4.0 Expanded Operation

Once the Alcan Gove alumina refinery and mine facilities have been fully expanded, the refinery's production of calcined alumina will increase to a base capacity of 3.5 million tonnes per year (Mt/y). Over time its capacity is expected to increase, through continuous improvement to 3.8 Mt/y. Alcan Gove's objective for the expansion is to sustain its internationally competitive alumina position and to have a positive impact on its environmental performance.

All new plant and equipment associated with the expansion will be located within the footprint of the existing operations. There is no requirement to access or acquire any land outside the existing lease areas detailed in Table 3.2.1 for the work covered by this EIS. However, Alcan Gove has reached an agreement with Perkins Shipping to unload construction materials on a wharf within the existing Perkins lease area. Perkins Shipping will expand their existing wharf to provide sufficient area for these operations.

The grade of Gove bauxite to be used with the expanded refinery will have a lower alumina content and higher silica content than the bauxite being used in the existing refinery. The change in grade has been introduced to extend mine life and improve the utilisation of the bauxite resource. The use of the changed bauxite grade will result in an increase in bauxite consumption and residue generation per tonne of alumina produced. However, the expanded refinery design will involve process efficiency improvements in the digestion plant that will reduce the amount of bauxite consumed per tonne of alumina produced by 10%, together with a 23% reduction in the amount of residue generated per tonne of alumina.

4.1 Expansion Projects

Expansion of the refinery will be undertaken by the implementation of the following four separate Alcan projects:

- Third Stage Expansion. This project includes the main refinery upgrade by the installation of new plant and equipment that will integrate into the existing Stage 1 and 2 refinery processes. Infrastructure services will be augmented to meet the demands of the additional refinery capacity. Components of the Third Stage Expansion are described in this section and include the following:
  - Mine;
  - Refinery;
  - Residue Disposal;
  - Port;
  - Workforce and Accommodation;
  - Construction Activities.
- Liquor Purification. The purpose of the liquor purification plant is to remove impurities from the liquor which will help reduce the caustic consumption rate and improve refinery productivity.
- Waste Water Inventory Reduction. This project will involve the neutralisation of the surplus alkaline liquor and a small proportion of red mud before being sent to the RDA. The waste water and runoff from the RDA will be neutralised and saline making it suitable for discharge to the marine environment. In this way the inventory of stored water in the RDA can be reduced and the quality of the marine discharge will be improved.
- Gas Conversion. Alcan has entered into a Heads of Agreement for the supply of natural gas to Gove in time for the commissioning of the Third Stage Expansion. The gas field development and pipeline is the subject of a

separate EIS. Alcan Gove is designing the Third Stage Expansion to use natural gas as its primary fuel type. The existing refinery (Stages 1 and 2) will be converted to also use natural gas. The use of natural gas will significantly improve the refinery's air emissions. In the event that supply of gas is delayed, the refinery will be fuelled in the interim by fuel oil. In the circumstance that the delays are extended, alternative controls will be employed.

Details of each of the above projects are given below.

A summary contrasting the key aspects of the existing and expanded refinery is given in Table 4.1.1.

4.2 Mine

4.2.1 Expansion

At the mine, current production is 6.5 million dry tonnes per year (Mdt/y). Of this, around 4.7 Mdt/y are used in the refinery to produce alumina and depending on demand, about 1.8 Mdt/y are exported. To enable the expansion to take place, the rate of bauxite mining will increase to 8.0 Mdt/y and the bauxite that is currently exported will be diverted to the refinery. All bauxite exports will cease. This is consistent with the objective of adding value to the product before export takes place.

4.2.2 Mining Operations

While the existing mining rate will increase, no significant change in the mine plan is required to extract the increased tonnage. The existing mining procedures will continue and all mining will take place in accordance with existing approvals and within the existing mine lease.

As at present, clearing, overburden removal and rehabilitation of mined areas will be performed using large bulldozers, scrapers, loaders and trucks. Mine face breakage will be performed using dozers to rip the ore. Bauxite haulage to the crushing station will be performed using loaders and haul trucks. Where direct unloading into the crusher hopper cannot be conducted, trucks will dump material at a nearby "Run of Mine" stockpile. Ancillary equipment of a water tanker and grader will be used in haul road building and maintenance.

Mining operations at satellite ore bodies of Rocky Bay and Eldo will be developed and rehabilitated using the same methods used for the existing mining operation. The locations of these bauxite ore bodies are shown on Figure 3.4.1.

To cater for the increased mining rate, the following additional mobile equipment will be required:

- One Caterpillar 992D loader, or equivalent, for additional ore and overburden handling;
- One heavy-duty bulldozer, equivalent to a Caterpillar D11, for mine face ore ripping and timber clearing; and
- One 100 tonne capacity long range haul truck for additional ore hauling and overburden transport.

Existing environmental management procedures at the mine will continue and will be augmented as necessary. These include monitoring water quality and silt flow from the mining and preparation areas, dust control with water carts, monitoring of vegetation health, and continuing to maintain buffers between mining areas and public roads. A new nursery is planned to supply seedlings for rehabilitation.

The existing successful rehabilitation methods will continue to be used as described in Section 19.3.1. The rate of rehabilitation will increase to match the increased rate of mining.

Table 4.1.1
Summary of Expansion Components

Component	Existing Refinery	Expanded Refinery	Effect
Mine			
Production	Bauxite – 6.5 Mt/y, open pit (1.8 Mt/y is exported).	Bauxite – 8 Mt/y, open pit. Additional mobile equipment required and existing crushing and screening equipment upgraded.	No change to existing mining and rehabilitation practices. All bauxite consumed in expanded refinery Bauxite exports cease.
Overland Conveyor	Conveyor from mine to refinery.	Conveyor to remain with slight increase in speed.	No significant change to conveyor operations.
Refinery			
Production	Alumina – 2.0 Mt/y.	Alumina – 3.5 Mt/y increasing to 3.8 Mt/y.	New equipment within existing footprint.
Digestion	Low temperature digestion.	High temperature double digestion (all stages).	10% improvement in alumina extraction and 25% less residue per tonne of alumina.
Mud Separation	Multi-stage thickeners.	Alcan high rate decanters plus conversion of existing thickeners to additional washers.	Two existing redundant washers available for storage of contaminated stormwater. Elimination of caustic to ground from thickener descaling.
Evaporation	Multi-stage evaporation plant with seawater cooling.	Additional multi-stage evaporation plant with closed circuit cooling (Stage 3 only).	No seawater discharge from Stage 3 evaporation process.
Precipitation	Multiple precipitation tanks with two stage cooling and cooling towers.	Additional multiple precipitation tanks and cooling tower.	Extension of existing precipitation operations.
Classification and Filtration	Hydrocyclone classification and vacuum filtration.	Additional hydrocyclone classification and vacuum filtration.	Extension of existing classification and filtration operations.
Calcining	Rotary calciners (4), stationary calciner (1).	Three new stationary calciners plus one existing. One existing rotary calciner on standby and others decommissioned. Stacks for stationary calciners to be 70 m compared to 32 m for rotary calciners.	Improved energy efficiency and dust control.
Alumina Handling	Alumina is stored in four silos and conveyed from silos to ships for export.	Existing alumina storage and shiploading conveyor facilities will remain. Alumina handling systems feeding the silos will be upgraded.	Improved dust control.
Lime Plant	Double shaft lime kiln and two silos.	Kiln capacity to be increased by 40% and additional silo installed.	Increased throughput. Improved stack emission control.

