Section 5 Waste Management

5.1 Introduction

Waste management is an integral part of the GLNG Project and is taken into consideration during construction, operation and through to the eventual decommissioning of the project's components (CSG fields, gas transmission pipeline and LNG facility).

Santos is committed to the reduction of waste generated by its operations through recovering, re-using, recycling and efficient utilisation of all resources. Santos aims to promote best practice disposal methods of waste products, both on-site through appropriate maintenance of waste disposal areas and off-site through utilising environmentally responsible waste management contractors.

This section provides a summary of likely waste streams to be generated by the project (including estimated quantities), and proposed waste management and mitigation measures to minimise the project's environmental impact.

A summary of each waste type, estimated volumes and management options for wastes generated by construction and operation of the project are summarised in Table 5.3.1, with a complete Waste inventory register included in Appendix K.

A Waste Management Plan (WMP) for the project has also been developed in accordance with current legislative requirements and will be incorporated into the Environment Management Plan (EMP) for each of the projects components (refer to Appendix K). This WMP provides a framework for waste management on site through developing strategies, monitoring performance, setting performance targets and implementing action plans for improvement.

5.2 Regulatory Framework

Section 1.9 of the EIS provides an overview of the general regulatory framework as it applies to the entire project, however, legislation relevant to waste management associated with the project includes:

- *Environmental Protection Act 1994 (Qld);*
- *Environmental Protection (Waste Management) Policy 2000; and*
- *National Environment Protection Measure (Movement of Controlled Waste between States and Territories) 2004.*

5.2.1 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) aims to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (being ecologically sustainable development).

Under the EP Act "waste" is defined as anything that is:

- left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity; or
- surplus to the industrial, commercial, domestic or other activity generating wastes.

A list of all regulated wastes is included in Appendix K of this EIS.

5.2.2 Environmental Protection (Waste Management) Policy 2000

The *Environmental Protection (Waste Management) Policy 2000 (Qld)* (EPP Waste) aims to achieve the object of the EP Act in relation to waste management by identifying environmental values to be enhanced or protected, providing a framework for the making of consistent and fair decisions in relation to waste management and minimisation, providing for the preparation of waste management programs and industry waste reduction programs and providing for government planning for waste management.

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Legislative amendments to the EPP Waste that took effect on 1 January 2009 were considered during preparation of this EIS.

5.2.3 National Environment Protection Measure (Movement of Controlled Waste between States and Territories) 2004

The *National Environment Protection Measure (Movement of Controlled Waste between States and Territories) 2004* provides a national framework for developing and integrating State and Territory systems for the management of the movement of controlled wastes between States and Territories originating from commercial, trade, industrial or business activities. The management systems include tracking systems to assist agencies and emergency services to ensure that controlled wastes are directed to and reach appropriate facilities and the an obligation to provide information to assess the appropriateness of proposed movements of controlled wastes.

5.3 Waste Generation

Waste generation will occur throughout construction, operation and decommissioning of each of the project components.

At each project site an on-site induction will inform site personnel of the required waste management procedures and facilities. Contractors will be required to place a high emphasis on housekeeping and cleanliness in the workforce accommodation areas. All work areas will be maintained in a neat and orderly manner and all hazardous wastes will be appropriately stored in bunded areas away from watercourses or other environmentally sensitive areas, and in accordance with legislative requirements.

All incidents that deviate from normal operating conditions will be reported internally and at such times immediate corrective action initiated. Santos will report such incidents to the relevant authorities where required.

There are three major waste streams of concern for the GLNG Project which are discussed briefly in this section and in more detail throughout this EIS as outlined below:

- Associated Water (Section 6.7);
- CO_2 (Sections 6.8, 7.8 and 8.8); and
- Dredge Material (Section 8.17).

An overall summary of likely waste streams and approximate quantities is provided in Table 5.3.1.

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Table 5.3.1 Summary of Estimated Quantities for Waste generated by the Project

Waste Type	Solid	Liquid	Gas	Estimated Quantity per CSG field[1]		Estimated Quantity for the Gas Transmission Pipeline[2]		Estimated Quantity for the LNG facility (3 Mtpa)[3], [4]	
				Construction	Operational	Construction	Operational	Construction	Operational
Air emissions (Dust, SO_2, and NO_x)			✓	Primarily dust related, with some minor sources of combustion pollutants such as NO_x due to diesel and petrol vehicles operation on site.	NO_x emission rate is estimated to be 0.461 g/s per compressor unit. This emission rate is equal to 166 mg/m^3 per compressor. Refer to Section 6.8 for further information.	Same as construction for CSG field	Minor quantities	Same as construction for CSG field	See Section 8.8.3.1 for detailed air emissions of SO_2, NO_x, CO and CH_4

[1] Estimated quantities for operation waste per CSG field is based on information obtained from 2002 Scotia Waste Audit.

[2] Estimated quantities for the construction and operation wastes for the gas transmission pipeline are sourced from Enertrade, 2006.

[3] Estimated quantities for construction wastes for the LNG facility based on the LNG Plant Pre-FEED studies

[4] Estimated quantities for operational wastes for the LNG facility are sourced from URS, 2008.

