety	exposure from radiation
Human Health / safety	exposure from fuel spills
Transport	The transport of large volumes of waste materials may result in an accidental spill leading to irreversible or long-term impacts on flora or fauna species and waterways.
Storage	Above or below ground storage may result in uncontrolled release of gases and/or offensive odours.

6.4 Risk management

A documented risk assessment shall be conducted prior to working with hazardous substances and repeated any time the scope of work changes or any surrounding conditions (e.g. design or weather) change.

The risk assessment shall be compliant with Tellus' risk management protocols identified in the Environmental Impact Statement (EIS) and include as a minimum:

- The potential for personnel to be adversely affected by the hazardous substances.
- Other work occurring simultaneously in adjacent areas e.g. maintenance work along the Central Australian Railway.
- Selection of appropriate control measures using the hierarchy of controls (refer to Section 7.2 for more information).
- The potential for weather or other external conditions to influence the work with hazardous substances (e.g. temperature, power failure, wind, rain, dust, gases, poor lighting, etc.)
- Selection of appropriate equipment to safely carry out the task.
- Selection of appropriate Personal Protective Equipment (PPE)
- Environmental spill response procedures.
- Emergency procedures in the event of an incident.

The completed risk assessment shall be provided to the site general manager for approval prior to any work commencing with dangerous goods or hazardous substances.

7 WASTE MANAGEMENT

7.1 Introduction

Waste management refers to the acceptance, storage and handling of hazardous waste materials at the Apirnta Facility and the Chandler Facility.

Management of waste is structured as follows:

- **Key Activities** (refer to Section 6.2)
- **Risks** - The potential environmental impacts and residual risk levels are identified for each environmental aspect described in Section 6.3.
- **Objectives** - The guiding environmental management objectives and activities that apply to identified risks.
- **Hierarch of controls** - outlines the preferred hierarchy of controlling exposures to hazardous substances. In order of preference the hierarchy is: policy, criteria, procedure and waste zoning. Together, these aspects aim to either eliminate, avoid or minimise risk. In addition to these aspects, facility design, fire protection, administration, and PPE are also considered orders of control (refer to Section 7.2 for more information).
- **Mitigation Measures** - The procedures to be employed to ensure that the relevant objectives are met.
- **Responsibility** - Nominates the responsible position for implementing actions and monitoring (refer to Section 3 for more information).
- **Emergency Response Plan** (ERP) - The actions to be implemented in the case of an accident or noncompliance. This will include strategies of remediation and the person(s) responsible for the actions (refer to Section 7.3).

7.2 Hierarchy of controls

Tellus have developed a suite of waste acceptance documents under which Tellus would operate their facilities; define the type of waste materials that would be accepted by Tellus; explain how waste material will be tested and then how the material would be stored and isolated during operations. The documents are in order of a hierarchy as follows:

- Waste Acceptance Policy.
- Waste Acceptance Criteria (WAC).
- Waste Acceptance Procedure (WAP).
- Waste Zoning Guide (WZG).

7.2.1 Waste Acceptance Policy

The aim of the Waste Acceptance Policy document is to set a framework for each of Tellus' proposed Facilities. The Policy states before waste can be accepted for storage or permanent isolation at the proposed Chandler Facility, Tellus must be satisfied that the waste meets agreed acceptance criteria, has been subject to the tests set out in the WAP and that the waste can be accepted in accordance with Approvals and Licences issued by regulators.

7.2.2 Waste Acceptance Criteria

WAC have been established to determine waste types which can and cannot be accepted when considering the characteristics and design of the site to achieve safe operation of the facility and to ensure long term environmental protection through containment of potential pollutants present within the wastes. In some cases the criteria used will lead to straightforward "go or no go" decisions based on compatibility with the site characteristics and WAC, and in other cases acceptance values and parameters will be used.

The objective of the Chandler WAC is to establish and explain to regulators, customers and other stakeholders;

- The criteria that will be applied for the exclusion of certain types of wastes.
- The criteria that will be applied to the acceptance of certain types of wastes.
- The requirement for suitable packaging and the criteria that will be applied for packaging acceptance.

It is normal when establishing waste acceptance criteria for storage and permeant isolation to first determine which wastes, under normal circumstances, will not be accepted i.e. will be excluded. In making this determination, and in keeping with best practice in similar facilities, including those developed under Appendix A of the EC Waste Acceptance Criteria, wastes that may undergo undesired physical, chemical or biological transformation after they have been deposited will not be accepted at Chandler.

