GTL Methanol Plant
Burrup Peninsula

Public Environmental Review

Volume 1 - Report

URS

GTL RESOURCES PLC.

GTL Methanol Plant,
Burrup Peninsula

Public Environmental Review

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INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions emailed to the DEP/EPA Project Assessment Officer would be most welcome.

GTL Resources PLC proposes to construct a methanol plant on the Burrup Peninsula, Western Australia. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 4 (four) weeks from 9 September 2002, closing on 7 October 2002. Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?
If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people), please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission
You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:
- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Electronic submissions
It is requested that a single consolidated email response be provided after you have reviewed the full PER. Please note that, where an email response is received, an additional hard copy is not required (except for attachments that cannot be forwarded electronically). You will receive an electronic acknowledgement of your submission and will also be advised electronically when the EPA's report and recommendation become available.

Points to keep in mind
By keeping the following points in mind, you will make it easier for your submission to be analysed:
- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:
- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: 7 October 2002

Submissions should ideally be emailed to: ann.barter@environ.wa.gov.au

OR addressed to:
The Environmental Protection Authority
Post Office Box K822
PERTH WA 6842
Attention: Ms Ann Barter

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INTRODUCTION

GTL Resources PLC (GTL), through its 100% owned subsidiary Australian Methanol Company Pty Ltd, proposes to construct and operate a 1.05 million tonnes per annum (Mtpa) methanol plant on the Burrup Peninsula, Western Australia. The project location is on a 35 ha lease within the Withnell East Industrial Area, adjacent to the large North West Shelf Venture Project (NWSVP) Onshore Gas Plant (operated by Woodside). Within the lease area, the methanol plant will occupy an area of 15 ha.

The plant will convert natural gas to methanol using the proven, proprietary Combined Reforming Technology of Lurgi-Oel-Gas-Chemie GmbH (Lurgi). Approximately 40% of the world's methanol production capacity uses Lurgi technology, with Combined Reforming Technology applied in nine other projects worldwide.

The purpose of this Public Environmental Review (PER) document is to describe the proposed construction and operation of the project and the existing environmental setting; assess the potential environmental impacts; provide management and monitoring commitments to ensure that the project will be managed in an environmentally responsible manner; and allow an informed appraisal of the environmental acceptability of the proposed project.

PROJECT JUSTIFICATION

The project represents an opportunity to develop a value-adding downstream processing facility from the utilisation of the significant gas reserves of the North West Shelf. With a total capital investment of approximately $600 million, the project will provide significant benefits for the local and regional economy.

The development of such value-adding industries is supported by the WA Government which has set aside land on the Burrup Peninsula for industrial purposes. As part of this strategic development of the Burrup Peninsula, the State Government has committed $136 million for multi-user infrastructure development.

The project will offer a number of significant benefits for the region, including:

- provision of additional employment and training opportunities during the construction phase of the development;
- contribution to the local economy of the Pilbara area, both directly and indirectly, as a result of the long-term employment that will occur during the operational phase of the development;
- production of chemical grade methanol for use in the petrochemical industry; and
- contribution to the regional economy of Australia resulting from export earnings, taxes, salaries, and purchases of goods and services during the construction and operation phases of the development.

PROPOSED PROJECT

Major components

The proposal involves the construction and operation of:

- a natural gas pipeline for the input of gas;
- a methanol plant;
- plant infrastructure and utilities, including a mechanical vapour compression desalination plant;
- seawater supply and brine and wastewater discharge via Water Corporation's pipeline infrastructure;
- an export pipeline for methanol to Dampier Port; and
- shipping of product from Dampier Port by specialised tankers.

Through this PER document, GTL seeks approval to construct the methanol plant and associated infrastructure within the lease area; operate the plant and pipelines; and export the methanol product.

Environmental approvals for the establishment of the feed gas, methanol product and seawater pipelines will be sought separately by GTL or the Department of Mineral and Petroleum Resources (MPR). The pipelines will be laid within infrastructure corridors which are presently subject to a strategic environmental assessment being undertaken by MPR. Hence, the potential environmental impacts of installing the pipelines are not considered in this document, though the potential impacts associated with the operation of the pipelines are included.

Similarly, environmental approvals for extensions to the Dampier Public Wharf will be sought separately by the Dampier Port Authority, but potential impacts associated with the operation of the export facility are considered in this document.

Construction Summary

Construction of the plant is anticipated to take 30 months from award of the Engineering, Procurement and Construction contract to mechanical completion. Site works will commence once environmental approval and Native Title clearance have been granted.

Plant modules and other bulk materials will be shipped to the Mermaid Marine facility in King Bay for transport to the site via the existing road system. A minor upgrade of the Withnell Bay Road will be required.

Water and power for construction will be supplied to the site by the Water Corporation and Western Power, respectively, from extensions to existing infrastructure. Once operational, the plant will be self-sufficient in these utilities, though Western Power will provide start-up and standby power.

Construction will require approximately 500 workers. GTL is aware of community concerns regarding the potential effects of both temporary and permanent workforce accommodation requirements on local housing availability and rental costs. The company is currently investigating existing and potential future accommodation options for the construction workforce in the Karratha area and has accepted an invitation to join the Nickol Bay Accommodation Taskforce.

Operations Summary

Mechanical completion of the plant will be followed by a commissioning and performance testing phase, with first methanol production planned for June 2005. The plant will be designed for 24-hour operation and plant availability is expected to be better than 96%. Plant shutdowns for major maintenance and inspection will occur on a four yearly basis. The project is anticipated to have a lifespan of at least 25 years.

The three input streams to the plant will be natural gas (for feedstock and energy requirements); seawater (for cooling purposes and as feed for the desalination plant); and chemicals and catalysts required for the operation and maintenance of the plant. These inputs will be processed into methanol for export, whilst generating a range of atmospheric emissions, wastewater discharges and solid and semi-liquid wastes for disposal off-site.

Sixty personnel will be required to operate, maintain and support the plant. Adequate numbers of competent personnel will always be available to assemble an emergency response team and to perform critical operations.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

GTL has undertaken extensive community and stakeholder consultation during preparation of this PER to ensure that environmental and social issues are identified and addressed. The consultation programme has included:

- preliminary meetings with stakeholders;
- broader community information dissemination;
- public meetings; and
- targeted consultation with key stakeholders.

Groups included in the consultation have been the Shire of Roebourne, local politicians, government agencies, community groups, business and local interest groups, corporate residents of the Burrup Peninsula and aboriginal and environmental groups. Detailed information on the project has been provided to these groups and their input sought at an early stage to enable issues of concern to be addressed in an appropriate manner.

ENVIRONMENTAL EFFECTS

The environmental effects of the proposed project are summarised in Table ES1, presented at the end of the Executive Summary. Actual and potential effects on each of the key environmental factors (as identified in the PER guidelines) are summarised below, along with the management tasks proposed to mitigate any adverse effects and the predicted environmental outcome.

Terrestrial Flora

Approximately 15 ha of vegetation will be removed, which may include the Priority species *Terminalia supranitifolia* and *Eriachne tenuiculmis*. A definitive survey of the vegetation within the GTL lease area has not been possible due to the prolonged absence of rain on the Burrup Peninsula. GTL commits to undertake such a survey once sufficient rains are received.

In the absence of rain, an assessment of the conservation significance of vegetation on the GTL lease was undertaken on the basis of recent comprehensive surveys of the Burrup Peninsula. The results from these surveys were supplemented by dry season inspections of the lease to enable the assessment to be made with the best information currently available.

Of the five vegetation communities within the GTL lease that are considered to be threatened communities, three will not be impacted by the plant itself and two fall under the plant footprint. Of the two types directly impacted, one (ChCwIm) will be reduced by approximately 16% (of the total area occurring in the Withnell East Industrial Area and the Burrup Conservation and Heritage Recreational Area) and the other (GpImTe) reduced by approximately 10%. One of these (ChCwIm), is defined as critically limited in its area based on the Trudgen (2002) mapping. However, it is noted that the Trudgen mapping of this type on the GTL lease area was not accurate and ground truthing indicates that there is actually less of this community on the GTL lease than is shown in Trudgen's mapping.

Atmospheric modelling indicates that air emissions from the plant will not result in any significant increases in maximum downwind pollutant concentrations. It is therefore predicted that no significant impacts on vegetation surrounding the plant site will occur.

A Vegetation and Flora Management Plan will be implemented to minimise disturbance to vegetation communities. This will incorporate a Weed Management Plan, to prevent the spread of weeds and the introduction of new weed species. Seed will be collected from any prominent flora species (including Priority Flora) which may be present within the plant site. Germination trials will be conducted and attempts will be made to restore any Priority species removed during construction of the plant.

It is predicted that, although 15 ha of vegetation will be removed, there will be no significant impact upon Priority Flora species or upon vegetation associations of high conservation significance. No species are at threat of becoming extinct as a result of the project proceeding.

Terrestrial Fauna

Fauna species of conservation significance that were identified as occurring on, or potentially inhabiting, the proposed development site included the Western Pebble-mound Mouse, Pilbara Olive Python and land snails.

Western Pebble-mound Mouse mounds on the GTL site were located on the stony, gently sloping hummock grassed plains in the vicinity of drainage lines. All of the mounds were identified as being vacant. While it is unlikely that any live individuals are still present on the Burrup, it is also acknowledged that this species is particularly difficult to capture using the techniques employed to date in region.

The Pilbara Olive Python (*L. olivaceus barroni*) is a very large nocturnal python that inhabits rocky hills, ridges and areas of rockpile. Much of the GTL lease, and all of the plant site, is outside the preferred habitat for the python and hence impacts to this species are expected to be minimal.

Three species of land snails belonging to two families were found within the GTL lease. All three have been found widely in other surveys conducted on the Burrup Peninsula and they are known to also occur in other areas. *Rhagada* sp. apparently has the most restricted range, being limited to the Dampier region, but also occurs from south of King Bay up the Burrup Peninsula. It is concluded that there will be no major disruption to land snail populations from the development of the proposed GTL plant.

Management strategies will be implemented that aim to minimise impacts to fauna and contribute to the database of knowledge on fauna on the Burrup Peninsula. Further survey work will be undertaken (when weather conditions become favourable) and appropriate management measures will be further developed in consultation with CALM.

Landform, Drainage and Site Hydrology

The 15 ha plant site will be levelled prior to construction of the plant, with the volumes of cut and fill expected to be similar. The site has been located within the lease area in such a way as to minimise landform disturbance and earthworks outside of the plant boundary will be minimised. Vegetation clearing and soil stockpiling during construction will be managed to ensure that the potential for erosion and subsequent turbid water runoff is minimised.

A drainage line crossing the eastern end of the plant site will be diverted to the east, to maintain surface water flow to habitats downstream of the plant (including Withnell Bay). This drainage line, and others abutting the plant site, will receive uncontaminated stormwater from the site during the operations phase.

The site is not considered to be a significant recharge or discharge area to the deeper groundwater system, and significant aquifer zones are considered unlikely to be present. However, a ground and surface water monitoring programme will be initiated to ensure that any contamination sources are identified and any contaminants are retained within the site.

It is predicted that these management measures will ensure that disturbance of the surface water balance is minimised and that the quality of the downstream surface waters and the groundwater is maintained.

Marine Ecology

The marine ecology of King Bay and Mermaid Sound could potentially be adversely impacted by:

- the discharge of water from the Water Corporation outfall, which will contain the seawater return from the GTL plant;
- spills of methanol during loading and transport;
- spills of other hydrocarbons from methanol vessels;
- the introduction of pest species from other regions; and
- increased input of metals and antifoulants from visiting vessels.

Return Water
The return water to the Water Corporation outfall (up to 22 ML/day) will primarily comprise seawater from the plant cooling system (~75% by volume). Temperature of the return water will be managed to ensure that it remains within $2^{o}C$ of the 24 hour ambient seawater temperature for 80% of the time, with a maximum exceedence of $5^{o}C$.

The desalination plant will concentrate the chemical constituents of the incoming seawater, increasing the concentrations of ions in the return water. Coupled with evaporation losses from the cooling system, this will result in an approximate 40% increase in salinity of the return water. Following dilution in the receiving waters of King Bay, the salinity at the edge of the outfall mixing zone is predicted to be only 2% above intake salinity.

The only by-product of the methanol production process that will be discharged in appreciable quantities will be ammonia (predominantly ammonium ions) generated in the

steam reformation process. This will contribute approximately 50 tpa of nitrogen to the receiving waters.

Treatment of the cooling water and desalinator feed water with biocides, foam control agents and anti-scalants will be required for the efficient operation of the plant. These additives will be standard chemicals used world-wide for the same purposes and will require DEP approval prior to their application. Concentrations in the discharge water will be <0.6 mg/L at the entry to the Water Corporation outfall and <0.05 mg/L at the edge of the mixing zone.

During detail design, the plant will be optimised to minimise chemical use and to reduce nitrogen outputs to as low as reasonably practicable. If deemed practicable, treatment systems to reduce nitrogen levels in the return water will be retro-fitted to the operational plant, provided the capital and operating costs do not threaten the economic viability of the plant. The return water from the GTL plant may have some limited adverse impacts on invertebrates and fish in the vicinity of the outfall structure. However, it is considered that these impacts are unlikely to be of regional significance as they will be localised, due to dilution within the mixing zone, and transient, due to tidal flushing of King Bay.

Methanol Loading
Methanol is highly miscible in water and any product spilled during vessel loading would be rapidly diluted as it dispersed into the waters surrounding the wharf. Biodegradation would occur, primarily through aerobic and anaerobic microbial activity. In the unlikely event of a very large spill, some limited mortality of fish and invertebrates may occur in the receiving waters and, possibly, on adjacent shorelines. Methanol is considered toxic to marine life in concentrated forms, though less toxic than crude oil or gasoline, but impacts from short-term exposure are often reversible. The impacts would be transient (due to tidal flushing of the spill area) and highly unlikely to be locally or regionally significant.

Mechanisms to minimise the volumes of any methanol released as a result of spills or leakage during loading operations will include emergency cut-off valves and an automatic system for shutdown of loading pumps and activation of isolation valves. It is estimated that, in the event of a worst-case mishap such as a loading arm disconnection, the maximum spill volume would be in the order of only 200 L.

Shipping
The potential for international vessels to introduce marine pest species will be mitigated by the requirement that ballast water be managed in accordance with AQIS' Mandatory Ballast Water Management Arrangements and Port of Dampier regulations. Vessels will either exchange ballast water prior to entering Pilbara waters or undertake treatment of ballast water prior to discharge.

In-water hull cleaning and vessel maintenance is prohibited within the port, in accordance with Port of Dampier regulations and the ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance. This reduces the potential for the introduction of unwanted marine fouling species and limits the input of metals and organotins to the marine environment.

Increased shipping activity associated with plant construction and operation will increase the risk of vessel accidents (collisions, groundings, etc.) within Mermaid Sound. However, vessels will enter and depart the Port under the guidance of a Pilot, in accordance with Port of Dampier Regulations. Response to any significant oil spills will be in accordance with the Port of Dampier Marine Pollution Contingency Plan. This plan provides guidance on the

management and remediation of oil spills such that impacts on the marine environment will be minimised.

Atmospheric Emissions

During the construction phase, there will be some generation of wind-blown dust and combustion products from construction vehicles and equipment. The potential for off-site dust emissions to occur will be minimised through the development and implementation of the construction Environmental Management Plan, which will incorporate a range of dust suppression measures.

During the operations phase, the main emissions with potential for offsite effects are the products of fuel combustion, which will include small volumes of oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter and carbon dioxide (CO_2, discussed separately). Some emissions of volatile organic compounds (VOCs) have the potential to occur as a result of fugitive emissions from the plant, storage tanks and during ship loading, however these will be mitigated through vapour recovery and water scrubber systems. Under normal operating conditions, there would be no emissions from the methanol plant that could give rise to off-site odour impacts.

Atmospheric modelling of cumulative emission loads was undertaken using both the AUSPLUME and the TAPM models, taking into account a number of existing and proposed industrial developments on the Burrup Peninsula which have the potential to impact on air quality in the region. Start-up and upset emission scenarios for the GTL plant were also taken into consideration in the assessment.

Based on data available for other methanol plants recently proposed for construction in the region, the estimated emissions of **NO_X** for the GTL plant (per tonne of product) may be considered current industry best practice. At Dampier, the maximum predicted NO_2 concentrations from the GTL project were shown to be 8 µg/m^3 (1-hour average) and 0.1 µg/m^3 (annual average), which are well below acceptable NEPM standards. The worst case NO_2 concentrations predicted to occur as a result of emissions from the methanol plant are well below NEPM guideline levels, even when existing emission sources on the Burrup Peninsula are taken into account. No adverse impacts on local air quality are therefore expected as a result of these emissions. Modelling of NO_2 concentrations during worst case start-up conditions indicated that no significant increases in off-site NO_2 levels are predicted.

Cumulative smog modelling (as **ozone, O_3**) was also undertaken, which showed that the proposed GTL plant emissions:

- do not change the maximum predicted ground level concentrations of NO_2 or O_3 in the region from their current levels, and predicted regional maximum ground level concentrations of NO_2 and O_3 are well below the NEPM standards;
- contribute 1 ppb to the maximum 1-hour average NO_2 ground level concentration at Dampier; and
- do not contribute to other maximum ground level concentrations (1-hour NO_2, 1-hour O_3, or 4-hour average O_3 concentrations) at Dampier or Karratha. Overall, the modelling study indicates that emissions from the GTL plant are very low and would not result in any increase in smog generation potential in the area.

Desulphurisation of the natural gas for the project will ensure that **SO_2** emissions from the GTL plant will be extremely low. Worst case 10-minute, one-hour, 24-hour and annual average SO_2 concentrations predicted to occur as a result of emissions from the methanol plant are far below guideline levels, even when existing emission sources are accounted for.

Cumulative worst case 1-hour **CO** concentrations predicted by the modelling are far below the relevant assessment criteria for CO. The worst case 1-hour and 8-hour average concentrations predicted to occur post-construction of the methanol plant are less than 1% of NEPM guideline levels. No adverse impacts on local air quality are therefore expected as a result of these emissions.

GTL has undertaken a preliminary assessment to determine what the potential impacts may be from atmospheric deposition on environmental attributes such as native vegetation, aboriginal petroglyphs, land snails and ephemeral rock pools which are known to occur on the Peninsula. It is noted that these considerations are being further evaluated by the Office of Major Projects on a strategic basis. In the predominantly arid zone conditions of the Burrup, dry deposition is expected to be the dominant mechanism by which atmospheric pollutants may be deposited on terrestrial and aquatic environments.

GTL has demonstrated its commitment to minimise atmospheric emissions as far as practicable as part of the design of the plant, including application of best practice NOx minimisation through the use of Best Available Technology and a highly efficient plant design. The modelling outcomes indicate that air emissions from the site will not result in any significant increases in maximum downwind pollutant concentrations. No adverse impacts on vegetation, significant flora or habitat areas are therefore anticipated to result from the proposed project.

GTL is prepared to facilitate a 'whole-of-industry' approach in addressing cumulative atmospheric modelling and monitoring in a standardised manner as part of the Burrup Industry Group. Through this industry body it would be possible to overcome the paucity of data relevant to the region through appropriate, site-specific monitoring programmes with other prospective industries on the Burrup. GTL is also willing to support Government initiatives to further investigate and monitor potential cumulative effects from industrial emissions and to establish coordinated atmospheric monitoring and management.

Fugitive emissions of VOCs from ship loading activities and bulk storage tanks will be controlled by vapour blankets and vapour recovery systems. The majority of any fugitive emissions of nitrogen and methanol vapour from ship loading activities will be collected and treated to remove methanol vapours prior to discharge to atmosphere. Any residual hydrocarbon emissions from ship loading are therefore expected to be negligible.

Greenhouse Gases

The methanol manufacturing process uses a highly integrated and optimised process design in which all purged gases are used as fuel and includes heat exchange and heat recovery into an integrated steam cycle. The integrated energy management system includes the generation of electricity so that the whole plant is self-sufficient in energy and utilities.

The Greenhouse Gas (GHG) Inventory of the GTL project is predicted to be approximately 451,600 tonnes of $CO_{2\ (eq)}$ per annum. Of the six GHGs specified in the Kyoto Protocol, emissions of CO_2 constitute the great majority of the GHG contribution from the project. In addition, there are contributions from methane and relatively minor quantities of nitrous oxide

(N_2O) as a component of NO_x from combustion processes. Other GHGs specified in the Kyoto Protocol, i.e. hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, will not be present.

The energy efficiency of the conversion of natural gas to methanol is strongly dependent on the composition of the natural gas supply. The design point mass and energy balance for the proposed GTL methanol production facility corresponds to a natural gas utilisation efficiency of 34.56 GJ of natural gas per tonne of liquid methanol product as a nominal design point. This indicates that the efficiency achieved by the optimised plant is likely to be in the region of 34 GJ per tonne of methanol representing best practice beyond current conventional technology. This efficiency measure has been benchmarked against other proposed methanol facilities in Australia, which showed GTL to be similar in energy efficiency to that proposed by Methanex and superior to the Tassie Shoals methanol proposal.

Earlier gas to methanol plants built in the 70s and 80s were significantly less sophisticated than the latest state-of-the-art gas to methanol plants. However, since the introduction of combined reforming technology around 1990, further process improvements have consisted of small incremental improvements. Accordingly, comparison of the proposed plant with a conceptual plant built in 1990 would not show a major efficiency improvement. Whereas, the actual displacement of older less efficient methanol plants will show a significant efficiency improvement and hence a lower overall greenhouse intensity in meeting the world demand for methanol.

Best possible contemporary greenhouse efficiencies will be achieved by GTL through the adoption of Best Available Technology, with future efficiencies to be gained by the adoption of appropriate emergent technologies, including a number of ‘no regrets’ and ‘beyond no regrets’ measures. GTL will sign up to the voluntary Greenhouse Challenge Programme, and develop a Greenhouse Gas Emissions Management Plan, with the objective of identifying opportunities to reduce GHG emissions over the life of the Project.

Waste Management

The philosophy of “Reduce, Re-use, Recycle” will be applied where practicable to minimise the volume of liquid waste generated during plant construction and operation. Any potentially contaminated wastewater streams will be diverted to an evaporation pond for disposal. Depending upon DEP preference, sanitary wastewater will be used to irrigate areas within the plant site, routed to the evaporation pond or disposed into the return water stream to King Bay.

Management of solid wastes will incorporate the principles of avoidance (of difficult to manage materials); replacement (of materials for which more environmentally acceptable, cost-effective alternatives become available); segregation; waste minimisation; recovery, re-use and recycling; and environmentally acceptable disposal where no viable alternative exists. Spent catalysts and resins from the methanol plant will be returned to the manufacturers for reclamation or disposed of by specialist companies.

Noise

A quantitative noise assessment of the proposed GTL plant was undertaken using the criteria for assessing environmental noise in Western Australia specified in the *Environmental Protection (Noise) Regulations 1997*. Noise levels were predicted using the Environmental Noise Model (approved by ANZECC).

A notional total sound power level of 122 dBA was estimated for the plant, revised down from an initial estimate of 128 dBA in order to achieve a sound pressure level contribution not exceeding 65 dBA at the plant boundary. Noise from the proposed plant is expected to be broadband, and free of any tonal or impulsive components.

The technology provider, Lurgi, has committed to designing the plant to meet the 65 dBA noise limit at the plant boundary. Lurgi also advise that:

- the noisiest parts of the plant are the compressors and turbines with typical sound power levels of 115 dBA each;
- all compressors will be installed with sound hoods to reduce noise by 20 dB;
- the cooling tower will be a low noise design type with a sound power level of about 111 dBA for seven cells;
- large turbine drives will be installed with sound hoods also.

Predicted noise levels from the GTL plant do not impinge on any residential, commercial or industrial receivers. The predicted noise contributions from operation of the plant at the nearest sensitive receivers were 3 dBA at Dampier, 10 dBA at Hearson Cove and 39 dBA at the Withnell Bay Boat Ramp. Default daytime adverse meteorological conditions predicted a worst-case estimate of 13 dBA at Dampier, 23 dBA at Hearson Cove and 48 dBA at Withnell Bay.

There are a number of other industrial facilities planned within the King Bay – Hearson Cove Industrial Area, and as such cumulative noise is an issue to be considered for local residents.

An estimation of cumulative noise level expected at Withnell Bay as a result of the NWSVP facility and the proposed GTL plant has been calculated as 46 to 52 dBA. The predicated cumulative impact at Withnell Bay is less that the criteria value of 60 dBA for noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use. It is noted however, that there currently exists no specific regulatory criteria for recreational areas, which is the subject of current evaluation by MPR and the DEP. Through the adoption of sensible noise reduction measures to meet the 65 dBA criterion at the boundary, the GTL plant is therefore not expected to have a significant noise impact at Withnell Bay.

Cumulative modelling of noise at Hearson Cove and Dampier showed that:

- the worst case noise contribution predicted for the GTL plant is predicted to be an insignificant contributor at Dampier assuming other planned industries go ahead;
- the worst case noise contribution predicted for the GTL plant is less than the 25 – 30 dBA range of background noise levels reported for Hearson Cove, therefore the plant is predicted to be an insignificant contributor at Hearson Cove;
- noise levels at Hearson Cove are predicted to be dominated by noise from Methanex's proposed methanol plant; and
- the GTL plant is predicted to not increase cumulative noise levels at Hearson Cove and Dampier above those already predicted for operation of other proposed developments.

Noting that a recommended acceptable noise level at Hearson Cove has yet to be established by the WA Government (as previously described), the above observations confirm that the GTL project will not influence cumulative noise levels at Hearson Cove.

Minimisation of noise levels will be considered during the detailed engineering design phase, to ensure noise level criteria are met and, where possible, reduced further. The plant will be

designed to meet the 65 dBA noise limit at the plant boundary, and construction and traffic noise associated with the development are predicted to be not significant. It is therefore predicted that there will be no unacceptable noise impact from the construction and operation of the plant and the project will be managed to meet the desired environmental objective in relation to noise.

Light

Lighting for the plant will be designed, installed and operated to best practice, consistent with site safety and security requirements. Lighting will conform with the guidelines presented in the Australian Standard AS 4282 - 1997 *Control of the Obtrusive Effects of Outdoor Lighting*. Light sources will be sited and oriented so as to minimise overspill, with light intensities optimised to providing the required degree of illumination within the plant boundary. Other overspill reduction measures will be employed as practicable, such as employing directional beams and shrouding of the sides and rears of light sources.

The potential for light overspill from the methanol plant to affect recreation amenity at Withnell Bay during non-daylight hours, or to affect the behaviour of some marine fauna (such as turtles) in Withnell Bay will be minimal due to the close proximity of the NWSVP Onshore Gas Plant.

Public Health and Safety

A preliminary risk assessment has demonstrated that, as far as reasonably practicable, offsite risks have been minimised through the elimination of hazards or the control of remaining hazards. Further, the level of risk to persons outside of the plant boundary is within tolerable limits considered acceptable to the Environmental Protection Authority.

A thorough quantitative risk assessment will be undertaken during detail design of the plant. During all phases from engineering through to procurement and construction, quality assurance systems will be in place to ensure that the designed plant safety features are implemented correctly.

If process shutdown is required due to an emergency, the natural gas supply will be closed-off, the reformer will be shut down, and steam will be admitted to the system. During certain process upsets and emergency situations, the plant may need to be depressurised, under controlled conditions, to the flare. The flare stack will be designed and positioned to minimise safety risk to the workforce, plant equipment and the natural environment. Any liquids carried towards the flare during depressurisation will be intercepted by a knock-out drum, separated from the gas stream and returned to the raw methanol tank.

Culture and Heritage

The Burrup region of Western Australia contains an extremely rich diversity of Aboriginal rock engravings and archaeological sites. It also includes areas that are culturally significant to Aboriginal people who claim a traditional association with the area. However, there are no recorded sites of ethnographic (i.e. mythological, religious or cultural) significance to Aboriginal people that could be affected by the proposed GTL plant.

Surveys of the proposed lease area and adjacent areas identified five rock engraving site, all of which were listed on the Aboriginal Sites Register of the Department of Indigenous Affairs. Of the five sites identified, only one (Site P3519) would possibly be impacted by the construction of the GTL plant. This site, which consists of several small rock engravings, is

located just to the north of the proposed project lease area. As part of the proponent's ongoing heritage management programme, GTL will ensure that any archaeological sites in the general vicinity of the project (other than those for which an *Aboriginal Heritage Act 1972* Section 18 approval has been given) are adequately marked and protected from disturbance or interference during the construction and operations phases of the project. Site P3519 will be fenced to ensure that it is not inadvertently damaged.

Visual Amenity

Withnell Bay is a recognised recreational area for the local community and the likelihood of potential visual impacts at that location was investigated during the environmental assessment process and through further stakeholder consultations. The visual impact of the proposed plant from adjacent public viewpoints (e.g. nearby public roads and the Withnell Bay boat ramp area) was determined.

In the context of existing industrial infrastructure (i.e. NWSVP plant) the visual impact of the proposed GTL plant is not considered to be significant and, due to existing topography, the views of the plant from adjacent public areas will not be unduly adverse or visually intrusive. Views of the proposed plant from the most commonly visited public recreation site in the vicinity (Withnell Bay boat ramp) would be either partly or fully obscured by intervening landforms.

The proposed plant will not impact on the visual amenity of residents in Dampier or Karratha or of visitors to the popular recreation area of Hearson Cove. Views from the south of the GTL project area are obscured by a series of high rocky ranges.

ENVIRONMENTAL MANAGEMENT

Table ES1 provides a summary of the environmental issues related to the construction and operation of the plant, GTL's management objective for each issue and an assessment of the potential impacts. It also includes the management strategy proposed by GTL to ensure that actual and potential environmental impacts will be minimised.

A summary of GTL's environmental management commitments is included in Tables 8.2 and 8.3 of the PER document. Lurgi will be responsible for the development and implementation of a Construction Environmental Management Plan, while the Operations and Maintenance contractor, AMEC, will be required to develop and implement and Operations Environmental Management Plan. These management plans will comprise a series of specific plans to minimise or mitigate any potential impacts upon facets of the physical, biological and social environments.

SAFETY AND EMERGENCY MANAGEMENT

GTL will require AMEC to prepare and implement a Safety Management System, in which hazards are identified and measures to manage risks are detailed, in order to provide a safe working environment. A permit-to-work system will be implemented, along with procedures for the investigation of any accidents, incidents or near-misses which may occur.

An Emergency Management Plan will be developed as an integral part of the plant operating procedures and a competent emergency response team will always be present on site. The

team will be self-sufficient and will be able to integrate with Dampier emergency services, though they will not be dependent upon them.

CONCLUSION

The main long-term irreversible environmental costs of the proposed project will be:

- the loss of some 15 ha of regionally significant vegetation associations within the footprint of the plant site, and associated fauna habitat;
- the annual discharge of low volumes of atmospheric emissions of NOx, CO, SO_2 and particulates;
- the annual discharge of some 450,000 tonnes of greenhouse gas emissions;
- the annual discharge of some 50 tonnes of nitrogen, in the form of ammonia, in wastewater discharged to King Bay via the Water Corporation outfall;
- the production of solid wastes for disposal at landfill or at appropriate receival and treatment facilities;
- the incremental loss of visual amenity at Withnell Bay by the replacement of a natural landscape with an industrial one, albeit one that is already highly modified by the existing NWSVP Onshore Gas Plant.

The above "costs" will be mitigated by the facts that:

- it is unlikely that any species of flora or fauna will become extinct as a result of the project proceeding;
- the proposed plant site is appropriately zoned for industrial use and tenure is being provided by the State Government;
- the atmospheric emissions are relatively small and will contribute only marginally to cumulative loads in the air shed, while ground level concentrations will be well below NEPM standards for public health;
- the methanol process will be very energy efficient and result in the conversion of CO_2 and methane in natural gas to methanol, thereby reducing potential greenhouse emissions released if the gas was otherwise burned;
- methanol, as an additive to petroleum, reduces vehicle emissions;
- the plant will not be a risk to public safety and all appropriate risk criteria will be met at the plant boundary;
- the plant will not be a substantial emitter of noise and all applicable noise regulations will be met at the plant boundary and bettered if possible;
- the plant will not displace sites of Aboriginal Heritage value; and
- the plant will not adversely affect regional conservation values or natural heritage sites listed on the Register of the National Estate.

Furthermore, the above 'costs' will be balanced to some extent by the following social and environmental benefits of the project:

- public access to Withnell Bay will improve as a result of the upgrade of the road to the plant site;
- the project will create some 500 temporary jobs over the construction period and some 60 permanent jobs over the life of the plant;
- the proponent will contribute to industry based regional surveys of flora and fauna characteristics of the Burrup Peninsula, and to studies into the effects of atmospheric

emissions on the petroglyphs of the Burrup with a view to protecting both biodiversity and heritage values of the Peninsula; and

- the project will help realise the WA Government's stated policy to add value to natural resources of the region by undertaking downstream processing to produce a more valuable export product.

In conclusion, there are no long-term risks posed to local ecosystems as a result of the project proceeding. None of the environmental factors addressed in the PER are considered to constitute a "fatal flaw" which could stop the project from proceeding. The project can be readily managed to minimise environmental impacts and all management requirements are well understood and reliable. It is therefore considered that the project can be managed to meet the EPA's objectives for environmental protection and should be approved subject to GTL's compliance with their environmental management commitments and any additional conditions imposed by the Minister for Environment & Heritage.

Table ES1 Summary of Environmental Effects and Management Strategies

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Terrestrial flora	Vegetation communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Six broad-scale vegetation types occur on the GTL lease. These types are further divided into 20 vegetation assemblages, some of which are considered to be of significant conservation value (on the basis of Trudgen 2002).	Approximately 15 ha of vegetation will be removed. It is difficult to reliably determine the significance of impacts due to limitations in existing mapping and lack of wet season data. Weed species that have established on the Burrup may spread during construction and operation of the proposed plant. Modelling indicates that air emissions from the site will not result in any increases in maximum downwind pollutant concentrations. No impacts on vegetation are therefore expected.	Implement a vegetation and flora manage-ment plan to better assess significance of vegetation types and minimise disturbance to vegetation communities. This will include a wet season vegetation survey when suitable conditions occur. Develop a weed management plan to prevent the spread of weeds and introduction of new weed species.	The project will have a direct impact of 15 ha of vegetation, including small areas containing vegetation types that have been assessed as being of high conservation value (on basis of Trudgen's mapping).
	Declared Rare and Priority Flora; Flora of Conservation Significance	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). Protect other flora species of conservation significance.	Two listed Priority species (under the WA *Wildlife Conservation Act 1950*) have been recorded on the GTL lease: • *Terminalia supranitifolia*; and • *Eriachne tenuiculmis.* Neither species is listed under the *EPBC Act*.	Where clearing of vegetation cannot be avoided, some individuals of Priority species may be removed. Modelling indicates that air emissions from the site will not result in any significant increases in maximum downwind pollutant concentrations. No impacts on Priority species are therefore expected.	Seed collection of any prominent flora species present, including Priority Flora species, will occur as soon as possible, to ensure the availability of species for rehabilitation. Germination trials will commence prior to construction. During the rehabilitation process, attempts will be made to restore any Priority Flora species disturbed by the project.	The project will result in the removal of two Priority Flora species. Where possible these species will be re-established as part of site rehabilitation procedures.
Terrestrial fauna	Specially Protected (Threatened) Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *EPBC Act.*	An estimated 44 species of mammal, 165 species of bird and 92 species of reptile inhabit the Burrup Peninsula and the surrounding area. Potentially important species which may inhabit the lease area are: • Pilbara Olive Python (listed as threatened under the *Wildlife Conservation Act 1950* and vulnerable under the *EPBC Act*); and • Western Pebble Mound Mouse (listed as a Priority 4 species on the WA Priority Fauna List). The three species of land snails present within the lease area are not considered to be rare or endangered. Feral animals such as cats, foxes and mice may occur on the proposed site.	Removal and disturbance of potential fauna habitat during plant construction. Potential to improve conditions for feral animals, therefore causing populations to increase. Modelling indicates that air emissions from the site will not result in any significant increases in maximum downwind pollutant concentrations. No impacts on terrestrial fauna are therefore expected. No major disruption to land snail populations from the development of the proposed plant is anticipated as the three species recorded on the site are widespread on the Burrup Peninsula	Implement a fauna management plan to ensure that disturbance of fauna habitats will be minimised. Surveys to investigate the occurrence of Priority Fauna species will be conducted prior to construction and if required will be updated on a regular basis.	The project is unlikely to have a direct impact on larger or mobile fauna species but will result in the localised loss of fauna habitat. Less mobile fauna such as the land snails will be directly impacted. All three species of land snails are known to occur elsewhere on the Burrup.
Landform, drainage and site hydrology	Landform	Maintain the integrity, functions and environmental values of landforms.	There are two major landforms on the project lease and the immediate surrounds: • Rocky outcrops and scree slopes; and • Valleys, drainage gullys and alluvial fans.	The 15 ha site will be levelled prior to construction of the plant. Volumes of cut and fill are anticipated to be similar and there is unlikely to be a requirement for the significant import of material to the site. Any excess material will be retained on site for potential future use.	The plant site has been located within the lease area so as to minimise landform disturbance. Earthworks outside of the plant site will be minimised.	15 ha of gently sloping stony plain will be replaced by the levelled plant site. The integrity, functions and environmental values of the remaining 20 ha within the lease area will be retained as close to pre-development conditions as practicable.

Table ES1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
	Drainage, site hydrology and surface water	Maintain the integrity, functions and environmental values of natural surface water drainage. Maintain the integrity, function and environmental values of watercourses and sheet flow.	Drainage across the lease area is typically to the north-west. Most rainfall is channelled across the surface in small, ephemeral drainage lines. There are no permanent water bodies in the lease area.	A drainage line crossing the eastern end of the plant site will be diverted to the east during construction. The upper reaches of two minor drainage lines will be truncated during construction. This will alter surface and shallow groundwater flows.	The eastern drainage line will be diverted in such a way that erosion is minimised. Uncontaminated stormwater from the plant site will be discharged into the drainage lines to maintain their function and to minimise disturbance of the surface water balance.	Surface water and sheet flow will be managed to ensure that the integrity, functions and environmental values of watercourses upstream and downstream of the plant will be retained as close to pre-development conditions as practicable.
	Ground and surface water quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected consistent with the National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality.	The site is not considered to be a significant recharge or discharge area to the deeper groundwater system, and significant aquifer zones are considered unlikely to be present.	Vegetation clearing, soil stockpiling and diversion of drainage lines during construction could lead to increased runoff and erosion, which could adversely affect downstream water quality. Once operational, pollutants with the potential to impact on ground and surface water quality will be methanol, fuels and lubricants.	Water discharge from the site will be managed so as to minimise the potential for adverse impacts on the downstream environment, including Withnell Bay. A comprehensive management system will be established prior to the commencement of plant construction, to ensure there is minimal impact on ground and surface water resources. Pre-development ground and surface water data will be collected and a monitoring programme initiated. The programme would continue throughout plant construction and operation, to ensure contamination sources are identified and contaminants are retained within the site. Once operational, all stormwater potentially contaminated with hydrocarbons will be directed either to a corrugated plate interceptor or direct to an evaporation pond.	Impacts on surface water quality will be reduced to as low as practicable and no adverse effects on downstream ecosystems are anticipated. No impacts on groundwater within, or outside of, the lease area are anticipated.
Marine ecology including sea floor, marine flora and fauna	Seawater supply	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided.	King Bay is fringed with mangroves and rocky shorelines. Intertidal mudflats extend seaward from the mangroves, extending into a subtidal sandy seabed. Diverse invertebrate fauna communities are present in all of the above habitats. Fish utilise the King Bay mangroves and seafloor for feeding.	The intake and discharge of water through the Water Corporation infrastructure in King Bay could lead to increases in turbidity in the bay, dispersion of entrained contaminants and elevations in water temperature. This may have some localised impact on the invertebrate and fish populations in the vicinity of the intake and outfall structures.	Impacts associated with water extraction from King Bay will be managed by the Water Corporation. Quality of return water will managed to ensure that DEP criteria are met prior to discharge of the water into King Bay.	No significant impacts upon marine ecological integrity and biodiversity within King Bay are anticipated.
	Methanol loading	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided.	The Dampier Public Wharf abuts a rocky shoreline supporting a diversity of invertebrates, including oysters and corals. The subtidal sandy seafloor also supports a diverse invertebrate community. Fish utilise the habitats around the wharf, including the wharf itself, for feeding and shelter.	Methanol is highly miscible in water and any product spilled during vessel loading would rapidly disperse into the waters surrounding the wharf. Depending upon the size of the spill, some localised mortality of fish and invertebrates may occur.	A fibre optic link between the wharf and the plant site will allow an automatic shutdown of the loading pumps in the event of a mishap during vessel loading. This will minimise the quantity of methanol spilled into the marine environment.	No significant impacts upon marine ecological integrity and biodiversity within Mermaid Sound are anticipated.
	Increased shipping	Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS *Guidelines for Ballast Water Management* and ANZECC *Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance.*	Localised elevations in the concentrations of metals and organotins are present in export berths within the Port of Dampier and are likely to occur in the vicinity of the Dampier Public Wharf.	Potential introduction of unwanted marine organisms from ballast water or from hull fouling. Such species could displace or adversely affect native marine species. Some species could have adverse impacts upon nearby infrastructure. Increased frequency of shipping at the Dampier Public Wharf is likely to lead to further minor increases in the	Each vessel associated with the import of materials during plant construction or with product export during plant operation will be required to exchange ballast water in accordance with AQIS guidelines. In-water hull cleaning and vessel maintenance is prohibited within the Port of Dampier. This	The risk of introduction of unwanted marine organisms, and the input of metals and organotins, to Mermaid Sound will be minimised. There will be minimal increased risk associated with the increase in vessel movements.

Table ES1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
				concentrations of metals and organotins in the sediments adjacent to the wharf. The methanol vessels will increase the risk factors associated with vessel movements (collisions, groundings, etc.) within the Port.	reduces the potential for the introduction of unwanted marine organisms and limits the input of metals and organotins to the marine environment. Movements of methanol vessels within the Port will be in accordance with the Port Authority Regulations 2001. The regulations require that the vessels will enter and depart the Port under the guidance of a Pilot.	
Atmospheric emissions	General	(i) Ensure that gaseous emissions, from this proposal, in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria (including the NEPM for Ambient Air Quality, with advice sought from the DEP on specific pollutants as necessary) or cause an environmental or human health/amenity problem. (ii) Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke.	Existing emission sources within the Dampier and Karratha region include the NWSVP plant and the Hamersley Iron power station. Potential future emission sources include the expansion of NWSVP's LNG processing facilities and proposed fertiliser and gas-to-liquids plants in the King Bay – Hearson Cove area.	Primary gaseous emissions from the plant will include oxides of nitrogen, carbon monoxide, carbon dioxide and small amounts of sulfur dioxide and particulates. Maximum predicted ground level concentrations of pollutants due to emissions from the methanol plant and other sources on the Burrup were modelled and shown to be well below respective guideline criteria. The anticipated emissions due to the GTL plant are not predicted to significantly increase maximum predicted ground level concentrations from existing levels. No adverse impacts on local air quality are therefore expected as a result of these emissions. An assessment of the potential for the methanol plant to contribute to smog generation in the region using the TAPM model, showed that the proposed GTL plant emissions do not change the maximum predicted concentrations of NO_2 or ozone in the region from current levels.	Upon commissioning, it is proposed that a programme of stack emission monitoring be undertaken to verify the emission estimates used in this impact assessment. It is proposed that the monitoring programme during commissioning would be undertaken on an annual basis and reported to the DEP. The potential for off-site dust emissions to occur during the construction of the facility would be minimised through the development and implementation of an environmental management plan that would be prepared for this phase of the project. Vapour recovery systems will ensure that the majority of any fugitive emissions of nitrogen and methanol vapour from ship loading activities will be contained and returned to the methanol storage tanks to minimise emissions of volatile organic compounds.	The GTL project is likely to have a negligible impact on the environment, as atmospheric emissions are predicted to be well below NEPM standards.
	Odour	No unreasonable impacts at boundary of the plant.	There are currently no sources of odour from the project lease.	Under normal operating conditions, there would be no emissions from the methanol plant that could give rise to off-site odour impacts.	Management of odour is not anticipated to be a concern in regard to the GTL plant, though monitoring will be instigated during plant commissioning to test this.	No significant off-site odour impacts are expected from the GTL plant.
	Dust	(i) Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity. (ii) Use all reasonable and practicable measures to minimise airborne dust.	The project lease currently has vegetation cover, which limits dust generation. In 2000 the concentrations of particulate matter in the wider Dampier and Karratha region exceeded NEPM standards 18 times. The major causes were likely to be bush fires, ship loading operations and local iron ore stockpiling.	During construction of the proposed plant there is potential for mechanically generated and wind-blown dust to be emitted off-site, which could: • adversely impact upon nearby vegetation; or • reduce public amenity in the vicinity of the plant site. These dust particles will predominantly contain the larger size fractions (>20 µm) and would therefore be expected to affect local dust deposition levels and TSP concentrations rather than PM_{10} or $PM_{2.5}$ concentrations. The construction activities will also be relatively localised and well away from the nearest residential dwelling, which is located 10 km to the south-west.	Dust suppression measures will be utilised during construction of the plant, such as: • the use of water sprays to wet the site during dry windy conditions; • the use of speed limits to minimise dust generated by vehicle movements; • the use of minimum drop heights when loading and unloading soils and other excavated material; and • minimising areas of disturbed, exposed soils.	Dust and particulate matter are likely to have a negligible impact on the environment, human health or amenity.