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Waste Type	Solid	Liquid	Gas	Estimated Quantity per CSG field[1]		Estimated Quantity for the Gas Transmission Pipeline[2]		Estimated Quantity for the LNG facility (3 Mtpa)[3], [4]	
				Construction	Operational	Construction	Operational	Construction	Operational
Associated water/ Reverse Osmosis (RO) Brine		✓		The quantity of associated water produced will vary throughout the CSG fields because of variations in geological formations and field development activities. See Section 6.7.3 for further details.		Not applicable			
Dredge material	✓			Not applicable		Not applicable		8,000,000 m3 (in-situ) for Laird Point	
Electrical, electronics and batteries	✓			Minor quantities	0.9 m^3/yr	Minor quantities		60 batteries each year	Minor quantities
General waste (including putrescible waste)	✓			Minor quantities	120 m^3/yr	Minor quantities		12,500 m^3/yr	52,000 m^3/yr
Glass –general	✓			Minor quantities	4 m^3/yr	Minor quantities		Minor quantities	
Hydrotest water		✓		Not applicable		The volume and quality of water and location of disposal areas will be determined once final front end engineering design (FEED) studies are completed and are to be carried out in accordance with relevant approvals.		Not applicable	
Paper and cardboard	✓			Minor quantities	40 m^3/yr	260 m^3/yr	Minor quantities	Minor quantities	4,000 m^3/yr
Plastic oil containers	✓			Minor quantities	40 m^3/yr	Minor quantities		Minor quantities	1,650 m^3/yr

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Waste Type	Solid	Liquid	Gas	Estimated Quantity per CSG field[1]		Estimated Quantity for the Gas Transmission Pipeline[2]		Estimated Quantity for the LNG facility (3 Mtpa)[3], [4]	
				Construction	Operational	Construction	Operational	Construction	Operational
Operational waste from the LNG facility (specifically for items outlined in Table 5.3.8)	✓	✓		Not applicable		Not applicable		Not applicable	90.6 m^3/yr
Rubber and tyres	✓			Minor quantities	10 m^3/yr	Minor quantities		Minor quantities	36 m^3/yr
Scrap metal including steel drums (good and damaged condition), aerosol and aluminium cans	✓			Minor quantities	100 m^3/yr	Minor quantities		Minor quantities	2,500 m^3/yr
Waste chemicals (including drilling fluids)	✓	✓		Minor quantities	3 L/yr	Minor quantities		Minor quantities	200 L/yr
Waste oils (including waste lubricating oils and waste oil from the slop oil tank)		✓		Minor quantities	108,060 L/yr	Minor quantities		7,000 L/yr	50,100 L/yr
Wood (includes Timber waste)	✓			Minor quantities	35 m^3/yr	Minor quantities		10,000 m^3/yr	Minor quantities

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Table 5.3.2 below provides an Index for additional information on particular waste streams as discussed throughout the EIS.

Table 5.3.2 Index for waste discussion throughout this EIS

Technical Study	CSG field Section	Gas Transmission Pipeline Section	LNG facility Section
Land Contamination.	6.3.2	7.3.2	8.3.2
Surface Water.	6.5	7.5	8.5
Groundwater.	6.6	7.6	8.6
Associated Water Management.	6.6	N/A	N/A
Air Quality.	6.8	7.8	8.8
Greenhouse Gas.	6.9	7.9	8.9

5.3.1 Coal Seam Gas Fields

To extract CSG from the CSG fields, a range of activities will occur, from initial geophysical investigations through to production and processing of the CSG, as discussed in Section 3.

A summary of waste types, estimated volumes and management options for wastes generated in the CSG fields is outlined in Table 5.3.1. A complete waste inventory register is included in Appendix K of this EIS. Information below describes CSG field waste in further detail.

5.3.1.1 Construction Waste

Construction activities and likely waste types generated from activities within the CSG fields are outlined below in Table 5.3.3.

Table 5.3.3 CSG Field Construction Waste

Waste Stream	Source	Management Control
Air emissions	Vehicles on site and dust generation through construction activities.	Vehicle emissions are considered to be so low as to be not of concern. Dust suppression measures will be taken as set out in Section 6.8.5.2 and to be addressed in the Environmental Management Plan (EMP).
Drilling fluids	Well installation in the CSG field area	Waste drilling fluids will be stored separately from other waste and where possible recycled at a licensed facility, or otherwise disposed of at the local landfill under an approved “Disposal permit”.
General waste	All site operations	Non recyclable general waste will be disposed of at the local landfill.
Sanitary waste	All site operations	On site treatment and disposal by irrigation. Sludge from treatment plant will be disposed of at a local licensed facility.
Scrap metal	Installation of the well and pipeline infrastructure and construction waste.	Where appropriate, all metals will be re-used or returned to the supplier. All other metals will be stored separately on site and recycled at the local landfill.

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Waste Stream	Source	Management Control
Recyclable waste (aluminium cans, cardboard, glass, paper and plastic)	All site operations – especially the workforce accommodation areas.	Where appropriate recyclable waste will be recycled at local facilities.
Vegetation waste	Scouting, land clearing, track and road construction, well installation and development of compressor stations.	Will be cleared, stockpiled, mulched and reused for rehabilitation purposes.
Waste Oils	Well installation and gathering water pipeline infrastructure in the CSG fields area.	Same as drilling fluids.

5.3.1.2 Operational Waste

Operational activities in the CSG fields will generate waste in relation to specific field operations, as outlined in Table 5.3.4 below.