Materials possessing the following characteristics, unless they pass the WAC tests outlined in the WAP, will normally be excluded from storage and permanent isolation at the Chandler Facility unless they can be modified to a form that makes them suitable for storage or permanent isolation, and they subsequently pass the WAP tests.

Liquids

Unless they can undergo solidification/stabilisation processing or be incorporated into the hydraulic backfill mixtures to make them suitable for permanent isolation, liquid wastes are to be excluded from permanent isolation at the proposed Facility. It is assumed that containers containing liquids will eventually fail in the conditions of storage and allow the liquid to seep into the encapsulating salt bed.

The liquid material may cause a portion of the surrounding salt to dissolve, which will create a void and potentially undermine the structural integrity of the facility. Similarly, waste sludges are to be excluded from permanent isolation at the Facility unless treatment can be applied to remove any free liquid and create a waste form which is structurally sound and in keeping with maintaining the integrity of the underground storage rooms.

Explosive materials

The following classes of materials, as defined by *The Australian Code for the Transport of Dangerous Goods by Road and Rail* (2016) are not acceptable in the conditions of storage;

- Class 1.1 – substances and articles that have a mass explosion hazard (a mass explosion is one that affects almost the entire load virtually instantaneously).
- Class 1.2 – substances and articles that have a projection hazard but not a mass explosion hazard.
- Class 1.3 – substances and articles that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. This includes substances and articles that give rise to considerable radiant heat, or that burn one after another, producing minor blast or projection effects or both.

Materials that are not themselves explosive but which have the potential to form or generate an explosive atmosphere of gas or vapour will not be accepted for permanent isolation at the Facility unless they can be treated so that they no longer produce explosive gas which is higher than 10 % of the concentration which corresponds to the lower explosive limit.

Highly flammable materials

The following classes of materials, as defined in The Australian Code for the Transport of Dangerous Goods by Road and Rail (2016), in the conditions of storage will not be accepted;

- **Class 3 – Flammable liquids**. Liquids, or mixtures of liquids, or liquids containing solids in solution or suspension which give off a flammable vapour at temperatures of not more than 60 °C, closed cup test, or not more than 65.6 °C, open-cup test, normally referred to as the flash point.
- **Class 4.1 – Flammable solids**. Solids which, under conditions encountered in transport, are readily combustible or may cause or contribute to fire through friction; self-reactive substances which are liable to undergo a strongly exothermic reaction; solid desensitised explosives which may explode if not diluted sufficiently;
- **Class 4.2 – Substances liable to spontaneous combustion**. Substances which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up in contact with air, and being then liable to catch fire;

- **Class 4.3 – Substances which in contact with water emit flammable gases**. Substances which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

Some substances that are flammable, such as wood and synthetic materials, may on a case by case risk assessed basis be acceptable for permanent isolation if they require an open flame and available supply of oxygen for combustion since in the conditions of storage they will be buried in an environment which will become devoid of both these characteristics.

Class 4.3 substances may be suitable in the conditions of storage due to the absence of water at the Facility.

Highly reactive materials

The following classes of materials, as defined in *The Australian Code for the Transport of Dangerous Goods by Road and Rail* (2016), when in the conditions of storage will not be accepted:

- **Class 5 – Oxidising Substances**. Substances that, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other materials.

- **Class 8 – Corrosive substances**. Substances that, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage or even destroy, other goods or the means of transport; and may cause other hazards

Verification of the oxidising or corrosive nature of the material will be required, by a combination of chemical (pH) and other corrosivity testing.

Gases

Gases will not be accepted at the Facility, even if altered into a liquid or solid form (e.g. compressed, liquefied, dissolved, or adsorbed). Permanent isolation cannot be guaranteed, and gas migration could cause a loss of volume within the permanent isolation room, possibly undermining the structural stability.

Infectious materials

Infectious wastes such as "Clinical wastes" including waste generated by medical, nursing, dental, veterinary, pharmaceutical or other related activity which is;

- Poisonous or infectious.

- Likely to cause injury to public health.

- Contains human tissue or body parts.

Biodegradable materials

The chemical reactions involved in both aerobic and anaerobic decomposition processes produce combustible hazardous gases, and can cause significant volume reduction; therefore biodegradable wastes will generally deemed to be incompatible with the proposed Facility.