Component	Existing Refinery	Expanded Refinery	Effect
Impurities Removal	Organic impurities purged to residue disposal area.	Liquor purification (all stages).	Organic impurities destroyed in purification process resulting in greater recycling of liquor, 25% less caustic consumption per tonne of alumina, and 75% reduction in soluble caustic concentration in the residue.
Power Station	Three high pressure boilers and turbines with fourth high pressure boiler currently being installed.	Total of five high pressure boiler and turbine units.	Increased power generation capacity.
Fuel	22 PJ of 3.5% sulfur fuel oil.	43 PJ of natural gas (all stages). Eight days per year (approx) when gas supply may be interrupted and 1% sulfur fuel oil will be used.	Reduced sulfur and particulate emission rates, and reduced greenhouse emissions per tonne of alumina.
		If gas supply delayed, continue with 3.5% sulfur fuel oil until gas available with SO_2 control by switching to 1.5% sulfur fuel oil with unfavourable winds.	Switching strategy to minimise emission effects.
Residue Disposal Area (RDA)			
Residue and Waste Water Storage	Dry stacking of alkaline residue in containment structures.	Dry stacking of residue to continue. Progressive reduction of waste water inventory through operational controls and neutralisation with seawater.	Prior to capacity of the existing RDA being reached, a new containment area will be required. Investigations and separate approvals for new containment pond locations to be sought.
Air Emissions			
Combustion Emissions	Combustion of fuel oil generates SO_2, NO_x, particulate and greenhouse emissions.	When natural gas supply is secured, new and existing combustion sources converted to natural gas which will reduce emission rates. Additional emission control equipment to be used.	Reduced sulfur and particulate emission rates and reduced greenhouse emissions per tonne of alumina.
		If gas supply delayed, continue with 3.5% sulfur fuel oil until gas available with SO_2 control by switching to 1.5% sulfur fuel oil with unfavourable winds.	Switching strategy to minimise emission effects.
Fugitive Emissions	Fugitive dust sources include stockpiles, conveyors, roads and shiploader.	No significant additional fugitive dust sources. New dust control measures to be implemented for existing sources.	Overall reduction in fugitive dust emissions.
Liquor Purification	No equivalent technology currently in place.	Emissions from liquor purification plant controlled by scrubber.	No significant air quality effects.

Component	Existing Refinery	Expanded Refinery	Effect
Water			
Bunding and Containment	Most storage and containment areas compliant with Australian Standards.	All new storage and containment areas to be compliant with Australian Standards and existing areas to be upgraded as necessary.	Compliance with bunding and containment standards.
Caustic to Ground	Thickener cleaning and other practices can result in caustic material placed on ground.	Existing thickeners converted to red mud washers and no caustic to ground from thickener operations (all stages).	Significantly reduces the potential for caustic contamination of soil and groundwater.
Marine Discharge	Discharge to Melville Bay of cooling water from the evaporation process (with occasional carry-over events forming precipitate on discharge), some neutralised waste water from RDA, stormwater from the refinery and other minor waste streams.	Discharges to Melville Bay to continue. Evaporation cooling water for Stage 3 will be closed circuit to prevent carry-over events and precipitate formation. Progressively all of the waste water from the RDA will be neutralised and discharged. Stormwater and other minor waste streams will be controlled. Opportunities to improve Stages 1 and 2 discharges to be investigated.	No significant increase in discharge volume or contaminant load.
Water Supply	Wellfield extraction rates within existing permit conditions.	Increased water demand to be met by expanded wellfield. Water demand management programs to be implemented	New water extraction permit to be sought. Improved efficiency in water use.
Shipping			
Ship Movements	Export of bauxite, alumina and hydrate. Import of fuel oil, limestone and caustic soda.	Bauxite export will cease. Alumina exports will increase. Once gas supply secured, fuel oil imports will cease (apart from occasional delivery of backup supplies). If gas is delayed, fuel oil shipments will increase from 8 to 14 per year.	Ship movements will increase from 113 per year to 143 per year (with gas) or 156 per year (with oil).
Workforce			
Workforce Numbers	Existing workforce is 1,100.	Average construction workforce is 675 and will peak at approximately 1,200. Up to 120 additional positions for ongoing operations.	Construction workers village to be provided in Nhulunbuy. Operational workers to be accommodated in Nhulunbuy.

As discussed in Section 1.7.1.3, Alcan Gove operates in accordance with an approved Mining Management Plan that is reviewed and updated on an annual basis or when significant changes are proposed to existing approved operations. All changes associated with the increased mining rate will be approved in this way. Any impacts associated with the increased mining rate will be identified through the mine's existing environmental monitoring program. This will be reported to the NT Government through the submission of annual Mining Management Plans.

4.2.3 Crushing and Screening

Bauxite received into the crusher hopper will be processed through the existing crushing and sizing equipment. To cater for the expanded mine production, the following changes will be made to the crushing and screening area:

- The existing system will be upgraded to increase its reliability and capacity to 1,700 tonnes per hour (t/h);
- The existing vibrating grizzly will be replaced with wobble feeder screens;
- The primary crusher will be modified to crush to a finer size;
- The secondary screen will be replaced with larger opening size;
- The crusher surge bin will be modified to improve mass flow; and
- Material conveying systems within the crusher area will be upgraded where necessary to improve its handling of wet bauxite.

4.2.4 Overland Conveyor

The increased production required to be transferred to the refinery will be accommodated by increasing the speed of the existing overland conveyor from 3.7 metres per second (m/s) to 4.4 m/s which will result in a capacity increase to 1,500 t/h.

All drive motors and gearboxes will be replaced with larger equipment. Transfer housings at the head pulley will be lengthened. Catenary idlers and their support cables will be removed and replaced with combi-idler/slider bars at the load transfer point. Belt turnover stations will be extended and intermediate support rollers installed. All transfer chutes will be upgraded to handle the higher speed throughput and to reduce the potential of wet bauxite accumulating at the transfer locations.

4.3 Refinery

The original refinery plant layout had provision to install two additional stages. The Third Stage Expansion will generally occur in the locations allocated for that expansion. However, there will be some changes in process and equipment design, together with a combination of additional new plant integrated for all three stages and new plant in stand-alone areas.

Increased refinery production will be achieved by installing new process equipment that will integrate into the existing refinery process. The expansion will take place within the existing refinery footprint. The refinery areas to be affected by new plant and equipment are shown in Figure 4.3.1.

