

**PROJECT PORTFOLIO MANAGEMENT IN AN INDUSTRIAL
ORGANIZATION**

By

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PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF BUSINESS ADMINISTRATION

In the Executive Master of Business Administration Program
of the
Faculty
of
Business Administration

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SIMON FRASER UNIVERSITY
Spring 2011

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Abstract

Trail Operations is the only refining and smelting operation in the Teck Resources Limited organization. It has evolved into a major industrial complex in British Columbia and one of the largest combined Zinc Lead smelters in the world. Annual major expenditures to maintain facilities are approximately \$100M. Project selection and approval is ad hoc and lacks detailed evaluation. Justification often focuses on matching the 10% rate of return expected for investments to maintain an operating facility. New investment opportunities must now compete with other Teck opportunities and provide either a greater return on investment or other justification.

As a result, efforts to formalize the selection, timeliness, and return on investment of Trail projects are underway. This paper will identify issues related to the project process, the approach identified to address these issues, and a plan to implement the recommendations. This approach will treat the projects as a portfolio of potential investments and develop structured workflows for their creation, selection, planning, and management. The deployment of this methodology is in progress.

Dedication

I dedicate this paper first to my life partner, best friend, and wife Anne Elizabeth Peterson; and second to my children and grandchildren as proof that learning is a lifelong exercise.

Acknowledgements

I wish to acknowledge the continuing support of Teck as an organization and my fellow employees in particular. In addition, the support and active participation of my fellow EMBA students has been critical in my progress through this program. Each of them has contributed to my development and growth through this process. The flexibility and versatility of the Simon Fraser University organization and staff has been a key component in any success I have achieved in this effort.

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Glossary

Appropriation Requisition (AR)	A request for funding for a project. It includes information related to scope, schedule, cost and benefits anticipated. The AR goes through a series of approval levels determined by the magnitude of the funding requested.
Asset Portfolio Management	Determining the mix of assets to hold in a portfolio is portfolio management. Asset portfolio management is choosing assets which are consistent with the owner's investment objectives and risk tolerance. The ultimate goal is to achieve the optimum return for a given level of risk.
Assumption of Control	Assumption of Control is a document signed by the Owners Representative that clearly documents commissioning successfully completed and lists any outstanding issues that the project must resolve. From this point on any issues related to getting the facility to operating levels are the responsibility of the operating organization.
Basic Engineering	Provides a complete definition of the scope of the project as required for completing Hazard and Operability (HAZOP) and constructability reviews, obtaining fixed priced bids on major equipment, and producing a cost estimate with +/- 10 % accuracy.
Conceptual Engineering	The most basic level of project definition and includes sufficient sketches to assist with the overall definition of the project. No 'engineered' drawings or specifications are required.
Corporate Major Project	At Teck, this is a project with an estimated investment value greater than \$50,000,000.
Create Project Phase	This phase of a project includes: identification of the proposal, basic business case development, identification of key project attributes, assignment to the multiyear plan, and a decision to proceed to pre-scoping stage.
Decision Review Board (DRB)	A committee of senior executives whose goal is to determine the priority of projects for optimal utilization of resources and greatest return (The Enterprise Portfolio Management Council, 2009).
Detailed Engineering	Completion of detailed design as required to construct the facility and/or to allow tendering a fixed price competitive installation contract.

EPCM	<p>Engineering, Procurement, and Construction Management.</p> <p>In an EPCM arrangement, the client, in order to involve an experienced player in large projects, selects an EPCM contractor who primarily manages the whole project on behalf of the client. The EPCM contractor essentially ensures that the whole project is completed, as required and in time.</p>
Feasibility Study	<p>In a feasibility study, basic engineering and the evaluation of site conditions is completed; execution strategy defined and a feasibility level estimate suitable for appropriation of funding (usually +/- 10 %) produced.</p> <p>Engineering effort, measured in weeks or months, will typically cost 3 – 5 % of the value of the project.</p>
Gate Review Committee	<p>At Trail Operations, this is the Decision Review Board (DRB). See glossary.</p>
Major Project	<p>A Trail Operations project with estimated cost greater than \$ 300,000. See Figure 6.</p>
Manage Project Phase	<p>This phase implements the final scope, cost and schedule through the execution stage; utilizes the final benefit, resource, risk and strategic assessments to realize the intent of the project; follows through the operation and completion of the project ; and ends when the project enters the ready-for-learning stage.</p>
Minor Project	<p>A Trail Operations project with estimated cost less than \$ 300,000. See Figure 5.</p>
Operating Organization	<p>A grouping of personnel at Trail Operations that perform functions directly related to a specific operating area or plant within the overall operation</p>
Order of Magnitude Estimate (OME)	<p>An engineering study of a project that documents the evaluation of options, defines the initial scope, cost, and timing of a project. Comparative order of magnitude cost estimates are +/- 40 % accurate. The engineering effort for the OME, measured in days, generally costs less than 0.5 % of the total value of the project.</p>
Owners Representative	<p>A representative of the operating organization that owns the project. Also known as Project Sponsor. See Glossary</p>
Plan Project Phase	<p>Starting at the feasibility stage, this phase defines the final scope, cost, and schedule of the selected option; finalizes the evaluation of the benefit, resource, risk, and strategic assessments leading to an overall project ranking; requests approval of an AR, and ends when the project enters the execution stage.</p>

Pre-Feasibility Estimate (PFE)	At this stage, preliminary engineering design is completed. Pre-feasibility level cost estimate produced is +/- 25 % accurate. Engineering effort during pre-feasibility, measured in weeks, will cost less than 1.0 - 1.5 % of the total value of the project.
Preliminary Engineering	The level of engineering required to demonstrate a project concept. The purpose of preliminary engineering is to define the conceptual scope of the project and demonstrate the projects' viability.
Project	A defined set of tasks related to the expenditure of funds to update, modify, replace, install, implement, or demolish; a plant, process, or equipment.
Project Charter	This document defines the reason for the project, the objectives it is trying to achieve, the scope of the project, the strategic fit, and the overall approach to providing a solution. It is the primary definition of the proposal. The Project Charter is a living document and must be revised as project developments warrant it.
Project Portfolio Management (PPM)	Project Portfolio Management is the centralized management of one or more portfolios, which includes identifying, prioritizing, managing, and controlling projects, programs and other related work to achieve specific strategic business objectives (The Enterprise Portfolio Management Council, 2009).
Project Sponsor	The person responsible for moving a project ahead and ensuring its viability is regularly tested. At Trail Operations, this person is the Owners Representative.
Projects Group	Trail Operations organization that provides direction, guidance and support to operations areas in the development and execution of projects at Trail Operations.
RBBA	Risk Based Benefit Analysis. A process developed by Trail Operations to allow for the analysis of potential minor projects to the pre-scoping level for further consideration by the Senior Management Team. (see Appendix A)
Select Project Phase	Starting at the scoping stage, this phase develops the first detailed scope, cost, and schedule at a preliminary level; begins the evaluation process by examining the benefit, resource, risk, and strategic assessments leading to an overall project ranking; and ends when the project enters the feasibility stage.
Senior Management Team	Senior Managers reporting directly to the General Manager, Trail Operations.

Stage Gate Process	A process of a series of reviews than ensures thorough development and detailed evaluation of a project as it progresses from concept to ready-for-learning (Cooper, 1990).
Strategy	The framework of choices that determine the nature and direction of an organization (Brache, 2002).
Technical Representatives	Personnel at Trail Operations considered experts in particular areas of the operation or some aspect of the process.

1: Introduction

Teck Resources Limited¹ is a publicly traded diversified global resource company committed to responsible mining and mineral development with major business units focused on copper, metallurgical coal, zinc, and energy (see Figure 1). Trail Operations² is part of the Zinc business unit and is the only refining and smelting operation in the Teck organization. Trail Operations, the oldest part of the Teck organization, was founded in 1895 and has evolved into a major industrial site in British Columbia and one of the largest combined Zinc Lead smelters in the world.

Annual capital expenditures for Teck Resources Limited are approximately a billion dollars and Trails' portion for replacement and improvement of its facilities range between 8 and 12 percent of this total. The identification, development, analysis, selection and approval effort of individual projects to date have been 'best effort' but lack a comprehensive method of development and evaluation. Trail expenditures since the mid 1990's focussed on maintaining the 10% to 12% rate of return expected of investments to maintain an operating facility. Some new opportunities recognized as critical to Trails long term viability change the requirement for investment beyond maintaining operating capacity. These investment opportunities must compete with other Teck Resources opportunities and provide either a greater return on investment or other justification for the expenditures.

To meet these enhanced requirements for investment, Trail Operations finds itself having to reassess how it identifies, develops, evaluates, and executes projects. This reassessment will reflect the increased effort to meet Teck Corporate standards for these investments and move Trail Operations project capabilities to the next level of improvement. Over the past two years, the focus has been on attempts to provide early identification of projects and improve both the effectiveness of the development effort and the return on investment. The desire to establish a long term perspective on projects has resulted in the development of a ten year plan for expenditures including shutdowns with tentative timing, duration, and costs assigned. This has

¹ The terms 'Teck Resources Limited', 'Teck Resources' and 'Teck' are used interchangeably in this report to improve readability.

² The terms 'Trail Operations', 'Trail Ops.' and 'Trail' are used interchangeably in this report to improve readability

provided an opportunity to clearly define the annual requirements for engineering studies or additional research into proposals.

In the mid 2000's a number of functions in the Teck organization began to utilize a rudimentary version of the Stage Gate Process (Cooper, 1990) to guide and formalize the development of proposals or initiatives. These Teck functions; Exploration, Research, Business Development, and Technical Development all began to develop their own approach to Stage Gating their initiatives. In 2005 the Projects Group (See Glossary) at Trail developed their own version of a Stage Gate Process (Teck Trail Operations, 2009) and in 2010 the Teck Corporate Project Development Department established their Stage Gate Process (Teck Resources , 2010) for corporate major (>\$50M) projects.

The project Stage Gate Process at Trail Operations has mainly been used to inform Senior Management Team about the specifics of Trail major (>\$0.3M) projects. The evaluation performed is limited and is not consistent enough to allow the optimization of project selection and development. There are a number of reasons for this:

- ❖ Most projects identified are mandatory in nature in that they relate to the repair or replacement of equipment, facilities, or infrastructure. While the timing of such a project is open to debate, the requirement to perform the work at some point in time is not. Other than comparing estimated costs of options, little financial and benefit analysis occurs.
- ❖ Risk assessments tend to be very broad and look only at the risk of not performing the work. Evaluation of the risks inherent in actually executing the project only occasionally occurs.
- ❖ Strategic alignment is only considered from the context of maintaining operating levels and reducing operating costs.

This paper will develop the next stage in the evolution of the project process at Trail Operations and identify gaps in the existing processes by comparing existing Trail Operations practices to previously identified 'best practices'. It will then define the approach selected to resolve the identified issues and propose a path forward to significantly improve the entire process. Included is the selection of a new tool to support the new process. The underlying approach used will be to treat the projects as a portfolio of potential investments and build on the existing systems to develop structured workflows for the creation, selection, planning, and management of projects. The initial deployment of this methodology is in progress at this time. The phased implementation of future features of the Project Portfolio Management system will occur over the next two years.