Nuclear material

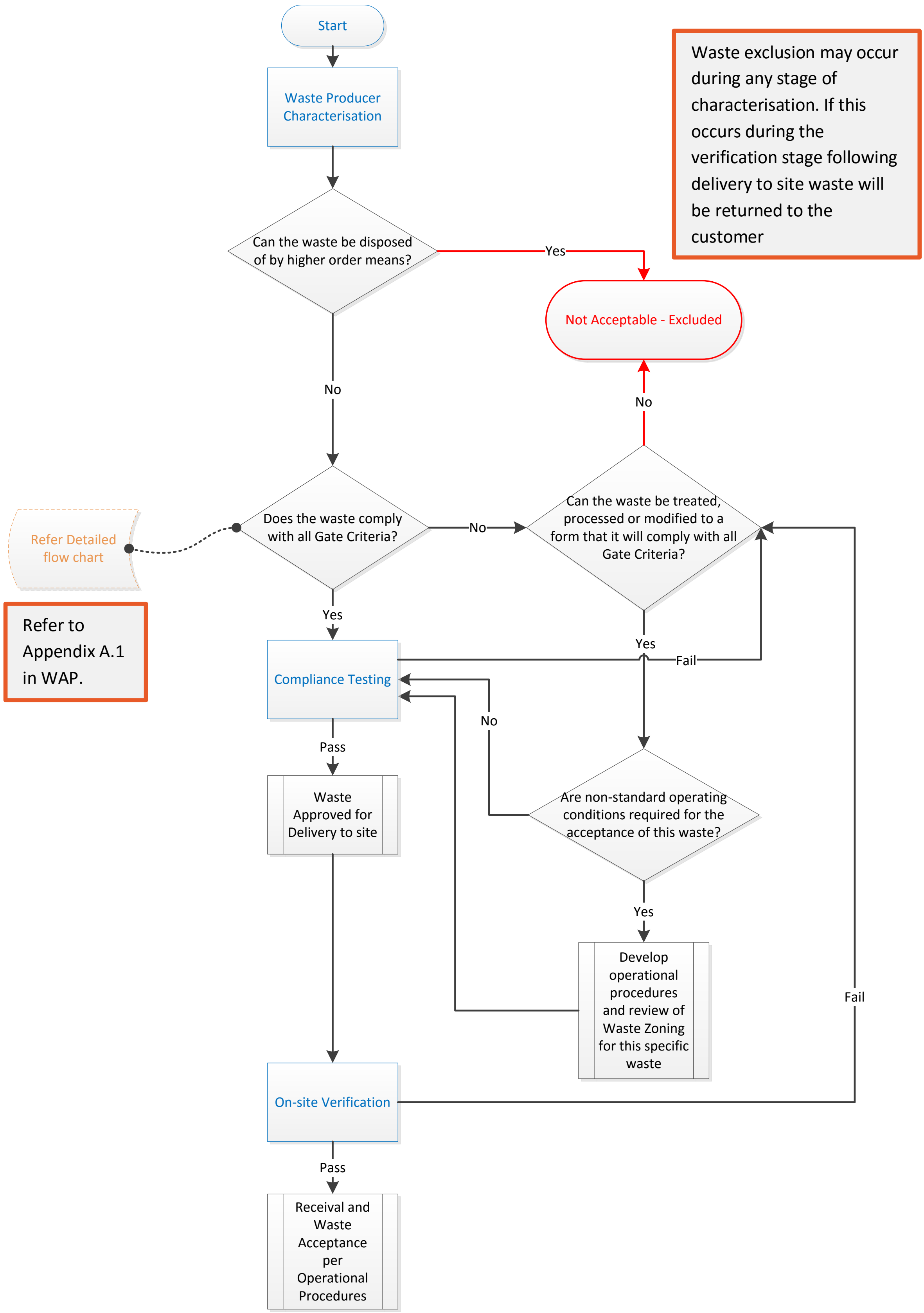
Wastes classified as nuclear wastes[3] will not be accepted at the proposed Chandler facility. For the avoidance of doubt the definition of nuclear waste does not include waste that results from the use of the products of a nuclear plant.

7.2.3 Waste Acceptance Procedure

Having established the overarching waste exclusion criteria to be applied at the proposed Facility (refer to WAC), a gated WAP, using specified test methods and criteria values will be applied to determine if a waste can be accepted. In addition to considering the specific characteristics of the waste, consideration is also given to how the wastes will perform in the conditions of storage and permanent isolation. This assessment will be performed by a suitably qualified person who has the necessary skill in determining such matters. A summary of the overall procedure for characterisation, compliance, acceptance and verification is set out in Figure 7-1 below.