Table ES1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
	Greenhouse gases	To minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.	There are no existing sources of greenhouse gas emissions within the lease area. Currently, the NWSVP plant and Hamersley Iron power station are the primary regional sources of greenhouse gas emissions.	Carbon dioxide will be the main greenhouse gas emitted from the plant. Annual greenhouse gas emissions (CO_2 equivalent) will be approximately 451,600 tonnes. This represents approximately 0.12 % of Australia's total net energy greenhouse gas emissions.	"No regrets" measures to be considered during plant design include: • efficient reforming process; • recovery of waste heat; • no fugitive emissions or flaring; • steam turbine drives • power recovery turbines, and • self-contained utility systems. GTL will participate in the Australian Greenhouse Office *Greenhouse Challenge* programme. During the operation of the proposed plant, ongoing monitoring of greenhouse gas emissions will occur, to assist in identifying opportunities to improve efficiency and reduce emissions.	The GTL project will utilise the best available efficient reforming technology resulting in lower emissions of greenhouse gases compared with other comparable methanol plants.
Waste	Liquid and solid waste disposal	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on-site or disposed off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on-site to prevent groundwater and surface water contamination or risk to public health.	There are no existing sources of liquid and solid wastes within the project lease area.	Unless properly treated, waste streams could contaminate the receiving environment in the vicinity of, or downstream from, the plant site.	Liquid waste disposal streams will be managed as follows. 1. Seawater blowdown from the cooling system will be discharged via the Water Corporation outfall into King Bay. 2. Stormwater runoff from clean areas of the site will be discharged to drainage lines adjoining the site. 3. Contaminated water will be routed to an evaporation pond. 4. Uncontaminated water will be discharged to natural drainage lines (if fresh) or to the seawater return system. 5. Treated sanitary wastewater will be disposed in accordance with DEP requirements. A monitoring programme will be implemented to ensure detection of any impacts on ground and surface water quality. The quality of the water discharged to the Water Corporation outfall will be monitored to ensure compliance with discharge quality criteria. Semi-liquid wastes will be disposed off-site at approved facilities. A solid waste management system will be implemented at the plant. • Recyclable wastes will be periodically removed by a contractor. • General refuse (domestic and industrial solid waste) will be disposed to landfill. • Solids from clarification of water in the corrugated plate interceptor will be disposed off-site at approved facilities. • Spent catalysts and adsorption masses will be disposed of by specialist companies. The disposal of hazardous materials will comply with local and State regulations.	It is predicted that no significant impacts on the receiving environment will occur as a result of waste disposal practices. Wastes will be minimised, reused or recycled where practicable.

Table ES1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Other emissions	Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the *Environmental Protection (Noise) Regulations 1997*. Protect the amenity of nearby Withnell Bay from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.	There are no existing sources of noise pollution in the project lease area. The NWSVP plant is the principal anthropogenic noise source in the vicinity of Withnell Bay.	Modelling of predicted noise levels during operation of the plant indicates that assigned levels for residential, commercial and industrial receivers will not be exceeded. Contribution towards cumulative noise levels are also not predicted to adversely impact on recreational amenity of Hearson Cove and Withnell Bay.	Minimisation of noise levels will be considered during the detailed engineering design phase, to ensure noise level criteria are met. The plant will be designed to ensure that the boundary criterion of 65 dBA will be met.	Boundary noise levels will comply with the *Environmental Protection (Noise) Regulations*. The GTL project will be an insigificant contributor to cumulative noise levels at Withnell Bay, Hearson Cove and Dampier.
	Light	Manage potential impacts from plant light overspill to visitors at Withnell Bay, and offshore fauna such as turtles, if applicable.	There are no existing artificial light sources in the project lease area. The nearby NWSVP plant is a substantial source of light overspill into Withnell Bay.	Light overspill could impact nearby sensitive receptors, such as visitors to Withnell Bay. Disturbance to fauna behavioural patterns may also occur.	Lighting will be operated to best practice, consistent with site safety and security requirements. Lighting will conform with the guidelines presented in the Australian Standard AS 4282-1997 *Control of the Obtrusive Effects of Outdoor Lighting*. Light sources will be oriented to minimise overspill, whilst providing the required degree of illumination within the plant boundary. Overspill reduction measures such as directional beams and shrouding of the sides and rears of light sources will be employed where practicable.	Light overspill is likely to have a negligible impact on users of Withnell Bay or the surrounding environment.
SOCIAL SURROUNDINGS						
Public health and safety	Risk and hazard	Ensure that risk to the public is as low as reasonably practicable (ALARP) and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for off-site individual fatality risk (Draft Guidance Statement No.2), and that ALARP is demonstrated, and the MPR's requirements in respect of public safety are met.	The sites most sensitive to potential impacts from the construction and operation of the plant are Withnell Bay and the NWSVP plant.	Potential in-plant hazards are chemicals (e.g. methanol, methane and hydrogen), operating conditions and pressure system components (e.g. furnaces, compressors). Potential hazards during product export are associated with the methanol export pipeline, ship loading and shipping. A Preliminary Risk Assessment has been undertaken in accordance with EPA Guidance for off-site risk. Calculated individual, cumulative and societal risks are within EPA acceptance criteria.	Three risk reduction measures will be followed, these include: • The development of a Safety Management Plan; • The implementation of an Emergency Response Plan that provides a rapid response to identify releases that would facilitate early manual isolation of any leaking equipment. • The development of an Emergency Management Plan.	The risk to the public and plant personnel from the operation of the GTL plant will be ALARP and within EPA risk criteria.
	Road transport and traffic impacts	Ensure that roads are maintained or improved and road traffic managed to meet an adequate level of service, adequate safety standards and Dept for Planning and Infrastructure requirements.	The road from Burrup Road to Withnell Bay and the road to Mt Wongama are both unsealed.	During plant construction, traffic loads on Burrup Road will increase due to the construction workforce and transport of plant components and materials. Temporary access restrictions along Burrup Road may occur during transport of some plant components. During operation of the plant there will be no significant increase in traffic on Burrup Road.	Withnell Bay Road will be upgraded prior to the transport of heavy loads to the site. A Traffic Management Plan will be developed to meet service and safety requirements.	Increases in risk or disruption to traffic flow are anticipated to be minimal.

Table ES1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management	Predicted Outcome
Culture and heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*. (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Five archaeological (rock engraving) sites have been identified within the general vicinity of the lease area. No sites of ethnographic significance have been identified which could be affected by the proposed development. Heritage surveys with Native Title claimant groups with interests in the Burrup Peninsula have been partially completed.	One of the five archaeological sites identified (P3519) could potentially be impacted by plant construction.	GTL will make every effort to preserve site P3519. However if due to engineering constraints this is not possible, the company will seek approval under section 18 of the Aboriginal Heritage Act, to relocate engraved rocks away from the construction area. If site P3519 can be retained in its present location, then it will be fenced prior to construction to protect it from inadvertent damage. The construction and operations workforces will be provided with cultural awareness training. Initial site preparation works will be monitored to ensuren that any presently unrecorded sites which may be uncovered are managed appropriately.	There is the potential loss of one archaeological site. All other sites will not be disturbed.
	Register of the National Estate	Identify any areas in close proximity to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Act*.	Six registered places and two indicative places are present in the general Burrup region.	Of the eight places, only the Dampier Archipelago could potentially be impacted. Potential impacts would be limited to those associated with vessels traversing Mermaid Sound – introduced marine pests, vessel collisions or groundings etc.	Vessels associated with the construction phase or exporting methanol will comply with AQIS guidelines with respect to ballast water exchange, thereby minimising the potential for introduction of marine pests into the Archipelago.	It is likely that the project will have a negligible impact on the Dampier Archipelago.
Aesthetic	Visual amenity and recreation	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse. Not to compromise recreational uses of the Withnell Bay area, as developed by local authority and planning agencies.	There are currently no sources of visual pollution in the lease area. However, the NWSVP plant is almost adjacent the lease area and presents an industrial landscape at the southern end of Withnell Bay.	In the context of existing infrastructure (i.e. NWSVP plant) the visual impact of the proposed GTL plant is not considered to be largely significant and due to existing topography the visual amenity of the plant from adjacent public areas should not be unduly adverse. Views of the plant from the nearby public recreation site (Withnell Bay boat ramp) would be either partly or fully obscured by the existing topography.	Measures will be implemented to minimise the visual impact of the plant (e.g. selection of colours to maximise blending of the infrastructure into the surrounding environment).	The GTL plant will have only a minor impact on visual amenity from the nearby recreational area (Withnell Bay boat ramp) due to existing topography either partly or fully obscuring views of the plant. Such impact will be minor in the context of existing visual impact from the NWSVP plant.

1.1 OBJECTIVE AND STRUCTURE OF DOCUMENT

This document is a Public Environmental Review (PER) for a proposal to construct and operate a 1.05 million tonnes per annum (Mtpa) methanol plant on the Burrup Peninsula, Western Australia (Figure 1). Its purpose is to describe the proposed construction and operation of the project, the existing environmental setting, assess the potential environmental impacts, and provide management and monitoring commitments to ensure that the project will be managed in an environmentally responsible manner.

In accordance with the WA *Environmental Protection Act 1986*, the PER is submitted by GTL Resources PLC (GTL) to inform the WA Environmental Protection Authority (EPA), key stakeholders and other Decision-Making Authorities of the proposal, and identify and address the anticipated environmental impacts associated with the project.

It has 13 sections, summarised below, prepared in accordance with EPA Guidelines for the PER (presented in Appendix A, Part I):

- **Section 1** introduces the proponent and the proposed project. It also presents a brief description of the project background and schedule, relevant environmental legislation under Western Australian and Commonwealth Government jurisdiction, and introduces the scope of works undertaken for the PER.
- **Section 2** describes the project, including its major components and the methanol production process.
- **Section 3** provides justification for the proposed development of the methanol plant.
- **Section 4** evaluates the alternatives considered.
- **Section 5** describes the existing environmental and social setting of the project.
- **Section 6** summarises the issues raised to date during GTL's stakeholder and community consultation programme, and GTL's responses to these issues.
- **Section 7** assesses the potential and anticipated effects of the project on the biophysical and social environment.
- **Section 8** outlines the environmental management programme proposed for the project, and identifies GTL's commitments to minimise environmental effects and waste discharges.
- **Section 9** presents a summary of environmental costs and benefits.
- **Sections 10 to 13** acknowledge sources of information used in the development of the PER, the published literature and reports referred to in the text, the Study Team, and presents a glossary of technical terms and abbreviations used in the document.

Technical appendices, which provide detailed information on impact assessment studies undertaken to address the effects of the proposal, are presented at the end of the report.

1.2 THE PROPONENT

GTL is a public company which was founded in 1996 and became a public company in 1998. GTL is listed on the Alternative Investment Market of the London Stock Exchange. Information on the company is available at www.gtlresources.com.

The official proponent name is Australian Methanol Company Pty Ltd (AMC); ACN 100 656 666. AMC is a company limited by shares and 100% owned by GTL Resources PLC. It was formed in 2002 to own and operate the proposed Burrup methanol plant.

The designated contact details for the Proponent are:

Michael Kendal
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1.3 GTL's KEY ACTIVITIES AND EXPERIENCE

GTL's core activity is Gas to Liquids - the conversion of stranded natural gas into marketable liquid products.

This is GTL's first of several project opportunities around the world in gas to liquids technology. Its staff are drawn from the energy sector and all have experience in the design, construction and management of chemical projects.

1.4 GTL's HEALTH, SAFETY AND ENVIRONMENTAL POLICY

GTL recognises that people are its most valuable asset and that the protection of the health and safety of those involved in or affected by its operations, and the protection of the environment, are key business performance objectives. Safety and environmental objectives will rank equally with business objectives. It is management's responsibility at every successive level to carry out this policy and to be visibly committed to achieving high levels of performance in this area.

GTL will specifically:

- effectively organise and plan for health and safety;
- provide and maintain safe places and systems of work;
- provide adequate training for staff to ensure that they are competent to perform their duties;
- identify the health, safety and environmental hazards arising from its operations, and assess and manage the associated risks;
- work towards continuous improvement in health, safety and environmental performance, and require that all contractors demonstrate at least the same level of commitment;
- develop and maintain emergency contingency plans in conjunction with local authorities emergency services;
- comply as a minimum with the host government's legislation and codes of practice; and
- make available appropriate resources to fully implement the policy.

1.5 SUMMARY DESCRIPTION OF PROPOSED PROJECT

GTL proposes to construct and operate a methanol plant producing 1.05 Mtpa of methanol at the Withnell East Industrial Area (WEIA) on the Burrup Peninsula. The proposal involves:

- a natural gas pipeline for the input of gas;
- a methanol plant;
- plant infrastructure and utilities;
- seawater supply and brine and wastewater discharge via Water Corporation's pipeline infrastructure;
- an export pipeline for methanol to Dampier Port; and
- shipping of product from Dampier Port by specialised tankers.

1.6 PROJECT BACKGROUND

The Proponent submitted a referral and Environmental Scoping Document (URS 2001) to the EPA in November 2001, which provided sufficient information on the proposal to enable a decision to be made on the appropriate level of formal assessment required. GTL initially considered a proponent-initiated Environmental Protection Statement (EPS) to be an appropriate level of assessment for the following reasons:

(1) the land proposed for the plant site is appropriately zoned for industrial land use and occurs adjacent to the large North West Shelf Venture Project (NWSVP) Onshore Gas Plant (operated by Woodside) at Withnell Bay;

(2) the proposed project was principally of local interest and will have localised impacts, many of which can be readily managed;

(3) the local community was familiar with industrial projects and are generally supportive of them. This is as a result of a number of recent referrals to the EPA for developments on the Burrup Peninsula, including:
   - Syntroleum Sweetwater LLC (proposed Gas to Synthetic Hydrocarbons plant),
   - Plenty River Corporation Limited (proposed Ammonia/Urea plant),
   - Burrup Fertilisers (proposed export-oriented Ammonia plant),
   - Water Corporation (proposed Desalination and Seawater Supplies project);

(4) a comprehensive stakeholder and community consultation programme by GTL had been initiated, a large proportion of which had been facilitated by the Department of Mineral and Petroleum Resources' (MPR) Office of Major Projects (see Section 6). Consultation had not revealed any additional concerns to those raised during the stakeholder consultation phases for the projects listed above. It was considered that all potential significant environmental issues and community concerns associated with industrial projects in the Burrup area had been identified and that the assessment process did not require a formal public review period. A commitment was made by GTL to continue the consultation process throughout the preparation of the EPS document.

The EPA subsequently agreed that the proposal had the potential to be progressed as an EPS and the intention to set an EPS level of assessment was advertised by the EPA in December 2001. This provided GTL with the opportunity to pursue the EPS assessment route while recognising that the ultimate level of assessment would not be granted by the EPA until the final assessment document was submitted by the Proponent. The Department of

Environmental Protection (DEP) issued a scope of work to be addressed by the EPS and a draft EPS was submitted to the DEP in March 2002.

During the final stage of EPS preparation (and associated investigations) in May and June 2002 it became evident that, while an EPS method of assessment would still provide for a sound environmental outcome, issues related to the use of the Burrup for industry had arisen suggesting that a PER level of assessment had become more appropriate. These issues included:

- some elements of the local community were less supportive of further industrial development on the Burrup Peninsula than at the time the EPA granted GTL the opportunity to pursue the EPS assessment route. The primary opposition was to development within the King Bay – Hearson Cove corridor rather than at Withnell East;

- whilst most of the potential impacts would still be localised in nature and readily managed, it was recognised that the level of interest in the project was expanding beyond the local sphere. For example, the potential effects of emissions on petroglyphs could attract international attention, although the GTL emission of sulphur dioxide would be minimal relative to existing and other proposed sources (refer Section 7.4.1.1); and

- inability to complete a "wet season" vegetation survey due to lack of adequate rainfall.

In recognition of the above issues, GTL requested that the project now be assessed as a PER. This request was accepted by the EPA and notification of a PER (four week review period) level of assessment for the project was advertised over the period 8-22 July 2002. To provide GTL with adequate guidance to assess the environmental factors of the project at the PER level, the EPA issued a set of guidelines for the PER (see Appendix A, Part I).

1.7 PROJECT SCHEDULE

The effective date of the Engineering, Procurement and Construction (EPC) contract will coincide with the granting of the lease for the Withnell East site. This is contingent upon environmental approvals and Native Title clearance, which are expected in November 2002.

The project schedule is 30 months from award of contract to full mechanical completion of the methanol plant, which is anticipated in May 2005.

Mechanical completion will be followed by a commissioning and performance testing phase to demonstrate the reliability, integrity and capacity of the plant. This period will last for seven months and during this period methanol will be produced and shipped. The first "on specification" methanol production is planned to be 1.5 months after mechanical completion, in mid July 2005.

The plant will be constructed and commissioned on a lump sum turnkey basis and the handover date to AMC is planned for November 2005.

1.8 APPLICABLE LEGISLATION

This proposal is subject to assessment at the level of a PER under Part IV of the *Environmental Protection Act 1986*. Should approval for development be granted, the WA Minister for Environment & Heritage will issue a statement under Section 45 of the *Environmental Protection Act 1986* listing the management and environmental protection conditions to be applied to the proposal. Works approval and licensing are to be sought under Part V of the *Environmental Protection Act 1986.*

The proposal was also referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). A referral was submitted to Environment Australia in November 2001 in accordance with Part 3 of the *EPBC Act*, to determine whether the proposal was a Controlled Action considered to have the potential to significantly impact on matters of National Environmental Significance. Environment Australia subsequently advised that the GTL proposal does not constitute a Controlled Action (refer Appendix A, Part II).

In addition to complying with conditions of approval set by the WA Minister for Environment & Heritage, GTL will also comply with relevant environmental legislation, regulations, Australian Standards and codes of practice administered by other State and Commonwealth Government agencies. These Acts, standards and codes of practice, their application and responsible Government departments are listed in Table 1.1.

Table 1.1 Key Environmental Legislation and Standards

Act / Standard / Code	Application	Responsible Department
STATE		
Aboriginal Heritage Act 1972 (in particular Section 18)	Protects Aboriginal sites from disturbance.	Dept of Indigenous Affairs
Agriculture and Related Resources Protection Act 1976	Management of weeds and pests.	Agriculture Western Australia
Bush Fires Act 1954	Management of fire safety.	Bush Fires Board
Conservation and Land Management Act 1984	Management of flora and fauna and reserves.	Dept of Conservation and Land Management
Dampier Port Authority Act 1985	Protects marine waters within the boundaries of the Dampier Port Authority.	Dampier Port Authority
Dangerous Goods (Transport) Act 1998 and Regulations 1999	Regulations for transport and handling of dangerous goods.	Dept of Mineral and Petroleum Resources
Environmental Protection Act 1986 (Part V) and Regulations	Works Approvals, Pollution Prevention, Licences.	Dept of Environmental Protection
Explosives and Dangerous Goods Act 1961 and Regulations	Specifies storage, handling and blasting requirements.	Dept of Mineral and Petroleum Resources
Health Act 1911.	Sewage disposal facilities.	Dept of Health
Land Administration Act 1997	Manages Crown land and the compulsory acquisition of land generally, and related matters.	Dept of Land Administration
Local Government Act 1995	Governs the constitution, functions, election and administration of local government in WA.	Dept of Local Government
Main Roads Act 1930	Regulates the construction, maintenance, supervision of, and access to roads.	Main Roads Western Australia
Marine and Harbours Act 1981	Provision of safe and efficient shipping and boating.	Dept for Planning and Infrastructure
Native Title Act 1993	Handles Aboriginal claims for land ownership.	Ministry for Premier and Cabinet
Petroleum Pipelines Act 1969	Regulates the construction, operation and maintenance of pipelines.	Dept of Mineral and Petroleum Resources

Table 1.1 Key Environmental Legislation and Standards (cont'd)

Act / Standard / Code	Application	Responsible Department
Poisons Act 1964	Regulates and controls the possession and use of poisons and other substances.	Dept of Health
Pollution of Waters by Oil and Noxious Substances Act 1987	Protection of the sea and certain waters from pollution by oil and other noxious substances.	Dept of Environmental Protection
Port Authorities Act 1999	The control, management and operation of ports.	WA Ports
Shipping and Pilotage Act 1967	Shipping and pilotage in and about ports, shipping boat harbours and mooring control areas.	Dept for Planning and Infrastructure
Soil and Land Conservation Act 1945	Controls land degradation and clearing of land.	Agriculture Western Australia
State Planning Commission Act 1985	Controls the development of land in the State.	Ministry for Planning
Waterways Conservation Act 1976	Conservation and management of waters and the associated land and environment.	Dept of Environmental Protection
Western Australian Marine Act 1982	Regulation of navigation and shipping.	Dept for Planning and Infrastructure
Wildlife Conservation Act 1950	Rare flora and fauna protection.	Dept of Conservation and Land Management
COMMONWEALTH		
Australian Heritage Commission Act 1975	Identifies areas of national heritage significance.	Australian Heritage Commission
Environment Protection & Biodiversity Conservation Act 1999	Protects matters of National Environmental Significance.	Environment Australia
Environmental Protection (NEPM-NPI) Regulations 1998	Reporting of emissions to air, land and water.	Environment Australia

1.9 SCOPE OF WORKS

A draft scope of work to be undertaken to address EPA environmental factors and objectives was presented in the Environmental Scoping Document accompanying the EPA referral (URS 2001). The scope of work was subsequently confirmed and endorsed by the DEP, and is presented as Appendix A (Part I). The following studies were undertaken in preparing the PER for assessment by the EPA:

- Hydrogeology (Appendix B);
- Surface Water Hydrology (Appendix C);
- Vegetation and Flora (Appendix D);
- Fauna (Appendix E) ;
- Land Snails Survey (Appendix F);
- Air Quality Impact Assessment (Appendix G);
- Greenhouse Gas Assessment (Appendix H);
- Noise Impact Assessment (Appendix I);
- Visual Impact Assessment (Appendix J);
- Aboriginal Heritage Assessment (incorporated in text);
- Community and Stakeholder Consultation (Appendix K, Appendix L); and
- Preliminary Risk Assessment (Appendix M).

2.1 PROJECT COMPONENTS AND LOCATION

The Proponent proposes to construct and operate a 1.05 Mtpa methanol plant on the Burrup Peninsula, Western Australia within the WEIA, identified in the *Burrup Peninsula Land Use Management Plan* (Figures 1 and 2). The proposed plant site is east of the existing NWSVP plant (Plates 1 and 2) and adjacent to the Central Burrup Conservation, Heritage and Recreation Area (Figure 3).

The proposed plant footprint will be ~15 ha (Figure 4). The project will involve construction and operation of the following major components:

- a gas supply pipeline taking gas from the Dampier to Bunbury Pipeline to the GTL site;

- a 1.05 Mtpa methanol plant (Figure 5) comprising the following main components:
  - feed gas conditioning,
  - gas purification,
  - steam reforming,
  - autothermal reforming,
  - gas compression and synthesis,
  - methanol purification,
  - air separation,
  - product storage tanks,
  - plant infrastructure, including a mechanical vapour compression desalination plant, and
  - utilities;
- a methanol product transfer pipeline from the plant site to the Dampier Public Wharf, laid within an infrastructure corridor;

- seawater supply and return pipelines between King Bay and the plant site, also laid within an infrastructure corridor;

- ship loading operations at the Dampier Public Wharf, extended to accommodate vessels up to 45,000 DWT; and,

- methanol tanker ships to transport product to overseas markets.

The infrastructure corridors shown in Figure 2 are indicative only and may change. The corridors are presently subject to a strategic environmental assessment being undertaken by MPR.

Environmental approvals for the establishment of the feed gas, methanol product and seawater pipelines within the infrastructure corridors will be sought separately by GTL or MPR, taking account of strategic advice provided by the EPA. Hence, the potential environmental impacts of installing the pipelines will not be considered in this document, though the potential impacts associated with the operation of the pipelines are included.

Similarly, environmental approvals for extensions to the Dampier Public Wharf will be sought separately by the Dampier Port Authority (DPA), but potential impacts associated with the operation of the export facility are considered in this document.

The key elements of the project and the organisations responsible for providing these elements are summarised in Table 2.1 below.

Table 2.1 Key Elements of the Proposed GTL Methanol Plant

Key Element	Description	Responsibility
Methanol production facility	The methanol production facility will be located on the 35 ha site in the Withnell East Industrial Area. The production facility will comprise one methanol train for processing natural gas to methanol, an air separation unit, steam generation and all associated storage and pumping facilities.	GTL
Water systems	The supply of good quality water is an integral requirement of the methanol process and facilities. These facilities include desalination, demineralisation, cooling water, stormwater management facilities and domestic wastewater treatment.	GTL
Water supply	Water utilised on the complex will be derived from the desalination of seawater. It is intended that a contracted supply of seawater will be sought from the Water Corporation's proposed multi-user seawater supply system and brine and wastewater will be returned to the common return system.	Water Corporation (seawater supply) GTL (desalination plant) WA Government (common user corridor)
Natural gas supply	Natural gas will be supplied by pipeline from the NWSVP export pipeline facilities on the Burrup Peninsula. Gas will be contracted for supply from a common transportation system that supplies town gas from Dampier to Bunbury.	Apache Energy (feed gas supply) GTL (branch line from export pipeline to plant)
Product pipeline	Methanol product will be transported by a single pipeline from the storage facilities on the complex site to the port for loading directly onto dedicated chemical tankers. The pipeline will follow a common user pipeline corridor.	GTL (pipeline) WA Government (common user corridor)
Port facilities	New berthing installations are required. New liquids loading facilities are required to provide for the export of the product methanol.	Dampier Port Authority GTL
Shipping	The methanol product will be exported to GTL customers by bulk chemical tankers, the majority of which will be on time charter to GTL. Shipping will vary from 30,000 to 45,000 DWT loadings and when the complex is at full production there will be up to 35 tanker loadings at the Port of Dampier each year.	GTL
Support facilities	Administration, maintenance, safety, security, emergency response, laboratory, and operations control services will be provided from facilities located on the site.	GTL
Construction	The construction of the complex is planned to start in the first quarter of 2003. Construction facilities will be located on the site. To support the construction, accommodation, transportation and delivery facilities will be required.	GTL
Access	All weather access to the site for construction and operation is required. Large heavy loads will need to be moved to the site from the port and safe reliable commuting is required from accommodation zones in the local area.	WA Government

The methanol plant will be designed by Lurgi-Oel-Gas-Chemie GmbH (Lurgi) of Frankfurt, Germany. The processes for synthesis gas generation and methanol synthesis will utilise Lurgi's proprietary Combined Reforming Technology, which has been proven in methanol plants such as the Titan plant in Trinidad. Approximately 40% of the world's methanol production capacity uses Lurgi technology. A description of the process is included in the

Preliminary Risk Assessment (Appendix M). The project is anticipated to have a lifespan of at least 25 years. Key project characteristics are summarised in Table 2.2 below.

Table 2.2 Key Characteristics of the Proposed GTL Methanol Plant

Characteristic	Description
Project purpose	Produce up to 1.05 Mtpa of methanol for export
Project life	Over 25 years
Capital value	Approx. $ 590 million
Complex capacity	Up to 1.05 Mtpa of methanol from one production plant
Lease area	Approx. 35 ha
Site area	Approx. 15 ha
Complex facilities	
Process plant	1 x 3,000 tonnes per day (tpd) methanol production plant
Air separation unit	1 x 1,240 tpd of oxygen from cryogenic air separation unit
Product storage	2 x 47,708 t pure methanol storage tanks (each 60,000 m^3 capacity) 2 x 1,350 t pure methanol intermediate storage tanks 1 x 1,350 t raw methanol tank
Power generation	Onsite electrical power generation will be via 8 MW steam turbine generator (primary) and 600 kVA emergency diesel power generator
Water systems	Supply of up to 34 ML/day of raw seawater for operation of the seawater cooling (tower) system and for operation of the desalination plant. Desalination for up to 1.7 ML/day of fresh water for steam systems, potable water and sweet water cooling system make-up Demineralisation to produce up to 5.2 ML/day of high pressure steam quality water for the process.
Steam generation	Three level steam system (110 bar, 38 bar and 5 bar) with high pressure steam generated from heat recovery from the process and auxiliary boiler, and medium pressure steam generated from heat recovery from the process.
Utilities	Instrument and plant air systems. Wastewater systems for process, contaminated storm and domestic water. Nitrogen reticulation for inerting and purging purposes from the air separation unit.
Support facilities	Administration, maintenance, laboratory, emergency response & control room facilities.
Complex operation	24 hours/day for 7 days/week for 52 weeks/year
Complex reliability	The plant will require a shutdown for catalyst replacement and predictive and preventative maintenance once each 3-4 years for approx. 21 days. Additional shutdowns for process upsets and mechanical breakdowns are allowed for, to achieve an average of 350 operating days per year.
Natural gas pipeline	200 mm nominal diameter pipeline from the Dampier to Bunbury gas export pipeline to the GTL facility boundary.
Product export pipeline	500 mm nominal diameter pipeline from the GTL plant tank farm to the ship loading facilities.
Port facilities	One berth, provided by the Dampier Port Authority
Complex efficiency	34.56 GJ/t of methanol [High Heating Value (hhv)]
Construction period	23 months
Workforce	500 at peak construction; up to 60 for normal operations

In general terms, methanol is produced by the combination of natural gas and water which is then converted in a series of process steps to produce a single product. Natural gas provides the energy that is needed to drive the process. No by-products are generated in the process and the primary atmospheric emissions are the products of combustion of natural gas.

2.2 CONSTRUCTION SUMMARY

GTL will enter into a lump sum turnkey project with Lurgi to construct the project using Lurgi's proven, proprietary methanol process. The scope of work of the EPC contract will include all of the necessary facilities required to take gas from the supply point to the project and to produce, store and export of methanol to the point of sale. The items excluded from the

EPC contract are elements of supporting infrastructure to be provided by DPA and the Water Corporation.

Those items of plant which lend themselves to modularisation will be assembled in modular form and shipped to the site via the Mermaid Marine facility for transport to the site by road. The remainder of the bulk materials will be transported using the same route for on site assembly and construction.

GTL is currently working closely with the Industrial Supplies Office to fulfill its local content policy.

2.2.1 Utilities Required During Construction Phase

The proponent will require the Western Australian and Commonwealth Governments to provide the following utilities:

Water: The Water Corporation will provide up to 20 m^3/h of potable water for the project from the existing Burrup Peninsula water supply infrastructure. Water for the construction site will be provided by a temporary line from an existing tank to the GTL site storage tanks. This water will be used for earthworks, dust suppression, hydrotesting of tanks and pipes, commissioning requirements and potable use. Once the processing plant is fully operational, GTL will produce its own potable water from a mechanical vapour compression desalination plant on site.

Water for the accommodation village during construction will be supplied through existing infrastructure in the Karratha township.

Electricity: Power for construction needs representing about 200 MVA will be provided via an extension from Western Power's 33 kV overhead line. Power for commissioning and ramp up will be provided by this link to supply 4 MW of power. Once fully operational, the plant will be self sufficient in power demand by generating 8 MW from process steam. However, power for start-up and standby during the commissioning and operational phases will be provided by Western Power.

Communications: During construction, it is envisaged that Telstra will supply local phone communications, to be supplemented with cellular telephones and hand-held UHF/VHF radios for field usage. Subcontractors will be required to establish a compatible communication system. Once the methanol plant is operational, all communication equipment within the processing plant must be classified as intrinsically safe.

2.2.2 Construction Workforce

Construction will require approximately 500 workers. GTL is currently investigating existing and potential future accommodation options for the construction workforce in the Karratha area, including the establishment of a dedicated work camp. The company is aware of community concerns regarding the potential effects of both temporary and permanent workforce accommodation requirements on local housing availability and rental costs. GTL has accepted an invitation to join the Nickol Bay Accommodation Taskforce, instigated by the Department for Planning and Infrastructure (DPI), to address these issues.

2.2.3 Construction Wastes

Construction waste will include inert waste (debris, empty drums, empty paint and coating containers, empty and depressurised aerosol containers, scrap metal, plastics, etc.) and putrescible wastes (cardboard, waste paper, wood, vegetation, domestic garbage, food waste, etc.). The quantities of construction waste are not quantifiable at the present preliminary design stage. Management of construction waste is detailed in Section 7.4.3.2.

2.3 OPERATIONS SUMMARY

2.3.1 Synopsis

Operation and maintenance of the plant will be managed by AMEC PLC. Operation will basically involve receipt of gas, gas purification, reforming to synthesis gas, conversion to methanol, purification of methanol, storage and shipping to market. Figure 6 shows a simplified process flow diagram for the plant, based upon a diagram provided by Lurgi. A detailed description of the process is provided in Appendices G (Air Quality Assessment) and M (Preliminary Risk Assessment).

Methanol plants are typically very clean facilities. The plant will utilise natural gas for energy requirements. Essentially there will be three input streams of materials to the plant:

(i) natural gas;
(ii) seawater for cooling purposes and as feed for the water desalination plant; and
(iii) miscellaneous supplies and chemicals and catalysts required for the operation and maintenance of the plant.

These inputs will be processed into methanol for export. The process will generate a range of atmospheric emissions, wastewater discharges, and solid and semi-liquid wastes for disposal off-site. These are summarised in Table 2.3, and their environmental effects are discussed in Section 7.4.

Table 2.3 Characteristic Inputs and Outputs of Proposed GTL Methanol Plant

Characteristic	Description
Feed gas	85.4 tph from the Dampier to Bunbury gas pipeline.
Seawater input	Up to 34 ML/day
Catalysts	Hydrogenation: CoMo / NiMo catalyst. Desulfurisation: zinc oxide mass. Pre-reforming: Ni containing catalyst. Steam Reforming: Ni containing catalyst. Autothermal Reformer: Ni containing catalyst. Methanol Synthesis: Cu containing catalyst.
Approximate gaseous emissions under normal operations	NO_x: 48 kg/h or 403 tpa. CO: 9 kg/h or 76 tpa. VOC: 1 kg/h or 8.4 tpa. CO_2: 0.404 kg/kg methanol or 424,000 tpa.
Wastewater discharge	
Brine	Up to 4.2 ML/day from desalination plant.
Cooling tower blowdown	Up to 12.9 ML/day from the cooling tower.
Process	Up to 120 KL/day from the methanol production plant.
Demineralised regenerated water	Up to 1.9 ML/day.

Table 2.3 Characteristic Inputs and Outputs of Proposed GTL Methanol Plant (cont'd)

Characteristic	Description
Total seawater return	Up to 22 ML/day.
Domestic wastewater	Up to 7 KL/day. To be irrigated on landscaped areas of the plant or disposed in an alternative manner in accordance with DEP requirements.
Stormwater	The plant will have separate contaminated and clean stormwater systems. Run-off from areas designated potentially contaminated will be directed to an evaporation pond. The evaporation pond will be sized to contain 500 L/h. Run-off from areas designated uncontaminated will be collected through a rectification system and directed through a corrugated plate interceptor into natural watercourses. Discharge to natural watercourses will be via a weir or other design into an impingement slab to prevent erosion. Stormwater accumulated in the bunded areas of the storage tanks will be analysed prior to discharge. If contaminated, it is to be directed to the evaporation pond and if clean, to the clean stormwater system.
Wastewater specification Brine	Up to 55,000 mg/L (TDS), temperature to be within 2^{o}C of 24 hour ambient seawater temperature for 80% of the time with a maximum exceedence of 5^{o}C and zero free biocides. Water treatment chemicals to be agreed with appropriate authorities. 6-9 (pH), 10 mg/L (ammonia), zero (free chlorine), 28 mg/L (TSS).
Stormwater	10 mg/L (TDS).
Solid wastes	Collected by contractor for recycle/reuse: batteries, paper, cardboard, scrap metal. Collected by contractor for disposal: waste oil. Returned to vendor: catalyst waste. Landfill: fluorescent tubes, HID lamps, general refuse, ceramic fibres. Recycled: glass, plastics and chemicals Composted: organic waste

Note: All analyte concentrations to be based on 24 hour composite samples, unless otherwise agreed.

Under normal operating conditions, gas is purged from the synthesis loop. This gas, which contains nitrogen with quantities of hydrogen, methanol, methane and oxides of carbon, is passed to the fuel gas system and is not flared. During certain process upsets and emergency situations the plant will be depressurised to flare. Any liquids carried toward the flare during depressurisation will be intercepted by a knock-out drum, separated from the gas stream and returned to the raw methanol tank. The flare stack will be designed and positioned to minimise safety risk to the workforce, plant equipment and the natural environment.

2.3.2 Maintenance

The plant and equipment will be maintained using a reliability centred system that makes full use of condition monitoring techniques. Equipment defects likely to have an adverse effect upon safety or the environment will be given priority action. The plant availability is expected to be better than 96% and will operate for at least 350 days per year. Plant shutdowns for major maintenance and inspection will occur on a four yearly basis.

2.3.3 Workforce and Accommodation

Sixty personnel will be required to operate, maintain and support the plant for 24-hour operation. Adequate numbers of competent personnel will always be available to assemble an incident management team and to perform critical operations.

GTL is aware of the potential for this and other proposed projects to place additional pressure on the local housing situation. As indicated in Section 2.2.2, GTL has accepted an invitation to join the Nickol Bay Accommodation taskforce to address these issues. Housing availability for operational staff is being investigated along with employment arrangement options and assistance will be sought from the relevant authorities. A fly-in/fly-out arrangement is not the preferred option.

2.3.4 Utilities

Utility requirements of the plant include potable water, boiler feed water, firewater, electricity, plant and instrument air, fire protection, communications and fuel storage. All the utilities consumed in the methanol facility except seawater will be produced within the limits of the plant. Similarly, wastes produced in the methanol facility will be treated within the limits of the plant.

All water required for the operational phase will be piped to the site. GTL has received a proposal from the Water Corporation regarding both provision and disposal of cooling and process water. Approximately 1,250 m^3/h of seawater will be required for cooling and firefighting purposes and as feed to the water desalination plant. Potable water and boiler feed water make up will be produced on site. Return water from the GTL site will be discharged through the proposed Water Corporation outfall into King Bay. A water flow diagram is presented as Figure 7.

In the present design, all electrical requirements are generated on site using steam generated in the process. There will be no utilisable quantities of surplus energy generated. Western Power will provide additional power for start up and shutdown requirements. A 600 kVA diesel generator will provide emergency power requirements on site.

Up to 1,000 L of diesel fuel for the emergency generator will be stored in a Diesel Storage Tank (1 m diameter, 1.5 m in length). The tank will be provided with a full containment dyke to hold the entire contents of the tank. The emergency power generator system will be located in a shelter, which will be enclosed on three sides. The shelter will be designed to prevent rainfall from entering the diesel storage tank containment dyke.

2.3.5 Product Storage

Methanol will be stored in two fixed roof storage tanks each of 60,000 m^3 capacity. Each tank will be contained in a bunded area with the following dimensions:

Top of Bund	151.2 m x 151.2 m
Base of Bund	141.5 m x 141.5 m
Height of Bund	3.6 m
Bund Capacity	65,790 m^3

2.3.6 Product Pipeline

Methanol will be pumped from the plant site to the ship loading facility on the Dampier Public Wharf through a 500 mm steel pipeline approximately 7.4 km in length. The pipeline will be partially buried and covered over with rock armour to protect against third party damage or interference. Cyclone protection for the methanol loading line at the Dampier

Public Wharf will be addressed during the detail design phase. The pipeline will remain full during idle periods between ship loading operations.

2.3.7 Ship-Loading System

Ships will be loaded through a mechanised loading arm mounted on a new platform to be installed at the northern end of the wharf. Two loading pumps will be installed with a capacity of 2,000 m^3/hr each. There will be a fibre optic link between the plant site and the wharf to allow full automatic start up and shut down sequence of the pumps and pipeline system. An emergency shut down sequence will also be initiated through this link in the case of an unplanned event occurring. Loading operations will be controlled from the wharf and monitored from the plant's main control room.

It is proposed that a water scrubber is installed at the port to receive and treat any vapours emitted during ship loading activities. This will ensure that the majority of any fugitive emissions of nitrogen and methanol vapour from ship loading activities will be collected and treated to remove methanol vapours prior to discharge to atmosphere.

Prior to decoupling the loading arm, the residual methanol in the arm and line will be drained and pumped to a "slops" containment tank. This tank will be emptied back into the line during the next loading cycle.

2.3.8 Shipping Operations

Vessels for methanol export will enter Mermaid Sound and proceed to the Dampier Public Wharf. Shipping will mainly be undertaken using dedicated 30,000 and 45,000 DWT tankers, at a typical frequency of one vessel every 10 days. Loading time will be 18-25 hours, with vessel turnaround within 36 hours. The sharing, or otherwise, of loading facilities with other proposed projects on the Burrup Peninsula will be dictated by the DPA.

The project represents an opportunity to develop a value-adding downstream processing facility from the utilisation of the significant gas reserves which exist offshore north-west Western Australia. With a total capital investment of approximately $600 million, the project will provide significant benefits for the local and regional economy.

The development of such value-adding industries is supported by the WA Government which has set aside land on the Burrup Peninsula for industrial purposes. As part of this strategic development of the Burrup Peninsula, the State Government has committed $136 million for multi-user infrastructure development on industrial land on the Burrup, which includes seawater supply and brine return, port expansion, pipeline corridors and road works.

The project will offer a number of significant benefits for the region, including:

- production of chemical grade methanol for use in the petrochemical industry;
- contribution to the regional economy of Australia resulting from export earnings, taxes, salaries, and purchases of goods and services during the construction and operation phase of the development;
- contribution to the local economy of the Pilbara area, both directly and indirectly, as a result of the long-term employment that will occur during the operational phase of the development; and
- provision of additional employment and training opportunities during the construction phase of the development.

4.1 LOCATION

Initial siting studies were undertaken in 2000 by GTL. On the basis of these studies, GTL selected a site on Middle Arm Peninsula near Darwin, Northern Territory as their initial preferred option.

In January 2001, GTL signed a letter of intent with an affiliate of Phillips Petroleum for the supply of gas for the onshore methanol plant. At this time, the methanol plant's production for its first ten years of operation had already been sold to a major US energy company. GTL also initiated the preparation, by URS, of documents for Commonwealth and Territory environmental approvals. A referral under the *EPBC Act* was submitted to Environment Australia and a Notice of Intent was submitted to the Northern Territory Government in February.

The proposal was declared a Controlled Action under the *EPBC Act*, with the controlling provisions given as listed threatened species and communities (Sections 18 and 18A) and threatened migratory species (Sections 20 and 20A). The Commonwealth subsequently accredited the environmental assessment process under the Northern Territory *Environmental Assessment Act 1982*. The Territory Government set the level of assessment as an Environmental Impact Statement (EIS) and guidelines were prepared which incorporated Environment Australia's requirements.

In March 2001, the methanol plant was granted Major Project Facilitation Status by the Federal Minister for Industry, Science & Resources, Senator Nick Minchin. In April 2001, GTL signed a Heads of Agreement for the design and construction of the plant with Lurgi.

EIS studies were commenced by URS in May 2001. Significant progress had been made on most studies when, in July, GTL was forced to reconsider the plant location due to the significant uncertainty regarding the supply of feed gas from the Bayu-Undan and Greater Sunrise gas fields in the Timor Sea. This uncertainty arose from the lack of resolution of fiscal terms under the Timor Sea Agreement between the Governments of Australia and East Timor.

The Burrup Peninsula was considered the most suitable alternative location for the plant due to the proximity of a reliable, established supply of natural gas, the availability of suitably zoned industrial land, the world-class port facilities and the provision of multi-user infrastructure for strategic industrial use. After considering a number of sites on the Burrup and nearby areas, in conjunction with the Office of Major Projects from the MPR, the WEIA was identified as the preferred project location. A Memorandum of Understanding for the sale of gas to GTL was subsequently signed in October 2001 with affiliates of Apache Corporation, Globex Energy Inc. and Santos Ltd.

Key factors in selecting Withnell East as the preferred location were:

- availability of sufficient land area;
- elevated location with no intertidal areas;
- reasonably flat terrain, enabling disturbance of the landscape to be minimised;
- low potential for threatened species or ecological communities to be adversely impacted;
- low potential for disturbance of public amenity;
- proximity to established industrial development;
- proximity to established feed gas supply, infrastructure corridor and export facilities; and
- likely availability of water supply (through Water Corporation) for desalination plant, process make-up water and plant cooling purposes.

GTL is aware of the phased development of the Burrup/Maitland Strategic Industrial Area being coordinated by the State Government through the MPR Office of Major Projects. The existence of port facilities favours use of the Burrup industrial land and it is anticipated that future development of port facilities on West Intercourse Island would provide the infrastructure necessary for the development of the Maitland area as Phase 2. While GTL acknowledges that aspects of the Maitland area are attractive for industrial development (e.g. flat terrain, appropriate zoning) it is not considered to be a viable option at this time as it is impossible for the infrastructure necessary to support the project to be planned, approved and constructed within the timeframe required for the GTL project.

4.2 COOLING SYSTEMS

The process plant includes a combination of air cooling and water cooling. Due to the high ambient air temperatures in summer, air cooling alone would not be sufficient and a water cooling tower circuit is necessary to achieve the process temperatures required. The main process cooling is achieved via a seawater cooling tower system which requires a water intake of 1,250 m^3/hr.

Seawater will be provided from the Water Corporation facility being developed in the King Bay area. Wastewater will also be discharged into King Bay, via a common user header system. Both the seawater intake and wastewater return will be controlled by the Water Corporation.

A detailed description of the natural and social environment of Burrup Peninsula is provided in the Woodside North West Shelf Gas Project PER (1997), Consultative Environmental Review (CER) for the Plenty River Ammonia/Urea Plant (Woodward Clyde 1998), CER for the Syntroleum Gas to Synthetic Hydrocarbons Plant (HLA Envirosciences 1999), Water Corporation Burrup Peninsula Desalinated Water and Seawater Project EPS (2001), and the Burrup Fertilisers and Methanex PERs (SKM 2001, 2002). The following summary has been obtained partly from these reports, and partly from the results of site surveys undertaken on behalf of GTL.

5.1 PHYSICAL ENVIRONMENT

5.1.1 Regional Setting

The Burrup Peninsula is located in the vast Pilbara region, situated in the North West of Western Australia (Figure 1). The Pilbara covers an area of over 500,000 km^2, extending from the Indian Ocean to the Northern Territory border. Thought to be around 2.8 billion years old, the Pilbara contains some of the earth's oldest rock formations and most important mineral deposits.

5.1.2 Climate

The Burrup Peninsula experiences a tropical-arid climate. Mean annual rainfall is 315 mm/year (Dampier), the majority of this falling between January and June. From January to April rainfall is dominated by tropical thunderstorms and cyclones. Average annual relative humidity ranges between 45% in the morning to 39% in the afternoons. Humidity is highest in late summer and lowest in late winter. Maximum temperatures range between 26.1°C in July to 36.2°C in March with the average minimum temperature ranging from 13.4°C in July to 26.5°C in February. Winds in this area are characterised by seasonal dominance of easterlies in winter and westerlies in summer. Average wind speeds in both seasons vary from 10 km/hr to 20 km/hr and sustained periods of winds to 35 km/hr can occur, particularly in winter. The strongest winds, in excess of 300 km/hr, occur in association with tropical cyclones between November and April.

5.1.3 Topography and Geomorphology

The Burrup Peninsula extends north, approximately 20 km from the Pilbara coast, and is bounded by Mermaid Sound to the west and Nickol Bay to the east (Figure 1). The topography of the peninsula is described as rugged, dominated by steep bare rock piles and narrow valleys.

