8 ENVIRONMENTAL CONSIDERATIONS

8.1 Introduction

Consistent with international industrial practice, Indcor has provided the engineering team with guidelines and the statutory requirements for the construction and operation of the plant.

In addition, Hatch managed the design and environmental assessment process for the Magnola magnesium processing plant in Quebec, Canada (currently being commissioned). This plant represents the latest environmental approval benchmark for magnesium metal plants. The experience and issues raised during the Magnola assessment provided an excellent knowledge basis for the TasMag Project.

The basis of the guidelines is to minimise the discharge of contaminants into the environment, avoid as much as possible any environmental degradation and assure workers' health and safety as well as that of the public.

8.2 Environmental Objectives

Consistent with international industrial best practice, TasMag has set environmental objectives based on Australian and International regulatory standards and Indcor's commitment to safeguard the environment and public health and safety.

Indcor is committed to adopting the following environmental objectives and these were conveyed to the design team:

- Virtual elimination of chlorinated hydrocarbon (CHC) emissions to the environment;
- All process effluent including contaminated process water, bleeds, cooling water, excess water from the residue landfill, runoff from the process areas, paved surfaces, roofs and other site drainage will be reused, recycled and contained with the processing plant;
- Minimise HCl losses by installing magnesium oxide scrubbing technology;
- Apply best available technology and management practices to reduce potential CHC emissions from the secure landfill to non-detectable levels;
- The destruction of CHC contaminated activated carbon will be carried out at an approved facility for chlorinated hazardous waste;
- 100% dry and secure storage of casting and electrolytic sludge pending reprocessing;
- In order to avoid emissions of harmful greenhouse gases SF6 will not be used;
- Minimise the storage and transport requirements of liquid chlorine and HCl;

- All dangerous and hazardous goods will be managed in accordance with the relevant Australian Workplace Standards Authority's laws and regulations;
- Achieve less than the individual fatality risk level of 50 in a million per year for industrial sites in accordance with the nationally accepted "Risk Criteria for Land Use Safety Planning" by the Department of Planning, Sydney;
- Achieve less than the injury risk criteria for exposure to toxic gas, smoke and dust of 10 in a million per year from exposure to toxic gas, smoke gas and gas in accordance with the nationally accepted "Risk Criteria for Land Use Safety Planning" by the Department of Planning, Sydney;
- Maximise the positive economic benefits to the local region through employment and procurement policies;
- Protection of surrounding sensitive natural and historical heritage values; and
- Development of environmental guideline values that are based on appropriate Australian and International regulatory standards.

These objectives will form the basis of the engineering design and will be achieved subject to reasonable and achievable practical constraints judged in accordance with the principles of Best Practice Environmental Management established by the Environmental Management and Pollution Control Act 1994.

8.3 Environmental Guideline Values

As part of the environmental objectives, minimum environmental guideline values have been adopted. These values include air and liquid emission limits, ambient air quality standards, occupational health and safety exposure limits and soil quality standards.

The values set are based on Australian and international regulatory standards. State and Commonwealth regulatory bodies were consulted to determine their respective standards, including those for contaminants and health and safety issues. Where relevant these limits were reviewed and incorporated into the environmental guideline values. For certain non-regulated contaminants, the regulations in force in other countries were researched and evaluated.

Reference was also made to the Magnola Magnesium Plant environmental guideline values. These values were set by the Ministry of Environment in Quebec, Canada. As there were very few regulatory limits for the more significant contaminants, the Quebec Ministry of Environment carried out a thorough investigation of regulatory limits set by other industrialised countries. Consequently, the limits for the Magnola Magnesium Plant represent the current approval benchmark for magnesium plants in the world and therefore where international regulatory limits were unobtainable, the limits set by the Ministry of Environment in Quebec were used.

8.3.1 Air Emissions and Ambient Quality

8.3.1.1 Stack Emissions

Emission limits in the Australian guidelines are intended to reflect the maximum allowable value when measured by the recommended test method for the pollutant in question under normal operating conditions.

Most Australian States have regulated stack emission limits. There is some variance in the values but generally they are of a similar magnitude. New South Wales is the only State to have set an emission limit for dioxins and furans. However, this limit is set for incinerators and not for a magnesium metal processing plant and therefore should be applied with caution. With respect to polyaromatic hydrocarbons, chlorinated benzenes, phenols and polychloninated biphenyls, no Australian regulatory limits have been established. The limits established by Magnola were initially based on those determined for incinerators.

8.3.1.2 Ambient Air Quality

In June 1998, the National Environment Protection Council (NEPC) issued the National Environment Protection Measure (NEPM) for Ambient Air Quality. The NEPM consists of a goal, a protocol, and standards for six pollutants:

- carbon monoxide;
- nitrogen dioxide;
- photochemical oxidant (as ozone);
- sulphur dioxide;
- lead; and
- particles.

The NEPC used the latest worldwide health-related research and existing data on the current state of Australian airsheds. Standards were set which could reasonably be expected to be met within 10 years, taking into account available technology and also social and economic factors.

Only Victoria and Tasmania have legislated criteria for ambient air quality, separate from NEPM values.

The Environment Protection Authority (EPA) of Victoria is the only State to have set design ground level concentrations for a large variety of pollutants. These values are often referred to by the other Australian States when determining ground level concentrations for specific industries and their respective licence conditions. The concentrations of these pollutants are to be applied as design criteria in the calculation of chimney heights.

8.3.2 Noise Emissions

Most Australian states have set a noise limit as a certain dBA above the background noise level for industrial premises. The method of determining the background level by the different states varies but is generally dependent on the land use classification of the area.

The Environment Protection (Noise) Regulations 1977 is currently in force in Tasmania. Currently, the Tasmanian noise limit is applied at the sensitive receptor, however a new policy whereby it is expected that noise measurement would at the boundary of the premises has been discussed.

Prior to setting the noise limit at the processing site, background noise levels will need to be monitored. The Tasmanian noise limits are conservative and in keeping with the rest of Australia. However, Tasmania often has particularly low background noise levels compared to other States. In cases where the day time noise limit cannot be met due to very low background noises, the Tasmanian authorities have historically made an allowance to increase the limit to background +10 dBA.

8.3.3 Liquid Effluent Emissions

A large number of pollutants generated by the process for which Magnola has emission limits, are not found in the Tasmanian or other Australian regulations. When required, the different Australian states use their statutory power to determine numerical limits for these pollutants on a case-by-case basis.

