21 March 2013

Productivity Commission
Major Project Development
LB2 Collins Street
East Melbourne
VIC 8003

Dear Commission Members

RE MAJOR PROJECT DEVELOPMENT ASSESSMENT PROCESS

Enthalpy, through its experience and successful history, believes it is able to address the Commission's goals; and we therefore provide our thoughts on critical aspects of successful investment decision processes and project delivery.

Achievement of a desired, robust and repeatable result should be driven by policy, process and minimum standards. This is the fundamental proposition that Enthalpy has brought to projects of a capital-intensive nature for worldwide mining, resources, infrastructure, oil and gas, energy, government and utility industries since 1988. Process and standards for projects must exclude superfluous "red tape". They must instead focus on governing value, management of risk, transparency of progress, and certainty of outcome – put simply: delivery on expectation with no surprises.

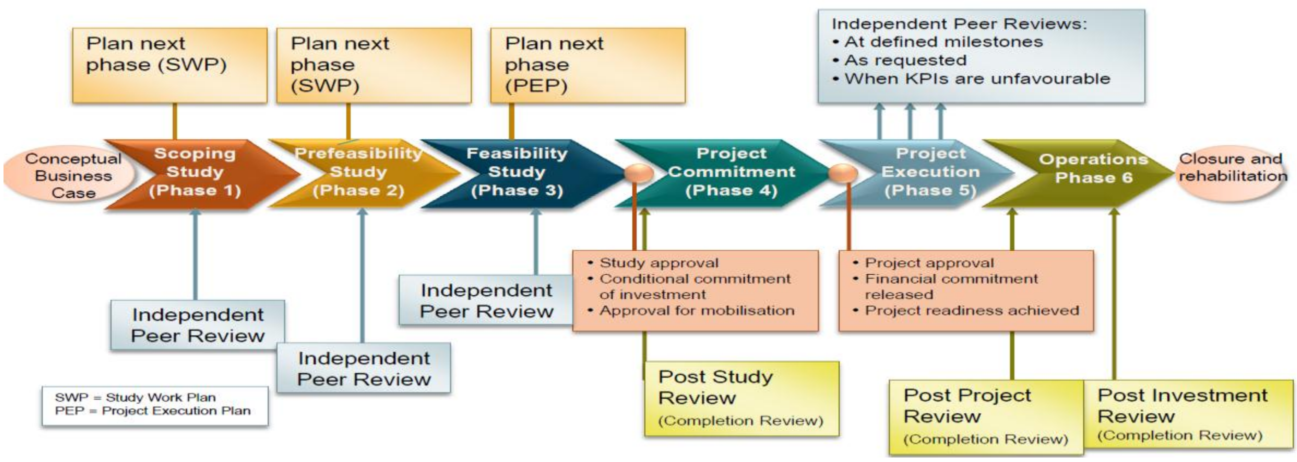
Enthalpy Perspective – Project Process

It's often talked about amongst projects professionals that the probability of successful capital projects globally is poor with:

- 50% of projects overrunning budget
- 50% of projects overrunning schedule
- 25% of projects are delivered inside both budget and schedule.

So what can be done to improve these odds?

Enthalpy's Capital Investment System, backed by our best practice minimum standards, relies on a consistent phased approach (refer figure below) to ensure the successful delivery of investment outcomes.



Enthalpy believes that consistent, phased approaches and project minimum standards must facilitate an effective decision making process. We believe this ensures:

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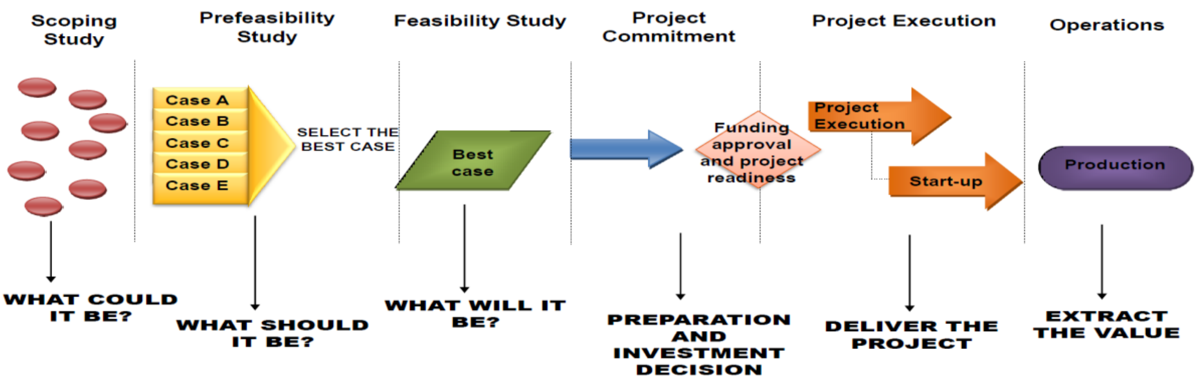
- Comprehensive, calculated and consistent evaluation of investments – technical and commercial for the definition of NPV
- Streamlined investment process that minimises delays due to poor focus and/or rework
- Plans and capacity to identify and manage risks in all phases
- Understanding the benefits of the investment prior to commitment
- Transparency, confidence and certainty for the decision makers
- Opportunity to establish sustainable assets that align with business strategy
- Optimised investment choices that can be defended for financing
- Progressive decision making providing an exit strategy along the way.

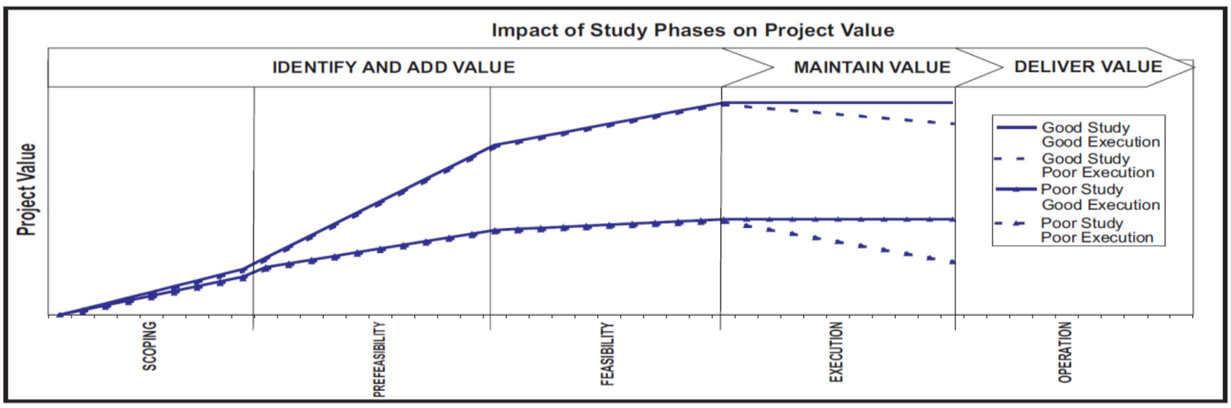
The value and importance of study phases cannot be underestimated. These phases ensure that appropriate perspective and influence is exerted at the right time to deliver the maximum value for business. We define a study as having a clear process with set standards and decision making points for scoping, prefeasibility and feasibility study phases as per the figure below.



As explained in the benefits above, the study process considers alternative project configurations to make decisions. Decisions need to be made on whether or not to proceed with project development, and if so, what is the optimum configuration. However, once a decision to proceed is made, and design, procurement and construction efforts commence, there is little opportunity to influence the project outcome without significant cost impacts.

Regardless of where the study phases begin and end or how many phases are realised, each study phase creates value for the project owner. This value can arise either directly – through identification and development and by aiding in the optimal configuration for the go-forward project, or indirectly – by halting or redirecting further effort into technical thinking on how to make the project more feasible or economically viable.

Undertaking studies early or performing “front end loading” in studies effectively will improve project execution outcomes as represented below:



**Reference – courtesy of the Independent Project Analysis*

Project Concerns & Opportunities

In major capital projects, there is often an absence of clearly defined study phases with minimum standards that ensure both the technical and economical solutions are considered. Without a blended concern, long term project viability is questionable. This is not to say that technical issues are unimportant – it is just that they are part of the overall prerequisite for project viability, in addition to the financial viability, environmental benefit and the competitive advantage/service the project provides to investors or the community.

We believe that the Commission's outcomes and recommendations can help to ensure that regulatory and legislative requirements promote and facilitate project development and investment processes mentioned above. Currently there are many challenges for project development in Australia at both a state and federal level because of the amount of "red tape" and regulatory requirements for environmental, social, economic and approval processes. Government requirements must focus on the facilitation of efficient decision making processes that are streamlined and scalable based on risk rather than an inflexible one size fits all approach.

Conclusion

The project strategy and purpose must be well defined and agreed upon up front (why are we really doing this?). The process and standards employed must be simple and understood by all stakeholders. They must be adhered to and controls put in place to assist. Independent peer review at project milestones is critical. Transparent reporting and forecasting must be carried out at all stages of study and execution to make the right decisions for keeping things on track.

We believe that the above effective process, coupled with innovative thinking with respect to contracting and financing strategies, can greatly improve the success of all major capital project development.

Further to this letter please see attached the following Enthalpy documents, authored by our Neil Cusworth, founder and Director of Enthalpy, for your review and information:

- The Use and Abuse of Feasibility Studies - Cusworth, N & Mackenzie, W, 2007. Project Evaluation Conference, Melbourne, Victoria 19 – 20 June, 2007.
- Capital Investment Systems, Making the Right Investment Decisions – Cusworth N, 2006. Project Management Institute paper.
- Introduction to the Enthalpy Capital Investment System (power point).

Neil Cusworth was also recently awarded the AusIMM Mineral Industry Technique Award (MITA) for 2013.The MITA is awarded in recognition of Neil's contribution in developing innovative, cost saving and effective techniques in the minerals project sector.

We trust that the above letter and attached documentation have contributed to the Commission's assessment of the Major Project Development within Australia. Enthalpy would welcome the opportunity to provide further feedback or consultation to the Commission should it be required.

Kind regards

JOHN BUFFINGTON
CEO

The Use and Abuse of Feasibility Studies

W Mackenzie[1] and N Cusworth[2]

ABSTRACT

The development of a resource project inevitably requires the investigation of a vast range of issues across most engineering disciplines – mining, metallurgical, chemical, civil, electrical, mechanical and environmental – as well as the geosciences.

It is also a characteristic feature of the resource industry that no two orebodies – and hence no two development projects – are the same. So these technical issues have to be addressed to a greater or lesser extent in evaluating any resource project's development potential.

Not surprisingly then, technical issues tend to predominate when assessing the development potential of a project in the process typically referred to as 'doing a feasibility study'.

But the principal purpose of a 'feasibility study' is to determine whether a development opportunity makes good business sense, not just whether it is technically possible.

Resolution of technical issues is often seen as the primary focus of a feasibility study, whereas in reality, these technical issues are the basis upon which an asset delivery and business plan is built. This is not to say that technical issues are unimportant – they are a prerequisite to the demonstration of a project's viability.

The feasibility study process must therefore demonstrate that not only have the technical issues been satisfactorily addressed, but also that the broader commercial, economic and social issues have been considered in the development of a comprehensive business plan, which includes an assessment of the risk-reward profile of the proposed development.

This paper will present a framework for the conduct of 'feasibility studies' and provide guidance to minimum standards and best practice.

INTRODUCTION

It is generally accepted that the preparation of a feasibility study is an important element early in the life cycle of a resource development project (eg Laird, 2001; Amos, 2001). It is also widely accepted that the feasibility study process is multi-phased and iterative (eg West, 2006). Typically, initial assessments of the development potential of a resource project are aimed at assessing the project's key technical and economic characteristics, with subsequent assessments designed to confirm assumptions and reduce the uncertainty associated with the development to an acceptable level. References to feasibility studies are often prefaced with 'order of magnitude', 'preliminary', 'indicative', 'pre', 'final', 'bankable', 'definitive', 'detailed' or other terms to indicate the level of detail investigated in a study. Resolution of technical issues is often seen as the primary focus of a feasibility study, whereas in reality, these technical issues are the basis upon which a business plan is built. This is not to say that technical issues are unimportant – they are a prerequisite to the demonstration of a project's viability.

Both the JORC (2004) and the VALMIN (2005) Codes use the term 'feasibility study', though neither Code provides a definition of the term. Some definitions are provided in other Codes of Practice, including:

> *A Feasibility Study assesses in detail the technical soundness and economic viability of a mining project, and serves as the basis for the investment decision and as a bankable document for project financing. The study constitutes an audit of all geological, engineering, environmental, legal and economic information accumulated on the project. Generally, a separate environmental impact study is required* (United Nations, 2004).

> *... 'feasibility study' means a comprehensive study of a deposit in which all geological, engineering, operating, economic and other relevant factors are considered in sufficient detail that it could reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production* (NI 43-101).

However, different people, different organisations and different situations inevitably give rise to different interpretations of what is to be investigated, what level of detail needs to be investigated, and even what is meant by technically feasible and economically viable in the context of a resource project development. Indeed, in the Mindev 97 Conference Proceedings (Barnes, 1997), an editor's note was included in the proceedings that highlighted the differing nomenclature used when referring to 'feasibility studies', cautioned against misunderstandings, and provided a table of 'equivalence of feasibility terminology'.

In ten years, it seems little has changed – it is commonplace in the industry for the term 'feasibility study' to be applied to a range of activities that include back of the envelope analyses, technology reviews, cash flow modelling and detailed project assessments complete with supporting development plans. The ubiquitous 'bankable' studies exhibit an extraordinary range in the extent and depth of the analysis of development issues – 'Bankable Feasibility Study' is perhaps one of the most abused and misleading phrases used in the industry.

This paper presents a framework for the conduct of 'feasibility studies' and provides guidance on minimum standards and best practice that allows consistency in evaluation approach across a wide range of projects. Rather than focus solely on technical issues, cost estimating or cash flow modelling, the framework treats technical feasibility and economic viability as platforms upon which a business plan is developed.

FEASIBILITY STUDY FUNDAMENTALS

All authors on the subject recognise the importance of feasibility studies in the project development cycle. Laird (2001), notes:

> *Ideally a final feasibility study is prepared when by virtue of preliminary evaluations, a project is known to be feasible and concepts are fairly well established.*

> *The feasibility study has one primary goal; to demonstrate that the project is economically viable if it is designed, constructed and operated in accordance with the concepts set forth in the study. Starting from a mineral resource database, the feasibility study will define the Ore Reserves, the mining methods, the mineral processing concepts and the scale of the project. The disciplined activity of developing a feasibility study leads the proponent to examine every aspect of the project, many of which might otherwise be ignored. All technical concepts will*

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be established and the corporate philosophy with respect to organisational structure, social and environmental responsibility, infrastructure contributions and financing will be determined. All the major decisions about how the project will be developed are made during the feasibility study. The success of the project will depend upon the assumptions and decisions in the feasibility study and the ability and empowerment of the development team.

The feasibility study process

The feasibility study process deals with uncertainty, and a phased and iterative study approach has evolved as a consequence. It is common practice for the feasibility study process to involve three phases, namely the conceptual or scoping phase, the preliminary or prefeasibility phase, and the final or definitive phase (eg West, 2006; Appleyard, 2001; Laird, 2001; White, 2001; Noort and Adams, 2006 and Shillabear, 2001), though additional study phases may be recognised during the project development cycle (Maslin, 2003).

Noort and Adams (2006) describe three phases of a study process as:

A scoping (concept) study should be used to define the potential of a project, eliminate those options that are unlikely to become optimal, and determine if there is sufficient opportunity to justify the investment required for further studies.

Prefeasibility studies should be used to select the preferred operating options from the shortlisted options defined by the scoping study and to provide a case for whether or not to commit to the large expenditure and effort involved in a subsequent definitive feasibility study.

