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Environmental Impact Statement – Chapter 26: Waste

Warragamba Dam Raising

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Contents

List of Tables

List of Figures

26 Waste

This Chapter provides an assessment of waste generated during construction and operation of the Warragamba Dam Raising. The relevant Secretary's environmental assessment requirements (SEARs) are shown in Table 26-1.

Table 26-1. Secretary's Environmental Assessment Requirements (SEARs): Waste

Desired performance outcomes	Secretary's Environmental Assessment Requirements[1]	Where addressed
19. Waste Desired performance outcome: All wastes generated during the construction and operation of the Project are effectively stored, handled, treated, reused, recycled, and/or disposed of lawfully and in a manner that protects environmental values.	1. The Proponent must assess predicted waste generated from the Project during construction and operation, including:	Section 26.3 Section 26.4
	a) classification of the waste in accordance with the current guidelines;	Section 26.2 Section 26.3
	b) estimates / details of the quantity of each classification of waste to be generated during the construction of the Project, including bulk earthworks and spoil balance;	Section 26.3
	c) handling of waste including measures to facilitate segregation and prevent cross contamination;	Section 26.3 Section 26.5
	d) management of waste including estimated location and volume of stockpiles;	Section 26.3
	e) waste minimisation and reuse;	Section 26.3
	f) lawful disposal or recycling locations for each type of waste; and	Section 26.3
	g) contingencies for the above, including managing unexpected waste volumes.	Section 26.3.
	2. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly with relation to sediment/leachate control, noise, and dust. This extends to the removal and replacement of concrete and associated dust during construction works of the wall, and an assessment of potential for concrete dust to run off into water and potentially enter downstream areas.	Section 26.3 Section 26.4 Chapter 7 (Air quality). Chapter 19 (Noise and vibration). Chapter 22 (Soils). Chapter 27 (Water quality).

1 Note: this chapter specifically addresses SEAR 19 in addition to those general requirements of the SEARs applicable to all chapters and as identified as such in Chapter 1 (Section 1.5, Table 1-1).

The proposed management and mitigation measures in this chapter are collated in Chapter 29 (EIS synthesis, Project justification and conclusion).

26.1 Assessment methodology

The methodology for waste impact assessment included identification of each waste stream, expected quantities of waste materials where known, and applicable waste management strategies.

Indicative quantities and types of waste that would be generated from the Project are discussed in Section 26.3 and form the basis for the preliminary classification in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (NSW Environment Protection Authority (EPA) 2014b).

Waste types and anticipated quantities of waste would be reviewed and revised as required during the detailed design of the Project and would be finalised as part of the detailed construction planning and during construction.

26.2 Legislative and policy framework

Both construction and operation of the Project would generate waste streams that would require management and disposal in accordance with relevant NSW policies and guidelines.

There are four main legislative instruments to manage waste in NSW:

- *Waste Avoidance and Resource Recovery Act 2001* (NSW) (WARR Act)
- *Protection of the Environment Operations Act 1997* (POEO Act)
- Protection of the Environment Operations (Waste) Regulation 2014 (NSW) (POEO Regulation)
- *Contaminated Land Management Act 1997.*

The EPA has established guidelines for the classification of waste. These have been considered in the assessment of waste generated by the Project and subsequent development of mitigation and management measures.

The movement of controlled waste is also regulated by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*, made under the *National Environment Protection Council Act 1994*.

The WARR Act is the primary legislation for managing waste. It aims to reduce waste generation and improve the conversion of waste into recoverable resources. Resource and waste management for the Project would be prioritised according to the principles of the resource management hierarchy defined in the WARR Act:

- avoidance of unnecessary resource consumption
- resource recovery (including reuse, reprocessing, recycling, and energy recovery)
- disposal.