4.3.1 Bauxite Stockpiles and Handling

The size of the existing bauxite stockpiles will not be changed.

The existing refinery and export stockpiles will become refinery stockpiles. Bauxite export operations will cease prior to the commissioning of the Third Stage Expansion.

The stacker will be upgraded to handle the additional tonnage. Stacking operations will deliver material onto all stockpiles similar to existing operations.

Each reclaimer system would typically operate with only one facility on-line at any time and so will be able to handle the total feed tonnage for all three stages. The existing refinery reclaimer will be replaced to increase its capacity.

In the event of both reclaimers being unavailable, plant feed would be supplied by a mobile front-end loader and hoppers installed to maintain the total feed requirement.

The feed conveyor systems from the reclaimers to the grinding mill feed bins will all be upgraded, modified and replaced to match the higher production capacity. The conveyor above the grinding mill feed bins will be replaced to improve system efficiency.

4.3.2 Grinding

The three existing grinding mills will be replaced with three shorter length although larger diameter rod mills that will each have a capacity of approximately 600 t/h. Compared to the existing grinding operations they will achieve a grind with a significantly reduced maximum size. Only two of these new grinding mills will be installed within the Third Stage Expansion project as it is expected that, prior to the expansion, the other new mill will have been installed as a separate Alcan Gove site project.

One new mill slurry tank and pump transfer system together with one train of indirect mill slurry heating equipment will be installed and the heated feed delivered to Stage 3 digestors.

4.3.3 Digestion

A new low temperature digestion plant having similar although larger capacity facilities to those of Stages 1 and 2 will be installed to cater for the additional capacity requirement of Stage 3. The new Stage 3 low temperature digestion will operate in a similar manner to the Stage 1 and 2 digestion process described in Section 3.5.2 except that it will be linked to a new high temperature digestion process.

Stage 3 will also incorporate a high temperature digestion process that will reprocess the residues from the low temperature digestion of all three refinery stages. Deep cone thickeners will be installed at the end of each low temperature digestion stage to extract the residues and new high pressure pumps will transfer this residue into the high temperature digestors. In conjunction with a liquor purification process, this will result in an approximate 10% improvement in alumina extraction from the bauxite and an approximate 23% reduction in residue per tonne of alumina being produced.

The new thickeners will be routinely cleaned every four months by the internal use of hot caustic cleaning liquor without the need to discharge waste material to the ground. This new design will minimise the current practice of the temporary storage of caustic material on the ground when the existing thickeners are cleaned.

The new high temperature digestion (HTD) area will be part of a counter current double digestion process. It will take preheated strong feed liquor from the new Stage 3 low temperature digestion (LTD) and settled mud slurry from all three LTD stages. The liquor will be further heated using flash steam and then the combined liquor and slurry will be heated before being digested at 220°C. The slurry will then be flash cooled and the mud and liquor separated in pressure decanters, with the liquor returning to Stage 3 LTD for further digestion of alumina. The separated mud will be diluted and cooled below the atmospheric boiling point before being sent to downstream residue separation and washing processes.

4.3.4 Residue Separation, Filtration and Washing

The residue from the digestion pressure decanters will be processed through the existing desanding area that will be modified to achieve a counter current washing of the separated sand materials. The sand residue will be either neutralised separately by the use of seawater or mixed with the red mud and neutralised. The process applied will be dependent on the process use of the sand when it is transferred to the RDA.

The existing multi-stage thickeners that are currently used for residue separation will be converted to red mud washers as part of the expansion project. This will provide an expanded counter current mud washing circuit having eight stages of mud washing. The new mud washing design will rearrange the process streams entering the circuit to maximise the purge of organic and inorganic impurities while at the same time minimising caustic soda losses. The new design will enable two existing washing tanks to be made available for the storage of stormwater from within the local bunded areas during rainfall events. This stored stormwater will be reused within the process. Further details are given in Section 11.7.3.

Six new vertical pressure filters will be installed in a new security filtration building to be located at the eastern end of the existing building. Under normal operating conditions, the new filters will process most of the turbid liquor flow from the thickeners. The existing filters will process the remainder.

4.3.5 Precipitation

To cater for the expanded refinery, the capacity of the precipitation area will be expanded by the addition of new agglomeration precipitators and new growth precipitators. The growth precipitators will be aligned into two rows of tanks between the existing precipitation and calcination areas. Two interstage cooling facilities will be installed on each growth precipitation train and will consist of flash vessels and a barometric condensor using cooling water that will be cooled by new cooling towers installed in a location adjacent to the existing precipitation cooling towers.

4.3.6 Classification and Filtration

The Stage 3 design will include the provision of a new hydrocyclone classification plant having three classification stages. The design will have the primary classified product of Stage 3 to be processed through scalping classification plant to reduce fines in the final product hydrate. Three different sized hydrate streams will be produced from classification. All hydrate streams will be filtered.

The filtration plant design for the expansion involves the integration of new filtration equipment with the existing filtration equipment and the installation of new filtration area facilities to conduct coarse seed filtration and final washed product hydrate filtration. The fine seed washing process will be altered to produce a filtrate stream that is termed oxalate rich stream liquor. This process circuit will require six drum filters to be available to enable the process to operate. This will provide improved efficiency in organic carbon control and compatibility with the liquor purification process. It will result in modification of some of the existing equipment and the introduction of new equipment.

To meet proposed filtration vacuum demands for Stage 3, six large additional vacuum pumps will be installed. To meet the additional blow air requirement with the additional filters installed, one existing air blower will also be installed, and two existing vacuum pumps will be converted to air blowers.

4.3.7 Calcination

To cater for the additional capacity and to improve overall calcination efficiency, three additional stationary alumina calciners will be installed as part of the Third Stage Expansion. The design capacity of each of the new calciners will be 3,000 t/d of alumina. New hydrate conveyors will be required to feed the new calciners and new and upgraded alumina transfer systems will be required to transport the alumina from the calciners to the alumina silo elevating and distribution systems.

The future strategic operational philosophy considers that the three new stationary calciners and the existing stationary calciner will be normally operational and one of the existing four rotary calciners will be maintained to operate on standby. This operational strategy will minimise any shortfalls in calcination capacity and the need to store hydrate on the ground. For infrequent occasions of reduced calcination capacity, the hydrate will be either stored as solids in the precipitation area slurry tanks or will be diverted as final washed hydrate to the port warehouse where is can be either marketed as aluminium hydroxide (commonly called hydrate) or returned to the refinery process.

4.3.8 Alumina Storage

No changes to the alumina storage silos will be undertaken as part of the expansion. However, the alumina handling systems feeding to the silos will be upgraded to accommodate the increased alumina production. One of the alumina silo elevators will be replaced with a unit having capacity to elevate the total future alumina production.

4.3.9 Evaporation

A new evaporation plant will be included in the Third Stage Expansion to concentrate the Stage 3 spent liquor. The new plant will have a capacity of approximately 80% of the existing evaporation plant and is likely to be of a similar design.