Definitive (full) feasibility studies should be used to refine the optimal operating scenario defined by the prefeasibility study. They are often used to assist with outside financing requirements. The definitive feasibility study provides the basis for the decision on whether in fact further study is required, whether the project is worth pursuing or whether to advance the project to design and construction.

The entire study process can require considerable time, effort and funding. For example, BHP Billiton's Ravensthorpe Yabulu Integrated Nickel Project involved the expenditure of US$85 million in studies prior to the decision to proceed with project development, which at the time was estimated to cost US$1400 million. These studies spanned a six year period and included eight months of continuous pilot plant test work and 200 000 engineering man hours (Pointon, 2004). Rio's HISMELT technology was studied for 21 years prior to the commitment to build a commercial plant being taken in late 2002 (HISMELT, 2007).

Table 1 is extracted from a database collected by the authors of nine resource development projects costing in excess of A$200 million. It shows the project type, the estimated project cost (at the time of study completion and exclusive of costs incurred to that stage), the cost of studies undertaken to reach that decision point (exclusive of project acquisition, exploration and resource definition drilling) and the cost of studies as a percentage of the estimated project cost. Notwithstanding the limitations of the small sample size, these data show that for the sample analysed the average project feasibility study cost approximately 2.3 per cent of the total estimated project cost – slightly more for a greenfields project and slightly less for a brownfields project.

The role of feasibility studies in value creation

A key feature of the feasibility study process is that the ability of an owner to influence the outcome of a project is at its peak when the feasibility study process is defining what the project should and will be – yet adequate project definition can be achieved in the study process for only a small fraction of the total project expenditure.

During the study process, alternative project configurations can be studied and decisions made on whether or not to proceed with project development, and if so, what the optimum configuration is. However, once a decision to proceed is made, and design, procurement and construction efforts commence, there is little opportunity to influence the project outcome. This characteristic of the project development cycle as illustrated in Figure 1.

Regardless of where the study phases begin and end or how many phases are recognised, and even regardless of whether a study recommends proceeding to the next stage of the development cycle or not, each study phase creates value for the project owner. This value can arise either directly – by ensuring

TABLE 1

Sample feasibility study costs.

Type		Project estimated cost A$ M	Cost of feasibility study A$ M	Percentage of total cost
Brownfields	Smelter	$197	$4.2	2.1%
Brownfields	OP mine/refinery	$235	$8.7	3.7%
Brownfields	UG mine	$250	$3.0	1.2%
Brownfields	Mine/materials handling	$593	$10.5	1.8%
Brownfields	Smelter	$680	$14.0	2.1%
Greenfields	OP mine/concentrator	$750	$12.9	1.7%
Greenfields	OP mine/refinery/new technology	$750	$23.0	3.1%
Greenfields	OP mine/refinery/new technology	$901	$12.7	1.4%
Greenfields	OP mine/rail/port	$1950	$74.0	3.8%
			Min	1.2%
			Max	3.8%
			Average All Projects	2.3%
			Average Brownfields	2.2%
			Average Greenfields	2.5%

that viable opportunities are identified and developed, and by aiding in the identification of the optimal configuration if a project is developed, or indirectly – by halting or redirecting further effort on a project that is either technically infeasible or economically unviable in its proposed configuration.

It also follows that once a decision to proceed is made, and design, procurement and construction efforts commence, there is little opportunity to create value no matter how good the project execution is. Excellence in project execution is required just to maintain the value opportunity created from a good feasibility study, and excellence in project operation is required to deliver the value. A poorly defined project will not deliver the same outcome as a well defined project no matter how well executed and operated. Little scope exists to add or create value during project execution. This is illustrated in Figure 2.

There is a compelling case for the feasibility study process to be of the highest quality.

The importance of study phases

Having established that a feasibility study requires a multi-phased, iterative evaluation process, that the most influence on project outcome is exerted during the study process, and that the study process needs to be of the highest quality to deliver the maximum value, it is also important to remember that each study phase adds value. Laird (2001) notes:

> *It is critical that the purpose of the study be defined prior to its initiation, particularly when other partnerships or joint venture relationships are involved.*

This should be expanded – the purpose of each study phase must be clearly defined. Essentially, the purpose of each study phase is to answer the following questions:

- Scoping study:
  - What could it be?
  - Does it make sense to pursue this opportunity?
- Prefeasibility study:
  - What should it be?
  - Have I analysed enough alternatives?
  - Have I identified the optimum project configuration?
- Feasibility study:
  - What will it be?
  - What risks will this project involve?
  - What rewards will this project provide?
  - Have I presented an investment case that is unlikely to vary significantly?

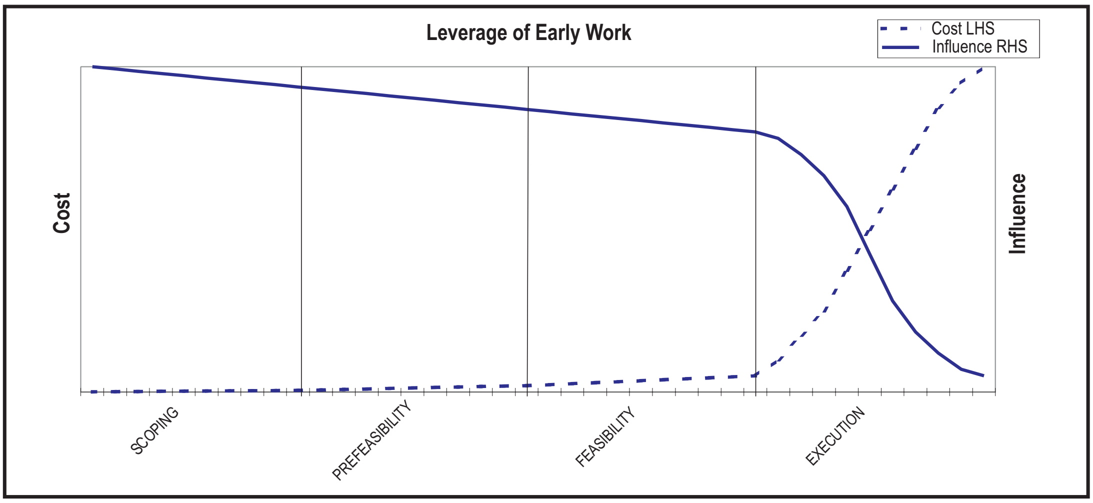


FIG 1 - The leverage of early work.

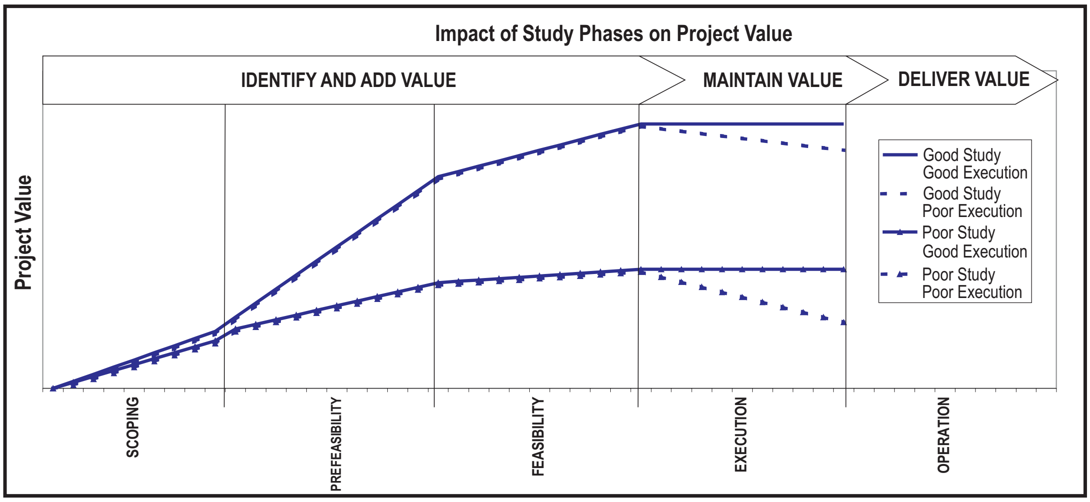


FIG 2 - The ability to create or add value.

In the event that a feasibility study culminates in a decision to proceed with project development, it is important that all of these questions – including those addressed in earlier study phases – be answered to ensure that value is maximised. Unless all study phases are completed, some of these questions will be left unanswered and value may be destroyed through wasted effort or lost opportunity.

INDUSTRY TRACK RECORD

The industry track record for delivering against feasibility study expectations is not good. Lawrance (1997) reports that:

> *There is strong evidence that, at least for major projects, there is an unwelcome record of failure* (Morris and Hough, 1986, p 5). *The World Bank (1978) lists 109 operations of which a quarter had cost overruns of 25 per cent or more, one-tenth had cost overruns of 50 per cent or more. Approximately half had time overruns of 25 per cent or more and approximately one-third had time and cost overruns of 50 per cent or more.*

Gypton (2002) reports that from a sample of 60 projects developed in North, Central and South America since 1980, the average cost overrun was 22 per cent, with only 40 per cent projects costing within ±15 per cent of the feasibility study estimate.

It would seem things have not got any better over time, although Gypton does note that:

> *Published comparisons of expectations (feasibility) versus actual performance … are almost non-existent. Feasibility study shortcomings are a sensitive subject at the very least, and in most cases, the operator is more interested in running a mine, not analysing what happened and why.*

But given that a feasibility study is about the delivery of a business plan, not just construction of a mine, process plant and infrastructure, project construction cost is but one measure of business success. Construction schedule, ramp-up time, product quality, product output, operating cost, safety and environmental outcomes are all key measures of business success for a resource development project, and published information on these measures of project success is also virtually non-existent.

Little information is available on the attainment of expected construction schedule, but the proliferation of public company reports that include the phrase 'on revised schedule' or the like indicates that project delays are not uncommon.

In relation to commissioning and ramp-up time, Nice (2002) contrasts the ramp-up of seven Australian projects with project ramp-up studies by other authors in 1979 and 1998 and concludes the most likely outcome for a process plant is that it will take 24 months to achieve name-plate capacity, and that this has been the case for the last 30 to 40 years. In the authors' experience, very few project owners allow such a ramp-up period in the financial modelling of their project, and generally argue that their project is different because times have changed, their project is simple, uses well known technology, has been done before, or some other excuse – they are usually disappointed

For other measures of project success, McCarthy (2004) provides a summary of overall project performance against expectations for 56 Australasian gold projects over a 15 year period from 1988-89. He concluded:

> *It is reasonable to conclude that about half of gold mining projects perform more or less as expected, and that stakeholder expectations will be met. About one quarter of projects will fail prematurely, usually under adverse financial circumstances, often involving extended litigation, administration or receivership. These projects have the potential to leave adverse environmental and community legacies and to reflect badly on the industry as a whole. A further quarter of projects will perform substantially better than the owner's expectations in terms of size or mine life. Different stakeholders will have different views on whether this is a good thing.*

Both the Gypton (2002) and McCarthy (2004) studies indicate that only about half of projects meet expectations – be that of cost and time to build the project or be that overall business outcome. With a rather fatalistic outlook, Gypton concludes:

> *… we need to acknowledge the fact that feasibility studies, and their estimates, are flawed documents by necessity. We should be prepared to test the economics of our projects at capital levels of say +20-25 per cent over the base estimate, including the contingency, and honestly ask ourselves if the project can withstand this risk.*

Whilst not disputing that a wider range of outcomes should be considered when testing the financial returns of a project, this approach will increase the number of false negative outcomes – it will kill off projects that may well be viable. This demands a better approach to study management and execution.

STUDY MANAGEMENT AND EXECUTION

In an analysis of the poor performance, both Gypton (2002) and Vancas (2002) list failure of owners' project management as a root cause. Gypton also notes:

> *Given the site-specific and intermittent nature of mine development, there is not a workable, detailed standard for the minimum level of definition required for a final feasibility study.*

The authors argue that improving the quality and definition of feasibility studies by the project owner is a key element – along with excellence in project execution and operation – in unlocking the value of a mineral resource

Since 1988, Enthalpy Pty Ltd (Enthalpy) has specialised in the provision of owners project management services, and from this experience, has developed a Capital Investment System (CIS) that has been used by major mining houses and government bodies both in Australia and offshore. The CIS consists of Policies, Process Manuals, Minimum Standards and Toolkits for the assessment and development of new business opportunities in the resource sector. Elements of the CIS have been licensed to Independent Engineers (Australia) Pty Ltd ('IEA'), which, since 2001, has been providing independent advice and opinions to project owners and financiers using the Enthalpy CIS as a benchmark.

A key outcome from the CIS is the development of a consistent approach to the scoping and conduct of feasibility studies. This is described below.

Project development and study framework

In scoping, managing, implementing and reviewing investment opportunities in a range of environments over the last 20 years, the authors have developed and refined the framework illustrated in Figure 3 for the project development lifecycle.

This framework incorporates three study phases together with the implementation and start-up, operation and closure and decommissioning phases of a project. Under this framework:

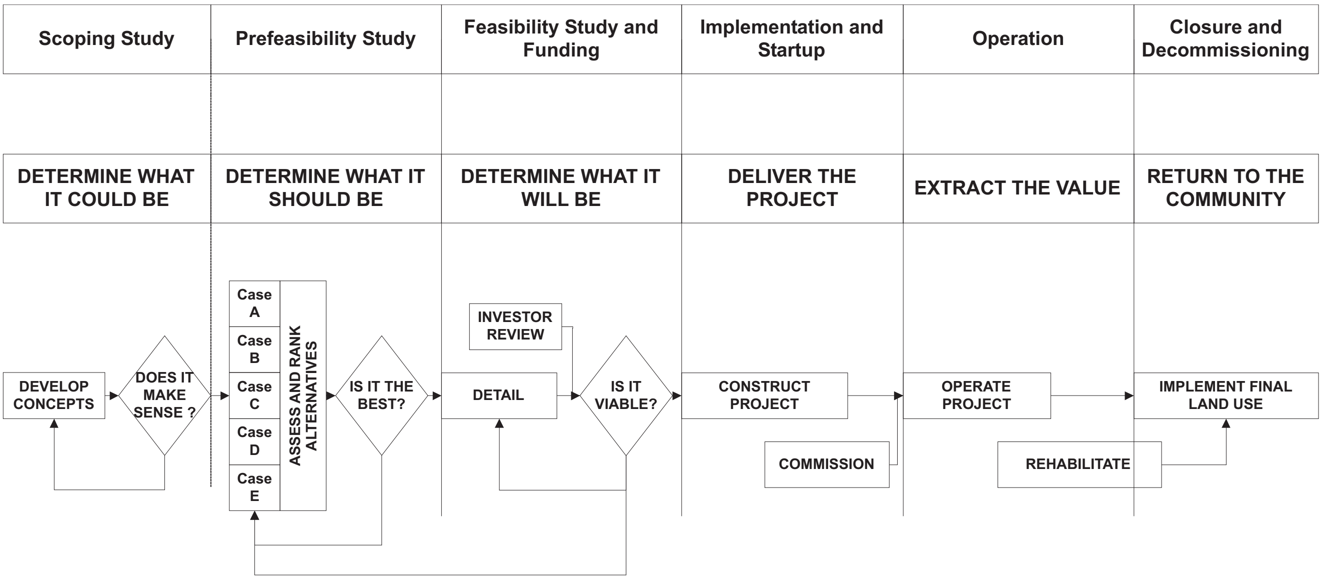


FIG 3 - The project development framework.

Scoping studies are typically undertaken during project generation or exploration and structured to:

- assess the potential of the new or expanded business opportunity;
- describe the general features of the opportunity including potential cases to be studied in the next phase;
- determine key business drivers for the opportunity and any potential fatal flaws;
- develop order of magnitude costs of the opportunity (both capital and operating);
- identify technical issues needing further investigation, such as geological drilling or test work required;
- determine the costs and time to undertake further development work to complete a prefeasibility study;
- identify the resources, personnel and services required to undertake further work on the opportunity; and
- provide a comprehensive report with supporting appendices that includes a recommendation to proceed or otherwise.