2: Trail Operations Project Process and Issues

Teck Resources Corporate Project Development Department has reviewed ‘Best Practices’ for project identification, development, execution, and completion. This review generated guidelines that are available to all Teck Operations. In this section the current project process at Trail Operations will be compared to those guidelines (Teck Resources , 2010) and other sources (Longman & Mullins, 2005) (Buttrick, 2000) (Kerzner, 2009) (Project Management Institute, 2004) (Sanwal, 2007) (The Enterprise Portfolio Management Council, 2009) (Nicholas & Steyn, 2008) (Toney, 2002) to establish how a project development and portfolio management process ‘should’ work, what are best practices in the field, and how are they used. A summary of the issues identified are used to define the approach necessary to bring Trail Operations project processes to a standard necessary to support major opportunity capital expenditures at Trail Operations.

2.1 Projects

As of 2010, the total recorded asset value of Trail Operations is approximately \$1.6B distributed across the five major process plant organizations, a significant maintenance organization and various support organizations (Projects, Finance, Human Resources, Information Technology, Technical Support, and Commercial Services). Maintenance is a significant portion of the annual operating expense of approximately \$325M. The maintenance effort also includes annual funding required to keep and improve existing plant capacities and meet evolving regulatory requirements. Trail Operations spends approximately \$55M per year on capital investments and another \$45M per year on non-routine expenditures for in-kind replacement of worn equipment and facilities. These expenditures occur through the execution of approximately 200 projects of various sizes and complexity.

Prior to 1992, a wholly owned subsidiary named Cominco Engineering Services Limited (CESL) provided extensive Project and Construction Management capabilities within the Trail Operations ranks. In 1992, in the face of market and competitive pressures, Trail was close to being a bankrupt operation and major changes were required for the operation to survive. Production levels had to increase and reliability of operations had to improve while reducing

costs. The workforce at Trail went from approximately 2300 in 1992 to 1500 in 1998 and has remained at approximately that level. The 35% reduction in staffing led to the reprioritization and elimination of numerous support activities considered necessary prior to 1992. Among the expertise lost was Design and Project Engineering with the sale in 1995 of the Engineering, Procurement, and Construction Management (EPCM) arm of CESL. With this sale, the capability to manage projects was outsourced to the engineering consulting firm that purchased CESL. No staffing provision to allow for the need to monitor and provide overview of projects from within the Trail Operations organization occurred.

After 1995, Trail Operations project development, selection, and tracking occurred manually through an ad hoc process with projects largely limited to those necessary to sustain operations. To maintain a level of investment necessary to keep the operation viable, each operating area assigned one or two maintenance engineers additional tasks to identify projects and scope the work, develop basic estimates and generate appropriation requisitions. Various plant personnel took on the extra tasks of awarding contracts, coordinating contractor efforts and controlling costs. Project execution occurred but not always at levels consistent with compromised Trail's previous reputation for close adherence to safety, environment, and contractual obligations, and formalized control of projects was minimal.

Recognizing that project management activities can only be deferred so long, in 2000, a newly formed Projects Group began to establish a more formal approach to project development and execution. The initial effort focussed on establishing workflow processes for the estimation and execution phases; implementing engineering study standards; and establishing contract management and administrations policies. A rudimentary Stage Gate Process, established in 2005, helped ensure projects went through a basic review process. Since a multiyear plan was not available, the review has focused on the current year's projects and little consideration of future year's requirements or their impacts was involved. The development of an excel spreadsheet to track the ad hoc processes and provide current project forecasts for expenditures and timing was a major step forward in adding a basic level of governance to the project process. Since then the processes have evolved and become more formal. While Stage Gating is required for all major capital projects, it does not follow the corporate Stage Gate Process which can cause mismatching of project requirements for very large projects. Risk Based Benefit Analysis (RBBA - see Appendix A) is required for all minor projects. All projects have monthly updates of actual expenditures and forecast expenditures.

The core business processes required for Project Governance (See Figure 2) are included to some extent in the evolution of the project process at Trail Operations. Most key processes are

developed in some form with the exception of Project Portfolio Management. The outstanding work required included a more detailed project development process and the development of a project portfolio management system.

During the 2009 operating year, the initial effort occurred to identify projects required in the future in the form of a ten-year plan. This plan expanded during 2010 and now consists of approximately 900 current and future capital projects. The resulting list is workable however the additions further complicate the excel spreadsheet where all information is recorded. As of late 2010 the stability of the spreadsheet deteriorated and a series of linked excel spreadsheets was developed. These spreadsheets are fragile and have suffered repeated failures and rebuilds. To improve the stability of these spreadsheets, access to them has been limited with an attendant loss of collaboration and involvement. In late 2009, an upgrade to the appropriation approval process occurred through the introduction of an electronic generation and approval system.

Trail Operations has some project classification aspects that tend to complicate the development and execution processes. One aspect is the types of expenditure; there are four main types of expenditures (routine, non-routine, minor capital, and major capital) at Trail Operations. Another aspect is project expenditure categories; there are four categories (sustaining, mandatory, discretionary, and opportunity). Each of these expenditure types and expenditure categories has different process workflows, evaluation efforts, and execution processes. The combinations can leave personnel confused and frustrated when trying to promote a particular project. One goal of the new system is to reduce the added complexity of these types of expenditure and expenditure categories by reducing the number of acceptable process workflows. The best solution would be to develop workflow that is independent of these aspects and closely follows the Teck corporate Stage Gate Process.

As previously discussed, the present project process has evolved since the restructuring of 1992 through a number of phases. The first phase focussed on developing basic project skills in the operating plant areas to complete projects considered critical to the continued operation at Trail. These tended to be maintenance based and of lower dollar value. As Trail Operations viability improved a phase that included the implementation of larger projects began that was supported by the in depth involvement of EPCM firms. Around 2000, a phase of increased Trail Operations involvement developed and improved project management skills established through actual hands on experience with project execution. The next phase began in 2005 with the efforts to provide better project evaluation through the use of Stage Gating. In the latest phase, the need to improve the identification and planning of projects was the initial focus but it became apparent that during the evolution of the project process a number of gaps had developed and needed

resolution. The next phase identified in the evolution of the project process is a method of evaluation of the entire spectrum of projects anticipated and implementing a method of optimizing the selection and timing of those projects. The method identified is Project Portfolio Management (PPM).

The following sections define Project Portfolio Management and then describe the Teck Resources ‘Best Practices’ framework for projects and support a structured approach to the development, governance, and implementation of projects. As previously stated the content of these sections draw significantly from a variety of documents and experience and in particular from documents developed by the recently established Teck Resources Limited, Project Development Group (Teck Resources , 2010).

2.2 Project Portfolio Management

At the present time, Trail Operations does not have a Project Portfolio Management (PPM) system but recognizes it as the next phase in the evolution of project management at Trail. Project Portfolio Management can also address a number of the gaps or issues identified in the present project process. The objective of this section is to clearly define what Project Portfolio Management is and how it relates to other aspects of the project process.

The official definition of Project Portfolio Management is:

“The centralised management of one or more portfolios, which includes identifying, prioritizing, managing, and controlling projects, programs and other related work to achieve specific strategic business objectives (The Enterprise Portfolio Management Council, 2009: 15).

In practice, Project Portfolio Management is a process of review and analysis of a large selection of projects against a set of specific criteria to optimize the investment of scarce resources. Key to the best Project Portfolio Management systems is a project evaluation process that answers the following five basic questions (*project aspect in italics*):

- ❖ Are we doing the right things? = *Portfolio Management*
- ❖ Are we doing them the right way? = *Project Management*
- ❖ Are we getting the promised benefits? = *Benefit tracking or auditing*
- ❖ Are we utilizing our capacity? = *Resource Management*
- ❖ Are we able to absorb all the changes? = *Change Management*

A Project Portfolio Management system that can fully answer all these questions in the affirmative is a mature and fully functioning system with well-defined and utilized processes.

Attempting to implement all this capability at once is more than most organizations can accommodate unless a phased approach is used.

The project evaluation process occurs at various points during the project life cycle. The initial review provides the basis to move the project into the project development process. The project development process usually follows a series of phases. At the beginning of each phase, a responsible party evaluates the business case, asking whether the project is still relevant and able to meet the organizations objectives. If the answer is no, then the project should be stopped. This way the organization can ensure the projects stay focused on delivering a strategy, goal, or other benefit, and that employed resources are where they will offer the best return. If the answer to any of these questions is no, immediate action is needed to bring the project back on track or remove it from the process until the underlying analysis warrants it returning as a viable project.

When a major proposal is composed of a group of smaller blocks of work, the resulting group of projects is a program. Trail operations have not used this approach often but there are currently two or three significant initiatives planned in phases over a number of years that fit the program approach. Confusion sometimes develops between the terms Portfolio, Program, and Project. To understand the differences between a Portfolio, Program, and Project think in terms of the number of individual projects involved. A Portfolio is a collection of all the individual projects and programs an organization is considering for investment. Programs are large efforts composed of a number of interrelated individual projects, all with one overriding set of goals and objectives (Nicholas & Steyn, 2008). Programs consist of multiple projects, but projects can be independent and simply part of the portfolio. Projects differ from programs in that they tend to be more tactical in nature.

To deliver against the principles of project governance a set of defined and implemented related core business processes are required. The process of managing a portfolio focuses on alignment of the project portfolio with business objectives achieved through the project selection and analysis processes. This analysis is an ongoing process that occurs as projects progress through the Create, Select, Plan, and Manage steps of project development (Makieff & Angelino, 2008). The individual definition of each of these steps is included in the discussion of each step. The ultimate responsibility for achieving a portfolio of strong and relevant projects resides with the Senior Management Team based upon the recommendations of the Gate Review Committee (See Glossary) and the Projects Group.

The Project Portfolio is a single point of reference that includes all major and minor projects, including all ideas or proposals. The portfolio is a vehicle to collect all relevant project information and should contain, as a minimum:

- Basic Project data: project name, project number, Owners Representative, Project Manager.
- Project attributes: originating Organization, expenditure type and category, a complexity rating, and project inter-dependencies (i.e. projects that depend on it, projects it depends on).
- Schedule data: Stage Gate and project key interim milestones (baseline, forecast and actual).
- Cost data: Summary costs, original and current budget, forecast final cost and actual to date cost by project development stage.
- Evaluation data: as developed through the Stage Gate Process.
- Progress data: Physical progress (planned and actual), and earned value performance indices.

At Trail, the implementation of Project Portfolio Management is an opportunity to address the gaps that exist in the present process and evolve to the next level of overall project management. The foundation for this evolution is improved project governance and a more rigorous application of process workflow.

2.3 Aligning Business and Projects

The objective of a project is to implement changes that will improve returns for stakeholders in a safe, sustainable, and socially and environmentally responsible manner. Company growth and improved returns most often result from projects that invest in the expansion of existing processes, or the development of new businesses from new processes. To ensure the viability of these improvements the company must be committed to following a consistent approach to the development and management of projects. The basic aims (Teck Resources , 2010) are:

- Identify and screen proposals for viable projects based upon a clear view of strategy, overall project portfolio and key business constraints,
- Develop the definition and planning of the identified projects to a level of detail appropriate for funding, while at the same time maximizing the project's return,
- Implement the projects and deliver operating facilities in a manner that meets or improves upon their success criteria,
- Allow for the operation of the facilities to meet and wherever possible exceed target returns.

Project governance is the basis for delivering the first three of the above goals for any portfolio of projects.