[3] *Nuclear material is waste of a nuclear plant; or results from the testing, use or decommissioning of nuclear weapons, whether or not that material has been conditioned or reprocessed*

Figure 7-1: Waste Acceptance Procedure summary



7.2.4 Waste Zoning Guide

The WAP includes specified test methods and criteria values to identify waste packages which may react with each other, and thereby group them according to the principles of compatibility. Reactive groups must be physically separated during transport, receipt, storage and during permanent isolation, forming a structure of waste segregation and zoning.

To prevent dangerous interactions, dangerous goods should be kept apart (segregated) from all other goods with which they are not compatible. Segregation can be achieved by storing and handling incompatible goods in separate areas or by the use of physical barriers or distances within the same area. Systems and procedures will be developed and enforced, and personnel involved in the storage and handling of dangerous goods will be trained and supervised to ensure segregation is maintained at all times.

It is important to recognise some wastes, which may be dangerous goods, may be delivered to site and be stored at Apirnta before being transferred to the Chandler facility, arrangements therefore need to be made for the safe storage of these wastes.

Useful guidance for segregating incompatible dangerous goods is provided in *Australian/New Zealand Standard AS/NZS 3833 The Storage and Handling of Mixed Classes of Dangerous Goods in Packages and Intermediate Bulk Containers* which is referenced in the code of practice[4] which, in turn, supports the National Standard. Tellus will adopt the segregation protocols presented in AS/NZS 3833 for all waste materials that are stored on site at either Apirnta or at the surface of Chandler prior to underground permanent isolation. The Dangerous Goods segregation chart is presented in **Figure 7-2**

[4] *Page 29 The National Code of Practice for the Storage and Handling of Workplace Dangerous Goods NOHSC:2017(2001)*

Figure 7-2: Dangerous Goods Segregation Chart (Australian Standard AS3833 figure 6.1)

CLASS		2 (2.1)	2 (2.2)	3	4 (4.1)	4 (4.2)	4 (4.3)	5 (5.1)	5 (5.2)	6	8
COMPRESSED GASES 2.1 Flammable	2	Compatible	KEEP APART	Segregate from	Segregate from	Segregate from	Segregate from	Segregate from	ISOLATE	KEEP APART	KEEP APART
2.2 Non-flammable/ non-toxic	2	KEEP APART	Compatible	KEEP APART	Segregation may be necessary	Segregate from	Segregation may be necessary	Segregation may be necessary	Segregate from	Segregation may be necessary	KEEP APART
FLAMMABLE LIQUIDS (and Combustible liquids)	3	Segregate from	KEEP APART	Compatible	KEEP APART	Segregate from	Segregate from	Segregate from	ISOLATE	KEEP APART	KEEP APART
FLAMMABLE SOLIDS 4.1 Flammable solids	4	Segregate from	Segregation may be necessary	KEEP APART	Compatible	KEEP APART	Segregate from	Segregate from	Segregate from	KEEP APART	Segregation may be necessary
4.2 Spontaneously combustible	4	Segregate from	Segregate from	Segregate from	KEEP APART	Compatible	KEEP APART	Segregate from	ISOLATE	KEEP APART	KEEP APART
4.3 Dangerous when wet	4	Segregate from	Segregation may be necessary	Segregate from	Segregate from	KEEP APART	Compatible	KEEP APART	Segregate from	Segregation may be necessary	Segregation may be necessary
OXIDIZING SUBSTANCES 5.1 Oxidizing agents	5	Segregate from	Segregation may be necessary	Segregate from	Segregate from	Segregate from	KEEP APART	*	Segregate from	KEEP APART	KEEP APART
5.2 Organic peroxides	5	ISOLATE	Segregate from	ISOLATE	Segregate from	ISOLATE	Segregate from	Segregate from	Compatible	KEEP APART	KEEP APART
TOXIC SUBSTANCES	6	KEEP APART	Segregation may be necessary	KEEP APART	KEEP APART	KEEP APART	Segregation may be necessary	KEEP APART	KEEP APART	Compatible	Segregation may be necessary
CORROSIVE SUBSTANCES	8	KEEP APART	KEEP APART	KEEP APART	Segregation may be necessary	KEEP APART	Segregation may be necessary	KEEP APART	KEEP APART	Segregation may be necessary	*

LEGEND:

Compatible	Dangerous goods of the same Class should be compatible; consult MSDS or suppliers about requirements for individual substances.
*	Dangerous goods of the same Class could be incompatible or react dangerously. Consult the MSDS or suppliers about requirements for individual substances.
Segregation may be necessary	Segregation of these Classes may be necessary. Consult the MSDS or supplier.
KEEP APART	Dangerous goods of these Classes should be kept apart by at least 3 m. Consult the MSDS or supplier.
Segregate from	These combinations of dangerous goods should segregated by at least 5 m and kept in separate compounds or building compartments.
ISOLATE	This requirement applies to organic peroxides, for which dedicated stores or storage cabinets are recommended. Adequate separation from other buildings and boundaries is required.