Prefeasibility studies are typically undertaken after the delineation of a mineral resource and structured to:

- assess the likely technical and economic viability of the opportunity;
- consider different mining, process, location and project configuration cases;
- consider different capacities for the project;
- determine and recommend the preferred optimum case to be examined during the feasibility study;
- outline the features of the recommended project;
- determine key business drivers for the opportunity and examine any potential fatal flaws;
- determine the risk profile of the opportunity;
- determine the nature and extent of the further geological, mining, metallurgical, environmental, marketing or other work needed to be undertaken during the feasibility study;
- determine the costs and time to undertake this work and prepare a feasibility study, including an estimate of the costs and time to develop the project following completion of the feasibility study;
- identify the resources, personnel and services required to undertake further work on the opportunity; and
- provide a comprehensive report with supporting appendices that includes a recommendation to proceed or otherwise.

Feasibility studies are typically undertaken after detailed data gathering of all material information relevant to the project development structured to:

- demonstrate the technical and economic viability of a business opportunity based on the proposed project;
- develop only one project configuration and investment case and define the scope, quality, cost and time of the proposed project;
- demonstrate that the project scope has been fully optimised to ensure the most efficient and productive use of the mineral resource, capital and human resources applied to the project;
- establish the risk profile and the uncertainties associated with this risk profile and develop mitigation strategies to reduce the likelihood of significant changes in the project assessment as set out in the feasibility study;
- plan the implementation phase of the proposed project to provide a baseline for management, control, monitoring and reporting of the project implementation and establish a management plan for the operations phase;
- facilitate the procurement of sufficient funds to develop the project in a timely manner; and
- provide a comprehensive report with supporting appendices that includes a clear recommendation to proceed with the investment or otherwise.

Minimum standards for the content and quality of each of the study phases have been established, which will be described later.

The framework recognises that the feasibility study process is iterative, and indeed any phase of a study may quite correctly recommend that the project be abandoned, shelved or reassessed. Whilst this may seem obvious, it is often difficult for a study team to reach such a conclusion after spending considerable time, effort and resources on the study. Accordingly, studies often do not progress smoothly through the study phases.

The framework provides clear decision points after the completion of each phase, though in practice, a decision to reassess a project or abandon a study can be made at any time.

However, under the framework, the rationale for this decision must be clearly reported and stored along with all project data, interpretations and reports. This will provide a valuable repository of project information in the event that circumstances change – projects that were previously assessed as not feasible can become feasible through, for example, ongoing exploration success, changes in technology, changes in markets, or the availability of infrastructure.

The framework also specifically incorporates the overlap of the following activities across project phases:

- the funding or financial closure activities commence before the completion of the feasibility study, but continue after the feasibility study is completed;
- the commissioning activities overlap with the construction and operation phases; and
- the rehabilitation activities overlap with the operation and the closure phases.

Of these, the commencement of financial closure activities well before the completion of the feasibility study is particularly important as financial closure can take a considerable time (particularly in the case of non-recourse project debt funding), and feasibility studies have a limited shelf life due to the need to refresh cost estimates and changes in economic or regulatory circumstances.

Bankability

The framework deliberately avoids the use of the term 'bankable feasibility study'. Guanera (1997) notes:

> *The definition of a bankable document is theoretically:*
>
> *A document which outlines the technical risks inherent in a mining project, delineates methods of eliminating those risks, and quantifies the potential economic returns that can be attained at various commodity prices.*
>
> *The bank itself will ultimately define what is required in a document that it will utilise to justify financing a mining project, so realistically, one could say that there is no such thing as a bankable document.*

Johnson and McCarthy (2001) continue this line and argue for the use of the term 'Bank-Approved' as opposed to 'Bankable':

> *The term 'bankable' feasibility study initially seems to have an added ring of veracity over the more mundane phrase 'feasibility study'. Adding 'bankability', after all, seems to imply that the study is like money a party can take to the bank. Unfortunately, the term is misleading … At the very least the knowledgeable lender, experienced in lending to mineral projects, will require that its own consultants and internal research departments review the study. The lender often then requires the parties to augment the study as support for the lending request. One can argue in good faith, then, that there really is no such thing as a 'bankable feasibility study' except after the selected financing lender prepares or approves one. In short, it would be far less misleading if the term were 'Bank-Approved' Feasibility Study.*

Guarnera (1997) notes:

> *Whether it is a financial institution that is considering financing a mining project or a mining company going to a financial institution for capital to finance their project, there are four general areas of risks involved in the analysis of a mining project:*
>
> - *bank risk,*
> - *country risk,*
> - *company risk, and*
> - *project risk.*

Given that the first three risk areas are difficult for a project owner to address, the focus of the minimum standards is on addressing project risk. Rather than attempt to define 'bankability', the authors have developed a set of criteria in Table 2 that a feasibility study should achieve to facilitate the procurement of bank debt. The minimum standards for the feasibility phase incorporate these characteristics.

Minimum study standards – content

Many authors provide some guidance as to the topics to be addressed during the study process (eg White, 2001; Noort and Adams, 2006; Amos, 2001; Kuestermeyer, 2002). Table 1 of the JORC Code also provides guidance on the criteria to be considered when assessing technical feasibility and economic viability, and the VALMIN Code lists issues to be considered when preparing an independent technical assessment or valuation.

Most authors note that the topics to be addressed in a feasibility study are project specific, but these can generally be categorised as either 'technical' or 'economic'. In the authors' experience, the early study phases tend to focus primarily on technical issues such as the resource, the metallurgical response,

TABLE 2

Study requirements for procurement of debt funding.

Characteristic	Required standard
Project configuration	The configuration of the project can be described and detailed in a unique manner and on a stand alone basis in regards to resource, process technology, scope, quality, cost and time parameters.
Project optimisation	To have reached a stage where all technical and commercial aspects have been optimised and defined.
Project variation	Parameters are unlikely to be varied materially following authorisation to proceed and commit funds to the project.
Study traceability	All aspects of the study report are capable of being tracked to a series of validated criteria and values, which are based on the appropriate level of representative test work, calculations and professional judgement which are acceptable to competent professional specialists.
Project control baseline	Budget and schedule are sufficiently detailed for use as a control base line for management of the project.
Study audits	Able to be audited and reviewed by lender's Independent Engineers and a full sign-off obtained.
Risk assessment	Sufficient to allow the project equity and debt providers to assess and allocate the risks of implementing and operating the project.
Financial model	Able to provide inputs to and be referenced in loan agreement documentation as required by debt providers.

the flow sheet, the mine design, the availability of water, waste dumps, tailings storage and environmental baselines. As studies progress, further site investigation and test work provides increasing confidence in the technical issues, allowing greater accuracy in costing and more sophisticated cash flow models to be prepared. Additional topics such as construction planning, infrastructure availability and permitting often appear in later study phases to support the required levels of accuracy. Less often, final phase feasibility studies include detailed execution and commissioning plans to provide even greater confidence in the working capital and cash flow requirements.

Although this approach to topic selection can result in reliable and valid recommendations being developed, it is our opinion that this approach is flawed for two reasons. Firstly, the failure to adopt a consistent table of contents for each study phase creates the potential for key issues to be either overlooked in early phases or forgotten in later phases. Secondly, it ignores or trivialises issues best categorised as 'business issues' such as competitor analysis, corporate capability (financial, managerial, technical and personnel), strategic fit and project rationale that are relevant to the deliberations on whether to proceed to the next phase or not.

Accordingly, a key feature of the CIS is the adoption of a comprehensive standard table of contents, to be applied across all study phases, which is presented in Table 3.

TABLE 3

Feasibility study table of contents.

Section No	Topic
1	Summary and recommendations
2	Development approach and rationale
3	Risk
4	Health and safety
5	Environment and community
6	Geology and mineral resource
7	Mining and ore reserve
8	Mineral processing
9	Product logistics
10	Waste management
11	Infrastructure
12	Human resources
13	Information technology
14	Project execution
15	Project operation
16	External relations
17	Capital costs
18	Operating costs
19	Product sales and revenue
20	Ownership and legal
21	Commercial
22	Financial analysis
23	Funding
24	Status of studies
25	Future work plan
26	Appendices

The inclusion in this table of contents of topics such as development approach and rationale, risk, human resources information technology, commercial and funding under the category of 'business issues' is an important addition to those in the usual technical and economic categories. This ensures that a study report, regardless of the study phase, includes analysis of all issues relevant to the proper consideration of a request for funding – be that funding for further studies or funding for actual project development. In addition, the adoption of a consistent table of contents for each study phase not only ensures a comprehensive assessment, but also assists with the capture and storage of project information, facilitates independent project reviews, minimises unnecessary duplication of work and eases the progression between study phases.

Minimum study standards – quality

Again, many authors provide guidance as to the level of accuracy for each study phase of a feasibility study (eg White, 2001; Cusworth, 1993). Indeed, most engineering firms have in-house standards (eg McCarthy, 2006; Kuestermeyer, 2002). However, Gypton (2002) notes:

> *The major EPCM firms have produced various guidelines, but these documents invariably are heavily influenced by the Chemical Process Industry, which has substantially different capital cost drivers.*

The CIS addresses this deficiency by expanding the standards applicable to each study phase to include standards for the 'business issues', not just the technical issues. It should also be emphasised that under the study framework, the progression from phase to phase of the study process does not involve a steady progression of each element of the study table of contents – the importance and effort applied to each study element changes from phase to phase. Technical issues should largely have been addressed during scoping and prefeasibility study phases to ensure that the optimum project configuration has been identified and is being defined in the feasibility phase. Conversely, there is little point in developing a detailed project execution or funding plan during the early study phases. This is shown in Figure 4.

Examples of the minimum standards illustrating these differences in progression of definition are:

- Table 4 Hydrogeology – essentially completed at the completion of the prefeasibility phase, and
- Table 5 Funding – only cursory review in scoping and prefeasibility phase, but detailed review in feasibility phase.

Minimum study standards – deliverables

The CIS provides minimum standards not only for content and quality of the study, but also for the deliverables from each study phase. Whilst it goes without saying that each element of the table of contents must be written up and consolidated into a report, which usually includes supporting appendices, the framework and minimum standards recognise that, in the event that a recommendation to proceed to the next phase of the project development cycle is made, then a key deliverable is a work plan for that subsequent phase. The standards to be achieved from the three study phases are provided in Table 6.

Minimum study standards – policy

The CIS includes policy governing the conduct of feasibility studies that mandates the adoption of the minimum standards for all study phases. These policies recognise the conflicts between the need for consistency in approach to feasibility studies, yet the flexibility to address the inevitable project specific issues by referring to the standards as minimum standards, and study managers are obligated to adopt a flexible approach such that any value improvement or risk reduction opportunities not specifically covered by the minimum standards are investigated.

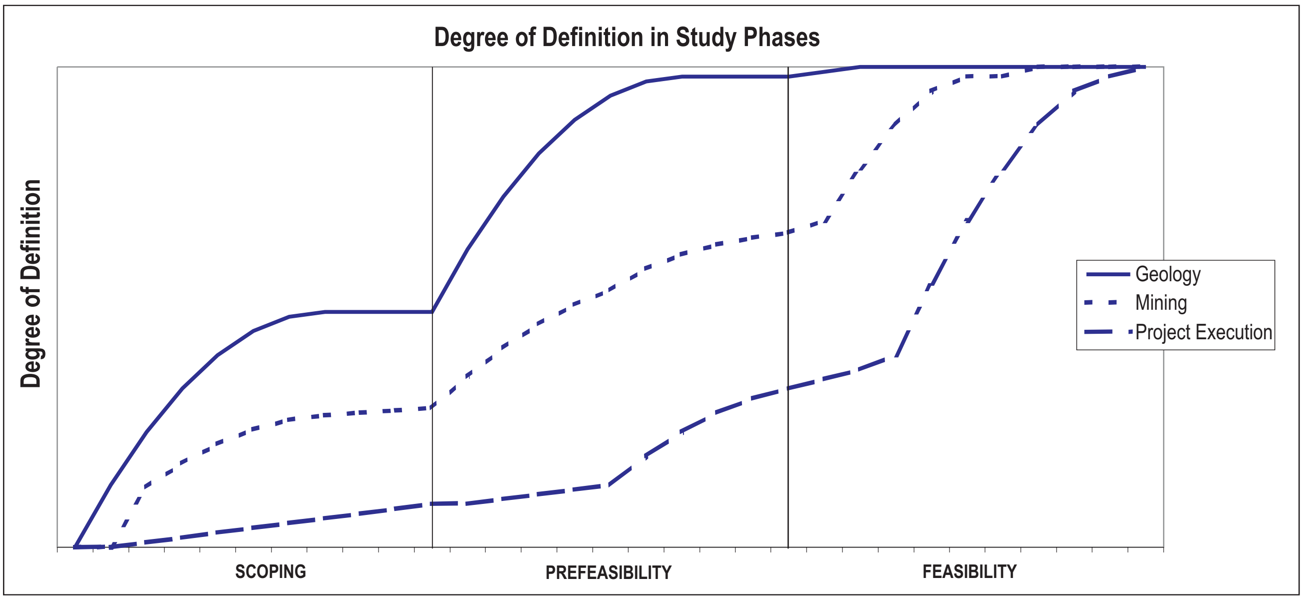


FIG 4 - The degree of definition in study phases.

TABLE 4

Study phase standards for hydrology.

Scoping study	Prefeasibility study	Feasibility study
Describe: The potential deposit groundwater regime(s) and any implications for mining. The likely project water demand (potable and process). The potential for suitable quantities and quality of groundwater (if necessary) to be available to support project development.	Describe: The groundwater regime existing within the deposit, including a description of aquifers and aquicludes, water levels, porosity and permeabilities and pore pressures, with specific mention of the likely impact on mining, with reference to: • test work; • groundwater modelling; • water quality; and • groundwater management program during construction and operation, including expected inflows, dewatering bore design (if required) and pumping rates. Provide a detailed assessment of the project groundwater requirements (potable and process) including an integrated site-wide water balance. If the project requires a water supply to be provided via a borefield, then describe: • the proposed means required and the test work that has been carried out to define the extent and rate at which the water can be supplied and its quality, • description of the proposed supply method (including capital and operating cost estimates conforming with the requirements of Sections 17 and 18); • numerical modelling of the water supply operation; and • ongoing monitoring requirements with costs associated.	Describe: The groundwater regime existing within the deposit, including a description of aquifers and aquicludes, water levels, porosity and permeabilities and pore pressures, with specific mention of the likely impact on mining, with reference to: • test work; • groundwater modelling; • water quality; and • groundwater management program during construction and operation, including expected inflows, dewatering bore design (if required) and pumping rates. Provide a detailed assessment of the project groundwater requirements (potable and process) including an integrated site-wide water balance. If the project requires a water supply to be provided via a borefield, then describe: • the proposed means required and the test work that has been carried out to define the extent and rate at which the water can be supplied and its quality, • description of the proposed supply method (including capital and operating cost estimates conforming with the requirements of Sections 17 and 18); • numerical modelling of the water supply operation; and • ongoing monitoring requirements with costs associated. Note: The availability of sufficient water to meet the project's needs must be confirmed together with confirmation that water abstraction permits will be available.

TABLE 5

Study phase standards for funding.