2.4 Project Governance

Corporate governance (Sanwal, 2007) is a system of structuring, operating, and controlling a company to achieve long term goals to satisfy shareholder and other stakeholder needs, while complying with laws, regulations and social and environmental requirements. Project governance, is a subset of this with a focus on the governance of project development and execution. Figure 2 displays the core business processes that support effective project governance; all of these business processes are integral to the project process. The outcome for Trail Operation's and ultimately Teck Resources, of effective governance of projects should be confidence in the consistent delivery of promised project benefits aligned to Trail Operation's strategic goals.

The development of more rigorous project governance is an underlying premise of good project portfolio management. Teck Resources Limited deals with a relatively small number of very large and expensive projects while Trail Operations deals with a large number of relatively less expensive projects. As a result, project governance for Trail Operation's is not the same as project governance for Teck Resources but they should be similar to each other. Rather than a Board of Directors serving as the governance board, the Senior Management Team should provide this highest local level of oversight for Trail. Governance must start at this level of the organization. The goal of the Senior Management Team is to determine the priority of projects for optimal utilization of resources and greatest returns (The Enterprise Portfolio Management Council, 2009).

2.4.1 Principles of Project Management Governance

According to the Association for Project Management (2005) the objective of project governance is to help avoid the most common causes of project failure. They cite the following causes:

- Lack of a clear link with key strategic priorities.
- Lack of clear senior management ownership and leadership.
- Lack of effective engagement with stakeholders.
- Lack of skills and proven approach to project and risk management.
- Lack of understanding of, or contact with supply industry at senior levels.
- Evaluation of proposals driven by initial price, rather than long-term value for money.
- Lack of effort to break down development and implementation into manageable steps

The APM guide for this view of project governance defines 11 principles, correlated to the Sarbanes-Oxley Act of 2002. The following are the recognized principles of project management and their current application at Trail Operation's.

- 1) The board has overall responsibility for governance of project management.
 - ❖ At Trail, this means the Senior Management Team has responsibility.
- 2) The roles, responsibilities, and performance criteria for the governance of project management are clearly defined.
 - ❖ This exists for individual projects and implementing Project Portfolio Management will reinforce it.
- 3) Disciplined governance arrangements, supported by appropriate methods and controls, applied throughout the project life cycle.
 - ❖ This exists for individual projects and implementing Project Portfolio Management will reinforce it.
- 4) A coherent and supportive relationship is demonstrated between the overall business strategy and the project portfolio.
 - ❖ Implementing Project Portfolio Management will reinforce it.
- 5) All projects have an approved plan containing authorization points at which the business case is reviewed and approved. Decisions made at authorization points are recorded and communicated.
 - ❖ This is in the existing Stage Gate Process but the business case analysis and implementing Project Portfolio Management will reinforce it.
- 6) Members of delegated authorization bodies have sufficient representation, competence, authority, and resources to enable them to make appropriate decisions.
 - ❖ This exists for individual projects and Project Portfolio Management will reinforce it once the full capabilities of analysis are implemented.
- 7) The project business case is supported by relevant and realistic information that provides a reliable basis for making authorization decisions.
 - ❖ This is in the existing Stage Gate Process and implementing Project Portfolio Management will improve it.
- 8) The board or its delegated agents decide when independent scrutiny of projects and project management systems is required, and implement such scrutiny accordingly.
 - ❖ The Senior Management Team has used this approach and will be encourage to consider this further once Project Portfolio Management is fully implemented.

- 9) There are clearly defined criteria for reporting project status and for the escalation of risks and issues to the levels required by the organization.
 - ❖ The reporting criteria in use today do not directly address risk. Implementing Project Portfolio Management will reinforce it.
- 10) The organization fosters a culture of improvement and of frank internal disclosure of project information.
 - ❖ This exists for individual projects and implementing Project Portfolio Management will reinforce it.
- 11) Project stakeholders are engaged at a level that is commensurate with their importance to the organization and in a manner that fosters trust.
 - ❖ This exists for individual projects and implementing Project Portfolio Management will reinforce it.

These principles of governance of project management are the foundation of a governance system. Another key factor is a Project Development Framework (like stage gating) to follow a project from concept to start up.

2.4.2 Components of the Governance of Project Management

There are four components required for functional governance of project management (Association for Project Management, 2005):

- Portfolio direction.
- Project sponsorship.
- Project management.
- Disclosure and reporting.

Governance of project management is not the rigid application of a complex methodology; the best results come from the intelligent application of basic principles and appropriate delegation of responsibility and the monitoring of internal control systems.

Portfolio Direction

All projects and associated programs should be included in the portfolio. The portfolio should be analysed and evaluated based on the organization's aims and constraints to ensure the projects remain relevant. The key questions asked with their applicability at Trail Operations are as follows:

- 1) Is the organization's project portfolio aligned with its key business objectives, including those of profitability, customer service, reputation, sustainability, and growth?

- ❖ Trail's ten year plan focuses on replacing deteriorating assets and maintaining operational reliability. How this fits into key business direction needs definition.
- 2) Are the organization's financial controls, financial planning, and expenditure review processes applied to both individual projects and the portfolio as a whole?
 - ❖ This exists for individual projects and implementing Project Portfolio Management will reinforce it.
 - 3) Is the project portfolio prioritized, refreshed, maintained, and pruned in such a way that the mix of projects continues to support strategy and take account of external factors?
 - ❖ The ten year plan is not yet a project portfolio. The implementation of Project Portfolio Management will address this.
 - 4) Does the organization discriminate correctly between activities that should be managed as projects and other activities that should be managed as non-project operations?
 - ❖ Yes and the opportunity to improve will come with better evaluation and analysis of the projects in the portfolio.
 - 5) Does the organization assess and address the risks associated with the project portfolio, including the risk of corporate failure?
 - ❖ Since most projects are mandatory, there is little analysis given to project outcome risk; the only risk assessed to any degree is the risk associated with execution of the project.
 - 6) Is the project portfolio consistent with the organization's capacity?
 - ❖ At the present time, it appears that resources will be stretched beyond availability in 2011, 2012, and 2013. Use of resource levelling with the portfolio will better define the problem and allow development of scenarios to resolve the issues.
 - 7) Does the organization's engagement with project suppliers encourage a sustainable portfolio by ensuring their early involvement and by a shared understanding of the risks and rewards?
 - ❖ Yes, to a degree. Shared risks and rewards with EPCM and Contractor suppliers have been tried with limited success.
 - 8) Does the organization's engagement with its customers encourage a sustainable portfolio?
 - ❖ Customers' requirements rarely enter into a project evaluation unless the product is uniquely tied to a specific customer.
 - 9) Does the organization's engagement with the sources of finance for its projects encourage a sustainable portfolio?
 - ❖ Trail Operations financing comes either from Trail Operations or from Teck Corporate.
 - 10) Has the organization assured itself that the impact of implementing its project portfolio is acceptable to its ongoing operations?

- ❖ Without a portfolio, this is difficult to determine. The ability to demonstrate an expenditure plan into the future is a requirement of justifying the opportunity projects required to secure Trails' future.

Project Sponsorship

Project sponsorship is the link between the Senior Management Team and the Project Sponsor. At Trail Operations Project Sponsors are called Owners Representatives. Owners Representatives are drawn from a variety of titles and levels in the operation but on a project, their role has significant decision making, directing, and representational accountabilities. Project Managers report directly to their Owners Representatives and receive their project authority and direction from them. Owners Representatives own the project business case. The key questions asked regarding Project Sponsorship and the present applicability at Trail Operations are as follows:

- 1) Do all major projects have competent sponsors at all times?
 - ❖ Yes.
- 2) Do sponsors devote enough time to the project?
 - ❖ Usually project sponsorship is an 'add on' to the individual's 'real' job. As a result the effort can be compromised.
- 3) Do project sponsors hold regular meetings with project managers and are they sufficiently aware of the project status?
 - ❖ Usually, this varies with the individuals.
- 4) Do project sponsors provide clear and timely directions and decisions?
 - ❖ Usually, this varies with the individuals.
- 5) Do project sponsors ensure that project managers have access to sufficient resources with the right skills to deliver projects?
 - ❖ The Project Sponsor does not usually get involved in finding and applying resources, this is left to the Project Manager, and the Projects Group.
- 6) Are projects closed at the appropriate time?
 - ❖ Yes, in most cases.
- 7) Is independent advice used for appraisal of projects?
 - ❖ Not as a general rule but it does occur when appropriate.

- 8) Are sponsors accountable for and do they own and maintain the business case?
 - ❖ A business case is not usually developed beyond the necessity to replace equipment.
- 9) Are sponsors accountable for the realisation of benefits?
 - ❖ If the project is justified by benefits, they are usually monitored.
- 10) Do sponsors adequately represent the project throughout the organization?
 - ❖ Yes, but it can vary with individuals.
- 11) Are the interests of key project stakeholders, including suppliers, regulators and providers of finance, aligned with project success?
 - ❖ If this is monitored, it is only to a limited degree.

Project Management

The teams responsible for executing projects must be capable of achieving the project objectives as defined at each gate. The Gate Review Committee and Owners Representative need to determine the effectiveness of their project teams by considering the skills and experience of Project Managers, and the processes, tools, manpower and other resources available to them. Effective delegation to have decisions made at the appropriate level consistent with internal controls is a required skill. The key questions asked with their applicability at Trail Operations are as follows:

- 1) Do all projects have clear critical success criteria and are they used to inform decision-making?
 - ❖ Success criteria are usually limited to completion of the scope on time and on budget.
- 2) Is the Senior Management Team assured that the organization's project management processes and project management tools are appropriate for the projects that it sponsors?
 - ❖ Yes, from the perspective of providing project monitoring rather than project control.
- 3) Is the Senior Management Team assured that the people responsible for project delivery, especially the project managers, are clearly mandated, sufficiently competent, and have the capacity to achieve satisfactory project outcomes?
 - ❖ Yes, although the number available is limited.
- 4) Are project managers encouraged to develop opportunities for improving project outcomes?
 - ❖ Yes with some significant improvements realized.
- 5) Are key roles and responsibilities for the governance of project management clear and in place?
 - ❖ Not in documented forms that all recognize and follow.

- 6) Are service departments and suppliers able and willing to provide key resources tailored to the varying needs of different projects and to provide an efficient and responsive service?
 - ❖ Service departments are but suppliers are limited.
- 7) Are appropriate issue, change, and risk management practices implemented in line with adopted policies?
 - ❖ Only polices for change management of contracts are established.
- 8) Is authority delegated to the right levels, balancing efficiency and control?
 - ❖ In general, yes.
- 9) Are project contingencies estimated and controlled in accordance with delegated powers?
 - ❖ Yes but they tend to be included in the overall project funding and are usually consumed.

