5.7 Air Quality

This section characterises the emissions to air from the proposed quarantine incinerator and presents the emissions predicted impact at ground level in the region surrounding the proposed facility. The stack height has been selected in order for the predicted emissions to air to comply with all relevant air quality design criteria. The full Air Quality Assessment is presented in Appendix G.

5.7.1 Methodology

Meteorological data recorded by the Bureau of Meteorology (BoM) automatic weather station (AWS) at Darwin airport (eight km to the north of East Arm Wharf) was the closest source of reliably recorded data to the proposed incinerator site.

A regional-scale prognostic meteorological model, The Air Pollution Model (TAPM), was used to simulate a year of meteorology for the proposed incinerator site. Recorded and concurrent hourly wind speed and direction data from Darwin airport BoM AWS were assimilated into the predicted flow fields. TAPM was thereby used to produce hourly site representative surface level winds, temperature, atmospheric stability and mixing heights at the incinerator site.

The dispersion model Ausplume (Version 6) was used in association with synthesised meteorology, recorded background concentrations, and the defined emissions to predict peak ground level concentrations surrounding the incinerator. Assessment was conducted against Victorian EPA and NSW Department of Environment and Conservation (DEC) design criteria, and National Environment Protection Measure (NEPM) air shed goals. This compliance approach was used at the direction of Northern Territory EPA.

5.7.2 Existing Environment

The air quality at East Arm Wharf is typical of an operational port and is reflected in the surrounding industrial areas. The nearest sensitive receptors are Government House and Kormilda College, details of which are located in section 5.6.2.

Background Data

Twenty-four hour averaged PM2.5 and PM10 data (particulate matter of diameter less than 2.5 and 10 microns respectively) was obtained from Casuarina, and hourly averaged PM10 data was obtained from Palmerston, from October 2004 to September 2005. Recorded PM2.5 data was not available from Palmerston. Twenty-four averaged PM10 concentration recorded at Casuarina predominantly displays a range of 0 – 35 µg/m^3. This is lower than that recorded at Palmerston, where 1-hour averaged PM10 concentration is predominantly within the range of 0 – 50 µg/m^3. Concentrations above these ranges occur in both datasets, however with greater frequency at Palmerston.

As background air monitoring was not undertaken as a part of this study, historic NOx and CO levels are unknown. For the purpose of future emissions from the incinerator, it is important to note that the major source of carbon monoxide emissions in the Darwin airshed is burning and wildfires (Environment Australia 2003).

The supplied ambient monitoring data is considered to be representative of the particulate matter concentration in the vicinity of the proposed incinerator, and it is clear that background levels of particulate matter are high in the locality, particularly during the dry season. The high particulate matter readings are primarily due to dry season bushfires and the 1 July annual cracker night.

An inventory of waste types to be treated in the proposed incinerator is outlined in section 5.9 Waste Management.

5.7.3 Potential Impacts

The type and concentration of emissions from the proposed incinerator are dependent on the composition of the waste being combusted, incinerator design and combustion conditions. Emission constituents from quarantine and waste incinerators can generally be characterised as:

- Particulates;
- Acid gases;
- Trace metals;
- Trace organics; and
- Odour.

Particulates

Particulate Matter (PM) is emitted because of incomplete combustion and by the entrainment of non-combustible (inorganic matter) in the flue gas. The PM can exist in either solid or aerosol form, and may adsorb heavy metals or polycyclic organics. The quantity of PM in the incinerator exhaust gas is highly dependent on the incinerator combustion conditions. Typically, the fine size fractions of PM, i.e. PM10 and PM2.5, are found in combustion chamber exhaust gases.

Acid Gases

Acid gases include hydrogen chloride (HCl), hydrogen fluoride (HF), sulphur dioxide (SO_2) and nitrogen oxides (NOx). The term acid gas is used because when these gases react with water or water vapour they form acids. The formation of acid gases is dependent on the composition of the waste. Quarantine waste typically has high hydrogen content because of its high paper, plastic and moisture content. This free hydrogen is then readily available to react with halogenated compounds in the waste stream, such as chlorine, from PVC plastics or other compounds.

Nitrogen oxide (NO) is a minor product of combustion, which slowly oxidises to nitrogen dioxide (NO_2) in the emitted plume. The two main sources of nitrogen oxides are the oxidation of nitrogen present in the combustion air and the oxidation of organic nitrogen found in the quarantine waste being incinerated.

Trace Metals

The quantity of trace metals (including lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), antimony (Sb), chromium (Cr) and nickel (Ni)) in the incinerator exhaust gas is directly related to the quantity of trace metals in the waste feed. Sources of trace metals include foil wrapping, inks and paints. Some trace metals can be adsorbed onto fine particulate matter in the flue gas stream, known as fine-particle enrichment. Metals with high vapour pressure, such as mercury, do not show significant particle enrichment under high temperature incineration and instead remain in the exhaust gas in vapour phase.

Trace Organics

Products of incomplete combustion include carbon monoxide (CO) and trace organics such as polycyclic aromatic hydrocarbons (PAH's).

Dioxins can be produced during incineration when organic material undergoes combustion in the presence of chlorine or chlorine compounds.

Odour

Odour emissions from the incinerator exhaust stack are generally associated with the release of combustion gases and trace organics. Based on previous experience, the in-stack odour level is typically low, in the order of 200 to 400 odour units (OU). The discharge characteristics of the proposed stack are considered more than adequate to disperse the anticipated odour emissions so that the Victorian SEPP-AQM odour criterion is met at and beyond the site boundary.

Operational Parameters

The proposed incinerator structure is to be located in existing wharf facilities at the East Arm Wharf, and its position is shown in Figure 3-2.

The discharge characteristics of the incinerator stack for normal and bypass operations are summarised in Table 6.

Table 6 Discharge Characteristics

Scenario	Waste Feed (kg/hr)	Stack Height (m)	Exhaust Temperature (°C)	Exhaust Velocity (m/s)	Stack Diameter (m)
Normal	450	25	180	12.8	0.58
Bypass*			900	15.6	

* Bypass of the treatment process may be required during abnormal operating circumstances such as maintenance of the facility.

The mass emission rates and maximum in-stack concentrations used in this assessment were supplied by Advanced Combustion Engineering (ACE) with the exception of heavy metals (supplied by GHD) and PAH's (taken from National Pollutant Inventory manual) – based actual raw data from the same or similar treatment processes. The mass emission rates for normal and bypass operations are presented in Table 7.

Table 7 Mass Emission Rates for Normal and Bypass Operations

Constituent	Normal Operation (450 kg/hr)		Bypass Operation (450 kg/hr)	
	Maximum In-stack Conc. (mg/m^3)	Mass Rate (g/s) [1]	Maximum In-stack Conc. (mg/m^3)	Mass Rate (g/s) [1]
Total Suspended Particulates (TSP)	35	2.19E-02	250	1.56E-01

[1] Mass rates are based on maximum in-stack concentrations and dry exhaust flow rates of 0.625 Nm^3/s corrected to 7% oxygen; except dioxins corrected to 11% oxygen.

Constituent	Normal Operation (450 kg/hr)		Bypass Operation (450 kg/hr)	
	Maximum In-stack Conc. (mg/m^3)	Mass Rate (g/s) [1]	Maximum In-stack Conc. (mg/m^3)	Mass Rate (g/s) [1]
CO	150	9.37E-02	150	9.37E-02
SO2	100	6.25E-02	100	6.25E-02
Nox	200	1.25E-01	30	1.87E-02
HCl	50	3.12E-02	150	9.37E-02
HF	5	3.12E-02	10	6.25E-03
PAH's (as BaP)[1]	10	6.25E-03	50	3.12E-02
Hg (inorganic)	0.2	1.25E-04	0.2	1.25E-04
Pb	2	1.25E-03	2	1.25E-03
As	2.5	1.56E-03	2.5	1.56E-03
Cr (as Cr VI)	2.5	1.56E-03	2.5	1.56E-03
Ni	2.5	1.56E-03	2.5	1.56E-03
Sb	2.5	1.56E-03	2.5	1.56E-03
Cd	0.1	6.25E-05	0.1	6.25E-05
Dioxins	1.00E-07	7.50E-11	3.00E-06	2.25E-09

Mass emission rates for fine particulate fractions of the total suspended particulate (TSP) emissions were unavailable and therefore a conservative approach was adopted whereby PM2.5 and PM10 emissions were modelled on the mass emission rate for TSP.

NOx emissions were modelled as 100% NO_2. This is considered a conservative approach given that NOx is mainly comprised of NO when emitted from natural gas combustion and that the NO converts to NO_2 in the atmosphere over time by complex photochemical reactions. This conservative approach is considered appropriate given the absence of emission monitoring data to establish the actual NOx to NO_2 ratio, and given that Ausplume cannot account for the conversion of NO to NO_2 that occurs post discharge.

Emissions from the incinerator during normal and bypass operations were modelled assuming continuous 24-hour operation, seven days per week. This is a conservative approach for the bypass scenario given that such an occurrence is sporadic and of short duration. The modelling demonstrated that during bypass events the levels of the above tabled constituents would still be compliant.

[2] Emission data obtained from National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Sewage Sludge and Biomedical Waste Incineration: mass rate is equal to 0.05 kg of pollutant per tonne of waste feed into incinerator.

Ausplume Modelling

Atmospheric dispersion modelling was performed using meteorology representative of the proposed incinerator positioning on Darwin East Arm Wharf.