Table 5.3.4 CSG Field Operational Waste

Waste Stream	Source	Management Control
Air emissions	Compressor station operation	• Implementation of a preventative maintenance program to ensure gas turbines are operating efficiently to minimise CO emissions and un-combusted hydrocarbons (primarily methane, with minor VOC emissions); • Optimisation of gas turbine operations to minimize time periods of operation at low efficiency levels that may result in excess GHG emissions and higher than normal levels of NOx emissions; and • Implementation of a quantifiable monitoring and measuring program.
Associated water	CSG production	Associated Water has the potential for reuse including: • Potable, industrial re-use and treated irrigation for Roma CSG field; • Treated irrigation and untreated irrigation for Fairview CSG field; and • Treated irrigation for Arcadia Valley CSG field. Further options are discussed in Section 6.7.
Electrical, electronics and batteries	All site operations	Electrical equipment and batteries will be stored separately on site and collected by recycling contractors.
General waste	All site operations	Non recyclable general waste will be disposed of at the local landfill.
Recyclable waste (aluminium cans, cardboard, glass, paper, plastics and tin)	All site operations	Where appropriate recyclable waste will be recycled at local facilities.

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Waste Stream	Source	Management Control
Reverse Osmosis (RO) Brine	Water treatment operations	It is highly likely that brine containment ponds will be required to manage brine prior to its safe disposal (crystallisation and encapsulation or transfer to licensed landfill sites), see Section 6.7 for further information.
Rubber and tyres	All site operations	Rubber and tyres will be stored separately from other waste, where appropriate will be reused and recycled. The final disposal options will be at an approved facility.
Sanitary waste	All site operations	On site treatment and disposal by irrigation. Sludge from treatment plant will be disposed of at a local licensed facility.
Waste chemicals / Unused chemicals	Gas separation and treating options	Waste chemicals will be stored separately from other waste and disposed of at an approved facility.
Waste oils and lubricants	CSG production, gas separation and treating options	Same as waste chemicals.
Waste solvents	Gas separation and treating options	Same as waste chemicals.

Table 5.3.5 below provides a detailed breakdown of specific wastes which have been included under waste oils and chemicals for the CSG fields in Table 5.3.1.

Table 5.3.5 Summary of Waste Oil and Chemicals

Waste chemical category	Nature and composition	CSG field sources
Waste oils	Derived from petroleum or hydrocarbon fuels or oils.	Used or off-spec petroleum fuels, used lube oils, used hydraulic oils, used cutting oils, used mineral oils and contaminated greases.
Acids	Low pH, moderately to highly corrosive, highly reactive.	Acid cleaning of components, well acidizing activities and alkali neutralisation.
Alkalis	High pH, moderately to highly corrosive, highly reactive.	Caustic cleaning of components, acid neutralisation.
Oxidising agents	Peroxide, hypochlorite, permanganate and other chemical solutions.	Used for cleaning or in well development or injection operations.
Triethylene Glycol (TEG)	Hydrocarbon based, hydrophilic.	Dehydration of natural gas at CSG compressor facilities.
Anti-scalants	High solubility for cations, anions and metals, may be corrosive.	Used in aqueous solution to prevent scale build-up in piping and heat exchange tube bundles.
Biocides	Typically hydrocarbon based, primary property is biological toxicity.	Used in aqueous solution to prevent biofouling in pipelines, cooling towers, and geologic formations.
Anti-corrosives	Typically hydrocarbon based, may have oily properties.	Used in aqueous solution to prevent corrosion of metal surfaces in piping or other equipment.
De-emulsifiers	Typically hydrocarbon based, surfactant or detergent properties.	Used in oily emulsions to break the emulsion and separate free oil.

Waste chemical category	Nature and composition	CSG field sources
Non-halogenated solvents	Typically hydrocarbon based without halogen groups.	Used as general solvents and to remove oils from metal surfaces.
Pesticides and herbicides	Typically hydrocarbon based, toxicity to fauna and flora.	Used for pest and weed control around developed facilities.
Surfactants and detergents	Typically hydrocarbon based, may have hydrophilic or hydrophobic properties, and may contain phosphates.	Used to clean metal or non-metal surface, used for general washing or equipment, clothing, etc.
Paint residues	Typically hydrocarbon based but may be water based residues from paint pigments.	Used to paint metal and non-metal surfaces of most CSG facilities.

5.3.2 Gas Transmission Pipeline

The 435 km gas transmission pipeline will transport gas from the CSG fields to the LNG facility. It is anticipated that construction of the gas transmission pipeline will take approximately 18 months to 2 years to complete.

A summary of each waste type, estimated volumes and management options for wastes generated by the gas transmission pipeline construction and operation are summarised in Table 5.3.1, with a complete waste inventory register included in Appendix K.

5.3.2.1 Construction Waste

Pipeline construction is a lineal process that comprises a number of stages including access track construction, right-of-way (ROW) clearing and grading, trenching, pipe laying, trench backfilling and ROW reprofiling/restoration. These activities will require significant earthworks and will generate relatively small amounts of waste.