Soils of the Burrup Peninsula are generally alluvial deposits in the hinterland valleys with unconsolidated marine sediments along the coast. Soils are shallow, mostly limited to 2 m depth, with a fractured bedrock basement. The soils have high silt and clay fractions and exist as a matrix for dense boulders and rocks.

The Burrup Peninsula is comprised of Proterozoic and Archaean igneous rocks that outcrop extensively. The granophyre (Proterozoic) outcroppings observed on the peninsula have developed from a process of intrusion into the older Archaean rock followed by weathering of the older rocks leaving the comparatively erosion free granophyre exposed. The base of the

granophyre intrusions consists of a differentiated coarse-grained gabbro, also resistant to erosion.

The 35 ha GTL lease area is located in a valley to the east of the existing NWSVP gas plant (Figure 3, Plate 1). The valley extends east west; the plant site is in the south-western corner. The site has an elevation of about 10-15 m above Australian Height Datum (AHD) and land slope is about 2^{o} fall to the north-west. To the south of the site are a series of low, rocky outcrops, rising up to 80 m AHD.

The GTL lease area has two basic landforms – rocky outcrops and scree slopes; and valleys, drainage gullys and alluvial fans. Rocky outcrops are the weathered remains of the intrusive Gidley Granophyre. The alluvium is described as gravelly silt, varying from gravelly sandy silt near the surface to silty sandy gravel with a cobble or boulder component immediately above the bedrock. Depth to bedrock in the vicinity of the plant site is likely to be 2 m, with pockets of deeper soils and some areas with fractured rock outcrops. The plant site itself, which represents 15 ha of the total lease area, is situated in the valley of low topography away from the rocky outcrops (Figure 3, Plate 2).

The outcropping fine to medium grained granophyric rhyodacite (granophyre) on the northern and southern valley indicates the existence of this granophyric rhyodacite formation on the surrounding steep hills. The fine grain size and split boulder scree aggregates of the granophyre makes the rock resistant to weathering. There is a high probability that granophyre underlies the selected plant site, due to the close proximity of the outcrop.

Based on Geological Survey of WA (1979) mapping, Archaean granite underlies the valley. An outcropping of granite is located south of the lease area, indicating that granite could also possibly underlie the plant site. The rock is likely to be leucocratic and coarse grained, with approximately even proportions of potassium and sodium feldspars, as found further south (HLA Envirosciences 1999). Air photographs reveal trending joints and dolerite dykes northwest and northeast of the plant site that may occur below the surficial sediments at the plant site.

5.1.4 Hydrogeology

The drainage lines in the area appear to be structurally controlled, and predominantly trend either northeast or northwest. A drainage line passes through the eastern portion of the methanol site, and smaller drainage lines also occur through the centre and western edge of the site. These drainage lines flow northwest towards Withnell Bay.

The important hydrogeological units in the vicinity of the plant are the:

- surficial sediments, comprising alluvium and colluvium, covering the valley floor, but generally unsaturated; and

- weathered and jointed granophyre (and possibly granite) immediately beneath the surficial sediments and outcropping in some areas on the site.

It is considered unlikely that the sedimentary cover is more than 2 m thick beneath the plant site. As these sediments are likely to have reasonably high permeability, it is likely that they would only contain significant groundwater for a reasonably short period after rainfall within the catchment.

The only possible regional aquifers at the project site would be zones of fractured granite or granophyre that are open at depth. The plant area is approximately 10 m to 15 m above sea level and the regional water table is probably between 5 m and 10 m below ground surface.

Recharge to the groundwater system occurs as direct recharge following rainfall events, and also by infiltration from creek flow. Discharge from the groundwater system occurs as throughflow and creek flow during the dry season and evapo-transpiration from minor, local areas of vegetation within the valley.

5.1.5 Hydrology

After rainfall events most of the water on the Burrup Peninsula flows across the surface in drainage channels. The density of the granophyre and its surface proximity prevents subsurface water storage and flow. Drainage channels usually begin as steep-sided valleys and fan out into alluvial deposition areas on the lower slopes. Soils on the lower slopes are highly permeable and will recharge groundwater.

There are no permanent water bodies at the plant site and streams in the area are small and ephemeral, typical of the Burrup region, and only flow after heavy rain. The creeks in the area appear to be structurally controlled, and predominately trend either northeast or northwest. Smaller creeks flow northwest through the centre and western edge of the site towards Withnell Bay. Two drainage lines passes through the central (Plates 3 & 4) and western sections of the lease with other smaller drainage lines running north-west from the centre and western edge of the site (Figure 3). These drainage lines cross the alluvial valley floor before discharging into Withnell Bay about 500 m to the north-west of the site.

5.1.6 Seismicity

The Australian Geological Survey Organisation instrumental seismicity database contains no record of earthquake epicentres on or near (within 10 km) the Burrup Peninsula. Since 1968, there are records of three seismic events within a 50 km radius and 19 events within a 100 km radius of the GTL site. However, the epicentres of the events do not show any strong spatial alignment or concentration of seismicity near the site and there is no indication of the presence of active faulting capable of generating a significant earthquake (>6 on the Richter Scale). The epicentres cannot be correlated to any known geological structures in the vicinity of the site, though there is inherent uncertainty in their locations.

Regional seismicity provides the best indication of seismic risk for the GTL site. Several hundred earthquakes have been recorded within 1,000 km of the site since 1856, with diffuse activity throughout north-western Australia and a concentration of events in the Java Trench. The GTL site is within the Western Background Seismic Source Zone, which exhibits sparse seismic activity (Gaull et al. 1990).

While a linear geological feature from No Name Creek (2.5 km to the west-south-west of the GTL site) to Watering Cove (2 km to the east of the site) may have been formed by a fault, there is no evidence to suggest that such a fault would still be active. It is concluded that there is little danger from active faulting on the Burrup Peninsula and the only earthquake hazard would arise from regional seismicity, i.e. seismic shaking from a source at some distance.

5.2 BIOLOGICAL ENVIRONMENT

5.2.1 Vegetation and Flora

5.2.1.1 Introduction

The Burrup Peninsula lies within the Fortescue Botanical District, which is part of the biogeographical region known as the Eremaean Botanical Province (Beard 1975), and within the Pilbara biogeographic region in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell 1995). Beard (1975) described the vegetation of the botanical province as predominantly open grassy plains or mixed grass and spinifex with shrub steppe occurring further inland on the granite plains. Thackway & Cresswell (1995) described the vegetation as "quaternary alluvial plains with a grass savanna of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* over *Triodia pungens.* Samphire, *Sporobolus* and Mangal occur on marine alluvial flats".

The dominant vegetation type of the Burrup Peninsula can be broadly described as mid-dense hummock (*Triodia* sp) grass with mixed scrub and open low woodland, punctuated by habitat and substrate related minor communities. The result is a complex mosaic of vegetation assemblages that makes classification and mapping in the area a difficult task. As an indication of the complexity of vegetation for the Burrup Peninsula, Blackwell & Cala (1979) described a group of five basic vegetation units for the area, that were further divided into 28 communities.

Results of a recent survey of the area concluded that the Burrup Peninsula, along with Dolphin, Angel and Gidley Islands, comprise an arrangement of vegetation units distinct from the surrounding region (Trudgen & Griffin 2001; Trudgen 2002). A similar observation was made by Blackwell et al. (1979) who, although recognising the Burrup Peninsula as part of the Abydos Plain, also identified it as containing a unique mixture of coastal and eremaean species in close association with species more typical of the Northern (Kimberley) Botanical Province. Trudgen attributed much of this difference between the Burrup and its surrounds to a combination of geology, microclimates and episodes of isolation from the mainland at times of higher sea level.

The Burrup Peninsula was also found to contain a large number of vegetation associations (each with small area of occurrence), a rich flora for its size, and a high number of geographically restricted or uncommon species (Trudgen 2002). A significant geographic based pattern for the distribution of floristic units on the peninsula, in accordance with landscape groups (i.e. rockpiles, slopes, drainage lines, etc.), was also identified (Trudgen & Griffin 2001; Trudgen 2002).

In a review of the current knowledge of the area, Welker (2002) concluded that the Burrup Peninsula should be considered a different floristic sub-region of the west Pilbara, with a high level of conservation value at a regional level.

5.2.1.2 Vegetation and flora studies undertaken for the GTL Project

Astron Environmental was commissioned to conduct a preliminary vegetation and flora survey of the proposed GTL lease in October 2001. The objective of the survey was to provide broadscale survey information at a general level to satisfy the requirements for a Referral Document. The methodology and results of the survey are provided in Part 1 of Appendix D. As this preliminary survey was conducted at the height of the dry season it was

not possible to undertake a more comprehensive survey due to most of the annual and all ephemeral species having already died off and many perennial species were dormant.

A more detailed "wet season" survey of the site was scheduled to occur during the first half of 2002, after the first significant rainfall. The survey would have been designed to provide a full, quantitative assessment of the site (involving sampling of 50 m x 50 m quadrats) as per the EPA Guidelines for Biological Surveys. However, at the time of preparation of this PER, insufficient rainfall had been received on the Burrup Peninsula to enable a meaningful wet season flora survey to be undertaken. The Burrup Peninsula and Karratha are currently highlighted as being in an area of severe rainfall deficiency (rainfall in the lowest 5% of historical records) (Bureau of Meteorology, 6 February 2002).

Whilst GTL re-affirmed its commitment to undertake a detailed vegetation survey following significant rain, the project schedule did not allow for a continued delay due to the absence of rain. In order to progress the assessment of impacts to vegetation, Astron was commissioned to provide an updated review of the status of the vegetation and flora on the GTL lease site based on the findings of the recent Trudgen (2001, 2002) and Welker (2002) reports, supported by further dry season field work to confirm mapping of the vegetation types. The aim of this review was to place the vegetation and flora on the GTL lease into a regional perspective. The Astron review is presented in Part II of Appendix D and the key findings of this review are discussed further in Section 7.3.1 as part of the assessment of impacts to vegetation and flora.

5.2.1.3 Vegetation types on the GTL Lease

The preliminary vegetation and flora survey conducted by Astron Environmental in October 2001 identified six broadscale vegetation types which are further divided into 20 vegetation assemblages. They were described in accordance with Specht, modified by Aplin (1979). These are detailed below and presented in Figure 8.

1. Hillocks with Rockpiles and Small Piles of Outcropping Rock.

Open Low Woodland B over mixed Shrubland over Open Hummock and Tussock Grass in small pockets on rocky outcrops.

1a Low Woodland (10-30%;<5m) of *Brachychiton acuminatus, Terminalia supranitifolia* over Low Shrubland (10-30% 1-2m) of *Dichrostachys spicata, Rhagodia preissii* var *preissii* over Very Open Grassland (2-5%) of *Cymbopogon ambiguus* and *Triodia epactia* (Burrup Form).

2. Stony Hill Slopes with Small Outcropping Rockpiles

Mixed Shrubland over Mixed Low Open Heath over Hummock Grassland on rocky hills, rockpiles and ridges.

2a Open Shrubland (5-20%; 1-1.5 m) of *Grevillea pyramidalis, Acacia inaequilatera, A. colei* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/*T. wiseana* (Burrup Form).

The rockpiles that occur within this habitat generally have small pockets of vegetation incorporating low trees and shrubs (associated with 1a). The very shallow drainage lines criss-crossing the slopes have more dense vegetation of the same species.

2b Shrubland (10-30%; 1-2 m) of *Acacia inaequilatera* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

2c Low Open Heath (30-70%, <0-0.5 m) of *Tephrosia rosea* with *Indigofera monophylla* (Burrup Form) over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form). There are scattered (<2%) *Corymbia hamersleyana, Acacia inaequilatera, A. colei, Dichrostachys spicata*.

2d Shrubland (10-30%; 1-2 m) of *Ipomoea costata* with *Grevillea pyramidalis* over Low Shrubland (10-30%; 0.5 m) of *Indigofera monophylla* (Burrup Form), *Tephrosia rosea* var *clementii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

3. Lower Gently Undulating Stony Slopes

Very Open Low Woodland over Very Open Mixed Shrubland over Open Low Shrubland over Hummock Grassland in undulating stony slopes.

3a Very Open (2-10%) to Low Woodland (10-30%; <10 m) of *Corymbia hamersleyana* (2-10% <5 m) over Very Open Shrubland (2-10% 1-2 m) of *Dichrostachys spicata, Acacia bivenosa, A. colei, Grevillea pyramidalis* over Open Low Shrubland (5-10%; 0-0.5 m) of *Indigofera monophylla* (Burrup Form),*/Corchorus walcottii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form) and *Cymobopogon ambiguus*.

3b Very Open Shrubland (2-10%; 1-2 m) of *Dichrostachys spicata, Acacia colei, A. inaequilatera, Grevillea pyramidalis* over Open Low Shrubland (2-10%; 0.5 m) of *Indigofera monophylla, Tephrosia rosea* var *clementii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

3c High Open Shrubland (2-10; 2 m) of *Acacia colei* over Open Shrubland (2-10%, 1-2 m) of *Grevillea pyramidalis* over Low Open Shrubland of *Indigofera monophylla* (Burrup Form) over Hummock Grassland of *Triodia epactia* (Burrup Form) *T. wiseana* (Burrup Form).

4. Gently Sloping Stony Plain

Mixed Very Open to High Shrubland over Hummock Grassland.

4a Very Open to High Shrubland (2-10%; 1-<2 m) of *Acacia bivenosa, A. colei, A. inaequilatera, Hakea lorea* over mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/ *T. wiseana* (Burrup Form). This vegetation type covers much of the proposed plant site. An example of this type is shown in Plate 5.

4b Open Low Shrubland (2-15%; 0.5 m) of *Senna oligophylla* over Hummock Grassland of *Triodia wiseana* (Burrup Form).

4c Hummock Grassland (30-70%) of *Triodia wiseana* (Burrup Form)

5. Broad Drainage Zone

Low Woodland B over Mixed Shrubland over Mixed Dwarf Shrubland over Hummock Grassland.

5a Low Woodland (10-30/40%; <10 m) of *Corymbia hamersleyana* over Shrubland (10-30%; 1-1.5 m) of *Acacia inaequilatera, A. coriacea, A. bivenosa* over Dwarf Shrubland (10-30%; 0-0.5 m) of *Indigofera monophylla* (Burrup Form), *Corchorus walcottii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

6. Drainage Lines

Woodland lined drains

6a Narrow to broad, shallowly incised drain lines with Open – Woodland (2-10; 10-30% varies; <10 m) of *Eucalyptus victrix* and occasional *Corymbia hamersleyana/ Terminalia canescens* over Dwarf Shrubland (10-30%, 0-0.5 m) of *Stemodia grossa* over Hummock Grassland (30-70%) of *Triodia angusta* (Burrup Form). Dormant Sedges present.

6b Narrow rocky drainlines with Woodland of *Terminalia canescens* (10-30 – 40%) over Open Shrubland of *Acacia coriacea* over Dwarf Shrubland (10-20%; 0-0.5 m) of *Stemodia grossa* over Hummock Grassland (30-50%) of *Triodia angusta* (Burrup Form).

6c Shallow drainline with Open to Woodland (2%; 10-30%; <5 m) of *Corymbia hamersleyana* over Shrubland (10-30%; 1-1.5 m) of *Dichrostachys spicata, Acacia coriacea, A. inaequilatera, A. colei* over Dwarf Heath (30-60%; 0-0.5 m) of *Indigofera monophylla* (Burrup Form) over Open to Mid Dense Hummock Grassland (10-70%) of *Triodia epactia* (Burrup Form)/*Triodia wiseana* (Burrup Form).

6d Open Woodland (2-10%; <10 m) of *Corymbia hamersleyana* over High Shrubland (10-30%; >2 m) of *Acacia bivenosa* over Open Low Shrubland (2-10%; 0-0.5 m) of *Senna oligophylla, Indigofera monophylla* (Burrup Form) over Mixed Hummock Grassland (30-70%) of *Triodia epactia(*Burrup Form*)/T. angusta* (Burrup Form).

Shrubland lined drains

6e Very shallow drainline criss-crossing undulating lower slopes of Open Shrubland (2-20%; 2 m) of *Acacia bivenosa* over Dwarf Heath (30-60% - check in wet; 0-0.5 m) of *Tephrosia rosea* var *clementii, Indigofera monophylla* (Burrup Form), over Dense Hummock Grassland (50-80%) of *Triodia wiseana* (Burrup Form)/ *T. epactia* (Burrup Form).

6f Shallow drain lines across gently sloping plain of Shrubland of *Acacia colei, Grevillea pyramidalis, Acacia bivenosa* over Dense Hummock Grassland of *Triodia angusta* (Burrup Form).

6g Broad shallow drainline with colluvial soil with High Shrubland to Open Scrub (30-60%; 2 m) of *Acacia bivenosa, A. inaequilatera, A. colei* over scattered *Ipomoea costata* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)*/T. angusta* (Burrup Form).

6h Shallow, broad drainline of Open Woodland (2-10%; <10 m) of *Corymbia hamersleyana* over Shrubland (10-30%; 2 m) of *Acacia colei* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)*/T. angusta* (Burrup Form).

5.2.1.4 Flora

A flora list was not compiled during the initial survey due to the senescence and dormancy of vegetation at that time. Only key species in each vegetation type and Priority Species were recorded as part of the vegetation descriptions. As a result of this a total of 55 vascular plants were recorded, representing 28 families. This relatively low number of species is due to the fact that thorough searches of each habitat were not made. This list should not be regarded as comprehensive and a more complete list will be compiled during a wet season survey to be undertaken when conditions become more favourable.

Two Priority Species were recorded during the initial survey.

- *Terminalia supranitifolia* (Priority 1) were recorded in the rockpiles in the south-western corner and along the southern side of the lease.
- *Eriachne tenuiculmis* (Priority 3) was recorded in three locations in the major drainlines.

Priority 1
Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size or being on lands under immediate threat. Such taxa are under consideration for declaration as "rare flora" but are in urgent need of further survey.

Priority 3
Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (ie not currently endangered). Such taxa are under consideration for declaration as "rare flora" but are in urgent need of further survey.

Seven species highlighted by Trudgen (2002) as having high conservation value were recorded as occurring on the GTL lease. These are outlined in Table 5.1 below.

Table 5.1 Flora Identified as having Significant Conservation Status (Trudgen 2002) Recorded Within the GTL Lease

Species	Synopsis of Status
Terminalia supranitifolia	Priority 1 species
Eriachne tenuiculmis	Priority 3 species
Triodia angusta (Burrup Form)	Locally very common to abundant, moderately restricted. Not previously recognised as distinct.
Triodia epactia (Burrup Form)	Locally very common to abundant. Quite geographically restricted. Not previously recognised as distinct.
Rhynchosia sp. Burrup	Locally common, but very geographically restricted with records in the data set only from the Burrup Peninsula and Dolphin Island. Not previously recognised as distinct.
Corchorus walcottii	Locally common, quite restricted geographically. (Not strictly newly recognised, but restricted in circumscription)
Triumfetta appendiculata (Burrup Form)	Locally common, quite restricted geographically. Not previously recognised as distinct.

5.2.2 Fauna

5.2.2.1 Introduction

The Burrup Peninsula supports a diverse terrestrial fauna, representing Eyrean or Eremaean species with some Torresian species. Typically, arid-zone animals that have adapted to high temperatures and intermittent rainfall dominate this fauna. As many as 44 species of mammal, 164 species of bird and 93 species of reptile may inhabit, or visit, the Burrup Peninsula and the surrounding area, and adjacent coastal seas. None of these vertebrate species are endemic to the Burrup Peninsula. However, a number of key species are endemic to the Pilbara, and are restricted in their distribution to the Burrup Peninsula with several species representing isolated populations.

Astron Environmental was commissioned to undertake a comprehensive desktop literature review of the fauna of the Burrup Peninsula, sites adjacent to the WEIA and the Pilbara in general. This involved a search of WA Museum and Department of Conservation and Land Management (CALM) databases, published literature and unpublished environmental reports. Publications used to define geographic distribution patterns and species taxonomy in this report include Cogger (2000), Storr et al. (1983, 1986, 1990, 1999), Johnstone & Storr (1998), Pizzey & Knight (1997) and Strahan (1998). Unpublished reports include those of Butler (1987, 1994), Slack-Smith (1999, 2000) and Astron Environmental (1999a, 1999b, 2000).

A search of the CALM Reserve List fauna species, consultation with CALM scientists familiar with fauna in the region, and liaison with WA Museum staff and the Nickol Bay Naturalist Club were undertaken. Species lists on international agreements for the conservation of fauna were also checked. These include the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA) and the Convention on the Conservation of Migratory Species of Wild Animals.

A fauna trapping survey was not conducted on the site due to a combination of dry conditions and the fact that almost the entire site was burnt during separate incidences mid-2001 and early 2002. CALM (Karratha) advised that a fauna trapping survey was not required at this time.

5.2.2.2 Fauna habitats

Six main fauna habitats, based on topography and vegetation types, have been identified on the GTL lease. The distribution of these habitats is presented in Figure 9 and a description is provided below:

Habitat 1. Ridges and hillocks with rockpiles and outcropping rock
Occurs in the south-west corner of the lease and along the southern boundary of the lease. It accounts for only a small area of the lease but the rockpiles and pockets of vegetation, which afford shade and moisture, provide valuable habitat. It is vegetated with pockets of tree and shrub species, which generally provide dense foliar cover and therefore shade, over open *Cymbopogon ambiguus* and *Triodia epactia* grasses.

Habitat 2. Stony hill slopes with small outcropping rockpiles
This habitat occurs at the toe of the high rocky hills and ridges on the southern side of the lease. (The higher portion of this occurs as Habitat 1). This area only accounts for a small proportion of the lease but the variation of vegetation strata within it provides a wide range of habitat. Low tree species occur on the isolated rockpiles, while mixed shrubs provide an open

canopy cover over most of the area. Beneath this is a low level shrub cover that is dense and forms a heath in areas, over mid-dense hummock grassland. The slopes are dissected by shallow drainage lines, which typically contain areas of denser vegetation.

Habitat 3. Lower, gently undulating stony slopes
The lower, gently undulating stony slopes are vegetated with scattered *Corymbia hamersleyana* trees over mixed shrubs over hummock grass. The broad shallow drainage lines that dissect the slopes are more densely vegetated with woodland of *Corymbia hamersleyana* over mixed shrubs over hummock grass.

Habitat 4: Very gently sloping stony plain with dense mantle boulders, rocks and stones
The plant footprint is located on a considerable portion of the very gently sloping stony plain that occupies much of the lease area. It is predominantly vegetated with tall *Acacia bivenosa* and *A. colei* over hummock grass, but also includes areas dominated by the low shrub *Senna oligophylla* or hummock grass alone (see Plate 5). It is within this relatively open stony habitat type that mounds of the Pebble-mound Mouse are found in abundance.

Habitat 5. Broad drainage zone
A broad shallow drainage zone that supports a woodland of *Corymbia hamerselyana* occurs in the south-eastern corner of the lease. The habitat intercepts only a small area of the lease itself (occupies approximately 5% of the total lease area), but it is a significantly large habitat extending to the south-east. The woodland is regarded as important habitat, occurring relatively infrequently, in terms of total landmass, on the Burrup Peninsula.

Habitat 6. Drainage lines
The lease area is criss-crossed with drain lines of varying depth, width and vegetation. These include two major areas, woodland and shrubland-lined drainage lines. Two significant drainage lines dissect the lease.

6a Woodland lined Drainage Lines
The first of these is a narrow but deep *Eucalyptus victrix* drainage line that runs from the south, through the centre of the lease, towards Withnell Bay. The smaller inflowing tributaries associated with this drainage line contain a woodland of *Corymbia hamersleyana*. A rocky pool area, located further downstream near the northern boundary of the lease (see Figure 1), is flanked by *Terminalia canescens*. The fact that this pool has significant layers of calcrete deposited around its edges, and contains a population of sedges (*Cyperus vaginatus)*, indicates that water is retained in this area for some time after rains. The deep consolidated stony walls of this drainage line, towards the northern half of the lease, also indicates that this is an important water flowline for the area.

The second major drainage system is a broad shallow drainage line that enters the south-east of the site and flows towards the north-west. It consists of another woodland habitat, dominated by *Corymbia hamersleyana*, with tall shrub species over hummock grass.

6b Shrubland lined drainage lines.
Minor drainlines dissect the site dominated by *Acacia bivenosa, A. colei* or *A. inaequilatera* over hummock grasses.

Four of the fauna habitats found on the lease area are well represented on the Burrup Peninsula. The stony plain habitat (4) that occupies the majority of the lease area, however, and the smaller area of broad drainage zone (habitat 5) that intersects this habitat, are not common in conservation areas on the Burrup Peninsula (V. Long, Astron, pers. obs.). The attributes that typify habitat 4 (ie. relatively flat, open, wide expanse) are the very

characteristics that make these areas suitable for industrial development. Habitats 2, 3 and 4 occupy much of the GTL lease area and most of the proposed plant will be constructed over habitat type 4 (see Figure 1).

5.2.2.3 Mammals

Recent surveys and published distributions indicate that a total of 42 species of mammal may inhabit the Burrup Peninsula (Strahan 1998; Butler 1994; Butler & Butler 1987; Astron 1998; 1999a, 1999b). These consist of a single monotreme (Echidna), seven dasyurid marsupials (Dunnarts, Quolls), three macropods (Wallabies), 17 species of bats from six families, nine Murids (native rodents) and five introduced mammals. Of these 42 species, 23 species have been recorded from the immediate area surrounding the proposed development site (Butler 1994, Butler & Butler 1987).

Those mammals most likely to inhabit the extensive rockpile areas that occur within and adjacent to the southern boundary of the lease include nomadic species, such as the Common Wallaroo (*Macropus robustus*) and Red Kangaroo (*M. rufus*), and those species with specific rockpile habitat preference. These include the Common Rock Rat (*Zyzomys argurus*), the Common Planigale (*Planigale maculata*), Rothschild's Rock-wallaby (*Petrogale rothschildi*) and the Northern Quoll (*Dasyurus hallucatus*). The rockpiles, and their proximity to available water [i.e. from the rock pool found in close vicinity to the northern boundary and in the deep rocky gully approximately 125 m south of the lease area (Figure 1)], also provide suitable habitat for a number of bat species.

The lower slopes, vegetated with shrub species over hummock grasses, also provide suitable habitat for species such as Little Red Kaluta (*Dasykaluta rosamondae*), Stripe-faced Dunnart (*Sminthopsis macroura*) and Delicate Mouse (*Pseudomys delicatulus*). The Western Pebble Mound Mouse (*Pseudomys chapmani*) has been recorded on the Burrup Peninsula, but only from distinct mounds formed at the mouth of their nesting burrows. To date, no live *P. chapmani* have been captured. It is unlikely that any live individuals are still present on the Burrup, however the secretive nature of many marsupial mice may preclude them from all but the most rigorous survey, grossly underestimating their actual abundance. Major creeklines can also provide habitat for the Water-rat (*Hydromys chrysogaster*), as recorded previously on the Burrup.

5.2.2.4 Birds

The largest vertebrate group represented on the Burrup Peninsula is birds, with 165 species from 53 families likely to inhabit or visit the region. Of these, 127 species of bird have been observed on the Burrup Peninsula during recent field surveys (Astron 2002). None of these species are scarce or endemic to the Burrup Peninsula. The families, which make the greatest contribution to species richness, are the Scolopacidae (waders - 17 species), Laridae (gulls and terns - eight species), Columbidae (pigeons and Doves - seven species), Meliphagidae (honeyeaters - seven species), and Accipitridae (kites, goshawks, eagles and harriers – 11 species). There are a number of important differences in the diversity of and type of birds occupying or visiting the Burrup Peninsula. First, there are no species endemic to the Burrup Peninsula; all birds recorded or purported to occur in the area occur elsewhere in the Pilbara. Second, the lower species diversity is in part accounted for by the limited range of habitats available compared with the Pilbara as a whole. For example the Burrup has no extensive open fresh water, has only a limited area of natural mangal, and few extensive stands of natural woodland.

Twenty-nine birds likely to be found on the Burrup Peninsula are currently listed under international migratory bird agreements. The majority of these species are waders (shorebirds) and seabirds that are unlikely to utilise the habitats that occur on the GTL lease.

5.2.2.5 Reptiles

Eighty-five terrestrial reptile species including 26 skinks, 15 geckos, 14 land snakes, eight dragon lizards, eight monitor lizards, six legless lizards and three blind snakes, have been recorded from the Burrup Peninsula. There are also representatives from other families, including two species of tree frogs, a single species of water snake and at least three species of sea snake. A number of these reptile species are endemic to the Pilbara region, including the gecko species *Diplodactylus mitchelli* (Mitchell's Gecko) and *D. savagei*, the varanid *Varanus pilbarensis* (Pilbara Monitor), the skink species *Lerista quadrivincula* and *Egernia pilbarensis*, the death-adder *Acanthophis wellsi* and the python *Liasis olivaceus barroni* (Pilbara Olive Python).

5.2.2.6 Invertebrate fauna

Recent taxonomic developments have identified the Burrup Peninsula as having a unique land snail fauna. Of the six species of land snails recovered from the Burrup, three species are known to inhabit areas of rock piles (Astron 2002).

A survey for land snails in the GTL lease was undertaken in February 2002 by Dr Fred Wells (see Appendix F). Three east-west transects were made through the middle of the lease area, and in the northeast and southwest corners of the lease. Each transect was sampled at 100 m intervals for large species of land snails; samples of leaf litter and debris were collected where they were present at a site. Additional samples were made both within and outside the lease at areas considered likely to have land snails; a total of 32 sites were made. At least 5 km was walked when sampling the transects. During the walks searches were made for land snails not collected at the sample stations, but none was found. A search was also conducted of the Museum computerised land snail database for land snail records from the area.

Three species of land snails belonging to two families were collected during the study: *Rhagada* sp. in the family Camaenidae and *Pupoides beltianus* (Tate, 1894) and *P. contrarius* (E.A. Smith, 1894) in the family Pupillidae. None of these species is considered to be rare or endangered. All three have been found widely in other surveys conducted on the Burrup Peninsula. They are known to also occur in other areas. *Rhagada* sp. apparently has the most restricted range, being limited to the Dampier region, but also occurs from south of King Bay up the Burrup Peninsula.

5.2.2.7 Significant species

Four species formally identified as having conservation significance (i.e. protected by legislation and/or CALM Reserve listing) may potentially occur within the GTL lease area. Details on each of these species are presented in Table 5.2.

Table 5.2 Significant Species that may Occur Within the GTL Lease

Species	Comment
Mammals	
Hydromys chrysogaster (Water Rat)	Priority 4 CALM Priority List Prefers freshwater rivers but is known to inhabit marine and estuarine environments. (Strahan 1998). This species has been recorded on the Burrup Peninsula. May be present along water courses or in mangrove systems.
Pseudomys chapmani (Western Pebble-mound Mouse)	Priority 4 CALM Priority List Prefers hummock grass lower stony slopes, where pebbles of a size manageable by them are found. Have only been recorded on the Burrup Peninsula from distinct mounds formed at the mouth of their nesting burrow, with no specimen from the Burrup ever being vouchered and lodged in the WA Museum (Nora Cooper pers. comm.). Twenty-three nests were recorded on the GTL site. All were assessed as being vacant (as per Anstee 1996). Although it is unlikely that any live individuals are still present on the Burrup, the secretive nature of many marsupial mice generally precludes them from all but the most rigorous survey, leading to a gross underestimation of their actual abundance.
Reptiles	
Liasis olivaceus barroni (Pilbara Olive Python)	Schedule 1 Wildlife Conservation Act. Vulnerable under the *EPBC Act*. The Pilbara Olive Python is a very large (<6.5 m) nocturnal python, which is restricted to the Pilbara region. It is often associated with rockpiles around permanent water pools and is know to exist near seasonal creeks. Known from the Burrup and may occur in or near the project area, particularly in the major rock piles to the south of the lease and near the semi-permanent pool north of the lease. All populations of the Pilbara Olive Python are under threat of extinction.
Notoscincus butleri	Priority 4 CALM Priority List Usually found in hummock grasslands on stony or sandy ground. A relatively poorly known species, *N. butleri* was recently collected on the northern side of Hearson Cove – King Bay axis area of the Burrup Peninsula (Biota 2001). It is likely to occur in the Project Area and could be impacted by habitat disturbance of the lower slope grasslands.

Other species of high conservation value (not formally recognised) that may occur in the lease area include:

- The two camaenid land snails *Rhagada sp.* and *Quistrachia legendrei*. For further information on the presence of land snails on the GTL lease, see Appendix F.

- Rothschild's Rock Wallaby (*Petrogale rothschildi*), which is known to inhabit rockpile areas of the Burrup Peninsula and may be present in the rockpile habitat in the south-western corner and along the southern boundary of the GTL lease. Although this species in not currently listed as a CALM Priority Species, a Rock Wallaby Protection Programme has been developed.

5.3 SOCIAL ENVIRONMENT

5.3.1 The Pilbara Region

The Pilbara region makes a significant contribution to Western Australia's economy by providing the overwhelming majority of the State's three largest exports - petroleum, natural gas and iron ore. The region is sparsely populated, with most large population centres occurring adjacent to major ports and mining areas. Within the Pilbara region there are four local government areas, including the Shire of Roebourne, Shire of Ashburton, East Pilbara Shire, and the Town of Port Hedland.

Aboriginal people have lived in the Pilbara region for more than 30,000 years resulting in a rich legacy of rock art and places of cultural significance.

5.3.1.1 Economic development

Mineral and Energy Resources
Mining in the Pilbara region dates back more than 100 years to the discovery of gold at several localities and with the proclamation of the Pilbara Goldfields in 1888. Exploration for iron ore in the Pilbara commenced during the 1960s subsequent to which many of the present day mines were discovered (e.g. Mt Tom Price in 1962 followed by Mt Whaleback, Pannawonica and Paraburdoo ore bodies). These discoveries resulted in the establishment of the townships of Goldsworthy, Newman, Tom Price, Paraburdoo and Pannawonica. Deep water ports were then established at Dampier, Port Hedland and Wickham (Cape Lambert) to export the iron ore.

During the 1960s, the region's prosperity escalated with approval to extract major iron ore deposits, resulting in the establishment of the town of Dampier to accommodate mine employees. Australia's largest salt producer, Dampier Salt, commenced operations in Dampier in 1971, subsequently expanding to incorporate over 9,000 ha of salt pans and producing over 2.4 Mtpa of salt.

Since the 1980s, further iron ore mining projects have been initiated including Jimblebar, Channar, Marillana Creek, Marandoo and Brookman No. 2 Detritals and Yandicoogina. The Pilbara also experienced the first mine and town closures at Mt Goldsworthy and Goldsworthy/Shay Gap, respectively. Other commodities have also been discovered and developed including gold, copper and manganese especially in the East Pilbara region.

Petroleum exploration on the North West Shelf, off the coast of Dampier, has been ongoing for many years resulting in the NWSVP, Australia's largest resource development. The project is currently based on the offshore North Rankin, Goodwyn, Perseus, Wanaea, Cossack, Lambert and Hermes Fields. The associated domestic gas treatment, condensate, LNG and LPG plants, operated by Woodside, are situated at Withnell Bay adjacent to the GTL lease.

These operations commenced with the construction of Domestic Gas processing facilities in 1983. An LNG plant, with two production trains, commenced operation in 1989 and a third train came on-stream in 1993. Expansion of the plant to bring train four into operation, as well as a second trunkline onshore to supply the Onshore Gas Plant, began in 2001. In conjunction with the planned expansion, a 520 bed accommodation village has been established for the construction workforce in Karratha and refurbishment of the company's existing Karratha housing is ongoing. Construction and commissioning of train four is expected to be complete by the fourth quarter of 2004.

The Port of Dampier is recognised as one of the most important industrial ports in Australia. Industries such as the NWSVP, Hamersley Iron and Dampier Salt contribute approximately 20% of Western Australia's total export earnings and make Dampier the largest tonnage port in Australia.

The resource industry in Karratha accounts for 25% of the State's total export earnings, making Karratha the most economically significant area of the Pilbara region (WA Planning Commission 1998). Petroleum has emerged as Western Australia's biggest resource industry accounting for 39% of the State's earnings from resources development in 2000 (Department

of Resources Development 2001). The GTL project represents one of a number of proposals to develop value-adding downstream processing facilities from the utilisation of the significant gas reserves of the North West Shelf.

Other downstream processing proposals in the region, all proposed for King Bay-Hearson Cove Industrial Area (Figure 1), include:

- Gas to Synthetic Hydrocarbons Plant (Syntroleum Sweetwater LLC);
- Ammonia/Urea Plant [Dampier Nitrogen (formerly Plenty River Corporation Ltd)];
- Ammonia Plant (Burrup Fertilisers Pty Ltd);
- Dimethyl-ether plant (Mitsubishi Gas); and
- Methanol plant (Methanex).

Tourism

Tourism is not a major contributor to the region's economy but provides the necessary facilities for both holiday and business travel. Major attractions in the region include the gorge at Karijini National Park, the oasis at Millstream and the historic settlements of Marble Bar and Cossack. The region's coastline, the islands of Dampier Archipelago and off Onslow are also popular for aquatic activities. Dampier and Karratha are popular destinations for tourists and other travellers, due to the spectacular terrain, offshore islands, recreational fishing, large mining and petroleum projects and aboriginal heritage and rock art on the Burrup Peninsula.

The Western Australian Tourism Commission has a number of ongoing initiatives to expand and promote tourism in the Pilbara especially industry-related tourism. In recent years tourists have been encouraged to visit several of the industries in the area, which have tourist viewing stands and facilities. The NWSVP has generated considerable tourism interest and is a major attraction of Karratha and the Burrup Peninsula. It is also possible to visit and inspect the Dampier Port facilities.

5.3.1.2 Population characteristics

The Australian Bureau of Statistics (ABS) 2001 Census of Population and Housing (2002a), found the Pilbara's population to be 42,742. This accounts for 2.3% of the State's total population. The Shire of Roebourne has a population of 15,974. The Basic Community Profile and Snapshot population data for the Shires and Towns of the Pilbara region are presented in Table 5.3

Table 5.3 Population of the Shires and Towns in the Pilbara Region

Shire/Town	1996	2001
Ashburton	8,783	6,888
East Pilbara	7,945	6,786
Port Hedland	13,116	13,099
Roebourne	14,954	15,974
TOTAL	**44,798**	**42,747**

Source: ABS (2002a, 2002b)

5.3.2 Shire of Roebourne – Karratha and Dampier

The proposed GTL plant is located within the Shire of Roebourne and, as such, socio-economic factors associated with the proposal are most pertinent to the townships of Karratha and Dampier, as the nearest population centres to the plant. The regional population of this area was 14,954 in 1996, with Karratha being the largest population centre contributing almost 70% of the population. Due to possible future industrial developments in the region, the population of Karratha is expected to increase significantly. Other towns within the Shire are Roebourne, Wickham and Point Samson. The socio-economic attributes of Karratha and Dampier are discussed further below.

5.3.2.1 Karratha

Karratha is located about 14 km south of the proposed GTL plant and was established in the late 1960s to act as a regional centre for the expansion of Hamersley Iron and Dampier Salt operations (Pilbara Development Commission 1995; WA Planning Commission 1998). In recent times the community has expanded due to the need to accommodate the workforce of the NWSVP. Karratha became the administrative centre for the Shire of Roebourne in 1978.

5.3.2.2 Dampier

Dampier is located approximately 10 km to the south-west of the proposed GTL plant. Dampier was built in 1966 by Hamersley Iron to accommodate employees of the company's operations and their families (Pilbara Development Commission 1995). The town is today managed by the Shire of Roebourne, however the Hamersley Iron Special Agreement lease allows the company to possess decision making powers on issues affecting the town. It is predicted that the population of Dampier will increase and the importance of the area for tourism will grow.

5.3.2.3 Community infrastructure

The community of Karratha has access to a wide range of modern infrastructure. Karratha airport, 14 km from Karratha and 8 km from Dampier, provides the major air facilities for the region.

A range of public infrastructure is available including a modern shopping centre, district hospital, light industrial area, educational facilities that include two high schools and a tertiary college, cultural and sporting facilities, tourist accommodation and various social and tourist facilities, state emergency service facilities, and well developed urban infrastructure.

5.3.3 Tenure and Zoning

The proposed GTL lease is currently undeveloped vacant crown land located within the Withnell East Industrial Policy Area which is earmarked for strategic industrial use in accordance with the *Burrup Peninsula Land Use Plan and Management Strategy* (O'Brien Planning Consultants 1996) and the Shire of Roebourne *Town Planning Scheme.* As such the allocation of this area for strategic industrial use has been endorsed by the WA Government and reaffirmed through recent Ministerial position statements (Brown 2002). Methanol

product, seawater and return water pipelines will be located within designated infrastructure corridors under the jurisdiction of Landcorp or MPR.

The area of the proposed GTL project is currently in the process of being acquired by the Western Australian Government. Notices were issued under section 29 of the *Native Title Act 1993* by the State in January 2000. As a result the State has been negotiating with three claimant groups, which are the Ngarluma Injibarndi people, the Wong-Goo-Tt-Oo people and the Yaburara Mardudhunera people with the aim of reaching a negotiated agreement that would enable any native title rights and interests to be acquired. The Federal Court completed hearing evidence for the claims in 2001 and will decide the result of these claims later in 2002. The State will not be able to grant the proponent a lease for its plant site until the native title matters are resolved.

The proponent was not nominated as a grantee party for the purpose of the *Native Title Act 1993* procedures, meaning the State Government has primary responsibility for the conduct of negotiations with claimant groups. The proponent has agreed to assist the State with the negotiations and provide required project specific information. The proponent has held meetings with all three claimant groups and provided them with a briefing about the project. The outcomes of these consultations are detailed further in Section 7.5.3.

5.3.4 Recreational Values

The Burrup Peninsula consists of a number of protected coves which are utilised by the local community for recreational purposes such as swimming, fishing and boating. Withnell Bay, located approximately 750 m to the north and west of the GTL project lease, is the nearest recreational area, typically used by fishermen with 4WD vehicles to access other coastal areas further north along the Peninsula. Public access to Withnell Bay is difficult at present.

5.3.5 Heritage Values

The area proposed for the development of the project has been subject to a number of detailed Aboriginal heritage surveys. The first surveys were undertaken by the WA Museum in the 1970s in connection with the North West Shelf developments. Further surveys have been undertaken in more recent times in connection with the establishment of common user infrastructure corridors. GTL reviewed the previous survey work and commissioned specific surveys over the proposed plant site and an adjacent area required for infrastructure access.

An archaeological survey by Greenfield (2001) identified five rock engraving sites in the general vicinity of the proposed lease area. All of these sites had been located in previous surveys and were listed on the Aboriginal Sites Register of the Indigenous Affairs Department. None of the sites will be disturbed by the proposed project.

The Yaburara Mardudhunera claimant group participated in the Aboriginal heritage survey of the project area. The Wong-Goo-Tt-Oo and Ngarluma Injibarndi claimant groups initially advised the proponent that they are not prepared to undertake ethnographic surveys until native title negotiations are completed. One of these groups, the Ngarluma Injibarndi, have subsequently advised that they will undertake the survey and it is planned to be completed following the finalisation of the native title negotiations.

5.3.6 Register of the National Estate

A search of heritage places listed on the Register of the National Estate was undertaken in August 2002 at http://www.ahc.gov.au/register/index.html. The regions of Karratha, Dampier and the Burrup Peninsula were searched and revealed that eight places are registered under the National Estate (Table 5.4).

Table 5.4 Heritage Places Listed on the Register of the National Estate Within the Proximity of the Proposed GTL Site

Place Name	Location	Status
Coastal Islands Mary Anne to Regnard	Mardie	Registered
Coastal Margin Cape Preston to Cape Keraudren	Port Hedland	Indicative Place
Dampier Archipelago Marine Areas	Dampier	Indicative Place
Dampier Archipelago	Dampier	Registered
Indigenous Place (010087)	Dampier	Registered
Indigenous Place (010096)	Dampier	Registered
Indigenous Place (010097)	Dampier	Registered
Karratha Station Group	Karratha	Registered

The status of the heritage places are listed as either:

- Indicative Place: The data provided to or obtained by the Commission has been entered into the database, while the place is being assessed. The Australian Heritage Commission has not decided whether the place should be entered into the Register.

- Registered: The place is within the Register of the National Estate. Although some places may be legally registered because they are within a larger registered area, they may not necessarily possess intrinsic significance.

5.3.7 Conservation Values

The Burrup Peninsula contains areas of significant conservation value which were identified as requiring particular management in the *Burrup Peninsula Land Use and Management Strategy* (O'Brien 1996). Through this consultative process 62% of the Peninsula was allocated for conservation, heritage and recreation purposes. The proposed Dampier Archipelago Marine Park, which would be situated to the north and west of the Peninsula, is also an important area of conservation value.

The proponent is committed to a comprehensive Community Consultation Programme during the environmental assessment process and it recognises the importance of undertaking the majority of consultation prior to the finalisation of the PER so that environmental and social issues can be addressed. A summary of the methodologies employed and results to date are provided below.

6.1 STAGE 1: PRELIMINARY CONSULTATION

Preliminary consultation with key community stakeholders was undertaken in Karratha on 24-25 October 2001. The proponent held detailed discussions with the Shire of Roebourne, government agencies, community groups, business and local interest groups to provide information about the project, discuss the community consultation program, and seek input and exchange information on the proposed project:

Issues raised during these meetings were:

- effects on flora & fauna, particularly endangered fauna species;
- cumulative impacts of GTL water discharge via the proposed Water Corporation outfall on the marine environment;
- atmospheric and noise emissions, including cumulative impacts;
- community safety and risk from both the methanol plant and shipping;
- management of surface water run off to prevent contamination of the marine environment;
- the impact of contaminated runoff from the plant site on the tidal areas downstream of the plant site;
- the impact of the cooling water returned to King Bay by the proposed Water Corporation Plant;
- waste disposal;
- transport of plant modules and equipment to site during construction;
- construction and operational workforce accommodation;
- access to public recreational areas (e.g. Withnell Bay and Conzinc Bay);
- native title; and
- GTL power requirements and the impact on the North West power grid.

A complete report of the outcomes of the Stage 1 consultation is attached as Appendix K (Cognito 2001). The summary table contained within the Stage 1 report was sent to the stakeholders consulted as a record of the environmental issues discussed during the meetings and an offer to supply the full report (upon their request) was made to the stakeholders.