Disclosure and Reporting

This component seeks to ensure that the content of project reports will provide timely, relevant, and reliable information that supports the organisation's decision making processes, without fostering a culture of micro-management. An effective reporting process includes measures of both key drivers of success and key indicators of success. An efficient reporting process will minimise the reporting burden throughout the organisation without compromising effectiveness. A culture of open and honest disclosure is a key requirement for effective reporting. The key questions asked regarding Disclosure and Reporting and the present applicability at Trail Operations follows:

- 1) Does the board receive timely, relevant, and reliable information of project forecasts, including those produced for the business case at project authorisation points?
 - ❖ Yes, reporting requirements are fully met.
- 2) Does the board receive timely, relevant, and reliable information of project progress?
 - ❖ In most cases. Some ambiguity exists on the timing of reporting potential cost overruns but that is being addressed.
- 3) Does the board have sufficient information on significant project-related risks and their management?
 - ❖ Trail Operations risk assessment process requires improvement.
- 4) Are there threshold criteria that are used to escalate significant issues, risks, and opportunities through the organisation to the board?
 - ❖ Yes, but this will be improved with the implementation of Project Portfolio management.

- 5) Does the organisation use measures for both key success drivers and key success indicators?
 - ❖ Yes, but not specific to the project process.
- 6) Is the organisation able to distinguish between project forecasts based on targets, commitments and expected outcomes?
 - ❖ Forecasts and budgets (targets) are automatic but commitments are developed manually at the present time.
- 7) Does the board seek independent verification of reported project and portfolio information as appropriate?
 - ❖ Yes, when the project value warrants it.
- 8) Does the board reflect the project portfolio status in communications with key stakeholders?
 - ❖ Not currently as there is not portfolio to discuss.
- 9) Does the business culture encourage open and honest reporting?
 - ❖ Yes, in all instances.
- 10) Where responsibility for disclosure and reporting is delegated or duplicated, does the board ensure that the quality of information that it receives is not compromised?
 - ❖ In my experience, the answer is yes.
- 11) Is a policy supportive of whistleblowers effective in the management of projects?
 - ❖ Yes, a third party provides whistleblower capability to all Teck employees for any situation.
- 12) Do project processes reduce reporting requirements to the minimum necessary?
 - ❖ Yes. The limited reporting capability of the linked spreadsheets prevents excessive demands for reports.

The implementation of a Project Portfolio Management system at Trail Operations will ensure that all reports are generated from data held in the system and the data is available for viewing by any appropriate personnel.

2.5 Project Development

One of the suggested best practice approaches recommends process workflows (See Figures 4, 5, & 6) that use of four main steps; Create, Select, Plan, and Manage, (see glossary for specific definitions) to guide the discussion of project development (Makieff & Angelino, 2008). The workflows allow for project development over several stages or phases within the main steps. The reason most generally accepted for multiple stages or phases is that the ability to influence

project success and enhance value is greatest at the start of the process and declines as the project proceeds through development towards implementation (Figure 3). Additionally, the cost to develop the project increases as the depth of development increases. Best practice (Project Management Institute, 2004) indicates that breaking the development process into a series of clearly defined phases or stages allows greater control over the development process and opportunities to control the costs associated with development. This approach is “linear” in nature because the stages are sequential and fixed so as to ensure that project outputs are delivered on-time and within costs (McCarthy, Tsinopoulos, Allen, & Rose-Anderssen, 2006).

Teck Resources uses and recommends a Stage Gate Process for project development. Trail Operations has adopted its own Stage Gate Process (Cooper, 1990) which does not match the Teck Resources Stage Gate Process. Resolving the differences through clearly defined work processes is part of this project. Establishing a Stage Gate Process should focus on finding a balance between the time and resources invested in the development of a project and the risk of failure to achieve the desired benefits. The Stage Gate Process should aim for the presentation of a project for full funding approval but avoid:

- a high rate of rejection at the point of funding (the end of the feasibility stage).
- having project ‘value’ decreasing the more it is studied as more deficiencies are exposed.
- a high rate of recycle to earlier stages as better options are identified.
- having extended implementation and operational ramp-up stages that destroy business value.

Teck Resources has selected a stage gating process of seven stages and six gates for project development. Trail Operations currently uses six stages and five gates.

2.5.1 Stage Gate Process

A Stage Gate is the entry point for the next project development stage. Each gate controls entry to the next stage through a formal process of review by the Gate Review Committee to ensure they clearly understand the impact of approving the application of additional funds and resources for the further development of the proposal. The impact is reflected in changes to benefits, costs, risk profile, resource usage, and many other factors. For effective operation of the Stage Gate Process, the following is required:

- An executive committee (Gate Review Committee) acting as ‘Gate Keeper’ or Reviewer with the authority to cancel inappropriate projects (Cooper, Edgett, & Kleinschmidt, 2002b).
- Defined criteria for progressing from one stage to the next (past the Stage Gate) (Cooper, Edgett, & Kleinschmidt, 2002a). Progress from one stage to the next requires the completion

of a clear set of criteria to ensure the best chance of success. The minimum criteria are common to demonstrate that all proposals are judged the same for viability, priority, and access to funding (see Appendix B).

- A template for the information and standards for levels of detail and accuracy that must be presented at the end of each development stage (see Appendix B).
- A project classification system based on defined attributes to classify the importance of the project. This allows for defined approval levels, and efficient allocation of resources to those projects that have the greatest potential.
- A project list to capture all projects, their attributes and progress status through all the development and implementation stages (A Project Portfolio).
- A review process that allows rigorous evaluation of the project as it progresses through the development Stage Gate Process (Project Portfolio Management).

The Stage Gate Process is rigorous in that at each stage certain items are reviewed and assessed to the degree warranted by that stage of development.

2.5.2 Analysis and Evaluation

The analysis and evaluation process for projects requires a review at each stage of the Stage Gate Process. Associated with the process, a project evaluation scorecard is used to calculate a decision scoring number. A variety of aspects is included in the scoring model. Each aspect is tailored to the specific needs and goals of the organization.

The benefit assessment includes the evaluation and assessment of any benefits identified with the outcome of the project. It also includes an analysis of several business categories such as return on investment, impact, strategic importance, implementation time frame, and the increased improvement to the business drivers.

A risk assessment is required that at a minimum identifies potential risks to the execution of the project. In addition, a degree of difficulty assessment may analyse other business categories such as the availability of resources, change management issues, the complexity of the design and development and the integration of the system (Kerzner, 2009).

A review of the project and its links to strategy is a key component of the analysis. To do the ranking properly the strategic plan (Brache, 2002) must be broken down into key components that provide a basis for evaluating specific projects relative to the strategic direction of the organization.

Resource loading should also be part of the assessment scorecard to resolve any potential impacts that may delay or increase the costs associated with a particular project. Decisions around

manpower assignment may make one project a higher score than another and require a rescheduling of some activities.

The project evaluation scorecard is used to compare the information from the various assessments to measure the projects viability and worth. The information developed and rankings assigned determine if a project is approved for further development or rejected.

2.5.3 Gate Reviews

The Owners Representative is the person that takes the project from the idea stage in the operating area through to completion or termination. Their main role is to ensure that the project remains relevant to the organization and delivers the promised benefits. To perform this role they need to:

- Ensure that the project continues to meet the business need recorded in the Project Charter.
- Ensure that the project remains a viable business proposition or is terminated.
- Arrange for project Stage Gate and agreed interim reviews.
- Ensure the completed project, or each stage deliverable matches the needs of the business.
- Represent the organization in key project decisions.
- Sign off key project deliverables and project closure.
- Resolve project issues that are outside the control of the Project Manager.

The Owners Representative is responsible for presenting the project to the Gate Review Committee at the completion of each development stage. At each gate, they should agree on the gate criteria for the following gate, as well as the overall implementation plan for that stage. This ensures the project team will clearly understand the requirements it must achieve at the end of each stage.

Evaluation of the actual project stage deliverables against the criteria should be straightforward for Gates 1 and 2, however for Gate 3 and 4, the magnitude of the deliverables and the complexity of the scope may require the Gate Review Committee to mandate an independent team to review the stage deliverables. Review team members are usually technical experts from the organization who are in a position to independently assess the merits of the project and advise the Gate Review Committee of the degree of compliance with the relevant gate criteria. These reviews can take time and the Owners Representative should agree early with the Gate Review Committee on the requirements for independent review and allow sufficient time in the project stage plan.

The Owners Representative should also develop a project review plan with the project manager that identifies all key decisions made during the stage and the necessary review processes. This review plan should be agreed with the Gate Review Committee ahead of entry to the following stage, so that the reviews can be conducted in a planned manner.

2.5.4 The Gate Decisions

The Stage Gate review is an opportunity to confirm alignment of the project to the organizations current goals and priorities. This is a key part of the portfolio management process and is accomplished by the Gate Review Committee getting answers to the following four questions:

- Is there a real need for the project and is it still viable?
- What is the priority in relation to other projects in the portfolio?
- Are the funding and other resources available to implement the project?
- Is the plan for the next stage achievable and at an acceptable level of definition?

Based on the answers the Gate Review Committee has four decision options available;

- Allow the project to proceed to the next stage, with or without qualifications.
- Redirect the project if it proves viable but does not fit the organizations goals.
- Recycle the project back to the previous stage to correct any deficiencies.
- Stop the project and develop an exit strategy.

The Gate Review Committee's role is complex and it must be prepared to make unpopular decisions (Cooper, Edgett, & Kleinschmidt, 2002b). Its' recommendations are presented to the Senior Management Team in the case of large capital commitments. The following sections will review the current process workflow for each of the project development steps and discuss how the current Stage Gate Process interfaces with those steps.

2.6 Create

This is the initial phase in project development. This phase of a project includes: identification of the proposal, basic business case development, identification of key project attributes, assignment to the multiyear plan, and a decision to proceed to pre-scoping stage. This is the first documentation of the 'Create' phase and no formal process exists at Trail. This is a critical phase (Cooper, Edgett, & Kleinschmidt, 2002a) and will have three main workflow stages only one of which is currently part of the Stage Gate Process in Trail (Figure 4). All three phases;

concept identification, project details assignment, and on multiyear plan, will be included in the implementation of Project Portfolio Management.

Project Portfolio Management uses a defined workflow to track the identification and conceptualization of all significant expenditure opportunities. A minimum amount of information is required before the project moves ahead to the next step and becomes part of the multiyear plan or portfolio. Project Portfolio Management does not suggest or imply any limit to the planning horizon. The broader the planning horizon the more effective the evaluation and analysis is at laying down a long term framework for expenditures, the less likely a surprise expenditure will develop, and the more optimized the expenditures will become. Details of the stages in the proposed workflow are in the following sections.

2.6.1 Concept Identification and Development

The first gate is concept identification. Operating areas review issues and problems in their areas and capture their ideas for solutions as potential projects. Each area has developed their own rudimentary Excel spreadsheet to try to capture as much project information as possible in one location. Until the development of spreadsheets, a lot of background information was lost when personnel changed positions and paper files were misplaced or destroyed. There is no common method of storing information and reports that serve to support the project proposals. The plant representatives have been asking for more guidance in the type and quality of information they should be gathering to support the proposed projects and a tool to facilitate the storage and retrieval of information.

Included in the first step is the creation of a Project Charter. The Project Charter defines the reason for the project, the objectives it is trying to achieve, the scope of the project, the strategic fit, and the overall approach to providing a solution. It is the primary definition of the proposal. The Owners Representative usually completes it because it defines the basis of the proposal. The framework for the Project Charter defines what Trail Operations hopes to achieve through delivery of a project. It covers:

- The goals and objectives.
- The business and project management organizational structures.
- Roles and accountabilities of key bodies and participants.
- The project development Stage Gate Process.
- The project review process.
- The overall quality assurance process.