Currently, the Environment Protection (Water Pollution) Regulations 1974 are in force in Tasmania. However, a State Policy on Water Quality Management was published 1997 and any new developments are subject to the requirements of this policy. The State Policy requires that protected environmental values or uses for surface waters and ground waters be determined through a community consultative process. The Board of Environmental Management will then set water quality objectives to ensure that the protected environmental values are protected. Through consultation with the proponent and review of site specific data, the Board will set permissible emission limits or water quality guidelines to ensure water quality objectives are met. Wherever practicable and appropriate, these guidelines will be based on site-specific information and will be used in conjunction with the guideline limits outlined in the latest edition of the Australian Water Quality Guidelines.

According to the guidelines, emission limits on the discharge of wastes from point sources must be consistent with the following key principles:

- the discharge limits must be set at levels which will not prejudice the achievement of water quality objectives; and
- waste discharges to the environment should be reduced to the maximum extent that is reasonable and practicable having regard to best practice

environmental management, and in accordance with the hierarchy of waste management.

The Policy does allow the Board to designate a mixing zone around the point of discharge in cases where, after waste reduction, it is not reasonable or practical to reduce the levels of pollutants in the emission to the levels required to achieve the water quality objectives established for the receiving waters.

8.3.4 Groundwater Quality

Like effluent emission limits, most Australian states base their groundwater quality limits on site-specific information and the Australian Water Quality Guidelines. A number of states have an Environment Protection Policy of some kind that sets out policies on groundwater management. The aim of these policies is to establish guidelines to ensure that aquifers are not degraded.

According to the Tasmanian State Policy on Water Quality Management 1997, direct discharges to groundwater are not permitted except in the following circumstances:

- the return of mineral tailings to mines provided that it can be demonstrated that this practice will not prejudice the water quality objectives for the groundwater aquifer outside an attenuation zone and this is the means of disposing of the tailings which poses the least net environmental risk; and
- the use of wastewaters to re-charge aquifers where the quality of the water being discharged is equal to or better than the water quality in the aquifer as measured by key water quality indicators.

If the potential exists to cause indirect contamination of groundwater, the policy outlines that the appropriate safeguards must be taken to minimise the risk and the extent of the contamination.

The guideline values are dependent on the protected environmental values established by the Board of Environmental Management for the groundwater. Once these are determined, the emission limits can be set using site-specific data, the Australian Water Quality Guidelines, 1992 guidelines and any other regulatory limits that are deemed to be appropriate. In the interim, the Magnola limits are proposed to apply.

8.3.5 Soil Quality

Most Australian states base their guideline levels on the threshold or investigation levels established by the Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council outlined in the document “Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, 1992”.

The 1992 guidelines have subsequently undergone a systematic review of its policies and technical components and now forms part of the National Environmental Protection Measure "Assessment of site contamination". The changes to investigation levels are based either on phytotoxicity/ecological values or health based risks. The concentration of contaminants has a greater direct impact on ecology than human health. Consequently, the health based investigation levels are at least an order of magnitude greater than the environmental investigation levels.

The Tasmanian Government outlines its approach towards the off-site disposal of contaminated soils in an information bulletin: "Off-site disposal of contaminated soil in Tasmania", May 1996. It classifies contaminated soil into three classes:

- fill material;
- hazardous waste; and
- hazardous waste for remediation.

Soil to be used as fill material must exhibit contaminant levels below the limits prescribed in the information bulletin.

8.3.6 Health and Safety

Australian states use the limits established by the National Occupational, Health and Safety Commission. These are outlined in the document "Exposure standards for atmospheric contaminants in the occupational environment".

Table 18 below, outlines the most conservative workers health and safety limits for each of the contaminants to be potentially generated by the magnesium processing plant.

Table 18: Workers Health and Safety Limits

Area	Limit	Source
Noise	82dBA (8h)	Workers Health and Safety Regulations, Quebec
Heat	25 units, continuous work	Workers Health and Safety Regulations, Quebec
Chlorine	0.1mg/m^3 (24h) 0.3mg/m^3 (30 min) 3mg/m^3 peak limitation	Workers Health and Safety Regulations, Quebec and National Occupational, Health and Safety Commission (NOHSC)
Hydrogen chloride	7.5mg/m 0.4mg/m^3 (24h) 3mg/m^3 (30 min)	Workers Health and Safety Regulations, Quebec and NOHSC
PAH's	Non-detectable	Workers Health and Safety Regulations, Quebec
CHC's	Non-detectable	Workers Health and Safety Regulations, Quebec
Hydrogen	Non-detectable	Workers Health and Safety Regulations, Quebec
Infra red radiation	Non-detectable	Workers Health and Safety Regulations, Quebec
PCB	1mg/m^3 TWA (42% chlorine)	NOHSC

8.4 TasMag Specific Considerations

8.4.1 Residual Environmental Impacts

Notwithstanding the criteria set, certain concerns have been identified such as the production of chlorinated organic compounds (CHCs) in the electrolytic cells. CHCs are environmentally persistent pollutants, and include some known or suspected carcinogens, such as dioxins and furans. The CHCs generated from electrolysis are deported throughout the process, where they are either removed or destroyed. Some of the CHCs will report to the leach cake, which will be securely land-filled in lined residue basins. The predicted worst-case concentration of dioxins and furans in the leach cake will be no more than that recommended by the state regulatory agency as acceptable for landfill with no foreseeable health effect.

With respect to industrial water, it is envisioned to investigate design of the plant with no process effluent. The collection of runoff from the plant site and its use as process water will be investigated.

8.4.2 Emissions to Environment

Conventional pollutant emissions to the atmosphere will include HCl, SO_2, CO, NOx, Cl_2, total particulate and PM10. Emission standards as well as quality criteria are expected to be met.

One of the key aims of the design team is to recover chlorine to the greatest practicable extent and to destroy as much as is practicable any remaining CHCs prior to their release into the environment

Residual CHCs in gaseous emissions are expected to be very low, as evidenced by the Norsk Hydro plant in Quebec, which reports no significant gaseous emissions of CHCs to the public and regulatory authorities. The Norsk Hydro plant is considered to be an emission benchmark.

Nevertheless, Hatch is examining design solutions to prevent the potential formation of CHCs and their release to the environment in gaseous and leach cake emissions.