Scoping study	Prefeasibility study	Feasibility study
Funding: *Sources* An outline only of the potential source of funding for: • ongoing work, and • project development. *Structures* • Present the range of funding structures potentially available and discuss the cost and schedule ramifications.	Funding: *Sources* An outline only of the potential source of funding for: • ongoing work, and • project development. *Structures* • Report on the preliminary appraisal of the alternative funding structures undertaken. Make a recommendation as to the form and nature of sources and funding. • Identify the Independent Engineer qualified to advise lenders and acceptable to both parties and the status of any reviews.	Funding: Discuss: • the debt/equity mix, sources of finance, costs, choices of financiers, and the structure (recourse, non-recourse, etc); • the detailed terms of financing offers received and the status of any technical, legal or commercial due diligence by financiers; and • the risk management/allocation issues (including country assessment and mitigation measures). Evaluate risks and discuss risk allocation strategy. Report on the status of the Independent Engineer's latest project review. *Project funding support* • The type and size of completion support should be identified with reference to insurance support, contractual terms and the contracting strategy. • Any guarantees needed to ensure the financing structures can be used, should be noted. Any warranties to be obtained from technology supplies, engineers or equipment supplies should be outlined and the values quantified. • Describe guarantees and support required from the Company and external parties (eg parent company debt guarantee, off-take guarantee or price guarantee). Describe the issues that are or are likely to be conditions precedent to drawdown and the achievability and status of these CPs.

On the other hand, the policy mandates that a statement of compliance with the minimum standards be provided in each study phase report, and if any of the requirements of the minimum standards cannot be satisfied, or do not apply to the investment opportunity being studied, then the reasons for or justification of the non-conformance must be clearly and explicitly stated.

Minimum study standards – independent reviews

An essential element of the CIS is the declaration of review points in the project development cycle. During the study phase, these review points are set near the end of the prefeasibility and feasibility study phases such that the study phase work is complete and the study report in near final draft stage. These reviews are termed Independent Peer Reviews ('IPR') in recognition of the following principles:

- independent – implies previously uninvolved, impartial, unbiased and unaffected by the outcome of the review;
- peer – signifies a person who has the necessary experience and qualifications to be considered as an equal or better by the study team leaders and therefore qualified to opine on the study; and
- review – means providing a definitive, clear opinion on the study in relation to the standard achieved and must not involve rewriting the deliverables.

An IPR should focus on consistency between study areas and disciplines, key value drivers and key risks. The reviewer should be cognisant of the need to distinguish between matters of fact and matters of opinion. The reviewer and the study manager must agree on matters of fact, but may agree or disagree on matters of opinion. To illustrate this important distinction, an example from the authors' experience is as follows.

Statement of fact:

> *The Proponent initiated a schedule review in May 2006. The major outcome from this review was the recognition by the Proponent and the EPCM Contractor that schedule slippage was occurring and the target date for first gold pour of 5 October was not achievable. The project was rescheduled (Rev F) and the forecast date for completion of the project (defined as the completion of construction, commissioning and handover to operations of the last of the process plant facilities) was 15 March 2007.*

Statement of opinion:

> *The IPR Team is of the opinion that the revised schedule for completion of the project by mid-march 2007 is achievable, though it is an aggressive schedule with little if any float and multiple critical path items.*

TABLE 6

Study phase standards for future work programs.

Scoping study	Prefeasibility study	Feasibility study
Provide a future Work Plan (ie up to the point of commitment to a prefeasibility study) that includes a description of the following. *Scope and objectives* Define the scope and objectives for a project prefeasibility study (PFS), including: • declare the base and alternative cases to be considered, • declare technical issues requiring further investigation, and • identify test work to be undertaken. *Approach* Declare the execution strategy for the PFS, including: • minimum standards for the PFS Report, • resources required and organisation structure, • key personnel, and • key performance indicators for the PFS. *Cost and schedule* Provide an estimate of cost and schedule to undertake the PFS, including: • budget based on scope statement breakdown, • schedule (Level 2), and • key milestones.	Provide a future Work Plan (ie up to the point of commitment to a feasibility study) that includes a description of the following. *Scope and objectives* Define the scope and objectives for a project feasibility study, including: • declare preferred case to be considered in the feasibility study; • declare the scope of the preferred case for the project; • declare technical issues requiring further investigation; • identify test work to be undertaken; and • key technical or commercial issues, which must be overcome to prevent the feasibility study activities from being curtailed, suspended or terminated. *Approach* Declare the execution strategy for the feasibility study, including: • minimum standards for the feasibility study report, • procedures and systems to be employed, • reporting requirements, • contents of the study report, • the development of documentation or any data room, • resources required and organisation structure, • key personnel, and • key performance indicators for the feasibility study. The approach to the feasibility study will incorporate phases consisting of: • activities needing to be completed prior to commitment of the feasibility study; • feasibility study activities planned; and • any post feasibility study, but pre-project commitment activities. *Cost and schedule* Provide an estimate of cost and schedule to undertake the feasibility study, including: • budget based on scope statement breakdown, • schedule (Level 2), and • key milestones.	In addition to a detailed Project Execution Plan (see Section 14), provide an Early Works Plan for the period from completion of the feasibility study through to project approval that includes a description of the following. *Scope and objectives* Define the scope and objectives for the project: • declare the scope of the preferred case for the project; and • key technical or commercial issues, which must be overcome to prevent the project implementation activities from being curtailed, suspended or terminated. *Approach* The Early Works Plan will incorporate activities to be completed prior to commitment of the project (eg community liaison, contract negotiation, owners team set-up, land acquisition, early site works, long lead item procurement, preliminary engineering, training, etc). Declare the execution strategy for the project Early Works Program, including: • conditions precedent to board approval, • procedures and systems to be employed, • reporting requirements, • resources required and organisation structure, • key personnel, and • key performance indicators. Where third party funding is required for the project, the Early Works Plan will also cover financial closure activities necessary to procure third party funding for the project, including where necessary satisfaction of the conditions precedent to such third party funding. *Cost and schedule* Provide an estimate of cost and schedule to undertake the Early Works program, including: • budget based on scope statement breakdown, • schedule (Level 2), and • key milestones.

The reviewer and the study manager must agree on matters of fact, but may agree or disagree on matters of opinion.

A cautionary note and lessons learned

Gypton (2002) pragmatically notes:

> *Private industry simply cannot afford to study a project to a point of 'absolute certainty.' Good judgment will always be required for project evaluations, and sometimes, you have to make a decision based on data that is known to be incomplete, and live with it.*

Whilst adoption of the recommended approach to study management and execution can not and will not guarantee a project's success, the authors believe that the recommended approach will improve the chances of identifying the optimum project configuration that maximises the project value for a given risk profile, at the same time as reducing the chance of incorrectly classifying a project as unviable. Benefits arising from the recommended approach are that:

- studies are comprehensive,
- studies are fit for purpose,
- studies and terminology are consistent,
- studies address the needs of all stakeholders, and
- the study purpose and standards to be achieved can be clearly communicated to all study contributors at the outset.

There is a considerable body of literature relating to the pitfalls and perils of pertinent project development issues such as resource estimation, cost estimation and construction management. Shortcomings in these areas undoubtedly contribute to many project failures, but inevitably, the root cause of the failure of some projects is the failure of the study process itself. As Gypton notes, good judgement will always be necessary during project evaluations; however, from the authors' experience, factors that contribute to the failure of studies, and lessons learned include:

- failure to progress through the study phases – which can lead to suboptimal project development, proliferation of scope change during execution, wasted effort on a flawed business concept, or at worst failure to recognise fatal flaws until it's too late;
- failure to integrate study disciplines – having study contributors operating in isolation can lead to failure to identify fatal flaws or material issues, which in turn can lead to incorrect risk assessment;
- failure to challenge and validate the study outcomes with an outsider's eyes – which can lead to an unhealthy emotional attachment to a project and poor judgement;
- failure to plan for the next study phase – which can lead to inappropriate budget or schedule expectations;
- failure to recycle through study phases – which can arise when broad economic circumstances change or additional options are identified during the feasibility phase, which require a reassessment of the optimal project configuration;
- failure to fix study scope – which can lead to interminable analysis of alternative project configurations; and
- failure to involve all stakeholders – which can lead to project delays or late scope changes as their requirements are addressed.

Finally and probably the most important lesson to learn is the importance of maintaining perspective and exercising good judgement during the study process – it is always better to be approximately right than precisely wrong.

STUDY USES AND ABUSES

Thus far, this paper has presented some study fundamentals, the industry's poor track record for delivering against study expectations and a comprehensive study management system and approach aimed at improving on this track record. The rationale for undertaking studies and the benefits that a good study process can bring should be obvious, and whilst each study phase has a different purpose, if the final study phase is reached, a feasibility study should ultimately be used to:

- demonstrate the technical and economic viability of a business opportunity based on the proposed project,
- demonstrate that the project scope has been fully optimised,
- establish the risk profile of the project,
- facilitate the procurement of sufficient funds to develop the project in a timely manner, and
- support a recommendation to proceed with the investment or otherwise.

But how can a study be abused? Aside from deliberately fraudulent or misleading use of feasibility studies, the most common abuse of studies arises from a misunderstanding of the study phases and their respective purposes. This abuse of the study process may be a contributing factor in the relatively poor correlation between study expectations and project outcomes.

By way of illustration, one needs to look no further than the case of a public company that lodged a prospectus in late 2004 to raise $5.5 million, ostensibly for the exploration and development of a resource project in Western Australia. Included in the prospectus were the following statements:

- a full feasibility has been completed for Stage 1 based on a five year plan, with all the key processing features costed;
- the maximum capital requirements for this stage of the project has been budgeted at A$14.5 million; and
- production start-up before end of 2005.

So far, so good. But further in the prospectus, the following statement appears:

> *However, there are number of milestones for the company in achieving development of the … project:*
>
> > *the resource needs to be upgraded to minable reserve status, a short infill drilling program (approximately 2000 m at an estimated cost of $650 000) needs to be undertaken to complete a mine plan to allow production to commence;*
> >
> > *secure mining license and environmental approval for an open cut operation (estimated to take between four to six months);*
> >
> > *undertake bulk testing to assist geological modelling of resource;*
> >
> > *develop open cut mine plan model; and*
> >
> > *undertake metallurgical test work program.*

A supplementary prospectus was subsequently issued to amend, supplement and clarify the disclosures made in the prospectus, but it is apparent that the company's understanding of the term 'full feasibility' differs markedly from a 'feasibility study' that complies with the minimum standards outlined above.

The project did eventually get into production in early 2007 at a reported cost of $41 million plus working capital, but it is clear that if not for the dramatic rise in commodity prices, the actual value of the project, whose scope is essentially unchanged but which came in 12 months late and at a cost 280 per cent over the prospectus forecast, would be substantially less than the project outlined in the prospectus.

The failure to understand the purpose of early phase feasibility studies, coupled with the failure to undertake studies that are fit for purpose represents an abuse of the study process. This can lead to the creation of unrealistic and unachievable expectations of project outcomes by all project stakeholders.

CONCLUSION

In the authors' experience, feasibility studies:

- are regularly portrayed as being much more comprehensive and accurate than they are,
- are often not fit for their intended purpose, and
- tend to focus on technical issues at the expense of critical business and project delivery issues.

The poor track record of the industry – which indicates only half of projects meet their feasibility study expectations – demands a better approach to the feasibility study process. This paper set out to present:

- a case for improvements in the study process;
- a framework for the conduct of feasibility studies; and
- guidance on minimum standards and best practice to provide consistent, fit for purpose project evaluations.

The authors hope that a compelling case for improvements in study standards, management and execution has been made.

REFERENCES

Amos, Q, 2001. Resources and risk – A lender's view, in *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice* (ed: A C Edwards), p 511 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Appleyard, G R, 2001. An overview and outline, in *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice* (ed: A C Edwards), p 3 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Barnes, E, 1997. Editor's note on feasibility, in *Proceedings MINDEV '97 Conference,* p 1 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Cusworth, N, 1993. *Cost Estimation Handbook,* pp 252-259 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Guarnera, B J, 1997. Technical flaws in bankable documents, paper presented to Assaying and Reporting Standards Conference [online]. Available from: http://www.dolbear.com/Publications/PubBankable.htm [Accessed 20 January 2007].

Gypton, C, 2002. How have we done? Feasibility performance since 1980, *Engineering and Mining Journal*, 1 January.

HISMELT 2007. HISMLET web site [online]. Available from: http://www.hismelt.com.au/EN/HT_PageView.aspx?pageID=3 [Accessed 20 January 2007].

Johnson, R C and McCarthy, M R, 2001. Essential elements and risks in bankable feasibility studies for mining transactions [online]. Available from: www.pdac.ca/pdac/publications/papers/2001/pdf/Johnson(T-17).pdf [Accessed 9 January 2007].

Joint Ore Reserves Committee of The Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia (JORC), 2004. *The JORC Code* [online]. Available from: http://www.jorc.org/pdf/jorc2004web.pdf [Accessed 12 January 2007].

Kuestermeyer, A, 2002. Minimum requirements for feasibility studies, *Pincock Perspectives* 34(September) (Pincock, Allen & Holt: Lakewood, Colorado).

Laird, A M, 2001. How to develop a project, in *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice* (ed: A C Edwards), p 21 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Lawrance, A, 1997. Pre- and post-development audits, in *Proceedings MINDEV '97 Conference,* pp 145-152 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Maslin, W J, 2003. Risk management practices at Solid Energy New Zealand Limited, in *Proceedings Mining Risk Management Conference,* pp 135-146 (The Australasian Institute of Mining and Metallurgy: Melbourne).

McCarthy, P L, 2004. New mining projects — Expectations and outcomes in *Proceedings PACRIM 2004 Conference,* pp 57-61 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Nice, R W, 2002. Ramp-up times – Why are they never properly considered? Paper presented to ALTA 2002 Ni/Co Conference, Perth.

Noort, D J and Adams, C, 2006. Effective mining project management systems, in *Proceedings International Mine Management Conference,* pp 87-96 (The Australasian Institute of Mining and Metallurgy: Melbourne).

Ontario Securities Commission, 2005. National Instrument 43-101 Standards of Disclosure for Mineral Projects [online]. Available from: http://www.osc.gov.on.ca/Regulation/Rulemaking/Current/Part 4/rule_20051223_43-101_mineral-projects.pdf [Accessed 19 January 2007].

Pointon, C, 2004. Ravensthorpe Yabulu Integrated Nickel Project teleconference [online]. Available from: http://www.bhpbilliton.com/bbContentRepository/Presentations/Full230304.pdf [Accessed 18 January 2007].

Shillabear, J H, 2001. Lessons learned preparing mining feasibility studies, in *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice* (ed: A C Edwards), p 435 (The Australasian Institute of Mining and Metallurgy: Melbourne).

United Nations Economic Commission for Europe, 2004. United Nations Framework Classification for Fossil Energy and Mineral Resources [online]. Available from: www.unece.org/ie/se/pdfs/UNFC/UNFCemr.pdf [Accessed 23 January 2007].

VALMIN Committee, 2005. *The Valmin Code* [online]. Available from: http://www.ausimm.com.au/codes/valmin_2005.pdf [Accessed 15 January 2007].

Vancas, M F, 2003. Feasibility studies: Just how good are they? in *Proceedings Hydrometallurgy 2003 – Fifth International Conference in Honor of Professor Ian Ritchie – Volume 2: Electrometallurgy and Environmental Hydrometallurgy* (eds: C A Young, A M Alfantazi, C G Anderson, D B Dreisinger, B Harris and A James), pp 1407-1413 (The Minerals, Metals & Materials Society: London).

West, R, 2006. Preliminary, prefeasibility and feasibility studies, in *Australian Mineral Economics* (eds: P Maxwell and P Guj), pp 113-128 (The Australasian Institute of Mining and Metallurgy: Melbourne).

White, M E, 2001. Feasibility studies – scope and accuracy, in *Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice* (ed: A C Edwards), p 421 (The Australasian Institute of Mining and Metallurgy: Melbourne).

CAPITAL INVESTMENT SYSTEMS
MAKING THE RIGHT INVESTMENT DECISIONS

Neil Cusworth
Managing Director
Enthalpy Pty Ltd

INTRODUCTION

Investment decisions to develop or acquire new capital assets should be made on complete information evaluated via a feasibility process. By necessity the information is never final, hence due to this uncertainty, no investment decision is without risk.