Victorian EPA State Environment Protection Policy – Air Quality Management (SEPP-AQM) guidelines were used to assess the compliance of all constituents over three averaging periods (3 minute, 1 hour and 24 hour) with the exception of 24-hour PM2.5 and PM10. For 24-hour PM2.5 and PM10 the NSW Department of Environment and Conservation (DEC) design criteria, and National Environment Protection Measure (NEPM) air shed goals were adopted.

A variety of stack heights were modelled however full compliance was only obtained for heights of 25 m and above.

Particulate levels in the region are high in the dry season. One factor contributing to this is the land "burn-offs". Particulate matter modelling results exceed NEPM air shed goals and NSW DEC design criteria over 24-hour averaging periods on occasion. Non-compliance is definite at an averaging period of 1 hour for particulate matter however the number of SEPP-AQM exceedances remains the same. In all cases, the predicted increment on ambient background PM levels due to the proposed incinerator is minimal.

With respect to meteorological conditions that may enhance ground level pollutant concentrations (e.g. inversion) it is unlikely that levels, with the exception of particulate matter, would rise above design criteria limits.

Plume

The stack will emit a plume that would either be clear or white. A white plume would occur because of high water content in the gas.

The results of the air quality modelling conclude that during typical operation, hot air from the stack plume will not interfere with flight paths of passing aircraft. On the rare occasion that the incinerator experiences an exceeding emissions event, the plume will increase in both temperature and velocity. Sensors connected to alert systems will be installed to detect any changes in these parameters.

Potential for Odour Generation from Processing and Storage of Products and Waste

The incinerator emission, after treatment by the secondary chamber (or afterburner) and Air Quality Control System (AQCS), will have minimal odour that will not be able to be detected on East Arm Wharf, nor the nearest sensitive land use some kilometres away.

The incinerator's emissions during emergency bypass will have higher odour levels associated with it if the cause of the bypass is the failure of the secondary chamber (or afterburner). In this instance there may be some odour detectable on the wharf downwind of the facility, but not at the nearest sensitive land use. Failure of the primary chamber burner, or the AQCS, and activation of the emergency bypass due to these causes is not expected to cause any significant odour.

The storage of quarantine wastes in not expected to cause local odour issues unless there is a lag of a few days between waste receipt and waste processing for putrescible quarantine wastes (i.e. food wastes and/or contraband food products). In the event of a breakdown or scheduled maintenance period refrigerated shipping containers would be recommended for the temporary storage of putrescible quarantine wastes in order to avoid the generation of potentially offensive odours during their subsequent handling and treatment.

Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention (May 2004) requires that best available technology be applied to reduce or eliminate the discharge of Persistent Organic Pollutants (POPs) into the environment, particularly for new sources. In addition it requires that in considering a technology that could result in the use and/or discharge of POPs that consideration of alternative technologies that may reduce or eliminate such uses and or discharges be considered.

An evaluation of alternative technologies took place as part of the overall assessment undertaken for the proposed quarantine waste treatment facility. Although some of the technologies would not produce POPs (unless present in the waste stream) they would not be able to effectively treat all types of quarantine wastes as safely and as effectively as the preferred option of incineration.

In addition, if POPs were to find their way into the waste stream, then incineration has the ability to destroy them at high levels of efficiency which none of the other technologies can do, apart from using cement kilns or plasma technology.

Annex C of the Stockholm Convention covers the unintentional discharge of dibenzo dioxins and furans and PCBs from a variety of sources, including waste incineration. The convention requires that where such unintentional emissions will be produced that the best available technique and environmental practices be applied.

The Convention defines “Best Available Techniques” (BAT) as using the most effective and advanced techniques that can be practically adopted to *prevent or minimise* harmful emissions of by-product POPs and other environmental impacts, or *reduce* them to acceptable limits.

“Available” techniques means those techniques that are accessible to the operator and that are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages.

“Best Environmental Practices” means the application of the most appropriate combination of environmental control measures and strategies.

The Convention requires Parties (of which Australia is one) the use of BAT for new sources as soon as practicable but no later than four years after entry into force of the Convention for that Party (which is May 2008 for Australia).

The environmentally sound design and operation of waste incinerators requires the use of best available techniques and best environmental practices to prevent or minimise the formation and release of dioxins and furans. Best available techniques and best environmental practices for incineration include practicing proper waste handling, ensuring good combustion, avoiding dioxin/furan formation conditions, capturing the dioxins and furans that are formed, and handling residues appropriately.

In choosing incineration and applying best available technology and practices the provisions and intent of the Stockholm Convention can largely be met. The one notable exception lies in the area of waste characterisation from which initiatives in waste segregation, recycling, and minimisation by the diversion of particular wastes to other waste treatment technologies, can be considered once the waste characteristics are fully understood.

Unfortunately quarantine waste is relatively poorly characterised at present, and quarantine rules preclude the opening of waste containers, once sealed, and the sorting of wastes for their auditing and classification due to the risks this may present.

Of the possible control technologies discussed in the Convention guidelines the proposed facility incorporates a suite of them in the form of:

» Afterburner;

» Rapid quench system (to avoid dioxin/furan formation);

» Scrubbing process;

» Sorption process; and

» Particulate collection.

Fabric filters (bag filters) are widely applied in waste incineration and have the added advantage, when coupled with semi-dry sorbent injection (spray drying), of providing additional filtration and reactive surface on the filter cake.

These emission control attributes have the co-benefit of controlling other potential pollutants (e.g. PAHs, heavy metals) whilst controlling dioxins and furans to meet an emission standard of less than 0.1 ng TEQ/Nm^3.

Eurepean Union Waste Incineration Directive

The emission limit for dioxin specified in the European directive is the same as that specified in the Stockholm convention guidelines and that proposed for the Darwin quarantine waste facility (i.e. less than 0.1 ng TEQ/Nm^3).

For hazardous wastes with more than 1% of halogenated organic substances the Eurepean Union (EU) requirement is for incineration at 1100^{o}C for two seconds (residence time). This is their highest incineration requirement. The proposed DPC facility is intended to operate at 1200^{o}C and two seconds, and so is of a higher standard.

Heat recovery is widely adopted in Europe particularly on larger facilities in the colder countries where waste heat is used for heating premises. Given the size of the proposed Darwin facility and climate it is expected that heat recovery will only be employed to reduce combustion gases to suitable temperatures for their effective treatment and not for heating or steam generation purposes.

The recycling of ash and other residues is also unlikely to be considered in the context of a quarantine incinerator in Darwin. The EU guidelines cover municipal, hazardous and biomedical waste incinerators (there is no mention of quarantine facilities), and the recycling of metals from large municipal incinerators, for example, is required in order to reduce wastes to landfill and recover these resources.

Draft National Action Plan for Addressing Dioxins in Australia

The draft national action plan recommends that State and Territory governments use the recommendations in the Stockholm Convention with respect to Best available Techniques and Best Environmental Practices guidance for new facilities and for existing facilities when they are upgraded.

The draft action plan also requires achievement of the 0.1 ng TEQ/m^3 of dioxins as a goal for achieving best practice for controlling emissions of dioxins from combustion sources throughout Australia.

By complying with the Stockholm Convention the relevant aspects of the draft national action plan are also met.

Occupational Exposure

Emissions to air have been determined to not adversely affect the local air quality for workers, the public or the environment in general. This is discussed in more detail in the health assessment (section 5.13).

5.7.4 Mitigation Measures

Pollution Control Equipment

Air emissions control is a critical component of the proposed incinerator system. The proposed air quality control system will limit particulate, metals, acid gas, and dioxin emissions but the control of other gases (including NOx and CO) and organic compounds is generally a function of the combustion efficiency of the incinerator secondary chamber. The expected combustion efficiency for the emissions control chamber will exceed 99.95%. The destruction and removal efficiency for potentially hazardous organic constituents will be 99.9999%.

The air pollution control equipment now considered to be 'best practice' is a dry system that involves injecting lime and activated carbon into the gas stream (after the temperature of the gas stream has been reduced) and collecting this material in a baghouse. As gases mix with these materials and pass through filter bags caked with these materials the lime removes most of the hydrogen chloride, and some of the other acid gases, and the lime and carbon work to remove heavy metals, organic products of incomplete combustion (e.g. PAHs), and dioxins and furans.

It is possible to meet currently accepted emission standards with appropriate incineration technology fitted with the latest generation of air pollution control equipment. The exact design of the air pollution equipment will be undertaken during the detailed design phase.

Process Anomalies

In the event of a malfunction of the incinerator, the incinerator will be switched off immediately to reduce any adverse air quality impacts. The process will not recommence until the issue has been rectified.

Environmental Management Plans

Environmental Management Plans have been established for the construction and operation of the proposed incinerator.

During the construction phase the following mitigation measures will be implemented:

- Minimise production of dust and use dust suppressant if necessary;
- Ensure all equipment is well maintained and in good working order;
- When equipment and vehicles are not in use they must be switched off;
- Minimisation of the area disturbed at any one time; and
- Avoid the use of unsealed roads where possible.

An EMP specific to the operation of the proposed facility will be in place prior to commissioning. The Operational EMP will include the following aspects:

- Monitoring of the incineration process and incorporation of interlocks to ensure the process is operating under optimum conditions and is compliant with statutory guidelines;
- Monitoring of all raw material and waste streams where possible;

- Regular visual monitoring of the plume emissions from the stack to ensure compliance;
- Regular staff training to ensure equipment and materials are used in an environmentally sound manner;
- Focus on operational training for start up and shut down procedures;
- Regular preventative maintenance of equipment; and
- Annual review of systems.

Conclusion

In summary, a stack height of 25m combined with best available technology, air quality control systems, normal operation and regular maintenance will ensure that the operation of the incinerator will comply with air quality criteria.