2.6.2 Project Details Assignment

When the operating area is satisfied that the project is necessary and needs to be included in the multiyear plan, they forward the information to the Projects Group. There is currently no clear definition of the information required to document the project at this stage. In the new Project Portfolio Management process, the Projects Group will review the proposal for completeness of information and update it as required. A preliminary budget will be entered according to the proposed level of expenditure, duration, and timing proposed. Once satisfied with the completeness of the information, the Projects Group will assign the project a permanent unique project number and add the project to the multiyear plan.

2.6.3 Assignment to Multiyear plan

Until 2009, the planning horizon focussed entirely on developing a plan to be included in the next year's annual budget. During the 2010 planning process, the Projects Group began developing a ten-year expenditure plan for major and minor capital expenditures. The intention is to have all proposed expenditures on a multiyear plan that facilitates evaluation based on some recognised criteria similar to that used in Project Portfolio Management. 2011 will see the start of developing longer term plans for other classes of expenditure.

The ten-year plan is a start at establishing a portfolio but, because of the limitations of the spreadsheets and inadequate resources to perform the analysis manually, the functions of portfolio management are not attempted. This is a significant concern when capital and manpower resources are limited. The recent requirement to complete for funding with major corporate initiatives further raises the bar and requires a more rigorous analysis and evaluation of all projects to ensure Trail Operations is selecting the right projects. The following quotation, attributed to most organizations, also describes the current situation in Trail:

“Notwithstanding noble efforts to do so, most organizations continue to fail in aligning their discretionary investment expenditures with the organization’s financial, strategic, and risk objectives. The decision making process in most organizations remains heavily politicized, intuition led, and silo prone” (Sanwal, 2007: 1).

On a regular basis, the Projects Group organizes a review of the projects on the multiyear plan for each area. The review provides an opportunity to reassess the project details, determine if a change in the situation warrants a change in the project status, and implement any changes identified. All proposals on the multiyear plan are reassessed annually. They move forward as

appropriate to further project development, move forward to meet an emergent need, or simply remain on the multiyear plan. A project may remain on the plan indefinitely or it move forward to pre-scoping for development as appropriate. The multiyear plan becomes the project portfolio; a collection of all proposed projects for the foreseeable future.

2.7 Select

Starting at the pre-scoping stage, this phase (Figures 5 & 6) develops the first detailed scope, cost, and schedule at a preliminary level; begins the evaluation process by examining the benefit, resource, risk, and strategic assessments leading to an overall project ranking; and ends when the project enters the feasibility stage. Currently, projects are recorded as ideas during the Create phase, but it is only after they have been proposed for the next or subsequent annual budget that detailed studies are initiated. This leads to rushed decision making and often incomplete projects end up on the next annual plan. After the annual budget approval, some of the rushed projects end up deferred to allow for further study or cancelled and other solutions examined and evaluated. The first step in the Select phase is the pre-scoping stage.

2.7.1 Stage 1: Pre-scoping

Pre-scoping studies are typically very preliminary and intended only to outline a potential expenditure. Also referred to as the “Idea Stage”; this is the first stage in the existing Stage Gating Process and is used to clarify the scope of work. For smaller projects, a concept review (See Figure 5) is done to identify options and resolve any questions. On larger projects, this stage (See Figure 6) is gated to get approval for funding to do an order of magnitude estimate.

The overall objectives of Stage 1 are to:

- Establish the need for a proposal.
- Establish conceptual scope for an order of magnitude study.
- Establish preliminary project justification.

The originating Owners Representative has overall responsibility for the execution of Stage 1. Although the overall duration of Stage 1 may vary considerably, the engineering effort required during this phase is typically minimal and generally measured in hours using in house engineering resources. Pre-scoping studies are typically based on minimal information, may be limited to paper studies, and may in some cases be somewhat hypothetical. In some cases outside engineering resources may be required to conduct a scoping study. The Engineering Coordinator in the Projects Group can provide assistance in working with outside engineering resources. The

plant will pay the costs at this stage. The stage terminates with Gate 1, which is the formal entry point for the Scoping stage. Given the often creative and preliminary nature of the pre-scoping work, this gate is generally treated as a 'soft' gate. The gate criteria are defined for guidance purposes, but the formal review processes are not as rigorously applied as at later gates

The degree of project definition and engineering at Stage 1 can vary depending on the nature of the project. At a minimum a Project Charter (Longman & Mullins, 2005) including the following are required:

- Project statement.
- Project objectives (deliverables).
- Project concept.
- Plausible justification.
- Back of envelop cost estimates (+ 100% /- 50 %).

The result of the gate will be to approve the project for further study, hold the project until its viability improves, or cancel it entirely. If approved for further study, it will move to Stage 2. For a guide to the required criteria at Stage Gate 1 see Appendix B.

Stage 1 is considered a 'soft' gate and may or may not conclude with a Stage 1 Gating Meeting. If a formal meeting is held, it requires the attendance of the following persons:

- Project Applicant
- Operating Manager
- Owners Representative
- Projects Manager
- Engineering Coordinator
- Manager, Maintenance Services
- Senior Manager of the area forwarding the project.
- Operations accountant or the accountant for the area forwarding the project.

Optional attendees (will attend at their discretion):

- Manager, Environment, Health, Safety, and Quality
- General Manager, Trail Operations
- Controller, Trail Operations

The result of the gate will be to approve the project for further study, hold the project until its viability improves, or cancel it entirely. If approved for further study, it will move to Stage 2.

2.7.2 Stage 2: Scoping.

A scoping study defines the overall scope of a project. The study aims to provide confirmation of existing assumptions related to project scope, cost, duration, and timing. This applies to capital projects only but significant non routine expenditures would benefit from this process. The result is an “order of magnitude” capital and operating cost estimate to serve as the basis of further study.

For projects valued at greater than \$300,000, this stage (See Figure 6) is the main vehicle for providing the supporting information to justify the further expenditure to fully define the project. For projects valued at less than \$300,000, the main vehicle (See Figure 5) for providing the supporting information is a Risk Based Benefit Analysis (RBBA - See Appendix A). The main issue with the RBBA is that it is not always used, not always completed fully, and no standards are applied to information provided. This can be resolved by applying the gate criteria (See Appendix B) in a judicious manner to these projects.

The scoping study intends to identify key areas of potential risk and uncertainty for future investigation, as well as the major configuration and options requiring study in the pre-feasibility study stage. The originating organization has overall responsibility for the execution of Stage 2. Although the overall duration of Stage 2 may vary considerably, the engineering effort required during this phase is typically minimal and generally measured in hours or days. The associated engineering cost of this stage will generally be less than 0.5 % of the total value of the project. The Projects Group funds the cost of the Stage 2 engineering study.

The degree of project definition and engineering at Stage 2 includes at least:

- Project objectives and preliminary design criteria,
- Conceptual process flow sheet, utility requirements, general arrangements and site location for each of the alternatives considered,
- Preliminary risk / benefit analysis or economic justification, and
- Comparative order of magnitude cost estimates (+/- 40 %).

This stage terminates at Gate 2, which is the entry gate for the pre-feasibility stage. Given the importance of Stage 3, this gate requires rigorous application of the criteria and detailed review during the Gate 2 review meeting. Stage 2 concludes with a Stage 2 gating meeting and requires the attendance of the following persons:

- Project Applicant
- Operating Manager
- Owners Representative

- Projects Manager
- Engineering Coordinator
- Manager, Maintenance Services
- Senior Manager of the area forwarding the project.
- Operations accountant or the accountant for the area forwarding the project.

Optional attendees (will attend at their discretion):

- Manager, Environment, Health, Safety, and Quality
- General Manager, Trail Operations
- Controller, Trail Operations

Gate 2 will review and answer the following questions:

- Have all the identified criteria for this gate been met (See Appendix B).
- Are project objectives, design criteria, and scope clearly defined?
- Have alternative solutions been appropriately considered?
- Have comparative cost estimates been done for each of the major alternatives considered?
- Does the Risk Based Benefit Assessment (RBBA – See Appendix A) support ongoing consideration?
- Does the business opportunity meet the required hurdle (payback, ROI, etc.)?
- What additional criteria should be considered during Stage 3?

The scoping study is the stage at which rigorous analysis and evaluation of projects will start. Prior to this stage, the details of the proposal are mainly conceptual and not amenable to serious scrutiny. The increased degree of project definition and engineering at Stage 2 enables a preliminary analysis and evaluation of the project to occur.

2.7.3 Analysis and Evaluation

In the current environment the only analysis and evaluation done is within each operating organization. It is usually limited to a rough assessment of the operating organizations most critically requirements, how much money the operation had to spend the previous year, and the time to get it done. The review at a Trail Operations level focuses on putting together a total budget that is within a dollar value that can be justified to the corporate office. The Analysis and Evaluation process includes the following components:

Benefits Assessment

Since more than 90% of projects presented are classified as mandatory it is generally felt that the benefits are so obvious that a real benefit analysis is a waste of precious time and resources. This occurs even though most involved readily agree that no project would be put forward unless some benefit is the result. Many times the benefits are improvements to operating rates, online times, or a reduction in maintenance costs.

Only opportunity projects receive rigorous benefit analysis and that is usually limited to ROI and payback calculations. In some limited cases, increasing market share or entering a new or emerging niche market may define the opportunity and in those cases; a more rigorous benefit analysis is completed and included in the formal presentation associated with the appropriation requisition when submitted.

Risk assessment

Neither project risk nor execution risk are evaluated formally. On some larger projects, an assessment of the risk to complete the project by the EPCM consultant results in funds set aside to address unforeseen issues. A regular review of these funds during the execution stage results in the reduction of the funds as consumed or the identified risks are reduced. The definition, evaluation, and management of risk (Kerzner, 2009) is a topic that needs to be further refined by Trail Operations.

Strategic Alignment

The project Create process promotes the identification of proposals through multiple channels and is approved by managers from different operating organizations. The problem with this decentralized authorization of projects is that each manager may prioritize his/her investment opportunities as “critical,” employ different criteria for approval, and select opportunities that support operating area strategy without consideration to overall Trail Operations current year priorities. Further, managers may not necessarily consider competing opportunities or the operational impact of independent decisions. Centralizing this function in a Project Portfolio Management tool, with predefined selection criteria, allows the Senior Management Team to assess and optimize the portfolio of opportunities to maximize benefits for all of Trail Operations, and in support of Trail Operations strategy.

Trail Operations usually only develops an annual tactical plan of objectives that are to be accomplished within the next 6 to 9 months. This plan focuses on current operational issues and provides some direction to address those issues. While some of these may lead to projects in the

future, none of them has a direct correlation to projects on the multiyear plan at this time. As a result, efforts to try to align projects to strategy are on hold. A more detailed analysis of Trail Operations strategy based on contingency theory is in section 3.2.

Resource Impact

Every project demands resources from the organization. Funding is only one resource, more often the resource that is most scarce is manpower. Trail Operations currently experiences delays in project execution and development because there are not enough people available to address all the issues related to moving a project forward. This is addressed to a degree by hiring consultants to work for and within the Projects Group on an ‘as needed’ or more often an ‘as available’ basis.

Review and Ranking

This is an ongoing process based entirely on the latest issues occurring in an operating organization. It may occur at different points in the workflow depending on what type of project is involved. There is a lack of formal evaluation and analysis and what occurs is based almost solely on individual’s intuition at the time. No overall ranking of projects is done except when a project requires an operating shutdown for execution. In those cases, the project moves forward to be available during the required timeframe.