What is at issue is that the systematic evaluation processes used, and the definition standards to be achieved, should ensure the evaluations are complete and to a known quality.

During the 90's and even more recently, the media have reported on a number of large projects and acquisitions that could only be described as technical and economic disasters. These well publicised investments destroyed shareholder value and resulted in challenges to Boards and Management of many resource companies.

Capital Investment Systems incorporating defined processes and standards have now evolved to meet these challenges.

This paper sets out the experiences of Neil Cusworth, Managing Director of Enthalpy, relating to the Best Practices now being used or developed to make Capital Investment decisions.

CONTEXT

The costs and efforts needed to define any new capital asset development or acquisition utilise the resources available from shareholders' investments. If the intended development or acquisition proceeds, then the investigation costs add to the costs of the new development or acquisition. Alternatively, if the intended development or acquisition does not proceed, then the shareholders' funds are lost or reduced in value.

Yet to grow or sustain a business, investments must be made. The challenge then is to decide how much of shareholders' funds should be put at risk, prior to the investment decision, in seeking to define the investment. The alternative is to take higher risks during the delivery of the development project or purchase of the existing business or asset.

Over the past fifteen years too many examples of investment decisions which did not deliver the promised values have been witnessed in the resource and industrial sectors. Two fundamental aspects underlie such unfavourable outcomes:

(a) The investment decisions were made on flawed or inadequate evaluations; or
(b) The new project developments or acquisitions were not delivered to the evaluations made; or
(c) Both (a) and (b) occurred.

Failures in successfully delivering new projects or acquiring assets or businesses are the subject of continual developing skills, with this paper focusing on the first of these issues.

THE CAPITAL INVESTMENT PROCESS

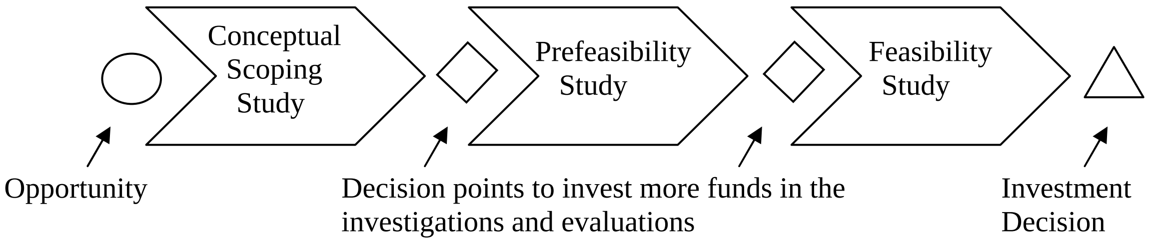
For any shareholder to agree to put funds at risk, an evaluation of the costs and risk reward must be made so that an informed decision can be made. The evaluation then becomes the determinant as to the level of risks and the accuracy of the forecast of outcomes.

The logic is clear. More shareholder funds spent evaluating an investment will normally result in a greater level of accuracy. The questions then become how much to invest, and how to go about the process, to get a defined quality of decision making information.

Phased Approach

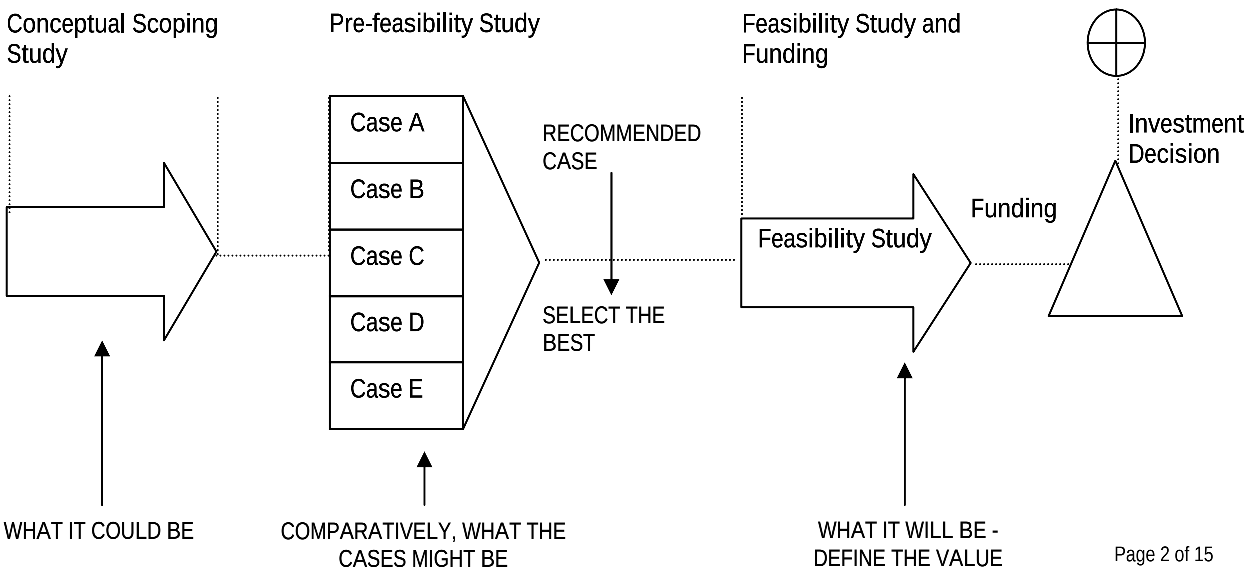
Experience has shown Best Practice to be to adopt a phased, step-by-step approach to the evaluation of potential investments so as to control the amount of shareholders' funds put at risk during the investigations. This ensures that, should any potential investment not show signs of viability, the investments can be terminated at minimum loss.

The resource sector typically uses phases of:



Each phase has different objectives as well as degree of effort needed to achieve the quality of definition of the investment parameters.

The representation of Best Practice for these objectives is:



Later in this paper, the objectives of each phase will be described in more detail, as Principles of Best Practice.

Integrated Evaluation of Capital Investment Opportunities

Over the 90's the industry learnt that evaluations of new Capital projects and acquisitions had to be reset from 'technically orientated' to 'whole of business' considerations.

Now, feasibility processes must include and consider issues of safety, health, community, sustainability, risk and management as much as production, products and economics.

This has in turn forced a change in the approach to feasibility evaluation if the full balance of business investment criteria is to be considered.

Standards of Evaluations

Since the 1960's, various standards existed which gave guidelines as to the standards of definition needed for evaluations in each phase of the process of capital investment.

Many of these standards were developed by the major Engineering Contractors to define what type and quality of Engineering Deliverables were needed to achieve capital cost accuracy levels. These guidelines still exist and are in use by Owners and Engineers.

By the early 90's, these standards proved to be inadequate to address Owner and Investor standards in areas other than Capital Costs. The Australasian Institute of Mining and Metallurgy responded in 1993 with a Cost Estimating Handbook for the Mining Industry which proposed quality and content definition for resource feasibility studies. This began the process of including Standards for evaluation including environment, operating costs, implementation, marketing, etc.

Since then, more development has been needed so that standards of evaluation are available to cover business factors now impacting the integrated evaluation process.

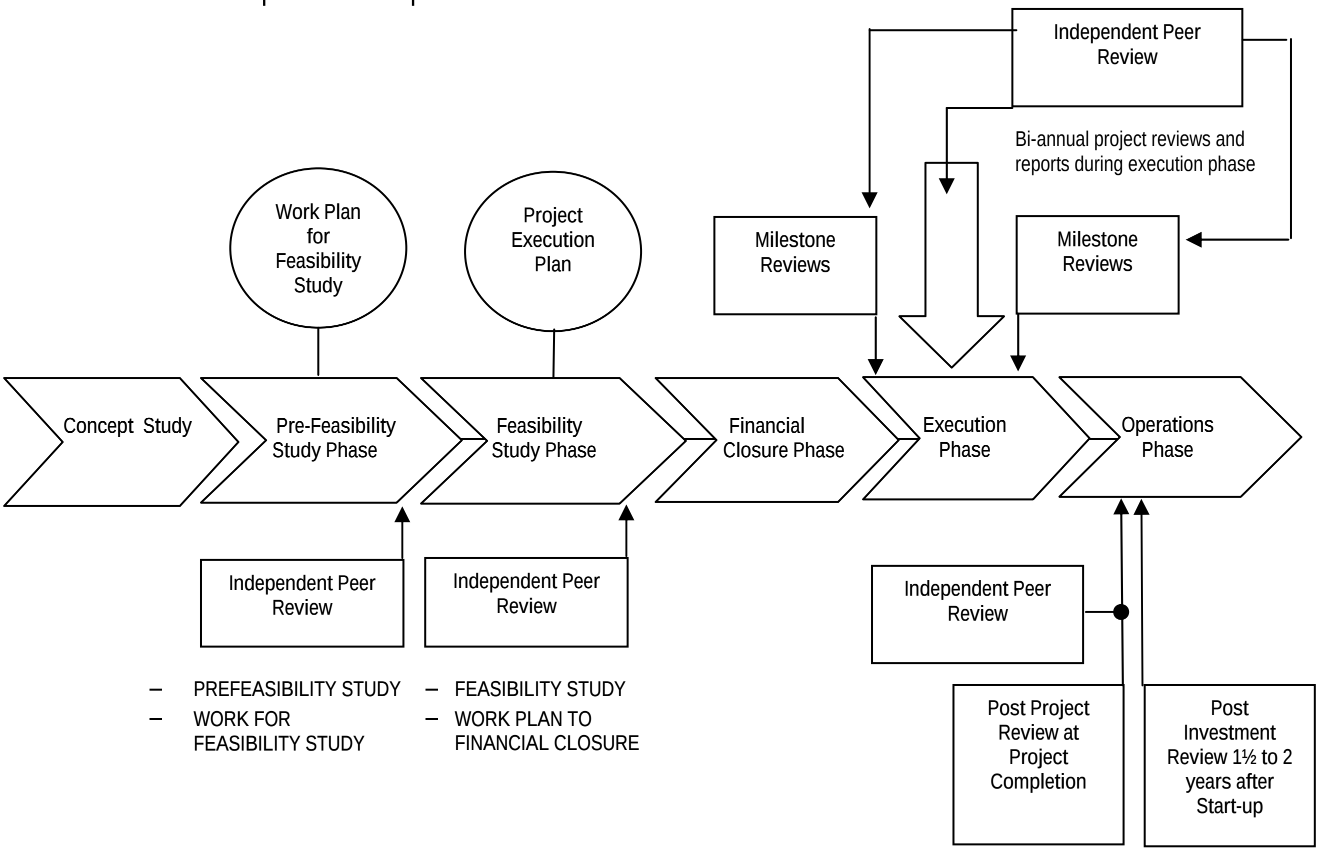
These Standards are described further below.

Quality Assurance

The Capital Investment Process is driven towards the representatives of shareholders or stakeholders, such as Lenders, making informed decisions to commit funds to new business ventures. Yet most Boards either do not have the technical skills or resources to ensure that investment recommendations necessarily cover all aspects and that evaluations have reached acceptable and defined standards.

The result is that a process of Independent Peer Review has been developed to create the contestable advice needed for Boards and for Lenders.

This Peer Review process is represented as follows:



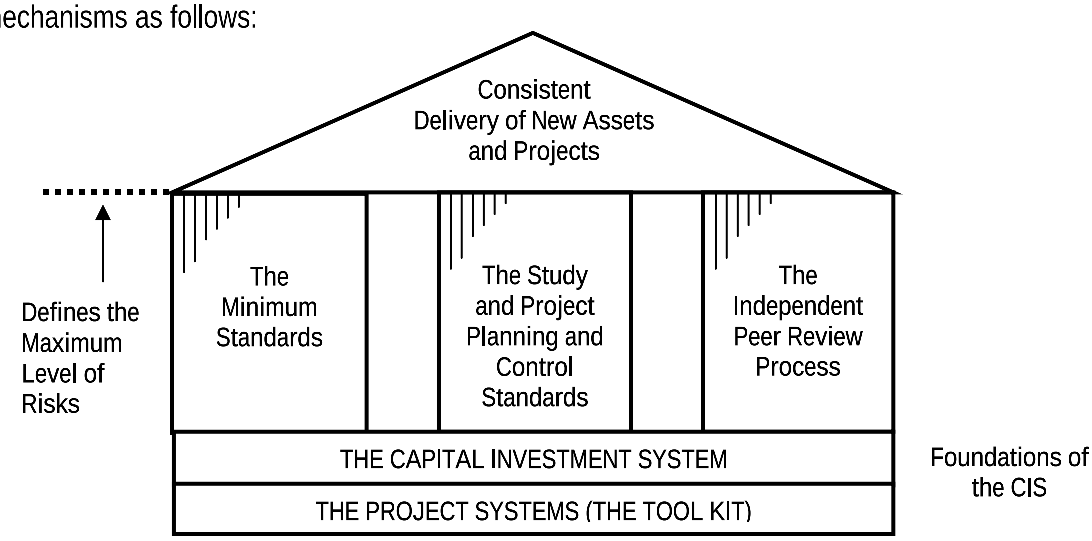
Planning and Control

The ability to reliably deliver the evaluations of opportunities for investment decision, and then to be capable of achieving the planned outcomes via project implementation or business acquisition, is dependent on planning and control.

Only through planning and control techniques can forecasts become reality. Therefore a minimum standard of planning and control must be exercised through the feasibility study evaluation process.

Structure of the Capital Investment Process

The structure of the Capital Investment Process is dependent on three primary management mechanisms as follows:



If any one of these structures proves to be inadequately defined or poorly implemented, then the Capital Investment Process can be put at risk (making inappropriately based investment decisions likely).

Major companies in the resource sector all use to varying extents these three management processes. However many do not define the Minimum Standards to be achieved for the quality of evaluations and studies, rather they adopt guidelines or lower level check lists of content.

This is a major failure as effectively the shareholders do not define the quality to be achieved and needed for their investment decisions. In such cases Management, in effect, is delegating a critical corporate governance standard to project or operating level.

Enthalpy has created a structure which captures all these aspects in one system. (Refer Appendix A)

PRINCIPLES OF CAPITAL INVESTMENT

Over the last 15 years of internal development, reviews, or observations of Capital Investment Systems ("CIS") in use with major resource companies, certain fundamental principles have been identified, as follows:

Principle 1	CIS Policy comes from the Board and the President / CEO. It is a statement of the shareholders' representatives to management.
Principle 2	The Policy should authorise Standards, Processes and Procedures. Only the shareholders' representative can change the standards.
Principle 3	The CIS Policy in relation to other Policies must be stated and integrated with all the business policy streams of the business.
Principle 4	Investment Decisions should only made based on recommendations complying with the CIS. If not complying, the Board should reject.
Principle 5	The processes of developing a new Capital Asset and acquiring an existing Asset or Business are the same. Acquisitions need the same rigour, only done faster.
Principle 6	The CIS must ensure that alternatives are considered. The value-add comes from this phase, no other.
Principle 7	A phased approach should be used in a controlled, step-by-step process, ensuring known levels of investment funding is at risk.
Principle 8	Consistent Reporting and Comparisons of Opportunities is needed, with ability to compare opportunities within a portfolio of possible investments.
Principle 9	Risks must be identified, defined and mitigation steps planned. Risk management must be used proactively to get the balanced risk to reward during the evaluation process.