5.8 Greenhouse Management

This section provides a summary of the Greenhouse Gas Assessment for the Quarantine Waste Treatment Facility. For the detailed report refer to Appendix I.

The Northern Territory Government's objective for managing greenhouse gas emissions from new and expanding operations is to minimise emissions to a level that is as low as practicable. In accordance with the Northern Territory Government's *Guidelines for the preparation of a Public Environmental Report (PER) for the Quarantine Waste Treatment Facility – East Arm Wharf*, the aim of this Greenhouse Gas Assessment was to:

- Estimate emissions from the operation of the proposed facility, according to National reporting protocols;
- Estimate lifecycle emissions and greenhouse gas efficiency and compare these factors with similar technologies producing similar products (ie. a similar incinerator);
- Compare emissions from the project with national emissions;
- Demonstrate consideration of best practice options, measures and technologies to minimise total project greenhouse gas emissions, including offsets;
- Prepare a program as part of the proposed project EMP for the ongoing monitoring, investigation, review and reporting of greenhouse gas emissions, including offsets; and
- Consider the risk of climate change to the project.

The boundary of this assessment was set to include the following:

- Emissions and energy consumption associated with operation of the facility;
- Emissions associated with off-site generation of electricity consumed at the site; and
- Emissions and energy consumption associated with transport of quarantine waste to the facility.

5.8.1 Methodology

Data and Assumptions

A biomedical waste treatment facility operated by Stericorp in Laverton North, Victoria provides a comparative blueprint for the assessment of the proposed facility at East Arm Wharf. For the purpose of this Greenhouse Gas Assessment, data including electric power consumption, estimated annual fuel consumption and GHG emissions for quarantine waste combustion were assumed to be the same as for the Stericorp waste treatment facility. This data was sourced from Advanced Combustion Engineering (GHD 2003). The important difference is that the proposed incinerator will be operated using LPG, primarily propane, rather than Natural Gas (i.e. methane).

The proposed facility will initially be operated at a throughput of 300 kg waste per hour, and all calculations were based on this figure. Electricity consumption for the AQCS has been included in the calculations. The total hours of operation per year were estimated to be 7,800 hrs (325 days) and the timeframe for the operation of the facility was assumed to be a minimum period of 20 years (with an Air Pollution Control Device review to be conducted after 10 years).

Transport emissions were calculated using distance travelled and based on the truck movements provided. These are detailed in the full report in Appendix I. It was assumed that the trucks were fuelled by diesel.

Calculations

Calculations were based on National Standards using the Factors, Methods and Calculations as described in the Australian Greenhouse Office (AGO) Factors and Methods Workbook (December 2005) produced by the Australian Greenhouse Office at the Australian Government Department of Environment and Heritage.

5.8.2 Potential Impacts

Direct and Indirect Emissions

As guided by the AGO Factors and Methods Workbook (and as per *The GHG Protocol)* three different scopes of emissions categories were defined relating to direct and indirect emissions, as follows:

- Scope 1 covers direct emissions produced from sources within the boundary of East Arm Wharf and as a result of the incinerators activity including LPG combustion to operate the incinerator; combustion of the quarantine waste and transport fuel emissions from the combustion of transport fuel;
- Scope 2 covers indirect emissions from the consumption of purchased electricity produced by another organisation (electricity use);
- Scope 3 includes other indirect emissions that are a consequence of the organisation’s activities but are not from sources owned or controlled by the organisation (includes electricity transmission and distribution losses).

Estimated emissions from the operation of the proposed incinerator facility for each Scope are shown in Table 8. Refer to detailed calculations in the full report in Appendix I.

Table 8 Estimated GHG emissions from operation of Quarantine Waste Treatment Facility East Arm Wharf

	Scope of Emissions	CO2-e (tonnes)
Direct Emissions	Scope 1	8,369
Indirect Emissions	Scope 2	534
	Scope 3	194
	TOTAL	**9,097**

Fuel and energy use for the full fuel cycle from extraction to consumption for the waste treatment facility is estimated to be 9,097 tonnes of carbon dioxide equivalent (CO2-e) per year. The total emissions over the proposed 10-year lifetime of the project would be approximately 90,970 CO2-e (tonnes).

Comparison with National Estimates

According to the National Greenhouse Gas Inventory 2004, Australia's net greenhouse gas emissions across all sectors totalled 564.7 million tonnes of CO2-e in 2004 under the accounting provisions applying to Australia's 108% emissions target. Of these net greenhouse gas emissions, the waste sector comprising solid waste disposal on land, wastewater handling and waste incineration accounted for 19.1 million tonnes of carbon dioxide equivalent (Mt CO2-e) or 3% of the total national emissions (AGO 2006). Waste incineration accounts for 0.1% of the waste sector emissions in 2004 and 0.003% of the 2004 net national emissions across all sectors (AGO 2006).

In comparison to the National Greenhouse Gas Inventory 2004, the estimated emissions for the proposed project (9,097 tCO2-e per year) would constitute 0.0016 % of the net national emissions for all sectors. In terms of the waste sector, the estimated emissions for the proposed project (9,097 tCO2-e per year) would constitute 0.048% of the total national emissions for waste in 2004.

5.8.3 Comparative Technology

The quarantine waste incinerator installed by Stericorp in Laverton North represents 'best practice' standards for biomedical waste management. The proposed facility at East Arm Wharf is similar to Stericorp facility except that it will be fired on propane rather than methane. Recent greenhouse gas emissions estimates for the Stericorp facility are compared to the proposed Quarantine Waste Facility in Table 9 below. The data in Table 9 is based on a throughput of 300 kg/hour for both incinerators.

Table 9 Estimated GHG Emissions for Biomedical Waste Incinerator at Laverton North and Proposed Incinerator at East Arm Wharf.

Source	Greenhouse gas emissions (t CO2 –e/yr)	
	Stericorp, Laverton North, Victoria	Darwin Port Corporation East Arm Wharf
Electricity	1086	611
Fuel	776	1008
Waste Combustion	7410	7410

Source	Greenhouse gas emissions (t CO_2 –e/yr)	
Refrigerated waste storage	6	*
Transport	*	68
TOTAL	9,278	9,097

*Data not available

As per Table 9, greenhouse gas emissions for the proposed East Arm Wharf facility are estimated to be less than that of the Stericorp facility. Data on transport emissions was not available during the greenhouse gas assessment for the Stericorp facility, although they are expected to be more significant than the proposed quarantine facility as biomedical wastes are collected from a larger catchment than that from which quarantine wastes will be collected for the East Arm Wharf facility. The total emissions for the Stericorp Facility are therefore underestimated.

5.8.4 Mitigation Measures

Best Practice Design

Following the evaluation of several different incinerator models and methods (URS 2004), GHD has proposed a particular type of incineration and air quality control system technology to cater for quarantine wastes. GHD has proposed that a smaller incinerator be established (450 kg/hr) with the view to reassess its appropriateness in ten years time in terms of waste volumes, efficiency and potential new technologies for waste disposal.

The proposed new quarantine waste treatment facility will be designed and operated to minimise total greenhouse gas emissions. The design will be based on a similar proven biomedical waste incineration technology installed in Laverton North, Victoria that represents 'best practice' standards for biomedical waste management.

Energy Efficiencies

It is proposed to operate the East Arm Wharf incinerator continuously at a lower than design throughput rate to facilitate fuel and operating efficiencies due to retained thermal heat (no daily preheat required) and reduced thermal stress (caused by stop/start operations). This eliminates the need for daily start up and burn down cycles and is seen to be an efficiency improvement on the current Stericorp model.

The proposed quarantine waste incinerator will be equipped with an automated loader and bin tipper system to load waste into the incinerator hopper. The hopper will be fitted with a lid to provide an airlock that prevents the ingress of ambient air into the primary chamber thus improving the performance of the incinerator by maintaining optimum conditions within the incinerator.

The induced draft and heat exchange fans will be equipped with variable speed drives. This will reduce energy consumption by enabling the fan outputs to be optimised with respect to the incinerator load level.

The combustion chambers are internally lined with refractory insulation to reduce heat loss, which in turn reduces the consumption of auxiliary fuels (natural gas) used to keep the incinerator at the required operating temperature.

Combustion efficiency is continuously monitored, which allows the incinerator to be operated at optimum conditions (greater than 99.95%), which reduces auxiliary fuel consumption.

Energy efficient components are used in all electrical equipment.

Environmental Management Plan

The project Environmental Management Plan (EMP) will include measures for the ongoing monitoring, investigation, review and reporting of greenhouse gas emissions and abatement measures.

5.9 Waste Management

5.9.1 Existing Environment

Waste Classification and Potential Waste Facility Clients

Quarantine waste may be classified as any material foreign to a region or country that is capable of being a host to insects, helminths (parasitic worms) or other parasites, diseases (e.g. bacteria, viruses, fungi, prions, etc), weeds, or any other organisms that are not existent, or prevalent, in that region or country, and that are capable of being a threat to the health and well being of indigenous or local ecosystems, people, or local plant and/or animal industries.

Darwin, and surrounding districts, quarantine waste streams are generated by:

» Darwin Port operations under the control of the Darwin Port Corporation (including East Arm, Stokes Hill Wharf, Fort Hill Wharf and Iron Ore Wharf);

» Darwin Airport operations under the control of AQIS and ACS;

» Australian Navy and Air Force operations under the control of the Department of Defence;

» ACS in the form of illegal fishing boats and people smuggling;

» Quarantine Agricultural Produce from interstate movement by air, rail or road;

» Illicit drugs and contraband seized by the Northern Territory and Federal Police; and

» Health Care Institutions.