Due to the complexity of the process design tasks, it is premature to attempt to quantify the CHC process stream at present. The important point to emphasize at this early stage is that the destruction and reduction of CHCs within the process is the core focus of the engineering design work. The aim of the team is to minimise the release of CHCs to the environment and the design target is the virtual elimination of these compounds from emission streams (over and above a betterment of all State, National and International standards).

Process effluents, if any, will be neutralised before discharge to the environment. Residual pollutants will include particulate matter, magnesium carbonates, magnesium oxides and chlorides, calcium sulphate, other sulphates and organochlorides.

Solid wastes will include hazardous as well as non-hazardous waste including:

- Hazardous wastes:
  - Electrolytic dust and sludges.
  - Refining furnace sludges.
  - Alloying furnace sludges.
- Non-hazardous wastes:
  - Spent electrolyte.
  - Spent electrodes.
  - Spent anodes.
  - Refractories from the electrolytic cells.
  - Refractory from casting ladles.
  - Off-spec metal.

A noise level of 40dBA could be expected at 1km from the main noise emitter - the fluidised beds off-gas fans.

9 CAPITAL AND OPERATING COSTS

9.1 Basis of Estimates

9.1.1 Introduction / Background

Capital costs estimates have been undertaken and/or reviewed by:

- BHPE as part of the preliminary feasibility study;
- Hatch as part of the optimisation study;
- Multiplex in its capacity as, then, joint venture party and construction contractor;
- Enthalpy as consultant to Indcor; and
- Indcor management for the purposes of this Memorandum.

Operating cost estimates have been undertaken and/or reviewed by:

- BHPE as part of the preliminary feasibility study;
- Hatch as part of the optimisation study;
- Enthalpy as consultant to Indcor; and
- Indcor management for the purposes of this Memorandum.

These capital and operating cost estimates are each based upon the construction and operation of a four cell house 90,000tpa magnesium metal / alloy production facility.

9.1.2 Accuracy of Estimates

The most recent capital cost estimates (Hatch and Multiplex) are considered to be at ± 20-25% accuracy, whilst the most recent operating cost estimates (Hatch) are ± 15-20% accuracy.

9.2 Capital Cost Estimates

9.2.1 BHPE

BHPE concluded that based on the data and engineering design definition produced for the preliminary study, the broad estimation of the capital cost (subject to exclusions noted) has a most likely outcome of A$920 million. The BHPE estimate includes a contingency allowance of A$159 million (21% of direct and indirect costs).

The work program and approach adopted by BHPE to the preliminary feasibility study capital cost estimate was:

- Single budget quotes for major plant and mechanical equipment based on short form specifications. Hatch, the specialist magnesium process consultant for the BHPE study advised BHPE on those suppliers deemed most appropriate.

- Minor equipment item costs were estimated from BHPE's in-house records and data from previous projects.
- Engineer's quantities and internal all-up cost rates for civil, structural, construction installation, refractory and major electrical and instrumentation items.
- Factorised costs for minor piping and electrical services.
- Factorised indirect cost estimates.
- Local construction equipment and man-power rates together with statutory requirements based upon extensive experience at existing operations in Bell Bay, Tasmania – the proposed smelter location.
- Based on an exchange rate of A$ = US$0.61, and other appropriate foreign rates applicable at that time.
- Q3, 1998 A$.

The BHPE estimate includes only facilities within the magnesium metal plant battery limits and excludes mine development and infrastructure for transportation and energy (gas, electrical, power, steam). Such facilities were assumed to be supplied by others and were reflected in BHPE's calculation of operating costs (refer section 9.3). Also excluded from the estimate are baseline environmental studies which are site specific.

Indirect costs included in the estimate are an allowance for engineering which includes provision for procurement, construction management, temporary construction facilities, and initial cold commissioning of the plant.

Excluded are Owners' costs and allowances for training of operators and technology transfer from UTI/VAMI, technology fees, land costs, geology and ore grade estimation, mine planning and development, government charges and fees, marketing and baseline environmental impact assessment work.

BHPE's contingency allowance was built into the cost and quantity rates which have been applied in the estimate. The allowance varies for each discipline ranging from 8.1% to 32.3% and includes both design growth and general contingency. The contingency allowance included in the estimate averages 21% of total direct and indirect costs.

BHPE concluded that their estimate was accurate to within ± 20% based upon the process information available at that time. Indcor considers the estimate to be preliminary and in the order of ± 30% accurate as it was completed prior to extensive laboratory and pilot testwork.

The BHPE costs broken down by classification is as follows:

	A$M	% of Total	Basis
Major Mechanical Equipment	325	35	Single quotes
Estimated Other Direct Costs	291	32	Estimated by quantities
Factorised Other Direct Costs	202	22	Factorised
Indirect Costs	102	11	Factorised
Off-sites	0	0	Excluded
Development Cost	0	0	Excluded
Owners' Cost	0	0	Excluded
	920	100	

The detailed BHPE estimate is summarised in Table 19 below:

Table 19: BHPE Capital Cost Estimate

xxxxxxxxxxx

9.2.2 Hatch

The Hatch approach to preparation of the Optimisation Study capital cost estimate was to:

- Re-evaluate mechanical and electrical equipment items due to advancement of the process design based upon the BHPE rates.
- Re-evaluate minor mechanical and electrical equipment items based upon in-house information and recent project experience.
- Estimate engineering quantities and all-up cost rates for civil, structural and construction installation, together with major electrical and instrumentation itmes.
- Re-measure and re-cost the refractory area to suit UTI/VAMI technical data received.
- Reassess the ratios of minor service piping, process electricals, electrical and instruments used by BHPE and re-set to match Hatch experience and process design.
- Split engineering services from project and construction management services.
- Provide an estimate of Indirect and Owners' Costs for consideration based upon experience and factored quantities.
- Q2, 1999 A$.

Hatch concluded that the estimated capital cost had risen to approximately A$1,034 million. The Hatch estimate includes a contingency allowance of

A$183 million (21% of total direct and indirect costs). Hatch concluded that their estimate was accurate to within ± 20-25%.