The likely waste streams generated and sources of such waste are outlined in Table 5.3.6 below:

Table 5.3.6 Gas Transmission Pipeline Construction Waste

Waste Stream	Source	Management Control
Air emissions	Vehicles on site and dust generation through construction activities.	Vehicle emissions are considered to be so low as to be not of concern. Dust suppression measures will be taken as set out in Section 7.8.5.2 and to be addressed in the Environmental Management Plan.
General waste	Initial scouting, land clearing, pipeline track and road construction. Workforce accommodation areas.	Non recyclable general waste will be disposed of at the local landfill.
Putrescible waste	Workforce accommodation areas	Putrescible waste will be stored in covered containers and disposed of at the local landfill.
Recyclable waste (aluminium cans, cardboard, glass, paper, plastics and tin)	Workforce accommodation areas	Where appropriate recyclable waste will be recycled at local facilities.
Sanitary wastes	Workforce accommodation areas	On site treatment and disposal by irrigation. Sludge from treatment plant will be disposed of at a local licensed facility.

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Waste Stream	Source	Management Control
Scrap metal	Pipeline construction	Where appropriate, all metals will be re-used or returned to the supplier. All other metals will be stored separately on site and recycled at the local landfill.
Vegetation waste	Initial scouting, land clearing, pipeline, track and road construction.	Will be cleared, stockpiled, mulched and reused for rehabilitation purposes..
Waste oils	Plant and equipment associated with land clearing, pipeline, track and road construction.	Waste oils will be stored separately from other waste and disposed of at an approved facility.
Hydrotest water	Hydrostatic testing of the pipeline.	Water treatment and disposal in accordance with approval conditions.

An EMP will be developed and implemented to minimise the environmental impact associated with gas transmission pipeline construction activities. For example topsoil will be re-established to return land to pre-construction use, including the reinstatement of natural drainage patterns, and the installation of erosion control measures. If Horizontal Direction Drilling (HDD) is adopted as the preferred methodology to cross major watercourses, waste management methods will be incorporated into site specific management procedures prepared prior to the commencement of drilling operations.

All waste material will be removed from the gas transmission pipeline ROW daily and disposed of to an authorised facility as agreed to by the local authority and in accordance with EPA waste management guidelines.

It is proposed that there will be two temporary accommodation facilities (TAFs) provided for the construction workers:

- Main accommodation facility for approximately 500 people; and
- Satellite accommodation facility for approximately 100 people.

Sewage wastes generated at the TAFs will be treated in a mobile package sewage treatment plants. Treated plant effluent will be disposed of by irrigation in accordance with the relevant authority requirements.

Laydown areas will be at various locations along the gas transmission pipeline corridor for equipment storage, vehicle laydown areas, site office and administration facilities, and meeting points for crews prior to commencing work on the gas transmission pipeline ROW. Additional waste streams from those outlined in Table 5.3.6 generated from the laydown areas are likely to include:

- Office and administration waste such as paper, cardboard, printer toners and cartridges; and
- Pipe cut-offs, spacers and timber skids, which will be recycled where practical.

During the commissioning stage of the gas transmission pipeline the integrity of the gas transmission pipeline is verified by undertaking hydrostatic testing. The hydrotest water will potentially be treated with chemicals such as biocide, oxygen scavengers and corrosion inhibitors, depending on such factors as quality of the test water and the length of pipe tested. Use of any chemical on site should be minimised and carefully controlled to avoid contamination of local water sources. If associated water is to be used for testing, then it is suggested that an appropriate water treatment technology is used to reduce the inherently high total dissolved solids (TDS) concentrations to acceptable background levels (i.e. TDS of proposed streams to which water may be discharged).

The hydrotest water will be treated and disposed of in accordance with approval conditions. The volume and quality of water and location of disposal areas will be determined once final front end engineering design (FEED) studies are completed and the construction contractor has been appointed. A detailed

assessment of its impacts and recommended mitigation measures should be undertaken prior to construction.

Once the gas transmission pipeline has been constructed the surrounding affected area (within the proposed gas transmission pipeline ROW) will be re-established with topsoil cover, returning land to pre-construction use. As part of this process natural drainage patterns will be reinstated, disturbed vegetation will be rehabilitated and where necessary erosion controls will be implemented.

Any contaminated soil/gravel will where possible be land farmed on site. Where on site land farming is not possible, the contaminated soil will be disposed of by a licensed contractor at a licensed facility.

5.3.2.2 Operational Waste

The only significant waste stream associated with gas transmission pipeline operational activities will be sludges from pigging operations. This is regulated waste under the EP Act and will be disposed of by a licensed contractor at a licensed facility.

5.3.3 LNG Facility

The LNG facility located on Curtis Island will include the following associated components:

- A potential bridge to cross Port Curtis between Friend Point and Laird Point to access the LNG facility from Gladstone; and
- Marine facilities including a product loading facility (PLF) and materials offloading facility (MOF).
- Channel and swing basin dredging to provide ship access (refer to Section 8 for further details on the dredge material placement facility).

A summary of each waste type, estimated volumes and management options for wastes generated by the LNG facility is provided in Table 5.3.1, with a complete waste inventory register included in Appendix K.

5.3.3.1 Construction Waste

The construction of the LNG facility will be a major undertaking and is likely to generate waste from the various stages of construction. An EMP will be developed and implemented to establish a series of environmental controls (administrative, engineering, and monitoring and auditing procedures) to minimise these impacts.

Table 5.3.7 outlines construction wastes anticipated for the LNG facility.