2.7.4 Stage 3: Pre-feasibility or Senior Management RBBA Review

For projects valued at less than \$300,000, a Senior Management Review (See Figure 5) of the Risk Based Benefit Analysis (RBBA - See Appendix A) details is performed. The objective is to confirm the value of the project before authorizing an expensive estimate that will be suitable for the appropriation of funds. The review is a less extensive evaluation based on the criteria identified for a pre-feasibility gate.

For projects valued at more than \$300,000, a preliminary feasibility study (See Figure 6) is done. The pre-feasibility study is the most important stage in the project development process because when it is complete it must provide confidence that the correct project scope and business case moves forward through the increasingly costly project development process. Stage Gate 3 is the most important gate from a Project Portfolio Management perspective because it locks the company into a single option and authorizes much greater resource usage as the project is developed.

Usually the Projects Group; with support and input from Operations, Technical Representatives (See Glossary) and others as appropriate have overall responsibility for the execution of all projects during Stage 3. The originating organization has overall responsibility for project justification. Engineering effort during Stage 3 is generally measured in weeks and the associated cost will generally be less than 1.0 - 1.5 % of the total value of the project.

The degree of project definition and engineering at Stage 3 includes at least:

- Project objectives and design criteria are formally approved by Operations or others as appropriate,
- Complete the evaluation of any remaining alternatives and select one to advance to Stage 4,
- Complete a preliminary hazard / risk analysis, constructability review, and maintainability review,
- Confirm the justification of the project.
- Preliminary engineering design is completed. Process flow sheets, mechanical, ventilation, piping, civil, structural, electrical and instrumentation design is sufficiently advanced to establish general project scope and to confirm that the project can be executed as considered,
- Preliminary datasheets are established and budget pricing is obtained for major equipment,
- Pre-feasibility level cost estimate produced (+/- 25 %).

It is worth repeating that the pre-feasibility study is the most important stage in the project development process because when it is complete it must provide confidence that the correct project scope and business case moves forward through the increasingly costly project development process. As stated previously, Stage Gate 3 is the most important gate from a Project Portfolio Management perspective. It is most important that a thorough analysis and evaluation of the project occur at this stage.

Stage 3 concludes with a Gating meeting. Projects passing this gate expect to proceed to execution. The following persons will participate in a Gate 3 review.

- Project Applicant
- Operating Manager
- Owners Representative
- Projects Manager
- Engineering Coordinator
- Manager, Maintenance Services
- Senior Manager of the area forwarding the project.
- Operations accountant or the accountant for the area forwarding the project.

Optional attendees (will attend at their discretion):

- Manager, Environment, Health, Safety, and Quality
- Controller, Trail Operations
- Manager, Energy and Public Affairs (if potential PR issues)
- General Manager, Trail Operations

Gate 3 will review and answer the following questions:

- Have all the identified criteria for this gate been met (See figure 6 and 7)?
- Are the project objectives, design criteria, and scope, defined and approved?
- Is the review of alternatives complete and is the most effective solution presented?
- Does the Risk Based Benefit Assessment (RBBA – see Appendix A) support ongoing consideration?
- Does the Business Opportunity meet the required hurdle (payback, ROI, etc.)?

The outcome from the Gate 3 meeting will be that the project is either:

- Rejected and no additional effort will be expended,
- Recycled for further definition,
- Approved to proceed to Stage 4. A project will only be advanced to Stage 4 if it is almost certain (> 95 % probability) that the project will be executed.

2.8 Plan

Following the best practice approach, the Plan phase (see Figures 5 and 6) starts at the feasibility stage and defines the final scope, cost, and schedule; finalizes the evaluation of the benefit, resource, risk, and strategic assessments leading to an overall project ranking; and ends when the project enters the execution stage. Under current practices, operating organizations inform the Projects Group which projects they want on the next annual plan. Little specific project information exists with the listing because the process of developing projects and the storage of relevant documents is ad hoc and varies by organization. Basic planning is performed to the extent necessary to enable the execution of individual projects but many aspects of good planning are left to chance.

The only formal planning effort relates to capital projects based on the cost of a project. Projects valued at less than \$300,000 require completion of an internally developed RBBA (see Appendix A). For major capital projects, those with a cost greater than \$300,000, a feasibility estimate is required for approval.

2.8.1 Stage 4: Feasibility or Estimating

Stage 4, can be either a straight forward estimating effort for projects valued less than \$300,000 (Figure 5) or, for projects valued more than \$300,000 a full feasibility study and estimate (Figure 6) is developed. The feasibility study, leads directly to an implementation decision and the request for funds to proceed with the execution stage. A project rejected or recycled at this stage is an indication that the preceding stages have not functioned properly. The feasibility study provides a detailed evaluation of the selected single development option for the project. No significant project scope change from that approved at Gate 3 should occur; either during this stage or after this stage is complete. The Projects Group with support and input from the originating organization, Technical Representatives (See Glossary), and others as appropriate has overall responsibility for the execution of all projects in Stage 4. Engineering effort during this stage, measured in weeks or months, with costs of engineering effort typically 3 – 5 % of the value of the project. The Projects Group collects the cost of engineering in this stage and charges them to the project once approved. This cost must be included in the estimate as a separate line item.

Fully defined values for the rate of production, the production methods used, the process technology applied, and the associated infrastructure requirements form the basis for this study. A project start-up model which estimates cost and production ramp up establishes the working capital requirements. The overall objectives of Stage 4 are:

- Complete basic engineering (See Glossary).
- Complete evaluation of site conditions.
- Define project execution strategy.
- Establish a feasibility level estimate suitable for appropriation of funding.
- Complete final project justification.

Gate 4 is the point at which the organization usually commits to fully fund the cost of the project. Though important from a financial perspective, all the key decisions have really been committed at Gate 3 and failure to achieve the required hurdles at Gate 4 can result in significant loss of value. The degree of project definition and engineering at Stage 4 includes but is not limited to:

- Confirmation of previously established project objectives, design criteria, and flow sheets. These documents should not change after Stage 4 is complete.
- Basic engineering is substantially complete, approved by Operations or others as appropriate, and suitable for the start of detailed design. Mechanical, ventilation, piping, civil, structural,

electrical and instrumentation design is sufficiently advanced to clearly define the project scope of work.

- address all the identified criteria for this gate (See Appendix B)
- Hazard and operability reviews and, constructability and maintainability reviews are completed.
- Specifications and datasheets are established for all major equipment. Fixed price and delivery quotations are obtained for major / critical equipment.
- Engineering, project management, construction management, and project services estimates based on deliverables list or time and duration are completed.
- Preliminary project organization chart developed with named individuals.
- Feasibility level cost estimate produced (+/- 10 %).

Stage 4 concludes with a Gating Meeting. The intent of this meeting is a final verification of the project scope, cost, and justification prior to submitting the Appropriation Requisition for approval and initiating Stage 5 – Project Execution. The appropriation requisition will require an attachment of the detailed ranking of the project based on an update analysis and evaluation of the project. The following persons will participate in a Gate 4 review.

- Project Applicant
- Operating Manager
- Owners Representative
- Projects Manager
- Engineering Coordinator
- Manger, Maintenance Services
- Senior Manager of the area forwarding the project.
- Proposed Project Manager
- Operations accountant or the accountant for the area forwarding the project.

Optional attendees (will attend at their discretion):

- Manager, Environment, Health, Safety, and Quality
- Controller, Trail Operations
- Manager, Energy and Public Affairs (if potential public relations issues)
- General Manager, Trail Operations

Gate 4 will review and answer the following questions:

- Are the project objectives, design criteria, and scope of work sufficiently defined and approved by operations?

- Is the feasibility estimate complete?
- Have all the identified criteria for this gate been addressed (See Appendix B)
- Does the finalized Risk Based Benefit Assessment (RBBA – See Appendix A) support advancing the project to execution?
- Does the business opportunity meet the required hurdle (payback, ROI, etc.)?

The outcome from the Gate 4 review will be that the project is either:

- Rejected and no additional effort will be expended,
- Recycled for further definition,
- Agreement to submit Appropriation Requisition.

If the project receives approval to advance to Stage 5 – Project Execution it is usually a formality to receive formal approval of the Appropriation Requisition.

2.8.2 Approval

The Appropriation Requisition (AR – See Glossary) is a document used to provide a summary of key project characteristics and financial benefits, confirmation of the completed Stage Gate reviews and a record of the signatories who approved the capital expenditure. Supporting documents such as the Gate Review Committee recommendations are attached. The originating organization ensures the AR is prepared and submits it with the necessary supporting documentation for approval by the appropriate organization signatories. It is the formal vehicle for recording the authorization of major project expenditures. The AR is one of the key documents supporting the governance of the project process.

Based on the expenditure level, project approvals are required from the level of the individual Operating Manager up through the hierarchy to a predetermined level of authority. For projects less than \$300,000 approval up to and including the Manager, Operations is required. For projects from \$300,000 to \$500,000 approval up to and including the General Manager, Trail Operations is required. For projects greater than \$500,000, approval by the Chief Executive Officer in Vancouver is required.

In rare cases, approvals to proceed occur by the top level of approval required without following the gating process. This may occur for a variety of reasons but most often, it is in order to expedite the execution of the project. The Project Portfolio Management system must be able to accommodate this modified workflow while clearly documenting the reasons for circumventing the normal workflow.

2.9 Manage

Project Portfolio Management is required during the Manage phase (See Figure 5 & 6) to ensure that all the objectives identified earlier in the project process are achieved. The Manage phase implements the final scope, cost and schedule through the execution stage; utilizes the final benefit, resource, risk and strategic assessments to realize the intent of the project; follows through the operation and completion of the project; and ends when the project enters the ready-for-learning stage. It is during this phase that all the planning turns into reality.

It is interesting to note that even with all the effort to improve the project process, in general, industry has issues with developing the correct projects as demonstrated by the following:

“Large capital projects remain a source of challenge for most organizations despite the widespread efforts and attention given to these projects. Research reveals that a significant number of executives deem the process as ineffective as a result of gamesmanship, politics, and conflicting views on organizational priorities. The ultimate outcome of this ineffective process is suboptimal funding to projects that are not worthy of investment” (Sanwal, 2007: 104)

2.9.1 Stage 5: Execution

Approval of the appropriation requisition marks the entry into the execution stage (See Figures 5 & 6) of the project. Stage 5 concludes with the completion of construction and commissioning activities and the formal handover of facilities to Operations. Typical project management efforts are required to execute the project. The overall objective of Stage 5 is to execute the project scope as previously defined in Stage 4 with no fundamental changes. Completion of the associated engineering, procurement, construction, and pre-commissioning activities occurs during this stage. Engineering effort during this phase will be as defined within the feasibility study. Cost of all activities during this phase, including engineering, procurement, construction, 3rd party commissioning and incremental and pre-defined operating and maintenance costs, are capitalized and funded from the approved appropriation requisition.

Depending on the magnitude of the project, the Project Execution stage may be very straight forward as in the purchase of heavy equipment or it may be further broken down into smaller stages, such as:

- **Detailed Engineering:** design work is completed to the point where specifications and datasheets are prepared for all equipment. Construction drawings are prepared to provide the basis for tenders for bid or use in construction.