Principle 10	All major investment decisions, outcomes and forward plans are subject to Independent Peer Reviews. Boards cannot be expected to get into detail, and need independent eyes and ears of their own.
Principle 11	The role of Project Teams must be clearly stated, well planned and adequately resourced to deliver the planned outcomes.
Principle 12	Assessment Effort and Quality Levels must be appropriate. Inadequate levels of definition at study phase is one of the major causes of project failure.
Principle 13	The Portfolio Management System must be part of the overall CIS process.
Principle 14	The CIS requires Benchmarking to be practiced. An extra or new approach is required to beat history – with knowledge of the past the first step in demonstration.
Principle 15	The CIS requires Post Project and Post Investment Reviews, as only from Lessons Learnt can improvements be made.
Principle 16	Work Plans and Project Execution Plans ensure planning is made a key to project success.
Principle 17	Ownership of the CIS must come from the shareholders, not just management.
Principle 18	Capturing Best Practices is the only way to learn the good aspects, and to improve the deltas.
Principle 19	Continuous Improvement is a must for an organised process to get positive benefits.
Principle 20	Accessibility and Transparency means lessons and improvements are available to everyone and able to be challenged.

MINIMUM STANDARDS

Minimum Standards refer generically to the content, quality and accuracy that <u>must</u> be achieved at each phase in the investment evaluation process. Rather than guidelines or check lists, Minimum Standards set criteria which <u>have to be exceeded</u> if the degree of confidence in risk allocation and assessment is to reach the requirements of the shareholders.

Content

Minimum Standards should define the content to be covered in any evaluation of an investment opportunity. It should not be optional whether a Feasibility Study evaluates, or not, issues that must be considered mandatory criteria by shareholders. Regardless of the size, type or complexity of any project or acquisition, each business driver needs to be investigated and the forecast outcomes defined. Therefore, Minimum Standards should be declared which set the contents of Feasibility Study reports, similar to the following.

The summary level Table of Contents of a typical resource project Feasibility Study Report is:

1. Summary & Recommendations
2. Development Approach
3. Risk
4. Safety
5. Environment
6. Geology & Mineral Resource
7. Mining & Ore Reserves
8. Mineral Processing
9. Waste Management
10. Infrastructure
11. Human Resources
12. Information Technology
13. Project Execution
14. Operations
15. External Relations
16. Capital Costs
17. Operating Costs
18. Marketing
19. Ownership & Legals
20. Commercial
21. Financial Analysis
22. Funding
23. Status of Studies
24. Work Plan – Future

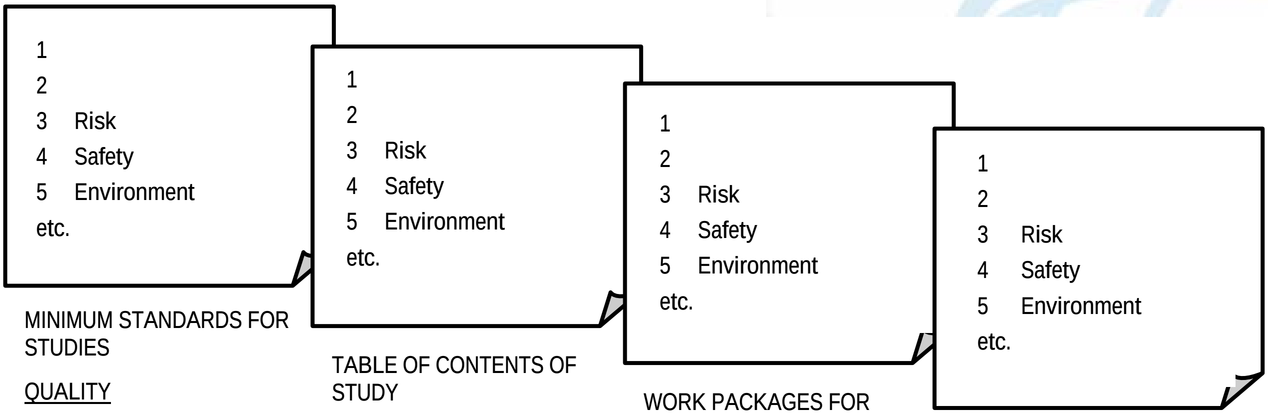
This content has evolved from the technical, project orientated version of the early 90's into a Business based evaluation structure.

Hurdle issues such as Risk, Safety and Environment have been brought forward so as to give the emphasis now needed for demonstration of the sustainability of a business. A focus has been added on human resources, external relations, ownership and legals, which previously were dealt with outside the evaluation process.

Importantly, Studies should now integrate and report on the plans for the next step in development by presenting matters such as Status and Work Plans for the future.

Another advancement made has been the development of a common order of contents between the Minimum Standards, the contents of Study Reports, Work Packages for control purposes and then the Deliverables produced.

This order (refer below) helps create a consistent pattern across every phase of multiple studies.



MINIMUM STANDARDS FOR STUDIES

QUALITY

TABLE OF CONTENTS OF STUDY

CONTENTS

WORK PACKAGES FOR STUDY PHASES

SCOPE

DATA ROOM CONTENTS – DOCUMENTATION CODING, ETC.

DELIVERABLES

Quality

The quality of definition to be achieved at each phase is driven off the objectives needed for decision making. For each phase the Minimum Standards are proposed to be:

<u>Conceptual – Scoping Studies</u> - shall be structured to identify:

- The <u>potential</u> of the new or expanded business
- The general features of the project
- The order of magnitude of costs of the project (both capital and operating)
- Technical issues needing to be further investigated or testwork conducted
- The costs and time to undertake further development work before a prefeasibility study can be commenced.

<u>Prefeasibility Studies</u> - shall be structured to:

- Assess the likely technical and economic viability of the project
- Consider different mining, process, location and project configurations to determine and recommend the preferred optimum for final study
- Consider different capacities for the project to determine and recommend the preferred optimum for final study
- Outline the features of the project
- Determine the nature and extent of further geological, mining, metallurgical, environmental and marketing work needed to be completed prior to, or during, the final feasibility study
- Determine the costs and time to complete this work, and to develop the project following completion of a feasibility study
- Determine if there may be any fatal flaws in the potential project.

Feasibility Studies - shall be structured to:

- Demonstrate the technical and economic viability of the project
- Provide the basis for making an investment decision
- Clearly recommend one mining, processing, location and project configuration, all in the most optimum form possible
- Be capable of being audited by third parties
- Prevent the need to be materially varied after project commitment
- Have sufficient trackability and data so as to act as the Control Baseline for the project
- Set the basis of implementation and timing for both the Business establishment and the Project Execution Phases.

For each area of a Feasibility Study the Minimum Standard to be achieved during each phase needs to be defined.

Two 'part examples' of the Minimum Standards for Project Execution for both a Conceptual – Scoping Study and Feasibility Study (part only) are presented.

(a) Conceptual – Scoping Study

NO.	ISSUE	STANDARD
13.1	Scope	The physical scope of the project must be stated along with the resultant trials and output assumptions.
13.2	Work Breakdown Structure (WBS)	A preliminary WBS for the project shall be prepared and utilised to produce a structure for the project costs to Level 2 as a minimum.
13.3	Contracting Strategy	Broadly identify the various contracting strategies that could be utilised to deliver the project and which select or nominate to support the basis of factorised estimates for indirect costs.
13.4	Project Organisation	The Project Organisation for implementation of the project shall be broadly addressed including the general type of structure, and joint venture arrangements etc. which might be employed.
13.5	Project Health, Safety and Security	Identify key or special health, safety and security issues that will require management during the Execution phase of the project.
13.6	Planning and Scheduling	The preparation of a Level 2 schedule showing all the major activities during the subsequent studies and commitment to implementation and start-up of the project. Structured generally in accordance with the Work Breakdown Structure. Critical path identified by judgement only.
13.7	Engineering	An approach to Engineering, including the requirements for specialist input, the application of new technologies and the engineering resources required for the subsequent Study and Execution phases should be noted.
13.8	Procurement and Contracts	Key items of equipment with long lead times or critical technology issues should be identified including potential manufacturers and suppliers. Major contracts that need to be let in the implementation phase shall be identified in outline only.

NO.	ISSUE	STANDARD
13.9	Construction	The broad approach to construction, industrial relations, labour resources, logistics and specific construction issues should be presented.

(b) Feasibility Study (part only)

NO.	ASPECT	STATEMENT REQUIRED
13.1	Mission Statement	A clear and simple statement of the project and business objectives.
13.2	Scope	The physical scope of the project must be defined and referred to a control baseline. Change control procedures to be utilized shall be identified for scope, cost and time.
13.3	Criteria	Key performance indicators (KPI's), control quantities, product specification and quality standards to be achieved, shall be defined.
13.4	Work Breakdown Structure (WBS)	A WBS for the project shall be declared and utilized to produce an integrated control and reporting standard for the proposed project costs and the Project Schedule.
13.5	Approach	The Project Execution approach and the Project procedures to be used shall be defined in the approach outlined in the Feasibility Study.
13.6	Contracting Strategies	The contracting strategies for the project shall be developed and presented in the Feasibility Study, with the approach and responsibility for implementation outlined.
13.7	Risk Management	The risk management programs, approach and resources to be implemented within the Project Execution phase should be presented.
13.8	Project Organisation	The Project Organisation for implementation of the project shall be addressed including the type of structure, joint venture arrangements, and the changes that occur between the set-up, mobilization, implementation and commissioning phases.
13.9	Project Occupational Health, Safety and Security	A Project Occupational Health, Safety and Security Plan shall be outlined. Objectives shall be set with reference on how they will be achieved, the resources and systems needed, reporting and control techniques.

Accuracy

The accuracy of Capital and Operating Cost estimates is a subject not yet to the stage of an absolute. The definition of accuracy remains an imprecise art form, but is now advancing.

What a Best Practice Capital Investment System must have is a definition of the Minimum Standards to be met, which then targets the work needed to be done to derive a reasonable level of confidence in the accuracy of cost estimates.

What has been learnt in recent years is that any investment decision depends on Operating Cost Estimates as much as Capital Costs. Therefore, work has been done to advance the accuracy assessments in this area.

Appendix B provides the Accuracy Guidelines developed by the author in pursuit of this endeavour.

IMPLEMENTING A CAPITAL INVESTMENT SYSTEM

Lessons from the development of Capital Investment System processes and then the application within some major resource groups, indicates that the endorsement by executives of a company of a complete CIS is critical to its eventual success. The process must be top-down driven from the Board and Executives.

The depth of experience and training in project management skills will have an influence on the level of success in the investment development phases. Not all project personnel are equipped to evaluate investment opportunities.

Every Company needs to challenge its current investment processes, systems and skill levels if it is to be developing projects to lowest cost and avoiding disasters of the past. How the Capital Investment System is organised within the corporate structure will be critical to the success or otherwise.

CONCLUSIONS

The Capital Investment System and Processes used by a Company are critical to the competitive edge of any business. Every year, the demands for greater effectiveness from shareholder funds will increase as this is a natural evolution found in business.

For this to happen lessons must be learnt continually and improvements made, as recent lessons show the importance and benefits of having in place well defined processes, structures and minimum standards.

Why have a Capital Investment System?

A defined Capital Investment System will increase shareholder confidence when making investment decisions, while yielding a reduction in project disasters (never assume the system will totally eliminate).

The processes and structures will lead to improvements in the cost effective use of development funds, and give consistent management and more disciplined decisions.

Finally:

- One bad project can destroy the investment benefits of ten good projects.

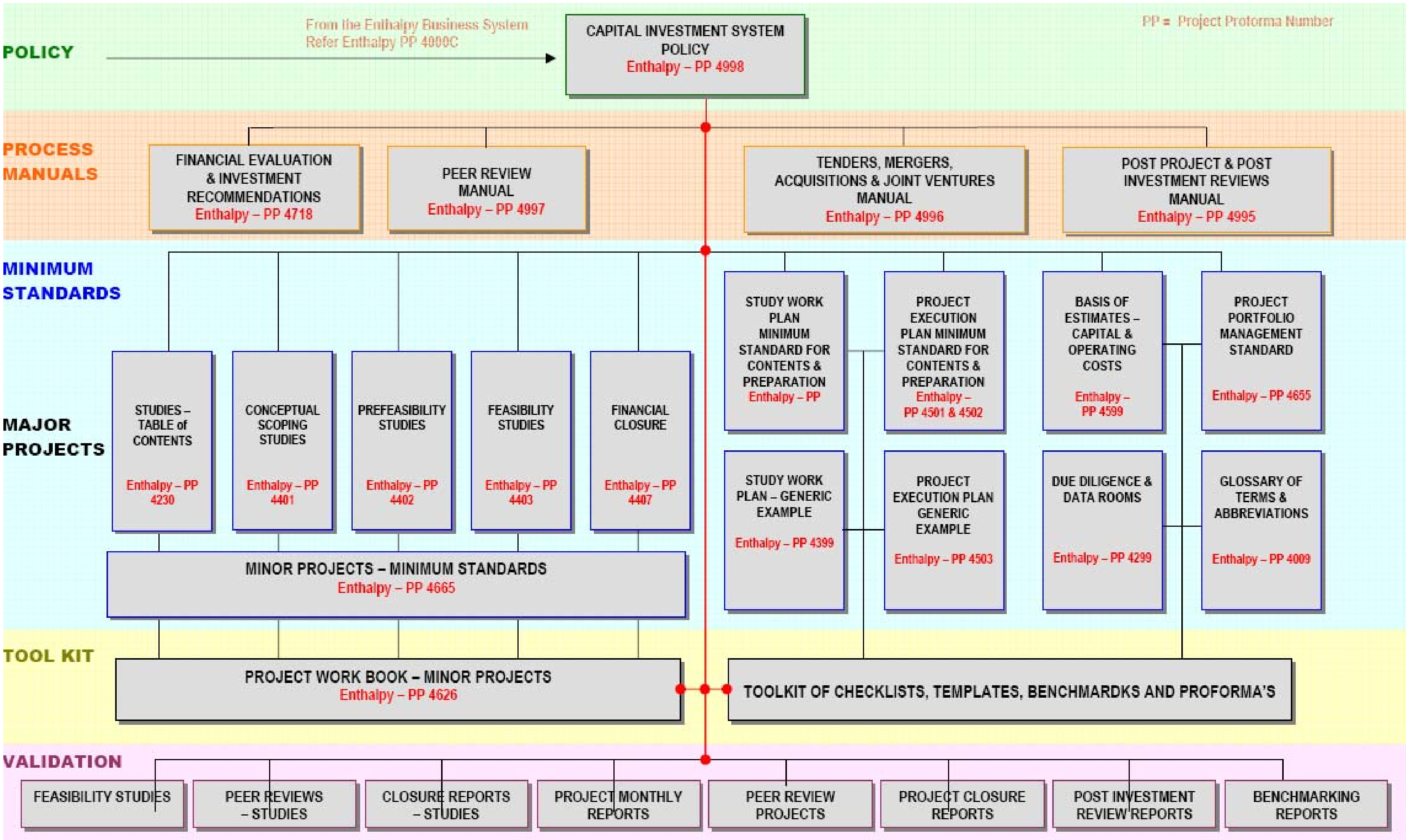
- A Capital Investment System has such a low cost to establish and it is insignificant relative to the reduction in risks.

- A good process and structure will see better use of shareholder funds at risk in the development cycle.

- In the end, to stay competitive, and to ensure the correct investment decisions are made, every investment must be made to Best Practice.