NOTES:

1 In all cases, the MSDS or supplier of the goods should be consulted.

2 The segregation of dangerous goods of Division 1.4S may be necessary. Consult the MSDS or the supplier of the goods.

3 Combustible liquids shall be segregated in the same manner as flammable liquids of Class 3.

4 Dangerous goods of Class 9 should be segregated in accordance with MSDS.

6 If the dangerous goods have a Subrisk of another class, then the segregation requirements for the Subrisk need to be determined and the more stringent segregation requirements applied.

7 Where smoke detectors are to be stored, their supplier should be consulted and any specific storage and handling recommendations followed.

Applying the WAC (refer to WAC document) will result in a set of wastes that can be safely placed in underground storage rooms for permanent isolation. The application of the criteria in effect limits the hazardous properties and physical form of the wastes.

When analysing waste for acceptance, it is essential to ensure that wastes which may react with each other are identified and classified into compatible groups

Following acceptance wastes will be segregated into zones to ensure wastes that have the potential to react together are kept apart.

As well as segregating wastes during initial receipt and storage, accepted wastes must be physically separated during permanent isolation, the most appropriate zone in the facility in which to dispose of the waste will be selected by the competent person based on zone selection principles and methodology.

Waste placement at Chandler will normally occur as individual packages which are transported underground, and placed package by package in the assigned zones within the underground rooms. In certain situations, bulk placement of wastes using dry or hydraulic backfill techniques may be utilised when it has been determined as appropriate to do so by a suitably qualified person(s).

Isolation as a control measure is usually used to control physicochemical risks for hazardous chemicals because of the consequences when incompatible materials interact. Hazardous chemicals should be physically separated from any chemicals or other things that may be incompatible[5]. This is achieved by a physical separation distance, barriers, or a combination of both. At the proposed Facility these barriers may include the waste packaging, clay barriers, solidified and stabilised wastes, passive chemical barriers such as lime, calcium apatite or zeolite and prior to backfilling the use of separation distance.

7.2.5 NORM waste

The types and forms of radioactive waste that are likely to be managed at the proposed Facility would be generated from mining and processing of mineral ores or other material containing NORM, such as phosphate minerals, mineral sands, coal, some gold bearing rocks and hydrocarbons. These generally contain long lived radionuclides at relatively low concentrations. NORM such as scales arising in the oil and gas industry may have higher activity concentration levels but would need to meet the criteria set for the facility.

[5] *section 4.1 Managing the Risks of Hazardous Chemicals in the Workplace – Code of Practice 2012*

Tellus intends to only accept radioactive wastes up to exemption level as defined in Section 3.2 of RPS 6[6]. Tellus will develop in the next phase of its work a NORM Management Plan (NMP), that consists of a Radiation Management Plan (RMP) and Radioactive Waste Management Plan (RWMP), and other project specific management arrangements as agreed with the Authority.

The NORM management plan will include:

- a description of operation/process including a description of where in the process doses may arise;
- a demonstration of compliance with relevant radiation protection standards;
- the relevant elements of a radiation management plan;
- the relevant elements of a radioactive waste management plan;

7.2.6 Facility design

Engineering controls involve making engineering design decisions that lead to safe or safer work practices for a process, or piece of equipment, used to store or handle hazardous substances. Examples include:

- Providing adequate fire breaks.
- Providing adequate ventilation, including local exhaust ventilation, to eliminate flammable or harmful atmospheres.
- Providing separation between certain hazardous wastes.
- Zoning wastes appropriately both in temporary storage and permanent isolation.
- Installing lighting which provides ample illumination for the tasks to be performed.
- Providing adequate spill control to cope with the largest foreseeable spill.
- Constructing effective barriers between incompatible goods.
- Installing detection systems and alarms for fire and hazardous atmospheres.
- Incorporating suitable devices to protect installations from external hazards.