6.2 STAGE 2: BROAD COMMUNITY INFORMATION DISSEMINATION

The objective of this stage was to raise the broader community awareness, increase understanding of the project and encourage public involvement via the following mechanisms.

6.2.1 Media Releases

Information regarding the project was conveyed to the public by:

- radio interview on ABC Regional Radio (January 2002);
- newspaper articles in the West Australian and Financial Review (January-February 2002);
- front page article in the North West Telegraph which included information on the progress of the project, environmental aspects and the stakeholder consultation. The article included a photograph showing the relative visual impact of the plant and notification of a forthcoming shopping centre display; and
- relevant press clippings were distributed to possible stakeholders to indicate the progress of the project and environmental assessment work and to offer further information.

6.2.2 Websites

The Environmental Scoping Document, which supported the formal referral to the EPA, was made available on the GTL website and the local Pilbara internet provider site (Kisser).

6.2.3 Shopping Centre Display

A public display was established and manned at the Karratha City Shopping Centre from 7-10 February 2002. The display consisted of posters providing information on GTL, Project Outline, Environmental Studies, Workforce and Accommodation, Approvals and Consultation, Project and Assessment Schedule and how to access further information and be involved in the stakeholder consultation process. High quality maps and images were also presented showing the visual impact of the proposed plant (see Appendix J) from public viewpoints.

People visiting the display were encouraged to complete forms enabling them to provide written comments, request project information or express interest in employment related to the project. Analysis of the feedback and comments received at the shopping centre display are provided in Appendix L. In general, most interest was focused on employment opportunities followed by request for additional information on the project, then comments relating to environmental concerns.

6.2.4 Public Meeting

A public meeting was held in Karratha on 7 March 2002 to provide a full briefing on the project including the proposed stages of development, environmental impacts and the Environmental Impact Assessment process for this project. Personal invitations were posted to stakeholders and the meeting was also advertised in the local press. A series of information sheets were distributed to meeting attendees to provide details on the company, the product and its uses, project and operational details. Approximately 65 people attended the meeting. A summary of the pubic meeting which provides details of the attendees, information provided and issues raised (and responses provided) can be viewed in Appendix L.

6.3 STAGE 3: STRATEGIC CONSULTATION

The objective of this stage was to inform targeted (key) stakeholders and seek their views on the proposed plant, thereby assisting to identify any issues of concern not raised previously. This also provided an opportunity for the proponent to respond to the issues, supply further information etc, as appropriate.

Approximately 60 key stakeholders were identified as being either directly impacted by the proposal or having showed particular interest during Stages 1 and 2. The key stakeholders included corporate residents of the Burrup Peninsula, aboriginal and environmental groups, local politicians and certain government agencies. The document *Environmental Brief for Key Stakeholders* was sent to these stakeholders on 28 February 2002 to encourage their comments on the proposal. This document provided detailed information on the project and environmental aspects and was an updated version of the *Environmental Scoping Document* with the inclusion of current information on greenhouse gas emissions, project schedule and the scope of work required to address EPA environmental factors. A cover letter was enclosed within the report to:

- explain the EPS level of assessment process that was being pursued at that time;
- encourage recipients to review the Environmental Brief and submit comments to the proponent or DEP by 28 March 2002; and
- offer access to further information and consultation if required.

Ongoing consultation has occurred with those stakeholders who provided comments or were seeking additional information. Key stakeholders were also notified of the recent change in the level of assessment from an EPS to PER.

6.4 SUMMARY OF ISSUES RAISED FROM STAKEHOLDER AND COMMUNITY CONSULTATION

This section summarises the issues raised in submissions, either verbal or written, received from community members and other stakeholders during the three consultation phases. The following organisations and groups were consulted during the development of the PER:

- Aboriginal Claimant Groups, namely Ngarluma Injibarndi, Wong-Goo-Tt-Oo and Yaburara Madudhunera people;
- Australian Greenhouse Office;
- Chevron Australia;
- Conservation Council of Western Australia;
- Dampier Port Authority;
- Dampier Salt;
- Dampier Archipelago Preservation Association;
- Department of Conservation and Land Management, Karratha;
- Department of Environmental Protection (Perth and Karratha);
- Department of Indigenous Affairs;
- Department of Mineral and Petroleum Resources;
- Department of Planning and Infrastructure;
- Environment Australia;
- Epic Energy;
- Friends of the Burrup;
- Hammersley Iron;

- Karratha and Districts Chamber of Industry and Commerce;
- Karratha Visitors Centre;
- Mermaid Marine Australia;
- Main Roads Western Australia;
- Marine and Coastal Community Network;
- Nickol Bay Naturalists Club;
- Parliamentarians (Hon. Robin Chapple MLC, Hon. Barry Haase MHR, Hon. Norman Moore MLC, Hon. Fred Riebling MLA)
- Pilbara Development Commission;
- Shire of Roebourne;
- (Former) Water and Rivers Commission, Karratha;
- Water Corporation;
- Western Australian Tourism Commission;
- Western Power;
- Western Stevedores; and
- Woodside Energy Limited.

Issues raised by stakeholders during the development of this PER, and GTL's responses, are presented in Part III of Appendix L. These include questions and comments from detailed submissions provided by DEP, CALM (Pilbara) and Woodside. GTL will provide copies of the PER to key stakeholders and will continue consultation during the formal public review process to ensure that all issues have been addressed.

7.1 SYNOPSIS OF EFFECTS

Impacts of the GTL plant are likely to include:

Physical impacts

- Some 15 ha of relatively flat land on the Burrup Peninsula will be cleared and levelled;
- three small drainage lines will be disturbed;
- small volumes of atmospheric emissions of pollutants such as oxides of nitrogen (NO_x), carbon monoxide (CO) and particulates will be released;
- disposal of low volumes of wastewater containing some 50 tpa of nitrogen (as ammonia);
- disposal of low volumes of solid waste; and
- approximately 450,000 tpa of greenhouse gas emissions will be released.

Biological impacts

- Loss of 15 ha of regionally significant vegetation and potential disturbance to Priority/ Declared Rare Flora (DRF), however no individual flora species are likely to become extinct;
- potential habitat loss or modification for significant fauna species (this is minimised by avoiding the rocky hills to the south of the plant which is the preferred habitat for the Pilbara Olive Python);
- methanol spills at the Port could cause localised toxicity to marine life if they occur; and
- shipping may increase risk of introduced marine species, but this is considered to be manageable.

Social impacts

- Direct impact to sites of Aboriginal heritage significance will be avoided;
- improvement of the road to Withnell Bay for plant operation will increase access to the Bay and provide an alternative recreational beach area on the Burrup which may be accessed by non-4WD visitors;
- increased pressure on housing infrastructure and services in Karratha during construction period will occur;
- increase in Karratha population as a result of the 60 employees and family during plant operation;
- limited and acceptable risk to the public resulting from operation of the plant, pipeline, ship-loading and export of methanol;
- localised noise generation at plant site; and
- the plant will modify the present visual aesthetics and amenity values of the Withnell Bay area.

Further detail on the above effects is provided in Section 7.3.

7.2 ENVIRONMENTAL FACTORS CONSIDERED RELEVANT TO THIS PROPOSAL

Through discussions with the DEP and other stakeholders at an early stage of project assessment, and through subsequent correspondence with the DEP (refer Appendix A, Part I), it was determined that the following Environmental Factors apply to this project:

BIOPHYSICAL
- terrestrial flora
- terrestrial fauna
- marine ecology including sea floor, marine flora and fauna
- landform, drainage and site hydrology
- water quality

POLLUTION MANAGEMENT
- atmospheric emissions
- Greenhouse gases
- liquid and solid waste disposal
- non-chemical emissions, including noise and light

SOCIAL SURROUNDINGS
- risk to public health and safety
- road transport and traffic impacts
- culture and heritage
- visual amenity
- workforce accommodation
- recreational access

OTHER
- Environmental Management Plan

Further detail on the studies undertaken to assess the potential impact on each Environmental Factor are outlined in the following sections. The proposed management commitments to be employed by GTL to appropriately address those environmental factors are also described below. An Environmental and Safety Management System framework is included in Section 8.

7.3 BIOPHYSICAL ENVIRONMENT

7.3.1 Vegetation and Flora

EPA Objective
Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect flora listed in the Schedules of the *EPBC Act*. Protect other flora species of conservation significance.

Assessment
Astron Environmental was commissioned to provide an updated review of the status of the vegetation and flora on the GTL lease site based on the findings of the recently available Trudgen (2001, 2002) and Welker (2002) reports, supported by further dry season field work to confirm mapping of the vegetation types. The aim of this review was to place the vegetation and flora on the GTL lease into a regional perspective and enable the following assessment to be made with the best information currently available.

7.3.1.1 Regional significance of Burrup vegetation

In 2001, MPR commissioned M.E. Trudgen and Associates to undertake a Flora, Vegetation and Floristic Survey of the Burrup Peninsula and surrounding areas to improve the level of

knowledge of flora in the region, with the aim being to place the vegetation and flora of the core survey area (CSA) into a regional context by comparing the floristics of the CSA with areas on the adjoining mainland (Trudgen & Griffin 2001, Trudgen 2002).

Trudgen concluded that on a regional scale the conservation value of flora on the Burrup is high, based on a detailed floristic analysis highlighting a high level of dissimilarity between vegetation communities in the CSA and those sampled in other areas in the Fortescue Botanical District. On a sub-regional scale, the geographically restricted geology of the Burrup Peninsula was shown to not be represented on the Abydos or Onslow Coastal Plains, and a high level of species difference was also recorded. Thirty-nine species recorded for the CSA have been highlighted as having high conservation value. In essence, Trudgen considers many of the vegetation associations in the CSA are regionally unique, threatened (because of their low frequency of occurrence and small areal extent) and of national heritage value. He also indicates that many of the vegetation associations found in the areas zoned for industrial development are not well represented in the Burrup Conservation, Heritage and Recreation Area (CHRA).

Trudgen's report acknowledges a number of limitations related to frequency of sampling (once only), variable timing of sampling between different regions, and unevenness in distribution of sampling sites. The report however contains the following additional significant limitations:

(1) The survey did not sample coastal and saline habitats which occur over a large part of the King Bay Industrial Area, and the mapping provided is at broad formation scale only, and not at the same level of detail as for the rest of the CSA.

(2) The results of the survey and the vegetation map do not include rockpiles. Rockpile vegetation was not assessed for individual conservation purposes as was the remaining vegetation on the Burrup. This would seem to be a significant omission of the report in view of the fact that the Priority 1 species, *Terminalia supranitifolia* occurs most commonly on the rock piles and small rocky outcrops.

(3) The results nowhere indicate abundance of flora, in particular Priority Flora or flora listed as having high conservation status.

(4) The report does not indicate the number of samples taken in the major habitats.

(5) Time and cost restraints did not allow for checking of the final vegetation map. The map is detailed and although all measures were taken to ensure accuracy as far as possible, it is likely that some areas may be misrepresented. In saying this, however, the map is only intended as a guide and ground truthing should occur in each instance.

As a result of Trudgen's review, the validity of EPA's statement in 1995 (as described in EPA Bulletin 801, based on information provided by O'Brien Planning Consultants for the establishment of the Burrup Land Use Management Plan) that 'all vegetation communities on the Burrup Peninsula are represented in the northern area of the Peninsula', has been queried.

Welker Environmental Consultancy was subsequently engaged to undertake a high level review of Volume 2 of Trudgen's report, so as to provide advice in relation to areas of vegetation that may require special consideration by proponents of projects in the areas zoned for industrial development, to avoid impact to flora and vegetation of regional conservation significance.

In his report, Welker (2002) endeavours to place the Burrup study into context with other similar large botanical surveys produced recently in Western Australia, including the Southern Swan Coastal Plain (Gibson et al. 1996*)* and the Regional Forest Agreement (Mattiske & Havel 1998) studies, both undertaken in the south of the state. To do this, much of the report concentrated on trying to define terms relating to vegetation (such as "formation", "association", "community", "complex", etc.). Trudgen (2002) in his report (Volume 1) also attempts definition of these. In the light of this, Welker considers the conservation significance of communities, Threatened Ecological Communities (TECs) and the EPA's current position on these. Welker then discusses the approach, methods, limitations, other considerations and the flora and floristic communities of the Trudgen & Griffin (2001) Report (Vol 2). Using topographic units presented in O'Brien (1994), and the assumption that there is a strong correlation between terrain and floristic community types as defined by PATN, Welker calculates how much of the broad habitat types (which roughly co-relate to the 50-group level of vegetation) on the Burrup are represented in the CHRA.

Welker (2002) concludes that, based on a 50-group level of floristic analysis, all major vegetation communities remain represented in the northern conservation zone of the peninsula as defined by vegetation associations, i.e. the original EPA statement appears to remain valid using this approach. This conclusion has been queried, for a number of reasons, by Long in Appendix H of this report. It has been argued by Welker that the alternative approach of using a 200-group classification system of vegetation communities is too detailed and is inconsistent with previous definitions of associations (e.g. Blackwell & Cala 1979) providing the basis of EPA direction for EIA vegetation studies on the Burrup to date. Welker also concludes that while new TECs may well be listed from the Trudgen study according to the 200-group level scale, it is likely that CALM would require more survey work before defining floristic communities as "threatened" on the basis of this work.

In his assessment of the regional significance of the vegetation communities of the Burrup, Welker confirms that the vegetation is not typical of the mainland vegetation adjacent to the Burrup, and as such it is of conservation significance. He goes on ... "Although much of the flora of the Burrup is common to the mainland (about 87% of species), the floristic composition of vegetation communities is quite different, influenced by the presence of a "Kimberley" floristic element"… "Therefore, the Burrup may be considered as a subregion of its own. Any major reduction in the representation of floristic communities on the Burrup at the 50-group level locally may be considered significant at the subregional level".

As noted by Welker (2002), a range of factors need to be considered in determining the environmental significance of vegetation communities during the EIA process, other than variation in floristics, including:

- presence of Rare, Priority and uncommon flora;
- whether it is a habitat for significant fauna;
- other ecological functions;
- occurrence;
- condition; and
- rate of vegetation changes with distance.

The role of vegetation communities as habitat for fauna and other ecological functions is of particular significance. In this respect the vegetation of rockpile landforms on the Burrup Peninsula, shown to demonstrate a unique floristic composition and important habitat for fauna in the area, is regarded as clearly significant.

Welker (2002) also provides the following advice to potential developers of industrial projects:

"Special attention to vegetation in areas zoned for industrial development is particularly important if the development will potentially:

- disturb Declared Rare or Priority Flora, or a TEC;
- cause a significant decrease in the representation of a vegetation community in a regional context;
- cause the loss of a vegetation community or significant decrease in the numbers of significant flora locally (i.e., within the Burrup)."

It should be noted that Trudgen's Assessment of Rarity, detailed in Volume 1 of the Burrup study (Trudgen 2002), summarised in Appendix D in this report, should also be considered when determining the significance of vegetation communities during the EIA process. This volume was not assessed by Welker.

7.3.1.2 Conservation significance of vegetation on the GTL lease

Given the above understanding and advice, Astron has endeavoured to determine the conservation significance of the vegetation on the GTL plant site based on interpretation of Trudgen's data and maps. Ten vegetation types consisting of 16 distinct vegetation associations have been identified by Trudgen as occurring within the GTL lease area. These are described in Table 7.1 below.

The Burrup vegetation survey resulted in the production of a map indicating the frequency of vegetation occurrences on the Peninsula. The conservation value and rarity of vegetation communities can be assessed by considering the frequency of occurrence and whether or not the vegetation is represented in areas of the Burrup that will remain protected from development. A portion of this map which presents the frequency of occurrence of vegetation units within the WEIA and surrounds is provided in Figure 10.

According to Trudgen's frequency map, and Welker's comments regarding associations that are restricted locally and located in areas zoned for industrial development, it is apparent that there are six associations that will require special attention. Vegetation associations that occur within the GTL lease considered to have high to extremely high conservation value based on frequency are presented in Table 7.2 and Figure 10.

As Trudgen (2002) points out, the area of a vegetation type or community is of importance because smaller areas are more likely to be eliminated by man-made disturbance. The original area and the proportion of vegetation that is to be disturbed by industry on the Burrup needs to be known so that the significance of communities can be assessed. To facilitate this assessment the distribution of the major vegetation types as mapped by Trudgen (Figure 11) has been used as the basis for calculations of area occupied by various vegetation complexes within the GTL plant site, lease area, and in the WEIA.

Using Trudgen's (2002) map, the area of vegetation types on the Burrup Peninsula can be determined. Such an exercise allows comparison of areas of vegetation in zones set aside for conservation and industry. To this effect, areas of vegetation types mapped by Trudgen (2002) in the GTL lease have been determined and compared with areas of vegetation types in the WEIA (refer Figure 11) and the zone of the Burrup Peninsula reserved for conservation.

These areas have been summarised in Table 7.3. Useful ratios determined from the areas in Table 7.3 are included in Table 7.4.

Table 7.1 Vegetation Units on the GTL lease identified by Trudgen

Vegetation Type	Code	Unit Description
Rock outcrop vegetation	**R**	Rock outcrop, including rock pocket vegetation
Eucalyptus victrix scattered low trees, low open woodlands and low woodlands	**EvTr**	Scattered low trees of *Eucalyptus victrix* over *Tephrosia rosea* var. *clementii* low open shrubland over *Triodia epactia* (Burrup form), *Triodia angusta* (Burrup form) medium dense hummock grassland
	EvTeCv	*Eucalyptus victrix, Terminalia canescens* low woodland over *Dichrostachys spicata, Scaevola spinescens* (narrow form) scattered open shrubland over *Cyperus vaginatus, Cyperus bifax, Triodia epactia* (Burrup form) sedgeland/hummock grassland with *Sesbania cannabina* annual herbs
Corymbia hamersleyana scattered low trees to low woodlands	**ChDs**	*Corymbia hamersleyana* scattered low trees to low woodland over *Dichrostachys spicata* open shrubland to open heath over *Triodia epactia* (Burrup form), *Triodia wiseana* (Burrup form), *Triodia angusta* (Burrup form) hummock grassland
	ChAbTa	*Corymbia hamersleyana* low open woodland to low woodland over *Acacia bivenosa* scattered tall shrubs to shrubland over *Indigofera monophylla* (Burrup form) scattered low shrubs to low open shrubland over *Triodia angusta* (Burrup form), *Triodia epactia* (Burrup form) hummock grassland
	ChCwIm	*Corymbia hamersleyana* scattered low trees to low open shrubland over *Grevillea pyramidalis* subsp. *pyramidalis* scattered tall shrubs over *Indigofera monophylla* (Burrup form), *Corchorus walcottii* low open heath over *Triodia epactia* (Burrup form) hummock grassland
Terminalia canescens scattered low trees to low forest	**TcDsDa**	*Terminalia canescens* low open woodland to low closed forest over (*Dichrostachys spicata, Flueggia virosa* subsp. *melanthesoides*) high open shrubland to shrubland over *Dicliptera armata* annual herbland
Grevillea pyramidalis subsp. *pyramidalis* scattered shrubs to high shrublands	**GpImTe**	*Grevillea pyramidalis* subsp. *pyramidalis, Acacia colei* open shrubland over *Indigofera monophylla* (Burrup form) low open shrubland over *Triodia epactia* (Burrup form) hummock grassland
Acacia inaequilatera (with various other species) scattered shrubs to high shrublands	**AiImTw**	*Acacia inaequilatera,* (*Acacia colei*) scattered tall shrubs to tall open shrubland over *Indigofera monophylla* (Burrup form) low open shrubland to low shrubland over *Triodia wiseana* (Burrup form) *Triodia epactia* (Burrup form) hummock grassland
Acacia colei (with various other species) scattered shrubs to high shrublands	**AcCaTe**	*Acacia colei, Cullen pustulatum* high open shrubland over *Indigofera monophylla* (Burrup form) *Triumfetta appendiculata* (Burrup form) low shrubland with *Cymbopogon ambiguus, Triodia epactia* (Burrup form) tussock/hummock grassland
	AcImTe	*Acacia colei, Acacia elacantha* high open shrubland over *Grevillea Pyramidalis* subsp. *pyramidalis* scattered shrubs over *Indigofera monophylla* (Burrup form) scattered low shrub to low open shrubland over *Triodia epactia* (Burrup form*), Triodia wiseana* (Burrup form) hummock grassland
Acacia bivenosa (with various other species) scattered shrubs to high shrublands	**AbTw**	*Acacia bivenosa* high open shrubland over *Triodia wiseana* (Burrup form) hummock grassland
	AbCwTe	*Acacia bivenosa* scattered tall shrubs to high open shrubland over *Indigofera monophylla* (Burrup form),*Corchorus walcottii* scattered low shrubs over *Triodia epactia* (Burrup form) hummock grassland
Indigofera monophylla (Burrup form) scattered low open shrubs to shrubland	**ImTrTe**	*Indigofera monophylla* (Burrup form), *Tephrosia rosea* var. *clementii* low shrubland over *Triodia epactia* (Burrup form) hummock grassland

Table 7.2 Vegetation Associations within the GTL Lease Considered to Have Moderate to Extremely High Conservation Value Based on Frequency.

Vegetation Code	Frequency On Burrup	Location* (IA or CHRA)	Conservation Rating
EvTeCv	2-4 (2 actual)	None in CHRA. Both are within WEIA*. One overlaps south-eastern corner of GTL lease. Does not fall under plant footprint.	Extremely High
TrTe(Ta)	10-24 (13 actual)	One only in CHRA. Ten in WEIA, two in Conzinc South IA. Does not fall under plant footprint.	Very High
ChCwIm	10-24 (11 actual)	Six in CHRA. Five in WEIA of which four are in GTL lease. All four are under the plant footprint. Larger area in WEIA than in CHRA.	Very High
AbTw	10-24 (12 actual)	Four in CHRA east of Conzinc Bay. Eight in WEIA, three of which are in GTL lease. One of the three falls under plant footprint.	High
EvTr	10-24 (9 actual)	Five in CHRA. Two in WEIA and two in Burrup West IA. One under plant footprint	High
GpImTe	10-24 (17 actual)	Ten in CHRA. Four in WEIA. Three in Burrup West IA. Two under plant footprint.	Moderate

Notes: * IA = Industrial Area
CHRA = Conservation Heritage Recreational Area
EIA = Withnell East Industrial Area

Table 7.3 Areas of GTL Vegetation Types on the Burrup Peninsula

Vegetation Type or Topographic Unit	GTL Plant Area (m^2)	GTL Lease Area (m^2)	WEIA Area (m^2)	CHRA Area (m^2)	WEIA + CHRA Area (m^2)
AbCwTe	0	52930	57076	33119	90195
AbTw	2771	7489	53434	493304	546738
AcImTe	55350	92973	396904	4269723	4666627
AiImTw	2974	25026	137234	154550	291784
ChAbTa	1468	40274	56174	762088	818262
ChCwIm	8760	9502	36277	18063	54340
ChDs	2354	8545	16000	322073	338073
EvTaCv	526	2153	111326	594131	705457
EvTeCv	0	4458	11440	10080	21520
EvTr	7409	7413	11042	130172	141214
GpImTe	14038	27627	44382	91006	135388
ImTeAc	0	12427	25025	1418580	1443605
R	0	2472	100568	17165878	17266446
TcDsDa	0	1013	9111	217645	226756
TrTe(Ta)	0	26584	72869	7324	80193
Tw	5679	40560	98921	583063	681984
Σ	**101329**	**361446**	**1237783**	**26270799**	**27508582**
Total Vegetation*	**101329**	**358974**	**1137215**	**9104921**	**10242136**

Notes: WEIA = Withnell East Industrial Area
CHRA = Conservation, Heritage and Recreation Area
* = Rock outcrops excluded

Table 7.4 Selected Area Ratios for Vegetation on the GTL Lease

Topographic Unit	Plantsite Area / Lease Area (%)	Plantsite Area / WEIA (%)	WEIA / WEIA + CHRA (%)
AbCwTe	0	0	63.3
AbTw	37	5.2	9.8
AcImTe	59.5	13.9	8.5
AiImTw	11.9	2.2	47.0
ChAbTa	3.6	2.6	6.9
ChCwIm	92.2	24.1	66.8
ChDs	27.5	14.7	47.3
EvTaCv	24.4	0.5	15.8
EvTeCv	0	0	53.2
EvTr	99.9	67.1	7.8
GpImTe	50.8	31.6	32.8
ImTeAc	0	0	1.7
R	0	0	0.6
TcDsDa	0	0	4.0
TrTe(Ta)	0	0	90.9
Tw	14	5.7	14.5

Notes:
WEIA = Withnell East Industrial Area
CHRA = Conservation, Heritage and Recreation Area

7.3.1.3 GTL site mapping limitations and implications on impact assessment

As previously indicated, one of the limitations of using the Trudgen mapping is that it has not been checked on the ground and therefore some inaccuracies may occur. Ground truthing of the GTL site found some discrepancy between what was mapped for the Trudgen Burrup Survey and what actually occurs on the site. Vegetation associations described as EvTeCv, AbTw, TrTe(Ta) and AbCwTe on the Trudgen Burrup Survey maps were found to vary with what occurs on the site.

Evaluation of vegetation based on frequency is therefore somewhat complicated in the case of the GTL site. It may be the case that some of the associations to be impacted by the GTL plant, according to Trudgen, may in fact be less threatened than is apparent. For example, the ChCwIm type would apparently be a threatened association if the Trudgen mapping was accurate. In this instance, it is not and ground truthing indicates that there is actually less of this association on the GTL lease than is shown in Trudgen's mapping.

In conclusion, it is currently difficult to reliably determine the significance of impacts from the GTL plant on vegetation communities as the available Burrup mapping would appear to be questionable for the WEIA, including the GTL lease. These limitations are further compounded by the lack of wet season vegetation data due to the drought conditions that have prevailed in the areas over the last 12-18 months.

7.3.1.4 Threatened vegetation communities

As part of their updated review of the status of the vegetation and flora on the GTL site (Appendix D, Part II), Astron Environmental has attempted to develop the above assessment

further by proposing an appropriate definition for "threatened vegetation" on the Burrup and assessing the disturbance to such vegetation from the project. This is done in the absence of any determination by CALM on the status of TECs on the Burrup Peninsula.

Trudgen defines a community as threatened if less than 600 ha (of an original 2,000 ha or more) remains. None of the Burrup communities found to date total more than this area. Therefore, based on area alone and on this definition, all Burrup vegetation is rare and much is threatened. In an effort to distinguish between these relatively small vegetation types and due also to the lack of an agreed definition as to a basic vegetation unit in any case, Astron has trialled an alternative assessment for “threatened vegetation” which is more appropriate to the ecology of the Burrup. In determining acceptable remaining proportions, the 30% threshold as noted in Trudgen (2002) and recommended by the World Conservation Union (IUCN) was used. This, however, generally reduces the area minimum dramatically. The choice of area thresholds is purely arbitrary: they result from no assessment of survivability or research of any kind and must be treated with caution.

The alternative assessment is based on the following definitions:

“Threatened” vegetation is that which has been so degraded that its survival is endangered.

“Critically endangered” vegetation is that for which survival is questionable. **The “critical” values below are included in brackets**, and have been nominally taken as 30% of the “threatened” values.

Threatened (**critically endangered**) vegetation is that for which:

- the proportion of that in the WEIA area as a proportion of that in the CHRA zone and the WEIA together is greater than 70% (**90%**)
  This proportion is relevant because it is possible – even likely – that the entire WEIA will be disturbed, leaving only that protected in the CHRA.

- the area of a vegetation type conserved in the conservation zone is less than 10 ha (**3 ha**).
  This is one sixtieth of the more commonly accepted values and is, realistically, an absolute minimum.

- the proportion destroyed by the GTL plant alone is over 10% (**30%**).
  Unlike that within the lease itself, the vegetation within the plant boundary will be totally destroyed. Some conservatism is therefore in order. The ratio has been determined based on the fact that three projects could occur in the WEIA Zone, tripling the destroyed area.

The Trudgen vegetation types that are considered threatened on the basis of the definitions above are presented in Table 7.5.

On application of the alternative (more appropriate) "threatened community" assessment to Trudgen's Burrup Survey mapping, five of the vegetation types on the GTL lease are considered threatened. Three of these will not be impacted by the plant itself, so are subject only to secondary impacts. Of the remaining two types, one (ChCwIm) will be reduced by approximately 16% and the other (GpImTe) reduced by approximately 10% from direct impact. One of these (ChCwIm) is critically limited in its area based on the Trudgen mapping (2002), however it has been noted earlier (in Section 7.3.1.3) that the Trudgen mapping of this type on the GTL lease area was not accurate.

Table 7.5 Threatened Communities

Vegetation Type	Proportion of Total[1] in WEIA[2]	Area Retained in CHRA[3] (ha)	Proportion of Total[1] that will be destroyed by GTL Plant[4]	Comments
AbCwTe	63%	3.3	0%	None of this vegetation will be destroyed by the plant site, though 93% of the WEIA area is within the GTL lease.
ChCwIm	67%	1.8	16%	Most of this vegetation type occurs within the WEIA. The GTL plant will destroy ~16% of the total. This vegetation has a naturally limited distribution and is very poorly represented on the Burrup and within the CHRA.
EvTeCv	53%	1.0	0%	This vegetation type is extremely limited in distribution, with that in the GTL lease being 44% of that found in the CHRA. It will not be disturbed by the plant itself.
GpImTe	33%	9.1	10%	Although a substantial portion will be destroyed by the plant (1.4 ha), there is 9.1 ha protected in the CHRA.
TrTe(Ta)	91%	0.7	0%	Most of this vegetation type is in the WEIA, which is a concern. However, none shall be destroyed by the GTL plant, 33% of the current total area is within the GTL lease.
Threatened Criteria	≥70%	≤10 ha	≥10%	
Critical Criteria	≥90%	≤3.0 ha	≥30%	

1. "Total" refers to the total area of vegetation in the WEIA region and the Conservation Area. It excludes possible areas in other industrial zones.
2. This column gives the proportion of the total area of the vegetation type which may be destroyed by industry. Threatened proportions are defined as those over 70% and "critical" proportions, those over 90%.
3. This is the total area in hectares, of each vegetation type which will definitely be preserved. Threatened areas are those under 10 ha, (though Trudgen (2002) states areas less than 600 ha are threatened) and critical areas, those under 3 ha.
4. This gives the proportion of the total that will definitely be destroyed by GTL's plant site alone, as part of this project. It does not include further destruction on the GTL lease, nor that due to other developments in the WEIA area. Areas above 10% are defined as threatened and above 30%, critical.
5. Quantities which define critically threatened are shaded

Whether threatened vegetation should be further disturbed or eliminated, is not a scientific matter. However, according to EPA Position Statement 2 (2000), the EPA would expect alternative mechanisms to be put forward to address the protection of biodiversity.

The consideration of indirect impacts upon vegetation as a result of cumulative atmospheric emissions is described in Section 7.4.1.

7.3.1.5 Significant flora

While it is evident that there are vegetation types that are threatened by this development, it is unlikely that the component individual flora species of those types are under threat. Two Priority species (CALM 2001) and another five species highlighted by Trudgen (2002) for their conservation value have been recorded on the site during the dry season survey (see Section 5.2.1.4). Although it is anticipated that all of the flora found on the site would be represented elsewhere on the Burrup, this claim cannot be fully substantiated until such time as the wet season survey is conducted.

Management
Given the absence of rainfall and the inability to undertake a wet season survey, GTL considers that it has reviewed all the available relevant information to determine the conservation significance of the vegetation within its lease area and plant footprint. Impacts to vegetation have been minimised by designing a plant layout that is as compact as practicable and by committing to maintain surface water flows around the perimeter of the plant so that downstream vegetation communities are not adversely affected. There is little more that GTL can do to minimise impact on significant vegetation without threatening the economic viability of the project. GTL will continue to consult with DEP, MPR and CALM in order to identify a satisfactory outcome and protect the environmental values within the lease to the greatest extent achievable commensurate with commercial viability of the project.

A detailed wet season survey of the GTL lease area will be undertaken as soon as appropriate conditions prevail. Given the discrepancies between the Astron mapping and Trudgen (2002) mapping on the lease, GTL commits to map the vegetation within and surrounding the WEIA in the wet season to enable better confirmation of the actual rarity of the vegetation associations currently described as threatened. Where possible, any vegetation types not well represented in the CHRA that occur within the lease area (but outside the plant footprint), will be protected from future disturbance.

Seed collection of any prominent flora species present, including Priority Flora species, will occur as soon as possible, to ensure the availability of species for rehabilitation. Germination trials will commence prior to construction. During the rehabilitation process, attempts will be made to restore any Priority Flora species disturbed by the project.

As part of the development of the Final Environmental Management Plan (EMP), GTL will prepare and implement a Weed Management Plan that will also apply to the import of fill to site, based on the advice of CALM and other experts in the field. This plan will include, but not be limited to:

- inspection of vehicles, machinery, and other equipment brought onto the site to ensure that such equipment are free of weeds and seeds of weeds;
- traffic will be controlled and kept to designated tracks. Travelling cross-country by vehicle or foot will be prohibited; and
- ensure that imported fill does not contain topsoil or vegetation so that the potential for translocation of weed species is minimised.

7.3.2 Terrestrial Fauna

EPA Objective
Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *EPBC Act*.

Assessment

Fauna habitats
The species diversity of the Burrup Peninsula is comparatively high considering its relatively small area compared with the Pilbara as a whole. This high diversity can be explained in part by the multitude of different macro-habitats found along the Burrup Peninsula. Perhaps more important to many organisms are the number of microhabitats within each broad habitat. Of particular importance are the rock-piles and boulders of the granophyre outcrops and ridges

(Habitat 1 described in Section 5.2.2.2) as the numerous fissures and cavities created by the rock-piles provide food and shelter. These areas are home to a number of small mammals, many reptiles (including the Pilbara Olive Python), land snails and a number of macropod species (i.e. Euro, Rothchild's Rock Wallaby). The location of the proposed GTL plant is to the north of this habitat (see Figures 3 & 9) thereby avoiding impact to these areas.

The woodland lined drainage lines (Habitats 5 and 6 in Figure 9) also represent a fairly unique habitat on the Burrup Peninsula, providing canopy shade, nesting hollows and a source of food for a variety of fauna species. While most of these habitats are located on the eastern half of the lease, and outside the area to be disturbed by the proposed plant, one of the two major drainage lines (referred to as the "central drainage line") contained within the GTL lease will be modified by the plant. In addition to the section of the central drainage line that will be infilled by plant, there is also the potential for modification of water flows to areas further downstream, on the northern side of the lease. These potential impacts will be minimised by implementing drainage and surface water management measures aimed at maintaining water flows into the central drainage line on the northern (downstream) side of the plant.

Areas of stony, gently sloping hummock grassed plains (habitat 4) will be removed by the proposed plant. Astron (2002) noted that as the attributes that typify this habitat (i.e. their relatively flat, open, wide expanse) are the same characteristics that make them suitable for industrial development and due to this habitat occurring infrequently in conservation and recreation areas, then much of this habitat has been designated for industrial development. Increased development in the area will therefore have the cumulative impact of removing a large proportion of this habitat type from the local region.

Significant fauna species
A number of species of conservation significance or species of note were identified as potentially inhabiting the proposed development site.

The Western Pebble-mound Mouse is currently listed as Priority 4 on the CALM Priority List, indicating that it is a species in need of monitoring. The majority of the Western Pebble-mound Mouse mounds identified on the GTL site were located on the stony, gently sloping hummock grassed plains (Habitat 4) in the vicinity of drainage lines. All of the mounds were identified as being vacant. While it is unlikely that any live individuals are still present on the Burrup, it is also acknowledged that this species is particularly difficult to capture using the techniques employed to date in region.

The Pilbara Olive Python (*L. olivaceus barroni*) is a very large nocturnal python that is restricted to the Pilbara region (Storr et al. 1986, Cogger 2000). It inhabits rocky hills, ranges and areas of rockpile. It is currently listed under Schedule 1 of the *Wildlife Conservation Act 1950* and highlighted as Vulnerable under the *EPBC Act*. Much of the GTL lease and all of the plant site is outside the preferred habitat (rocky hills and ridges: habitat 1) for the python and hence impacts to this species is expected to be minimal.

There are a large number of bird species that occur on the Burrup Peninsula which are considered to be significant and have special conservation status. Australian legislation protects most of these while others are protected through international agreements with countries like Japan and China. It is unlikely that the proposed GTL plant will impact directly on any of the birds that are protected under domestic legislation (*EPBC Act*) or international migratory bird agreements (CAMBA, JAMBA, Bonn Convention). The families Falconidae and Accipitridae are also protected; however some (e.g. Osprey and Nankeen Kestrel) often take advantage of man-made structures either for nest platforms, observation points or feeding sites. Some consideration of this habit should be taken into account during the planning stage

to ensure that all elevated positions of the plant do not encourage nesting of raptors, that may affect their breeding output. Similarly, any flares or stacks should be adequately protected.

Three species of land snails belonging to two families were collected during a study within the GTL lease: *Rhagada* sp. in the family Camaenidae and *Pupoides beltianus* and *P. contraries* in the family Pupillidae. None of these species is considered to be rare or endangered. All three have been found widely in other surveys conducted on the Burrup Peninsula and they are known to also occur in other areas. *Rhagada* sp. apparently has the most restricted range, being limited to the Dampier region, but also occurs from south of King Bay up the Burrup Peninsula. All of these features provide evidence that there will be no major disruption to land snail populations from the development of the proposed GTL plant.

Management
GTL will undertake the following management strategies to minimise impacts to fauna and contribute to the database of knowledge on fauna on the Burrup Peninsula.

In consultation with CALM, GTL will undertake a fauna survey of the lease area and vicinity prior to construction should conditions be favourable. This survey will provide baseline information regarding the fauna present on site and in the nearby vicinity of the site, and may help to clarify some of the issues relating to the range of species on present, in particular, the Pebble-mound Mouse and the Pilbara Olive Python. The results of this survey would provide the basis for appropriate management measures to be developed in consultation with CALM. For example, consideration could be given to conserving a proportion of the habitat favoured by the Pebble-mound Mouse, i.e. the gentle sloping stony plain (Habitat 4), within the GTL lease, but outside the plant footprint.

All practicable measures will be taken to maintain existing drainlines and waterflows, in particular the two major drainlines and associated waterholes situated outside the lease. Drainage and surface water management measures will be implemented with the objective of maintaining water flows into the central drainage line on the northern (downstream) side of the plant.

GTL will support a collaborative research programme into the status of the Pilbara Olive Python on the Burrup Peninsula, currently being conducted by the WA Museum, the Nickol Bay Naturalist Club and CALM.

As part of the Rock Wallaby Protection Programme, CALM currently lays 1080 baits along the Mt Wongama Road and the track to Watering Cove to form a major east/west control line aimed at preventing foxes from reaching the northern section of the Burrup Peninsula. Management of the GTL lease will include providing CALM personnel access to the Mt Wongama and Watering Cove roads and nearby areas to enable the continuation of the current fox baiting programme. Information provided by CALM regarding the Rock Wallaby Protection Programme will also be used for all construction and operations personnel, and distributed for implementation.

GTL will establish a procedure for the prevention, and if necessary the control of all introduced fauna within their lease. This will be done in consultation with CALM.

7.3.3 Marine Ecology

EPA Objective
Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided. Minimise the risk of introduction of unwanted marine organisms consistent with the Australian Quarantine and Inspection Service (AQIS) guidelines for ballast water management and the ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance.

The assessment and proposed management associated with the three main sources of potential impacts – the seawater supply and return system, methanol loading and increased shipping activity - are detailed below.

7.3.3.1 Seawater system

Assessment
Under normal operating conditions, the GTL plant will discharge to the Water Corporation outfall located at the mouth of King Bay some 746,810 kg/h of saline water at a dissolved solids concentration of 52,275 mg/L (based on a seawater input concentration of 37,277 mg/L). The wastewater discharged will largely comprise the return of seawater that has undergone an increase in concentration (salinity) as a result of extraction of fresh water (desalination) for use in the methanol process (Table 7.6).

The use of large volumes of seawater within the plant for cooling will dilute the desalination plant wastewater stream, but will also introduce heat into the discharge wastewater stream.

The only by-product of the methanol production process that will be discharged in appreciable quantities is ammonia, predominantly in the form of ammonium ion, which is generated in the steam reformation process. Small amounts of water treatment chemicals, including biocides, anti-scalants, anti-fouling agents and neutralising agents will be used, and these will also appear, in a non-toxic form, in the wastewater stream. Under standard operating conditions there will be no loss of catalyst to the wastewater stream.

As can be seen from Table 7.6, most of the increases in concentration of the metallic ions and other components listed are due to the overall increase in concentration of the seawater that occurs as a result of the desalination process. The small number of components that are added to, modified or produced during the methanol production process are further discussed below.

Water neutralization
Caustic soda (sodium hydroxide [NaOH]) is added in a small, continuous stream to the lower section of the methanol distillation columns to maintain a high pH and prevent corrosion. Water from this unit is recovered for re-use in the plant, while the caustic is neutralized with sulphuric acid (H_2SO_4), prior to discharge from the plant. The neutralization process will result in a slight increase in the discharge concentration of two ions that naturally occur in seawater, namely sodium and sulphate ions (Na^+, SO_4^{2-}) However, the fact that these chemicals will be used to neutralize the process water, and the high volume and buffering capacity of the cooling water return stream, will result in there being no significant impact on the pH of the discharge water.

Table 7.6 Intake and Return Seawater Characteristics

Component	Unit	Intake	Return
Quantity total	kg/h	1,049,000	746,810
Quantity H_2O	kg/h	1,011,162	709,034
pH		8.1	> 7
TDS	mg/L	37,277	52,275
* TSS	mg/L	20	28
* Alkalinity (as $CaCO_3$)	mg/L	120	168
* Ca^+ - Ions	mg/L	415	582
* Mg^+ - Ions	mg/L	1,400	1,960
* K^+ - Ions	mg/L	410	573
Na^+ - Ions	mg/L	13,000	18,215
* Cl^- - Ions	mg/L	20,000	28,012
* Fe	mg/L	0.15	<1
* Cu	mg/L	<0.005	<0.008
* Ni	mg/L	<0.007	<0.007
* Co	mg/L	<0.001	<0.001
* Mo	mg/L	0.01	0.01
* Ba	mg/L	0.007	0.01
* Str	mg/L	8.95	13
*Cr	mg/L	0.3	1
*SiO_2	mg/L	~1	3
SO_4^- - Ions	mg/L	~1,800	2,564
* HCO_3^- - Ions	mg/L	100	138
* CO_3^- - Ions	mg/L	19	26
NH_4^+ Ions	mg/L	<0.003	10
Free chlorine	mg/L	0.3	0.3
Methanol (CH_3OH)	mg/L	0	nil
* Organic matter	mg/L	1	3
Dissolved oxygen	mg/L	1	3
Deposit Control Agent / Anti-scalant	mg/L		0.58
ClO_2 (for chlorination)	mg/L		0.2
Foam Control Agent	mg/L		0.15

* Indicates that increased concentration is due to desalination

Water treatment

Treatment of the cooling water and desalinator feed water will be required for the efficient operation of the plant. This may include the use of biocides, foam control agents and anti-scalants, the requirement for which will be dependent upon the quality of the intake water and detailed process design. The following chemicals from Ashland Specialty Chemical Company were used in preliminary calculations to define the expected residue components in the wastewater streams from the seawater cooling system and the desalinator:

- Generox 225A & 225B (biocides, chemical oxidants);
- Drewsperse 747A (deposit control agent; i.e. anti-scalant);
- Drewplus G-5170 (foam control agent); and
- Ameroyal CF (anti-scalant, foam control agent).

The chemicals selected during the detail design phase may differ from these, but will also be standard chemicals used world-wide for these purposes. Any water treatment chemicals will be discharged at low concentrations (0.1 - 1 mg/L) in the return water stream.

Process byproducts

The processing of natural gas at high temperature will result in the generation of small (relative to plant output) amounts of ammonia (NH_4^+). This results from an unavoidable reaction of nitrogen within the feed gas, and within the "oxygen" from the Air Separation Unit, with hydrogen produced in the combined reforming stage. The ammonia cannot be recycled and must be removed from the process system. The ammonia is condensed with the process condensate and this stream is treated within a cationic exchange demineralisation unit to allow recovery of the condensed water for recycle to the process. The ammonia is captured by the cationic exchange resin and released during bed regeneration using dilute sulphuric acid. The wastewater stream from this periodic regeneration contains the ammonia as a neutralized ammonium sulphate.

It is proposed to discharge this wastewater stream, via the plant water treatment system, to the Water Corporation outfall (Figure 7). Under average operating conditions, the amount of nitrogen discharged on an annual basis, based on an ammonia discharge concentration of 8 mg N/L and flow of 710,000 L/h, will be approximately 50 tpa. On a pro-rata basis (relative to discharge water volume), this is less than the quantity that the Water Corporation has identified as an acceptable nitrogen loading rate for King Bay (800 tpa; A. Bath, pers. comm.).

The predicted quality of the GTL return water (showing the effects of these additional components) at the point of discharge to the Water Corporation seawater return line is shown in Table 7.7.

Table 7.7 Quality of Treated Wastewater

Parameter	Concentration at end of pipe (mg/L)	Concentration at edge of mixing zone (mg/L)	ANZECC & ARMCANZ Guidelines (mg/L)	
			99%[3]	95%[3]
Temperature	Average 2°C above mean ambient receiving temperature	--	--	--
Total Dissolved Solids	52,275	37,900	--	--
Copper	<0.008	<0.008	0.0003	0.0013
Nickel	<0.01	<0.01	0.007	0.07
Cobalt	<0.001	<0.001	0.005	1
Zinc	<0.007	<0.007	0.007	0.015
Ammonia (NH_4^+ as N)	8.0	0.5	0.5 (as N)	0.91 (as N)
Nitrogen (as N)	8.0	0.5	0.1 default trigger for N as a nutrient	
H_2SO_4 (as H_2SO_4)	0	0	No guideline	
NaOH (as NaOH)	0	0	No guideline	
Chlorine (as ClO_2)	0.2	0.01	No guideline	
Chlorine (as free chlorine)	traces	negligible	No guideline	
Anti-scale	0.58	0.03		
Anti-foam	0.15	0.007		

Data are based on a total flow of 1,011 m^3/hr. Dilution by wastewater contributed by other industries is excluded, hence the end of pipe concentrations are also representative of the concentration at the point of entry to the Water Corporation return line.

Concentrations at the edge of the Water Corporation's mixing zone are based on a dilution of 1:20, as per Water Corporation outfall modelling, predicted at maximum wastewater discharge volume (208 ML/d). At lesser volumes the mixing, and hence dilution achieved at this point, will be greater.