The Hatch Optimisation Study evaluates in detail the differences from the BHPE estimate. Points worthy of note are:

- Contingency and growth allowance has been left as per BHPE at 21% of the estimate values for individual items and remains built into direct costs.
- Significant increases in provisions for piping, electrics and refractory ($113M) were made by Hatch, based on a review of factors and some quantity take-offs.
- The re-allocation of the EPCM cost below the Directs line and into the EPCM contractor's area.
- Whilst not included in the Hatch capital cost estimate, Hatch recommended provisions be included for.
  - ➢ Site Preparation (A$22 million);
  - ➢ Rework of plant for process failures (unquantified);
  - ➢ Escalation;
  - ➢ A catch-all account for Consultant's Fees to cover UTI / VAMI and insurance 1 risk monies to allow full process guarantees to be provided; and
  - ➢ EPC Margin.
- Again whilst not included in the Hatch capital cost estimate, Hatch recommended and quantified for inclusion by the Owner of:
  - ➢ Spares;
  - ➢ First Fills; and
  - ➢ Owner's Operating Systems.
- A "start-up" cost equal to the difference between the first two year's cost and revenue, effectively working capital was presented by Hatch.
- The Hatch estimate does not include:
- Any off-site (smelter) infrastructure or mine establishment;
  - ⇒ Feasibility Study costs (some but not all of the costs included);
  - ⇒ Finance establishment costs;
  - ⇒ Land acquisition costs; and
  - ⇒ Owners' management.

The Hatch capital cost estimate (completed in May 1999) is summaries in Table 20.

9.2.3 Multiplex

As an engineering and construction contractor, Multiplex prepared an EPC estimated cost based on time, cost and performance guarantees. Multiplex's approach included:

- Adopt the Hatch process design, equipment and equipment list.
- Make adjustments to the direct costs, principally to transfer risks and risk allocation into the EPC Indirect Costs.
- Increase the total value of EPCM type service costs for delivery of the project by an EPC contract strategy. Engineering costs are now shown in the project direct costs and Project and Construction Management shown under indirects.
- Amend Hatch's escalation to "Design Swell", effectively doubling-up the Design Growth allowance included in the directs by Hatch and BHPE.
- Include the EPC margin for risk.
- Reduce the Hatch ramp-up costs.
- Eliminate the Hatch process rework provision.
- Add the costs of the Feasibility Study (both for past and future work).
- The contractor's estimate does not include owners' costs as previous Hatch provisions for spares, initial fills, Owner's operational computer systems, etc.
- Not include any Owner's Costs for management, land, finance establishment, etc.
- As per the Hatch estimate, the contingency on direct costs remains buried within the individual direct costs.

The Multiplex capital cost estimate (completed in May 1999) is summaries in Table 20.

9.2.4 Enthalpy Review

Fin September 1999 Indcor engaged Enthalpy to review the capital cost estimate of the Project based upon the previous BHPE, Hatch and Multiplex estimates. Enthalpy's approach was to:

- Align like cost items between the BHPE, Hatch and Multiplex estimates.
- Extract contingency from within the direct costs, and show these provisions as separate line items.
- Determine the split between Direct Costs and EPC Indirect Costs (being those developed by Multiplex).
- Determine Owners' Costs and Project Indirect Cost, excluded by Multiplex.
- Assess the Multiplex EPC estimate and make adjustments as justified and required, to represent an independent fair cost estimate of the total project to the Owners.
- Develop a conventional EPCM assessment of costs, to determine the provision for Multiplex taking the EPC price, schedule and performance risks.

- Determine the relationships between Direct, Indirect and Contingency and benchmark these against other major projects.

Table 20 below summarises each of the cases.

Table 20: Hatch and Multiplex Capital Cost Estimates

	Hatch EPC A$ million	Multiplex EPC A$ million
Direct Costs		
Site work	28.83	28.63
Piling	1.15	1.14
Concrete	49.90	49.57
Structural Steel	133.01	132.13
Architectural	42.46	42.18
HVAC	2.90	2.88
Environmental	0.31	0.31
Process Piping	43.45	43.16
Mechanical Equipment	267.12	265.34
Safety, Security and Protection	0.34	0.33
Refractory	36.30	36.06
Process Electronics	131.94	131.06
Electrical and Instrumentation	36.85	36.61
Indirect costs	57.83	57.44
Civil Site Preparation	18.05	Excluded
Temp. Construction Facility	-	-
PCM Portion	-	-
Infrastructure Development	Excluded	Excluded
Design Growth Allowances	68.83	68.83
Contingency	114.25	104.85
Total Direct Costs	**1,033.52**	**1,000.52**
EPC Indirect Costs		
PCM Portion	47.36	70.04
Construction Utilities	2.35	-
Additional Insurances	0.40	Excluded
Technology Fee and Basic Engineering	-	Excluded
Performance Guarantee Insurance	-	Excluded
Rework of Process	51.68	Excluded
Design Swell	-	50.03
Camp Costs	-	Excluded
Escalation	59.43	Excluded
Margin	65.01	64.24
Total Indirect Costs	**226.23**	**184.31**
Owners Costs		

Ramp-up Commissioning	23.48	10.00
Technology and Basic Engineering	65.57	30.77
Performance Guarantee Insurance	16.39	15.00
Finance Costs	-	10.00
Feasibility Study Costs	-	31.00
Capital Spares	14.70	-
First Fills	2.94	-
Laboratory Equipment	3.00	3.00
Computer Systems	2.50	-
Management Information System	5.00	-
Total Owner's Costs	**133.58**	**99.77**
TOTAL (A$M)	**1,393.33**	**1,284.60**
TOTAL (US$M at current FX rates)	**700**	**650**

Enthalpy's conclusions to its review and assessment of the project studies are as follows:

- The Hatch and Multiplex capital cost estimates include direct costs and indirect EPC costs, but do not include Owners' Costs.
- The BHPE cost estimate included direct costs and some, but not all indirect costs. No Owners' Costs were included.
- The Enthalpy assessment makes allowance for all direct, indirect EPC and Owners' Costs.
- Therefore, the various estimates of costs are not directly comparable in the total, but are comparable at sub-levels.

An important aspect to recognise is that the BHPE, Hatch and Multiplex estimates are based on different contracting strategies (EPCM versus EPC).

If all the required scope items were included in the BHPE, Hatch and Multiplex estimates then on a true comparative basis, the EPC all up equivalent costs would become:

	EPC	
BHPE	A$1,147.8 million	US$575 million* (US$2.90/lb)
Hatch	A$1,406.4 million	US$700 million* (US$3.50/lb)
Multiplex	A$1,350.2 million	US$675 million* (US$3.40/lb)
Enthalpy	A$1,240.9 million	US$620 million* (US$3.10/lb)

* at current A$:US$ exchange rates

Enthalpy's EPCM estimate was A$1,163.1 million (US$580 million at current exhange rates) or approximately $80 million less than its EPCM estimate.