To support the waste hierarchy, the *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (EPA 2014a) provides a framework and targets for waste management and recycling in NSW. Targets established under this strategy comprise:

- avoiding and reducing the amount of waste generated per person in NSW
- increasing recycling rates to 70 per cent for municipal solid waste, 70 per cent for commercial and industrial waste, and 80 per cent for construction and demolition waste
- increasing waste diverted from landfill to 75 per cent
- managing problem wastes better and establishing 86 drop-off facilities and services across NSW.

NSW Government agencies such as WaterNSW, can support these targets by:

- implementing waste reduction policies and programs, such as sustainable procurement
- incorporating resource recovery and waste reduction objectives into its operations complying with relevant legislation.

The POEO Act defines ‘waste’ for regulatory purposes and establishes management and licensing requirements for its transport, storage, disposal, and reuse. Waste is defined under the POEO Act to include:

- any substance (whether solid, liquid, or gaseous) that is discharged, emitted, or deposited in the environment in such volume, constituency, or manner as to cause an alteration in the environment
- any discarded, rejected, unwanted, surplus, or abandoned substance
- any otherwise discarded, rejected, unwanted, surplus, or abandoned substance intended for sale or for recycling, processing, recovery, or purification by a separate operation from that which produced the substance
- any processed, recycled, re-used, or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations, or
- any substance prescribed by the regulations to be waste.

Waste classification

The POEO Act, POEO Regulation and supporting guidelines, including the Waste Classification Guidelines (EPA 2014b) provide classifications and descriptions that apply to waste in NSW. Many waste types are pre-classified under the POEO Act and do not require testing. However, if a waste type/stream is not pre-classified, it may need to be tested to determine its classification.

Under the POEO Regulation, the EPA may grant exemptions from some of the requirements under the POEO Act in the form of either a 'resource recovery order' or a 'resource recovery exemption' (refer to clauses 91, 92 and 93 of the POEO Regulation). These 'resource recovery exemptions' are granted where the land application or use as fuel of a waste material is a genuine, fit for purpose, reuse of the waste rather than another path to waste disposal. An exemption facilitates the use of these waste materials outside of certain requirements of the waste regulatory framework.

Potentially relevant resource recovery orders under Part 9, clause 93 of the POEO Regulation are:

- Excavated Natural Material Order 2014
- Excavated Public Road Material Order 2014
- Reclaimed Asphalt Pavement Order 2014
- Recovered Aggregate Order 2014
- Stormwater Order 2014.

Potentially relevant resource recovery exemptions under clauses 91 and 92 of Part 9 of the POEO Regulation are:

- Excavated Natural Material Exemption 2014
- Excavated Public Road Material Exemption 2014
- Reclaimed Asphalt Pavement Exemption 2014
- Recovered Aggregate Exemption 2014
- Stormwater Exemption 2014.

Additional guidelines considered for the assessment are:

- *Sustainable Design Guidelines Version 4.0 ST-114* (Transport for NSW (TfNSW) 2017b)
- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries)* (Department of Environment and Climate Change (DECC) 2008d, 2008e, 2008f, 2008g, 2008h).

26.3 Assessment of potential construction impacts

Significant earthworks and quantities of materials would be required for construction of the Project. Raw materials (such as fly ash, sand, cement, and aggregates) to produce concrete would generate the majority of materials required for construction of the Project.

An assessment of potential waste impacts during construction is provided below. Waste streams generated and estimates of quantities are provided in the following sections. Site layouts showing construction work areas and potential stockpile locations are shown in Chapter 5 (Figure 5-2).