- **Construction:** the major fabrication and construction contracts tendered for bids, analysed, awarded and controlled in accordance with the contracting strategy and established procedures. Engineering is completed, and equipment tendered and procured in accordance with the procurement plan. Formal change control, cost reporting and forecasting occurs.
- **Commissioning:** the project transitions from construction to operation. This stage includes the transfer of custody of the physical facilities and the verification of construction completion, conformance with quality standards and achievement of performance objectives. It also represents the culmination of all the operations readiness planning activities which must ensure that a viable operations team is in place to start-up and assumes operation and management of the constructed facilities.

Project execution occurs under the direction of a Project Representative (Project Manager or Project Coordinator) working with an Owners Representative from the sponsoring organization. In practice, the depth of involvement of the organization tends to vary inversely with the size of the project. Larger projects are left more to the Project Representative simply because Owners Representatives have jobs within the organization that they must continue to perform and they do not have enough time to get deeply involved in large projects. Smaller projects tend to be left to Owners Representatives to complete since there are not enough Project Representatives to be assigned to all the projects and smaller projects usually need to be more closely integrated into the operating regime of the plant.

In any case, the project management effort is limited by the lack of depth in the Projects Group. In most cases the actual project management and control is left to the originating organization or an EPCM contractor for major projects or a general contractor for minor projects, the depth of involvement by Trail Operations personnel is best described as project monitoring.

Project Portfolio Management is not intended to replace established project execution systems but may provide a repository for Project information such as records of progress, contract documentation, quotations, associated documentation, and in particular, the monthly changes to actual costs and revised forecast cash flows. From this information, a series of reports required by different groups is generated on a monthly or as requested basis.

Stage 5 concludes with the completion of construction and commissioning activities and the formal Assumption of Control (See Glossary) of facilities by Operations. A Gate 5 Project Completion Review may be held to ensure that the facilities are supplied and installed in accordance with agreed scope of work and is ready for start-up.

The following persons will participate in a Gate 5 Project Completion review.

- Owners Representative

- Operations and Technical Representatives
- Project Manager
- Construction Manager
- Commissioning Representative
- Construction Coordinator

A Gate 5 Project Completion Review will answer the following questions:

- Are facilities installed per specified requirements?
- Have deficiencies been identified and corrected?
- Have equipment and controls been commissioned?
- Have Operations formally assumed control of the facilities?

The outcome of the Gate 5 Project Completion Review will be that the project is either:

- Held pending resolution of outstanding deficiencies, or
- Advanced to Stage 6 - Start-up and Operation. The capital phase of the project is closed.

Completion of project execution and handover to operations occurs at Gate 5. This gate is a 'soft' gate because the option to recycle or stop a project is extremely remote. Gate 5 is still important because it documents the milestone of execution completion and provides for a formal evaluation of readiness for operation.

2.9.2 Stage 6: Operation

At the completion of the execution phase, the operating organization proceeds through a number of steps to bring the new facility up to operating levels. This varies dramatically with the type of project and the scope of work involved. The large process projects require pre-commissioning checks, commissioning review, equipment tests, and feed on testing before the facility actually starts operating.

The introduction of process materials into the project facilities with the intention of producing final product is the beginning of Stage 6 and it concludes when the facilities have achieved a minimum of 75 % of design capacity. The originating organization has overall responsibility for activities in Stage 6. All costs during this phase are considered operating costs and are expensed. However, if significant deficiencies are identified related to the new facilities, the cost to resolve the deficiencies may be considered project costs and may be capitalized.

For major projects, a Post-Implementation Report is often required. The originating organization is responsible for initiating the review and for directing the preparation and submission of the report to the Gate Review Committee. The findings of the Post-Implementation

Report become part of the project information. The report should provide documented evidence of the following:

- Predicted project benefits realized.
- The most effective operational processes designed.
- The project actually met the Business Unit's needs.
- The project benefits contributed as planned to the overall strategy and business goals.

The introduction of a Project Portfolio Management System does not significantly impact this stage. Improvements in document flow and notifications may evolve out of the improved document storage and retrieval capabilities. Consideration of a standard template for the major projects Post-Implementation Report is a later refinement of the system.

2.9.3 Stage 7: Ready-for-Learning

The ready-for-learning stage is where the lessons learned are identified and documented. In some cases a special review is held during Stage 5 – Execution. The special review occurs, if significant trends or issues (cost, technical, constructability, schedule, safety, etc.) are identified that may significantly jeopardize the ability of the project to deliver on its primary objectives. The outcome of this special review will be to:

- Cancel or abandon the project. Cost incurred to date will be expensed.
- Proceed with the project scope as is and accept that cost will exceed approved funding. A supplemental appropriation will be required if funding exceeds the approved appropriation by more than 10 %. A trend notification is required to notify the Senior Management Team of the situation.
- Proceed with a modified scope. A Project Change Notice form that documents the change and any potential impacts is required to formally add or remove identified scope from the project and must include the cost and schedule implications of the scope change.

Project audits are rarely performed but if one does occur, it is usually part of a general financial audit. For some projects, post mortems occur that focus more on analysing the execution efforts, costs, and schedule rather than determining if identified benefits are actually achieved. Major capital projects may undergo a Post Expenditure Audit after project completion of Stage 5. The Finance Department usually has overall responsibility for this Audit. The Post Expenditure Audit analyzes the accuracy of the project's original forecast and explains any significant variations from the original Appropriation Requisition. Significant variances in the project scope, expenditures, operating costs and/or revenue forecasts are reported and explained.

A Project Closeout Review is an approach to record a project's performance and capture any lessons learned, best practices, and knowledge gained which would benefit future projects. This includes both 'hard' data and 'soft' information. The former is relatively easy to extract from project documents while the latter requires time spent with the personnel involved in the project to extract pertinent pieces of information and document experiences. Project Closeout Review ends when all relevant project data and information and the derived best practices and lessons learned are stored in a repository that facilitates access and retrieval by managers of future projects.

Since all project information is available in the Project Portfolio Management system it will form the chief source of information used during audits. In addition, there is a capability to develop an audit function that automatically generates standard reports of changes through the life of the project. The results of the Post Expenditure Audit and the Project Closeout Review will be stored in the project website and found through a search of all the projects websites.

2.10 Summary of Trail Operations Project Issues

Trail Operations is working to improve its profit profile by implementing opportunity projects that expand the ability to consume new feed stocks and the capacity to produce niche products. These new investments must compete with other Teck Resources opportunities and provide either a greater return on investment or other justification for the expenditures. To compete with other Teck Resources opportunities and continue current funding, Trail Operations must improve the processes involved in project identification, development, and execution. The preceding reviews of existing and best practice techniques have identified improvements in Trail Operations processes that are categorized and detailed as follows:

ESTABLISH COMPLETE PROCESS WORKFLOWS

- ❖ Incorporate outstanding project governance requirements,
- ❖ Revise stage gating at Trail to:
 - ✓ Follow the corporate Stage Gate Process as much as possible,
 - ✓ Include a detailed Create phase,
 - ✓ Include a detailed Ready-To-Learn phase,
 - ✓ Develop links between the project Stage Gate Process and the Trail Operations Technical Development and Business Development Stage Gate Processes,
 - ✓ Provide greater rigour to Risk Based Benefit Analysis (RBBA) process.
- ❖ Reduce the complexity by developing workflows independent of minor project differences.

- ❖ Implement program management in addition to project management.
- ❖ Incorporate flexibility that allows appropriate projects to pass through unnecessary gates.

ESTABLISH A PORTFOLIO APPROACH TO PROJECTS

- ❖ Have all proposed expenditures on a multiyear plan,
 - ✓ Define long term expenditure forecasts,
 - ✓ Define the annual requirements for engineering studies or additional proposal research.
- ❖ Follow newly established workflows to;
 - ✓ Move projects through development and onto an annual expenditure plan,
 - ✓ Develop document management system,
 - ✓ Develop audit support tools and systems.
- ❖ Produce reports required by different groups, generated on a monthly or on request basis.
- ❖ Implement links to other systems to reduce input efforts.
- ❖ Replace existing spreadsheets,
 - ✓ Eliminate multiple spreadsheets of the same or similar information.

ESTABLISH PROJECT EVALUATION

- ❖ Establish rigorous evaluation methods to allow the optimization of project selection.
 - ✓ Benefit identification. For all projects.
 - ✓ Risk assessment. Both project risk and execution risk.
 - ✓ Resource assessment. Start with manpower and expand.
 - ✓ Strategic alignment. Need time for Trail to establish a definition of strategy.
 - ✓ Analysis and evaluation. Use weightings and ratings for each category to establish a rank.

3: Proposed Solutions to Project Issues

3.1 Introduction

The previous section reviewed a ‘best practices’ framework for projects, identified related issues with Trail Operations project processes and summarized the issues that need to be addressed in any solution. This section will elaborate on the organizational characteristics of Trail Operations, define selected solutions to the identified issues, and discuss proposed methodology for implementing the identified solution.

3.2 Trail Operations Organizational Characteristics

Implementing change in organizations requires careful planning and a consideration of the characteristics of the organization and situation. Contingency theory (Donaldson, 2001) is a class of behavioural theory that proposes that the best course of action for an organization depends (is contingent) on the organizations internal and external situation. The essence of Contingency theory is that organizational effectiveness results from fitting characteristics of the organization, such as structure, to contingencies that reflect the situation of the organization. The better the ‘fit’ the more high performing the organization will be. Contingency theory is dynamic, as the situation changes the organization will adapt to maintain the appropriate fit. Contingency theory says maximum performance results from adopting, not the maximum, but rather the appropriate level of the structural variable that fits the contingency. The three main contingencies considered and the evaluations relative to Trail Operations are:

- **Environment;** the rate of process technology and market change for an organization determines whether an organization is mechanistic (hierarchical) or organic (participatory) in structure. Trail Operations experiences very slow changes in process technology, its market is primarily commodity based and is relatively stable so it has a low environmental velocity (McCarthy, Lawrence, Wixted, & Gordon, 2010). Contingency theory says this is an example of a mechanistic or hierarchical organization. The hierarchical structure is efficient for routine operations. The operating units in Trail tend to be routine which enables Senior Managers to possess all the knowledge and information necessary to make quick decisions and the centralized control promotes efficiency. Trail makes a variety of products but they all come

from the same basic source and result from repeated recycle and is classed as vertically integrated.

- **Organizational size;** Trail Operations is physically a very large facility with about 1500 employees. According to contingency theory, larger organizations tend to have a bureaucratic structure identified by features such as: repetitive operations and administration, and rule driven decision making which allows decisions to occur at the lowest appropriate level of the organization. Employees at Trail are encouraged to make decisions that are in their area of control and use their expertise to maintain routine operation. The rules around the definition and scope of control provide a framework for employees to exercise their decision making.
- **Organizational Strategy;** the operating areas at Trail Operations are identified by the functions they perform in the overall process. The area activities are focused on one main product and dealing with any by-products produced in an appropriate manner. This operating area specialization promotes enhanced efficiencies. Contingency theory would indicate that this promotes a type of strategy defined as an ‘Achieved Strategy’ that is manifested in a set of concrete activities rather than a strategy of intentions. This reflects in the broad strategic goal of maintaining full production levels through improved equipment reliability and increased process on line time.