Cooling water will be used indirectly to provide water vapour removal in the last three flash stages. Cooling towers will be installed to remove the recirculated cooling water heat energy. The cooling tower will be of concrete construction and counterflow in design and will use an approved splash pack design. The cooling water will require makeup water injection of approximately 55 cubic metres per hour (m^3/h) to replenish water losses due to evaporation from the cooling tower. The makeup water will be sourced from a combination of the western pond and the groundwater recovery bores with any additional makeup required being provided from the refinery's raw water supply. Chemical additives to reduce biological activity and protect metal surfaces from the hot aerated water will also be required although of limited quantities due to the high replenishment rate. A low or periodic blowdown will be required to maintain water quality.

The existing Stage 1 and 2 evaporation and cooling facilities will remain unchanged.

4.3.10 Lime Plant

As part of the expansion, the capacity of the lime plant will be increased from 140 t/h to 200 t/h. This will be achieved by installing a new burner system in conjunction with a modification to the kiln's internal furnace geometry. A new burnt lime storage silo of 1,200 t capacity will also be installed.

4.3.11 Plant Infrastructure

All new process areas will be concrete-bunded with sumps installed. Where necessary, new roadways will be installed throughout and around all new plant areas and these shall be asphalt surfaced with curbing and drainage included. Stormwater drainage will be extended to all new facilities. Details of the proposed refinery drainage system are given in Section 11.7.

Interplant piping will be installed in overhead pipe racks using existing pipe-rack routes where appropriate with elevated structures added where necessary.

Utilities will also be extended to all new areas of the refinery and will include plant and domestic water, high-pressure fire hydrant water, plant air supply, steam, telephone, sewerage, data links and electrical supply. Existing standards for safety showers, plant lighting, safety lights, cooled water fountains, guarding and access ways will be applied in the new plant areas.

Existing office and workshop infrastructure in some refinery areas will be demolished to install new plant. New office and workshop facilities will be installed elsewhere as part of the expansion. No significant expansion of the general maintenance workshops, main office block or the warehouse is expected.

4.3.12 Refinery Inputs

Section 3.8 describes the main material inputs required for the existing refinery operations. All of the same materials will be required for the expanded refinery although the consumption rates will increased in line with the refinery's increased production. One significant change will be the proposed replacement of the existing consumption of fuel oil with natural gas.

The major inputs for the expanded refinery are summarised in Table 4.3.1. The use of the materials and their origin, transportation and storage requirements will be the same as given in Table 3.8.1.

Table 4.3.1
Major Inputs – Expanded Refinery

Material	Consumption (t/y)[1]	
	Existing Refinery	Expanded Refinery
Bauxite	4,700,000	8,020,000
Caustic Soda (NaOH)	210,000	350,000
Limestone	87,000	145,000
Acids	1,100	1,800
Flocculants and Reagents	1,500	2,500
Fuel Oil	480,000	850,000 (oil fired) 34,000 (gas fired)
Natural Gas	0	42.75 PJ
Diesel	7,200	10,200
Unleaded Petrol	1,150	1,150

Material	Consumption (t/y)[1]	
	Existing Refinery	Expanded Refinery
Seawater - Evaporation Cooling - Waste Water Treatment	 5,100 m^3/h 180 m^3/h	 5,100 m^3/h 175 m^3/h
Freshwater	650 m^3/h	1,025 m^3/h
Filter Cloth - Security - Disc	 50 sets 12,900 each	 45 sets 23,500 each
Grinding - balls - rods	 80 70	 0 150

[1] *All units in tonnes per year unless otherwise noted.*

4.3.13 Refinery Outputs

4.3.13.1 Alumina

Following expansion, the refinery will have a base annual production rate of 3.5 Mt/y of alumina. The marketing of aluminium hydroxide will remain at its current rate of 60,000 t/y with the majority produced for export. As discussed previously, the refinery's capacity is expected to increase over time, through continuous improvement, to 3.8 Mt/y.

4.3.13.2 Bauxite

Bauxite exports will cease approximately 15 months prior to commissioning the expanded refinery.

4.4 Liquor Purification

4.4.1 Purpose

The purpose of the liquor purification plant is to remove impurities from the liquor which will help maintain liquor productivity, improve flow capacity from reduced liquor viscosity, minimise the impact of scale, and enable improved recovery of soluble caustic. The liquor purification plant will be split into two separate processing plants, one for the removal of inorganic impurities and the other for organic impurities. The plant will use proven technology and its implementation will occur only after consultation with the refinery workforce and other relevant stakeholders.

4.4.2 Inorganic Removal Plant

The process to remove inorganic impurities involves cooling of cold strong evaporated liquor (SEL), then precipitating and separating the inorganic impurities.

The SEL may come from the existing Stage 1 and 2 evaporators. It will be cooled using a plate heat exchanger to reduce the SEL temperature. The cooling medium will be cooling water from the evaporator cooling tower.

Once cooled, the SEL will pass through a series of two mechanically agitated precipitators to remove the inorganic impurities. The first precipitator will overflow to the second precipitator and the second will overflow to the inorganic thickener. Impurities will precipitate on recycled seed in the precipitators. The net production of precipitate will be extracted from the inorganic thickener or a filter, the remainder will be recycled to the precipitators as seed. Overflow from the thickener will be pumped back to the Stages 1 and 2 evaporators. Thickener underflow will be filtered to remove excess liquor and causticised to recover caustic with the insoluble inorganics pumped to the RDA via the red mud circuit.

4.4.3 Organic Removal Plant

The process to be used for the removal of organics involves the combustion of organic carbon bearing liquor and bauxite to form soluble sodium aluminate.

A small portion of bauxite slurry from the bauxite grinding area will be ground further in a small, dedicated ball mill and mixed with strong evaporated liquor (SEL). The resultant slurry will be dried and incinerated in a solid / liquid calciner (SLC) to produce 600 t/d of sinter. The sinter containing anhydrous sodium aluminate and ferrite will be cooled and redissolved in process liquor in the refinery's red mud circuit.

The objective of the SLC is to remove organic carbon present in the sinter, while the presence of bauxite in the sinter is to ensure that the sodium in the sinter is reacted to soluble sodium aluminate or ferrite.

4.4.4 Plant Emissions

Alcan Gove has undertaken extensive testing to confirm that the plant's emissions, particularly its emissions of organic compounds and particulates (small airborne particles), will be low enough to ensure all relevant environmental and health standards are met. An assessment of these effects is provided in Section 8.7.

4.4.4.1 Control of Organic Emissions

Emissions of organic compounds will be kept low because the plant has been designed to avoid intermediate temperatures that can degrade and volatilise organic compounds.

During the drying stage, the sinter, a mixture of bauxite and refinery liquor, is sprayed into a hot gas stream. The water in the feed evaporates and cools the gas. When nearly all the water has evaporated, the final drying takes place in the cooled gas stream. In this way the boiling water protects the organic compounds in the feed until nearly all the water has been evaporated. Then the organic compounds are only exposed to a cooled gas stream. The cooled gas is by then too cool to degrade or volatilise the organic compounds in any significant way.