26.3.1 Waste streams

Liquid and solid waste streams generated during construction of the Project would include:

- demolition wastes including concrete and steel (largest volumes) and smaller volumes of bricks, tiles, timber (untreated and treated), other metals, electrical and plumbing fittings and furnishings
- excavated wastes (spoil) such as soil and rock including virgin excavated natural material (VENM)
- hazardous wastes such as petroleum products, paints, and contaminated materials
- vegetation (green) wastes from the removal of trees, shrubs, and groundcover that are unable to be mulched and reused within the Project
- general construction waste such as timber formwork, scrap metal, steel, concrete, concrete slurry from scarifying, packaging material (crates, pallets, cartons, plastics, and wrapping materials), and concrete batching plant wastewater
- construction wastes from placement of concrete including surface preparation, curing and treatment wastes

- waste from the operation and maintenance of construction vehicles and machinery including adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses, and tyres
- general wastes from the site office/construction compound such as putrescibles, paper, cardboard, plastics, glass and printer cartridges and wastewater.

26.3.2 Demolition waste

As discussed in Chapter 5 of this EIS, some of the existing Warragamba Dam elements and infrastructure would require demolition or removal to enable the Project to be built. This includes:

- the existing road and main spillway bridge across the top of Warragamba Dam
- the drum and radial gates associated mechanical and electrical infrastructure and portions of the piers within the main spillway
- the fuse plugs in the auxiliary spillway
- other minor concrete structures to allow the tie-in of the new dam and spillway elements
- minor areas of roads, operational laydown areas, drainage systems and other infrastructure external to but associated with the dam
- existing gantry crane and associated equipment
- miscellaneous dam crest services and equipment.

26.3.3 Excavated material and spoil management

Excavated soil and rock (spoil), would make up most of the solid waste generated by the Project during construction. About 269,000 cubic metres of spoil would be generated during construction, primarily due to the removal of the fuse plugs, foundation preparation, the auxiliary spillway upgrade and temporary construction works such as the coffer dams. Waste estimates are shown in Table 26-2.

Generally, the spoil produced would be classified as Virgin Excavated Natural Material or Excavated Natural Material and would be suitable for reuse. Some spoil would be reused for temporary construction facilities such as coffer dams and base areas for construction facilities, however once construction is completed this material would need to be removed.

The Project design has considered the principles of the resource management hierarchy as defined under the WARR Act, including minimising excess spoil generation, as far as practical. Where possible and fit for purpose, spoil would be beneficially reused as part of the Project before being emplaced. This would be investigated during the construction of the Project following a refinement of the earthworks balance during the detailed design.

While off-site opportunities would be investigated for the reuse of material during detailed construction planning, given the distance of Warragamba to any potential reuse sites and the large amount of spoil being generated by Western Sydney Airport construction, the likelihood of finding suitable and economically viable reuse options is expected to be low. Excess spoil would be reused where possible, or otherwise disposed of to an appropriate location either on site or off site.

Opportunities to dispose spoil on site will be investigated during the detailed design and if required, will be addressed in the construction waste management plan, which would include a spoil management plan.

The impacts of clearing and earthworks in the emplacement area are assessed in Chapter 10 (Biodiversity construction area), Chapter 18 (Aboriginal cultural heritage), Chapter 15 (Flooding and hydrology) and Chapter 27 (Water quality). The impacts of spoil emplacement during construction are assessed in Chapter 7 (Air quality) and Chapter 19 (Noise and vibration), as well as the previously identified reports.

Table 26-2. Anticipated spoil volumes

Activity	Volume (m^3)	Classification
Removal of the fuse plugs in the auxiliary spillway	83,000	General solid waste (non-putrescible) Excavated Natural Material – consisting of basalt rocks and engineered clay core
Excavation for the foundations and tie ins of the modified dam wall including the left abutment works	60,000	General solid waste (non-putrescible) Mostly Virgin Excavated Natural Material with some Excavated Natural Material
Coffer dams	21,000	General solid waste (non-putrescible) Virgin Excavated Natural Material, Excavated Natural Material, Building and demolition waste, asphalt waste
Access road works	40,000	General solid waste (non-putrescible) Virgin Excavated Natural Material, Excavated Natural Material, Building and demolition waste, asphalt waste
Excavation for the auxiliary spillway modifications	25,000	General solid waste (non-putrescible) Virgin Excavated Natural Material, Excavated Natural Material, Building and demolition waste, asphalt waste
Erosion protection works downstream of auxiliary spillway	30,000	General solid waste (non-putrescible) Mostly Virgin Excavated Natural Material with some Excavated Natural Material
Excavations for Temporary Works such as temporary site access roads and for site facilities such as batch plants	10,000	General solid waste (non-putrescible) Virgin Excavated Natural Material, Excavated Natural Material, Building and demolition waste, asphalt waste
TOTAL	**269,000**	