Hydraulic backfill plant

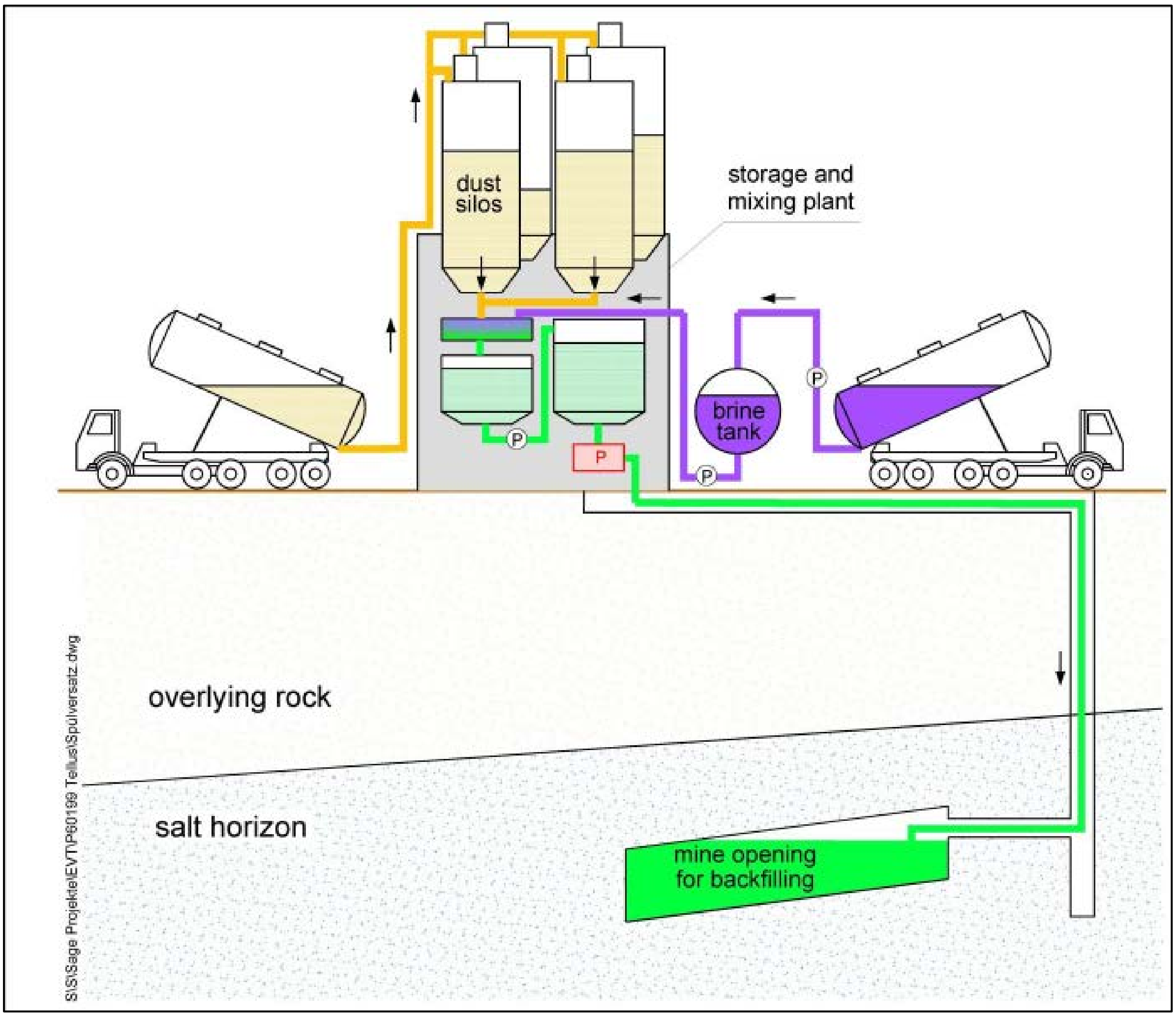
Tellus has undertaken a scoping study to examine an alternative waste transport and placement methodology, generically described as hydraulic backfilling, this technique is widely practiced in Europe in repositories similar to the proposed Chandler facility. The application of hydraulic backfilling is a feasible option to dispose of suitable and compatible wastes in excavated rooms of

[6] National Directory for Radiation Protection - Radiation Protection Series Publication No. 6

salt mines. These wastes can be liquid or solid but need a grain size small enough to achieve appropriate hydraulic properties.