Table 5.3.7 LNG Facility Construction Waste

Waste Stream	Source	Management Control
Air emissions	Site operation	The methods of control are described in Section 8.8
Batteries	All site operations	Will be collected and transported off-site for treatment at a local licensed facility.
Concrete	During construction	Where possible reused on site, or recycled at a local facility.
Dredging material	Laird point dredging activities	See Section 8.17 for placement
General waste	Worker accommodation areas	Non recyclable general waste will be disposed of at the local landfill.
Packing materials	During construction	Where possible reused on site, or recycled at a local facility.
Paint residues	During construction	Will be collected and transported off-site for treatment at a local licensed facility.

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Waste Stream	Source	Management Control
Putrescible waste	Workforce accommodation areas.	Putrescible waste will be stored in covered containers and disposed of at the local landfill.
Recyclable waste (aluminium cans, cardboard, glass, paper, plastics and tin)	Workforce accommodation areas	Where appropriate recyclable waste will be recycled at local facilities.
Sanitary waste	Workforce accommodation areas	Solid waste will be removed from the Island and liquid waste /effluent streams will be treated to an acceptable standard, prior to being irrigation and/or transport to a licensed facility.
Scrap steel	During construction	Where appropriate, all metals will be re-used or returned to the supplier. All other metals will be stored separately on site and recycled at the local landfill.
Wood waste	During construction	Where possible reused on site, or recycled at a local facility.
Vegetation waste	Land clearing and earthworks	Will be cleared, stockpiled, mulched and reused for rehabilitation purposes.
Waste oils	Plant and equipment associated with land clearing, pipeline, track, bridge and road construction	Waste oils will be stored separately from other waste and disposed of at a licensed facility.

Where there is the ability to recycle materials, the waste will be segregated into bins and skips and removed from the site by authorised recycling contractors. These recyclable materials will potentially include scrap steel, wood and plastic materials.

Construction activities will also generate dust during vehicle movement activities, clearing and other earthworks. As dust has the potential to impact local surface water, the local air shed and nearby flora, trafficked areas will be regularly watered to reduce the quantity of dust generated by the movement of equipment and vehicles. Paving the main access road will also reduce dust generation (refer to Section 8.8 for more details), and further measures will be implemented to manage stormwater runoff as discussed in Section 8.5.

During dewatering of excavations the groundwater cannot be discharged to the local drainage system and would require treatment if discharge is to occur. Due to the elevated concentration of naturally occurring arsenic in the area as discussed in Section 8.2.2 it is recommended that deep excavations below groundwater table be avoided if possible and the use of piling be considered. Where excavations are present, groundwater will require characterisation to determine suitability for discharge.

The use of fuels and chemicals onsite will be associated with such activities as vehicle refuelling and general site facility and associated infrastructure construction. Potential liquid waste streams will include oily waste water (from equipment wash water), runoff/drainage from chemical and hydrocarbon storage areas (such as oil-filled transformer yards and general washdown water. Appropriate design of fuel and chemical storage areas, which includes spill containment bunding and sealing the surface area, will reduce the risk of groundwater contamination resulting from spills (refer to Section 8.6 for further details).

Regulated wastes such as batteries will be stored separately in appropriate containers and collected by recycling contractors. Where possible, these materials and other regulated wastes will be transported under the EP Regulations waste tracking process and taken to authorised recycling premises; otherwise they will be disposed of at a licensed facility.

Access to the LNG facility from the mainland during construction is discussed in Section 3. One of the options is for a barge and ferry to operate across Port Curtis if the access road and bridge is not

constructed. The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) regulates the discharge of operational ship-sourced pollutants (GBRMPA, 2009). Within the Great Barrier Reef, MARPOL is implemented through the Protection of the Sea (Prevention of Pollution) from Ships Act 1983, Transport Operations (Marine Pollution) Act 1995 and the Great Barrier Reef Marine Park Act 1975.

The MARPOL annexes describe the conditions under which itemised substances can be discharged, as well as design specifications for ships to minimise these discharges. In addition, MARPOL places a duty on the ship's Master or operator to report any incident that involves a discharge or probable discharge of oil, noxious liquid substances or harmful packaged substances (GBRMPA, 2009). Santos will expect charter parties to comply with the requirements specified through MARPOL.

5.3.3.2 Operational Waste

Sources of wastes from the operation of the LNG facility include administration areas, plant area, amine and dehydration units, sewage treatment plant, Reverse Osmosis (RO), hot-oil system and mercury removal catalyst units. Note: There are no proposed on-site solid waste disposal areas for the LNG facility. Waste streams will be stored separately and removed from site by an approved contractor to an appropriate licensed facility. Operational waste streams are outlined below:

Solid

- Administration areas and associated infrastructure are likely to generate putrescible waste, general waste, recyclable waste (including paper, plastics, cardboard, aluminium cans and glass), first-aid station waste and sanitary waste; and
- Office waste including paper, toner and printer cartridges and used electrical or electronic waste.

Solid operational waste from the LNG facility is projected in Table 5.3.8.

Table 5.3.8 Projected quantities of solid waste for a 3 Mtpa and 10 Mtpa facility

Solid Waste stream	3 Mtpa Quantity (kg/yr)	10 Mtpa Quantity (kg/yr)
Cellulose	1,100	2,700
Biological sludge	4,200	6,300
Oily sludge/float	7,200	21,000
Ceramic balls	4,100	12,300
Molecular sieve wastes	39,000	120,000
Activated carbon	35,000	105,000
General waste	52,000	125,000

Sourced from Santos GLNG Project: Pre-FEED Studies.