Related waste may constitute wastes with similar characteristics or hazards (e.g. biohazards associated with clinical and related wastes), or potentially hazardous wastes generated within the operational precincts of the DPC and Darwin Airport, that can be managed and treated in the same way as quarantine wastes in order to protect public health and the environment. Non-quarantine designated wastes from potentially high risk sources where the competent authority deems that waste to be of potentially high risk due to its origin, or nature, may also be considered to be related wastes.

Quantification of Waste

The quantities of quarantine and related wastes generated in the Darwin precinct by the major producers were investigated by URS in their report to the Department of Infrastructure, Planning and Environment entitled '*East Arm Port, Darwin: Quarantine Waste Disposal Assessment*', dated 7 December 2004 (URS, 2004).

Table 10 Waste Characteristics and Quantities*

Source	Waste Characteristics	Waste Quantity (tonnes/annum)
Waste disposed in existing Fort Hill Wharf Incinerator (Quarantine waste from airport and shipping (including dunnage), Customs, Police, RAAF)	40% food/paper, 20% plastics, 20% glass, 20% timber *(Source: DPC, FHW Incinerator operator)*	92 *(Source: DPC)*
Quarantine waste collected from Darwin Ports and Airport by Wastemaster and sent for deep burial at Council Landfill	45% paper/cardboard, 18% paper towels/tissues, 13% unpackaged food, 7% packaged food, 5% polyolefin, 2% polystyrene, 3% aluminium *(Source: Sydney Airport survey)*	190 *(Source: Wastemaster)*
Non-quarantine waste collected from Darwin Ports and Airport by Wastemaster and sent to Council Landfill	65% food, 10% cardboard, 4% plastics, 6% glass, 15% steel cans *(Source: Darwin Shipping Agency survey)*	1,400 *(Source: Wastemaster/DPC)*
Non-quarantine waste collected from Darwin Ports by Collex and sent to Council Landfill	10% food, 10% paper, 20% cardboard, 20% wood, 5% plastics, 5% glass, 5% steel cans *(Source: Connoco Phillips survey)*	750 *(Source: Collex)*
Quarantine wastes collected from borders/train station (local deep burial)	10% food, 20% paper, 20% cardboard, 10% textiles, 10% steel cans, 10% aluminium *(Source: NT Quarantine Officers)*	1 *(Source: NT Quarantine Section)*
Medical Waste not able/allowed to be autoclaved at Royal Darwin Hospital	Cytotoxic waste, pharmaceutical wastes, anatomical wastes, some biohazardous wastes *(Source: RDH)*	11 *(Source: RDH)*
Medical Waste generated from other health care facilities within 300km from Darwin for which no suitable local disposal method exists.	Pharmaceutical wastes, anatomical wastes, some biohazardous wastes *(Source: AIHW/GHD)*	1 *(Source: GHD)*
Oil spill cleanup waste currently going to landfill	Rags, sawdust, and other absorbent materials	1 *(DCC)*
TOTAL		2,446

*Adapted from URS 2004

Consideration was given to the potential for some clinical and related wastes generated by health care institutions within 300 km of Darwin as possibly being able to avail themselves of a quarantine waste treatment facility. Many of the treatment technologies suitable for quarantine wastes are suitable for clinical and related wastes (and visa-versa). Some of the clinical and related wastes may not currently be managed appropriately because of a lack of available and appropriate treatment facilities. The estimated quantity of such wastes is small at about 1 tonne per annum (tpa).

Although Royal Darwin Hospital (RDH) takes in some waste from other institutions and can autoclave the majority of these wastes, there are some clinical and related wastes for which high temperature incineration is currently the preferred disposal method. RDH exports about 11 tpa of such wastes to incinerators interstate.

Waste Generation Levels

Given the lack of quarantine waste auditing and characterisation studies this report will work on the basis that the total for all quarantine and related wastes is 2,500 tpa, and for quarantine wastes only, the total is 300 tpa, at present.

A growth rate in the waste was estimated (URS 2004) at 4% per annum. This effectively results in a doubling of the amount of waste required to be treated over a 20-year period so that by the year 2026 it is estimated at 600 tpa.

Waste Storage and Disposal Options

During shutdowns at the incineration facility, or periods when large quantities of waste arrive in a short time span, contingency plans have been prepared to allow storage of waste by way of additional refrigerated containers, placed adjacent to the incinerator. The storage area will be isolated and clearly marked as quarantine waste until the waste can be treated. Alternate storage areas will be identified by DPC as appropriate and will follow the established quarantine procedures. Any waste that will require storage for a period exceeding 24 hours will be kept in refrigerated containers.

The throughput of the incinerator will be temporarily increased to allow the additional quantity of waste to be processed. Appropriate cleaning of temporary storage facilities will be conducted at the completion of their use.

In the event of an exceptionally large quantity of waste arriving DPC will investigate the option of sending the 'low risk' quarantine waste (such as food scraps and general waste from cruise ships) to deep burial at an appropriate facility, in consultation with the facility operator.

Sources of Waste Produced from the Incineration Process

The primary source of waste from the quarantine facility will be ash from the destruction of quarantine waste. This waste will be transported via trucks to the Shoal Bay landfill for ultimate disposal. Further information regarding the ash produced is discussed in Section 5.10 Residue and Ash Handling.

Secondary wastes are formed during the cleaning of the ash collection bins and the pollution control equipment. This waste is disposed of with the waste ash at the Shoal Bay landfill.

Personnel supervising the incineration process will produce small quantities of domestic waste.

Wastes Unable to be Disposed of Via Incineration

Some potentially hazardous or explosives wastes are unable to disposed of via incineration, URS 2004 reports these are being the following:

» *Wet cell batteries (eg car batteries)*: these are potentially explosive; lead will contaminate ash and potentially pass through the pollution control device; sulphuric acid is corrosive to the refractory and will create acid gases when burned (although these may be treatable in the pollution control device).

» *Dry cell batteries (eg flashlight)*: contain nickel, cadmium and other heavy metals (see heavy metals below).

- *Aerosol cans of any type*: will explode when heated; act like grenades and can damage refractory; slight chance of personnel injury.
- *Greases, oils, solvents, paints, adhesives, and engine additives*: in small quantities, these are probably allowing into solid waste landfills, which would be a better choice. In an incinerator, they add high calorific fuel that can ignite explosively, forcing a surge of combustion gas that may exceed the pollution control device's short-term volumetric gas-handling capacity. This would allow the gas to pass through too quickly and not allow the pollution control device enough time to fully treat the gas. In turn, this can cause the regulatory concentration limits to be exceeded for certain air pollutants. These items may also contain heavy metals, which will then increase their concentration in the air emissions or the ash, or both.
- *Anything containing heavy metals*: may help cause the ash to fail an ash leaching test. As specified in the NSW EPA guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes, Toxic Characteristic Leaching Procedure (TCLP) test – the ash is ground up and leached with acid solution. The leach is more acidic than conditions in a landfill; hence it will dissolve more metals than real-world conditions. If the ash fails the TCLP, the ash must go to a hazardous waste landfill or be immobilised prior to disposal at a solid waste class landfill.

These materials should be separated at the source (i.e. on ships) and recycled, reused or disposed in accordance with the relevant NT state regulations, in particular the *Waste Management and Pollution Control Act* 1998 (URS, 2005).

5.9.2 Potential Impacts

Inappropriate storage of the quarantine waste may lead to an outbreak of disease and may impact human life and affect the biodiversity of the Northern Territory. Refrigerated storage will be required if the quarantine waste is to be stored for longer than 24 hours.

Incorrect segregation of waste may lead to quarantine wastes being sent to landfill and as such all material entering the Northern Territory via air or sea will be treated in the quarantine incinerator.

Given the nature of quarantine waste, third parties should ensure that the waste is sealed and stored appropriately and in accordance with regulations. Subsequently inappropriate bagging and labelling of wastes by third parties may affect feed control (and subsequent emissions) of the incinerator. Because the waste arrives at the facility already sealed, it is therefore impossible to undertake segregation and classification of quarantine waste once it has left its source generator.

5.9.3 Mitigation Measures

Waste Management Program

A waste management program will be established with the following control measures incorporated:

- Wastes appropriately segregated and stored by waste type;
- Procedures in place for handling quarantined material that are consistent with the appropriate legislation; and
- Quarantine waste management procedures to be controlled by appropriately authorised and responsible personnel.

A monitoring and reporting system will be established to prevent/correct breaches occurring following the system outlined below:

» Daily inspections to be conducted during preparations to confirm waste management requirements are complied with focus placed upon the effectiveness of waste segregation procedures;

» Incidents, accidents and complaints (including non-compliance) related to waste disposal should be investigated, documented and improvement strategies implemented; and

» Environmental Incidents Forms will be completed for any form of environmental concern, including all spills and leaks. If any incident causes, or threatens to cause, pollution resulting in any degree of environmental harm, Office of Environment and Heritage must be informed within 24 hours of first becoming aware of the situation.

The implementation of control measures is the responsibility of the DPC. Incident investigation and improvement measures implementation (incorporating complaint management) is the responsibility of the DPC and the OEH.

Acceptance of Waste

An in-floor platform scale will be utilised to weigh all waste upon arrival. The waste bins will be bar-coded, allowing readings with a hand held scanner, for identification of the origin of the waste. Information included in the bar-code will include:

» Date;

» Time of day;

» Origin of waste; and

» Other related data.

This data, and the weight of the waste, will be downloaded onto a computer database system logging the waste received.

Non-approved waste arriving on site will be immediately identified and reported to the incinerator supervisor. The Waste Management Program will incorporate a procedure for arrival of non-approved waste.