APPENDIX A *

Enthalpy has created a structure which captures all these aspects in one system, as follows:



* As revised May 2006

APPENDIX B - Accuracy Guidelines

A - CAPITAL COST ESTIMATES

Estimate class	Scoping - Conceptual Study - Phase 1	Pre-feasibility Study - Phase 2	Feasibility Study – Phase 3 and Investment Decision	Execution Phase 4 – Definitive Estimate
CAPITAL COST ESTIMATES BASIS:				
A1 - Mining Costs:				
Resources/Reserves Status	Indicated	Probable	Proven/Probable	Proven/Probable
Resource/Reserve Analysis	Limited Data	Cross Sections	Detailed Block Model	Detailed Block Model
Geology	Preliminary	Preliminary	Detailed	Detailed
Geotechnical	Preliminary	Preliminary	Detailed	Detailed
Mine Plan	Sketch Only	Preliminary	Firm detailed - General optimised	Final for Year 1 and Firm thereafter
Mine Schedule	Assumed	Approximated	Calculated – Detail	Final for Year 1 and Firm thereafter
Mine Equipment	Assumed	In house data	Optimised	Quoted Specifically
Mine Services	Assumed	Sketch design	Full Outlines	Firm basis
A2 - Capital Cost Estimating Methodology:				
Direct Costs:				
Equipment Quotes Supply	None – factorised	Single check price	Multiple quotes	Fixed Prices
Civil/Structural Material Supply	Sketched only	Take-off sketch	MTO & Quotes Benchmarked	Tender Prices
Mechanical/piping and Construction	% of key equipment	Mix of MTO's and factors	MTO's & Hours to actual	Tender Prices
Electrical/Instruments	$ per kw	$ per kw	MTO's & Hours data	Detailed Estimates or Tender Prices
Information Systems / Control Systems	% of total budget	% of total budget	Mix of calculated and multiple quotes	Firm and Tender Prices
Labour Rates		Current best information	Current quotes	Actual
Labour Productivity	Not Applicable – included in factorisation	Assumed	Evaluated	Evaluated
Construction Equipment		$ / Hr	$ / Hr	Quotes
Indirect Costs:				
EPCM and other Services and Temporary Facilities	% per total	% of total	Calculated	Calculated
Owners Costs:				
Management Services, Commissioning, Preproduction, Contingency and Provisions	% per total	Calculated – Preliminary	Calculated – Detailed	Calculated and firm quotes
Contingency Amount	Typically 20 to 25 %	Typically 15 to 20%	Typically 10 to 15%	Typically 5 to 10%

CAPITAL COST ESTIMATES - CONTINUED

Estimate Class A3 - ESTIMATE CLASS	Scoping - Conceptual Phase 1	Pre-Feasibility Study – Phase 2	Feasibility Phase 3 & at Investment Decision Point	Project Execution Phase 4- Project Control or Definitive Estimate
Level of Definition (expressed as a percentage of complete engineering and project definition using appropriate indicators ie % of EPCM, % of Engineer)	1% to 2% of full project definition	10% to 15% of full project definition	10% to 25% of full project definition	40% to 60% of Full Project Definition
Typical Accuracy Range	± 30 to ± 35%	± 20 to ± 25%	± 10 to ± 15%	± 5 to ± 10%
Quotations / Tenders - Supporting the Estimates	None - Benchmark Data	Equipment Quotes and benchmark material supply and construction rates.	Multiple firm equipment quotes. Multiple material supply and construction quotes and rates checked.	Equipment on order, tendered or firm quotes available. Tenders for Material Supply and Construction costs. Some contracts awarded.
A4 - General Project Data needed to support the Estimate Class:				
Project Scope Description	General	Preliminary	Defined	Defined
Soils and Hydrology Report	Assumed	Preliminary	Defined	Defined
Integrated Project Plan (Mine & Plant)	General	Approximate	Specific	Specific
Contracting Strategy - Implementation	Assumed	Outline	Defined and Optimised	Defined and Detailed
Project Master Schedule - Implementation	Outline	Preliminary Bar chart	Detailed and Resourced Critical Path	Actual to Date, Detailed and Resourced To Go Critical Path.
Project Master Schedule - Commissioning and Ramp-up	Assessed	Outlined	Detailed Critical Path	Detailed and Resourced Critical Path
Work Breakdown Structure	Outline	Preliminary	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined
Foreign Exchange Strategy	None	Preliminary	Defined	Defined
Contingency	Assessed / Factorised	Calculated	Detailed Calculation and Analysis	Detailed Calculation on the To Go
Accuracy	Assessed by Judgement	Evaluated	Detailed Analysis - Monte Carlo	Detailed Analysis - Monte Carlo
Basis of Estimate and Methodology Statement	Outline	Preliminary	Complete	Complete
A5 - Engineering Deliverables:				
Block Flow Diagrams	Started / Preliminary	Preliminary / Complete	Complete	Complete
Process Flow Diagrams	Possibly Started	Started / Preliminary	Preliminary / Complete	Complete
P&ID's	None	Started	Preliminary / Complete	Complete
Heat & Material Balances	None Likely	Started	Preliminary / Complete	Complete
Design Criteria	Outline	Preliminary	Preliminary / Complete	Complete
Overall Site Plan	Sketch (Possible)	Started	Preliminary / Complete	Complete
Plot Plans	None	Started / Preliminary	Preliminary / Complete	Complete
Process/Mechanical Equipment List	Started / Preliminary	Started / Preliminary	Preliminary / Complete	Complete
Electrical Equipment List	None	Started / Preliminary	Preliminary / Complete	Complete
Specifications and Datasheets	None	Started	Preliminary / Complete	Complete
GA Drawings by Facility/Area	None	None	Preliminary / Complete	Complete
Mechanical / Piping Discipline Drawings	None	Started	Preliminary / Complete	Preliminary / Complete
Civil / Structural Discipline Drawings	None	Started	Preliminary / Complete	Preliminary / Complete
Electrical Single Line Diagrams	None	Started / Preliminary	Preliminary / Complete	Complete
Electrical Discipline Drawings	None	Started	Started	Preliminary / Complete
Instrumentation & Control Discipline Drawings	None	None	Started	Preliminary / Complete
Information Systems	None	Started / Preliminary	Preliminary / Complete	Complete
Information Systems Plan, as per PEP	None	Started	Preliminary / Complete	Complete
Spare Parts Listings	None	Started	Started / Preliminary	Complete
Environmental	Assessed only	Preliminary Study	EIS underway & may be nearing completion	EIS Complete
Cash Flow	None needed	Preliminary- annual	Detailed – Quarterly and Monthly	Updated monthly

B - OPERATING COSTS

OPERATING COST ESTIMATES				
Estimate Class	**Scoping – Conceptual Study Phase 1**	**Prefeasibility Study Phase 2**	**Feasibility Study Phase 3 and Investment Decision**	**Execution Phase 4 - Definitive Estimate**
B1 - Operating Cost Estimate Methodology:				
Basis of Estimate and Methodology Statement	Outline	Preliminary	Complete	Complete
Staffing Levels	Factorised	Preliminary	Detailed Estimate	Known
Cost Rates	Factorised	Calculated	Known basis	Known
Consumables	Factorised	Factorised	Estimated	Estimated - Detailed
Maintenance	Factorised	Factorised	Estimated	Estimated - Detailed
Spares	Factorised	Factorised	Estimated	Some quotes
B2 - Operating Costs:				
Labour Rates	Assumed average	Separate categories	Detailed Review	Detailed Review and updated to Actuals
Labour Burden	Assumed average	Calculated	Calculated	Calculated and updated to Actuals
Power & Water Costs	Data bank	Preliminary Calculations	Detailed Calculations	Detailed Calculations and updated to Actuals
Fuel Costs	Data bank	Budget Quotes	Firm written quotes	Firm written quotes and updated to Actuals
Expendable Supplies & Reagents	Data bank	Budget Quotes	Firm written quotes	Firm written quotes and updated to Actuals
Transport and Logistics	factored % of total estimate	Preliminary Calculations	Quotes and Calculations	Detailed Calculations and Quotes
B3 -Post Commissioning:				
Working Capital	factored % of total estimate	Preliminary Calculations	Detailed Calculations	Detailed Calculations
Sustaining / Replacement Capital / Improvement Capital	Factorised %	Factorised %	Detailed Calculations	Detailed Calculations and updated to Actuals
Business Systems (core and support systems, e-commerce, business management, office, etc)	factored % of total estimate	Preliminary Calculations	Detailed Review	Detailed Review and updated to Actuals
Training	factored % of total estimate	Preliminary Calculations	Detailed Review	Detailed Review and updated to Actuals
Ramp Up	factored % of total estimate	Preliminary Calculations	Detailed Review	Detailed Review and updated to Actuals
Insurances	factored % of total estimate	Budget Quotes	Firm written quotes	Firm written quotes and updated to Actuals
Escalation	factored % of total estimate	Preliminary Calculations	Detailed Review	Detailed Review and updated to Actuals
Foreign Currency Provisions	factored % of total estimate	Preliminary Calculations	Detailed Review	Detailed Review and updated to Actuals
Accuracy	±15 to 20%	±10 to 15%	±5% to ±10% (more to ±5%)	±5% or better

General Notes: Although this Cost Estimate Guideline defines the classes of Estimates, the classes should not be considered absolute levels to be complied with in all categories of costs to achieve a certain class.
Similarly, a particular class of estimate for Capital Costs may be met, but for demonstrable reasons the Operating Cost Estimates may achieve a different class of estimate.
The lowest class of estimate achieved for any area should decide the overall class achieved.
Should one or more individual categories of costs not achieve the stated levels, but other categories exceed the stated level, then the overall class in that area may be achieved.
The quality of definitions and accuracy of the estimates shall be the determinates of the Class of Estimate achieved by the end of a defined Phase of activities.

Terms Used:

None = work on development of deliverable has not begun, or is only conceptual in nature.
Started = work on deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion, may be sufficient to indicate, but not define the scope.
Preliminary = work on deliverable is advanced. Interim, cross functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals. Sufficient to define scope and major sizes and locations to allow MTO's to be prepared.
Complete = deliverable has been reviewed and approved. Sufficient to define scope and quantities to allow trackable MTO's to be prepared and quotations obtained.
Assumed = based on non-demonstrable experience.
Approximate = sketch or similar based on assumed or assessed data.
Outlined = primary features or dimensions shown.
Calculated = Utilising inputs, derive sizes or features on a trackable basis.
Defined = outline able to be aligned to a specific engineering or other deliverable.
Assessed = based on judgement of benchmarks.
Factorised = proportioned from previous cost data.

Enthalpy

CAPITAL INVESTMENT SYSTEM

Introduction to the
Enthalpy Capital Investment System

Enthalpy and the CIS

- Developed by Enthalpy over the last 20 years
- Used by our teams to deliver results
- Implemented and tailored for our clients
- Continuously improved
- Enthalpy system benchmarked as good industry practice by IPA (2005)

Enthalpy systems are well known to major engineers, project debt and equity providers

Enthalpy's CIS Clients

- Billiton
- BHP Billiton
- Codelco
- Barrick Gold
- Falconbridge
- Stanwell Corporation
- Solid Energy (NZ) (Review of CIS Process)
- Ensham Resources
- ZeroGen
- Oil Search (Review of CIS Process)
- Norilsk Nickel
- Cliffs Asia Pacific
- Gladstone Ports Corporation
- Asia Iron
- Lundin Mining
- OZ Minerals
- Mitsubishi Development
- API JV

Successful Project?

What is the probability of a successful outcome?

- 50% of projects overrun budget
- 50% of projects overrun schedule
- 25% of projects are delivered inside both budget and schedule

What is the CIS?

A methodology for achieving the successful delivery of investment outcomes

- System for investigating, recommending and executing capital investments
- Uses principles and processes widely accepted throughout mining industry and project management
- Defines the standard for studies, projects and commercial transactions

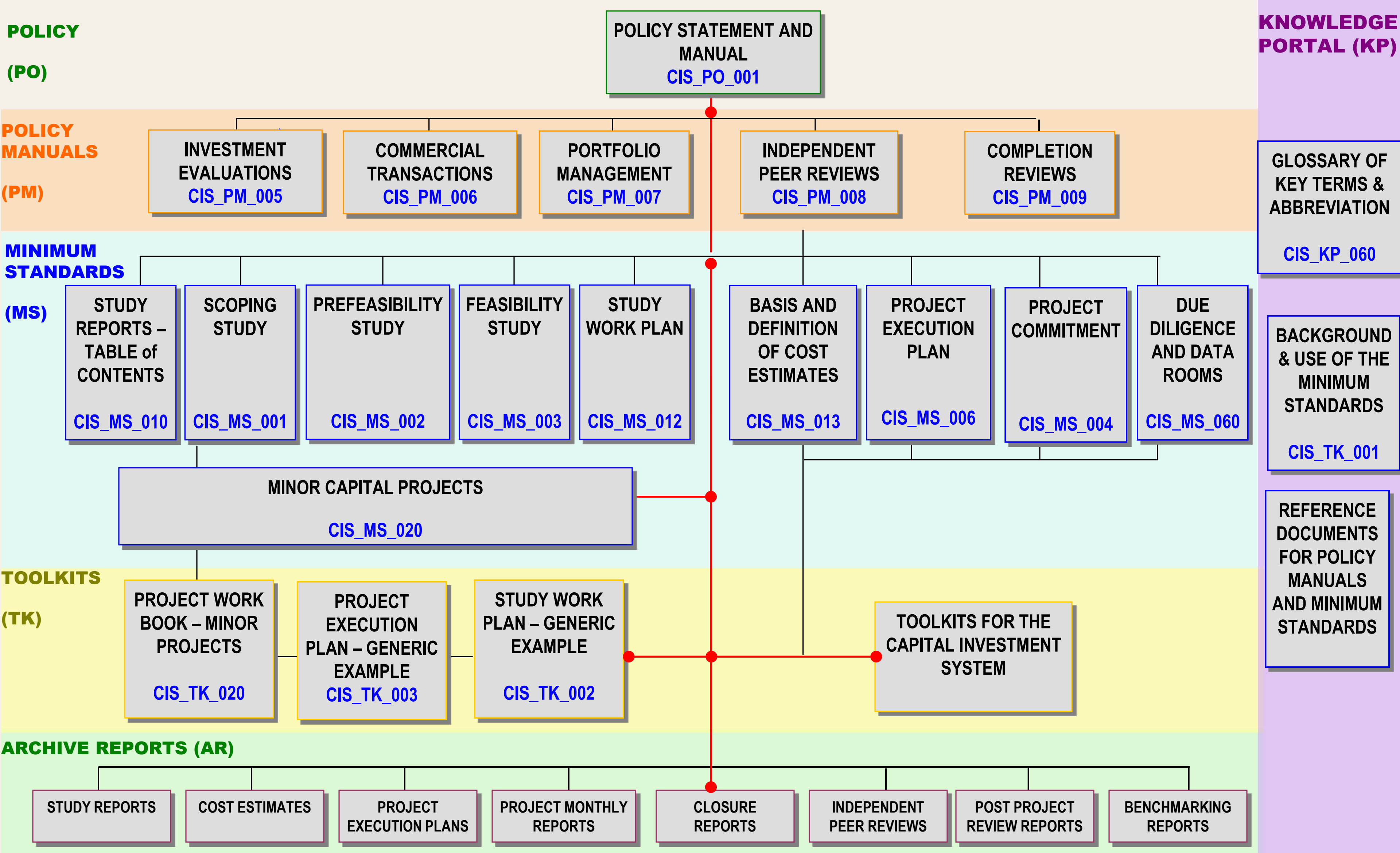
What is the CIS?

- Policies
- Policy Manuals
- Minimum Standards
- Toolkits
- Knowledge Portal
- Archive Reports

- Common understanding / language
- Consistent approach
- Sets standards of content, quality and accuracy

Enthalpy

Capital Investment System



Why Have a CIS?