Liquid

The LNG process is essentially a dry process. As such, there are only minor quantities of wastewater produced, although it is anticipated that there will be several other liquid waste streams generated during the operational life of the LNG facility including:

- Sanitary sewage from the LNG facility will be treated at an on-site sewage treatment plant (STP). Treatment will include primary and secondary treatment followed by chlorination. Plant effluent will be route to an irrigation system for disposal.
- Neutralised regeneration wastewater from the demineraliser unit and reject water from fresh water treatment.
- Process wastewater and contaminated stormwater runoff.

- Waste oils and grease from the on-site activities will be collected and disposed of off-site by licensed waste contractors. Recycling will be used if available. Where waste oils and greases are stored on-site prior to disposal this will be conducted in accordance with accepted industry practices, with measures put in place to prevent unauthorised off-site discharges. A detailed breakdown of specific wastes which have been included as Waste Oils/Solvents is included in Table 5.3.9 below.

Table 5.3.9 Projected quantities of waste oils/solvents for a 3 Mtpa and 10 Mtpa facility

Waste stream	3 Mtpa Quantity (kg/yr)	10 Mtpa Quantity (kg/yr)
Waste Lubricating oils	8,200	20,500
Spent oils	1,200	3,000
Spent solvents	130	325
Waste oil from slop oil tank	21,000	53,000

Sourced from Santos GLNG Project: Pre-FEED Studies.

Table 5.3.10 summarises the expected flows and water quality of liquid waste generated from the LNG facility for a 3 Mtpa facility.

Table 5.3.10 Expected flows and water quality

Waste Stream	Flow (m^3/hr)		Estimated Characteristics	
	Average	Maximum		
Treated process / contaminated stormwater.[5]	3	45	pH	6 to 7 units
			BOD	10 to 25 mg/L
			TSS	5 to 15 mg/L
			Oil	5 to 20 mg/L
Sanitary waste.[6]	1.2	1.9	pH	6.5 to 7.5 units
			BOD	10 to 25 mg/L
			Oil & Grease	5 to 15 mg/L
			Total Nitrogen	30 to 50 mg/L as N
			Total Kjeldahl Nitrogen	1 to 7 mg/L
			Ammonia nitrogen	1 to 7 mg/L
			Total Phosphorus	5 to 15 mg/L
			TDS	270 mg/L

Sourced from Santos GLNG Project: Pre-FEED Studies.

Process water

The design of the LNG facility's sediment ponds is still under development as part of FEED, however any liquid effluent discharged via the nearby seawater outfalls from the LNG facility will meet the required discharge criteria applied by the applicable regulatory agencies as discussed in Section 8.5.

[5] Average flows assume dry weather and also incorporate filter backwash water and reject stream from the sections of the reverse osmosis plant. Maximum flows assume wet weather and incorporate dry weather data.

[6] Assume an average population (visitors and transient workers) of 100 people and a maximum population of 150 people.

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Gas cleaning treatment activities may result in waste stockpiles and the need for waste storage facilities as outlined in Section 8.6. The waste storage facilities should be within bunded areas to minimise surface contaminants from infiltrating shallow groundwater resources.

Stormwater

The potential exists to utilise clean stormwater runoff from the site as a source of water, which is discussed further in Section 8.5. A stormwater filtration plant will be provided to treat the impounded stormwater that will be recycled for use on site. The filtered water will be potentially be stored in a pond and then pumped to users on demand.

Demineralised Water

The brine waste from the reverse osmosis plant is proposed to be discharged to Port Curtis. Marine water quality studies have modeled the impacts of this discharge (based on quality and quantity data) and assessed that impacts on marine water quality will be negligible (refer to Section 8.7 for further details).

Sanitary Waste

The irrigation area which will dispose of both treated sewage and water of a suitable quality from the water tank will be located and designed to ensure that:

- Sensitive areas are avoided;
- Soil erosion and soil structure damage is avoided;
- There is no surface ponding or runoff of effluent; and
- The quality of groundwater is not adversely affected.

Areas where treated wastewater is discharged to irrigation fields will be fenced and clearly marked with warning notices of the purpose of the area and not to use or drink the water.

Gaseous

The main sources of air emissions that may be released to atmosphere by the LNG facility under normal operating conditions and emissions during start-up and upset releases include:

- Gas turbines used to drive the refrigerant compressors;
- Power generation turbines;
- Inlet gas heater;
- Acid gas incinerator;
- The flare; and
- Fugitive methane emissions and greenhouse gases.

For an air emissions inventory refer to Section 8.8 of this EIS.

5.4 Waste Management

A WMP has been developed in accordance with current legislative requirements for the project and is included in Appendix K. The WMP provides a framework for waste management on site through developing strategies, monitoring performance, setting performance targets and implementing action plans for improvement.

The plan takes into consideration international best practice for waste management and includes opportunities and actions to be taken to implement the waste management hierarchy and cleaner production practices.

Key goals for the WMP are to:

- Continually maintain high standards of due diligence;
- Maintain proper housekeeping activities for every component of the project;
- Keep detailed records to ensure all wastes are properly handled, stored, treated, and disposed of from each site effectively; and
- Continually improve waste management policies, procedures, and practices.