Enthalpy also identified potential reductions in the direct cost areas of approximately $50M. When combined with those identified by Hatch and Multiplex, the potential adjustments are:

- Enthalpy Adjustments (Various) A$38.8M
- Hatch / Multiplex (Density-Cells) A$50.0M
- Optimised Dehydration A$25.0M
- Potential Value Analysis reductions A$53.0M
- TOTAL 'POTENTIALS' A$166.8M

These potential cost savings are order of magnitude only and are subject to the success of detailed technical investigations, further engineering and pricing to verify that they are achievable.

When translated through the project directs, indirects and Owners' costs, the total potential capital cost may be reduced to A$1,016.1 million under an EPCM contracting strategy.

The probability of all potential reductions being able to be secured to bankable stage has not been able to be assessed at this stage.

9.2.5 Indcor Current Estimate

In April 2001 the new management team of Indcor completed an extensive review of all previous capital cost data. For the purposes of this Memorandum Indcor has adopted the following estimate philosophy:

- Mine and mine service cost estimates are based on the use of a contract mining contractor with a campaign schedule. The estimates have been developed incorporating the Brian Speechly study which formed part of the Hatch optimisation study.
- Assumed minimal processing at the mine site. Finished product will be run-of-mine ore delivered to stockpiles established at the mine site as part of the mining operation. Ore will be loaded onto trucks and transported to the northern coast along existing forestry roads. Capital works include bridge construction, stockpile area development, upgrading of local road works, and installation of essential infrastructure.
- Include an allowance at Port Latta or Burnie to receive by road and ship by sea all run-of-mine magnesite ore.
- Regional allowance to receive magnesite at a regional port and transport by road run-of-mine ore to the magnesium metals plant. Similarly transportation of magnesium metal ingots (and alloy product) from the metals plant to the port for receival and trans-ship to the international markets.
- No allowance made for the potential cost savings identified by Enthalpy.

- Contingency allowances are included in the direct cost estimates.
- Escalation, working capital and financing costs are excluded on the basis that these costs will be incorporated into the overall financing package.
- Owners cost estimates have been developed based upon Indcor's evaluation and experience from similar projects, discussion with UTI/VAMI and Hatch estimates included in the optimisation study.
- The capital cost estimate includes a magnesium chemicals facility to be constructed as part of the final project to take advantage of the high quality magnesite feed product.

The Indcor overall capital cost estimate is included in Table 21 below.

Table 21: Indcor Capital Cost Estimate

	A$ million	Source
Mine and Ore Delivery		
Mine Development	8.00	Hatch Study
Ore Transport Facilities (Mine to Coast)	2.50	BHPE Study
Port Receival/Ship Facilities (Tasmania)	4.50	Indcor
Port Receival/Ship Facilities (mainland)	3.00	Indcor
Product Transport Facilities (mainland)	2.50	Indcor
Total Direct Mine and Ore Delivery Costs	***20.50***	
Magnesium Chemicals Plant		
Total Direct Magnesium Chemicals Plant Costs	***18.00***	Indcor
Magnesium Metals Plant		
Siteworks	7.73	Hatch Study
Raw Materials Handling	12.46	Hatch Study
Leach and Purification	42.61	Hatch Study
Granulation	3.81	Hatch Study
Crystallisation	132.98	Hatch Study
Dehydration	73.01	Hatch Study
Refining, Casting and Furnaces	51.14	Hatch Study
Potroom and Casting	129.56	Hatch Study
Potroom Cell Electrics	36.65	Hatch Study
Busbar	58.02	Hatch Study
Potshells	165.17	Hatch Study
Chlorine Handling	12.77	Hatch Study
HCl Absorbtion	29.94	Hatch Study
MgO Calciner	Included in Mg Chemicals	
Offices and Mess Facilities	30.66	Hatch Study
Plant Pipework and Pipebridges	32.04	Hatch Study
Plant Electrics	76.78	Hatch Study
Plant Services	47.32	Hatch Study
Total Direct Magnesium Metals Plant Costs	***942.65***	
Indirect Costs – Total Project		

Statutory Charges (and insurance fees)	1.50	Indcor
Construction Services	20.00	Indcor
Construction Utilities	2.35	Indcor
Engineering Design and Technical Support	47.49	Indcor
Technology License Fee	32.00	Indcor
Procurement and Construction Services	41.00	Indcor
Commissioning Support	17.50	Indcor
Total Indirect Costs	***161.84***	
Owners Costs – Total Project		
Management Team	16.00	Indcor
Ramp-up Team	28.00	Indcor
Bankable Feasibility / Basic Engineering	18.50	Indcor
Environmental Study and Approvals	7.00	Indcor
Insurance Program	12.50	Indcor
First Fills	6.50	Indcor
Capital Spares	16.00	Indcor
Mobile Equipment	4.50	Indcor
Laboratory and Equipment	3.50	Indcor
Office Equipment, Services and IT	8.00	Indcor
Pre-Production Labour	12.50	Indcor
Training	15.00	Indcor
Contingencies	Included in line items	
Working Capital	Excluded	
Escalation	Excluded	
Finance Costs	Excluded	
Total Owners Costs	***148.00***	
TOTAL (A$M)	**1,290.99**	
TOTAL (US$M at current FX rates)	**650**	

9.3 Operating Cost Estimates

9.3.1 BHPE

BHPE concluded that based on the work undertaken for the preliminary study, the estimated operating costs of a 90,000tpa capacity magnesium plant located in either Bell Bay, Tasmania; Latrobe Valley, Victoria; or Hunter Valley, NSW were US$0.65/lb Mg.

BHPE's approach to the operating cost estimate was:

- For individual consumables and utilities - develop a unit usage rate and obtain budget quotes. Specifically, BHPE obtained indicative budget pricing from 12 Australian energy suppliers. Energy is clearly the largest operating expense accounting for greater than 35% of operating costs.
- For labour - develop and utilise a benchmark man-hours / lb Mg and extend to cost. Specifically, an industry factor of 175 tonnes Mg per man-year was applied.

- For maintenance and materials - nominate separate factors as a percentage of capital.