There are fundamentally two types of hydraulic backfill, firstly *flushing backfill* which exhibits low viscosity and is transported by gravity and uses a saturated brine as the transport medium, and secondly *viscous slurry backfill* which exhibits high viscosity and needs a pump to be transported through a pipe system. A general arrangement for a viscous slurry backfill plant is shown in Figure 7-3.

Figure 7-3 Hydraulic backfill plant general arrangement



The backfill mixture must have a composition that does not harm the host rock. An image of a slurry backfill after placement in a disposal room can be seen in Figure 7-4.

Figure 7-4 Hydraulic backfill using viscous slurry technique

Early analysis undertaken in the K-UTEC commissioned scoping study[7] (K-UTEC 2015) has produced encouraging results based on the potential waste inventory that Chandler could receive. It is currently assumed that approximately 50% of the total material placed below ground over the 25 year life of project will be transported and placed in this manner.

7.2.7 Personal protective equipment

PPE is considered the last line of defense against hazardous substances. MSDS normally contain recommendations on the selection and use of PPE for the particular materials being used. Supervisors shall ensure that:

- Protective devices are selected which are suitable for the individual and give the required level of protection from the risks associated with the particular task
- All PPE meets relevant Australian Standards

- Use of correct PPE is enforced by the site supervisor and HSE Co-ordinator.
- PPE is readily available, clean and functional, and employees are individually fitted.
- There is a proper instruction on the need for, and correct use of, personal protective clothing
- An effective system of cleaning and maintenance for PPE is implemented.

7.2.8 Administration

Administration controls consist of properly designed and implemented work practices and procedures and may include:

- Safe work procedures that describe the correct methods for performing all activities associated with storing, handling and disposing of dangerous goods
- Training and supervision to provide the necessary knowledge and skill and ensure correct procedures are followed safely
- Good housekeeping, including regular cleaning of contamination from walls and surfaces, dust and drip removal from all work areas, and keeping lids on containers when not in use
- Workplace monitoring to ensure safe working conditions is maintained

7.3 Emergency Response Plan

Tellus has provided an outline ERP (refer to Appendix B). The plan will be updated following the completion of the Proposal’s detailed design. Please note – it is not appropriate at this stage of development to draft a detailed ERP when site layout and design details are still at concept stage.

8 CONTROL AND DOCUMENT REVISION

8.1 Document information

Property	Information
Approved by	Richard Phillips
Position	Environment and Approvals Manager
Document owner	Environment and Approvals Manager
Effective date	30/09/2016
Revision	A

8.2 Revisions

Revision	Date received	Review date	Level of amendment
A	08/09/2016	22/09/2016	Initial draft

8.3 Read by

No.	Full name	Date	Signature
1			
2			
3			
4			

9 REFERENCES

Dangerous Goods Act 2012 (NT).

Dangerous Goods Regulations 2012 (NT).

Work Health and Safety (NUL) Act 2011 (NT), Division 2 Primary Duty of Care.

Work Health and Safety (NUL) Regulation 2012 (NT), Chapter 7, Hazardous Chemicals.

APPENDIX A: POTENTIAL WASTE CATEGORY LIST

NEPM '75' code	Waste description (NEPM Schedule A, List 1)	Chandler Facility (tpa)	Chandler Facility (t LOM)
	Total Haz chem waste	**332,544**	**8,313,601**
	Total NORM's	**7,456**	**186,399**
	Commercial and Industrial (passed onto to 3rd party landfill)		
	Total (Haz. waste & NORM's)	**340,000**	**8,500,000**
N205	Residues from industrial waste treatment/disposal operations	**85,969**	**2,149,221**
N120	Soils contaminated with a controlled waste	**56,300**	**1,407,495**
N150	Fly ash, excluding fly ash generated from Australian coal fired power stations	**49,198**	**1,229,957**
N220	Asbestos	**36,250**	**906,250**
J120	Waste oil/water, hydrocarbons/water mixtures or emulsions	**22,291**	**557,267**
D220	Lead; lead compounds	**16,622**	**415,553**
C100	Basic solutions or bases in solid form	**16,530**	**413,253**
D110	Inorganic fluorine compounds excluding calcium fluoride (SPL)	**14,613**	**365,318**
D230	Zinc compounds	**9,840**	**246,008**
	NORMs	**7,456**	**186,399**
J100	Waste mineral oils unfit for their original intended use	**7,439**	**185,986**
D300	Non-toxic salts	**4,003**	**100,080**
B100	Acidic solutions or acids in solid form	**2,874**	**71,855**
N160	Encapsulated, chemically-fixed, solidified or polymerised wastes referred to in this list	**1,742**	**43,550**
F100	Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish	**1,649**	**41,225**