The objective of the WMP is to provide tools for addressing relevant aspects of waste management including waste minimisation, recycling and reporting for waste streams generated directly and indirectly from GLNG Project activities. The WMP will also ensure that all GLNG Project activities comply with policy, license/authority and other relevant legislative conditions.

5.4.1 Waste Prevention

Waste prevention is the first step in reducing the amount of waste generated. Where appropriate, the generation of waste can be prevented or reduced by substituting inputs for those that generate waste, increase efficiency in the use of raw materials, energy, water or land, redesign processes or products, and improve maintenance and operation of equipment.

Careful project planning (including development of a purchasing policy that assesses the environmental impacts of stock items) will ensure that the amount of material brought onto site for the construction and operation of the GLNG Project is minimised, resulting in a cost saving and reduction in the volume of waste going to landfill. Any excess materials and used chemical containers will, where practical, be returned to the supplier or other local users.

Santos will also consider packaging issues when purchasing resources for the project and will encourage bulk purchasing to reduce the amount of packaging waste.

The implementation of appropriate waste management strategies will be actioned to ensure that the site does not become impacted with unauthorised releases of fuels or other chemical spills during the construction and operational phases of the project's life.

5.4.2 Waste Recycling/Reuse

Waste, where practicable and taking into account health and hygiene issues, will be segregated and collected on-site at the LNG facility and stored in suitable containers for removal to approved facilities as agreed with the relevant local council prior to construction. It is anticipated that a portion of all construction materials can be recycled.

The following are examples of how materials (identified as construction wastes in the GLNG Project) have potential for reuse or recycling:

- Where possible, vegetation wastes from site clearing works will be cleared, stockpiled, mulched and reused for rehabilitation purposes;
- Where possible, recyclable materials will be purchased for use throughout the project;
- Recovering solvents, metals or oil and re-using them for a secondary purpose; and
- Recyclable building wastes will be collected separately and re-used or recycled, for example:
  - Wood from concrete formwork will be recovered and reused;
  - Scrap steel and off-cuts will be recycled;
  - Pallets for re-use or recycling;
  - Plastics will be recycled;
  - Paper and cardboard for re-use or recycling; and
  - Oils will be collected and sent for recycling.

Section 5 Waste Management

5.4.2.1 Market Demand for Recyclable Waste

Once volumes of recyclable waste generated by the construction and operation phases of the project (as identified above in Section 5.4.2) are known, an assessment will be undertaken to assess market demand for these recyclable waste streams. This will also be dependant on the availability and capacity of local facilities.

5.4.3 Waste Separation

Solid waste streams will be separated into various components at the point of their production. Waste separation at the source will be achieved by providing bins for re-usable or recyclable materials (such as aluminium cans, cardboard, glass, paper, plastics and tin). A number of areas will be allocated within the LNG facility for the collection of large quantities of waste to segregate wastes for recycling.

The GLNG Project will have dedicated storage areas for the management of any regulated wastes. All on-site waste management facilities will be in accordance with Santos' Environmental Health Safety Management System (EHSMS) Hazard Standard 04 Waste Management. This standard defines the minimum acceptable standards for waste management activities for all Santos operations and activities.

Santos will develop and provide appropriate waste management training to all employees and contractors concerned.

5.4.4 Waste Disposal

Wastes generated by the project will be disposed of in a way that causes the least environmental harm.

Operational and construction solid wastes that cannot be recycled or re-used will be disposed of at local authority waste disposal facilities.

5.4.4.1 Waste Tracking

Under the *Environmental Protection (Waste Management) Regulation 2000* (EP Waste Regulation), it is a requirement that the administering authority is provided with the relevant information required to manage the environmental risks associated with trackable wastes.

All defined trackable wastes generated during construction and operation of the GLNG Project will be tracked in accordance with the requirements of Schedule 2 of the EP Waste Regulation. This will include the completion of waste tracking certificates (refer to Appendix K) for the collection, transport and management of trackable or regulated wastes. Specifically this will include recording of the following information:

- Name, address, local government area and contact details of generator;
- Name, address, contact details and environmental authority number of receiver;
- Name, address, contact details and environmental authority number of transporter;
- The day and time the waste is given to the transporter;
- The load number;
- Registration number of the vehicle transporting the load;
- If the waste is a dangerous good:
  - The type and number of containers in which the waste is contained;
  - Its UN number;
  - Its packing group designator; and
  - Its dangerous goods class and any subsidiary risk.
- The following details of the waste:

  - The type of waste;
  - Amount expressed in kilograms or litres;
  - Its physical nature (solid, liquid, paste or gas); and
  - Its waste code.
- The waste origin code for the activity that generated the waste.

In addition to reports for regulated wastes, EPA waste transport certificates will be forwarded to Santos. A copy will be retained by the waste contractor and also sent to the EPA. The certificates will outline the type and amount of regulated waste, the name of the waste producer, and the nominated disposal/treatment/storage facility.

Waste contractors will also provide the site with regular reports which outline different waste types, their disposal methods and tracking records.

5.4.4.2 Waste Monitoring and Auditing

By monitoring and auditing waste management related activities for the GLNG Project Santos will be able to:

- Provide waste data to enable continuous improvement of waste avoidance, reduction and management measures throughout all components of the project;
- Monitor and, if required, initiate actions to fulfil waste objectives and targets;
- Assess actual waste management results and comparing with predicted impacts and mitigation measures;
- Monitor potential environmental impacts; and
- Enable positive actions to be taken in the event of incidents or accidents.