Once it is dried, the sinter is calcined (incinerated) so that all the organic compounds are destroyed. In order to do this, the dried sinter is placed immediately in a gas stream that is hot enough for complete combustion and it is kept in that stream long enough to ensure complete combustion. This means the sinter has been dried at the low temperature and then incinerated at a high temperature without being exposed to any temperatures in-between that would "scorch" the organic compounds and generate "smelly" organic compounds in the stack gas.

4.4.4.2 Control of Particulates

Particulates are small solids in the stack gas. The liquor purification plant process will use an extremely efficient air filter or baghouse on the stack gas to remove almost all the solids in the stack gas stream. The baghouse will use porous ceramic tubes, or elements, to filter the stack gas. These ceramic elements were used during the testing program and resulted in levels of particulates in the stack gas that were so low they were difficult to measure.

4.5 Waste Water Inventory Reduction

4.5.1 Background

As discussed in Section 3.6.3, the waste water which collects at the RDA is a combination of residue liquor and rainfall and contains high levels of caustic soda and dissolved metals. It is not suitable for release to the environment. Consequently, the waste water is currently stored in holding ponds at the RDA from where it is evaporated. Some of it is also retuned to the refinery washing process and some of it is neutralised with seawater before being discharged.

Careful management of the RDA and stored waste water is required to maintain an appropriate balance between rates of residue disposal, rainfall, evaporation, water reuse in the refinery and water treatment. Although the waste water inventory fluctuates in response to wet season rainfall, the long-term trend for the inventory is upward. If left unchecked, additional storage capacity will be required and there will be increased environmental risk.

4.5.2 Overview

The objective of the Waste Water Inventory Reduction Project is to reduce the waste water inventory at the RDA, thereby making more area available for residue storage and reducing the risk of waste water overflow.

Whilst the improved digestion process installed during the expansion will generate less residue per tonne of alumina, there will be an increase in the amount of residue produced due to the refinery's increased production rate. The additional residue generation will result in the existing RDA storage ponds being filled earlier than originally planned. To minimise the requirement for new storage ponds, it is planned to reduce, and in time eliminate, the current waste water inventory at the RDA. This will be achieved by implementing the liquor purification process to maximise the amount of waste water to be recycled from the RDA back to the refinery, and the neutralisation process to initially enable the disposal of surplus waste water and ultimately to neutralise all residue streams. The combination of these processes will enable the RDA storage areas currently used for the storage of alkaline waste water to ultimately become available for residue storage.

The neutralisation process produces a quantity of neutralised (saline) residue which needs to be kept separate from the alkaline storage areas to avoid re-contamination so as to maximise the recycling of the remaining alkaline waste water. In the medium term this will add some complexity to the operation of the RDA, however as the inventory of alkaline waste water is progressively reduced, the operation will be substantially simplified and the environmental issues associated with storage of large volumes of waste water progressively eliminated.

4.5.3 Neutralisation Plant

The process is based on the neutralisation of waste water by the addition of seawater. This results in the precipitation of a low density, gelatinous magnesium-aluminium and calcium-aluminium hydroxides which is the same process currently utilised in the labyrinth (Section 3.6.3).

It is proposed that the neutralisation plant be constructed to the east of the southern containment pond. The plant will consist of a mixing tank and two thickeners together with associated pumps, pipes and control equipment. The whole area will be bunded.

Waste water will be mixed with seawater from evaporation cooling and pumped to the thickeners. Here some caustic mud from the washers will be added to improve the efficiency of dissolved metals removal and to increase the density of the settled precipitate. Overflow from the thickeners will be clarified neutralised saline water. It will be discharged into the existing refinery outfall channel to Melville Bay.

Although the mud / precipitate underflow from the thickeners will have been partly neutralised, it will still contain some caustic material. Consequently, it will be disposed of in the RDA in a similar fashion to the current residue solids from the refinery.

4.5.4 Implementation Program

The waste management project will be implemented in the following stages:

- Water management program (2003-2005);
- Neutralisation Phase A (2005-2007);
- Third Stage Expansion with neutralisation Phase B (2007-2015); and
- Mud neutralisation (2015+).

At the end of the fourth stage, all of the red mud will be neutralised before disposal and all runoff from the RDA will be suitable for discharge to the marine environment.

4.5.4.1 Water Management Program (2003-2005)

At present all bauxite residue reporting to the RDA is caustic. Therefore, all RDA waste water is also caustic with input from residue slurry water, waste water from the refinery, and rainfall. The inventory of waste water is approximately 9 million cubic metres. Reductions to the RDA liquor inventory include evaporation, waste water return to the refinery, and the small neutralisation facility (labyrinth). In 2002, the average return of waste water to the refinery was 90 m^3/h. The labyrinth operated only about 25% of the time. When operating at capacity, it can process 30 m^3/h and discharges into Melville Bay though the seawater channel.

Over the last few years, heavier rainfalls than normal have put pressure on the waste water inventory at the RDA. Thus, to minimise environmental risk and avoid increasing requirement for new storage ponds, a water management program is being implemented. This program will improve overall refinery's efficiencies as well as reduce the RDA inventory. Specific technologies will also be used to effectively treat low caustic streams being added to the discharge channel. Details of the current surface water management practices at the refinery are given in Section 11.3.1.

4.5.4.2 Waste Water Neutralisation Phase A (2005-2007)

The waste water neutralisation plant for neutralising the waste water from the RDA is planned to be commissioned in the first quarter of 2006. The purpose of large-scale neutralisation is to reduce the inventory and therefore environmental risk at the RDA. It will also avoid the need to provide additional storage ponds which in turn, serve to increase the catchment area of the RDA.

The neutralisation plant will use either a significant proportion of evaporation discharge seawater from the channel (approximately 50%) or fresh seawater, plus a proportion of refinery residue slurry to effectively neutralise 150 m^3/h of waste water. Solid waste from this plant will be saline residue and will be pumped as slurry to a specific area in RDA. The overflow from the plant will return to the discharge channel, via the labyrinth. Runoff from the stored saline residue at the RDA will also return to the discharge channel via the labrynth.

4.5.4.3 Third Stage Expansion and Waste Water Neutralisation Phase B (2007-2015)

The Third Stage Expansion on the RDA will increase production of bauxite residue. Liquor purification will reduce the caustic content of waste water associated with the residue significantly, as will the need to dump waste water from the refinery to control dissolved impurities. Over time, the concentration of pond liquors will decrease (with respect to caustic soda and metals). Less seawater will be required to neutralise a given volume of waste water. Therefore, more mud will be processed in the neutralisation plant.

Phase B of the neutralisation program will increase its capacity to 300 m^3/h. This will be achieved via a continuous improvement process, which is now being used in Alcan Gove to improve overall performances, minimise waste and reduce operating costs.