26.3.4 Contamination

A soils and contamination assessment is provided in Chapter 22. A summary of the findings of the assessment is as follows:

- Areas of potential contamination have not been identified within the upstream study area that are likely to be materially influenced as a result in the dam wall raising.
- The downstream study area is very large and incorporates many suburbs of Sydney along the Nepean and Hawkesbury River systems which include many sites that could have site contamination issues (such as service stations, industrial facilities, commercial premises, etc) however based on the flood modelling the impacts to contaminated land downstream are expected to be reduced overall due to the dam raising.
- Some sites within the proposed construction zone have been identified as having past contamination issues or incomplete documentation following remediation. These include the following as shown in Figure 26-1:
  - explosives store and vehicle refuelling area (Site A)
  - former workshop yard on Farnsworth Avenue (Site B)
  - various commercial properties (Site C and Site D)
  - the Warragamba Dam viewing platform (Site F).

  Overall, the likelihood of encountering widespread contamination within the proposed construction zone has been assessed as low, but some areas (as identified in Figure 26-1) will require protocols to avoid disturbance of known encapsulated contaminated materials.

Figure 26-1. Construction area and potentially contaminated sites

26.3.5 Acid sulfate soils

Acid sulfate soils are addressed in Appendix N1 (Soils and contamination assessment report). Acid sulfate soils are mapped in areas commencing some 40 kilometres downstream of the dam, however, these soils are not known to be near areas to be disturbed for construction or within upstream areas. Acid sulfate soils are unlikely to be affected due to Project construction works or longer term as a result of the dam raising.

26.3.6 Other waste materials

The estimated volume, weight and/or area of waste materials generated during construction and potential management options are presented in Table 26-3.

Table 26-3. Waste materials generated and potential management options

Material	Volume or weight generated during construction	Management options	Waste classification
Concrete from hydroblasting	4,300 t	Further investigations into on-site reuse or taken off-site for reuse or disposal	General solid waste (non-putrescible) Building and demolition
Other concrete waste	60,000 t	Further investigations into onsite reuse or taken off-site for reuse or disposal	General solid waste (non-putrescible) Building and demolition
Steel such as drum and radial gates, crest bridge and gantry crane	2,500 t	Sent off-site for recycling	General solid waste (non-putrescible) Building and demolition
Timber formwork	11,000 m^2	Reused or send off-site for disposal	General solid waste (non-putrescible) Wood waste
Vegetation from clearing	4,000 t	Mulched and reused on site for landscaping	General solid waste (non-putrescible) Garden waste
General construction waste	10,000 t	Sent off-site for either recycling or disposal	General solid waste (non-putrescible)

26.3.6.1 Vegetation

It is estimated that construction would require the clearing of about 22.5 hectares of vegetation. Wastes would include logs, mulched timber, and weeds. Vegetation to be cleared would, where possible, be used on site for fauna habitat structures, fauna habitat re-creation or be mulched.

Mulch has the potential of creating tannin affected water, which in turn has the potential to cause water pollution if not managed appropriately. Mulch would be used, where possible, in landscaping and soil and erosion control measures for the Project. Weeds would be disposed of off-site.

26.3.6.2 Excess construction materials

It is possible that the Project could generate excess construction materials through accidental over-sourcing or construction and/or design changes that result in a reduced need once materials are sourced. This could include steel reinforcing, conduits and pipes, concrete and asphalt, timber formwork, chemicals such as pesticides, herbicides, paint and metal and electrical cabling. Where possible, excess items would be re-used on the Project, re-processed (concrete, asphalt) for use as road base or backfill; removed off-site to a recycling facility or disposed of at a licensed waste facility.