The concentrations are compared against criteria from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000). The 99% and 95% criteria refer to the level of protection afforded to receiving waters under the guidelines, e.g. at the 99% level, protection of 99% of species in the receiving environment is expected.

Comparison to guideline values indicate that the increased salinity and produced ammonia may have some localised adverse impacts on the invertebrate and fish populations in the vicinity of the outfall structure, as detailed in the EPS and subsequent amendment for the Water Corporation's desalinated water and seawater supplies project (Water Corporation 2001, 2002). Far field modelling undertaken by the Water Corporation indicates that these impacts are unlikely to be of regional significance as they will be primarily localised and transient due to tidal flushing of King Bay.

Cumulative Loading
The estimated total annual cumulative anthropogenic loading of nitrogen to Mermaid Sound from all identified sources, existing and proposed (excluding GTL), has previously been estimated at 54 tpa (PRCL 2002), as follows:

- domestic wastewater (direct and indirect discharges) 3.65 tpa
- process wastewater (via Water Corporation outfall) 20 tpa
- dry deposition of atmospheric nitrogen compounds 28.7 tpa
- wet deposition of atmospheric nitrogen compounds 1.65 tpa

The operation of the GTL plant could therefore result in an approximate 100% increase in the anthropogenic nitrogen load to Mermaid Sound, if all projects presently approved or under consideration proceed through detailed design and construction to operation. The potential implications of this increase in nitrogen load will considered during the detail design phase of the GTL plant.

Management
The proposed wastewater management system is shown in Figure 7 and discussed in Section 7.4.3.1. During detail design of the plant, the process will be optimised to minimise chemical use. In addition, an assessment will be undertaken of alternative systems to reduce the nitrogen content in the wastewater stream. The viability of each option will be assessed and the best practicable option will be applied.

Two systems that have been used for reducing ammonia discharge in seawater return systems are steam stripping and biological treatment. Both of these treatments have their own environmental costs, both capital and operational. Steam stripping uses additional energy to generate the required steam, while the separated ammonia is discharged to atmosphere. Biological treatment also uses additional energy to generate the feedstock (normally methanol) for the bacterial treatment process. The nitrogen present in the ammonia is subsequently discharged to the atmosphere, in the form of inert nitrogen gas, or in wastewater, in the form of nitrates, depending on the treatment process. The largely inert sludge produced in this process must also be disposed. These systems, and potentially any system developed in the future, could be retro-fitted to the constructed GTL plant, should the requirement arise and capital and operational costs be acceptable.

The discharge of return water from the GTL plant to the Water Corporation outfall will be licensed under Part V of the Environmental Protection Act. All biocides, anti-scalant, corrosion inhibitors and other additives will require DEP approval prior to their application. Following the detailed design phase, GTL will provide toxicity and environmental fate data for any components of the return water with which the DEP is unfamiliar.

During plant operation, chemical usage will be monitored (dose vs effect) to assess the efficiency of the application rates, which will be reduced to the minimum possible rate. Treatment chemicals will be periodically reviewed to ascertain whether there are less toxic/more efficient chemicals available on the market.

The following parameters will be monitored at the discharge point into the Water Corporation return water system:

- pH, temperature, salinity: Continuously
- Total nitrogen: High frequency (to be reviewed when a stable pattern in nitrogen discharge concentration is confirmed)
- Biocide, anti-foaming agent, anti-scalant: Periodically (at a frequency dependent upon application rates and potential toxicity)

Plant operation will be adjusted as necessary to meet discharge licence criteria. Quality of the return water stream will meet the specifications agreed with the Water Corporation and comply with water quality criteria determined by the DEP (which are expected to follow the ANZECC & ARMCANZ [2000] Guidelines).

7.3.3.2 Methanol loading

Assessment
Methanol is highly miscible in water and any product spilled during vessel loading would be rapidly diluted as it dispersed into the waters surrounding the wharf. Biodegradation would occur, primarily through aerobic and anaerobic microbial activity (Malcolm Pirnie [1999] in SKM 2002).

In the unlikely event of a very large spill, some limited mortality of fish and invertebrates may occur in the receiving waters and, possibly, on adjacent shorelines. Methanol is considered toxic to marine life in concentrated forms, though less toxic than crude oil or gasoline, but impacts from short-term exposure are often reversible (Malcolm Pirnie [1999] in SKM 2002). The impacts would be transient (due to tidal flushing of the spill area) and highly unlikely to be locally or regionally significant.

Management
Methanol loading operations will be manned whenever loading is occurring. In the event of an observed spill or leak, emergency cut-off valves will be activated. In addition, a fibre optic link between the wharf and the plant site will allow an automatic shutdown of the loading pumps and activation of isolation valves.

These measures will minimise the quantity of methanol spilled into the marine environment. It is estimated that, in the event of a worst-case mishap (e.g. a loading arm disconnection if a ship moves outside the operating envelope of the loading arm geometry), the maximum spill volume would be in the order of only 200 litres.

7.3.3.3 Shipping

Assessment

The potential will exist for unwanted marine organisms to be introduced from discharged ballast water or from hull fouling on vessels entering the port during the construction and operation phases. Such introduced species could displace or adversely affect native marine species and some species could have adverse impacts upon nearby infrastructure. Pathogens could also be introduced through ballast water, leading to threats to the health of biota in the receiving environment.

Increased frequency of shipping at the Dampier Public Wharf is likely to lead to further minor increases in the concentrations of metals and organotins in the sediments adjacent to the wharf. If metals concentrations in sediments become sufficiently elevated, then they may become toxic to benthic marine biota within the sediments (e.g. Long et al. 1995). The organotin tributyltin (TBT) is highly toxic at low concentrations, and at sub-lethal concentrations can cause imposex (the development of secondary male sexual characteristics) in female gastropod molluscs (e.g. Blaber 1970) and shell growth abnormalities in bivalve molluscs (e.g. Batley et al. 1992). However, given the low frequency of shipping associated with the export of methanol by GTL, it is predicted that tidal flushing within Mermaid Sound will be sufficient to prevent the concentrations of metals and TBT increasing to levels of concern in the vicinity of the Dampier Public Wharf or elsewhere within the Sound.

The methanol vessels will increase the risk factors associated with vessel movements (collisions, groundings, etc., as discussed in Appendix M) within the Port and hence increase the potential for oil spills. However, it is considered that the management practices described below will be sufficient to reduce the risk factors to as low as reasonably practicable (ALARP).

Management

Each international vessel associated with the import of materials during plant construction or with product export during plant operation will be required to manage their ballast water in accordance with AQIS' Mandatory Ballast Water Management Arrangements and Port of Dampier regulations. Vessels will access the AQIS Australian Ballast Water Decision Support System and either exchange their ballast water prior to entering Pilbara waters or undertake treatment of their ballast water prior to discharge.

In-water hull cleaning and vessel maintenance is prohibited within the Port of Dampier, in accordance with DPA regulations and the ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance. This reduces the potential for the introduction of unwanted marine organisms and limits the input of metals and organotins to the marine environment.

Movements of methanol vessels within the Port will be in accordance with DPA Regulations, which require that the vessels will enter and depart the Port under the guidance of a Pilot. Response to any significant oil spills will be in accordance with the Port of Dampier Marine Pollution Contingency Plan (DPA 1995). This plan provides guidance on the management and remediation of oil spills such that impacts on the marine environment will be minimised.

7.3.4 Landforms, Drainage and Site Hydrology

7.3.4.1 Landforms

EPA Objective
Maintain the integrity, functions and environmental values of landforms.

Assessment
The site will be levelled prior to the commencement of construction. Volumes of cut and fill are anticipated to be similar and there is unlikely to be a requirement for the significant import of material to the site. Any excess material will be retained on site for potential future use.

Management
The plant site has been located within the lease area so as to minimise landform disturbance. Earthworks will be limited to the plant site itself and to access routes into the site. Disturbance of landforms within the greater lease area will be minimised.

7.3.4.2 Groundwater hydrology

EPA Objective
Minimise impacts on regional groundwater parameters such as water levels and shallow groundwater flow.

Assessment
An assessment of potential impacts to groundwater is included in Appendix B.

It is anticipated that the construction and operation phases for the plant will have no effect on the regional groundwater table. The site is not currently a significant recharge or discharge area to the deeper groundwater system, and significant aquifer zones are not present. It is not intended to either abstract water from, or recharge water to, the hydrogeological system during the life of the plant.

During the construction of the plant, cut and fill operations will change the extent of sediment and colluvial cover over the bedrock. This will change the local flow paths associated with horizontal shallow groundwater flow. However, currently the main direction of groundwater flow is vertical into the deep groundwater system. This will also be the case after decommissioning and thus the resultant effect on the groundwater system from the construction of the project will be negligible.

Management
Groundwater levels and quality in the vicinity of the plant will be monitored during the operational phase of the project to confirm the integrity of methanol storage tanks.

7.3.4.3 Surface water hydrology

EPA Objective
Maintain the integrity, functions and environmental values of natural surface water drainage, including watercourses and sheet flow.

Assessment
A preliminary hydrological assessment is included as Appendix C.

An ephemeral drainage line occurs at the eastern end of the plant site, running from the elevated rocky outcrops south of the plant site, in a northwest direction through the lease area (Figure 3; Plates 3 & 4) towards Withnell Bay. This will be diverted to the east to ensure continuity of water flow within the downstream section of the same drainage line.

Other surface water flow intercepted along the southern boundary of the plant site will be diverted to either the west or east to maintain, as closely as possible, the pre-construction water flows within the downstream drainage lines. The upper reaches of two other minor drainage lines, in the western and central sectors of the plant, will be truncated during construction.

The integrity, functions and environmental values of each of the drainage lines are not expected to be significantly adversely impacted. Management measures (see below) will be implemented to minimise downstream effects on Withnell Bay.

Management
The eastern drainage line will be diverted in such a way that erosion in the receiving drainage lines is minimised. Uncontaminated stormwater from the plant site will be discharged into the drainage lines to assist maintenance of their functions and environmental values.

7.3.5 Water Quality

EPA Objective
Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected consistent with the ANZECC & ARMCANZ (2001) water quality guidelines.

Assessment
Vegetation clearing, soil stockpiling and diversion of drainage lines during construction could lead to increased runoff and erosion, which could adversely affect downstream water quality. Once operational, pollutants with the potential to impact on ground and surface water quality are methanol and hydrocarbons (e.g. fuels and lubricants).

No adverse effects on the downstream environment, including Withnell Bay, are expected as on-site water management (see below) will control discharge water quality.

Management
A comprehensive water management system will be established prior to the commencement of plant construction, to ensure there is minimal impact on ground and surface water resources. The plant will be designed such that all potential spillages are contained (see Section 7.4.3.1) and an evaporation pond will be constructed to receive any potentially contaminated water.

Pre-development ground and surface water data will be collected and a monitoring programme initiated. The programme would continue throughout plant construction and operation, to ensure contamination sources are identified and any contaminants are retained within the site.

7.4 POLLUTION MANAGEMENT

7.4.1 Atmospheric Emissions

7.4.1.1 General emissions

EPA Objective
The two main EPA objectives relating to general atmospheric emissions from the operating plant are as follows.

(i) Ensure that gaseous emissions from this proposal, in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria (including the NEPM for Ambient Air Quality, with advice sought from the DEP on specific pollutants as necessary) or cause an environmental or human health/amenity problem.

(ii) Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as oxides of nitrogen (NO_x), oxides of sulphur (SO_x), greenhouse gases, toxic gases, particulates and smoke.

Assessment
An air quality impact assessment has been undertaken to address the potential for atmospheric emissions from the GTL plant to affect local, regional and global air quality. This assessment is attached as Appendix G in its entirety, and the primary conclusions summarised below.

In the case of the GTL plant, the main emissions with potential for offsite effects are the products of fuel combustion, which will include NO_x, carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter, and carbon dioxide (CO_2). Some emissions of volatile organic compounds (VOCs) will also occur. Such VOC emissions will be predominantly methane, however complete speciation data of VOCs are not currently available.

During operation of the methanol plant, these emissions have the potential for impacts on local, regional and global air quality as listed below:

- *local air quality* - due to the emission of combustion products such as CO, SO_2 and NO_x;
- *regional air quality* - as VOCs and oxides of nitrogen are smog precursors; and
- *global air quality* - due to the emission of greenhouse gases such as CO_2 (discussed in more detail in Section 7.4.2).

Stack emissions
During normal operations the primary stack emissions from the site will be nitrogen, oxygen, CO_2, water vapour, NO_x, VOCs, CO, SO_2 and particulate matter. Nitrogen and oxygen will have no adverse environmental impacts and are not considered in detail in this assessment. Estimated pollutant emission rates are included in Table 7.8. Under normal operating conditions, there would be no emissions from the methanol plant that could give rise to off-site odour impacts. While there may be the potential for slightly odorous emissions in the immediate vicinity of the storage tanks on-site, these are extremely unlikely to be detectable beyond the plant boundary and will not cause any nuisance effects in accordance with EPA Draft Guidance No. 47 (EPA 2000).

Table 7.8 Stack Emission Data (Normal Operation)

Source	Height	Diam.	NO_X		SO_2		CO		VOCs	
	(m)	(m)	mg/Nm^3	kg/hr	mg/Nm^3	kg/hr	mg/Nm^3	kg/hr	mg/Nm^3	kg/hr
Auxiliary Boiler (Partial Load)	30	1.5	66	8.7	0.38	0.05	15	2.0	-	-
Reformer Waste Heat Stack	35	2.7	60	38.6	0.31	0.2	10	6.5	-	-
Pilot Burner Flare	65	-	198	0.01	Traces		Traces		Traces	
Diesel Generator	10	0.5	78	0.9	8.7	0.2	26	6.5	3.0	-
Process Condensate Stripper	15	0.6	-	-	-	-	18	0.4	18	0.4

Notes: (1) Concentrations corrected to 15% O_2.
(2) SO_2 emission rates are based on current design of 10ppm sulphur content in feed gas. Actual SO_2 emissions are anticipated to be lower as the characteristic sulphur content in North West Shelf gas is significantly lower than this value, therefore the above represents a conservative overestimate.

The emission rates of oxides of nitrogen include nitrogen dioxide (NO_2), nitric oxide (NO) and traces of nitrous oxide (N_2O). The principal species of concern, in terms of human health effects, is NO_2 and it is this compound that has ambient air quality guidelines specified in the National Environment Protection Measure for Ambient Air Quality. However, emissions of NO will react with oxygen in the atmosphere to form additional NO_2 as the plume travels downwind, hence the emission rates shown in Table 7.8 are for NO_X (expressed as NO_2).

Fugitive Emissions

General fugitive emissions from the plant have been estimated by Lurgi to be in the order of 0.5 kg/hr VOCs, corresponding to an annual emission of 4.4 tpa (Appendix G).

Fugitive emissions of methanol vapour could also occur from the intermediate and product storage tanks. The two methanol product storage tanks will have a capacity of approximately 60,000 m^3 each and would be of fixed cone-roof design. They would be blanketed with nitrogen to avoid contact between the product and moisture in the atmosphere. Gases vented from the headspace in the raw, intermediate and product storage tanks would be collected by a vapour recovery system that would direct any methanol vapours to a scrubber. Emissions of VOCs (methanol vapour) from this scrubber have been estimated by Lurgi to be minimal, at approximately 0.025 kg/hr. The methanol/water mixture would be sent back to the Raw Methanol Tank. The scrubber would be designed to treat a maximum flowrate of around 2,500 Nm^3/hr with a methanol content of approximately 1.5% methanol (by weight).

Fugitive emissions of nitrogen and methanol vapour could also potentially be released during the loading of ships with product. Two loading pumps would be installed with a capacity of 2,000 m^3/hr each. The loading period is expected to be about 18-25 hours every 10 days. It is proposed that a water scrubber would be installed at the port to receive and treat any vapours emitted during ship loading activities, and the scrubbed vapour trucked back to the plant and returned to the process. The scrubbed vapour will not contain ammonia, hence will not be odorous. Methanol emissions from this unit would therefore be expected to be minimal, and of a similar magnitude to those from the tank farm water scrubber discussed above.

Start-up and Upset Emissions

It is anticipated that start-up and shut-down of the plant would occur no more than twice per year. During start-up the boiler would be operated for approximately 50 hours at design load and the emissions are estimated to be:

- NO_X: 28.5 kg/hr

- SO_X: 0.13 kg/hr
- CO: 7.0 kg/hr

After start-up, the boiler would revert to partial load operation, with the emissions shown in Table 7.8 (refer Section 3.4 of Appendix G). Shut-down of the plant is estimated to take approximately 1 hour, with an average capacity of 50% for each emission source. Use of the diesel generator may be required for a safe shut-down of the plant in the unlikely event of a malfunction of the turbine driven generator and of the external power supply.

Under emergency conditions, the plant safety system provides for a blowdown condition in the worst case. Under a blowdown condition, the whole plant or sections of the plant may be discharged to atmosphere through the flare. When it does, the inventory of the plant is released under controlled conditions to the flare where it will be combusted before discharge to atmosphere. This event will discharge less than one day's normal emissions to the atmosphere in the form of a typical flare discharge composition.

The precise amount of discharge depends upon the plant inventory, however estimated emission rates have been provided by Lurgi as follows:

- NO_X: 50 kg/hr (13.9 g/s)
- SO_X: 10 kg/hr (2.8 g/s)
- CO: 50 kg/hr (13.9 g/s)
- VOCs: 50 kg/hr (13.9 g/s)
- Particulate: 10 kg/hr (2.8 g/s).

Other systems (including air compressors, gas compressors and circulating water systems) would be equipped with standard safety features to protect staff and equipment in the event of failures or operations outside of prescribed limits.

Local Air Quality

There are a number of existing and proposed industrial developments in the Burrup Peninsula, which have the potential to impact on air quality in the region. These facilities include:

- the existing NWSVP plant which is currently undergoing a major expansion;
- the existing Hamersley Iron Power Station;
- the proposed Syntroleum Gas-to-Liquids plant;
- the proposed Burrup Fertilisers ammonia plant; and
- the Dampier Nitrogen ammonia urea plant.

A discussion of recent studies of ambient air quality in the region is included in Appendix G. Emissions from the proposed Methanex methanol plant are not included as data were not available at the time that modelling (see below) was undertaken.

Atmospheric dispersion modelling of emissions from the GTL plant was undertaken using the AUSPLUME Gaussian plume dispersion model, developed by EPA Victoria. The study utilised AUSPLUME Version 5.3, which was released by EPA Victoria in October 2001, to predict ground level concentrations of pollutants emitted from the GTL plant in isolation and also cumulative impacts considering other identified sources.

Modelling was also undertaken by CSIRO using TAPM, a non-steady-state three dimensional dispersion model to investigate the plant's potential impact on smog generation in the area.

Meteorological data for modelling was provided by the DEP. Building wake effects from nearby structures were taken into consideration during the AUSPLUME modelling (Appendix G). The GTL stacks are sufficiently high that the BPIP (Building Profile Input Program) utility in AUSPLUME indicates that there would be no building wake effects under any wind direction. This will be reviewed and confirmed during the final design of the plant.

Oxides of Nitrogen

The EPA has developed a guidance statement for oxides of nitrogen emissions from gas turbines, with limits for emissions depending on the fuel type. However, as the Lurgi designed plant does not include gas turbines, these emission limits are not applicable. Emissions from the auxiliary boiler are well below the limit of 350 mg/Nm^3 set by the AEC/NHMRC (1985) for gas fired boilers and emissions from the diesel generator comply with the 500 mg/Nm^3 limit set for electricity generation from liquid fuels (see Section 4.1 in Appendix G).

The main source of NO_X emissions at the plant would be the Reformer Waste Heat Stack, which is estimated by Lurgi to emit 38.6 kg/hr of NO_X under normal operating conditions. This stack has a large flowrate of 56.2 Nm^3/s, hence while the estimated concentration of NO_X in the stack is relatively low, at 60 mg/Nm^3 (at 15 % O_2), the mass emission rate contributes 80% of the total site NO_X emissions (47.3 kg/hr).

Based on data available for other methanol plants recently proposed for construction in the region, the estimated emissions of NO_X for the GTL plant (per tonne of product) may be considered current best practice. The estimated NO_X emissions for the Lurgi plant correlate to 0.31 kg NO_X per tonne of methanol. Similarly, NO_X emission estimates of 132 kg/hr have been reported for the Tassie Shoal Project proposed for the Timor Sea, (two stages, each producing 5,000 tpd of methanol), which represents 0.32 kg NO_X per tonne of methanol. In comparison, the PER for the 6,000 tpd Methanex plant proposed for the Burrup, which includes gas turbines, gives an estimate of 359 kg/hr NO_X for the plant, which represents 1.4 kg NO_X per tonne of methanol. Estimated emissions of NO_X from the plant are therefore at the low range of current industry best practice.

The maximum predicted NO_2 concentrations given by the AUSPLUME model due to emissions from the methanol plant (under normal operation) and other NO_X sources on the Burrup Peninsula are summarised in Table 7.9.

Table 7.9 Maximum Predicted NO_2 Concentrations (Normal Operation)

Scenario	Maximum Predicted NO_2 Concentrations					
	1-Hour Averages (µg/m^3)			Annual Averages (µg/m^3)		
	Off-site	Dampier	Karratha	Off-site	Dampier	Karratha
Without Methanol Plant	143	58	57	19	1.6	0.7
With Methanol Plant	143	59	57	22	1.7	0.7
Methanol Plant Only	59	8	6	3	0.1	0.03
Guidelines	**246**	**246**	**246**	**62**	**62**	**62**

As shown in Table 7.9, current worst case ground level NO_2 concentrations are not predicted to increase due to emissions from the GTL plant. The resulting contour plots under the three scenarios are shown in Appendix G, Figures 7.1 to 7.3. Annual average NO_2 concentrations for cumulative emissions are shown in Appendix G, Figure 7.4.

The worst case NO_2 concentrations predicted to occur as a result of emissions from the methanol plant are well below NEPM guideline levels, even when existing emission sources on the Burrup Peninsula are taken into account. No adverse impacts on local air quality are therefore expected as a result of these emissions. Predicted NO_x deposition rates are considered later in this section. Modelling of maximum predicted NO_2 ground level concentrations during start-up conditions (Table 7.2 in Appendix G) indicates that assuming the worst case emission scenario associated with a cold-start (auxiliary boiler at full load and the diesel generator operating), no significant increases in off-site NO_2 levels are predicted. The maximum predicted levels are well below the NEPM standard.

Sulphur Dioxide

Desulphurisation of the process feed gas for the project will ensure that SO_2 emissions from the GTL plant will be extremely low. The maximum predicted SO_2 concentrations given by the AUSPLUME model due to emissions from the methanol plant and surrounding facilities are summarised in Table 7.10. Maximum off-site predictions are provided with and without the methanol plant operating, and with the methanol plant operating in isolation. These are also shown in contour plots included in Appendix G, Figures 7.5 and 7.6, for 10-minute and 1-hour averaging periods respectively.

Table 7.10 Maximum Predicted SO_2 Concentrations

Scenario	Maximum Predicted SO_2 Concentrations – Off-site			
	10-minute Averages ($\mu g/m^3$)	1-Hour Averages ($\mu g/m^3$)	24-Hour Averages ($\mu g/m^3$)	Annual Averages ($\mu g/m^3$)
Without Methanol Plant	10	7.1	2.2	0.30
With Methanol Plant	10	7.1	2.2	0.30
Methanol Plant Only	0.7	0.5	0.1	0.02
Scenario	**Maximum Predicted SO_2 Concentrations – Dampier**			
Without Methanol Plant	1.9	1.6	0.3	0.05
With Methanol Plant	1.9	1.6	0.3	0.05
Methanol Plant Only	0.06	0.04	<0.01	<0.01
Scenario	**Maximum Predicted SO_2 Concentrations – Karratha**			
Without Methanol Plant	1.2	0.8	0.1	0.01
With Methanol Plant	1.2	0.8	0.1	0.01
Methanol Plant Only	0.04	0.03	<0.01	<0.01
Guidelines	**715**	**572**	**228**	**57**

Worst case 10-minute, one-hour, 24-hour and annual average SO_2 concentrations predicted to occur as a result of emissions from the methanol plant are far below guideline levels, even when existing emission sources are accounted for (Table 7.9). No adverse impacts on local air quality are therefore expected as a result of these emissions. Deposition rates of SO_2 are considered later in this section.

Carbon Monoxide

The maximum predicted CO concentrations given by the AUSPLUME model due to emissions from the methanol plant and surrounding facilities are summarised in Table 7.11.

Table 7.11 Maximum Predicted CO Concentrations

Scenario	Maximum Predicted CO Concentrations		
	8-Hour Averages (µg/m^3)		
Without Methanol Plant	35	4	2
With Methanol Plant	35	4	2
Methanol Plant Only	7	0.3	0.1
Guidelines	**11,250**	**11,250**	**11,250**

As shown by the table, the cumulative worst case 1-hour CO concentrations predicted by the modelling are far below the relevant assessment criteria for CO. The worst case 1-hour and 8-hour average concentrations predicted to occur post-construction of the methanol plant are less than 1% of guideline levels. No adverse impacts on local air quality are therefore expected as a result of these emissions.

Smog Generation Potential

CSIRO have undertaken a regional smog modelling study using the TAPM model to investigate the potential for emissions from the proposed GTL plant to contribute to smog generation in the area (included in its entirety in Appendix G).

Modelling was performed over a 12-month simulation (1999) using NO_X and VOC emission data for the proposed GTL plant and the other existing and proposed emission sources on the Burrup Peninsula. The key findings of the modelling study are as follows:

- the proposed GTL plant emissions do not change the maximum predicted ground level concentrations of NO_2 or O_3 in the region from their current levels of:
  - NO_2 (1-hour average) 65 ppb,
  - O_3 (1-hour average) 89 ppb,
  - O_3 (4-hour average) 70 ppb;

- these predicted regional maximum ground level concentrations of NO_2 and O_3 do not exceed the NEPM standards;

- the proposed GTL plant emissions contribute 1 ppb to the maximum 1-hour average NO_2 ground level concentration at Dampier;

- the proposed GTL plant emissions do not enhance the maximum 4-hour average O_3 ground level concentration at Karratha. In fact, when the plant emissions are included, the maximum 4-hour average O_3 concentration at Karratha decreases by 1 ppb; and

- the proposed GTL plant emissions do not contribute to other maximum ground level concentrations (1-hour NO_2, 1-hour O_3, or 4-hour average O_3 concentrations) at Dampier or Karratha.

Overall, the modelling study indicates that emissions from the GTL plant are very low and would not result in any increase in smog generation potential in the area.

Atmospheric Deposition

The potential effects on the biophysical attributes of the area from increased cumulative atmospheric emissions on the Burrup was raised as an issue to be considered during the preparation of this PER (Appendix A). In response, GTL has undertaken a preliminary assessment to determine what the potential impacts may be from atmospheric deposition on environmental attributes such as native vegetation, aboriginal petroglyphs, terrestrial snails

and ephemeral rock pools which are known to occur on the Peninsula. It is noted that these considerations are being further evaluated by the Office of Major Projects on a strategic basis.

Atmospheric deposition is the process whereby airborne particles and gases are deposited on the earth's surface, and may arise from both natural and anthropogenic sources. Wet deposition is the fraction of atmospheric deposition contained in precipitation (commonly referred to as acid rain), while dry deposition is the fraction deposited in dry weather through such processes as settling, impaction, and adsorption. Acidic deposition impacts are largely witnessed in areas such as North America and European countries where concentrations of these pollutants are elevated by anthropogenic sources (e.g. US EPA 1999). In the predominantly arid zone conditions of the Burrup, dry deposition is expected to be the dominant mechanism by which atmospheric pollutants may be deposited on terrestrial and aquatic environments.

At this stage, the rate at which NO_X and SO_X is deposited on the Burrup Peninsula is unknown. Studies undertaken in the similarly arid areas of Mt Isa and Kalgoorlie have estimated that approximately 5% of total emissions are deposited. This estimate formed the basis for an assessment of deposition impacts as part of the air quality study for the proposed Methanex methanol plant, which estimated total cumulative NO_X and SO_X deposition rates of 4.8 $g/m^2/yr$ and 0.07 $g/m^2/yr$ respectively. These estimates were based on an affected radius of 7km and total annual emission loads for industries on the Burrup of 14,817 tpa NO_X and 226 tpa SO_X (i.e. assuming 5% of these loads are deposited). These loads include the proposed Methanex plant. This approach also assumes that the emissions are deposited uniformly over the affected area whereas, as indicated by the modelling, deposition levels are likely to be higher on elevated terrain.

The total annual emission loads estimated for the GTL plant are 403 tpa NO_X and 2 tpa SO_X. These loads represent an increase of 3% on NO_X emissions and less than 1% on SO_X. The estimated increases in deposition rates would therefore be proportional, giving cumulative deposition levels of 4.9 $g/m^2/yr$ NO_X and 0.07 $g/m^2/yr$ SO_X.

Relating the estimated deposition rates discussed above to the potential secondary impacts on surrounding biota such as vegetation, rock pools and petroglyph base-rocks, is difficult to quantify due to the absence of such information relevant to Australian arid zone areas such as the Burrup. Appendix G (Section 7.6.2) includes a synopsis of the potential anticipated effects of atmospheric deposition on key biophysical attributes on the basis of current available information.

GTL has demonstrated its commitment to minimise atmospheric emissions as far as practicable as part of the design of the plant, including application of best practice NOx minimisation through the use of Best Available Technology and a highly efficient plant design. The modelling outcomes presented in the previous sections indicate that air emissions from the site will not result in any increases in maximum downwind pollutant concentrations. No adverse impacts on vegetation, significant flora or habitat areas are therefore anticipated to result from the proposed project.

In considering the cumulative air quality impacts from GTL and other proposed developments on the Burrup and existing major sources, GTL recognises the potential for industry emissions to impact on the above bio-physical attributes, although the science is yet to be determined. GTL is prepared to facilitate a ‘whole-of-industry’ approach in addressing cumulative atmospheric modelling and monitoring in a standardised manner as part of the Burrup Industry Group. Through this industry body it would be possible to overcome the paucity of data relevant to the region through appropriate, site-specific monitoring programmes with

other prospective industries on the Burrup. GTL is also willing to support Government initiatives to further investigate and monitor potential cumulative effects from industrial emissions.

Management

Vapour Recovery Systems
Fugitive emissions of VOCs from ship loading activities and bulk storage tanks will be controlled by vapour blankets and vapour recovery systems. The majority of any fugitive emissions of nitrogen and methanol vapour from ship loading activities will be collected and treated to remove methanol vapours prior to discharge to atmosphere. Any residual hydrocarbon emissions from ship loading are therefore expected to be negligible.

The methanol product storage tanks, the intermediate storage tanks and the raw methanol tanks would also be fitted with vapour collection systems that would direct any methanol vapours to a scrubber. Emissions of VOCs from this scrubber have been estimated by Lurgi to be minimal, as previously described. Water from the scrubbers will be recycled back to the methanol distillation unit.

Monitoring Programme
GTL will be represented on the industrial liaison committee for coordination of atmospheric monitoring and management, which the DEP and MPR intend to establish.

Upon commissioning, it is proposed that a program of stack emission monitoring be undertaken to verify the emission estimates used in this impact assessment. This monitoring would include measurement of the following stack parameters over a range of operating loads:

- stack gas velocity, flow rate, and temperature for both the main flue gas stack, the auxiliary boiler and the diesel generator;
- O_2 and CO_2 concentrations for these stacks;
- NO, NO_2, NO_x, CO, SO_2 and VOC concentrations and mass emissions for these stacks, with the concentrations reported as corrected to 3% O_2; and
- minor stack emissions as appropriate.

The final stack heights (as constructed) would be verified and reported to DEP along with the above emission monitoring data. It is proposed that the monitoring programme during commissioning would be undertaken on an annual basis.

7.4.1.2 Salt water mist

For the operation of the seawater cooling tower consideration is given to evaporation and drift losses. Lurgi has advised the following information.

The water (vapour) losses generated by the working cooling tower are in the range between 1.6 and 2.0% (by weight) of the sea cooling water recycle flow, thus being in the range between 245 and 345 t/h, depending on the design features by the selected supplier. The evaporated water stream can be considered as free of dissolved solids and therefore considered to have no environmental consequences.

Likewise the drift losses depend upon the design features by the selected supplier. They vary in a wide range between 0.001 and 0.02 %w of the sea cooling water recycle flow, thus being in the range between 150 kg/h and 3.5 t/h. Assuming that the content of dissolved solids in the water particles being carried over, together with the evaporation losses, is the same as of the recycling seawater flow through the cooling tower, namely around 53,500 ppm, the dissolved solids in the drift losses are expected in the range between 8 and 185 kg/h.

The drift loss limit from cooling towers, as specified in AS 3666, is a maximum of 0.02% of total circulating flow rate. Based on the preliminary figures described above, this represents conformance with the Australian Standard. Depending on the final technology and supplier to be selected, the rate of drift loss may be as low as 0.5% of that recommended in the Australian Standard. GTL will ensure that best available measures will be incorporated into the design to ensure that there is an extremely low risk of salt water mist from the cooling water tower affecting vegetation in the area.

7.4.1.3 Dust

EPA Objective
The EPA objectives associated with dust generation during construction are to:

(i) ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity.

(ii) use all reasonable and practicable measures to minimise airborne dust.

Assessment
The methanol plant has the potential to impact on local air quality during its construction due to site clearing activities, the excavation and handling of soils, blasting, wind erosion from disturbed areas and stockpiles, site grading activities and vehicle movements. As the site is undeveloped, there is no significant potential for any dust emissions from these construction activities to contain contaminants or for the works to give rise to odorous emissions.

During the various construction phases of the methanol plant's development, there is potential for mechanically generated and wind-blown dust to be emitted off-site. These dust particles will predominantly contain the larger size fractions (>20 µm) and would therefore be expected to affect local dust deposition levels and TSP concentrations rather than PM_{10} or $PM_{2.5}$ concentrations. There is no current dust deposition data for the proposed site. The nearest residential dwelling, however, is located some distance away, approximately 10 km to the southwest. The construction activities will also be relatively localised and standard dust control measures would be expected to prevent any adverse off-site impacts due to nuisance dust.

Particulate emissions are expected to be negligible during normal operation of the plant. Under upset and start-up conditions, when the diesel generator is operating, there will be minor emissions of particulate however these discharges would not give rise to off-site air quality impacts.

Dust generated during construction of the proposed plant could adversely impact upon nearby vegetation and reduce public amenity in the vicinity of the plant site. As discussed in the previous section, these dust particles will predominantly contain the larger size fractions (>20 µm) and would therefore be expected to affect local dust deposition levels and TSP concentrations rather than PM_{10} or $PM_{2.5}$ concentrations. There is no current dust deposition data for the proposed site. The nearest residential dwelling, however, is located some distance

away, approximately 10 km to the southwest. The construction activities will also be relatively localised and standard dust control measures would be expected to prevent any adverse off-site impacts due to nuisance dust.

Management
GTL will be represented on the Dampier-Point Samson Dust Working Group, a DEP initiative which includes interested parties from industry and the community. The potential for off-site dust emissions to occur during the construction of the facility will be minimised through the development and implementation of the construction EMP. This management plan will include the use of dust suppression measures such as:

- the use of water sprays to wet the site during dry windy conditions;
- the use of speed limits to minimise dust generated by vehicle movements;
- the use of minimum drop heights when loading and unloading soils and other excavated material; and
- minimising areas of disturbed, exposed soils.

Regular checks would be made of dust levels being generated by the works and remedial action taken whenever visible off-site emissions occur.

7.4.2 Greenhouse Gases

EPA Objective
To minimise greenhouse gas (GHG) emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.

Assessment
URS, on behalf of GTL, undertook an assessment of the GHG emission consequences of the GTL plant, and identified appropriate management measures which could be adopted in accordance with current Australian and international policy on greenhouse emissions and climate change. The detailed greenhouse assessment report is attached as Appendix H, with the key results and conclusions summarised below. In undertaking the assessment, the proponent sought the advice of the Australian Greenhouse Office (AGO), and this feedback was taken into account when finalising the assessment report.

Greenhouse Inventory
The estimated GHG emissions from the GTL plant are summarised in Table 7.12, on a CO_2 equivalent basis. Of the six GHGs specified in the Kyoto Protocol, emissions of CO_2 constitute the great majority of the GHG contribution from the project. In addition, there are contributions from methane, as unburned methane emitted from the reformer furnace stack and auxiliary boiler, and relatively minor quantities of N_2O as a component of NO_x from combustion processes. Other GHGs specified in the Kyoto Protocol, i.e. hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, will not be present as no fluorinated compounds are involved in the methanol manufacturing process (Appendix H).

Table 7.12 Summary of GHG Emission Estimates

	kg CO_2-eq per hour	Tonnes CO_2-eq per year
CO_2	50,520	442,550
Methane	10	92
Nitrous Oxide	1,023	8,960
Total	*51,550*	*451,600*

The conversion of carbon in natural gas to carbon in methanol is limited by chemical conversion equilibria in the reformer and the methanol synthesis loop. Hydrocarbons that are not reformed to CO and H_2 (synthesis gas) and syngas components that are not converted to methanol have to be purged from the synthesis loop. Some additional gases are purged when the methanol is depressurised for drying. Purged gases are used as a fuel gas in the endothermic reformer. In addition some natural gas is required to supplement the energy demand of the reformer furnace. The net effect of these practical constraints of methanol synthesis results in 80% carbon conversion from natural gas to methanol in the direct manufacturing process, with the balance ultimately emitted as CO_2 from the methanol plant.

Consideration of Energy Efficiency

Methanol plant process efficiency

The methanol manufacturing process, shown in Figure 1 of Appendix H, uses a highly integrated and optimised process design in which all purged gases are used as fuel and includes heat exchange and heat recovery into an integrated steam cycle. The integrated energy management system includes the generation of electricity so that the whole plant is self-sufficient in energy and utilities. The high quality energy requirements for process heating, power generation and gas compression are larger than can be provided by the purge gas and the lower quality energy from heat recovery systems. Therefore additional high-pressure steam is required to complete the plant energy balance. Accordingly an auxiliary gas fired high-pressure steam boiler is included in the process design. This additional gas use means that 77.25% of the total carbon in the natural gas supply reports in the methanol product and 22.75% is discharged as CO_2. 66.4% of the total energy in the natural gas supply is embodied in the methanol product. Therefore 33.6 % of the input energy is consumed. This corresponds to an overall energy use in the process of 11.45 GJ (hhv) per tonne of methanol product.

In the methanol industry the efficiency of conversion of natural gas to methanol is typically presented in terms of GJ on natural gas required per tonne of methanol product. Since the calorific value of the methanol product is 22.69 GJ per tonne, the total natural gas requirement is 34.14 GJ per tonne of methanol product. For consistency with industry standards, the comparative performance with best practice is presented on that basis in the following section.

Since natural gas is used in the auxiliary boiler to supplement the steam supply, there will be a direct reduction in gas consumption arising from any measures that increase the supply of steam from waste heat or reduce the demand for steam. Similarly, the amount of natural gas fed to the reformer furnace will directly reduce as a result of any improvements in the reforming and synthesis processes. Therefore, by monitoring natural gas supply to the reformer furnace and the auxiliary boiler, the impact of any potential efficiency improvement measures would be readily identified. This key performance indicator will be carefully monitored to assess the net benefit of efficiency improvement measures implemented on the plant.

Comparative process efficiencies

The energy efficiency of the conversion of natural gas to methanol is strongly dependent on the composition of the natural gas supply (as demonstrated in Appendix H, Section 3.2). The design point mass and energy balance for the proposed GTL methanol production facility presented in Figure 12, corresponds to a natural gas utilisation efficiency of 34.14 GJ of natural gas per tonne of liquid methanol product as a nominal design point. This indicates that the efficiency achieved by the optimised plant is likely to be in the region of 34 GJ per tonne of methanol representing best practice beyond current conventional technology.

This efficiency measure has been benchmarked against other proposed methanol facilities in Australia. Figure 12 provides an indication of the efficiency of these methanol plants and shows the dependence of CO_2 emissions on the CO_2 content of natural gas. The PER for the proposed Methanex Methanol Complex (SKM 2002) states "this technology would endeavour to be the most efficient available and Methanex would be aiming to achieve a design efficiency of between 33 and 34 GJ/t". The proposed Methanex methanol plant is significantly larger than the proposed GTL plant, therefore it is to be expected that some minor energy efficiency benefits would accrue from the use of larger equipment. Taking that factor into account, there is no significant difference between the predicted basic process efficiency of the proposed GTL plant and the proposed Methanex plant.

During consultations, the AGO requested that GTL make a similar comparison with the proposed Tassie Shoal Methanol Production Plant in the Timor Sea, the results of which are presented below. The EIS for the Tassie Shoal Methanol Production Plant (CEE 2002) reports an energy efficiency factor for methanol production of 35 GJ per tonne of liquid methanol. However, the Evans Shoal gas resource to be used by the Tassie Shoal plant has a carbon dioxide content of 25% by volume. The EIS reports that the GHG emission rate will be 0.96 tonnes of CO_2 per tonne of methanol compared with 0.404 tonnes of CO_2 per tonne of methanol for the GTL plant. The CO_2 content of the North West Shelf gas to be used for the GTL plant has a CO_2 content of 2.2%, which influences energy efficiency of the conversion of natural gas to methanol. Figure 12 shows the comparatively high gas use rate by the Methanex plant in New Zealand, which was built in the mid-1980s and also the adverse effect of a high-CO_2 natural gas on the overall GHG emission from methanol production.

Earlier gas to methanol plants built in the 70s and 80s were significantly less sophisticated than recently constructed plants. However, since the introduction of combined reforming technology around 1990, further process improvements have consisted of small incremental improvements. Accordingly, comparison of the proposed plant with a conceptual plant built in 1990 would not show a major efficiency improvement. Whereas, the actual displacement of older less efficient methanol plants will show a significant efficiency improvement and hence a lower overall greenhouse intensity in meeting the world demand for methanol.

Global Context of the GTL Plant

The GTL plant will have the capability to convert natural gas into 1.05 Mtpa of methanol, an internationally traded commodity chemical. The output from the proposed plant will contribute about 4% of the world methanol market. It is expected that all of the output from the proposed GTL plant will be exported to expanding Asian markets for methanol.

From the point of view of Australia's GHG inventory, the conversion of natural gas into methanol for export was not an activity in Australia in 1990. Therefore there is no 1990 level of emission against which the GHG emissions from the GTL plant can be compared. There is also no entry for methanol production in the current (1999) national GHG inventory. Since Australia does not have an existing gas-to-methanol industry, this new activity would not

have been included in the energy sector growth projections on which the estimated 43% growth in Australia's GHG emissions by 2010, was based. Therefore, it is inappropriate to focus consideration of GHG minimisation measures for the GTL plant on the principle of reducing the growth in Australia's domestic emissions from 143% to 108%.

From a global perspective, the world methanol market is serviced by plants in several countries, which convert natural gas into methanol via synthesis gas. The basic chemistry of conversion is common, but there have been many improvements in the conversion technology, such as catalyst developments and combined reforming, which have improved the overall energy conversion efficiency from natural gas to methanol. Therefore the latest state-of-the-art gas to methanol plants are significantly more thermally efficient than the older plants. Accordingly, the closure of older methanol plants as new plants are brought on stream results in a reduction in the GHG consequences of meeting the demands of the methanol market. To the extent that the GTL plant will displace older capacity there will be a reduction in GHG emission from global methanol manufacture.

If the proposed plant were not to be built in Australia, then the demand for methanol would be met by new capacity constructed elsewhere in the world. In many countries the drive to minimise GHG emissions is not as strong as it is in Australia. Therefore, although the GHG emissions from a new methanol plant would be similar, the on-going investigation of GHG minimisation opportunities, as described below, may not be as effective elsewhere. Therefore, from the global GHG minimisation perspective, it is appropriate for Australia to host new methanol production capacity.

Management

No-Regrets Measures to be Adopted

The purchase of natural gas is the dominant operating cost associated with methanol manufacture, therefore there is a strong economic incentive for GTL to minimise natural gas consumption through the adoption of energy saving measures. Specific "no regrets" measures that will be included in the plant design include:

- ***Efficient reforming process***

Adoption of combined reforming to optimise the balance between steam reforming and autothermal reforming with oxygen. This technology allows the scale of the more energy intensive gas processing activities to be reduced by thermodynamic optimisation of the process design to accommodate the composition of the feed gas.

- ***Recovery of waste heat***

Waste heat is recovered wherever possible. This results in a high degree of waste heat recovery from the reformer stack and the auxiliary boiler stack, which is reflected in the relatively low exit temperatures from these stacks.

- ***No fugitive emissions or flaring***

As described above, fugitive emissions are avoided for safety reasons. Where waste gases are continuously purged these are gathered and routed to the reformer furnace where they are usefully combusted. There is no continuous flaring of waste gases. The process flare is maintained for the infrequent safe disposal of gases during process upsets or emergency depressurisation events.

- ***Steam turbine drives***

Large items of rotating equipment, such as compressors, are driven by steam turbines, resulting in the direct conversion of steam energy into mechanical energy. This is more

efficient than the conventional energy conversion route of steam energy to electrical energy via a turbogenerator and followed by the conversion of electrical energy into mechanical energy with an electric motor.

- ***Power recovery turbines***

Where practicable, pressure energy in gas streams is recovered by depressurisation through power recovery turbines.

- ***Self-contained utilities systems***

All steam and power systems will be integrated with the methanol production process on site. Process or utilities efficiency improvements will result directly in a reduction in natural gas use on site and hence CO_2 emission reductions. Energy efficiency improvements will not be inhibited by the need to develop off-site applications for surplus energy.

These measures, in conjunction with the use of best available technology, adoption of current best practice in process design and best management practice at the time of construction of the plant will result in minimisation of natural gas use and therefore minimisation of GHG emissions from the site.

Participation in the Greenhouse Challenge

GTL will participate in the Australian Greenhouse Office Greenhouse Challenge programme. This will involve:

- establishing and maintaining a greenhouse gas inventory for the plant, based on the difference between natural gas utilisation and methanol production; and
- identifying GHG emission reduction opportunities on-site and, where appropriate, committing to a timetable for their implementation.

Ongoing Monitoring of Opportunities to Minimise GHG Emissions

GTL will be invited to join the Lurgi Methanol Club, which meets annually to consider advances in methanol production technologies. Options for potential efficiency improvements and reductions in GHG emissions from the facility will be identified. The following aspects will be monitored to identify potential GHG minimisation opportunities:

- advances in catalyst technology;
- advances in equipment and process design;
- the integration of applicable renewable energy sources into the process; and
- outcomes from on-site energy audit activities.