Understand risk → Higher probability of successful outcomes → Better returns to investors

- Projects are capital intensive, risky and uncertain
- No investment is risk free
- Must clearly understand risk when investing capital
- Improved investment outcomes lead to superior shareholder returns and increased financier's confidence

Enthalpy

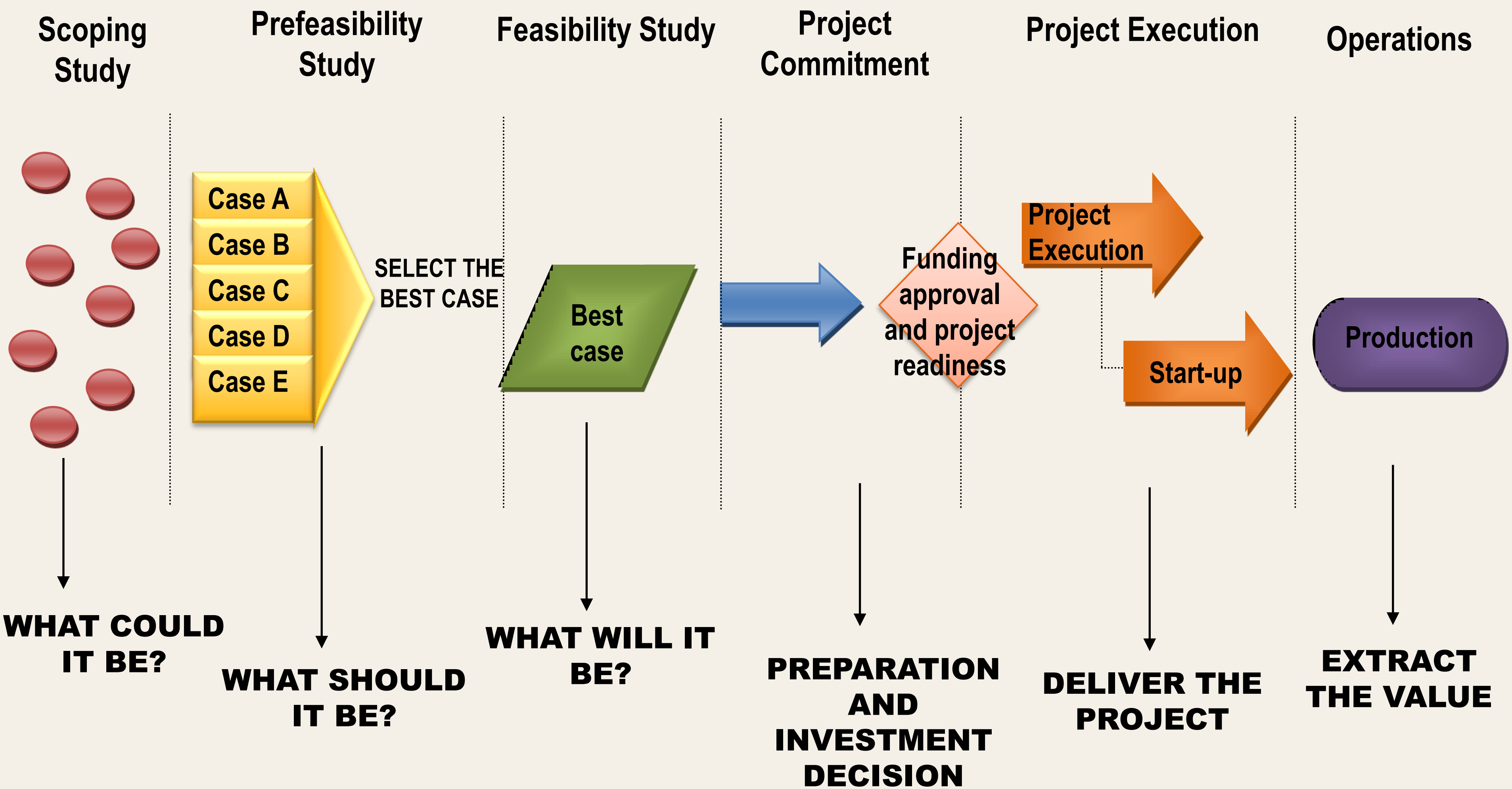
Features of Successful Projects

- Prefeasibility – considers alternatives to select optimum case
- Feasibility – defines business investment opportunities
- Clearly defined execution plan, organisation roles and accountabilities
- Regular stakeholder involvement
- Realistic budget and schedule
- Timely approvals and provision of funding
- Clear appreciation of risk and mitigation strategies

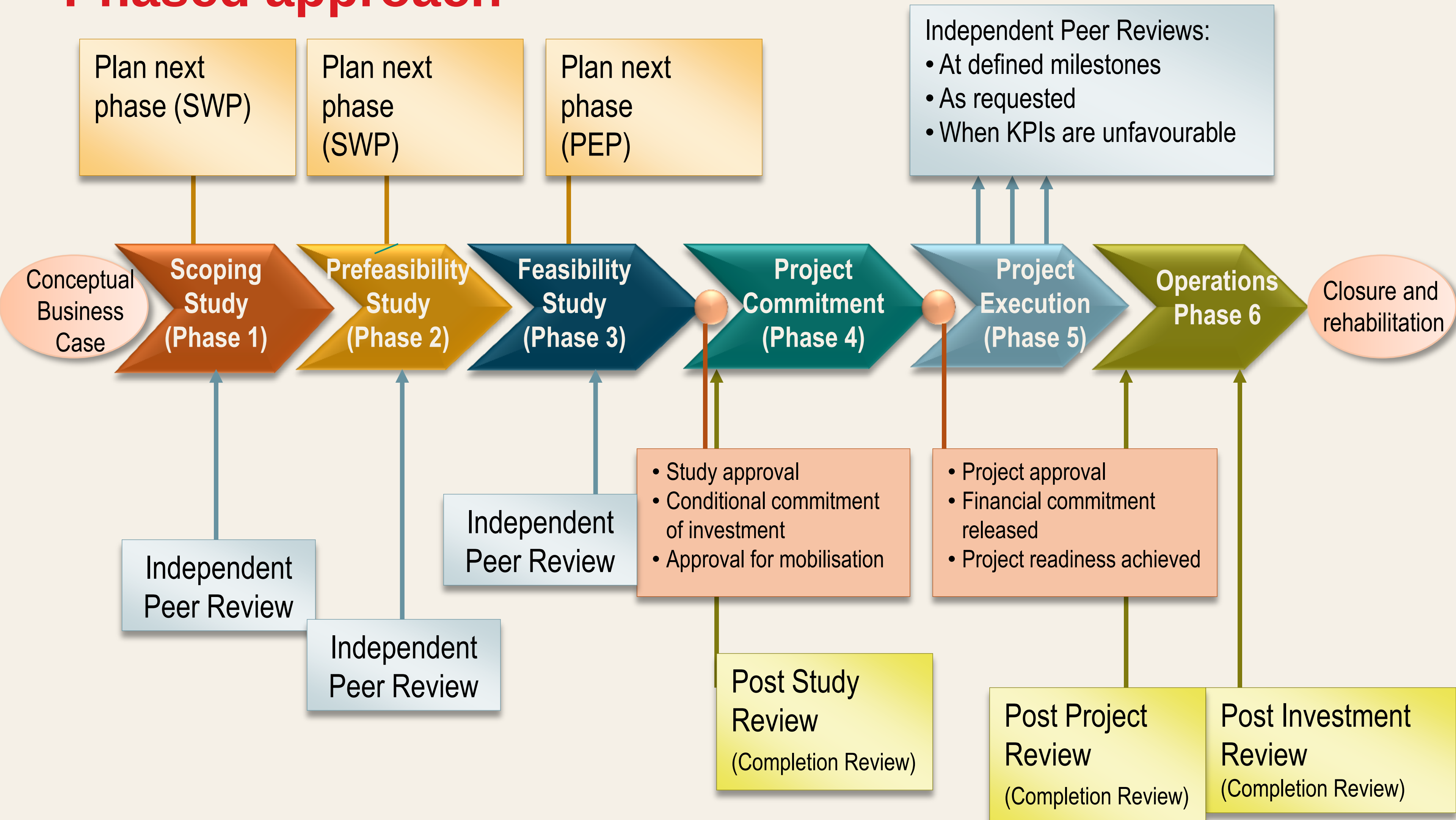
Benefits of the CIS

- Comprehensive, consistent and rigorous reviews of investments – technical and commercial
- Streamlined investment process
- Develop plans and capability to manage risks
- Understand the risk to reward balance of the investment prior to commitment
- Provide confidence to decision makers
- Sustainable assets and businesses that align with business strategy
- Optimise investment choices
- Progressive and supported decision making

Key principles



Phased approach



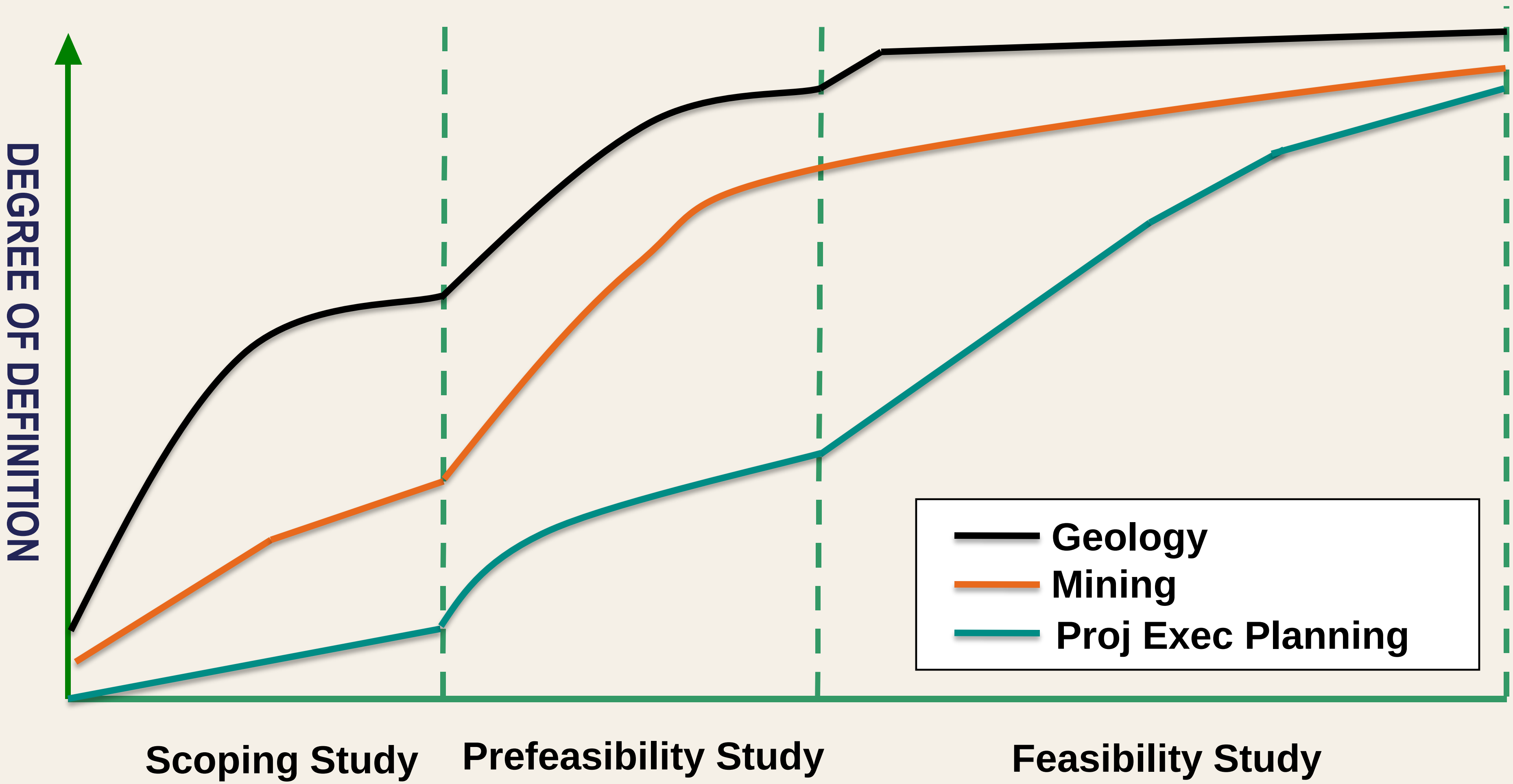
Minimum Standards

Define the content, quality and accuracy for:

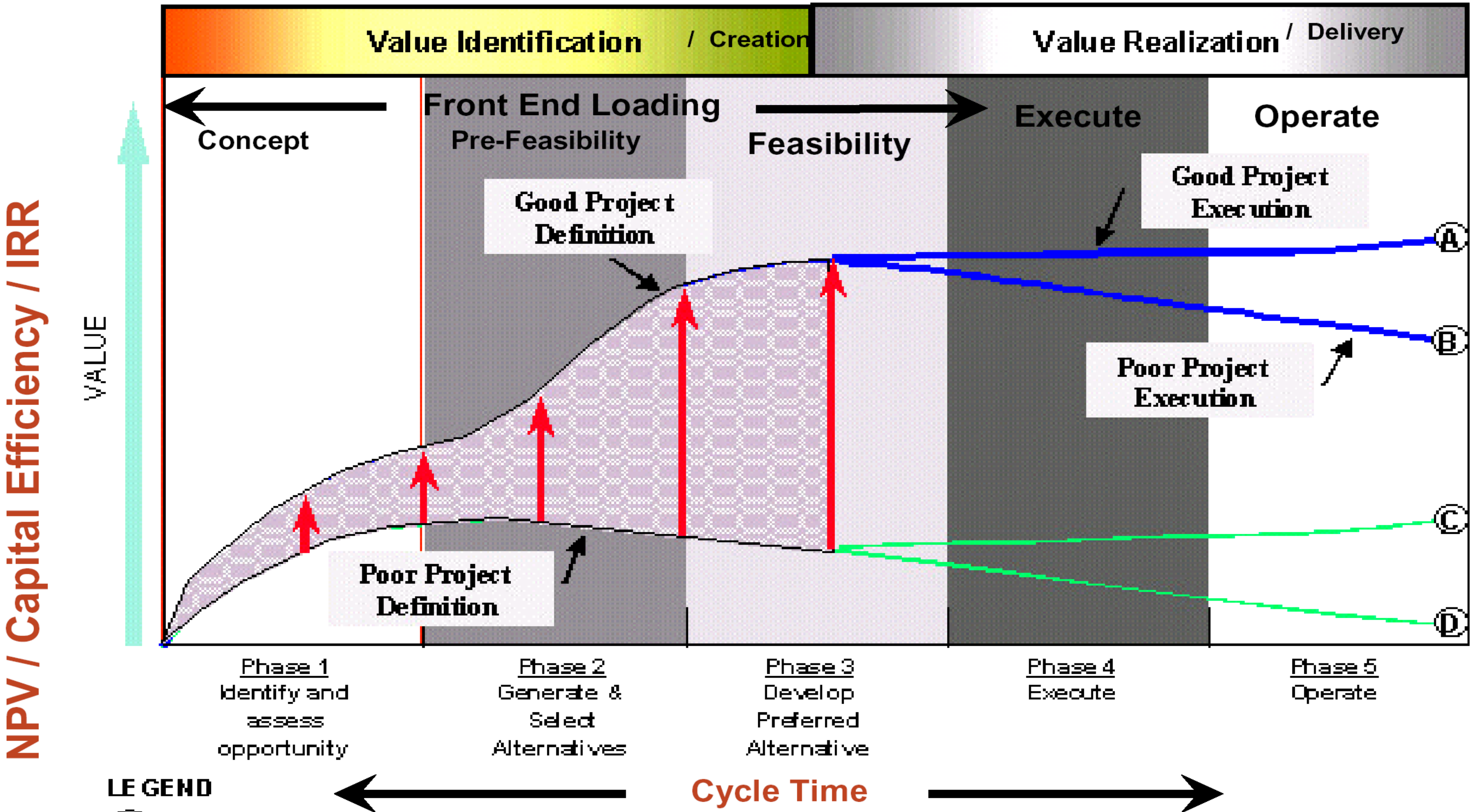
- Scoping, Prefeasibility And Feasibility Studies
- Study Work Plans
- Project Execution Plans
- Minor Capital Projects
- Cost Estimates
- Project Commitment
- Due Diligence And Data Rooms

Minimum Standards

Level of Effort and Definition



FEL Impact on Asset/Project Value



LEGEND

- (A) Good project definition and execution
- (B) Good project definition and poor project execution
- (C) Poor project definition and good project execution
- (D) Poor project definition and poor project execution

After IPA

Enthalpy