26.3.6.3 Concrete and slurry

One or more concrete batch plants would be used on site to produce concrete for the Project. The operation of concrete batching plants has the potential for creating large amounts of waste material if quality specifications are not met after the batching process. Where possible this material would be used for non-structural elements or elements that do not require the same standard of concrete or asphalt such as minor access tracks, or elements within temporary construction compound such as pathways. Cured concrete can be crushed down to a recovered aggregate and be utilised in general fill, pavement materials and for minor construction elements such as access tracks. If the concrete batching plant waste material cannot be used on site, it will be disposed of to a licensed waste facility.

The concrete batch plants include a wastewater treatment system to capture and treat wastewater and runoff. Treated wastewater would be reused either in concrete production or other construction uses.

Preparatory scarifying of the dam wall would also generate a substantial volume of concrete waste slurry (estimated 4,300 tonnes). Further investigations would be undertaken during preparation of the construction waste management plan for the potential reuse of the slurry material. If reuse was not possible the slurry would be dried and taken off-site for disposal.

26.3.6.4 Packaging

Materials delivered to site would result in packaging waste. This would include cardboard, paper, plastic, and glass. Where possible, materials would be bought in bulk to minimise the amount of package required. Sources of material that have sustainable packaging design, recycled and recyclable packaging would be favoured over other material sources where cost effective. All wastes would be collected and recycled or disposed of to an approved facility.

26.3.6.5 Plant and equipment

Waste would be produced from the maintenance of construction vehicles and plant. This would include tyres, waste fuels and oils, oils, and lubricant containers. These have potential to cause both land contamination and water pollution if not managed appropriately. These wastes would be disposed of off-site to a licensed waste facility or removed from site by a certified waste contractor.

26.3.6.6 Sewage and general waste

Sewage and general waste would be generated from the construction compound through amenities and offices. Wastes generated could include domestic waste by workers, sewage, office wastes (paper, cardboard, plastic, bottles, cans, paper, and food wastes). Inappropriate disposal of these waste streams has the potential to cause both land and water pollution. Appropriate recycling facilities would be provided at the construction compound to further minimise the amount of waste required to be disposed to landfill.

Contingency measures to manage waste generated from the construction and operation of the Project would be developed to manage unexpected volumes of waste or otherwise exceptional circumstances. Suitable areas will be identified to allow for contingency management of unexpected waste materials, including contaminated materials.

These areas will be hardstand or lined areas that are appropriately stabilised and bunded, with enough area for stockpile storage and segregation. These areas will be identified by the construction contractor prior to construction commencing.

Material that is identified as contaminated would be segregated from uncontaminated material on site to prevent cross-contamination. The Construction Waste Management Plan (see Section 26.5) will describe methodologies and strategies to prevent cross-contamination.

26.3.7 Waste transport

Waste materials would be taken off-site as soon as practical upon generation or stored temporarily in one of the materials storage areas in segregated stockpiles for further processing such as cutting large steel elements into smaller pieces, before reuse on site or taken off-site for disposal or reuse.

Spoil would be delivered to the spoil re-use or disposal sites in accordance with the conditions of approval and environment protection licences governing those sites.

The following criteria would be applied to determine spoil reuse and disposal sites, including how much spoil would be sent to each site:

- *environmental benefit*: in terms of a preference for the material to be reused for such purposes as coastal protection works, clean fill on other projects and land restoration
- *traffic impacts*: with a preference for haulage routes that keep to major arterial roads and minimise total haulage requirements as far as possible
- *approvals*: any receiving location would need to be approved to receive the applicable type and volume of spoil
- *economic*: feasibility of transporting the spoil compared to the options already identified, including consideration of the distances to be travelled.