NEPM '75' code	Waste description (NEPM Schedule A, List 1)	Chandler Facility (tpa)	Chandler Facility (t LOM)
M100	Waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated napthalenes, polychlorinated terphenyls and/or polybrominated biphenyls	**1,127**	**28,185**
N100	Containers and drums that are contaminated with residues of substances referred to in this list	**962**	**24,038**
N190	Filter cake contaminated with residues of substances referred to in this list	**765**	**19,120**
G110	Organic solvents excluding halogenated solvents	**584**	**14,606**
M250	Surface active agents (surfactants), containing principally organic constituents and which may contain metals and inorganic materials	**422**	**10,546**
A100	Waste resulting from surface treatment of metals and plastics	**403**	**10,080**
K140	Tannery wastes (including leather dust, ash, sludges and flours)	**356**	**8,899**
F110	Waste from the production, formulation and use of resins, latex, plasticisers, glues and adhesives	**310**	**7,756**
J160	Waste tarry residues arising from refining, distillation, and any pyrolytic treatment	**292**	**7,311**
G160	Waste from the production, formulation and use of organic solvents	**235**	**5,885**
R120	Waste pharmaceuticals, drugs and medicines	**234**	**5,842**
M230	Triethylamine catalysts for setting foundry sands	**192**	**4,810**
H100	Waste from the production, formulation and use of biocides and phytopharmaceuticals	**186**	**4,643**
T100	Waste chemical substances arising from research and development or teaching activities, including those which are not identified and/or are new and whose effects on human health and/or the environment are not known	**168**	**4,197**
N230	Ceramic-based fibres with physico-chemical characteristics similar to those of asbestos	**149**	**3,729**
D120	Mercury; mercury compounds	**94**	**2,351**
D190	Copper compounds	**77**	**1,916**
D140	Chromium compounds (hexavalent and trivalent)	**69**	**1,720**

NEPM '75' code	Waste description (NEPM Schedule A, List 1)	Chandler Facility (tpa)	Chandler Facility (t LOM)
R140	Waste from the production and preparation of pharmaceutical products	**57**	**1,434**
K190	Wool scouring wastes	**51**	**1,265**
M150	Phenols, phenol compounds including chlorophenols	**50**	**1,259**
G150	Halogenated organic solvents	**49**	**1,217**
N140	Fire debris and fire wash waters	**47**	**1,166**
G100	Ethers	**46**	**1,152**
T200	Waste of an explosive nature not subject to other legislation	**42**	**1,060**
T120	Waste from the production, formulation and use of photographic chemicals and processing materials	**38**	**961**
D330	Inorganic sulfides	**35**	**870**
H110	Organic phosphorous compounds	**30**	**749**
D130	Arsenic; arsenic compounds	**27**	**681**
M220	Isocyanate compounds	**19**	**468**
D360	Phosphorus compounds excluding mineral phosphates	**17**	**423**
E100	Waste containing peroxides other than hydrogen peroxide	**17**	**413**
D210	Nickel compounds	**13**	**314**
M260	Highly odorous organic chemicals (including mercaptans and acrylates)	**12**	**312**
H170	Waste from manufacture, formulation and use of wood-preserving chemicals	**12**	**293**
D100	Metal carbonyls	**7**	**174**
A130	Cyanides (inorganic)	**5**	**134**
M210	Cyanides (organic)	**5**	**123**
D270	Vanadium compounds	**5**	**122**

NEPM '75' code	Waste description (NEPM Schedule A, List 1)	Chandler Facility (tpa)	Chandler Facility (t LOM)
M160	Organo halogen compounds—other than substances referred to in this Table or Table 2	4	110
D150	Cadmium; cadmium compounds	2	62
A110	Waste from heat treatment and tempering operations containing cyanides	2	60
D160	Beryllium; beryllium compounds	2	38
D350	Chlorates	1	25
D170	Antimony; antimony compounds	1	25
D250	Tellurium; tellurium compounds	1	13
D340	Perchlorates	0	9
D200	Cobalt compounds	0	6
D310	Boron compounds	0	5
D290	Barium compounds (excluding barium sulphate)	0	3
D240	Selenium; selenium compounds	0	1
D180	Thallium; thallium compounds	0	1
M170	Polychlorinated dibenzo-furan (any congener)	0	1
M180	Polychlorinated dibenzo-p-dioxin (any congener)	0	1