BHPE concluded that their estimate, for the Bell Bay site, was accurate to within ± 20%.

9.3.2 Hatch

In developing the optimisation study, Hatch developed a comprehensive operating cost model. At this time Hatch optimised major areas of the BHPE estimate by refining process input requirements.

BHPE's estimates of quantities for operations, utilities, maintenance, rebuilds and overheads were reviewed and, in certain instances, amended. Unit cost rates were not changed from the BHPE estimates.

As a result of the optimisation study, Hatch amended the cash operating cost estimate to US$0.66/lb of magnesium metal based on key assumptions as follows:

- Exchange rate A$1.00 = US$0.61
- Power costs
  - Electricity (average) A$37.70/MWhr
  - Natural gas (average) A$3.11/GJ
  - Steam (average) A$9.67/t
- Labour (including on-costs) Average A$61,250 per person pa
- Magnesite (FIS plant) A$20/tonne

The Hatch operating cost estimate assumes that the Project has reached steady state operations and does not include:

- Royalties;
- Interest on Project borrowings;
- Sustaining capital;
- Product marketing and transport;
- Depreciation and amortisation; or
- Provision for closure and rehabilitation.

The Hatch operating cost estimate developed in the optimisation study (May 1999) is summarised in Table 22.

Table 22: Operating Cost Estimate (Hatch)

	Qty	Rate	US$M pa	US$ /lb
Plant Operations				
Magnesite (Mining & Transport)	409,806T	A$43 / T	10.68	0.054

Reagents			10.16	0.051
Manpower	332	A$52,967pa	10.73	0.054
Operating Supplies and Expenses			6.32	0.032
Sub-total Plant Operations			***37.89***	***0.191***
Utilities				
Electrical Power*	1.683 GWhr	A$0.0377 / kWhr	38.70	0.195
Natural Gas*	5.229M GJ	A$3.11 / GJ	9.92	0.05
Steam*	1.28M T	A$9.67 / T	7.55	0.038
Process Water	2.34M T	A$0.50 / T	0.71	0.004
Cooling Water	2.68M T	A$0.50 / T	0.82	0.004
Waste Disposal			2.00	0.010
Manpower	52	A$73,192pa	2.32	0.012
Sub-total Utilities			***62.02***	***0.313***
Plant Maintenance and Cell Rebuilds				
Maintenance Materials and Supplies			9.49	0.048
Cell and Furnace Rebuilds			9.70	0.049
Manpower	119	A$55,941pa	4.06	0.020
Sub-total Maintenance and Rebuilds			***23.25***	***0.117***
Total Direct Costs			***123.16***	***0.621***
Overhead Expenditure				
Insurance and Taxes			1.90	0.010
Product Development			0.50	0.003
Manpower	30	A$106,667pa	1.95	0.010
Contingency			3.97	0.020
Sub-total Overheads			***8.32***	***0.043***
TOTAL			**131.48**	**0.664**

* Subsequent discussions with power suppliers (refer section 7.4) have shown that these power cost estimates can be improved upon.

9.3.3 Enthalpy Review

In mid 1999 Indcor engaged Enthalpy to review the Operating Costs of the Project. The Enthalpy review was contained in the document "Review of Feasibility Study Estimate Major Resource Project" dated 2 September 1999. Enthalpy concluded that the Hatch operating cost estimate was accurate to within ± 15-20%.

9.3.4 Indcor Current Estimate

In April 2001, management of Indcor completed an extensive review of all operating cost data.

For the purpose of this Memorandum Indcor has adopted current operating costs based on discussions with utility providers and current exchange rates. The cash operating cost for the production of magnesium metal is currently estimated at US$0.54 based on the following key assumptions:

- Exchange rate A$1.00 = US$0.50

- Power Costs
  - Electricity (average) A$30.00/MWhr
  - Natural Gas (average) A$3.00/GJ
  - Steam (average) A$9.00/tonne
- Labour (including on-costs) A$58,627 per person pa
- Magnesite (FIS) plant A$20/tonne
- Include product marketing A$9.9M pa

The current estimates developed in Q1/01 by Indcor are summarised in Table 23.

Table 23: Operating Cost Estimate (Indcor)

	Qty	Rate	US$M pa	US$ /lb
Plant Operations				
Magnesite (Mining & Transport)	409,806T	A$43/T	8.80	0.044
Reagents			8.33	0.042
Manpower	332	A$52,967pa	8.79	0.044
Operating Supplies and Expenses			5.18	0.026
Sub-total Plant Operations			***31.10***	***0.156***
Utilities				
Electrical Power	1.683 GWhr	A$0.030 / kWhr	25.25	0.127
Natural Gas	5.229M GJ	A$3.00 / GJ	7.84	0.040
Steam	1.28MT	A$9.00 / T	5.76	0.029
Process Water	2.34MT	A$0.50 / T	0.58	0.003
Cooling Water	2.68MT	A$0.50 / T	0.67	0.003
Waste Disposal			2.00	0.010
Manpower	52	A$73,192pa	1.90	0.010
Sub-total Utilities			***44.00***	***0.222***
Plant Maintenance and Cell Rebuilds				
Maintenance Materials and Supplies			7.78	0.039
Cell and Furnace Rebuilds			7.95	0.040
Manpower	119	A$55,941pa	3.33	0.017
Sub-total Maintenance and Rebuilds			***19.06***	***0.096***
Total Direct Costs			***94.16***	***0.474***
Overhead Expenditure				
Insurance and Taxes			1.56	0.008
Product Development			0.50	0.003
Manpower	30	A$106,667pa	1.60	0.008
Marketing			4.96	0.025
Contingency			3.97	0.020
Sub-total Overheads			***12.59***	***0.064***
TOTAL			**106.75**	**0.538**

10. PROJECT ECONOMICS

With the assistance of consultants, Indcor has developed a comprehensive financial model for the TasMag Project.

10.1 Principal Assumptions

The base assumptions adopted therein are summarised in Table 24 below:

Table 24: Financial Modelling Assumptions

Item	Assumption	Memorandum Reference
Production Rate	85,000tpa Mg metal 5,000tpa Mg alloys	
Project Life	30 years	
Capital cost	A$1.151 billion	9.2
Magnesium Price	US$1.25 / lb Mg metal US$1.27 / lb Mg alloys	
Operating cost - Electricity cost - Steam cost - Gas cost	US$0.64 for Mg metal [1] A$25 / MWhr A$8 / tonne A$3 / GJ	9.3 7.4 7.4 7.4
Royalties	2.0% of gross revenue	11.3
Ramp-up period	2 years	
Exchange Rate	A$1 : US$0.60 [2]	
Debt : Equity Ratio	65% : 35%	
Debt Period	10 year amortising debt	
Interest Rate	8.0%	
Australian Tax Rate	30%	
Inflation Rate	2.0%	
Discount Rate	10%	

Note 1: Additional US$0.03/lb to produce Mg alloys.