Where potential GHG emission reduction opportunities are identified, a technical and economic assessment will be carried out to establish the feasibility of each concept. The impact on GHG emissions and the impact on the economic feasibility of the process will be assessed, and then implemented where practicable.

All potential projects will be classified as ‘economic’, ‘no regrets’ and ‘beyond no regrets’ measures for consideration (Appendix H). Capital investment projects which have a long pay back period, but which have significant GHG emission reduction potential, will be considered for funding on the basis of strategic investment. GHG reduction opportunities involving minor increases in direct operating costs (e.g. the integration use of renewable energy sources) will be evaluated in the light of the Greenhouse Challenge Programme. They will also be considered in the context of their wider impact on environmental and social outcomes in addition to their economic impact. Potential GHG reduction opportunities that are

uneconomic without an external source of finance will be assessed in cost terms of $/tonne of CO_2 emission avoided. As a carbon trading market develops, in accordance with State and Commonwealth GHG policy and legislative requirements, such projects will be considered in the light of the price of carbon on that market.

This on-going review programme of potential 'beyond no regrets' measures is consistent with the Prime Minister's undertaking "*…to ask industry to do more than they may otherwise be prepared to do, that is, to go beyond the no regrets minimal cost approach where this is sensible in order to achieve effective and meaningful outcomes"*.

7.4.3 Waste Management

EPA Objective
Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on-site or disposed off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on-site to prevent groundwater and surface water contamination or risk to public health.

7.4.3.1 Liquid wastes

Assessment
Liquid waste streams will be managed and appropriately treated to minimise the potential for contamination of the receiving environment in the vicinity of, or downstream from, the plant site. The proposed treatment and storage facilities are of sufficient capacity to handle the predicted inflows.

Prior to plant commissioning, all process and storage components (pipework, vessels, tanks, etc.) will require cleaning and testing. As this process will be undertaken sequentially, there will be ample opportunity for re-use and recycling of water. The wastewater may contain contaminants, including chemical residues and metal particulates, and will require management to ensure that no environmental impacts arise from its disposal (see below).

It is estimated that, with a maximum of 30 personnel operating the plant at any one time, 3.75 kL of sanitary wastewater will be produced daily (Beverly Stone, WA Health Department, pers. comm.). This calculation is based on the following assumptions:

- all personnel utilise shower and toilet facilities;
- basic kitchen facilities (kitchen basin and dishwasher) for tea and coffee are utilised; and
- no laundry washing facilities are provided.

Management
The philosophy of "Reduce, Reuse, Recycle" will be applied where practicable. While up to 20 m^3/h of potable water will be provided during construction from the existing Burrup scheme water supply, water use will be minimised where possible. Potable water will be produced on-site once the plant is operational and there will be minimal requirement for scheme water. Water will be recycled internally within the process wherever possible (see Figure 7) and the discharge of reusable water from the plant will be minimised.

The main liquid waste disposal streams will be managed as follows.

(i) Water used for cleaning and testing of the plant components prior to commissioning will be re-used and recycled wherever possible. At the end of the testing regime, the wastewater will be pumped to the evaporation pond for testing. If levels of contaminants and any chemical residues are sufficiently low (in accordance with criteria to be agreed with DEP), the wastewater will be disposed of into the seawater return line to King Bay or into natural drainage lines adjacent the site. If water quality is insufficient for disposal, then the water will be retained within the pond and allowed to evaporate.

(ii) Seawater return from the cooling system will be transferred via pipeline to the proposed Water Corporation outfall at King Bay (refer Section 7.3.3.1).

(iii) Brine from the water desalination plant, which will include traces of anti-scalants and anti-foaming agents, will be returned to the Water Corporation seawater return system (refer Section 7.3.3.1).

(iv) Blowdown from the Steam and Condensate System (Unit 150), which will be intermittent and of low volume (500 kg/h), could contain up to 0.01% methanol (52 g/h) and will be pumped to an evaporation pond (see below).

(v) Storm-water runoff from clean parts of the site will be discharged to natural drainage lines adjacent the site.

(vi) Drainage water from the core processing area will routed to a corrugated plate interceptor (CPI) oil/water separator unit for removal of oil, grease and suspended solids. If the CPI unit renders the water uncontaminated, then it will be discharged to drainage lines adjacent the site. If contaminants are retained in the water, then it will be pumped to the evaporation pond.

(vii) Water which may accumulate in the containment bunds surrounding any chemical storage facilities will be transferred to the evaporation pond using a liquid waste truck or a mobile pump.

(viii) Sanitary wastewater will be routed to a wastewater treatment plant (a fibreglass tank with biofilter), with the treated water pumped to landscaped areas of the plant or discharged into the seawater return stream, depending upon DEP preference.

The site collection sump was sized on the basis of a one in a hundred year storm, producing 391 mm in 24 hours over a core process area of 150 m x 150 m. Water will be released from the collection sump to drainage lines if proven to be uncontaminated.

The evaporation pond will be of sufficient size (30 m x 30 m x 1.5 m deep; 1350 m^3 capacity) to accommodate a continuous flow of 0.5 m^3/h of contaminated discharge from the process, with seasonal variations in evaporation and precipitation taken into consideration. The evaporation pond will be lined – the permeability of the liner will be confirmed during detail design, but is likely to be $<10^{-9}$ m/s.

7.4.3.2 Solid and semi-liquid wastes

Assessment

Construction waste will be classified in accordance with the DEP Guidelines for Acceptance of Solid Waste to Landfill. Although the quantities of construction waste are not quantifiable at the present preliminary design stage, examples of the types of waste typically generated are:

- inert - Debris, empty drums, empty paint and coating containers, empty and depressurised aerosol containers, scrap metal, plastics, etc.; and
- putrescible - waste paper, cardboard, wood (including packing cases), vegetation, domestic garbage and food waste, etc.

Sources of solid wastes in the operational methanol plant will be the administration and office buildings, plant area, CPI separator, sulphur removal beds and synthesis area. Many of the wastes will be similar in nature to the construction wastes detailed above, while additional solid and semi-liquid wastes are detailed in Table 7.13.

The useable life of the catalysts and resins cannot be predicted as it will be dependent upon operating practices and conditions. Catalyst life is typically in excess of one year.

Table 7.13 Typical Catalyst and Resin Wastes

Catalyst/Resin	Quantity
Hydrogenation catalysts	24 m^3 per fill
Zinc oxide catalysts – two vessels	15 m^3 each per fill
Pre-reforming catalyst	19 m^3 per fill
Steam reforming catalyst	45 m^3 per fill
Autothermal reforming catalyst	56 m^3 per fill
Methanol synthesis catalyst – two vessels	64.5 m^3 each per fill
Cation exchanger resins	2 x 10 m^3
Mixed bed filter resins	2 x 2 m^3 + 2 x 4 m^3

Management

Management of solid and semi-liquid wastes will be adequate to ensure there is minimal potential for contamination of the receiving environment in the vicinity of the plant site. A solid waste management system will be implemented at the plant, which will incorporate the following principles:

- avoidance of materials which are difficult to manage;
- replacement of materials if more environmentally acceptable, cost-competitive alternatives become available;
- segregation of waste to improve ease of management;
- reduction in the amount of waste produced;
- recovery, re-use and recycling of waste where feasible; and
- disposal of wastes in an environmentally acceptable manner where no feasible alternative exists.

Recyclable wastes will be periodically removed by a contractor; general refuse (domestic and industrial solid waste) will be disposed of at a Class II landfill; and spent catalysts and adsorption masses will be returned to the manufacturers for reclamation or disposed of by

specialist companies. The disposal of any hazardous materials will comply with local and State regulations.

7.4.4 Non-Chemical Emissions

7.4.4.1 Noise

EPA Objective
Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the *Environmental Protection (Noise) Regulations 1997*. Protect the amenity of nearby Withnell Bay from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.

Assessment
A quantitative noise assessment of the proposed GTL plant was undertaken by URS (attached as Appendix I), using the criteria for assessing environmental noise in Western Australia specified in the *Environmental Protection (Noise) Regulations 1997*. The Regulations specify "assigned noise levels" for noise receiving locations, the type of premise receiving the noise and the time of day (Table 7.14).

Table 7.14 Assigned Noise Levels not to be Exceeded by Emissions from the GTL Plant

Types of Premises Receiving Noise	Time of Day	Assigned Level		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises at locations within 15 m of a building directly associated with a noise sensitive use.	0700-1900 hours Monday to Saturday	45 + Influencing Factor	55 + Influencing Factor	65 + Influencing Factor
	0900-1900 hours Sunday & public holidays	40 + Influencing Factor	50 + Influencing Factor	65 + Influencing Factor
	1900-2200 hours all days	40 + Influencing Factor	50 + Influencing Factor	55 + Influencing Factor
	2200 hours all days to 0700 hours Monday to Saturday or to 0900 hours Sunday & public holidays	35 + Influencing Factor	45 + Influencing Factor	55 + Influencing Factor
Noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use.	All hours	60	75	80
Commercial Premises	All hours	60	75	80
Industrial and Utility Premises	All hours	65	80	90

The A-weighted sound pressure level (dBA) was used as it correlates fairly well with the human response. Since the proposed Plant will operate continuously 24-hours per day, noise emissions must not exceed the lowest assigned sound pressure levels, which are for night time, at residential premises. A sound pressure level of 20 dBA can be subjectively evaluated as almost silent.

Percentile sound pressure levels (L_N) are the sound pressure levels, which are exceeded for N percent of the measurement time. The two main percentile sound pressure level descriptors used to assess the impacts of environmental noise are:

- **L_{A10}** The A-weighted sound pressure level which is not to be exceeded for more than 10% of the representative measurement period. For a measurement period of 15 minutes, this is the sound pressure level exceeded for 90 seconds and is commonly termed the 'average maximum noise level'.

- **L_{A90}** The A-weighted sound pressure level exceeded for 90% of the time in the measurement period. For a measurement period of 15 minutes, this is the sound level exceeded for 13 minutes and 30 seconds and is commonly termed the 'background noise level'.

The "influencing factor" takes into account the amount of industrial and commercial land and the presence of major roads within a 450 m radius around the noise receiver. For the current noise assessment the "influencing factor" for the potentially most affected residences (in Dampier) was not calculated but was assumed to be zero to give a conservative assessment.

Noise levels as a result of operation of the proposed plant were predicted using the Environmental Noise Model (ENM), which is described in greater detail in Appendix I. ENM simulates outdoor sound propagation and predicts noise levels from known noise sources for close and distant locations. The model calculates attenuation due to noise source enclosure and other noise control measures, for distance from the source to the receiver, for the noise source size, type and directivity, for barriers and natural topographic features and for sound absorption in the air. Source sound power level, source location and height above ground, ground type, and meteorological conditions, which all influence the propagation of sound from the source to receiver, are specified by the model user.

GTL report a sound power level for the total plant of about 122 dBA, revised down from an initial estimate of 128 dBA in order to achieve a sound pressure level contribution not exceeding 65 dBA at the plant boundary. The technology provider, Lurgi, has committed to designing the plant to meet the 65 dBA noise limit at the plant boundary. Lurgi also advise that:

- the noisiest parts of the plant are the compressors and turbines with typical sound power levels of 115 dBA each;
- all compressors will be installed with sound hoods to reduce noise by 20 dB;
- the cooling tower will be a low noise design type with a sound power level of about 111 dBA for seven cells; and
- large turbine drives will be installed with sound hoods also.

Based on the advice from Lurgi, noise levels as a result of operation of the plant were predicted for a model of the plant comprised of essentially two noise sources:

- the cooling tower (Figure 4, Unit 650). This was modelled as seven noise sources, each with a sound power level of 102.5 dBA (to give a total of 111 dBA for the entire unit, as per Lurgi's advice). Each cooling tower noise source was located in the model at the part of the cooling tower cell closest to the southern boundary; and

- the remaining portion of the plant total sound power level, 122 dBA (total plant sound power level) – 111 dBA (cooling tower sound power level) equivalent to 121.6 dBA, was assigned to Units 700 (power generation), 800 (Instrument and Plant Air System) and 1300 (Air Separation Unit) (Figure 4).

Predicted sound pressure level contributions, as a result of operation of the GTL plant, are summarised in Table 7.15.

Table 7.15 Predicted Sound Pressure Level Contributions

Noise Receiver	Acoustically 'Neutral' Conditions (dBA)	Default Adverse Daytime Conditions (dBA) *	Default Adverse Night-time Conditions (dBA)
Dampier (nearest residential area)	3	13 (wind from north)	11
Hearson Cove (end of track)	10	20 (wind from west)	23
LPG Jetty at NWSVP Plant	36	45 (wind from east)	45 (drainage wind to west)
Withnell Bay Boat Ramp	39	48 (wind from south)	46 (drainage wind to west)

* Wind direction source to receiver

Appendix I (Figure 2) presents the predicted noise impact envelopes for residential, commercial and industrial receivers, as a result of noise emissions from the proposed plant under acoustically 'neutral' meteorological conditions. The predicted envelopes do not impinge on any residential (35 dBA), commercial (60 dBA) or existing industrial (65 dBA) receivers. Figures 3, 4 and 5 in Appendix I present predicted noise levels, as a result of noise emissions from the proposed plant, for the default adverse meteorological conditions as specified in EPA Guidance No.8 for Environmental Noise.

It can be seen from Table 7.15 that:

- noise level contributions at Dampier and Hearson Cove, as a result of operation of the GTL plant, are predicted to be well below the relevant criteria (in the case of Dampier, noting that a criterion for Hearson Cove as a recreational area currently does not exist) including for the WA DEP adverse meteorological conditions; and

- noise level contributions at the NWSVP plant LPG jetty and the Withnell Bay boat ramp, as a result of operation of the GTL plant, are predicted to be well below the relevant criteria value of 60 dBA for noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use, including for the DEP adverse meteorological conditions.

It is noted that the current modelling indicates the 65 dBA noise contour slightly projecting beyond the GTL lease boundary in the north and south directions. This result is due to assigning the total plant noise emissions excluding the cooling towers to a single building, instead of distributing it throughout the plant as would be the actual situation. The 65 dBA contour is within the GTL lease boundary for modelling with the cooling towers alone. This result demonstrates that results more closely reflect the outcome for an operating plant as the modelling is refined by the inclusion of more detail. At the current stage of development there is insufficient information to refine the modelling further, this would be done at the detailed

design phase. Lurgi has committed to designing the plant to meet the 65 dBA noise limit at the plant boundary.

Cumulative Impacts
An estimation of cumulative noise level expected at Withnell Bay as a result of the NWSVP facility and the proposed GTL plant has been calculated as 46 to 52 dBA. This calculation was performed by adding the predicted noise levels from the new GTL facility (39 to 48 dBA) with noise levels from the operating NWSVP plant (typically between 45 and 50 dBA, as measured by SVT). The predicated cumulative impact at Withnell Bay is less than the criteria value of 60 dBA for noise sensitive premises at locations further than 15 m from a building directly associated with a noise sensitive use, as detailed in Table 7.7 above. It is noted however, that there currently exists no specific regulatory criteria for recreational areas, which is the subject of current evaluation by MPR and the DEP. Through the adoption of sensible noise reduction measures to meet the 65 dBA criterion at the boundary, the GTL plant is therefore not expected to have a significant noise impact at Withnell Bay.

The EPA recognises **Hearson Cove** as an area used for passive recreational purposes. The existing background noise environment can, at times, be quite low, typically 25 to 30 dBA (SKM 2001). There are a number of other industrial facilities planned within the King Bay – Hearson Cove Industrial Area. As a result of the gradual change in landuse, the noise environment cannot be maintained at the existing levels. MPR has commissioned a study to determine what may be considered acceptable cumulative noise levels so as to maintain recreational amenity at Hearson Cove, however these results are not yet publicly available.

Table 7.16 presents a summary of "worst case" cumulative noise levels at Hearson Cove and Dampier, based on the noise predictions in this report and a summaries in the assessment reports for Burrup Fertilisers and Methanex (SKM 2001, 2002).

Table 7.16 Summary of Predicted Cumulative Noise Levels at Dampier and Hearson Cove

Project	Dampier	Hearson Cove
Methanex	23 dBA	51 dBA
Burrup Fertilisers	8 dBA	25 to 32 dBA
Syntroleum	31dBA	37 dBA
Dampier Nitrogen	21dBA	39 dBA
Sub-Total	*32 dBA*	*51 dBA*
GTL	13 dBA	23 dBA
Total	*32 dBA*	*51 dBA*

It is apparent that:

- the worst case noise contribution predicted for the GTL plant is predicted to be inaudible at Dampier assuming other planned industries go ahead;
- the worst case noise contribution predicted for the GTL plant is less than the 25 – 30 dBA range of background noise levels reported for Hearson Cove. Therefore, the GTL plant is predicted to be an insignificant contributor at Hearson Cove;
- noise levels at Hearson Cove are predicted to be dominated by noise from Methanex's proposed methanol plant; and

- the GTL plant is predicted to not increase cumulative noise levels at Hearson Cove and Dampier above those already predicted for operation of proposed industrial developments in the King Bay - Hearson Cove Industrial Area.

Noting that a recommended acceptable noise level at Hearson Cove has yet to be established by the WA Government (as previously described), the above observations confirm that the GTL project will not influence cumulative noise levels at Hearson Cove.

Construction noise and traffic noise were also considered as part of the noise assessment (Appendix I) and not considered to be significant. Nonetheless any significant noise associated with these activities can be appropriately addressed and managed as part of the Environmental Management Plan.

Conclusion
It is concluded that noise emissions from the proposed plant are predicted to not exceed the assigned levels for residential, commercial receivers. The GTL plant will not influence cumulative noise levels at Dampier and Hearson Cove, including for the DEP default adverse meteorological conditions.

The plant will be designed to meet the 65 dBA noise limit at the plant boundary, construction and traffic noise associated with the development are predicted not to be significant, and practicable noise reduction measures will be considered as part of detailed design (as detailed below). It is therefore predicted that there will be no unacceptable noise impact as a result of operation of the GTL plant and the project can be managed to meet the desired environmental objective in relation to noise.

Management
Lurgi has committed to meeting the 65 dBA criterion at the plant boundary, as well as adopting a range of noise mitigation measures such as:

- all compressors will be installed with sound hoods to reduce noise by 20 dB;
- the cooling tower will be a low noise design type to reduce the total sound power level; and
- large turbine drives will also be installed with sound hoods.

Minimisation of noise levels will be considered by an acoustic engineer during the detailed engineering design phase, to ensure noise level criteria are met and, where practicable, reduced further.

7.4.4.2 Light

EPA Objective
Manage potential impacts from plant light overspill to visitors at Withnell Bay, and offshore fauna such as turtles, if applicable.

Assessment
The potential for light overspill from the methanol plant to affect recreation amenity at Withnell Bay during non-daylight hours, or to affect the behaviour of some marine fauna (such as turtles) in Withnell Bay will be minimal due to the close proximity of the NWSVP plant.

Management
Lighting for the plant will be designed, installed and operated to best practice, consistent with site safety and security requirements. Lighting will conform with the guidelines presented in the Australian Standard AS 4282 - 1997 *Control of the Obtrusive Effects of Outdoor Lighting*. Light sources will be sited and oriented so as to minimise overspill, with light intensities optimised to providing the required degree of illumination within the plant boundary. Other overspill reduction measures will be employed as practicable, such as employing directional beams and shrouding of the sides and rears of light sources.

7.5 SOCIAL SURROUNDINGS

7.5.1 Risk to Public Health And Safety

EPA Objective
Ensure that risk to the public is ALARP and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for off-site individual fatality risk (Draft Guidance Statement No.2), and that ALARP is demonstrated, and the MPR's requirements in respect of public safety are met.

Assessment
A preliminary assessment of the potential risks to public health and safety as a result of the proposed development of the GTL plant is included as Appendix M. The primary outcomes and conclusions of the Preliminary Risk Assessment (PRA) are summarised in this section. The PRA was reviewed by MPR and a letter detailing the acceptability of the document is included in Appendix M.

The objective of the PRA was to demonstrate that, as far as reasonably practicable:

- offsite risks have been minimised, firstly through elimination of hazards and secondly through control of remaining hazards; and
- the level of risk to persons located offsite as measured by defined criteria is within tolerable limits considered acceptable to the EPA.

The risk assessment methodology was in accordance with the philosophy laid down in the EPA guidelines, through the following stages:

(1) *Hazard Identification* (i.e. identification of credible hazardous events for the facility);
(2) *Consequence Analysis* (i.e. an analysis of hazardous events identified to define causes and consequences);
(3) *Frequency Analysis* (to determine the frequency at which the hazardous events may occur);
(4) *Quantitative Risk Analysis* (quantification of the risk arising from all hazardous events by cumulatively combining the frequency and consequence for each event); and
(5) *Assessment of the total project risks* by comparing them to the EPA guidelines.

The hazards under consideration in the PRA were those associated with the operations at the GTL plant that have the potential to extend beyond the boundaries of the plant area. The study addressed all aspects nominated in the EPA guidelines and specifically included assessments of risks relating to leakage or failure of process equipment; hazards of supply, process, storage operations proposed; knock-on effects, process fires and explosions, and external events (cumulative risks); methanol export loading; and shipping.

From reviewing preliminary process information, the materials of interest in the PRA were methanol, methane (in natural gas), carbon monoxide, oxygen, hydrogen and various catalysts.

The Individual Risk Per Annum criteria as stated in EPA Bulletin 611 are:

(1) A risk level in residential zones of one in a million per year (1×10^{-6}) or less, is so small as to be acceptable to the EPA.
(2) A risk level in "sensitive developments", such as hospitals, child care facilities and aged care housing developments of between one half and one in a million per year (5×10^{-7} to 1×10^{-6}) is so small as to be acceptable to the EPA.
(3) Risk levels from industrial sites should not exceed a target of fifty in a million per year (5×10^{-5}) at the site boundary for each individual industry. The cumulative risk level imposed on an industry should not exceed a target of one hundred in a million per year (1×10^{-4}).
(4) A risk level for any non-industrial activity located in buffer zones between industrial facilities and residential zones of ten in a million per year (1×10^{-5}) or lower, is so small as to be acceptable to the EPA.

The conclusions drawn from the PRA are summarised in Table 7.17.

Table 7.17 Risk Assessment Conclusions

Risk	Conclusion
Individual Risk	The 5×10^{-5} risk contour does not extend beyond the site boundary. The 1×10^{-5} contour extends no more than 200m from the north and south of the site boundary. The areas north and south can be considered as industrial buffer zones. Therefore the plant is considered to comply with the EPA Criteria for individual risk (Figure 1.1 in Appendix M).
Impact on Adjacent Facilities	The 5×10^{-5} risk contour does not extend beyond the site boundary. The 1×10^{-5} contour extends to north and south from the site boundary, but is within 400 m of this boundary. As there are currently no proposed uses for the surrounding land, the plant is considered to comply with the EPA Criteria.
Cumulative Risks	The NWSVP plant is located approximately 1 km west from the GTL site boundary. The risk contours for the plant show the 1×10^{-6} contour extends from the eastern boundary of the processing equipment by approximately 400 m, and does not enter into the WEIA. The GTL plant 5×10^{-7} contour does not extend beyond the western boundary of the WEIA (Figure 1.1 in Appendix M).
Toxic Risks	Toxic risks from the GTL plant could arise from the CO produced in the reforming stages and consumed during methanol synthesis. This will pose negligible risk offsite.
Offsite Flammable Risks	There is minimal potential for offsite fatal impacts from methane, methanol or hydrogen releases.
Societal Risks	The Societal Risk (FN Curve) from the GTL plant is given in Figure 1.2 in Appendix M. It was concluded that the societal risk from this plant lies below the maximum for new plants within Western Australia.

Management

A thorough Quantitative Risk Assessment will be completed prior to the commencement of construction and production operations, once the detail design of the plant is finalised.

Incorporation of safety standards and features starts with the selection of technology. The overall process control philosophy, from concept to actual plant operation, will be developed

by Lurgi. They will also develop the control strategy, control systems and operator interface as well as selecting the proper field instrumentation. During all phases from engineering through to procurement and construction, quality assurance systems will be in place to ensure that the designed plant safety features are implemented correctly.

An Emergency Management Plan (see Section 8.2.2) will include measures to ensure a rapid response to identified releases, thereby facilitating early manual isolation of any leaking equipment and minimising release sizes.

If required due to an emergency, the natural gas supply will be closed-off, the reformer (Unit 100) will be shut down, and steam will be admitted to the system. If the plant is shutdown completely, steam will be continuously fed to the reformer while the temperature is gradually lowered. When the temperature is low enough, steam is replaced by nitrogen until the system cools down to ambient. The complete procedure takes approximately 12-24 hours.

Under normal operating conditions, gas from the process is not flared. However, during certain process upsets and emergency situations, the whole plant or sections of the plant may be depressurised, under controlled conditions, to the flare. This event will discharge less than one day's normal emissions to the atmosphere, with a typical flare discharge composition. The precise amount of discharge will depend upon the plant inventory, which will be known only when the plant is substantially designed.

The flare stack will be designed and positioned to minimise safety risk to the workforce, plant equipment and the natural environment. Any liquids carried towards the flare during depressurisation will be intercepted by a knock-out drum, separated from the gas stream and returned to the raw methanol tank. The likelihood of a flare-out (extinguished flare) during a major upset is extremely remote.

7.5.2 Road Transport and Traffic

EPA Objective
Ensure that roads are maintained or improved and road traffic managed to meet an adequate level of service, adequate safety standards and DPI requirements.

Assessment
During construction, portions of the plant will be shipped to Dampier in modular form and offloaded at the Mermaid Marine facility for transport to the plant site by truck. Traffic loads on Burrup Road are therefore anticipated to increase due to the construction workforce and transport of plant components and materials. Temporary access restrictions along Burrup Road may occur during transport of some plant components.

During operation of the plant there will be no significant increase in traffic on Burrup Road.

Management
A Traffic Management Plan will be developed to meet service and safety requirements. Any proposed traffic delays during these activities will be co-ordinated with the Shire of Roebourne and Main Roads WA as appropriate.

7.5.3 Culture and Heritage

7.5.3.1 Aboriginal heritage

EPA Objective
Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*.
Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.

Assessment
The Burrup region of Western Australia contains an extremely rich diversity of Aboriginal rock engravings and archaeological sites (Vinnicombe 2002). It also includes areas that are culturally significant to Aboriginal people who claim a traditional association with the area.

GTL has held meetings with the three claimant groups in the area (Ngarluma Injibarndi, Wong-Goo-Tt-Oo and Yaburara Mardudhunera) and provided them with a briefing on the project. Meetings were held in Roebourne, Karratha and Point Samson in November and December 2001, with the groups given the opportunity to ask questions and express any concerns in regards to the project. The outcomes of the heritage surveys conducted to date are summarised below.

Archaeological Survey Results
Surveys of the proposed plant site and the adjacent area required for infrastructure access were commissioned by the proponent and were conducted in October 2001. The survey identified five rock engraving sites in the general vicinity of the proposed lease area.

These sites were on the Aboriginal Sites Register of the Aboriginal Affairs Department. Of the five sites identified, only one, referred to as field site 3 and which is probably recorded as site P3519, would possibly be impacted by the construction of the GTL plant. This site, which consists of several small rock engravings, is located just to the north of the proposed project lease area. Management of site P3519 is discussed below.

Consultation with one of the three native title claim groups who claim to have traditional connection with the Burrup has been completed and they have raised no objection to the use of the project site.

Ethnographic Survey Results
There are no recorded sites of ethnographic (i.e. mythological, religious or cultural) significance to Aboriginal people that would be affected by the proposed developments. The proponent has undertaken a specific survey for any such sites with the Yaburara Mardudhunera people, who are one of the three groups claiming to hold native title interests over the Burrup area. No sites of ethnographic significance were identified by the survey.

The remaining two claim groups, the Wong-Goo-Tt-Oo and Ngarluma Injibarndi initially advised the proponent that they are not prepared to undertake ethnographic surveys until native title negotiations are completed. One of these groups, the Ngarluma Injibarndi, have subsequently advised that they will undertake the survey and it is planned to be completed following the finalisation of the native title negotiations.

In previous surveys of the area and evidence given to the Federal Court in the hearing of the native title claims by all three groups, no areas of ethnographic or cultural significance were identified that would be adversely impacted by the project.

Management
Heritage surveys with all native title claimant groups with an interest in the Burrup Peninsula have been partially completed, with outstanding surveys with the Wong-Goo-Tt-Oo and Ngarluma Injibarndi people dependent on the resolution of Native Title negotiations in the near future. GTL remains committed to ensure that consultations with these parties continue with the objective of achieving a mutually agreeable resolution. Aboriginal heritage surveys (both archaeological and ethnographic) of the plant site will be completed prior to any land disturbance, and proposed management strategies identified in the EMP in accordance with the *Aboriginal Heritage Act*.

Clearance will be obtained from the local Aboriginal community and the Minister for Aboriginal Affairs if significant sites are identified from consequent surveys.

As part of the proponent's ongoing heritage management programme it will ensure that any archaeological sites in the general vicinity of the project (other than those for which an *Aboriginal Heritage Act 1972* Section 18 approval has been given) are adequately marked and protected from disturbance or interference during construction and operational phases of the project. Protection options will be discussed with local Aboriginal group and with the Department of Indigenous Affairs. It is likely that Site P3519 will be fenced to ensure that it is not inadvertently damaged during construction.

The project workforce for both construction and operations will be provided with cultural awareness training. This training will include a section on the requirements of the *Aboriginal Heritage Act 1972* and the protection of cultural heritage sites in the general area as well as specific procedures to be followed in the unlikely event that a site of cultural heritage or archaeological significance is discovered in the course of construction work.

The proponent will put in place a monitoring programme to cover the initial site preparation work. This programme will include procedures to deal with any archaeological sites (i.e. burials, art sites, artifacts or shell middens) that may be uncovered in the course of earthworks.

The proponent has also indicated that it is prepared to assist Aboriginal people, along with the State and other developers, in the future management of the important cultural heritage values of the Burrup Peninsula. This may include the development of an Aboriginal cultural centre to provide information for visitors to the area.

7.5.3.2 Register of the National Estate

EPA Objective
Identify any areas in close proximity to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Commission Act 1975*.

Assessment
Of the places list under the National Estate (Table 5.4), the Dampier Archipelago is the only 'Place' that may be impacted by the proposed shipping of methanol. Potential Impacts to the marine environment and habitats of the Dampier Archipelago are discussed in Section 7.2. It is not possible to establish whether the three Indigenous Places listed on the register are within the GTL site, as descriptions and locations are not provided.

7.5.4 Visual Amenity

EPA Objective
Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse. Not to compromise recreational uses of the Withnell Bay area, as developed by local authority and planning agencies.

Assessment
The plant and facilities will be designed to minimise the visual impact. A visual impact assessment, included as Appendix J, was undertaken to assess the anticipated impacts on visual amenity as a result of the proposed development. Withnell Bay is a recognised recreational area for the local community and the likelihood of potential visual impacts at that location was investigated during the environmental assessment process and through further stakeholder consultations.

The visual impact of the proposed plant from adjacent public viewpoints (e.g. nearby public roads and the Withnell Bay boat ramp area) was determined. Computer generated models in combination with photographs from public viewpoints were developed to enable the proposed plant to be viewed in the context of the existing landscape and infrastructure (see Appendix J).

In the context of existing industrial infrastructure (i.e. NWSVP plant) the visual impact of the proposed GTL plant is not considered to be largely significant and due to existing topography, the views of the plant from adjacent public areas will not be unduly adverse or visually intrusive (see Figure 13). Views of the proposed plant from the most commonly visited public recreation site in the vicinity (Withnell Bay boat ramp) would be either partly or fully obscured by intervening landforms.

The proposed plant will not impact on the visual amenity of residents in the Dampier and Karratha or the popular recreation area of Hearson Cove as views of the GTL project area from the south are obscured by a series of high rocky ranges.

Management
To improve the visual amenity of the GTL plant, the following management strategies will be undertaken:

- appropriate paint colour schemes will be used to blend the plant into the surrounding landscape and limit visual impact and intrusion;
- all temporary disturbances will be revegetated with local plant species
- all equipment and other tools will be housed or stored as required at all times; and
- maintain a high standard of housekeeping.

At the time of decommissioning, the facilities will be removed and the site rehabilitated and landscaped according to a decommissioning and rehabilitation plan.

7.5.5 Workforce Accommodation

As described in Section 2.4.3, GTL is aware of the potential for this and other proposed projects to place additional pressure on the local housing situation. Housing availability for operational staff is being investigated along with employment arrangement options and assistance will be sought from the relevant authorities.

GTL has recently accepted an invitation to join a multi-stakeholder taskforce, chaired by the DPI, to address these issues.

7.5.6 Recreational Access

The current public access to the Withnell Bay boat launching and recreational area will not be adversely affected and improved access will result from the sealing of the Withnell Bay Road. GTL recognises that improvement of the existing unsealed road to Withnell Bay during the operational phase may increase access to the bay for recreational boaters with non-4WD vehicles. The potential impacts of a greater level of access to this area will be considered, so as to ensure that the recreational and environmental values are not adversely affected as a result of the project.

GTL will not place any limitations on access to Watering Cove. Access to the track leading to Watering Cove will be maintained via the Mt Wongama Road which will be re-aligned slightly along the northern boundary of the GTL lease.

8.1 ENVIRONMENTAL MANAGEMENT PLAN

GTL will develop a comprehensive Environmental Management Plan (EMP) to establish management and monitoring plans which ensure that actual and potential impacts associated with the construction, operation and decommissioning phases of the methanol plant are minimised, and that compliance with all relevant environmental regulations is achieved.

The specific objectives of the EMP will be to provide a planned structure which will:

- ensure that construction activities are undertaken in an appropriate manner and that impacts on the environment are minimised and monitored;
- ensure that impacts associated with the operational phase of the development are minimised and monitored; and
- minimise the risk of potential effects from unexpected incidents, and ensure that appropriate contingency plans are in place in the event of such incidents.

The EMP also identifies the timing and scope of individual components of the environmental management plan, and serves as a compliance document - recording the progress of management commitments and their conformity with requirements set by authorities and expectations of the public. An EMP is therefore a means of both documenting and auditing environmental management commitments made by the proponent

The EMP will provide detailed management plans for both construction and operational components of the methanol project, within which an *Environmental Effects and Management Register* will be outlined. These will detail the relevant environmental factors, potential effects related to each activity, applicable legislation and guidelines, and the proposed implementation strategy to address those environmental effects (including management commitments, performance objectives, proposed monitoring activities to be undertaken, and performance criteria).

Table 8.1 provides a summary of the environmental issues related to the proposed development of the methanol plant, and management commitments by GTL to ensure that the project is managed in an environmentally responsible manner. This will form the basis of the management strategies to be addressed in the EMP to the satisfaction of the EPA, DEP and other Government authorities.

Outlines for Construction and Operations Environmental Management Plans are presented as Tables 8.2 and 8.3. These contain summaries of the specific commitments made by GTL for the construction and operational phases of the proposed plant. The tables also list the objective of each commitment, the phase of the project at which each commitment will be implemented and the departments and agencies to be consulted for advice.

Table 8.1 Summary of Environmental Effects and Management Strategies

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
Terrestrial flora	Vegetation communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Six broad-scale vegetation types occur on the GTL lease. These types are further divided into 20 vegetation assemblages, some of which are considered to be of significant conservation value (on the basis of Trudgen 2002).	Approximately 15 ha of vegetation will be removed. It is difficult to reliably determine the significance of impacts due to limitations in existing mapping and lack of wet season data. Weed species that have established on the Burrup may spread during construction and operation of the proposed plant. Modelling indicates that air emissions from the site will not result in any increases in maximum downwind pollutant concentrations. No impacts on vegetation are therefore expected.	Implement a vegetation and flora management plan to better assess significance of vegetation types and minimise disturbance to vegetation communities. This will include a wet season vegetation survey when suitable conditions occur. Develop a weed management plan to prevent the spread of weeds and introduction of new weed species.
	Declared Rare and Priority Flora; Flora of Conservation Significance	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect flora listed in the Schedules of the *Environment Protection Biodiversity Conservation Act 1999* (*EPBC Act*). Protect other flora species of conservation significance.	Two listed Priority species (under the WA *Wildlife Conservation Act 1950*) have been recorded on the GTL lease - *Terminalia supranitifolia* and *Eriachne tenuiculmis.* Neither species is listed under the *EPBC Act.*	Where clearing of vegetation cannot be avoided, some individuals of Priority species may be removed. Modelling indicates that air emissions from the site will not result in any significant increases in maximum downwind pollutant concentrations. No impacts on Priority species are therefore expected.	Seed collection of any prominent flora species present, including Priority Flora species, will occur as soon as possible, to ensure the availability of species for rehabilitation. Germination trials will commence prior to construction. During the rehabilitation process, attempts will be made to restore any Priority Flora species disturbed by the project.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
Terrestrial fauna	Specially Protected (Threatened) Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*. Protect fauna listed on the Schedules of the *EPBC Act*.	An estimated 44 species of mammal, 165 species of bird and 92 species of reptile inhabit the Burrup Peninsula and the surrounding area. Potentially important species which may inhabit the lease area are: • Pilbara Olive Python (listed as threatened under the *Wildlife Conservation Act 1950* and vulnerable under the *EPBC Act*); and • Western Pebble Mound Mouse (listed as a Priority 4 species on the WA Priority Fauna List). The three species of land snails present within the lease area are not considered to be rare or endangered. Feral animals such as cats, foxes and mice may occur on the proposed site.	Removal and disturbance of potential fauna habitat during plant construction. Potential to improve conditions for feral animals, therefore causing populations to increase. Modelling indicates that air emissions from the site will not result in any significant increases in maximum downwind pollutant concentrations. No impacts on terrestrial fauna are therefore expected. No major disruption to land snail populations from the development of the proposed plant is anticipated as the three species recorded on the site are widespread on the Burrup Peninsula	Implement a fauna management plan to ensure that disturbance of fauna habitats will be minimised. Surveys to investigate the occurrence of Priority Fauna species will be conducted prior to construction and if required will be updated on a regular basis.
Landform, drainage and site hydrology	Landform	Maintain the integrity, functions and environmental values of landforms.	There are two major landforms on the project lease and the immediate surrounds: • Rocky outcrops and scree slopes; and • Valleys, drainage gullys and alluvial fans.	The 15 ha site will be levelled prior to construction of the plant. Volumes of cut and fill are anticipated to be similar and there is unlikely to be a requirement for the significant import of material to the site. Any excess material will be retained on site for potential future use.	The plant site has been located within the lease area so as to minimise landform disturbance. Earthworks outside of the plant site will be minimised.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
	Drainage, site hydrology and surface water	Maintain the integrity, functions and environmental values of natural surface water drainage. Maintain the integrity, function and environmental values of watercourses and sheet flow.	Drainage across the lease area is typically to the north-west. Most rainfall is channelled across the surface in small, ephemeral drainage lines. There are no permanent water bodies in the lease area.	A drainage line crossing the eastern end of the plant site will be diverted to the east during construction. The upper reaches of two minor drainage lines will be truncated during construction. This will alter surface and shallow groundwater flows.	The eastern drainage line will be diverted in such a way that erosion is minimised. Uncontaminated stormwater from the plant site will be discharged into the drainage lines to maintain their function and to minimise disturbance of the surface water balance.
	Ground and surface water quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance, are protected consistent with the National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality.	The site is not considered to be a significant recharge or discharge area to the deeper groundwater system, and significant aquifer zones are considered unlikely to be present.	Vegetation clearing, soil stockpiling and diversion of drainage lines during construction could lead to increased runoff and erosion, which could adversely affect downstream water quality. Once operational, pollutants with the potential to impact on ground and surface water quality are methanol, fuels and lubricants.	Water discharge from the site will be managed so as to minimise the potential for adverse impacts on the downstream environment, including Withnell Bay. A comprehensive management system will be established prior to the commencement of plant construction, to ensure there is minimal impact on ground and surface water resources. Pre-development ground and surface water data will be collected and a monitoring programme initiated. The programme would continue throughout plant construction and operation, to ensure contamination sources are identified and contaminants are retained within the site. Once operational, all stormwater potentially contaminated with hydrocarbons will be directed either to a corrugated plate interceptor or direct to an evaporation pond.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
Marine ecology including sea floor, marine flora and fauna	Seawater supply	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided.	King Bay is fringed with mangroves and rocky shorelines. Intertidal mudflats extend seaward from the mangroves, extending into a subtidal sandy seabed. Diverse invertebrate fauna communities are present in all of the above habitats. Fish utilise the King Bay mangroves and seafloor for feeding.	The intake and discharge of water through the Water Corporation infrastructure in King Bay could lead to increases in turbidity in the bay, dispersion of entrained contaminants and elevations in water temperature. This may have some localised impact on the invertebrate and fish populations in the vicinity of the intake and outfall structures.	Impacts associated with water extraction from King Bay will be managed by the Water Corporation. Quality of return water will managed to ensure that DEP criteria are met prior to discharge of the water into King Bay.
	Methanol loading	Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided.	The Dampier Public Wharf abuts a rocky shoreline supporting a diversity of invertebrates, including oysters and corals. The subtidal sandy seafloor also supports a diverse invertebrate community. Fish utilise the habitats around the wharf, including the wharf itself, for feeding and shelter.	Methanol is highly miscible in water and any product spilled during vessel loading would rapidly disperse into the waters surrounding the wharf. Depending upon the size of the spill, some localised mortality of fish and invertebrates may occur.	A fibre optic link between the wharf and the plant site will allow an automatic shutdown of the loading pumps in the event of a mishap during vessel loading. This will minimise the quantity of methanol spilled into the marine environment.
	Increased shipping	Minimise the risk of introduction of unwanted marine organisms consistent with the AQIS *Guidelines for Ballast Water Management* and ANZECC *Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance*.	Localised elevations in the concentrations of metals and organotins are present in export berths within the Port of Dampier and are likely to occur in the vicinity of the Dampier Public Wharf.	Potential introduction of unwanted marine organisms from ballast water or from hull fouling. Such species could displace or adversely affect native marine species. Some species could have adverse impacts upon nearby infrastructure. Increased frequency of shipping at the Dampier Public Wharf is likely to lead to further minor increases in the concentrations of metals and organotins in the sediments adjacent to the wharf.	Each vessel associated with the import of materials during plant construction or with product export during plant operation will be required to exchange ballast water in accordance with AQIS guidelines. In-water hull cleaning and vessel maintenance is prohibited within the Port of Dampier. This reduces the potential for the introduction of unwanted marine organisms and limits the input of metals and organotins to the marine environment.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
				The methanol vessels will increase the risk factors associated with vessel movements (collisions, groundings, etc.) within the Port.	Movements of methanol vessels within the Port will be in accordance with the Port Authority Regulations 2001. The regulations require that the vessels will enter and depart the Port under the guidance of a Pilot.
Atmospheric emissions	General	(i) Ensure that gaseous emissions, from this proposal, in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria (including the NEPM for Ambient Air Quality, with advice sought from the DEP on specific pollutants as necessary) or cause an environmental or human health/amenity problem. (ii) Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke.	Existing emission sources within the Dampier and Karratha region include the NWSVP plant and the Hamersley Iron power station. Potential future emission sources include the expansion of NWSVP's LNG processing facilities and proposed fertiliser and gas-to-liquids plants in the King Bay – Hearson Cove area.	Primary gaseous emissions from the plant will include oxides of nitrogen, carbon monoxide, carbon dioxide and small amounts of sulfur dioxide and particulates. Maximum predicted ground level concentrations of pollutants due to emissions from the methanol plant and other sources on the Burrup were modelled and shown to be well below respective guideline criteria. The anticipated emissions due to the GTL plant are not predicted to significantly increase maximum predicted ground level concentrations from existing levels. No adverse impacts on local air quality are therefore expected as a result of these emissions. An assessment of the potential for the methanol plant to contribute to smog generation in the region using the TAPM model, showed that the proposed GTL plant emissions do not change the maximum predicted concentrations of NO_2 or ozone in the region from current levels.	Upon commissioning, it is proposed that a programme of stack emission monitoring be undertaken to verify the emission estimates used in this impact assessment. It is proposed that the monitoring programme during commissioning would be undertaken on an annual basis and reported to the DEP. The potential for off-site dust emissions to occur during the construction of the facility would be minimised through the development and implementation of an environmental management plan that would be prepared for this phase of the project. Vapour recovery systems will ensure that the majority of any fugitive emissions of nitrogen and methanol vapour from ship loading activities will be contained and returned to the methanol storage tanks to minimise emissions of volatile organic compounds.
	Odour	No unreasonable impacts at boundary of the plant.	There are currently no sources of odour from the project lease.	Under normal operating conditions, there would be no emissions from the methanol plant that could give rise to off-site odour impacts.	Management of odour is not anticipated to be a concern in regard to the GTL plant, though monitoring will be instigated during plant commissioning to test this.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
	Dust	(i) Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity. (ii) Use all reasonable and practicable measures to minimise airborne dust.	The project lease currently has vegetation cover, which limits dust generation. In 2000 the concentrations of particulate matter in the wider Dampier and Karratha region exceeded NEPM standards 18 times. The major causes were likely to be bush fires, ship loading operations and local iron ore stockpiling.	During construction of the plant there is potential for mechanically generated and wind-blown dust to be emitted off-site, which could adversely impact upon nearby vegetation or reduce public amenity in the vicinity of the plant site. These dust particles will predominantly contain the larger size fractions (>20 µm) and will therefore be expected to affect local dust deposition levels and TSP concentrations rather than PM_{10} or $PM_{2.5}$ concentrations. The construction activities will also be relatively localised and well away from the nearest residential dwelling, which is located 10 km to the southwest.	Dust suppression measures will be utilised during construction of the plant, such as: • the use of water sprays to wet the site during dry, windy conditions; • the use of speed limits to minimise dust generated by vehicle movements; • the use of minimum drop heights when loading and unloading soils and other excavated material; and • minimising areas of disturbed, exposed soils.
	Greenhouse gases	To minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. Mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies including EPA Interim Guidance No 12.	There are no existing sources of greenhouse gas emissions within the lease area. Currently, the NWSVP plant and Hamersley Iron power station are the primary regional sources of greenhouse gas emissions.	Carbon dioxide will be the main greenhouse gas emitted from the plant. Annual greenhouse gas emissions (CO_2 equivalent) will be approximately 451,600 tonnes. This represents approximately 0.12 % of Australia's total net energy greenhouse gas emissions.	"No regrets" measures to be considered during plant design include: • efficient reforming process; • recovery of waste heat; • no fugitive emissions or flaring; • steam turbine drives • power recovery turbines, and • self-contained utility systems. GTL will participate in the Australian Greenhouse Office *Greenhouse Challenge* programme. During the operation of the proposed plant, ongoing monitoring of greenhouse gas emissions will occur, to assist in identifying opportunities to improve efficiency and reduce emissions.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
Waste	Liquid and solid waste disposal	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on-site or disposed off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on-site to prevent groundwater and surface water contamination or risk to public health.	There are no existing sources of liquid and solid wastes within the project lease area.	Unless properly treated, waste streams could contaminate the receiving environment in the vicinity of, or downstream from, the plant site.	Liquid waste disposal streams will be managed as follows. 6. Seawater blowdown from the cooling system will be discharged via the Water Corporation outfall into King Bay. 7. Stormwater runoff from clean areas of the site will be discharged to drainage lines adjoining the site. 8. Contaminated water will be routed to an evaporation pond. 9. Uncontaminated water will be discharged to natural drainage lines (if fresh) or to the seawater return system. 10. Treated sanitary wastewater will be disposed in accordance with DEP requirements. A ground and surface water quality monitoring programme will be implemented to ensure any impacts are detected. The quality of the water discharged to the Water Corporation outfall will be monitored to ensure compliance with discharge quality criteria. Semi-liquid wastes will be disposed off-site at approved facilities. A solid waste management system will be implemented at the plant. • Recyclable wastes will be periodically removed by a contractor. • General refuse (domestic and industrial solid waste) will be disposed to landfill. • Solids from clarification of water in the corrugated plate interceptor will be disposed off-site at approved facilities.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
					• Spent catalysts and adsorption masses will be disposed of by specialist companies. The disposal of hazardous materials will comply with local and State regulations.
Other emissions	Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the *Environmental Protection (Noise) Regulations 1997*. Protect the amenity of nearby Withnell Bay from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.	There are no existing sources of noise pollution in the project lease area. The NWSVP plant is the principal anthropogenic noise source in the vicinity of Withnell Bay.	Modelling of predicted noise levels during operation of the plant indicates that assigned levels for residential, commercial and industrial receivers will not be exceeded. Contribution towards cumulative noise levels are also not predicted to adversely impact on recreational amenity of Hearson Cove and Withnell Bay.	Minimisation of noise levels will be considered during the detailed engineering design phase, to ensure noise level criteria are met. The plant will be designed to ensure that the boundary criterion of 65 dBA will be met.
	Light	Manage potential impacts from plant light overspill to visitors at Withnell Bay, and offshore fauna such as turtles, if applicable.	There are no existing artificial light sources in the project lease area. The nearby NWSVP plant is a substantial source of light overspill into Withnell Bay.	Light overspill could impact nearby sensitive receptors, such as visitors to Withnell Bay. Disturbance to fauna behavioural patterns may also occur.	Lighting will be operated to best practice, consistent with site safety and security requirements. Lighting will conform with the guidelines presented in the Australian Standard AS 4282-1997 *Control of the Obtrusive Effects of Outdoor Lighting*. Light sources will be oriented to minimise overspill, whilst providing the required degree of illumination within the plant boundary. Overspill reduction measures such as directional beams and shrouding of the sides and rears of light sources will be employed where practicable.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
SOCIAL SURROUNDINGS					
Public health and safety	Risk and hazard	Ensure that risk to the public is as low as reasonably practicable (ALARP) and complies with acceptable standards. Ensure that risk is managed to meet the EPA's criteria for off-site individual fatality risk (Draft Guidance Statement No.2), and that ALARP is demonstrated, and the MPR's requirements in respect of public safety are met.	The sites most sensitive to potential impacts from the construction and operation of the plant are Withnell Bay and the NWSVP plant.	Potential in-plant hazards are chemicals (e.g. methanol, methane and hydrogen), operating conditions and pressure system components (e.g. furnaces, compressors). Potential hazards during product export are associated with the methanol export pipeline, ship loading and shipping. A Preliminary Risk Assessment has been undertaken in accordance with EPA Guidance for off-site risk. Calculated individual, cumulative and societal risks are within EPA acceptance criteria.	Three risk reduction measures will be implemented. 1. The development of a Safety Management Plan; 2. The implementation of an Emergency Response Plan that provides a rapid response to identify releases that would facilitate early manual isolation of any leaking equipment. 3. The development of an Emergency Management Plan.
	Road transport and traffic impacts	Ensure that roads are maintained or improved and road traffic managed to meet an adequate level of service, adequate safety standards and Dept for Planning and Infrastructure requirements.	The road from Burrup Road to Withnell Bay and the road to Mt Wongama are both unsealed.	During plant construction, traffic loads on Burrup Road will increase due to the construction workforce and transport of plant components and materials. Temporary access restrictions may occur during transport of some plant components. During operation of the plant there will be no significant increase in traffic on Burrup Road.	Withnell Bay Road will be upgraded prior to the transport of heavy loads to the site. A Traffic Management Plan will be developed to meet service and safety requirements.
Culture and heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972*; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Five archaeological (rock engraving) sites have been identified within the general vicinity of the lease area. No sites of ethnographic significance have been identified which could be affected by the proposed development. Heritage surveys with Native Title claimant groups with interests in the Burrup	One of the five archaeological sites identified (P3519) could potentially be impacted by plant construction.	GTL will make every effort to preserve site P3519. However if due to engineering constraints this is not possible, the company will seek approval under section 18 of the Aboriginal Heritage Act, to relocate engraved rocks away from the construction area. If site P3519 can be retained in its present location, then it will be fenced prior to construction to protect it from inadvertent damage.