5.10 Residue and Ash Handling

5.10.1 Quality and Quantity of Ash Produced

As previously stated, the incinerator is designed to accept up to 450 kg/hr of waste although this will actually depend on the volume, bulk density and calorific value of the waste. A minimum throughput of 300 kg/hr is envisaged during the initial commissioning and operations.

URS (2005) indicates that based on processing approximately 295 tonnes per year of waste (consistent with initial operations of the proposed incinerator), an estimated 59 tonnes of ash will be produced (approximately 80% reduction in solid waste). This quantity of ash relates to approximately 25 $3m^3$ bins of ash and equates to one $3m^3$ bin delivery of ash to landfill each fortnight. Future quantities of ash are reported by URS 2005 to be double current rates by 2025 with an estimated 673 tonnes of waste being incinerated. This results in approximately 135 tonnes of ash being produced in the year 2025 and delivery of one 3m^3 bin to landfill each week. Primarily the waste ash is produced in the primary chamber with additional small quantities from deposits throughout the process equipment and baghouse residues.

Characterisation of Ash

The Department of Environment and Conservation, NSW (DEC 2004), define the principal test used for assessing non-liquid waste is the Toxicity Characteristics Leaching Procedure (TCLP), which estimates the potential for the waste to release chemical contaminants into a leaching liquid. This property is called the leachable concentration and the guidelines set different maximum levels of leachable concentration of each contaminant in order for waste to be classified as inert, solid, industrial or hazardous. This TCLP test is generally used Australia-wide to determine how a waste should be managed.

The waste incineration facility will produce an ash that is biologically inert. The ash is classified as a solid waste type that can include putrescible waste and is considered to pose a higher environmental risk than inert waste, and consequently needs to be managed with greater care (DEC, 2004). A primary concern relating to the ash product is correct segregation of the wastes containing heavy metals prior to incineration. Wastes containing heavy metals are excluded from incineration as they may cause the resultant ash to fail a TCLP test. Ash that fails a TCLP test must be sent to a hazardous waste landfill or be immobilised prior to disposal at an accepted solid waste class landfill.

The Assessment, Classification and Management of Liquid and Non-liquid Wastes outlines the maximum threshold for contaminants in the ash and these are the contaminants that will be tested for in a TCLP test. Included within this list are metals such as beryllium, cadmium, chromium, lead, mercury, nickel and silver and other organic and inorganic contaminants.

During the initial stages of the incineration operation testing will be conducted on the ash to ensure its suitability to be disposed off to Shoal Bay landfill. Testing will continue until results show a large degree of continuity and the testing regime can then be reduced.

5.10.2 Methods of Handling and Disposal of Ash

The incinerator will be equipped with a hydraulic lifter for lifting and tipping the 3m^3 ash bins into a feed hopper. A continuous ash removal system within the incinerator allows the ash to fall into the bin. The ash bins are then loaded onto a truck and once the ash has been cleared for disposal (following appropriate physical and chemical testing) it will be taken for disposal at the Shoal Bay landfill.

The bins are securely attached to the transport vehicle and also covered to prevent dispersion of the ash on the journey.

Once unloaded at the landfill, the ash should be immediately covered with other waste to prevent dispersion into the air.

5.10.3 Potential Impacts

Ash on the surrounding flora and fauna, both marine and terrestrial, is classed as having an insignificant impact. There is anticipated to be no negative or positive impact on the physical, biological or human environment. A detailed waste segregation program will ensure that the ash produced is not of hazardous nature and this will be confirmed through TCLP tests. Ash tested to be hazardous will be taken to a hazardous landfill or taken off-site to be immobilised prior to disposal at Shoal Bay; both of which will not impact surrounding flora and fauna.

5.10.4 Mitigation Measures

During the initial stages of the incinerator's operation the ash will be TCLP tested to ensure its suitability for landfill. This is in essence precautionary as the ash is expected to be biologically inert and free of heavy metals.

The disposal of ash will be governed by the following measures:

» All transport of ash will be in covered bins; and

» The ash must be immediately covered with other wastes to prevent dispersion at landfill.

5.11 Transport

5.11.1 Existing Environment

The only road access to the location of the proposed waste treatment facility is via Berrimah Road, which once inside the port becomes a quasi-extension of this road. Berrimah Road consists of two traffic lanes, one in each direction.

Currently Berrimah Road past the Wishart Road turnoff caters for all traffic entering and exiting East Arm Port, passenger collection and delivery service to The Ghan, and industrial traffic servicing a number of local businesses including AQIS.

Due to the physical restrictions of the Berrimah landscape it is expected that the majority of the traffic will move along this passageway.

Table 11 Daily Traffic Flows into East Arm Port (27/04/06 – 02/05/06)

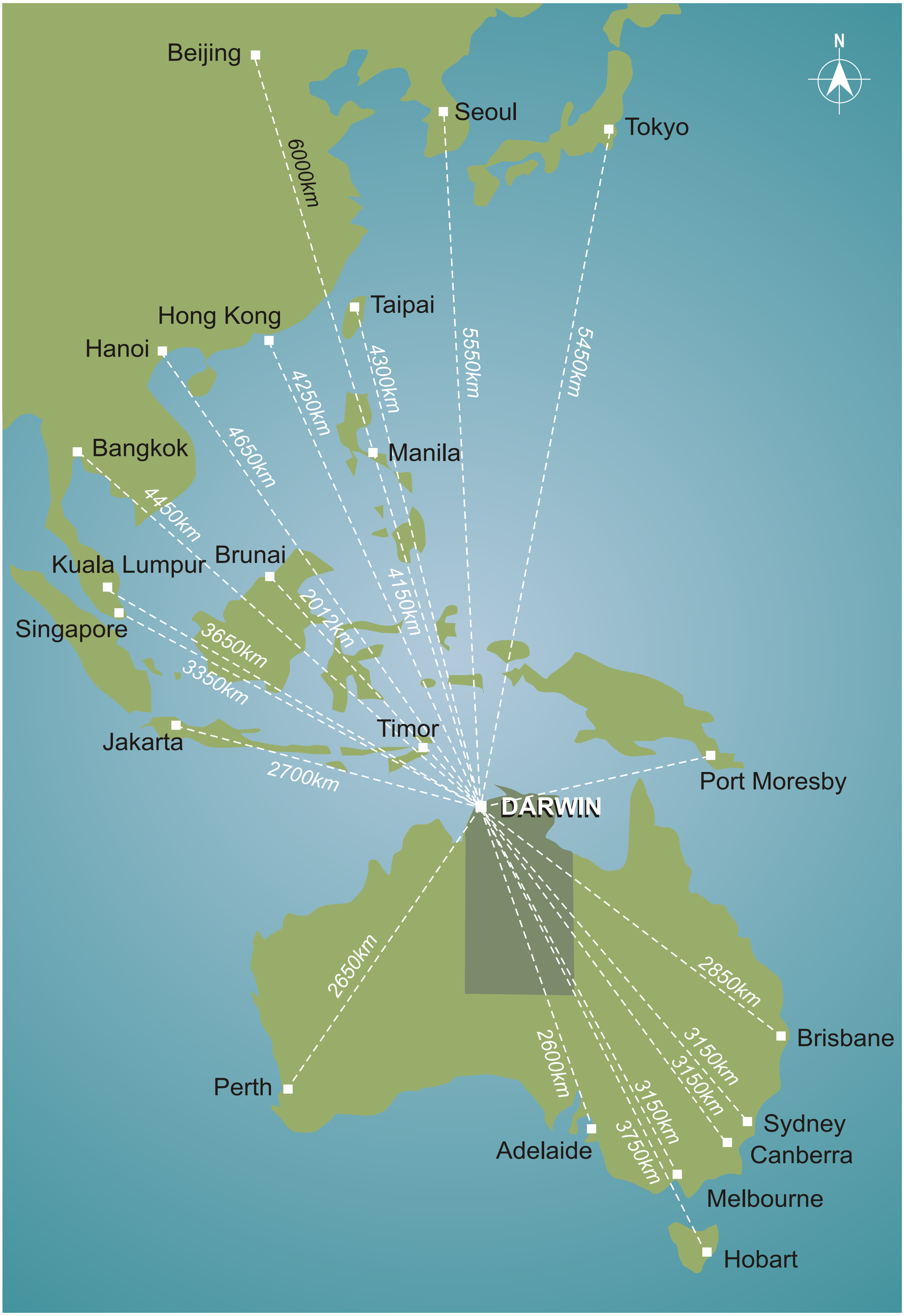
Day *	Number of Cars	Number of Trucks
Thursday	199	21
Friday	202	16
Saturday	97	66
Sunday	40	12
Monday (Public Holiday)	22	0
Tuesday	157	18

* 24 hour period beginning at 0600 hours for specified date.

The numbers of cars on any weekday are governed by the amount of workers required at East Arm Port with peak periods occurring at shift changes which generally occur at 0600 and 1800 hours, operating both night and day shifts.

The ships docked and the need for goods to be transported governs the numbers of trucks entering the port on any given day.

International and interstate sea traffic into Darwin originate from numerous locations and are outlined in Figure 5-7.



Source: Darwin Port Corporation

CLIENTS | PEOPLE | PERFORMANCE

Quarantine Waste Treatment Facility Public Environmental Report

International & Interstate Sea Movements into Darwin

job no	21-14332
file ref	2114332_LTN_07.cdr
scale	not to scale
date	7 June 2006

Figure 5.7

All equipment and material required for construction of the incinerator will primarily be transported via road. Trucks from interstate will carry goods into Darwin along the Stuart Highway and turn right into Berrimah Road, following this directly to East Arm Wharf. Locally fabricated and supplied products will be delivered using the appropriate service vehicles. Transportation of goods of industrial nature is common on both of these carriageways.