Note 2: Approximately 20% higher than the exchange rate at the end of April 2001.

10.2 Base Case Results of Financial Modelling

Based upon the assumptions listed above, at full production the following would apply:

	US$ million	A$ million
Gross revenue Royalties	248.2 * (5.0)	413.7 (8.3)
Net revenue	243.3	405.4
Operating Expenses	(127.6)	(212.7) *
EBITDA	115.7	192.7

Note: A$1 : US$0.60 assumed. Base currency is noted with an asteric "*".

The computed NPV (geared after tax) of the TasMag Project, after the required equity capital contribution, is US$386.5 million. The geared, after tax IRR is 15.1%.

If current A$:US$ exchange rates of approximately A$1.00:US$0.50 are applied, the NPV would rise to US$554 million and the IRR to 22.3%.

10.3 Financial Modelling Sensitivities

Table 25 below summarises the impact of various sensitivities on the geared after tax IRR.

Table 25: Sensitivity Analysis

Sensitivity	IRR Impact
Base Case	15.1%
Mg price ± US$0.05/lb	± 1.5%
Capital Costs ± 10%	± 2.2%
Operating Costs ± 5%	± 2.0%
A$ ± 5 cents	± 3.0%

11. OTHER MATTERS

11.1 Licenses and Permits

The TasMag Project resources are contained within two retention licenses (RL8717 and RL8718) each of $5km^2$. Both licenses were originally issued on 1 March 1988 to CRA Exploration Pty Ltd (a wholly owned subsidiary of what is now Rio Tinto Plc) and have been extended on each 3rd anniversary. The licenses were both transferred to TasMag on 29 May 1998 and have since been extended until 2 March 2003.

RL8717 comprises land which is categorised as State Forest – Multiple Use Forest Land and State Forest – Deferred Forest Land. RL8717 is partly within the Savage River, Australian Heritage Act, Registered Entry.

RL8718 comprises land which is categorised as State Forest – Multiple Use Forest Land. The entire measured and indicated resource (refer section 4) is contained within RL8718.

Apart from reporting and nominal rent requirements (rent for the year to March 2002 was A$510 + GST for each RL), the licenses have no minimum expenditure commitments.

Pursuant to the *Mineral Resources Development Act 1995*, a retention license authorises the licensee to carry out any of the following which is necessary to evaluate the potential for mining:

- Geological, geophysical and geochemical programs;
- Mining feasibility studies;
- Metallurgical testing;
- Environmental studies;
- Marketing studies;
- Engineering and design studies; and
- To enter on, or pass over, any Crown Land or private land for those purposes.

It is an offence for a person to hinder or obstruct a licensee from carrying out an activity under the license.

The holder of a retention license has the exclusive right to mark out and apply for a lease in respect of:

- The area or part of the area of land comprised in the license; and
- The minerals specified in the license.

RL8717 and RL8718 apply to all minerals.

11.2 Native Title

In order to maintain a native title claim, the persons making such claim must show that they enjoyed certain customary rights and privileges in respect of a particular area of land and that they have maintained their traditional connection with the land. Such a claim will not be recognised if the native title has been extinguished, either by voluntary surrender to the Crown, death of the last survivor of the community entitled to native title, abandonment of the land in question by the community or the granting of an inconsistent interest in the land by the Crown.

Both RL8717 and RL8718 are located on Crown land and there are no native Australian aboriginals in Tasmania having any continuing connection with the relevant land. However, it is possible that the land may be subject of a native title claim. Indcor is not aware of any claim having been made since the licenses were first granted on 1 March 1988. The likelihood of a claim being made appears remote.

11.3 Royalties

11.3.1 State Government Royalties

The Tasmanian State Government imposes a royalty on minerals extracted from within the State based upon sales revenue and mine profitability. For the purposes of royalty calculation, net sales equals sales revenue as reported in accordance with Australian accounting standards adjusted to remove:

- the impacts, if any, of product and currency hedging;
- costs of transporting mined material to the processing facility; and
- costs of refining that mined material.

A flat 1.6% royalty is applied to unhedged net sales revenue, whilst a further royalty based upon the mines profitability (before interest and tax) is calculated pursuant to the following formula: $(EBIT^2 \div \text{net sales}) * 0.4$.

The combined total State Government royalty is capped at 5% of net sales.

11.3.1. Other Royalties

TasMag is required to pay Mineral Holdings Australia Pty Ltd, a former holder of the RLs, a royalty of:

- A$0.50 per tonne (adjusted by CPI from February 1997) of ore mined or processed from the licenses or contiguous areas if such ore contains not less than 37.5% MgO; and
- A 2.5% net smelter royalty on all metallic minerals including precious and semi-precious metals excluding magnesium and calcium processed from the licenses or contiguous areas.

12. RISK ANALYSIS

12.1 Introduction

As part of the optimisation phase, Hatch undertook a preliminary risk analysis of the TasMag Project in order to:

- Identify major process risks for each process area;
- Provide an evaluation of the potential consequences of the risk issues
- Identify the potential likelihood of the risk occurring; and
- Identify an action plan for mitigating the risk issues.

Set out below is a summary of the risks identified and Hatch's preliminary assessment of the likelihood of the risk impacting operations of the TasMag Project. The analysis is summarised by plant area.