5.4.5 Cleaner Production Practices

The key principles of the waste management hierarchy and cleaner production play an integral part in the project. Cleaner production is a concept which industries can implement to continuously improve their products, services and processes with the aim of reducing pollution and waste at the source. It can also result in financial benefits (DEWR, 2007). Cleaner production is a broad term that encompasses eco-efficiency, waste minimisation and pollution prevention.

Cleaner production can be achieved through the implementation of the following procedures:

- Input substitution (this is not readily applicable to this project);
- Product reformulation (this is not readily applicable to this project);
- Production process modification including selection of the best available practicable technologies;
- Improved operation and maintenance including the selection and use of the most appropriate processes and equipment;
- Reuse of resources that are otherwise wastes; and
- Closed-loop recycling where a product is recycled and used again in the same form.

Cleaner production opportunities proposed for project include:

5.4.5.1 Construction

- Adoption of best practice procurement and construction methodologies to ensure minimal waste is generated during construction of the GLNG Project;
- Contracts with construction companies will encourage all contractors to adopt best practise waste minimisation procedures;

- Purchase of materials cut to standard sizes, reuse of concrete formwork where practicable; and
- Separate skips will be provided to maintain segregation and maximise economic reuse and recycling, in preference to disposal to landfill.

5.4.5.2 Operation

- The selection of best available technology for gas extraction and processing to ensure appropriate energy use and production efficiency of the gas;
- Employing production processes that are efficient in their consumption of energy, materials and natural resources;
- The selection of energy efficient equipment for the GLNG Project;
- Minimising generated wastes through recycling, and by reusing process residues where possible;
- Safely disposing of any residual wastes and process residues; and
- Promoting the safe use, handling, recycling and disposal of products through an understanding of their life cycle.

5.4.6 Non Compliance Waste Generation

In the event of a minor spill, or upset to normal operating conditions at any of the GLNG Project sites Santos' EHS 08 Contaminated Site Management protocol should be followed (refer to Appendix BB3 for further details).

All incidents that deviate from normal operating conditions will be reported, with corrective actions initiated as required. This will include reporting to relevant agencies where this is required, and actioning by Santos personnel and/or contractors to prevent a recurrence of the incident. Any non-compliance and incident reports will be reviewed and closed out by senior Santos management.

5.4.7 Groundwater Protection

It is not anticipated that GLNG activities will result in the stockpiling of any waste materials that may present a risk of groundwater contamination.

5.4.8 Stormwater Protection

Methods to avoid stormwater contamination by raw materials, wastes or products are discussed in detail in Sections 6.5, 7.5 and 8.5. Methods proposed have been developed in accordance with the requirements of the EPP (Water) 2008 to ensure where practicable, that stormwater is contained, recycled, re-used (e.g. irrigation and dust suppression) and where required treated and disposed of in an appropriate manner.

5.5 Decommissioning of the Project

Decommissioning of project components and infrastructure has not been planned in detail at this early stage of the project development. However, decommissioning will be undertaken as/when required and will be conducted in accordance with accepted industry codes of practice, Australian Standards, and stakeholder and regulatory requirements.

5.5.1 CSG Fields

Once the gas supply from each well is depleted (generally after 5 - 15 years of operation), the well site (lease) and associated facilities and infrastructure will be decommissioned, remediated and rehabilitated.

Santos will decommission, remove, make safe, and/or appropriately dispose of infrastructure, equipment and contaminated materials on/from all sites within the CSG fields in accordance with existing statutory

approvals and legislation unless otherwise agreed with the regulatory agencies. This will take into account the needs/concerns of the relevant landholders. For further details refer to Section 3.6.6.

5.5.2 Gas Transmission Pipeline

At the time of decommissioning, a decision will be made regarding the opportunities for future use of the gas transmission pipeline. If no longer required, the pipeline will be purged of gas and below ground facilities allowed to gradually degrade in-situ. However, if it is considered that the gas transmission pipeline may offer some future benefits, it will be filled with an inert material and the cathodic protection system maintained to prevent corrosion. All above ground facilities will be removed when it is decided that the gas transmission pipeline is no longer required.

5.5.3 LNG Facility

It is likely that the LNG facility and its associated infrastructure easements/corridors will be valuable either as a package or as individual elements to other industrial users. Prior to any decommissioning works Santos will submit a decommissioning plan that will outline waste management strategies approximately 5 years prior to commencing the decommissioning phase of the LNG facility project The decommissioning plan will be developed in consultation with the relevant stakeholders and regulatory requirements.

5.6 Summary of Findings

Waste management is an integral part of the GLNG Project and is taken into consideration during construction, operation and through to the eventual decommissioning of all the project's components (CSG fields, gas transmission pipeline and LNG facility) under 'normal' and other conditions.

As a generator of waste, Santos will ensure it meets its obligations under the *Environmental Protection Act 1994* (EP Act), *Environmental Protection Regulation 2008, Environmental Protection (Waste Management) Policy 2000, Environmental Protection (Waste Management) Regulation 2000* and the *National Environment Protection Measure (Movement of Controlled Waste between States and Territories) 2004* when designing, constructing, operating and decommissioning all components of the GLNG Project.

Santos aims to promote best practice disposal options of waste products both on-site through appropriate maintenance of waste disposal areas and off-site through utilising environmentally responsible waste management contractors.