Any equipment required from an international destination will be sea freighted directly into East Arm Wharf on typical cargo ships and will not result in an increase of sea traffic nor require specialised loading or unloading techniques.

During operation the wastes will be correctly sealed and delivered via truck to the incinerator from the selected collection points. The collection points will include Darwin International Airport, Stokes Hill Wharf, Iron Ore Wharf, Darwin Naval Base and East Arm Wharf. The vehicles delivering this waste will travel to East Arm Wharf along Berrimah Road, only resulting in a slight increase in traffic numbers. Transporting the waste to East Arm Wharf will reduce traffic congestion slightly in the Darwin CBD where the current incinerator is located.

The waste ash from the destruction of quarantine waste will be transported to the Shoal Bay landfill. The route the truck will typically follow is:

» Move through East Arm Wharf, exiting through the gatehouse and onto Berrimah Road;
» Continue along Berrimah Road, move straight through the traffic lights at the Stuart Highway and continue along Vanderlin Drive; then
» Pass straight through the two roundabouts on Vanderlin Drive taking a right at Vine Road and turning into the Shoal Bay landfill.

The overall distance to reach Shoal Bay landfill for delivery of ash from East Arm Wharf is approximately 14 kilometres.

5.11.2 Potential Impacts

There will be a minor increase in traffic movements in proximity to East Arm Wharf and along to the proposed route to Shoal Bay Landfill. The impact is considered to be minor as the proposed routes are presently frequented with industrial traffic movements and the increase is anticipated to be minor.

5.11.3 Mitigation Measures

Over time traffic congestion is anticipated to increase on Berrimah Road, which is the only carriageway into East Arm Wharf, and as such widening the road may need to be considered. This would be the result of increased traffic into and around East Arm Wharf and would not be a direct result of incinerator operations.

5.12 Biting Insects

5.12.1 Existing Environment

The location of the proposed incinerator at East Arm Wharf resides within known breeding habitats for mosquitoes and biting midges. The proposed site lies in upper tidal areas and mangroves (which are affected by monthly population peaks of biting midges).

Mosquitoes are known to present serious health risks to humans by acting as transmitters or vectors of pathogenic arboviruses (EPA 2000).

Diseases such as Ross River virus, Barmah Forest virus, Murray Valley encephalitis, Kunjin virus and Australian encephalitis can be transmitted via mosquito bites (DHCS 2006; DHA 2006).

5.12.2 Potential Impacts

Due to the location of the proposed incinerator, biting insects are a likely issue for personnel during the construction of the facility and the operational period.

Potential impacts from biting insects can typically be discomfort and occasionally disease.

5.12.3 Mitigation Measures

Mitigation measures to protect personnel working at the waste treatment facility are recommended to incorporate the following:

- Personal protection equipment including long sleeve shirts and trousers to assist in protecting skin and to discourage insect attacks;
- Ensure a repellent is made available to staff containing chemical diethyl toluamide (DEET) or picaridin which give best protection (Whelan 2004);
- Use of yellow or red lighting, rather than white lighting, will reduce attractiveness of lights to other insects (Whelan 2004). In this instance it may not be possible to install this type of light due to safety reasons and providing adequate lighting levels;
- For insects that have breached screened areas, or are a nuisance within the work area DPC should provide pyrethrin aerosols. Care should be taken to ensure only knockdown aerosols suitable for spraying in the air are used in proximity to people or food (Whelan 2004). Care should be taken if choosing to implement this due to the incineration equipment operating at elevated temperatures;
- Cream should be available to all personnel to allow symptoms of biting insects to be alleviated; and
- When possible install insect screens fitted with an automatic closing device on windows and screen doors that open outwards.

For preventing mosquito breeding at the construction and operational site, relevant Guidelines for Construction Practice as listed by Whelan (2002) should be adhered to. These include:

- Prevention of borrow pits and excavations from taking place within the tidal zone;
- Installation of silt traps in newly constructed stormwater drains;
- No embankments should be constructed across tidal areas unless there is provision made for sufficient tidal exchange to prevent any substantial ecological change; and
- An ecological and hydrological study should be undertaken if any water retention features are to be incorporated at the site.

5.13 Health and Social Impact

A detailed health risk assessment has been conducted for receptors surrounding the facility, and is presented in Appendix H. This assessment was undertaken in conjunction with the Air Quality

Assessment (refer to section 5.7), which estimates the atmospheric dispersion of emissions from the facility.

5.13.1 Potential Impacts

The major discharges from the proposed facility are emissions to air, the ash and non-combustible residues arising from incineration. As wet scrubbing in not being proposed there is not expected to be any liquid wastes generated from the incineration process, although there will be some liquid wastes generated from the cleaning of bins and waste receival areas.

Emissions to air have been determined to not adversely affect the local air quality for workers, the public or the environment in general. The deposition of particulate emissions is also a minor and transient effect given the best available technology being applied to control these emissions. Any deposition in the nearby aquatic environment would be diluted and dispersed such that any negligible impacts would not be discernible. As such effects on possible sources of food and their contamination by emissions or the depositions of particulates is very unlikely given the size of the sources and the extent of the local environs.

The landfilling of incinerator ash and non-combustible residues at a controlled secure landfill designed to contain and manage leachate is unlikely to result in any offsite effects. Some regular leachate testing of incinerator ash will be required to ensure that the ash does not contain unacceptable levels of potentially hazardous leachable components.

The issues of potential biological hazards or disease arising from the facility operations is unlikely as it is the purpose and prime function of the facility to manage such risks in the most effective manner possible and was largely the reason for the selection of the technology in question.

The management and operation of the proposed facility will be undertaken to ensure that the risks associated with the potential biological hazards are minimised during the handling of the waste and eliminated in the waste treatment process. Standard operating procedures will be developed to ensure a high standard for secure management of quarantine and related wastes. The proposed facility will also be subject to an Environmental Management Plan (EMP) to be approved by the EPA for its construction, management and ongoing operations.

Given the location of the proposed facility the issue of noise will only be applicable to persons operating or inspecting the facility and only in close proximity to certain areas of the facility and its operations, for which there would be a requirement for hearing protection when persons are in those designated areas.

5.13.2 Emission Release of Substances

The type and concentration of emission constituents likely to be emitted are discussed in section 5.7.

Of particular importance are particulates, nitrogen oxides (NOx), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), heavy metals (mercury, lead, arsenic, chromium, nickel, antimony, cadmium), and dioxins.

Detailed emission estimates for normal operating conditions and bypass operation (abnormal conditions) are presented in the detailed Air Quality Assessment (Appendix G). Bypass operation is expected to occur in the order of one or two instances per year, and when a problem occurs the combustion emissions can pass directly into the atmosphere without passing through the air quality control system.

Populations of Interest

Sensitive receptors include residential areas, schools and other similar uses where people are present for an extended period of time, except in the course of their employment or leisure. These receptors are considered particularly vulnerable, and the assessment of risk has focused on these groups.

Sensitive receptors identified were Government House and Kormilda College, details of these receptors are located in section 5.6.2.

Residents (adults and children) have been considered as the most sensitive receptors, and have been conservatively assessed assuming continuous exposure for a lifetime (70 years of exposure).

Other receptors that may be exposed are facility workers and workers on the wharf, and surrounding industrial land. Water bodies surround the site; Frances Bay on the east and northeast of the site between the Darwin Waterfront development; and East Arm south of the site.

The land from the coast to the nearest township northeast of the site consists primarily of bushland.

Routes of Exposure

The primary exposure route for sensitive receptors is determined to be through dispersion of emissions into air and inhalation. The most sensitive potential receptors (i.e. residents) are located approximately five kilometres from the site. Emissions that may reach this distance from the facility will be in the form of vapour or fine particulates.

Other exposure pathways that are considered are oral (soil ingestion), dermal (skin contact), and produce uptake and consumption (including livestock). The exposure pathways are only considered to be an issue near the facility where the heavier particles deposit and potentially accumulate in soils over the life of the facility. Emission controls proposed for the facility will remove almost all of the larger particles that could add to deposition. Therefore these exposure pathways are considered to be insignificant compared to direct inhalation.

Any deposition in water will also have a minimal effect due to tidal effects and wet season flushing of the harbour, effectively creating infinite dilution. Therefore, any sea-based food is unlikely to be impacted.

Health Risks to Residents

Health risks have been estimated for the two groups of sensitive receptors. Methodology for conducting health risk assessment in Australia is outlined in EnHealth 2002, and had been used in this assessment. Exposure was conservatively assumed to occur continuously for 24 hours per day, 7 days per week, for a 70-year duration.

Risks to potential residents to the north west of the facility were estimated to be higher than the township north east of the site.

The incremental lifetime cancer risks for residents at the proposed northwest development were estimated to be 8.4 x 10^{-6}, which is within acceptable levels (i.e. be a cancer risk of 1 x 10^{-5}). This risk primarily consists of approximately 76% contribution from hexavalent chromium and 19% from carcinogenic PAHs.

The non-cancer total Hazard Index for the most exposed sensitive receptor was estimated to be 3.7 x 10^{-4} for children and 2.0 x 10^{-4} for adults, which are significantly less than the maximum acceptable level of 1. The primary contributor to noncancer risk was hydrogen chloride (74%).

Assessment of Lead Exposure

Lead exposure is assessed using lead blood levels. World Health Organisation (WHO) and United States EPA do not specifically provide any guideline values or toxicity dose-responses. WHO indicate that to correct for uptake by other routes as well, it is assumed that 1 µg lead per m^3 air would contribute to 50µg lead per litre blood.