12.2 Hatch Assessment

12.2.1. Leach and Neutralisation Plant

Risk	Hatch Assessment
Magnesium in ore is less than cut-off grade (< 38% MgO) ⇒ higher throughput to maintain production	Low
Metallic impurities in ore higher than cut-off grade ⇒ increased consumption of MgO and higher leach residue for disposal	Low
Calcium content in ore higher than cut-off grade (> 4% CaO) ⇒ increased $CaCl_2$ content in brine, more $CaSO_4$ to remove by filtration ⇒ more filter cake for disposal	Medium, however selective mining and/or blending of ores can mitigate this risk
Uncertainty with sizing of solids removal step in leach filtration ⇒ incorrect sizing of filtration equipment	Low based upon proposed phase 2 testing program

12.2.2. Spent Electrolyte Granulation

Risk	Hatch Assessment
UTI / VAMI spent electrolyte technology not demonstrated in industrial practice ⇒ reliability and operating cost concerns	High, further testwork required, or alternative technology available
Hydrogen gas generation in granulation process not adequately quantified ⇒ unsafe working conditions	Low

12.2.3. Spent Electrolyte Dissolution

Risk	Hatch Assessment
Residual hydrogen gas generation in dissolution process not adequately quantified ⇒ unsafe working conditions	Low

12.2.4. Carnallite Crystallisation

Risk	Hatch Assessment
$CaCl_2$ content in fresh brine higher than design due to higher cut-off grade CaO ⇒ increased reagent consumption and potential additional equipment requirements	Medium, however gypsum precipitation and leach filtration equipment can be designed to mitigate this
Effect of $CaCl_2$ on $CaSO_4$ solubility not fully characterised ⇒ increased $CaSO_4$ in brine solution ⇒ increase installed capacity of $CaSO_4$ hemi-hydrate equipment	Low
Demonstration of $CaSO_4$ hemi-hydrate process in industrial application ⇒ plant availability concerns	Low, Messo process guarantee
Demonstration of carnallite crystallisation process meeting product specifications provided by UTI / VAMI ⇒ inability to meet carnallite product specifications	Low

12.2.5. Carnallite Dehydration

Risk	Hatch Assessment
Low chlorine conversion efficiency with UTI / VAMI combustion technology ⇒ inability to produce dead-burnt carnallite meeting MgO specifications	High, however alternative chlorine burning technology available
Dead-burnt carnallite specifications for MgO and H_2O not achievable due to flaw in UTI / VAMI dehydration process technology ⇒ may cause sludge accumulation in electrolytic cells and increase carbon anode wear	Medium
Dehydration equipment throughput sizing uncertain ⇒ over-design and over capitalise plant requirements	Medium
Carnallite particle sizing distribution ⇒ impact on dehydrator throughput capacity	Low

Demonstration of process design proposed by UTI / VAMI in industrial practice ⇒ failure to meet product specification	Medium

12.2.6. Carnallite Electrolysis

Risk	Hatch Assessment
Solid carnallite feed to electrolysis cell ⇒ additional mechanical equipment maintenance	Low
Demonstration of quality of electrolytic magnesium metal ⇒ lower quality metal produced	Low
Demonstration of electrolytic process in industrial practice ⇒ production rate implications	Low
Electrolysis throughput ⇒ equipment designed too conservatively ⇒ over spend on plant cost	Medium

12.2.7. Refining and Casting

Risk	Hatch Assessment
Quality of finished magnesium products ⇒ lower quality metal produced	Low
Operability of metal pouring system at casting machine ⇒ decreased output and lower quality metal produced	Low
Higher than expected loss of metal caused by poor shielding in casting machine ⇒ decreased output and lower quality metal produced	Low

12.2.8. Gas Handling

Risk	Hatch Assessment
Chlorine gas handling system operability ⇒ extraction of chlorine from cell house	Low
Dehydration tail gas scrubber technology demonstrability ⇒ scrubber reliability	Medium

GLOSSARY

A$	Australian dollars.
BHPE	BHP Engineering – consulting engineers to the TasMag Project and the authors of the preliminary feasibility study.
Carnallite	$MgCl_2$. KCl. $6H_2O$
$CaSO_4$	Calcium Sulphate.
CPI	Consumer Price Index – a measure of inflation in Australia.
CRAE	CRA Exploration – now part of Rio Tinto Plc – a former joint holder of the RLs.
Confidentiality Agreement	The confidentiality agreement signed by recipients of the Memorandum.
Enthalpy	Enthalpy Pty Ltd – consultants to Indcor and responsible for a review of the BHPE, Hatch and Multiplex capital and operating cost estimates.
EPC	Engineering, Procurement and Construction.
EPCM	Engineering, Procurement and Construction Management.
Fe_2O_3	Iron Oxide.
GJ	Giga joule.
GST	Goods and Services Tax – an input tax (10%) imposed in Australia.
H_2O	Water.
Hatch	Consulting engineers to the TasMag Project and the authors of the optimisation study.
Hartley Poynton	Indcor's corporate advisor.
Indcor	Indcor Limited, formerly Crest Magnesium NL, the parent company of TasMag.
KCl	Potassium Chloride.

K-Utec	Kali-Umwelttechnik of Sondershausen, Germany – party responsible for testing the production of carnallite crystallisate from $MgCl_2$ brine.
KWhr	Kilo-watt hours.
LOI	Loss on ignition.
L/s	Litres per second.
m	Metres.
M	Million.
Magnesite	The base ore of the TasMag Project ($MgCO_3$).
Memorandum	This information memorandum offering the TasMag Project for sale.
Messo	MESSO-Chemietechnik of Duisburg, Germany – party assisting the work undertaken by K-Utec.
Mg	Magnesium.
MgO	Magnesium Oxide.
$MgCl_2$	Magnesium Chloride.
$MgSO_4$	Magnesium Sulphate.
Multiplex	Multiplex Constructions Pty Ltd – formerly Indcor's joint venture partner in the TasMag Project, now a major shareholder of Indcor.
MWhr	Mega-watt hours.
NaCl	Sodium Chloride.
ORTECH	Process Research ORTECH of Mississauga, Canada – party responsible for testing the production of $MgCl_2$ brine for TasMag Project Magnesite.
Pitt and Sherry	Pitt and Sherry Consulting Engineers – environmental consultants to the TasMag Project.
Project	The TasMag Project.
RL	Retention License. The TasMag Project resources are contained in RLs.
ROM	Run of Mine.

SiO_2	Silicon dioxide (silica).
T	Tonne (1,000 kilograms).
TasMag	Tasmania Magnesite NL, a wholly owned subsidiary of Indcor.
TasMag Project	The Project the subject of the Memorandum and as described in section 2.2 of the Memorandum.
US$	United States of America dollars.
UTI/VAMI	The Ukranian National Research and Design Titanium Institute (UTI) and the Russian National Aluminium-Magnesium Institute (VAMI) – suppliers of technology to the TasMag Project.
Wt%	Weight percentage.