Spoil would be hauled using heavy vehicles to spoil reuse and disposal sites. Heavy vehicles would use pre-defined fixed routes, namely a northern route and a southern route to deliver construction materials and remove waste to and from the dam site as discussed and shown in Chapter 24 (Traffic and transport).

The anticipated spoil haulage routes will be determined once an offsite location is determined and this information would be included in the waste and traffic management plans prepared for construction. An objective of the waste and traffic management plans would be to use heavy vehicles that have transported materials to the site for waste removal to the waste disposal locations, to avoid or minimise any further truck movements from the site.

26.3.8 Waste disposal locations

Existing metropolitan waste management facilities would have capacity to receive the anticipated waste streams generated by the Project. General wastes from site offices such as putrescible wastes, paper, cardboard, plastics, glass, and printer cartridges would be collected for off-site recycling wherever practicable. Demolition and excavation wastes generated by the Project have the potential to contain hazardous materials. The management of this waste is discussed below.

There are a number of waste disposal facilities located near the construction site, as listed in Table 26-4. The construction contractor will be required to liaise with the facilities to determine the most appropriate facility for disposal, and this information would be included in the waste management plan prepared for construction.

Table 26-4. Potential waste disposal locations

Suburb	Class	Name
Eastern Creek	Advanced Resource Recovery Technology (ARRT) Facility Organic Resource Recovery Facility (ORRF)	SUEZ Eastern Creek Resource Recovery Park
Emu Plains	Reprocessing	No Fuss Liquid Waste Pty Ltd
Riverstone	Landfill	Riverstone Landfill
	Reprocessing	Back To Earth Mulch Makers
Schofields	Transfer Station	Hlebar, Vinko and Draga
South Windsor	Landfill	Hawkesbury City Waste Management Facility
	Transfer Station	South Windsor Resource Recovery Centre
	Transfer Station	Rock and Dirt Recycling
	Multi-Purpose (re-processing and transfer station)	Worth Recycling Pty Ltd
St Marys	Multi-Purpose (re-processing and transfer station)	Sims Group Limited
	Transfer Station	Hallinan's Recycling Services
	Reprocessing	Brandster Services
	Reprocessing	Solveco
	Transfer Station	Toxfree, St Marys

26.3.9 Summary of impacts and management

Potential waste impacts include:

- large volumes of spoil being directed to landfill due to inadequate recycling and reuse
- dust impacts due to incorrect storage, handling, transport, and disposal of spoil
- large volumes of waste being directed to landfill due to inadequate collection, classification, and disposal of waste
- contamination of soil, surface and/or groundwater from the inappropriate excavation, storage, transport, and disposal of liquid and solid waste
- risks to human health from the handling, storage, transport, and disposal of contaminated (including asbestos containing) material from demolition waste generated by the Project.

All wastes would be managed using the hierarchy approach of waste avoidance and resource recovery before consideration of waste disposal. Where practicable, the design of the Project has minimised the generation of waste through minimising demolition and excavation and reusing the existing dam wall, central spillway and auxiliary spillway, and the defunct hydroelectric scheme infrastructure for the provision of environmental flows. Management options are provided in Table 26-5.

Should the generation of wastes be unavoidable, or be unsuitable for reuse/recycling, disposal methods would be selected based on the classification of the waste material in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014b). The Waste Classification Guidelines provide direction on the classification of waste, specifying requirements for management, transport, and disposal of each waste category.

Construction waste management activities would not pose a significant risk to the environment or human health, with the implementation of standard measures (provided in Section 26.5) to adequately address waste generation, handling storage, transport, disposal, and reuse. A Construction Waste Management Plan, as part of the Construction Environmental Management Plan (CEMP), would be prepared and implemented for the Project. These plans would consider construction staging and specific conditions of approval that may be applied to the Project.