It is recommended that efforts be made to ensure that at least 98% of an exposed population, including preschool children, have blood lead levels that do not exceed 100 µg/l. In this case, the median blood lead level would not exceed 54 µg/l. On this basis, the annual average lead level in air should not exceed 0.5 µg/m^3. This proposal is based on the assumption that the upper limit of non-anthropogenic blood is 30 µg/l. These estimates are assumed to protect adults also.

The air dispersion modelling results indicates that the highest annual average GLC for lead at the sensitive receptors is estimated to increase by 1×10^{-4} µg/m^3. This is significantly below the level of 0.5 µg/m^3, nominated by WHO, and therefore it is considered that the potential lead loading from the waste facility will have negligible impact on surrounding sensitive receptors.

Assessment of Hydrogen Fluoride Exposure

In addition to the assessment of health risk, WHO propose a guideline value of 1 µg/m^3 for fluoride to protect adverse impacts on plants. This criterion is more stringent than protection of human health.

The highest annual average hydrogen fluoride concentration at sensitive receptors is 2.5×10^{-4} µg/m^3, which is significantly below the guideline value.

Review of the contour plots of annual average Ground Level Concentration (GLC) for unit emission (Figures 5 and 6 from the Air Quality Assessment Appendix G) indicated that the maximum annual average GLC anywhere is approximately 2 times that estimated at the most exposed sensitive receptors (i.e. at the proposed development to the northwest). Therefore, the estimate of fluoride GLCs will be significantly below the guideline value at all locations surrounding the facility.

5.13.3 Assessment of Background Exposure

Background levels of pollutants in air are unlikely to influence the results of this assessment due to the low levels predicted. EnHealth (2002) refer to the Canadian approach where 20% of acceptable exposure is attributed to each of air, soil, water, food and household material exposure. The predicted hazard index is less than 0.1% of the total allowable exposure and hence would not contribute significantly to the overall exposure of a receptor.

An assessment of heavy metals in ambient air has been conducted by the Department of Environment and Heritage (DEH, 2002). In this report it is indicated that lead levels in the ambient air of Darwin are reported generally below detection limits of 0.01 µg/m^3.

Dioxins are likely to be the only chemical group with threshold toxicity effects, which background sources may significantly contribute to health risk. A survey in Canada showed that the upper level of the daily intake rate is 1.2 pg TEQ/kg bw[2] (ATSDR, 1998). Studies have shown that background exposure to dioxins occurs mainly through food (over 90%). In New Zealand the calculated 90th percentile daily intake rate of dioxins (corresponding with high energy people) is 0.84 pg TEQ/kg bw (MfE, 2001). The results of

[2] TEQ/kg bw *refers to the Toxic Eqivalent (calculated from the summation of the relative toxicities from all the different types of dioxins) per kilogram body weight.*

the study of dioxin-like compounds present in serum, indicates that the mean of the average lifetime daily exposure is 1.4 pg TEQ/kg bw (MfE, 2001). The latter estimate is higher than the estimated dietary intake because it allows for historical exposure, which is likely to have been higher than the current level of exposure, as well as non-dietary exposure.

The background dose of 1.4 pg TEQ/kg bw, when compared with the allowable average daily dose of 2.3 pg/kg bw results in a background HQ of 0.61. As the maximum predicted HQ for dioxin from the facility was 1.6×10^{-6}, this increase in risk is considered insignificant compared to background exposure.

5.13.4 Health and Safety Concerns of Employees and Visitors to the Site

DPC controls and manages the East Arm Wharf. This wharf is a secure site. Within this site the proposed quarantine waste treatment facility will also be a secure site and will only allow authorised access to authorised employees, waste deliveries, and visitors.

DPC personnel required to undertake duties or works at the site, and any contractors required to undertake works at the site will be required to go through a site induction process with respect to the facility's Occupational Health and Safety Plan.

Once on site DPC employees, waste delivery personnel and visitors will be subject to the site's Occupational Health and Safety Management Plan.

Personnel will only be granted access to those areas that they are authorised to enter. For example, waste delivery personnel will only have access to the waste receival area. Visitors, including AQIS and Customs staff, will only have access under supervision or escort by authorised DPC personnel.

The exposure pathways are only considered to be an issue near the facility where the heavier particles deposit and potentially accumulate. Emission control systems for the facility will remove almost all of the larger particles that could add to deposition and therefore it is highly unlikely there will be any health concerns for employees in close proximity to the incinerator.

During bypass conditions the release of potential pollutants is still compliant and further discussed in Section 5.7.

5.13.5 Provision of Emergency First Aid Treatment

It is proposed that the building housing the incinerator will have a small office and staff amenities area. A first aid kit will be available in the staff amenities area. As the operation of the facility is likely to be a one-person operation there will be the need to ensure ready communications and support if there is an accident or incident.

The East Arm Wharf of the Port has an emergency response plan that includes the management of a medical emergency and this will apply to the proposed quarantine waste treatment facility.

5.13.6 Mitigation Measures

A management and administration plan discussing the following key aspects will be prepared once the final design and layout of the proposed facility has been finalised:

» Waste receival and storage;

» Waste handling and loading;

- Incinerator operations guide (including bypass operations);
- Incinerator maintenance and servicing guide;
- Air Quality Control systems operating guide;
- Incinerator ash and residues management (i.e. removal, storage, handling, transport and disposal);
- Baghouse waste management (i.e. removal, storage, handling, transport and disposal);
- Facility housekeeping guide;
- Waste processing record keeping;
- Environmental Management Plan (including monitoring requirements and understanding outputs);
- Emergency Response Plan (includes scenarios covering leaks, spills, fires, explosions, security breaches, cyclone warnings and procedures, emergency shutdown, emergency waste storage and containment arrangements in the event of a major breakdown or major seizure or requirement for the destruction of high risk quarantine related materials, etc.); and
- Staff training requirements.

In summary, it is unlikely there will be adverse health and social impacts for surrounding persons, including employees, providing all air quality systems are in place and mitigation measures are implemented.

5.14 Other Environmental Considerations

5.14.1 Terrestrial Flora

There are two species of threatened flora surveyed by Department of Natural Resources, Environment and the Arts (NRETA) within the 10-kilometre buffer zone of the incinerator site, the *Cycas armstrongii* and the bladderwart *Utricularia singeriana*. All Cycads that are wild in the Northern Territory are protected plants under sections 45 and 47 of the *Territory Parks and Wildlife Conservation* (TPWC) *Act* (1993). As protected plants, sections 50 and 52 address the granting of permits or licences to take and the willful destruction of cycads by a landholder.

There are five dominant vegetation communities (Table 12) present in the surrounding area as described by Acer Vaughan (1993). These communities are typical of the Darwin region.

The incinerator site is an area of reclaimed land that does not have any vegetative growth in the form of these communities on it. The construction and operation of the incinerator will not impact any threatened vegetation. There are no established vegetation communities that occur on the East Arm Wharf.

Table 12 Vegetation Communities

Vegetation Community	Description
Melaleuca Forest	Paperbark forest dominates the landward fringe of the intertidal zone where seepage from the hinterland occurs. This area is dominated by *Melaleuca viridiflora* and *Melaleuca leucadendron* with an absence of understorey species.

Vegetation Community	Description
Littoral Woodland Zone	Immediately adjacent to the landward extreme of the mangroves is a diverse plant community in the littoral woodland zone. The existing plant assemblage varies largely according to the substrate type and the degree of disturbance from clearance of previous developments and the effects of CycloneTracy in 1974. Dominant communities in the littoral woodland zone include:
Eucalypt Woodland	*E. bleeseri* (smooth-stemmed bloodwood) is found on the rocky steeply inclined slopes with *E. miniata* (Darwin woolly-butt) and *E. tetrodonta* (stringybark) becoming dominant on the undulating ground. Common secondary trees include; *A. aulacocarpa*, *Erythropleum chlorostchys* and *Brachychiton diversifolium*. Shrubs and seasonal grasses dominate the lower stratum
Vine-Thicket	Discontinuous patches of vine-thicket interspersed with eucalypt woodland around the slopes of the hinterland are dominated by a variety of rainforest species. Vine species are abundant and are a characteristic of this community.
Mixed Woodland	This vegetation community comprises variable vegetation on a variety of substrate types.

5.14.2 Terrestrial Fauna

There are 15 species of fauna identified under the EPBC Act Protected Matters Report and seven species are identified under the TPWC Act (1993) surveyed by NRETA. The five endangered species that have been identified by the EPBC Act are not known to exist on the East Arm Wharf. Marine species identified may utilise the waters of Darwin Harbour and mitigation measures must be stringent to ensure that this pristine environment is not disturbed.

Field surveys conducted by Acer Vaughan (1993) found that the fauna of the area is representative of the coastal Northern Australia. The surrounding islands are noted as representing a relatively minor high tide roosting area for birds including migratory waders. Eight species of mammal were recorded in the area including the grassland melomy, the northern brown bandicoot, the agile wallaby, antilopine kangaroos, the northern quoll and the northern brushtail possum. Most of the species observed are typical of disturbed or semi-disturbed areas around Darwin. Diggings from feral pigs were also observed in this area. The survey found a total of seven reptiles at the site all of which are generally common in the Darwin area. Three species of carlia skink and the prickly gecko were observed along the mangrove fringes.

Survey data results provided by NRETA are similar to those of Acer Vaughan (1993). The NRETA results are more comprehensive than the Acer Vaughan (1993) results as they cover a larger study area (10 kilometer buffer zone around the incinerator site). The results indicate that 107 species of reptile, 36 species of mammal, and 289 species of birds have been surveyed within the buffer zone. Of the species identified 7 are threatened species identified under the *TPWC Act* (1993) (Table 13) none of which are known to have established communities or habitats on the East Arm Wharf.