4.5.4.4 Mud Neutralisation (2015+)

The impact of liquor purification will be to significantly reduce the caustic content of the liquor entrained in the residue slurry. By 2015, the inventory of waste water at the RDA will be largely saline and it will not be able to be returned to the plant because of the detrimental affect of chlorine on alumina precipitation. All of the residue area can then be made saline and all residue liquor can be neutralised with seawater, in addition to saline runoff. This will result in a full neutralisation system with a continuous open circuit operation. All of the runoff will be directly discharged after some settling and there will be no stored waste water inventory.

4.6 Residue Disposal

Current practice is to dispose of the red mud and residue sand to the RDA. The RDA has been operating as a closed circuit with some liquor and rainfall returning back to the refinery red mud washing process. During the last five years, part of this runoff water has been mixed with seawater in a neutralisation process thus creating a partial open circuit operation.

The residue production changes from the expanded refinery are summarised in the following table.

Table 4.6.1
Residue Production Rates

	Solids (t/h)	Solids (t/y)	Solids (g/L)	Volume (m^3/h)
Existing Refinery				
Residue Sand	29.7	260,200		
Red Mud	191.1	1,674,000	690	270
Waste Water Return				90
Expanded Refinery				
Residue Sand	27.8	239,000		
Red Mud	313.5	2,691,000	681	463
Waste Water Return				300

A strategic review of residue disposal options completed in June 2002 assessed existing management issues, future capital requirements, current and projected environmental issues, and future operational plans. The strategic review recommended the current technique of high-density residue disposal be continued according to the existing Long Range Residue Disposal Plan until such time as the existing disposal area footprint is fully utilised. The Long Range Plan details the future disposal requirements. It also identifies a need to reduce the volume of stored waste water through an improved seawater neutralisation process and a requirement to neutralise residue sand using seawater to create a material suitable for rehabilitation capping of the RDA. Ultimately it is proposed that the residue disposal system be converted to a full mud and waste water neutralisation system having continuous open circuit operation. Details of this proposed neutralisation process are given in Section 4.5.3.

The Long Range Residue Disposal Plan is currently being revised and will include the detailed sequencing necessary to effectively store alkaline residue, neutralised residue and waste waters. The plan also includes the rehabilitation and decommissioning strategy for the RDA. In the short term (up to 2011) it is expected all storage areas will be contained within existing lease areas. Any new storage ponds that may be necessary in the medium term are not included in this EIS and will be the subject of separate environmental approvals. The timing of any additional storage ponds will depend on the level of rainfall received (and hence storage volume needed) and the timing of the neutralisation project.

As discussed in Section 4.5.4.4, once the waste water inventory reduction project is fully implemented, all of the residue generated will be neutralised. The residue will be neutralised by seawater and existing mud farming operations will continue. Residue sands will be neutralised and stored separately for future use in rehabilitation capping processes. The waste water will be suitable for discharge to the marine environment.

Apart from the waste water neutralisation plant, the expansion project does not require any new or modified equipment to be installed to manage the changed residue disposal conditions. All residue mud and residue sand volume increases will be handled by the infrastructure facilities that will exist when the expansion project is commissioned.

The proposed RDA rehabilitation program is discussed in Section 19.5.1.

4.7 Port

As bauxite exports will cease with the Third Stage Expansion, the existing bauxite ship traffic will also cease. Alumina ship movements will increase because of the increased alumina production rate. Lime and caustic soda imports will increase in line with this increased production. Fuel oil imports will increase until natural gas is available. The overall result will be that, after the expansion, average ship movements will increase from 113 to 143 per year.

The average number of ship movements into and out of Gove before and after the expansion are summarised in Table 4.7.1. No additional dredging or channel widening will be required to accommodate this additional shipping.

Table 4.7.1
Ship Movements

	Hydrate	Alumina	Bauxite	Limestone	General Cargo	Caustic Soda	Fuel Tankers		Total Ship Movements
							Fuel Oil	Other Fuels	
Existing Refinery									
No. of shipments per year	3	56	29	4	2	9	8	2	113
Average size of shipment	15,000 t	35,000 t	45,000 t	23,000 t	Unknown	24,000 t	77,000 t	Small quantities	

	Hydrate	Alumina	Bauxite	Limestone	General Cargo	Caustic Soda	Fuel Tankers		Total Ship Movements
							Fuel Oil	Other Fuels	
Expanded Refinery									
No. of shipments per year	4	107	0	6	3	18	14 (oil fired) 1 (gas fired)	4	156 (oil fired) 143 (gas fired)
Average size of shipment	15,000 t	32,000 t		23,000 t	Unknown	24,000 t	30,000 t	Small quantities	

4.8 Workforce and Accommodation

The workforce to operate and maintain the expanded refinery will increase by up to 120 people. The functions of the additional workforce positions are indicated in Table 4.8.1.

Table 4.8.1
Additional Workforce Requirements

Work Function	Personnel
Operations	30
Maintenance	80
Other Services	10
Total	**120**

The new employees would operate under the same working conditions and shift arrangements as existing workers.

The details of housing requirements for the additional workforce are based on the provision of permanent family style houses for approximately 30 workers while the remaining workers would work on a fly-in fly-out (FIFO) roster and be accommodated in single-person units.

New houses and units will be provided in Nhulunbuy. If some key managerial construction workers bring accompanying families with them, they could be accommodated in this new housing during the construction phase. The houses would then be vacated to enable them to be used by the additional operational workers for the expanded refinery. Employees living in the new houses will reside permanently in Nhulunbuy, while the residents in the units are likely to be employed on a FIFO basis.

The town support structure (eg. commercial and government services) will not require expansion. Services of water, power, communications and sewage will be required for all installed facilities and some upgrades would need to be implemented (Section 5.0).

4.9 Construction Activities

Construction of the expanded refinery will comprise both on-site and off-site activities. The off-site activities will occur during the pre-construction phase that will precede on-site construction activities.

4.9.1 Pre-Construction Phase

Prior to on-site construction or earthworks commencing, a number of pre-construction activities will be completed. These include:

- Procurement of large process plant and ancillary support infrastructure components, such as calciners and power station equipment, which require a long lead time for delivery;
- Development of a Construction Environmental Plan, including site management protocols for control of erosion and sedimentation and stripping procedures for topsoil management;
- Detailed design of all facilities; and
- Tendering for construction contracts.

4.9.2 Pre-Assembly Modules

4.9.2.1 Module Details

The construction method will include pre-assembling major items of equipment off-site and then shipping them to site for installation. These pre-assembly modules (PAMs) will be constructed at an off-site assembly yard that is equipped to undertake large industrial construction activities. The PAMs will be loaded onto a specially designed barge and shipped from the assembly site to Gove.

At Gove, the barge will dock at an expanded wharf to be provided by Perkins Shipping within their existing lease area. Its proposed location is shown on Figure 4.9.1.

The PAMs will be unloaded from the barges onto a large multiple-wheel (minimum 24 axles) low-loader called a self-propelled modular transporter (SPMT). The SPMT will transport the PAMs to a staging area to allow prompt turnaround of the barge. When the barge departs for its next load, the PAMs will be transported from the staging area to the jobsite for placement in their final positions.