Table 8.1 Summary of Environmental Effects and Management Strategies (cont'd)

Environmental Factor	Site Specific Factor	Management Objective	Existing Environment	Potential Impacts	Environmental Management
			Peninsula have been partially completed.		The construction and operations workforces will be provided with cultural awareness training. Initial site preparation works will be monitored to ensure that any presently unrecorded sites which may be uncovered are managed appropriately.
	Register of the National Estate	Identify any areas in close proximity to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the *Australian Heritage Act*.	Six registered places and two indicative places are present in the general Burrup region.	Of the eight places, only the Dampier Archipelago could potentially be impacted. Potential impacts would be limited to those associated with vessels traversing Mermaid Sound – introduced marine pests, vessel collisions or groundings etc.	Vessels associated with the construction phase or exporting methanol will comply with AQIS guidelines with respect to ballast water exchange, thereby minimising the potential for introduction of marine pests into the Archipelago.
Aesthetic	Visual amenity and recreation	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse. Not to compromise recreational uses of the Withnell Bay area, as developed by local authority and planning agencies.	There are currently no sources of visual pollution in the lease area. However, the NWSVP plant is almost adjacent the lease area and presents an industrial landscape at the southern end of Withnell Bay.	In the context of existing infrastructure (i.e. NWSVP plant) the visual impact of the proposed GTL plant is not considered to be largely significant and due to existing topography the visual amenity of the plant from adjacent public areas should not be unduly adverse. Views of the plant from the nearby public recreation site (Withnell Bay boat ramp) would be either partly or fully obscured by the existing topography.	Measures will be implemented to minimise the visual impact of the plant (e.g. selection of colours to maximise blending of the infrastructure into the surrounding environment).

Table 8.2 Construction Environmental Management Plan

Commitment No.	Description	Objective	Timing	Advice From
EPC 1	Prior to submitting a Works Approval application, the proponent will: • confirm the engineering design details for the emission of gaseous pollutants, including stack heights and diameters, exit temperatures and exit velocities; • confirm the estimated concentrations of gaseous emissions; • demonstrate that best practicable technology is being applied to reduce pollutants in atmospheric emissions and wastewater discharges; • characterise the physico-chemical composition and flow rate of wastewater streams; and • confirm the annual loads of all non-negligible contaminants and nutrients in the wastewater streams.	To more accurately define the plant design details and emissions characteristics, permitting comparison with the preliminary data provided in the PER.	During detail design	Water Corporation
EPC 2	Ensure that greenhouse gas 'no regrets' measures are considered in the detailed process and plant design phases, including: • efficient reforming process; • recovery of waste heat; • no fugitive emissions or flaring; • steam turbine drives; • power recovery turbines; and • self contained utility systems.	To minimise greenhouse gas emissions in absolute terms and to reduce emissions per unit product to as low as reasonably practicable.	During detail design	Australian Greenhouse Office
EPC 3	Consider plant noise levels during detailed engineering design.	To ensure compliance with boundary noise criteria and to determine contribution of noise at Withnell Bay.	Prior to construction	
EPC 4	Inform the EPC contractor that they are required to develop a Construction Environmental Management Plan comprised of a series of management plans including:	To manage all relevant environmental factors associated with the construction phase of the project.	Prior to construction	CALM Mineral and Petroleum Resources

Table 8.2 Construction Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
	• Vegetation and Flora Management Plan; • Weed Management Plan; • Fauna Management Plan; • Erosion and Surface Water Management Plan; • Dust Management Plan; • Noise Management Plan; • Solid Waste Management Plan; • Hazardous Materials Management Plan; • Traffic Management Plan; • Cultural Heritage Plan; • Safety Management Plan; • Emergency Response Plan (including Cyclone Contingency Plan); and • Emergency Management Plan.			WA Museum Commissioner of Soil & Land Conservation
EPC 5	1) Prepare a Vegetation and Flora Management Plan addressing: • locations of vegetation communities and identify areas to not be disturbed through optimisation of plant layout; • site clearance procedures; • procedures for rehabilitating areas of temporary disturbance; • results of an additional vegetation/flora survey at an optimal time following wet season rains; • seed collection of any prominent flora species present, including Priority Flora species, to ensure the availability of species for rehabilitation; • germination trials prior to and following construction, with a particular focus on the Priority 1 species *Terminalia supranitifolia*; • during the rehabilitation process, attempts will be made to restore any Priority Flora species disturbed by the project. 2) Implement the Vegetation and Flora Management Plan.	Manage construction works to minimise disturbance to significant vegetation communities and priority flora. Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Prior to construction During construction	CALM
EPC 6	1) Prepare a Weed Management Plan which will include obtaining fill from a weed-free source and identifying best practice weed management procedures in consultation with CALM. 2) Implement the Weed Management Plan.	To prevent the spread of weeds and the introduction of new weed species.	Prior to construction During construction	CALM

Table 8.2 Construction Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
EPC 7	1) Prepare a Fauna Management Plan that includes: • ensuring physical disturbance is kept within designated areas; • incorporating drainage design features aimed at maintaining water flows to major drainlines. • progressive rehabilitation of disturbed sites to maximise fauna habitat; • results of an additional survey to further investigate the occurrence of Priority Fauna species prior to construction (which, if required, will be updated on a regular basis); • establishment of procedures, monitoring requirements, workforce training and responsibilities to minimise disturbance of significant terrestrial fauna; • support for collaborative research programmes investigating the presence of the Pilbara Olive Python on the Burrup Peninsula. • CALM requirements regarding the Rock Wallaby Protection Programme. 2) Implement the Terrestrial Fauna Management Plan.	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950.* Protect fauna listed on the Schedules of the *EPBC Act*.	Prior to construction During construction	CALM
EPC 8	1) Prepare a comprehensive Erosion and Surface Water Management Plan, which addresses the following: • vegetation clearing and stockpiling; • diversion of drainage lines; • surface water monitoring programme; and • stormwater management. 2) Implement the Erosion and Surface Water Management Plan.	To minimise erosion and impacts on downstream environments	Prior to construction During construction	Commissioner of Soil & Land Conservation
EPC 9	Sufficient on-site fill is predicted. Should additional fill be required, approval from the Shire of Roebourne will be obtained to extract this from an alternative source.	To minimise earthworks outside of plant site.	Prior to construction	Shire of Roebourne
EPC 10	1) Prepare a Dust Management Plan, which will include measures such as: • the use of water sprays to wet the site during windy conditions; • the use of speed limits to minimise dust generated by vehicle movements; • the use of minimum drop heights when loading and unloading soils and other excavated materials; and • minimise areas of disturbed, exposed soils. 2) Implement the Dust Management Plan.	To minimise environmental or human health problem or significantly impact on amenity.	Prior to construction During construction	Commissioner of Soil & Land Conservation

Table 8.2 Construction Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
EPC11	1) Prepare a Noise Management Plan for construction activities to minimise noise generation, including: • the use of low noise equipment where practicable; • use of silencers where necessary; and • noise monitoring and reporting. 2) Implement the Noise Management Plan.	To minimise construction noise emissions and comply with Noise Regulations.	Prior to construction During construction	
EPC 12	1) Prepare a Solid Waste Management Plan, which will include the following management measures. • Recyclable wastes will be periodically removed by a contractor. • General refuse (domestic and industrial solid waste) and putrescible wastes will be disposed of at a Karratha Class II landfill. 2) Implement the Solid Waste Management Plan.	To minimise potential contamination to the receiving environment.	Prior to construction During construction	Shire of Roebourne
EPC 13	1) Prepare a Hazardous Materials Management Plan, which complies with local and State regulations. 2) Implement the Hazardous Materials Management Plan.	To minimise potential adverse effects, risk and liability associated with hazardous materials.	Prior to construction During construction	Mineral and Petroleum Resources
EPC 14	1) Prepare a Traffic Management Plan, which will cover the following: • traffic flow patterns and scheduling of traffic movements; • public safety, awareness and signage during construction; • capacity of existing road conditions to support proposed heavy loads and road usage; • monitoring the transportation of oversized loads; and • restriction of vehicle access to designated routes such that unnecessary disturbance to the surrounding environment is prevented. 2) Implement the Traffic Management Plan.	To minimise potential traffic impacts and ensure public safety during construction.	Prior to construction During construction	Main Roads Western Australia Shire of Roebourne

Table 8.2 Construction Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
EPC 15	Provide input to the Nickol Bay Accommodation Taskforce	To assist in the planning of accommodation and social infrastructure in Karratha and Dampier.	Prior to construction	Department for Planning & Infrastructure
EPC 16	1) Develop a Cultural Heritage Plan in consultation with Aboriginal groups. 2) Implement the Cultural Heritage Plan, including the provision of cultural awareness training to the construction workforce.	To increase personnel awareness of any Aboriginal sites of significance uncovered during construction.	Prior to construction During construction	Department of Indigenous Affairs
EPC 17	Complete archaeological and ethnographical surveys of the project site with all appropriate Aboriginal groups.	To identify any unrecorded sites of significance to local Aboriginal groups.	Prior to construction	Department of Indigenous Affairs
EPC 18	If it is possible to preserve Aboriginal heritage site P3519, then it will be fenced during construction.	To protect site P3519 from inadvertent damage.	Prior to construction	Department of Indigenous Affairs
EPC 19	If it is not possible to preserve Aboriginal heritage site P3519, due to engineering constraints, an approval will be sought under section 18 of the *Aboriginal Heritage Act*, to relocate engraved rocks away from the construction area.	To preserve the petroglyphs at an alternative location.	Prior to construction	Department of Indigenous Affairs
EPC 20	Monitor site preparation works to ensure that any presently unrecorded Aboriginal heritage sites, which may be uncovered, are managed appropriately.	To minimise disturbance to areas of Aboriginal and cultural significance.	During construction	Department of Indigenous Affairs
EPC 21	Prepare and implement the following plans: • Safety Management Plan • Emergency Response Plan • Emergency Management Plan In general, the following will be addressed: • provision of fire fighting equipment; • reporting of fires • alarms and communication signals; • muster points; • evacuation procedures; and • preparedness and procedures for cyclones.	To ensure that the risk to public safety is as low as reasonably practicable and to minimise the potential creation of hazardous working environments.	During construction	MPR Fire and Emergency Services Authority

Table 8.2 Construction Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
EPC 22	Document any complaints received from the community on a register and investigate substantiated complaints.	To ensure that social environmental impacts are minimised.	During construction	Shire of Roebourne
EPC 23	Undertake a Quantitative Risk Assessment, based upon final plant design, to assess all risks and hazards associated with plant operation and product export.	To ensure all risks and hazards are reduced to as low as reasonably practicable levels.	Prior to commissioning	MPR

Table 8.3 Operations Environmental Management Plan

Commitment No.	Description	Objective	Timing	Advice From
O&M 1	Inform the Operations and Maintenance contractor that they will be required to develop an Operations Environmental Management Plan comprised of a series of management plans including: • Flora and Vegetation Management Plan; • Fauna Management Plan; • Landscaping Plan; • Erosion and Sediment Management Plan; • Methanol Spill Contingency Plan; • Water Quality Management Plan; • Dust Management Plan; • Noise Management Plan; • Solid Waste Management Plan; • Liquid Waste Management Plan; and • Hazardous Materials Management Plan.	To manage all relevant environmental factors associated with the operation phase of the project.	Prior to commissioning	CALM MPR WA Museum Commissioner of Soil & Land Conservation Dampier Port Authority
O&M 2	Develop and implement a greenhouse gas framework agreement as part of joining the Greenhouse Challenge and the Australian Industry Greenhouse Network.	To participate in the national programme of managing greenhouse gas emissions with the aim of minimising emissions where practicable.	Prior to commissioning	Australian Greenhouse Office
O&M 3	Undertake stack emission monitoring	To verify emissions estimated in the PER.	During commissioning and annually thereafter.	
O&M 4	Undertake all reasonable and practicable measures to minimise atmospheric emissions based on investigations of optimum solutions for fuel and energy.	To minimise atmospheric emissions where practicable and comply with relevant guidelines.	During operation	Australian Greenhouse Office
O&M 5	Manage greenhouse gases through the undertaking of ongoing monitoring of greenhouse gas emissions.	To participate in the national programme of managing greenhouse gas emissions with the aim of minimising emissions where practicable.	During operation	Australian Greenhouse Office

Table 8.3 Operations Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
O&M 6	Access, via the Lurgi Methanol Club, the results of research and development of the methanol process in order to improve efficiency and reduce gas usage and implement plant improvements, where practicable.	To participate in the national programme of managing greenhouse gas emissions with the aim of minimising emissions where practicable.	During operation	Australian Greenhouse Office
O&M 7	Participate in agreed studies and investigations into the effects and remedies, such as alternative fuel technology, for greenhouse emissions and adopt and implement practicable and feasible actions.			
O&M 8	Uncontaminated stormwater from the plant site will be discharged into existing drainage lines.	To maintain water flow to rock pools and vegetation downstream from the site.	During operation	CALM
O&M 9	Quality of return water will meet Water Corporation requirements, in accordance with DEP criteria, prior to discharge of the water into King Bay.	To minimise impacts on biota in the vicinity of the outfall.	During operation	Water Corporation
O&M 10	1) Prepare a Vegetation and Flora Management Plan addressing details of ongoing management of terrestrial flora, vegetation and weeds. 2) Implement the Terrestrial Flora Management Plan.	Maintain species abundance and minimise operation impacts on vegetation and flora.	Pre-commissioning Commissioning	CALM
O&M 11	1) Prepare a Terrestrial Fauna Management Plan addressing details of ongoing management of terrestrial fauna, including fauna observation, handling and translocating procedures. 2) Implement the Terrestrial Fauna Management Plan.	Maintain species abundance and minimise operation impacts on terrestrial fauna.	Pre-commissioning Commissioning	CALM
O&M 12	1) Prepare a Landscaping Plan addressing details of ongoing management of landscaped areas within the Project Area. 2) Implement the Landscaping Plan.	To maintain species abundance and minimise impacts on vegetation and flora. To maintain visual amenity.	Pre-commissioning During operation	CALM
O&M 13	1) Prepare a Liquid Waste Management Plan, which includes the following management measures. • Contaminated water will be routed to an evaporation pond. • Uncontaminated water will be discharged to natural drainage lines (if fresh) or to the seawater return system.	To minimise potential contamination to the receiving environment.	Pre-commissioning	Water Corporation

Table 8.3 Operations Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
	• Treated sanitary wastewater will be disposed in accordance with DEP requirements. 2) Implement the Liquid Waste Management Plan		During operation	
O&M 14	1) Prepare a Solid Waste Management Plan, which will include the following management measures. • Recyclable wastes will be periodically removed by a contractor. • General refuse (domestic and industrial solid waste) and putrescible wastes will be disposed of at a Karratha Class II landfill. • Solids from clarification of water in the CPI separator will be disposed off-site at approved facilities. • Spent catalysts and adsorption masses will be disposed of by specialist companies. 2) Implement the Solid Waste Management Plan	To minimise potential contamination to the receiving environment.	Pre-commissioning During operation	Shire of Roebourne
O&M 15	1) Prepare the Hazardous Material Management Plan. 2) Implement the Hazardous Material Management Plan.	To minimise potential adverse effects, risk and liability associated with hazardous materials.	Pre-commissioning During operation	Shire of Roebourne
O&M 16	1) Prepare the Methanol Spill Contingency Plan. 2) Implement the Methanol Spill Contingency Plan.	To minimise the potential for contamination to the marine environment.	Pre-commissioning During operation	Dampier Port Authority
O&M 17	Methanol vessels will be operated within the Port in accordance with the Port Authority Regulations, 2001.	To minimise risk factors associated with vessel movements within the Port.	During operation	Dampier Port Authority
O&M 18	Conform to AQIS and IMO guidelines, requirements of the Dampier Port Authority and other appropriate ballast water management procedures.	To minimise the impact of shipping on the marine environment.	During operation	AQIS Dampier Port Authority
O&M 19	Inform vessel masters of prohibition of in-water hull cleaning and vessel maintenance (including antifoulant painting) in Dampier Port.	To reduce potential for the introduction of unwanted marine organisms and limit the input of metals and organotins to the marine environment.	During operation	Dampier Port Authority

Table 8.3 Operations Environmental Management Plan (cont'd)

Commitment No.	Description	Objective	Timing	Advice From
O&M 20	Contain and return emissions of nitrogen and methanol vapour from ship loading facilities through a vapour recovery system.	To minimise emissions of volatile organic compounds.	During operation	Australian Greenhouse Office
O&M 21	Compliance noise monitoring will be undertaken to assess noise contribution from GTL.	To identify areas of potential exceedance or confirm compliance with statutory guidelines.	During operation	
O&M 22	Lighting will be operated to best practice, as consistent with site safety and security requirements. Lighting will conform with guidelines presented in Australian Standard AS 4282.	To minimise impact by light overspill to nearby sensitive receptors.	During operation	CALM
O&M 23	Implement Safety Management System and Emergency Management Plan	To minimise risk to public and personnel.	Operation	MPR Fire and Emergency Services Authority
O&M 24	Implement Aboriginal Awareness Program by providing operation workforce with cultural awareness training.	To increase personnel awareness of any Aboriginal sites of significance in the vicinity of the plant.	Operation	Department of Indigenous Affairs
O&M 25	Document any complaints received from the community on a register and investigate substantiated complaints.	To ensure that social environmental impacts are minimised.	Operation	Shire of Roebourne
O&M 26	GTL will prepare a Preliminary Decommissioning Plan, designed to ensure the site is left in a suitable condition should decommissioning be required. The plan will include: • conceptual plans for removal of the complex and infrastructure; • the rationale for any plant, buildings or equipment that might be retained; • conceptual rehabilitation plans for all disturbed areas; • a process to agree on end land uses; • conceptual management plans to deal with any contamination issues; and • a conceptual public consultation plan.	To restore the project lease to, as near as practicable, its 'as found' condition and to leave it in a safe condition.	Prior to decommissioning	MPR Shire of Roebourne

8.2 SAFETY AND EMERGENCY MANAGEMENT

8.2.1 Safety Management System

Methanol is a flammable liquid and therefore its control at all times is an important safety requirement. GTL will give the highest priority to the safety of its personnel and to the protection of the environment. Operations will be conducted in accordance with an effective safety management system that addresses people, assets and systems. A safety culture that is proactive will be established and maintained. Workforce participation will be a key feature of the safety culture. Both long-term and itinerant contractors employed by GTL will be required to demonstrate at least the same level of commitment to safety and the environment as GTL.

A Safety Management System and appropriate procedures will be developed in conjunction with appropriate personnel and implemented. This Safety Management System will include the following elements as a minimum: Policy and Objectives, Organisation and Responsibility, Employee Selection, Competency and Training, Contractors and Support Services, Management of Change, and Performance Audit and Review.

8.2.2 Procedures

All of the work carried out in and around the plant will be controlled through a permit to work system that identifies hazards, manages the risk and provides a safe place of work. Operations personnel with responsibilities for management of the permit to work system will receive training in assessment of risk. All phases of the operation (pre-commissioning, start-up, stable operation and shutdown) will be conducted in accordance with valid and approved procedures. The procedures will be updated regularly utilising end user input and will then be used as a basis for future training.

Accidents, incidents and near-misses will be thoroughly investigated to establish root causes and action taken to prevent recurrence; these will be discussed with the workforce at regular safety meetings.

8.2.3 Emergency Management

An Emergency Management Plan will be developed as an integral part of the plant operating procedures. A competent emergency team will be established from members of permanent staff who will deal with any hazardous situations which may arise. The team will be self-sufficient and will be able to integrate with Dampier emergency services, though they will not be dependent upon them. Their competence will be maintained through a system of training that uses a range of scenarios of increasing difficulty and related to major plant hazards. The approved emergency procedures will be used as the basis for training.

In the event that the plant is able to remain operational during upset conditions, then sufficient personnel will be available to maintain operation of the plant whilst others attend to any emergency situations.

In the event of fire in the conservation estate surrounding the East Withnell Industrial Area, GTL acknowledges that the plant operators will not be permitted to extinguish these fires, nor will they be permitted to request that local Fire and Emergency Services Authority (FESA) personnel extinguish them. The fire protection system within the GTL plant will be sufficient to prevent any threat from fires in the surrounding conservation estate. Detail design of the

plant will incorporate the recommendations within the FESA/WA Planning Commission document *Planning for Bushfire Protection* (December 2001).

8.2.4 Audit

High standards of safety, operational, engineering and maintenance management will be established. To maintain these standards, management will receive feedback of performance through a comprehensive system of audit and critique, the audit findings will be formally reported, and deficiencies will be tracked through to completion.

The main long-term irreversible environmental costs of the proposed project will be:

- the loss of some 15 ha of regionally significant vegetation associations within the footprint of the plant site, and associated fauna habitat;
- the annual discharge of low volumes of atmospheric emissions of NOx, CO, SO_2 and particulates;
- the annual discharge of some 450,000 tpa of greenhouse gas emissions;
- the annual discharge of some 50 tpa of nitrogen, in the form of ammonia, in wastewater discharged to King Bay via the Water Corporation outfall;
- the production of solid wastes for disposal at landfill or at appropriate receival and treatment facilities; and
- the incremental loss of visual amenity at Withnell Bay by the replacement of a natural landscape with an industrial one, albeit one that is already highly modified by the existing NWSVP Onshore Gas Plant.

The above "costs" will be mitigated by the facts that:

- it is unlikely that any species of flora or fauna will become extinct as a result of the project proceeding;
- the atmospheric emissions are relatively small and will contribute only marginally to cumulative loads in the air shed, while ground level concentrations will be well below NEPM standards for public health;
- the methanol process will be very energy efficient and result in the conversion of CO_2 and methane in natural gas to methanol thereby reducing potential greenhouse emissions released if the gas was otherwise burned;
- methanol, as an additive to petroleum, reduces vehicle emissions;
- the plant will not be a risk to public safety and all appropriate risk criteria will be met at the plant boundary;
- the plant will not be a substantial emitter of noise and all applicable noise regulations will be met at the plant boundary and bettered if possible;
- the plant will not displace sites of Aboriginal Heritage value; and
- the plant will not adversely affect regional conservation values or natural heritage sites listed on the Register of the National Estate.

Furthermore the above 'costs' will be balanced to some extent by the following social and environmental benefits of the project:

- public access to Withnell Bay will improve as a result of the upgrade of the road to the plant site;
- the project will create some 600 temporary jobs over the 24 month construction period and some 60 permanent jobs over the life of the plant;
- the proponent will contribute to industry based regional surveys of flora and fauna characteristics of the Burrup Peninsula, and to studies into the effects of atmospheric emissions on the petroglyphs of the Burrup Peninsula with a view to protecting both biodiversity and heritage values of the Peninsula; and
- the project will help realise the WA Government's stated policy to value add to natural resources of the region by undertaking downstream processing to produce a more valuable export product.

There are no long-term risks posed to local ecosystems as a result of the project proceeding and none of the environmental factors addressed in the PER are considered to constitute a "fatal flaw" which would stop the project from proceeding.

The major public concern expressed about industry on the Burrup Peninsula in recent times relates to the impact of atmospheric depositions on the aboriginal rock art of the Peninsula. This issue is not proven at this stage, and will not be resolved for a number of years yet, until studies recently commissioned by the Government are completed. Irrespective of this, it should be borne in mind that GTL will be a very small emitter of atmospheric pollutants and its contribution to the regional airshed will be most unlikely to affect the outcomes of that study.

The project can be readily managed to minimise environmental impacts, and all management requirements are well understood and reliable. In addition, appropriate management commitments have been provided by the Proponent. It is therefore respectfully submitted that the GTL plant Proposal as described in this PER can be managed to meet the EPA's objectives for environmental protection and as such should be approved subject to GTL complying with its environmental management commitments and any additional conditions imposed by the Minister for Environment and Heritage.

The following people have been consulted regarding the proposal and their advice, assistance and comment is gratefully acknowledged.

Greg Trenberth, Chief Executive Officer	Dampier Port Authority
Linda O'Brien, Executive Officer	Karratha & Districts Chamber of Commerce
Leanne Rowlands, President	Karratha & Districts Chamber of Commerce
Peter Hinchcliffe	Karratha Tourist Bureau
Robyn Crane, Chief Executive Officer	Pilbara Development Commission
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Simon Thackray, Manager Authorisations	Office of Energy
Ronnie Newell	Soil and Land Conservation Commission
Beverly Stone	WA Health Department
Nora Cooper, Terrestrial Vertebrates	WA Museum
Noel Parkin, Pilbara Manager	WA Tourism Commission
Susan Worley, Regional Manager	Water and Rivers Commission
Dr Andrew Bath, Principal Scientist	Water Corporation
Gordon Thomson, Corp. Business Development	Water Corporation
Mark Warner, Corp. Business Development	Water Corporation
Brendan Bourke, Marketing and Sales Manager	Western Power
Terry Corfield, Networks Engineer	Western Power
Ziggy Wilk, Manager Pilbara Branch	Western Power

The environmental assessment documents for the GTL project have been prepared by URS Australia Pty Ltd, with assistance from a team of specialist consultants based in Perth and Dampier.

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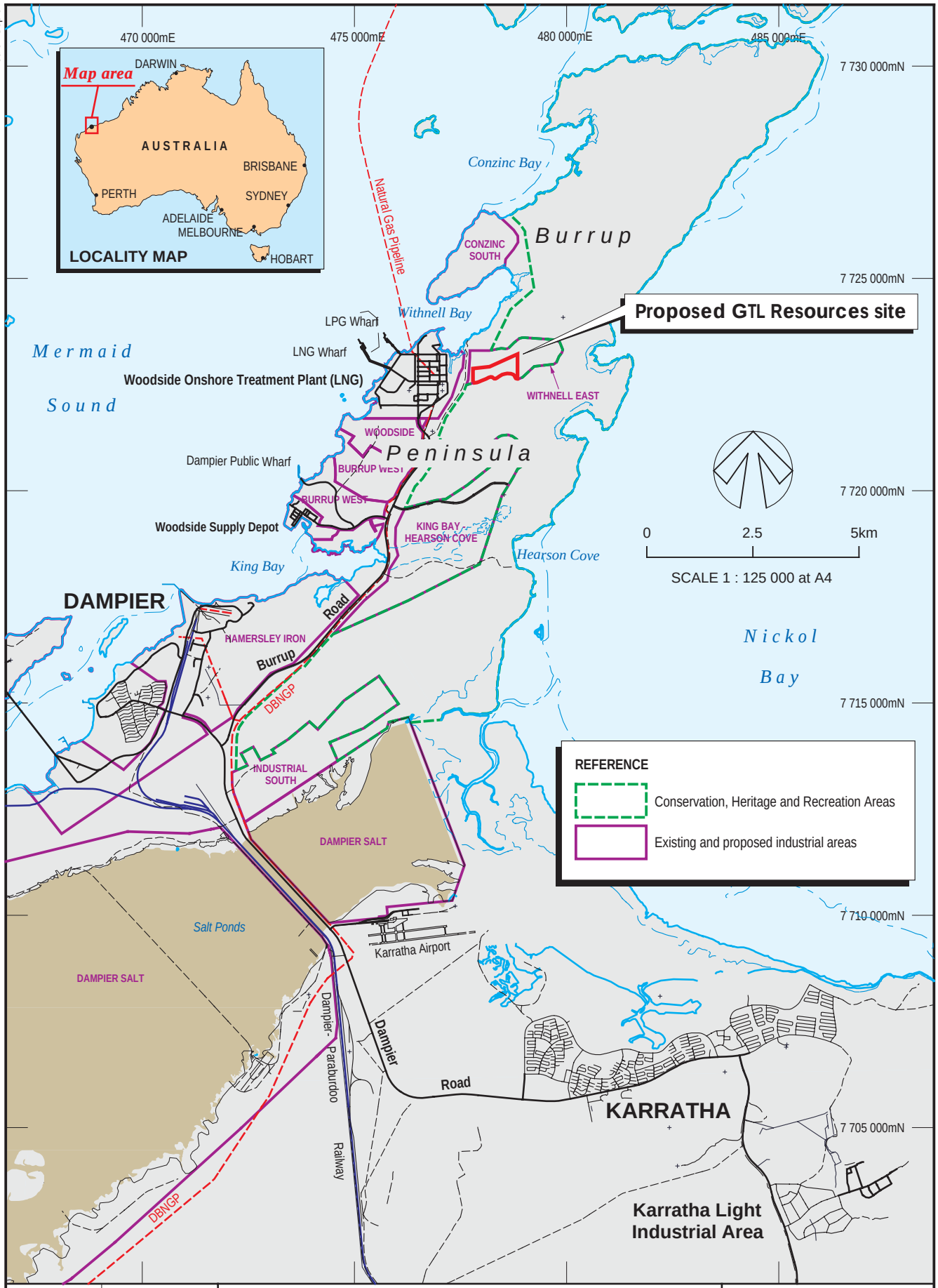
ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
AHD	Australian Height Datum (approximately equivalent to sea level)
ALARP	As Low As Reasonably Practicable
AMC	Australian Methanol Company Pty Ltd
ANZECC	Australian and New Zealand Environment & Conservation Council
AQIS	Australian Quarantine Inspection Service
ARMCANZ	Agriculture & Resource Management Council of Australia and New Zealand
°C	degrees Celsius
CALM	Department of Conservation and Land Management
CAMBA	China-Australia Migratory Bird Agreement
CER	Consultative Environmental Review
CH_4	methane
CHRA	(Burrup) Conservation, Heritage and Recreation Area
CO	carbon monoxide
CO_2	carbon dioxide
CSA	Core Survey Area
dB	decibels
dBA	decibels 'A' weighted
DEP	Department of Environmental Protection
DPA	Dampier Port Authority
DPI	Department for Planning and Infrastructure
DRF	Declared Rare Flora
DWT	dead weight tonnes
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENM	Environmental Noise Model
EPA	Environmental Protection Authority
EPC	Engineering, Procurement and Construction
EPS	Environmental Protection Statement
FESA	Fire and Emergency Services Authority
GJ	giga (10^9) joule
GHG	Greenhouse gases
GTL	GTL Resources PLC
h	hour
H_2	hydrogen
H_2O	water
ha	hectare
hhv	High Heating Value
IBRA	Interim Biogeographic Regionalisation for Australia
IRPA	Individual Risk Per Annum
IUCN	World Conservation Union
JAMBA	Japan-Australia Migratory Bird Agreement
kL	kilo (10^3) litre
kV	kilovolt
kW	kilowatt

L_{A10}	A-weighted sound pressure level exceeded for 10% of time
L_{A90}	A-weighted sound pressure level exceeded for 90% of time
LNG	liquefied natural gas
mg/Nm^3	milligrams per normal cubic metres
ML	mega (10^6) litre
MPR	Department of Mineral and Petroleum Resources
MSDS	Material Safety Data Sheet
Mtpa	million tones per annum
MW	megawatt
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NPI	National Pollution Inventory
Nm^3	normal cubic metres (at normal temperature and pressure - 0 °C, 1 atm)
N_2	nitrogen
N_2O	nitrous oxide
NO_x	oxides of nitrogen
NO_2	nitrogen dioxide
NPI	National Pollutant Inventory
NWSVP	North West Shelf Venture Project
OMP	Office of Major Projects
O_2	oxygen
O_3	ozone
PER	Public Environmental Review
PM_{10}	particulate matter less than 10 micrometres in diameter
ppb	parts per billion
ppm	parts per million
PRA	preliminary risk assessment
PRCL	Plenty River Corporation Limited
QRA	quantitative risk assessment
SO_2	sulphur dioxide
SO_x	oxides of sulphur
t	tonnes
tpa	tonnes per annum
tpd	tonnes per day
tph	tonnes per hour
TBT	tributyltin
TDS	total dissolved solids
TEC	threatened ecological communities
TSS	total suspended solids
VOC	Volatile Organic Compounds
WEIA	Withnell East Industrial Area



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BURRUP PENINSULA METHANOL PLANT

REGIONAL SETTING

Figure 1

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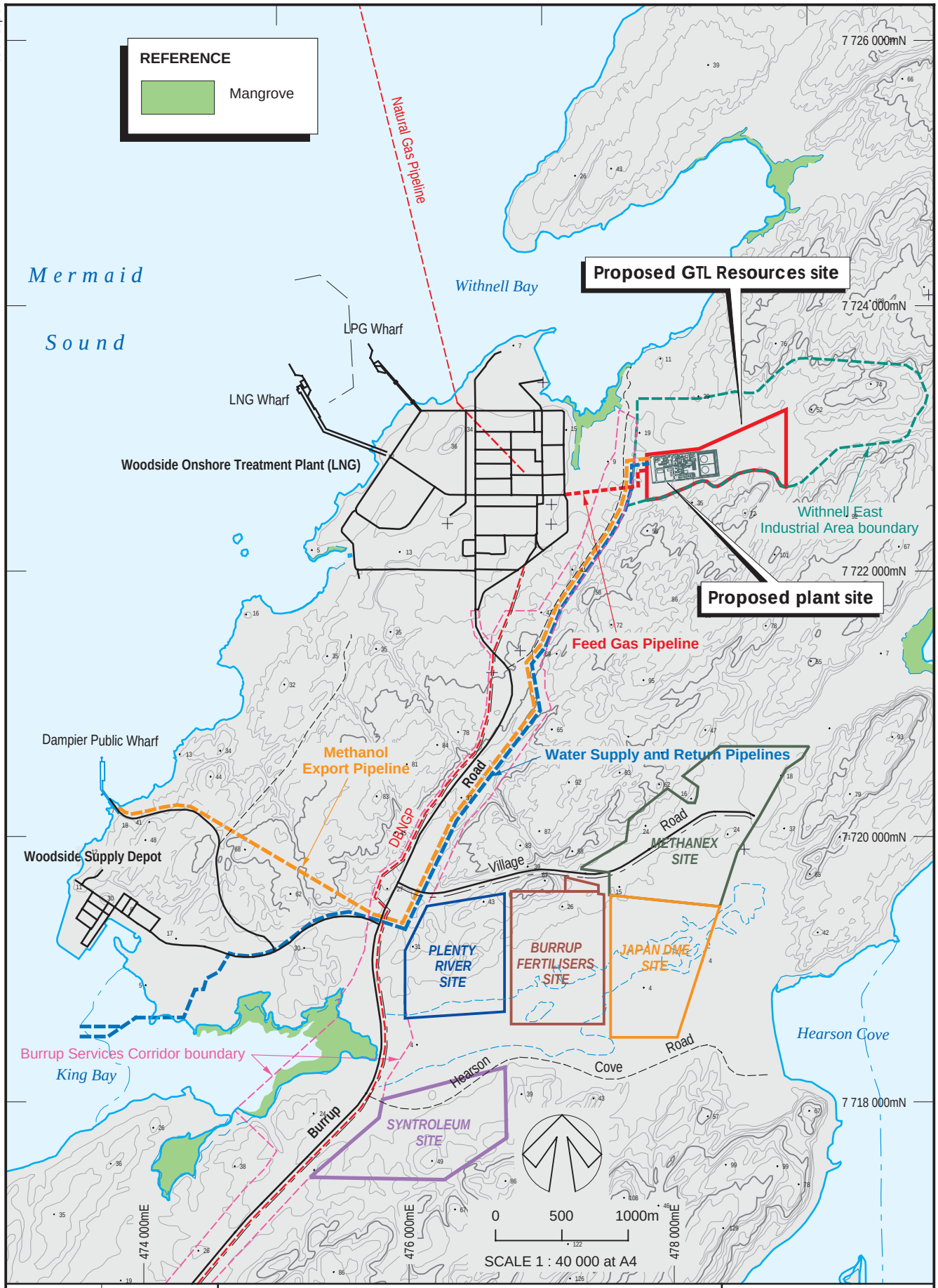

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BURRUP PENINSULA METHANOL PLANT

LOCATION PLAN

Figure 2

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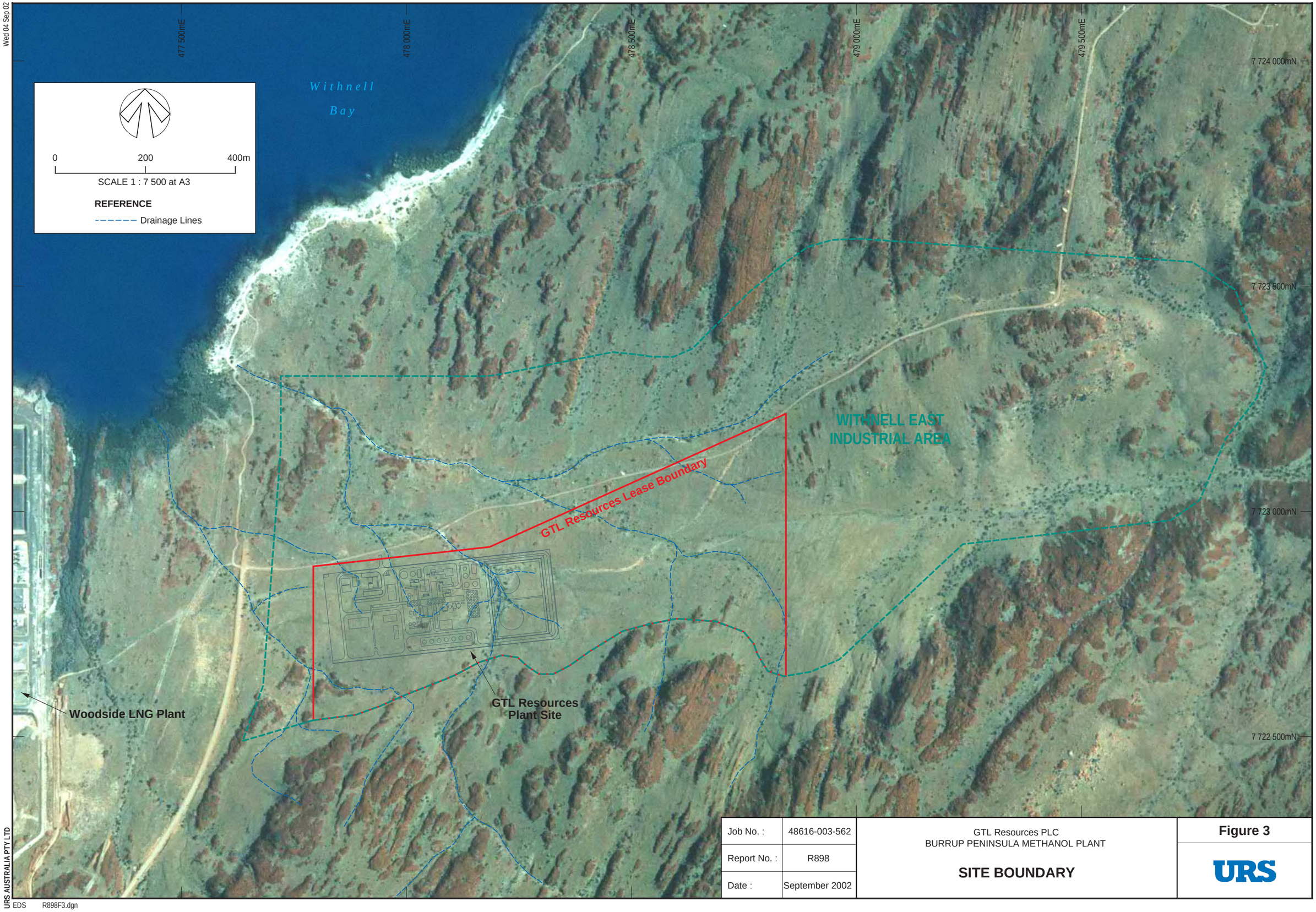

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BURRUP PENINSULA METHANOL PLANT