NRETA survey data identifies four feral animals in the buffer zone of the incinerator site including the feral pig (*Sus scrofa*), feral cats (*Felis catus*), water buffalo (*Bubalus bubalis*), and cane toad (*Bufo marinus*). Large feral animals such as the feral pig and water buffalo are not perceived to cause concern on the incinerator site due to the nature of the port facility. Cane toads are an adaptive species and can be transported quickly and unintentionally on vehicles. An exotic species management plan should be established to prevent the movement of both animals and plants on and off the site.

Table 13 Threatened Species*

Family	Name	Common Name	EPBC Act	TPWC Act
	Geophaps smithii smithii	Partridge Pigeon (eastern)	Vulnerable	
Passeridae	*Erythrura gouldiae*	Gouldian Finch	Endangered	Threatened
Otididae	*Ardeotis australis*	Australian Bustard		Threatened
Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	Vulnerable	Threatened
Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	Endangered	Threatened
	Balenoptera musculus	Blue Whale	Endangered	
	Megaptera novaeangliae	Humpback Whale	Vulnerable	
	Xeromys myoides	Water Mouse, False Water Rat	Vulnerable	
Cheloniidae	*Eretmochelys imbricata*	Hawksbill Turtle	Vulnerable	Threatened
Cheloniidae	*Natator depressus*	Flatback Turtle	Vulnerable	Threatened
Cheloniidae	*Chelonia mydas*	Green Turtle	Vulnerable	Threatened
	Caretta caretta	Loggerhead Turtle	Endangered	
	Dermochelys coriacea	Leathery Turtle Leatherback Turtle, Luth	Vulnerable	
	Lepidochelys olivacea	Pacific Ridley, Olive Ridley	Endangered	
	Pristis microdon	Freshwater Sawfish	Vulnerable	
	Rhincodon typus	Whale Shark	Vulnerable	

* Of the species identified 7 are threatened species identified under the *TPWC Act* (1993) none are known to have established communities or habitats on the East Arm Wharf.

5.14.3 Marine and Estuarine Communities

Mangrove Communities

Darwin Harbour has over 20,000 hectares of mangrove communities that occupy the intertidal area parallel to the coastline. Darwin Harbour has a total of 36 of the 51 species that are known to occur in the

Northern Territory. Mangrove communities generally comprise of well-defined zones of communities of species that interact together at particular heights in the tidal zone and on particular strata.

Zones of the Darwin Harbour include the following (Acer Vaughan, 1993):

» Sonneratia Zone;

» Tidal Creek Zone;

» Rhizophera Zone;

» Bruguiera Zone;

» Ceriops Zone;

» Salt Flats;

» Avicennia Zone;

» Mixed Mangrove;

» Hinterland Margin; and

» Rocky Shore Zone.

Marine and Estuarine Fauna

Coral Communities

The coral reefs are an important component of the Darwin Harbour ecosystem but are limited in distribution due to natural factors including the high turbidity of the water and availability of suitable substratum. The coral reefs are therefore limited to a depth of approximately 7m where the light penetration is sufficient for photosynthesis. The most significant coral communities are located at Lee Point, Nightcliff, East Point, Weed Reef, Channel Island and North and South Shell Islands. The coral communities located at the Shell Islands near the proposed area are considered different compared to the communities outside the harbour due to the higher turbidity, freshwater influence, warmer current regime and the surrounding mudflats (Acer Vaughan 1993).

GHD conducted a baseline coral survey in 2005 of four coral communities in the harbour – the South Shell Islands, Weed Reed, Wickham Point and Channel Island. Common corals from these sites, which usually occur in elevated ambient turbidity, include *Mycedium* and *Goniopora* spp. The low coral species diversity of the Darwin Harbour sites is considered normal for very silty coastal or near-shore reefs (Ayling *et al*. 1998).

Overall, these features suggest that the marine communities of Darwin Harbour are very silt tolerant and well adapted to low light, turbid water conditions.

Shallow exposed coastal reef areas such as these are also susceptible to physical extremes, including cyclonic and storm wave action, freshwater inundation and high water temperatures (Berkelmans and Oliver 1999, Ayling and Ayling 1997, 2004). These factors probably lead to regular disturbance and damage of the reef communities. The rarity of large coral colonies and establishment of deep loose coral rubble indicates that frequent disturbance from these or similar events remains a key ecological feature of the four reefs the GHD surveyed.

Fish

There is a large variety of fish found in Darwin Harbour ranging from pelagic sharks, mackerel, queenfish, threadfin salmon, jewfish and barramundi to snapper, coral trout, cod garfish, mullet and bream to the smaller fish such as gobies cardinal fish and coral and sponge garden areas. The species of fish found in the area surrounding the proposed site will not differ greatly to the species range found in Darwin Harbour and will reflect the habitat characteristics (Acer Vaughan 1993).

Mammals

There is little known about the importance of Darwin Harbour for marine mammal populations. Dolphins are sometimes spotted in Darwin Harbour but are generally found in the more open waters. Dugong populations in Darwin Harbour are considered to be low to moderately high. The populations are found in shallow coastal areas where the seagrass beds occur. The locations of the significant seagrass beds are off Mandorah, and outside Darwin Harbour off Casuarina Beach and Fannie Bay (Acer Vaughan 1993).

Reptiles

Several species of turtles have been recorded in Darwin Harbour including the green turtle, flatback turtle, and hawksbill turtle. The turtles are known to breed within Darwin Harbour but breeding grounds have not been recorded within the proposed site or surrounding area.

Saltwater crocodiles populate the tidal rivers and open waters of northern Australia and are also known to frequent Darwin Harbour. However the Conservation Commission of the Northern Territory maintains a management plan for Darwin Harbour and crocodiles found to be in popular areas are relocated to safer environments.

There are various species of sea snakes found in the Darwin Harbour and are common around the mangroves, mudflats and open waters (Acer Vaughan 1993). The NRETA survey data has identified several species that are common to the harbour.

Other Marine Biota

Phytoplankton in Darwin Harbour is considered to be an import primary producer. They respond to increases in nutrient concentrations while the zooplankton responds to an increase in phytoplankton. The biomass of phytoplankton in Darwin Harbour is generally low with maximum concentrations recorded in inlets and minimum concentration recorded in the deep main channels of Darwin Harbour. The phytoplankton found in the harbour are likely to be quite different to those found in the shallow inlets due to the local influences of effluent discharge and catchment conditions (Acer Vaughan 1993).

Zooplankton biomass is in the harbour is high and like the phytoplankton the characteristics of the zooplankton found in the deeper waters varies to that of the zooplankton found in the shallow inlets. This again is due to the local characteristics such as mangrove associations, catchment conditions and effluent discharge (Acer Vaughan 1993).

The extensive areas of intertidal mudflats in Darwin Harbour are inhabited by burrowing invertebrates including worms, small crustaceans and bivalve shellfish. Abundance and diversity of intertidal mudflats is considered low compared to the muddy seabeds below the low tide mark. The species and abundance of the mudflats surrounding the proposed area does not vary considerable compared with the associated mudflats in Darwin Harbour and the mudflats are considered to be similar to other areas in the Harbour (URSb 2005).

5.14.4 Visual Amenity

Existing Environment

The visual appearance of East Arm Wharf is consistent with the appearance of a typical operational wharf. Further information pertaining to structures and activities at East Arm Wharf are detailed in Section 5.1.

The wharf has light poles of varying height, approximately 20 metres high, and a crane that is approximately 40 metres high.

Potential Impacts

The quarantine incinerator will be consistent with developments in the surrounding area.

It is proposed that a stack height of 25 metres will be required for incinerator air emissions. This height is consistent with developments at the wharf and will not have a significant impact on the visual amenity of the area.

The plume emitting from the incinerator stack may be either clear or white depending on the amount of water emitting from the stack. Water, in the form of steam, may influence the plume to be white. The plume emitted will disperse and should not have significant impact on the visual amenity of the area.

Mitigation Measures

No mitigation measures are necessary for the visual amenity of the quarantine incinerator.

5.14.5 Indigenous Heritage

Existing Environment

The Port Expansion Master Plan was approved as part of the Environmental Impact Statement prepared for development of the Wharf. However, it was noted that Catalina Island and the associated sand bar are of cultural significance to the Aboriginal people and that the area is to be protected from the impacts of construction and activities undertaken at East Arm Wharf. Archaeological sites have been noted in this area, including a large shell midden of particular significance due to its potential research value (URSb 2005).

Potential Impacts

The development of the quarantine incinerator is on reclaimed land and will not impact on any Indigenous Heritage.

Mitigation Measures

In the event Indigenous relics are found during the construction or operation of the quarantine incinerator, work must cease and the Department of Natural Resources, Environment and the Arts (NRETA) must be contacted to inspect the finds. Such a requirement is included in the Construction and Operation EMP's.

5.14.6 Non-Indigenous Heritage

Existing Environment

There are no areas or items of non-indigenous heritage that will be affected by the development of the quarantine incinerator.

The Notice Of Intent prepared for the quarantine waste treatment facility (URSb 2005) identified a number of historical ships and aircraft wrecks located within areas in Darwin Harbour that are of non-indigenous heritage. None of the areas or items discussed will be effected by the quarantine incinerator.

Management Measures

In the event Non-Indigenous relics are found during the construction or operation of the quarantine incinerator, work must cease and the Department of Natural Resources, Environment and the Arts (NRETA) must be contacted to inspect the finds. Such a requirement is included in the Construction and Operation EMP's.