A preliminary estimate of the number of PAMs and their contents and size are summarised in Table 4.9.1.

Table 4.9.1
Estimated Pre-Assembly Module Details

Content	Quantity	Dimensions (LxWxH) m	Weight (t)
Process Facilities	49	24x10x25	250
Pipe Racks	46	24x8x6	60
Process Platforms	52	24x8x6	75
Precipitation Tanks	33	13 dia x 40	270
Thickener Tanks	8	18 dia x 28	300
Flat Bottom Tanks	52	8 dia x 10	60
Calciner Base Structure	1	24x15x32	800
Steam Boiler	1	16x15x20	250
Miscellaneous	8		
Total	250		

4.9.2.2 Pre-Assembly Site

A number of possible locations have been identified for the off-site assembly yards. Alternative locations currently under consideration include:

- Darwin, NT;
- Townsville, Qld;
- Motukea Island, PNG;
- Batangas, Philippines;
- Lampung, Indonesia; and
- Sites in Malaysia and China.

Further investigations including an assessment of commercial competitiveness and environmental, health and safety requirements will be undertaken before the preferred location is selected.

4.9.2.3 Barging

It is likely that a tug and barge combination would be used to transport the PAMs from the pre-assembly site to Gove. It has been estimated that approximately 40 barge journeys will be required consisting of 24 journeys to deliver the PAMs and an additional 16 journeys to deliver the balance of the construction equipment. If conventional on-site construction methods were used, approximately 37 barge journeys would be required.

When arriving at Gove, the barges will nose up to the wharf and partially ground the barge nose in front of the wharf. A drawbridge ramp will be lowered to connect the barge to the wharf and the SPMTs will travel across it. The barge will be continually trimmed to retain the correct barge angle for unloading by pumping ballast water into rear compartments. Gove has a 3.5 m tidal range and this arrangement is expected to provide unloading opportunities at all stages of the tidal cycle.

4.9.2.4 Haul Roads

Preliminary locations of the haul roads to be constructed to transport the PAMs and the likely laydown areas are shown on Figure 4.9.1.

A new construction haul road will be constructed around the western side of the refinery to gain access to the calcination area. This road will cross over the export conveyor, go around the alumina silos, and then cross the bauxite conveyor.

Another haul road will also be constructed around the eastern side of the refinery. SPMTs using this eastern haul road will first need to travel along the main refinery access road.

4.9.3 On-Site Construction

Initial on-site activities will relate to undertaking the earthworks necessary to prepare the various sites for the additional items of equipment to be installed. However, given the site is already flat and cleared and that the new items of equipment will be located adjacent to the existing plant, there will be only minimal earthworks and borrow materials required.

Areas proposed for site preparation and earthworks during construction would include:

- Processing facility areas outside and adjacent to existing plant areas;
- Bauxite ore stockpile area;
- Access roads around and within the plant areas;
- Lay down areas for construction materials/equipment temporary storage; and
- Areas for temporary facilities and offices for construction contractors.

All concrete requirements for the expanded refinery during construction would be supplied from an appropriately licensed temporary batch plant located adjacent to the existing refinery site.

Following the site preparations, civil works will be undertaken including building construction and the installation of process vessels, tanks, piping and ancillary equipment. Following this phase will be the installation of mechanical and electrical installations. Once all of the equipment has been installed, there will be a period of testing and commissioning before full integration with the existing refinery.

A strategy for soil and erosion management for all disturbed areas will be incorporated in the Construction Environmental Management Plan and will be the responsibility of the Principal Contactor. Strategies to be adopted to control sediment and erosion from the work areas are outlined in Section 16.4.5. Once work in an area has ceased, it will be rehabilitated by stabilising the surface against erosion and installing appropriate drainage measures.

The major construction materials to be used will be steel and concrete. Both of these are non-hazardous. A number of hazardous materials such as solvents, fuels, and biocides will be used.

4.9.4 Construction Workforce

The average construction workforce over the 30 month construction phase will be 675. It will peak during the middle of the construction phase at approximately 1,200. Further details of the construction workforce are given in Section 21.6.1.

The construction workforce will be accommodated in a purpose-built village to be located adjacent to the Army Depot on Arnhem Road at Nhulunbuy. This is the location of the previous construction village used for the refinery's initial construction. The location of this site is shown on Figure 4.9.2.

The buildings and infrastructure at the accommodation village will be constructed using conventional demountable components. All necessary infrastructure will be installed in accordance with local government requirements, including water, sewerage, drainage and electricity. The village will include a range of facilities including:

- Dining;
- Wet canteen;
- Recreation/entertainment;
- Pool;
- Multi-purpose hall;
- Medical/first aid; and
- Laundry.

Additional facilities will be provided by a proposed expansion of Captain Cook Shopping Centre which is adjacent to the village site. This expansion could include a supermarket, a new café, take-away food, swipe fuel facility, bakery, dry cleaners and gift shop. These facilities will be directly accessible from the accommodation village.

The accommodation village will provide single accommodation only. The village residents will work under fly-in fly-out arrangements.

It is expected that there will be a small number of senior managerial or supervisory construction workers who will be accompanied by their families. They will be housed in family style accommodation. A local indigenous consortium has been given approval to build 35 units near the Gove Hospital and they are expected to be built in 2004. It is likely that these units could be available to accommodate the accompanied senior construction personnel. At the completion of the construction phase they would then be available for additional operational personnel.

4.9.5 Infrastructure

Details of the infrastructure requirements for the construction phase are given in Section 5.0.

4.9.6 Construction EHS Environmental Management Plan

Due to the distinct differences in construction and operational activities, a management plan would be prepared to specifically address the activities to be undertaken during the construction phase.

The construction phase EHS Environmental Management Plan (EMP) will be prepared by the construction contractor to establish the specific design criteria and general management strategies to be adopted during construction with respect to:

- Vegetation conservation;
- Erosion and sediment control;
- Water management;
- Soil management;
- Storage of hazardous goods;
- Air and noise aspects;
- Rehabilitation;
- Health and safety; and
- Environmental monitoring.

Strategic EMPs for the above aspects of the construction phase are given in Section 25.

4.9.7 Tie-in and Commissioning

A commissioning and tie-in plan will be developed to set engineering and procurement priorities that will allow the expanded refinery to be constructed and commissioned in line with a clearly defined start up sequence and with minimal disruption to existing operations.

Tie-in of the new third stage facilities with the existing plant will require significant integration with the operating plans for the existing refinery. Every tie-in point will be identified. The equipment required to be off-line to enable the tie-in to be performed will then be identified and the timing aligned with when that equipment will be isolated for routine operations or maintenance. The tie-in detail and scope of work can then be incorporated into a schedule of work aligned with the routine operations schedule.

The majority of tie-ins will be carried out when the appropriate equipment is off-line. This may be while equipment is in normal stand-by mode, during normal planned outages such as stage shutdowns, entire liquor circuit shutdowns, or planned maintenance and de-scale periods for individual items of equipment.