26.4 Assessment of potential operational impacts

Limited waste would be generated from the operation of the Project. The main risks would include the mobilisation of unconsolidated materials if disturbed surfaces are not stabilised or successfully revegetated following construction. The likelihood of this would be minimised through implementing the relevant safeguards and management measures identified in Section 26.5.

26.5 Environmental management measures

Management measures have been developed to avoid, minimise, or manage potential risks associated with waste management. Relevant management and mitigation measures have been detailed in Table 26-5. These mitigation and management measures have been incorporated in the environmental management measures in Chapter 29 (EIS synthesis, Project justification and conclusion).

Table 26-5. Safeguards and management measures

Impact	ID	Environmental management measure	Timing	Responsibility
Generation and disposal of waste	W1	A construction waste management plan (CWMP) will be prepared for the Project prior to construction and will detail appropriate waste management procedures. The CWMP will: ▪ document expected waste types and volumes for the Project ▪ describe procedures for managing office and Project waste materials including separation, treatment, reuse and recycling and disposal in accordance with relevant guidelines ▪ detail waste reporting requirements including the implementation of a waste register ▪ detail the process for identifying waste re-use sites including approval requirements ▪ where practicable, structures would be deconstructed rather than demolished to allow as much material as possible to be re-used or recycled off-site.	Construction Operation	WaterNSW Construction Contractor
Disposal of spoil	W2	A spoil management plan will be prepared for the Project. The plan will detail spoil management measures including spoil haulage routes and spoil disposal sites.	Construction	Construction Contractor

26.6 Risk assessment

An environmental risk analysis was carried out in accordance with the SEARs, using the methodology provided in Appendix C (Risk assessment procedure). A Project risk matrix was developed and risk ranking evaluated by considering:

- the likelihood (L) of an impact occurring
- the severity or consequence (C) of the impact in a biophysical and/or socio-economic context, with consideration of:
  - whether the impact will be in breach of regulatory or policy requirements
  - the sensitivity of receptors
  - duration of impact, that is, whether the impact is permanent or temporary
  - the areal extent of the impact and/or the magnitude of the impact on receptors.

The likelihood and consequence matrix is shown on Figure 26-2.

Once the consequence and likelihood of an impact are assessed, the risk matrix provides an associated ranking of risk significance: **Low**; **Medium**; **High** or **Extreme,** as shown in Table 26-6**.** The residual risk was determined after the application of proposed mitigation measures.

The risk analysis for potential waste impacts is provided in Figure 26-2. This includes the residual risk of the potential impact after the implementation of mitigation measures.

Table 26-6. Risk ranking definitions

Risk definitions	
Extreme 21 – 25	Widespread and diverse primary and secondary impacts with significant long-term effects on the environment, livelihood and quality of life. Those affected will have irreparable impacts on livelihoods and quality of life.
High 15 – 20	Significant resources and/or Project modification would be required to manage potential environmental damage. These risks can be accommodated in a project of this size, however comprehensive and effective monitoring measures would need to be employed such that Project activities are halted and/or appropriately moderated. Those impacted may be able to adapt to change and regain their livelihoods and quality of life with a degree of difficulty.
Medium 9 – 14	Risk is tolerable if mitigation measures are in place, however management procedures will need to ensure necessary actions are quickly taken in response to perceived or actual environmental damage. Those impacted will be able to adapt to changes.
Low 1 – 8	On-going monitoring is required however resources allocation and responses would have low priority compared to higher ranked risks. Those impacted will be able to adapt to change with relative ease.