SITE BOUNDARY

Figure 3

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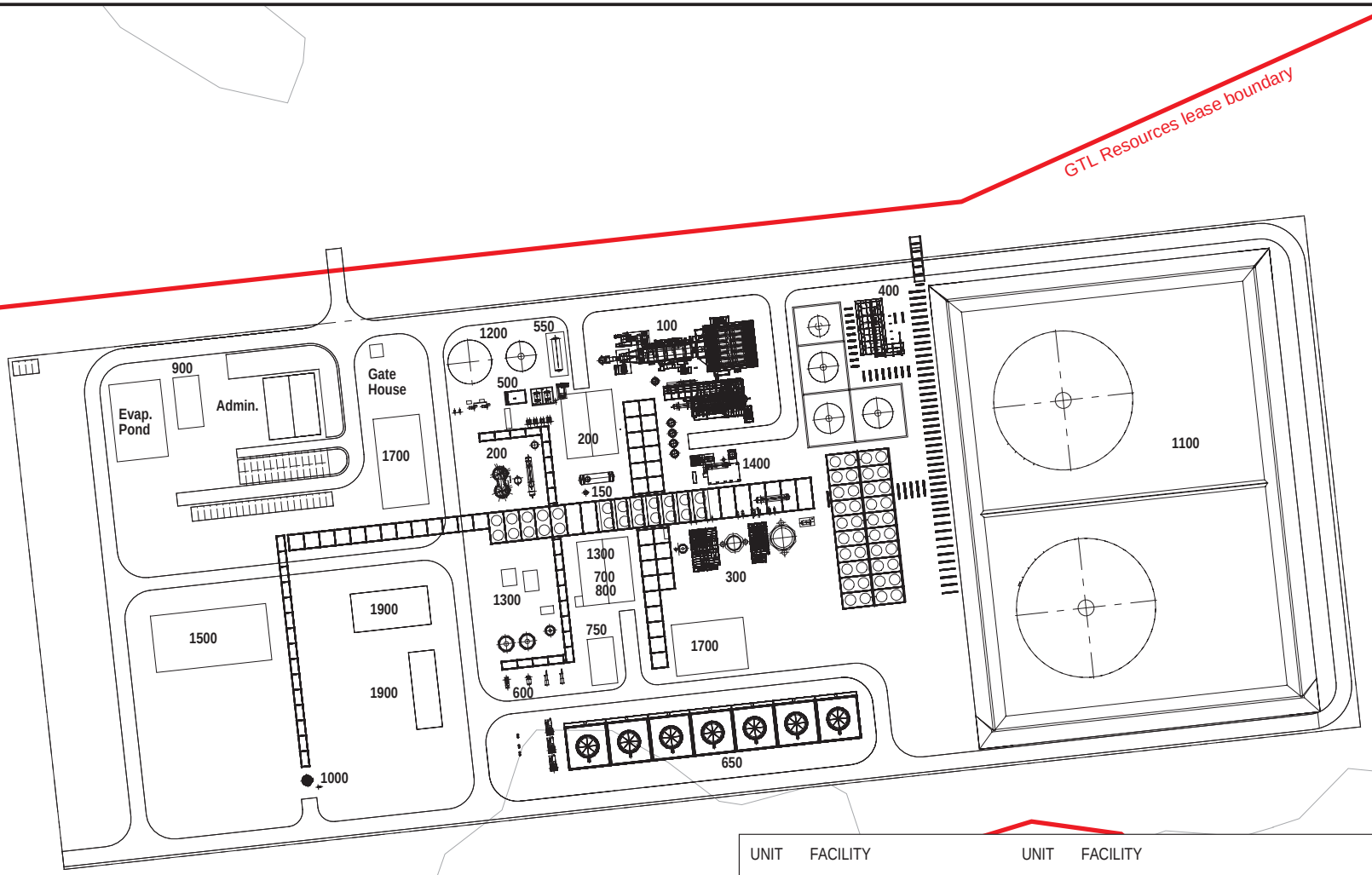
BURRUP PENINSULA METHANOL PLANT

PLOT PLAN

URS

Figure 4



UNIT	FACILITY	UNIT	FACILITY
100	Reforming	1000	Flare System
150	Steam and Condensate System	1100	Tank Farm and Loading System
200	Methanol Synthesis	1200	Fire Fighting System
300	Methanol Distillation	1300	Air Separation (ASU)
400	Intermediate Tank System	1400	Start-up Boiler (Auxiliary Boiler)
500	Water Treatment	1500	Rain Water System
550	Seawater Desalination	1600	Inert Gas System
600	Sweet Cooling Water	1700	Control Building with Electrical Substation
650	Seawater Intake Cooling System	1800	Pipe Racks and Sleepways
700	Power Generation	1900	Common Facilities
750	Emergency Power Generator		
800	Instrument and Plant Air System		
900	Sanitary Waste Water Treatment		

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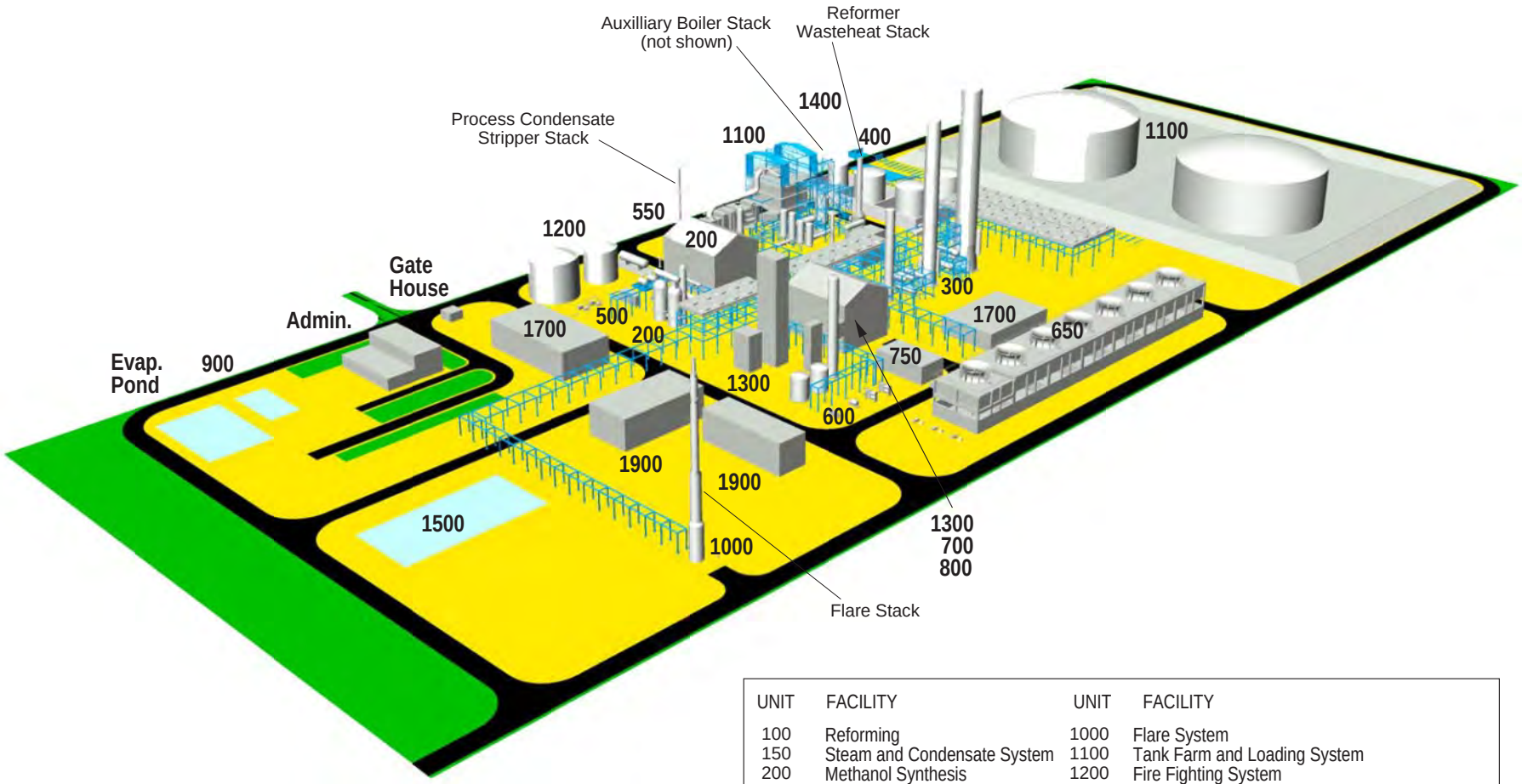
BURRUP PENINSULA METHANOL PLANT

PLANT PERSPECTIVE



UNIT	FACILITY	UNIT	FACILITY
100	Reforming	1000	Flare System
150	Steam and Condensate System	1100	Tank Farm and Loading System
200	Methanol Synthesis	1200	Fire Fighting System
300	Methanol Distillation	1300	Air Separation (ASU)
400	Intermediate Tank System	1400	Start-up Boiler (Auxiliary Boiler)
500	Water Treatment	1500	Rain Water System
550	Seawater Desalination	1600	Inert Gas System
600	Sweet Cooling Water	1700	Control Building with Electrical Substation
650	Seawater Intake Cooling System	1800	Pipe Racks and Sleepways
700	Power Generation	1900	Common Facilities
750	Emergency Power Generator		
800	Instrument and Plant Air System		
900	Sanitary Waste Water Treatment		

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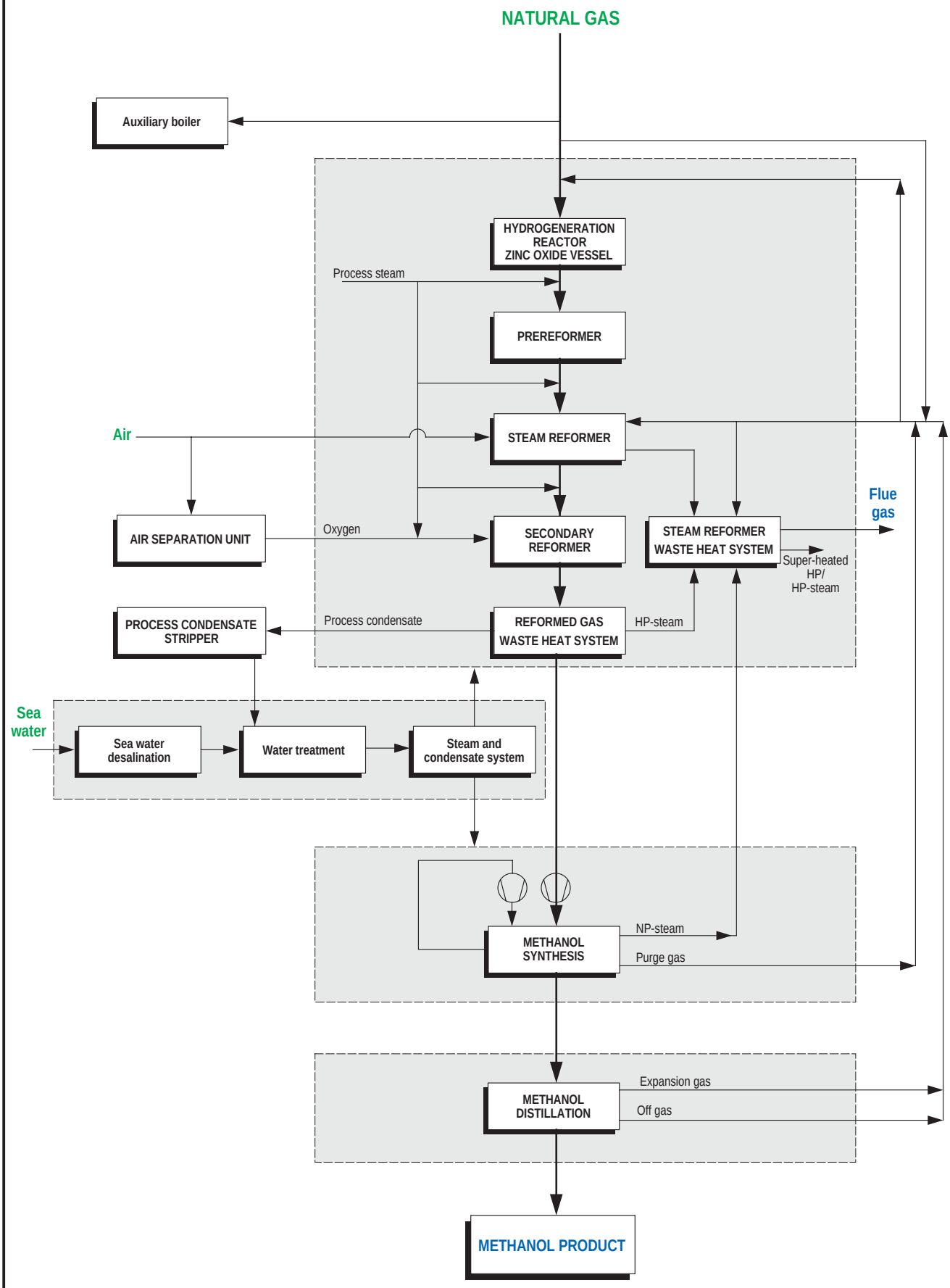
Figure 5



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BURRUP PENINSULA METHANOL PLANT

PROCESS FLOW DIAGRAM

Figure 6

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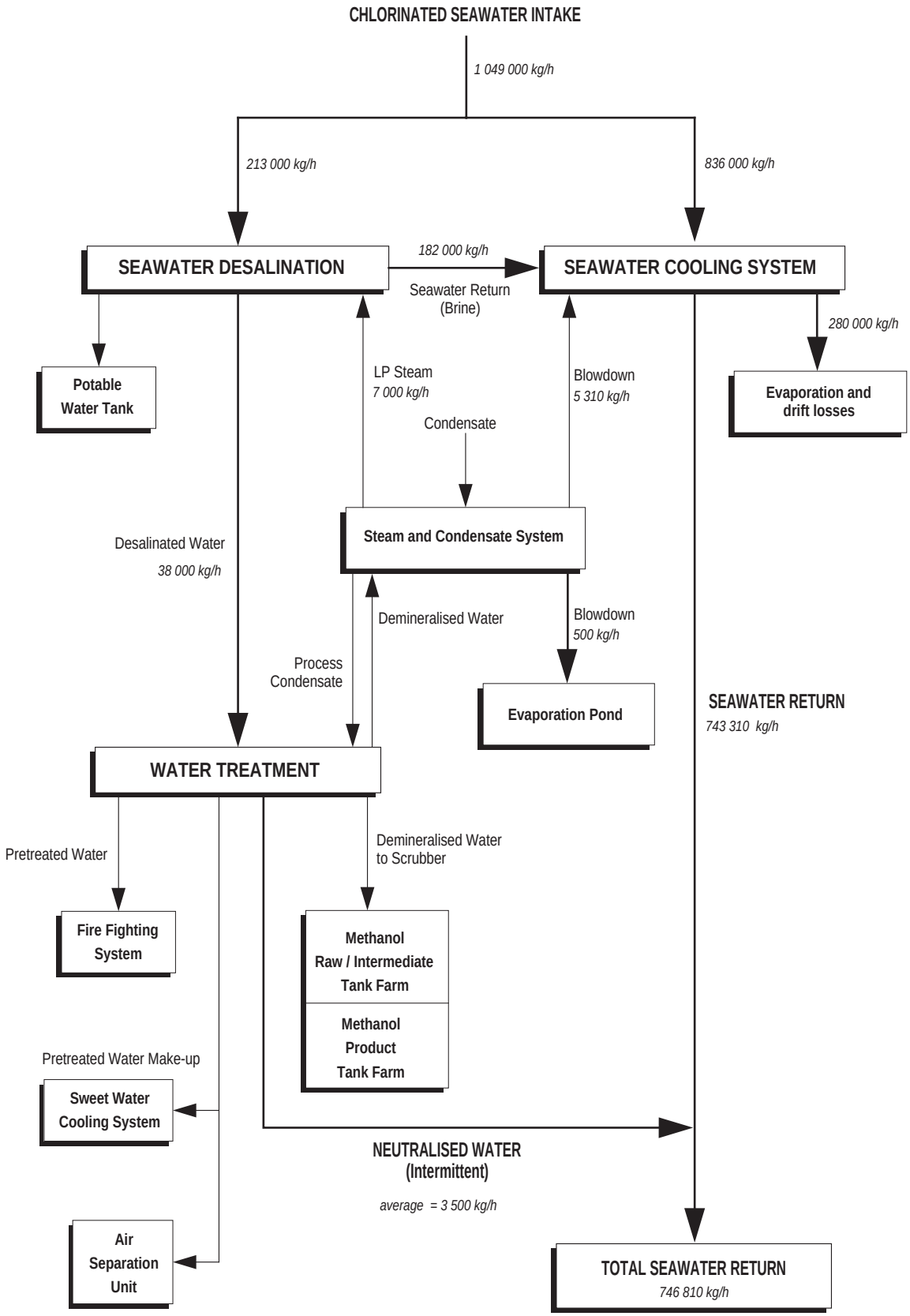

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BURRUP PENINSULA METHANOL PLANT

FLOW DIAGRAM - WATER SYSTEMS

Figure 7

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REFERENCE

Hillocks with Rockpiles and Small Piles of Outcropping Rock.

Open Low Woodland B over mixed Shrubland over Open Hummock and Tussock Grass in small pockets on rocky outcrops.

1a Low Woodland (10-30%;<5m) of *Brachychiton acuminatus*, *Terminalia supranitifolia* over Low Shrubland (10-30% 1-2m) of *Dichrostachys spicata*, *Rhagodia preissii* var.*preissii* over Very Open Grassland (2-5%) of *Cymbopogon ambiguus* and *Triodia epactia* (Burrup Form).

Stony Hill Slopes with Small Outcropping Rockpiles

Mixed Shrubland over Mixed Low Open Heath over Hummock Grassland on rocky hills, rockpiles and ridges.

2a Open Shrubland (5-20%; 1-1.5m) of *Grevillea pyramidalis*, *Acacia inaequilatera*, *A. colei* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/T. *wiseana* (Burrup Form).

2b Shrubland (10-30%; 1-2m) of Acacia inaequilatera over Hummock Grassland (30-70%) of Triodia epactia (Burrup Form).

2c Low Open Heath (30-70%, <0-0.5m) of *Tephrosia rosea* with *Indigofera monophylla* (Burrup Form) over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form). There are scattered (<2%) *Corymbia hamersleyana*, *Acacia inaequilatera*, *A. colei*, *Dichrostachys spicata*.

2d Shrubland (10-30%; 1-2m) of *Ipomoea costata* with *Grevillea pyramidalis* over Low Shrubland (10-30%; 0.5m) of *Indigofera monophylla* (Burrup Form), *Tephrosia rosea* var.*clementii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

Lower Gently Undulating Stony Slopes

Very Open Low Woodland over Very Open Mixed Shrubland over Open Low Shrubland over Hummock Grassland in undulating stony slopes.

3a Very Open (2-10%) to Low Woodland (10-30%; <10m) of *Corymbia hamersleyana* (2-10% <5m) over Very Open Shrubland (2-10% 1-2m) of *Dichrostachys spicata*, *Acacia bivenosa*, *A. colei*, *Grevillea pyramidalis* over Open Low Shrubland (5-10%; 0-0.5m) of *Indigofera monophylla* (Burrup Form),/*Corchorus walcottii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form) and *Cymobopogon ambiguus*.

3b Very Open Shrubland (2-10%; 1m-2m) of *Dichrostachys spicata*, *Acacia colei*, *A. inaequilatera*, *Grevillea pyramidalis* over Open Low Shrubland (2-10%; 0.5m) of *Indigofera monophylla*, *Tephrosia rosea* var.*clementii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

3c High Open Shrubland (2-10; 2m) of *Acacia colei* over Open Shrubland (2-10%, 1-2m) of *Grevillea pyramidalis* over Low Open Shrubland of *Indigofera monophylla* (Burrup Form) over Hummock Grassland of *Triodia epactia* (Burrup Form) *T. wiseana* (Burrup Form).

Gently Sloping Stony Plain

Mixed Very Open Shrubland over Hummock Grassland.

4a Very Open Shrubland (2-10%; 1-1.5m) of *Acacia bivenosa*,*A. colei*, *A. inaequilatera*, *Hakea lorea* over mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/ *T. wiseana* (Burrup Form).

4b Open Low Shrubland (2-15%; 0.5m) of *Senna oligophylla* over Hummock Grassland of *Triodia wiseana* (Burrup Form).

4c Hummock Grassland (30-70%) of *Triodia wiseana* (Burrup Form)

Broad Drainage Zone

Low Woodland B over Mixed Shrubland over Mixed Dwarf Shrubland over Hummock Grassland.

5a Low Woodland (10-30/40%; <10m) of *Corymbia hamersleyana* over Shrubland (10-30%; 1-1.5m) of *Acacia inaequilatera*, *A. coriacea*, *A. bivenosa* over Dwarf Shrubland (10-30% - check in wet - 0-0.5m) of *Indigofera monophylla* (Burrup Form), *Corchorus walcottii* over Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form).

Drainage Lines.

Woodland lined drains

6a Narrow to broad, shallowly incised drain lines with Open - Woodland (2-10; 10-30% varies; <10m) of *Eucalyptus victrix* and occasional *Corymbia hamersleyana/Terminalia canescens* over Dwarf Shrubland (10-30%, 0-0.5m) of *Stemodia grossa* over Hummock Grassland (30-70%) of *Triodia angusta* (Burrup Form). Dormant Sedges present.

6b Narrow rocky drainlines with Woodland of *Terminalia canescens* (10-30 -40%) over Open Shrubland of *Acacia coriacea* over Dwarf Shrubland (10-20%; 0-0.5m) of *Stemodia grossa* over Hummock Grassland (30-50%) of *Triodia angusta* (Burrup Form).

6c Shallow drainline with Open to Woodland (2%;-10-30% <5m) of *Corymbia hamersleyana* over Shrubland (10-30%; 1-1.5m) of *Dichrostachys spicata, Acacia coriacea, A. inaequilatera, A. colei* over Dwarf Heath (30-60%; 0-0.5m) of *Indigofera monophylla* (Burrup Form) over Open to Mid Dense Hummock Grassland (10-70%) of *Triodia epactia* (Burrup Form)/*Triodia wiseana* (Burrup Form).

6d Open Woodland (2-10%; <10m) of *Corymbia hamersleyana* over High Shrubland (10-30%; >2m) of *Acacia bivenosa* over Open Low Shrubland (2-10%; 0-0.5m) of *Senna oligophylla, Indigofera monophylla* (Burrup Form) over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/*T. angusta* (Burrup Form).

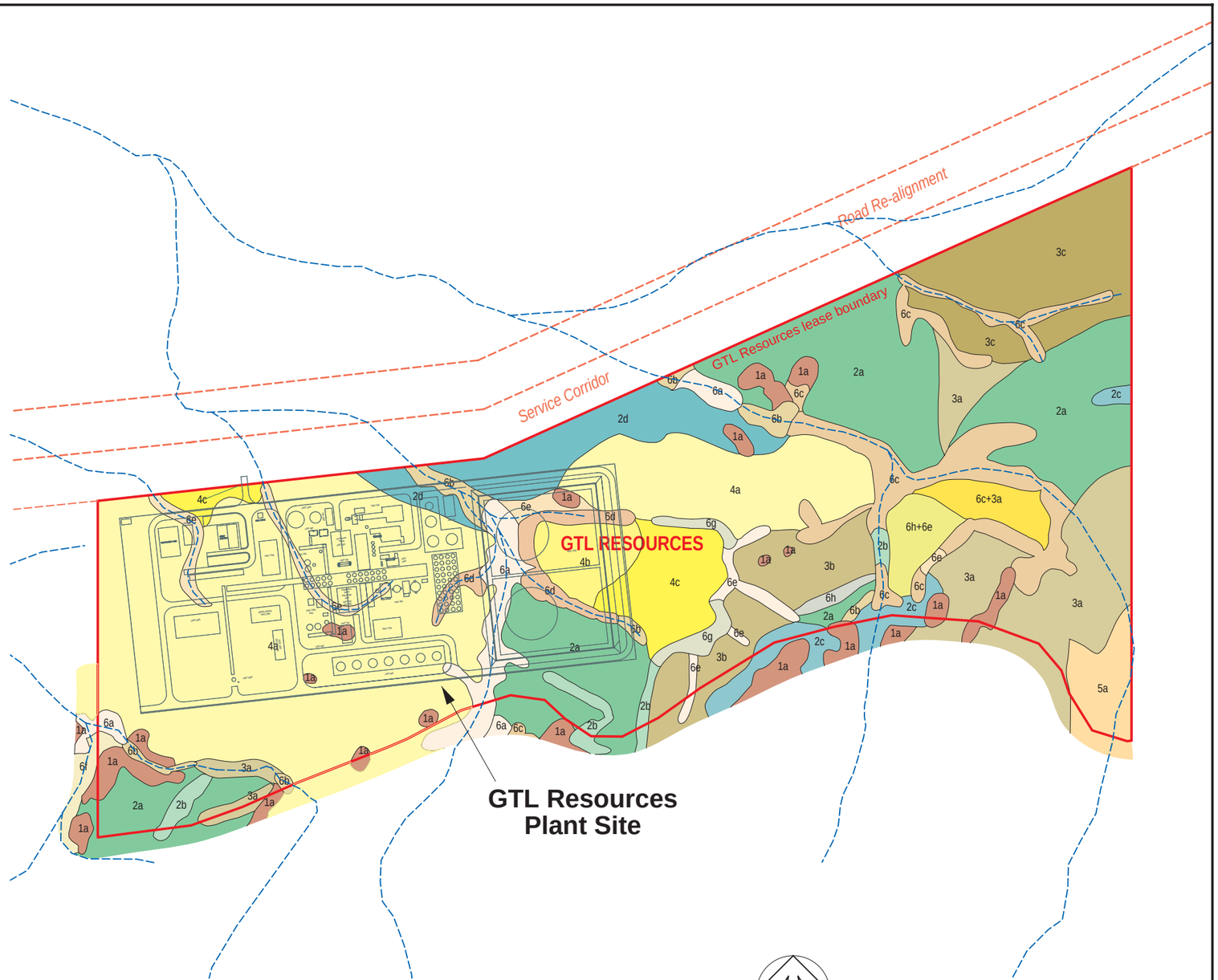
Shrubland lined drains

6e Very shallow drainline criss-crossing undulating lower slopes of Open Shrubland (2-20%; 2m) of *Acacia bivenosa* over Dwarf Heath (30-60% - check in wet; 0-0.5m) of *Tephrosia rosea* var *clementii*, *Indigofera monophylla* (Burrup Form), over Dense Hummock Grassland (50-80%) of *Triodia wiseana* (Burrup Form)/ *T. epactia* (Burrup Form).

6f Shallow drain lines across gently sloping plain of Shrubland of *Acacia colei, Grevillea pyramidalis, Acacia bivenosa* over Dense Hummock Grassland of *Triodia angusta* (Burrup Form).

6g Broad shallow drainline with colluvial soil with High Shrubland to Open Scrub (30-60%; 2m) of *Acacia bivenosa, A. inaequilatera, A. colei* over scattered *Ipomoea costata* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/*T. angusta* (Burrup Form).

6h Shallow, broad drainline of Open Woodland (2-10%; <10m) of *Corymbia hamersleyana* over Shrubland (10-30%; 2m) of *Acacia colei* over Mixed Hummock Grassland (30-70%) of *Triodia epactia* (Burrup Form)/*T. angusta* (Burrup Form).



0 25 50m

SCALE 1 : 5000 at A3

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GTL Resources PLC
BURRUP PENINSULA METHANOL PLANT

PRELIMINARY VEGETATION MAP

Source : Astron Environmental, July 2002

Figure 8

URS

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477750mE 478000mE 478250mE 478500mE 478750mE

7723000mN

7722750mN

7722500mN

REFERENCE

1	Ridges and hillocks with rockpiles and outcropping rock. Vegetated with pockets of woodland and very open grassland.
2	Stony hill slopes with small outcropping rockpiles. Vegetated with scattered trees, open to mid mixed shrubland over hummock grassland.
3	Lower, gently undulating stony slopes. Vegetated with scattered trees over mixed shrubs over hummock grass.
4	Very gently sloping stony plain with dense mantle of boulders and rocks. Vegetated with tall mixed shrubland with areas of low shrubland over hummock grassland.
5	Broad drainage zone supports an open forest of *Corymbia hamersleyana* trees over hummock grassland.
6a	Woodland lined drainage lines. Woodland species include *Eucalyptus victrix, Corymbia hamersleyana* and *Terminalia canescens* over shrubs and hummock grass.
6b	Shrubland lined drainage lines. Shrubland species include *Acacia bivenosa, A. colei, A. inaequilatera* over low shrubland of *Indigofera monophylla* over hummock grass.

REFERENCE

- Location of Pebble Mound Mouse mounds
- Location of waterhole
- Watercourse

Existing Road

Service Corridor

Road Re-alignment

Easement

GTL RESOURCES

0 50 100 150 m

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BURRUP PENINSULA METHANOL PLANT

FAUNA HABITAT MAP

Source: Astron Environmental, July 2002

Figure 9

URS

URS AUSTRALIA PTY LTD

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Wed 04 Sep 02

478 000mE

478 500mE

479 000mE

479 500mE

7 724 000mN

7 723 500mN

7 723 000mN

7 722 500mN

REFERENCE

Frequency

100 or more	Mud flat
50 - 99	Mangal
25 - 49	Sandy beach
10 - 24	Rocky coast
5 - 9	Rock
2 - 4	Undifferentiated
1	Disturbed area

0 200 400m

SCALE 1 : 7 500 at A3

REFERENCE

Drainage Lines

Withnell Bay

WITHNELL EAST INDUSTRIAL AREA

GTL RESOURCES

GTL Resources Lease Boundary

GTL Resources Plant Site

Woodside LNG Plant

Notes:

All coordinates AGD84/AMG.

Mapped using ortho-rectified aerial photography dated August 2000.

Compiled, produced & checked by:
M.E. Trudgen & Associates
in conjunction with Astron Environmental.

Cartography by:
Environmental Drafting Services 9278 8211

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BURRUP PENINSULA METHANOL PLANT

FREQUENCY OF OCCURRENCE OF VEGETATION UNITS IN THE WITHNELL EAST INDUSTRIAL AREA
Source : Trudgen 2002

Figure 10

URS

URS AUSTRALIA PTY LTD

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Wed 04 Sep 02

0 200 400m

SCALE 1 : 7 500 at A3

REFERENCE

Drainage Lines

478 000mE

478 500mE

479 000mE

Withnell Bay

WITHNELL EAST INDUSTRIAL AREA

GTL Resources Lease Boundary

GTL RESOURCES

GTL Resources Plant Site

Woodside LNG Plant

REFERENCE

Vegetation formation or association

1. *Eucalyptus victrix* scattered low trees, low open woodlands and low woodlands.
2. *Eucalyptus victrix*, *E. xerothermica* and *E. xerothermica* scattered low trees to low woodlands.
3. *Eucalyptus victrlx*, *Terminalia canescens* low open woodlands to low open forest.
4. *Corymbia hamersleyana* scattered low trees to low woodlands.
5. *Corymbia hamersleyana* low woodlands with *Eucalyptus victrix*, *Brachychiton acuminatus* or other species.
6. *Terminalia canescens* scattered low trees to low forest.
7. *Terminalia canescens* scattered low trees to low woodland with *Corymbia hamersleyana*, *Brachychiton acuminatus* or *Eucalyptus victrlx.*
8. *Brachychiton acuminatus* scattered low trees to low open woodland with various other low tree species.
9. *Terminalia supranififolia*, with various other species, open shrublands to high shrublands or open scrub, sometimes low open woodland.
10. Tall shrublands dominated by *Ficus* spp., *Flueggia virosa* subsp. *melanthesoides*, *Pittosporum phylliraeoides* var. *phylliraeoides* and other species.
11. *Acacia coriacea* subsp. *coriacea* scattered shrubs to tall shrublands.
12. *Grevillea pyramidalis* subsp. *pyramidalis* scattered shrubs to tall shrublands.
13. *Acacia inaequilatera* (with various other species) scattered shrubs to high shrublands.
14. *Acacia pyrifolia* (with various other species) scattered shrubs to high shrublands.
15. *Acacia colei* (with various other species) scattered shrubs to high shrublands.
16. *Acacia ampliceps* (with various other species) scattered shrubs to high shrublands.
17. *Acacia bivenosa* (with various other species) scattered shrubs to high shrublands.
18. Shrublands and high shrublands of *Cullen pustulatum*, *Cajanus cinereus* and various other species.
19. *Stylobasium spathulatum* shrublands and low shrublands.
20. *Ipomea costata* scattered shrubs to shrublands.
21. *Acacia tenuissima* scattered low shrublands.
22. *Acacia orthocarpa* shrubland to heaths.
23. *Indigofera monophylla* (Burrup form) scattered low open shrubs to shrubland.
24. *Adriana tomentosa* scattered low open shrubs to heath.
25. *Tephrosia rosea* var. *clementii* scattered low shrubs to low shrubland.
26. Low open shrublands to low open heath dominated by various species.
27. Hummock grasslands, hummock/tussock grasslands.
28. Tussock grasslands and tussock/hummock grasslands.
29. Sedgelands.
30. Samphires.
31. Herblands.
32. Rock pocket vegetation.

MF Mud flat

M Mangal

S Sandy beach

RC Rocky coast

NV Undifferentiated

D Disturbed area

For explanation of vegetation codes (eg. AclmTe) refer to "Reference for vegetation of core survey area" handbook.

Notes:

All coordinates AGD84/AMG.

Mapped using ortho-rectified aerial photography dated August 2000.

Compiled, produced & checked by:
M.E. Trudgen & Associates
in conjunction with Astron Environmental.

Cartography by:
Environmental Drafting Services 9278 8211

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DISTRIBUTION OF VEGETATION UNITS IN THE WITHNELL EAST INDUSTRIAL AREA
Source : Trudgen 2002

Figure 11

URS

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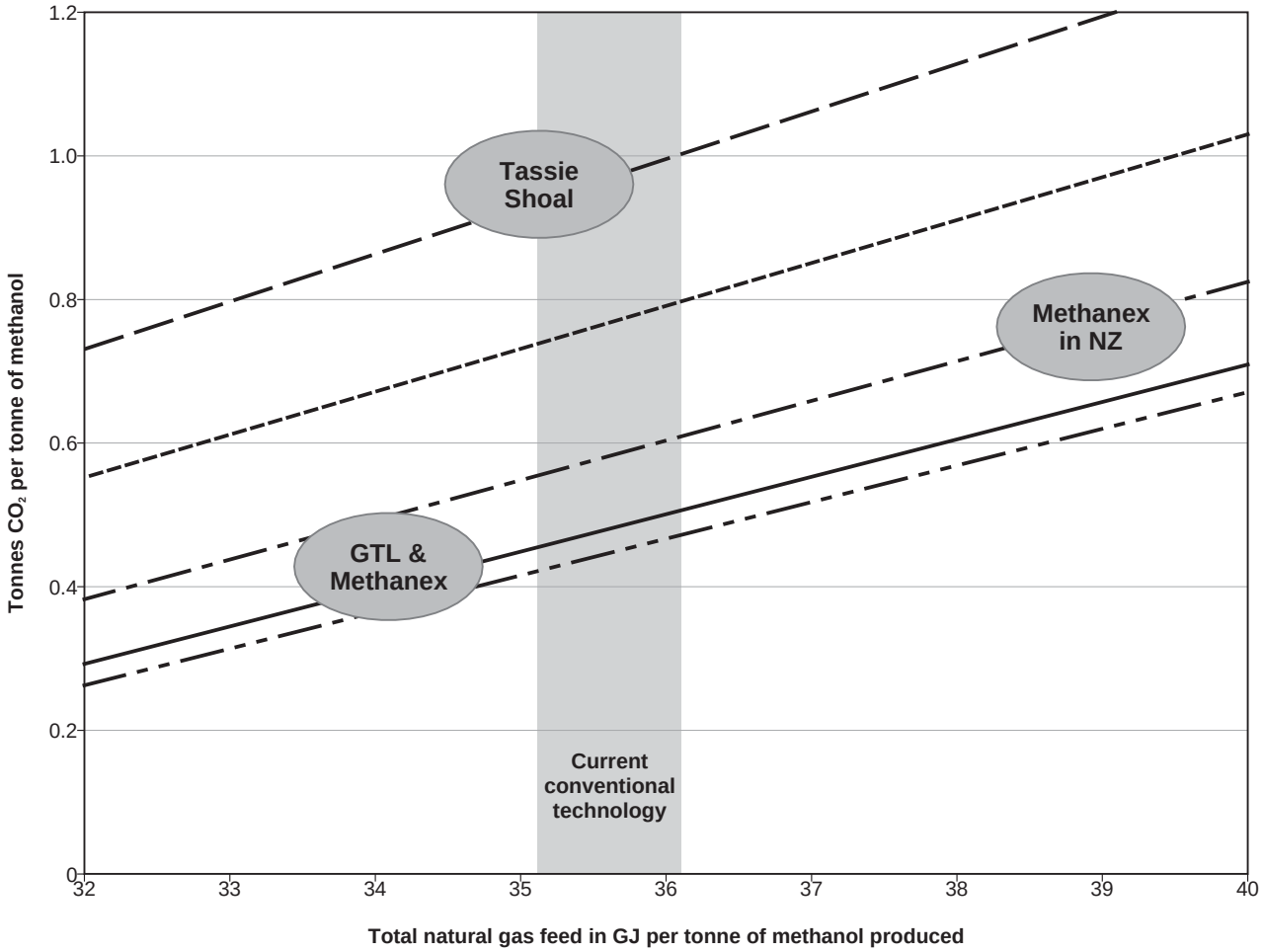
EDS R898F11.dgn



CO_2 content of natural gas

- 25% CO_2
- 17% CO_2
- 8% CO_2
- 2.2% CO_2
- 0% CO_2

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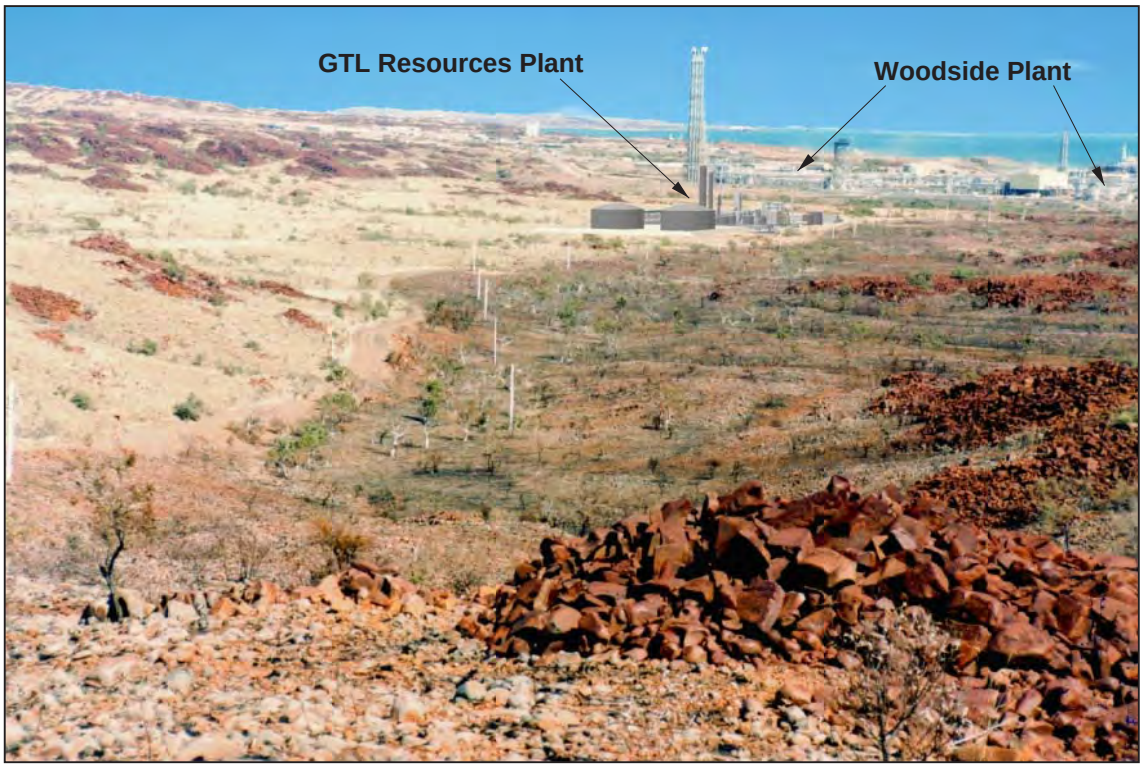
COMPARATIVE PROCESS EFFICIENCY DATA FOR METHANOL PRODUCTION

Figure 12

URS



View of the proposed GTL plant and existing Woodside plant from Mt Wongama Road

View of the proposed GTL plant from the Withnell Bay boat ramp area

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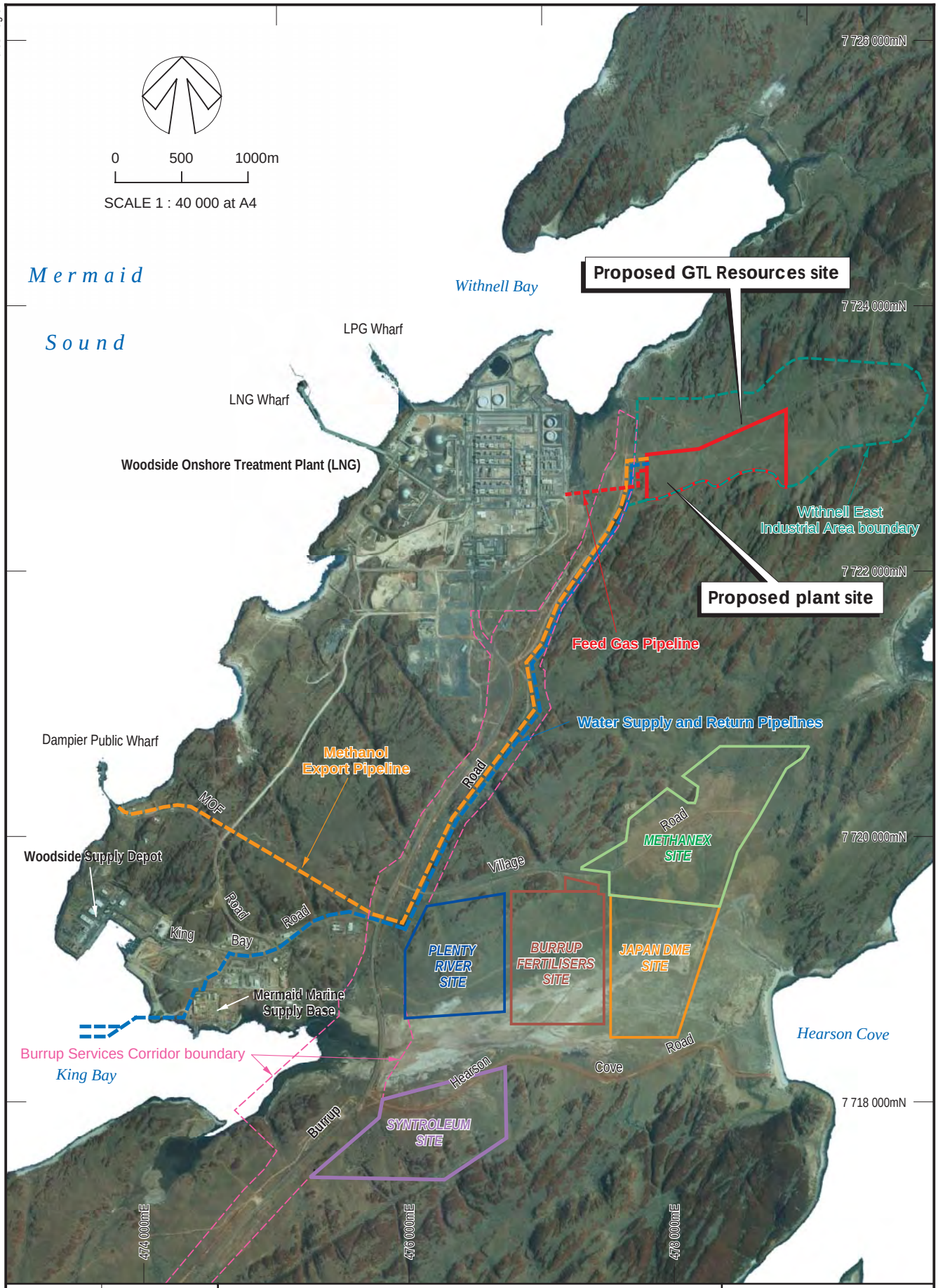
VISUAL IMPACT IMAGES

Figure 13

URS



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AERIAL PHOTOGRAPH OF CENTRAL BURRUP PENINSULA

Plate 1

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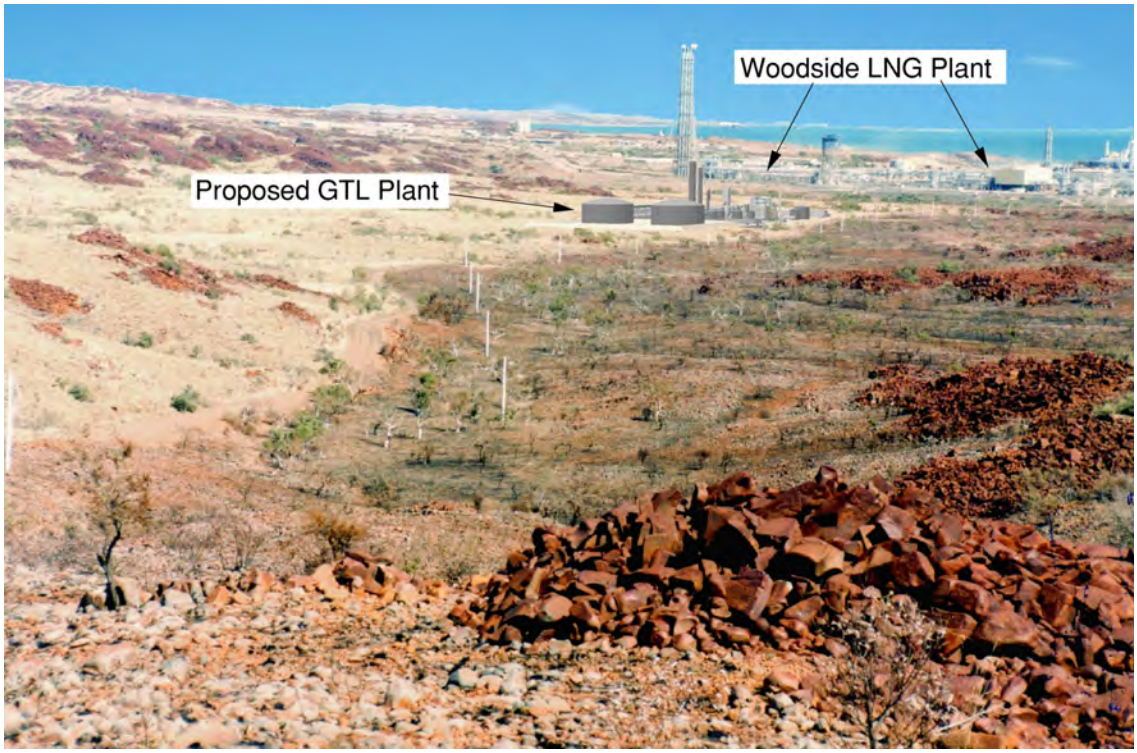

Plate 2 : View of the valley extending east from the Woodside plant. The approximate location of the GTL plant is shown.

Plate 3 : View across the small ephemeral drainage line that passes through the eastern part of the GTL plant site.

Plate 4 : Vegetation within the drainage line - open woodland over hummock grassland.

Plate 5 : Hummock (*Triodia)* grassland on the gently sloping stony plain within which most of the GTL plant site is contained.