There will be some items of plant or equipment that may not be scheduled to be off-line during the construction phase. These items of equipment will be identified so that the existing refinery operations can schedule for that equipment to come off-line at an appropriate time during the construction period so that tie-ins can be performed to meet the overall commissioning schedule.

4.10 Gas Conversion

4.10.1 Heads of Agreement

Alcan has signed an exclusive Heads of Agreement with the Blacktip Joint Venture (Woodside Energy Ltd 53.85% and Eni Australia BV 46.15%) for the supply of natural gas to Alcan Gove. It provides key commercial terms for the supply of gas to the refinery.

The Blacktip reserve is in the Joseph Bonaparte Gulf, 250 km south-west of Darwin. Woodside as operator of Blacktip has begun development studies aimed at selecting a preferred development concept. Alcan and the Blacktip joint venture partners are working with governments, landowners and other stakeholders to progress the project to the approval stage.

4.10.2 Pipeline

A pipeline approximately 1,000 km long will be required across the northern half of the Northern Territory to transport the gas to Gove. The route of the pipeline is a matter for negotiation and consultation with the Northern Land Council representing the traditional owners of land along the route, the NT Government and other key stakeholders.

Options for pipeline ownership, construction and operation are currently being developed.

The gas field development and pipeline is the subject of a separate EIS.

The pipeline will deliver gas directly into the refinery. There will be no requirement for any gas handling or storage facilities at the port.

4.10.3 Timeframe

The target for completion of the gas pipeline and associated infrastructure is during 2007.

The project is expected to take three years, with most of the construction work and associated employment occurring in the last year.

1. Grinding
2. Digestion and Separation
3. Security Filtration
4. Precipitation
5. Calcination
6. Hydrate Filtration
7. Classification
8. Evaporation
9. Liquor Purification
10. SNL Neutralisation
11. Power Station
12. Water Treatment Plant
13. Power Station Cooling Tower
14. Hydrate Storage
15. Cooling Towers

PROPOSED EXPANSION AREAS

SOURCE: ALCAN ENGINEERING PTY LTD

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ALCAN GOVE REFINERY EXPANSION ENVIRONMENTAL IMPACT STUDY

REFINERY EXPANSION AREAS

Project No. **12373-021-559**	Date 16-01-04		Figure **4.3.1**
CAD File No. -G-027d.CDR	Rev. D	A4	

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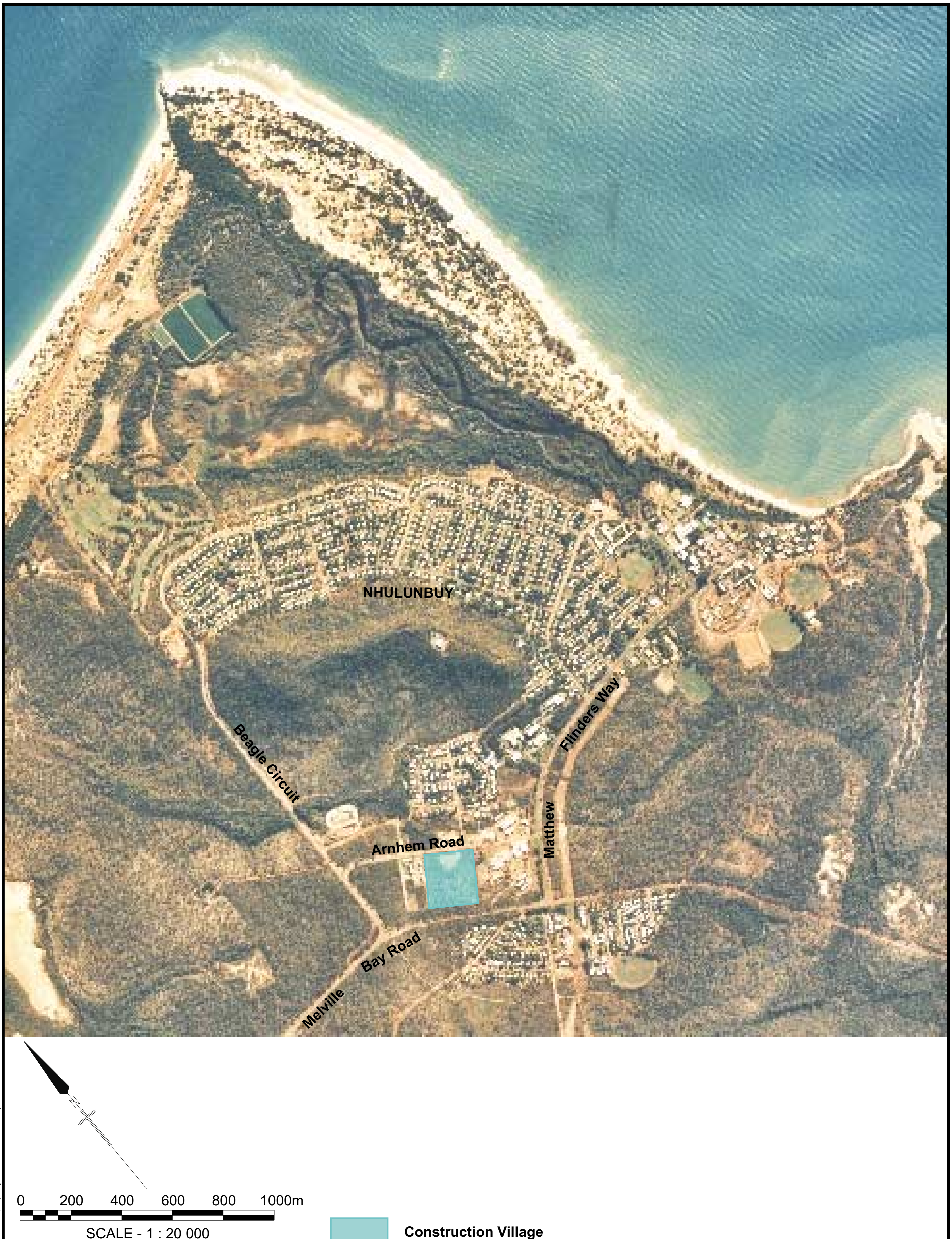
ALCAN GOVE REFINERY EXPANSION ENVIRONMENTAL IMPACT STUDY

REFINERY CONSTRUCTION ACCESS

Project No. **12373-021-559**	Date 29-01-04		Figure **4.9.1**
CAD File No. -G-064d.CDR	Rev. D	A4	



SOURCE: ALCAN ENGINEERING PTY LTD.

Construction Village

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ALCAN GOVE REFINERY EXPANSION
ENVIRONMENTAL IMPACT STUDY

LOCATION OF CONSTRUCTION WORKFORCE ACCOMMODATION

Project No. **12373-021-559**	Date 17-11-2003		
CAD File No. -g-063.cdr	Rev. A	A4	

Figure **4.9.2**