Figure 26-2. Risk matrix

		Consequence				
		Negligible	**Minor**	**Medium**	**Major**	**Extreme**
	LEGAL	No legal consequences	No legal consequences	Incident potentially causing breach of licence conditions	Breach of licence conditions	Breach of licence conditions resulting in shutdown of Project operations.
	SOCIO-ECONOMIC	Impacts that are practically indistinguishable from the social baseline, or consist of solely localised or temporary/short-term effects with no consequences on livelihoods and quality of life.	Short-term or temporary impacts with limited consequences on livelihoods and quality of life. Those affected will be able to adapt to the changes with relative ease and regain their pre-impact livelihoods and quality of life.	Primary and secondary impacts with moderate effects on livelihoods and quality of life. Will be able to adapt to the changes with some difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with significant long-term effects on livelihoods and quality of life. Those affected may be able to adapt to changes with a degree of difficulty and regain their pre-impact livelihoods and quality of life.	Widespread and diverse primary and secondary impacts with irreparable impacts on livelihoods and quality of life and no possibility to restore livelihoods.
	HEALTH	No health consequences	Accident or illness with little or no impact on ability to function. Medical treatment required is limited or unnecessary.	Accident or illness leading to mild to moderate functional impairment requiring medical treatment.	Accident or illness leading to permanent disability or requiring a high level of medical treatment or management.	Accident, serious illness or chronic exposure resulting in fatality.
	ENVIRONMENT	Localised (on-site), short-term impact on habitat, species or environmental media	Localised or widespread medium-term impact to habitat, species or environmental media	Localised degradation of sensitive habitat or widespread long-term impacts on habitat, species or environmental media. Possible contribution to cumulative impacts.	Widespread and long-term changes to sensitive habitat, species diversity or abundance or environmental media. Temporary loss of ecosystem function at landscape scale. Moderate contribution to cumulative impacts.	Loss of a nationally or internationally recognised threatened species or vegetation community. Permanent loss of ecosystem function on a landscape scale. Major contribution to cumulative effects
		A - negligible	**B** - minor	**C** - medium	**D** - major	**E** - extreme
Expected to occur during the Project or beyond the Project	**a** - expected	**13**	**14**	**20**	**24**	**25**
May occur during the Project or beyond the Project	**b** - may	**8**	**12**	**19**	**22**	**23**
Possible under exceptional circumstances	**c** - possible	**6**	**7**	**11**	**18**	**21**
Unlikely to occur during the Project	**d** - unlikely	**4**	**5**	**10**	**16**	**17**
Rare or previously unknown to occur	**e** - rare	**1**	**2**	**3**	**9**	**15**

Risk Definition (see Table 26-6)	**Low**	**Medium**	**High**	**Extreme**

Table 26-7. Waste risk analysis

Key impacts	Risk before mitigation			Mitigation and management	Risk after mitigation			Residual risk
	L	C	R		L	C	R	
CONSTRUCTION								
Waste generation resulting in: ▪ inadequate solid and liquid waste handling and disposal ▪ poor hazardous and contaminated waste management ▪ waste spillage and contamination of receiving soil, surface water and groundwater ▪ air emissions: volatiles and odours.	b	D	**22**	W1, W2	c	C	**11**	Large quantities of waste would be produced, which could potentially result in severe and widespread environmental pollution, and health and safety harm; hence an *Extreme* risk assessment. Mitigation measures are well developed and can be readily applied to ensure good waste management practices and the risk of environmental harm can be significantly reduced to a *Medium* residual risk. However, significant resources will be required to ensure mitigation measures are appropriately implemented, including quickly responding to a potential incident.
OPERATION								
Waste generation resulting in: ▪ Inadequate solid and liquid waste handling and disposal.	b	C	**19**	W1	d	C	**10**	Smaller quantities of waste would be generated during operations, however ongoing measures are required to effectively manage waste handling and disposal activities. A *Medium* residual risk highlights ongoing requirements for appropriate resourcing and monitoring.

Notes:
L = likelihood
C = consequence
R = rating

local people
global experience

SMEC is recognised for providing technical excellence and consultancy expertise in urban, infrastructure and management advisory. From concept to completion, our core service offering covers the life-cycle of a project and maximises value to our clients and communities. We align global expertise with local knowledge and state-of-the-art processes and systems to deliver innovative solutions to a range of industry sectors.

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