Contingency theory analysis of Trail Operations defines it as an organization with a mechanistic (hierarchical) management system. In such a system, decision-making takes place within a controlled and familiar framework; individual employees are responsible for well-defined tasks; functions are precisely defined; control, authority, and communication are hierarchical; interaction between members is typically between subordinate and superior; there is a requirement for obedience to superiors; and a greater importance is attached to internal (local) than to general (cosmopolitan) experience and skills. (Donaldson, 2001) While there are exceptions to this description, it is fairly accurate for Trail Operations.

Extrapolating from this information provides insights into this entire project. Some people might have a concern at the increase in rigour and formality proposed until they read the above characteristics for Trail Operations. This reinforces the role of the Senior Management Team. A functional strategy that focuses on ‘achieved strategy’ as opposed to ‘a strategy of intentions’ is precisely what Trail Operations uses. While not specified precisely, the underlying strategic message is to reduce costs and increase production levels.

Understanding these characteristics, and having them reinforced through experience at Trail Operations, provides insight into how the project process issues identified can be addressed and integrated into the regular functioning of Trail Operations. In some organizations, applying a

tool that forces a large degree of compliance may be considered onerous while at Trail it is considered part of the regular management of roles that allows for significant freedom for decision making at the most appropriate level. One might conclude that some of the issues identified in the current project process are the result of a lack of clarity of roles and tasks.

3.3 Establish Complete Process Workflows

The existing project process is well established and operating in a reasonable fashion. As previously discussed, there are issues with its implementation best summarized as lack of rigor in its use. While rigor is very important to ensure all aspects of the process are addressed, it is necessary that in clearly identified situations the rigor can be circumvented with appropriate oversight and approvals. This level of flexibility is difficult to apply in a mainly manual system because once the method of circumventing aspects is available it will tend to be abused. In addition, with a manual system, the resources necessary to provide oversight to prevent abuse becomes an issue.

The project governance issues are almost entirely related to the lack of rigor in the process. A review of the specific items discussed reveals that all of them are in place to some extent. This situation has developed even though written procedures are in place that relate to most items. The outstanding items relate to resource availability and competency, analysis and evaluation that require other resources, and not being able to see a broad enough picture of required expenditures into the future. Revising the workflows and implementing them in a system that cannot be overridden without Senior Management Team approval will address these issues.

The heart of the workflow for projects at Trail Operations is the Stage Gate Process. Modifying the existing one-size-fits-all approach, addressing the specific issues identified, and using the lessons learned by others (Cooper, 2009) to revise the Stage Gate Process is a good first step. The use of established criteria for each stage is critical to demonstrate the fair and equitable application of the new process for all users is another. Ensuring the revised Stage Gate Process is used consistently and appropriately is a much larger problem. The consensus amongst users is that only an impartial tool or system that forces compliance can resolve this problem.

The current implementation of the Stage Gate Process is not perfect but it does provide a good foundation to build upon. The Senior Management Team is familiar with the Trail Operation's Stage Gate Process and is aware that it requires modification to facilitate easier corporate review of major projects through better alignment with the corporate Stage Gate Process. Having a process in Trail that is more similar to the corporate process will simplify the presentation and approval of the recent opportunity projects. Establishing links with the Trail

Operations Technical Development and Business Development groups Stage Gate Processes are required.

The first issue identified during review was the total lack of a standard workflow related to the entire 'Create' process. This resulted in the development of a three step workflow (see Figure 4). Operating areas existing spreadsheets of proposed projects are unique to each area and lack consistency. Using a common workflow and criteria for proposal identification will level the playing field, provide a common approach that is transferrable between areas, and encourage better initial analysis of proposals. All associated data and information can be entered with the basic project set up.

A similar situation exists for the Ready-To-Learn phase of projects. Audits are infrequent and usually triggered by problems during the project execution. Reports are produced but the information is not distributed and available so others can learn from the mistakes that occurred. Having a system that first records all the relevant information and can quickly produce meaningful reports will enable more frequent and efficient reviews that will encourage increased use of audits as learning tools.

The present system of having a 'modified' workflow for almost every project is confusing and inefficient. A system that allows for flexibility within a few basic workflows but applies a degree of rigor will encourage closer adherence to mandatory requirements. The ability to skip gates when deemed necessary by Senior Management Team will discourage attempts to circumvent the project process.

3.4 Establish a Portfolio Approach to Projects

The ability to have all identified projects in one system accessible by any appropriate user is critical to Project Portfolio Management. Users will be able to update project parameters as the changes develop and ensure the project data is kept current. This will enable the development of long term expenditure plans by type of expenditure and allow Trail Operations a degree of certainty when reviewing future plans with the corporate office. In addition, multiyear plans for studies, estimates, and engineering resources can be developed and fine-tuned. This will also provide improved negotiating power when developing contracts with Engineering Consultants.

As a project moves through the various stages, the improved decisions should reduce the occurrence of projects added to the annual plan when they are not ready to move to execution and allow for full use of approved funds. Establishing a Project Document Management System using templates to collect the required information is part of this effort. Documents like; a Project Charter in a basic form, project objectives and a statement of the problem addressed by the

proposed project, provide a degree of commonality during the gate review process and improve the quality of the decisions. This improved collection of documents and information will enable improved auditing, and reporting for a variety of groups and requirements.

Establishing data links to other systems and automatically transferring data will improve accuracy and currency of all the information in the system. This will also address the desire for an ‘enter once’ approach to cost data. Other links to systems like the maintenance management system will ensure accurate project information is available for the development and implementation of maintenance processes and documents. The development of a Project Portfolio Management System will allow the elimination of the existing spreadsheets and enable a collaborative effort to maintain and evaluate projects

3.5 Establish Project Evaluation

The development and implementation of a project analysis and evaluation system in the Project Portfolio Management System is required but not urgent. Centralizing the analysis and evaluation function in the Project Portfolio Management System, with predefined selection criteria, will enable the Trail Operations Senior Management Team to assess and optimize the portfolio of projects to maximize benefits for all of Trail Operations, and in support of Trail Operations strategy. The Project Portfolio Management System has provision for all the ranking aspects but does not require them to be in place to allow the system to work. This provides an opportunity to phase the implementation of these features. When fully implemented the process will be used at each stage and will include:

Benefit Assessment: identified improvements to operating rates, online times, or a reduction in maintenance costs are available through links to existing monitoring systems to record any improvements. The rigorous benefit analysis opportunity projects receive will be continued and may be expanded.

Risk Assessment: both project risk and execution risk need to be evaluated formally. The opportunity to implement more detailed risk analysis (Kerzner, 2009) will be utilized when resources become available.

Resource Assessment: resource loading for the group of people involved in project development and execution is required to prevent unnecessary delays and missed milestone dates. These are important inputs into the Project Portfolio Management System, because in order to make well-informed decisions, management must understand the demand for resources, not just on current and future projects, but for development activities, as well. The resource management

process looks at the entire pool of workers and capacity of available infrastructure to support all projects. This is one of the first evaluation criteria identified for implementation.

Strategic Alignment: All projects should support, in some form, the overall strategy of Trail Operations. The methods used to identify weightings and ratings associated with strategic alignment will require the commitment of the Senior Management Team at Trail Operations. Trail Operations strategy needs more detailed definition and criteria developed to allow better ranking of each project.

Overall Ranking: The combined weightings and ratings of all four categories will establish a ranking number for use in comparing projects of various types and plant criticality. The ranking should not be used exclusively to select all projects but is a guide to relative ‘fit’ with Trail Operations objectives and capabilities.

3.6 Project Portfolio Management System Selection

The consistent response to discussions concerning improving or evolving the current project process has been a unanimous desire to implement the majority of functions, requirements and data collection in a computer system. The personnel involved feel strongly that an appropriate software system can prevent duplication of entries, provide a common approach to project development, allow broader access to information, enable automated approvals and report generation, provide for information storage through the life of the project, and allow for audits at any time through the project process.

To ensure the identification and selection process will address the issues identified this effort must be performed in two steps. First, define the selection criteria that any proposed solution must meet based on the identified issues and evolutionary direction that Trail Operations is trying to follow. Second, review available options and compare to the criteria identified. If a number of options meet the project based criteria, the final selection will focus on service and support availability.

Solution Criteria

Best Practice (Project Management Institute, 2004) indicates that Project Portfolio Management can be partially automated to facilitate execution of complex tasks to make them easier to manage and work. It notes that Project Portfolio Management systems following a formal methodology supported by appropriate technology tools face lower risk and more

predictable outcomes. This does not mean that technology is the total answer as the following quotation from 2007 indicates:

“In fact, despite the emergence of myriad project and portfolio management (Project Portfolio Management) tools, most, to this point, are glorified data aggregation and reporting tools. Technology, thoughtfully applied, can help you enable the process with greater efficiency, accountability, and transparency, but is not the solution or even one of the most essential components of the solution” (Sanwal, 2007: xix).

What all this means is that the technology selection process must focus on addressing the identified needs and support the development indicated. Overall, the need is to establish better project governance and establish rigorous workflows while maintaining some flexibility to be able to deal with the wide variety of projects identified annually at Trail Operations. Developments in Project Portfolio Management Software since 2007 have focussed on utilizing workflow to provide definition and rigor to the system.

The criteria identified for evaluation of possible software systems are:

1. Establish rigorous project process workflows:
 - Able to support the existing Stage Gate Process,
 - Some ability to differentiate between the types of expenditure,
 - Automate the registration of approval to move to the next stage,
 - Flexible enough to allow skipping steps with the proper approvals.
2. Provide a listing of all projects on the multiyear plan.
3. Ability to record status based on the applicable gate criteria.
4. Able to track budget, forecast and actual costs.
5. Ability to incorporate at least a milestone level of schedule.
6. Increase the rigour in project selection process through analysis and evaluation based on:
 - Benefit.
 - Resource requirements.
 - Risk.
 - Strategic alignment.
 - Overall ranking.
7. Resolve the continuing problems with spreadsheet and reports.
8. Fits with Corporate and Trail Operations Information Systems direction.
9. Optional ability to store project documents through the life of the project.

3.7 Project Portfolio Management System Support

As previously identified, manpower is an issue for the Projects Group at Trail Operations and while implementing Project Portfolio Management System will make people more effective in their roles and reduce rework and wasted time due to a more rigorous project workflow process, it will require support. Large organizations identify three roles (Soodek, 2008) that are required to implement and support Project Portfolio Management System:

1. **System Integration:** The guarantee of overall program success greatly increases if a Project Portfolio Management tool subject matter expert guides the organization through initial stages of implementation. This is in place through the use of experienced consultants for the initial implementation.
2. **Process Analysts:** During implementation, process analysts work closely with the systems integrator to examine and revise processes, generate configuration requirements, and drive training initiatives. Members of the Projects Group, acting as process analysts, are actively involved in the development of revised workflows, Stage Gates, stage criteria, definition of approval groups, definition of access levels and groups, and other process related issues.
3. **Administration:** The two key functions required are application and infrastructure administration. These functions will outlive the tool implementation program and are required as long as the tool is in production. These two functions have been combined into one role and efforts are underway to hire a person to fulfill this role.
 - a. **Application Administration:** configuration and customization of the application to fit the specific requirements of the customer; add and delete users and maintain role-based access groups, maintains calendars, manages schedule templates, and provides end-user support.
 - b. **Infrastructure Administration:** provides database administration, backup and recovery activities, application upgrades and fix packs, data and configuration migrations.
4. **Training:** The importance of training and communication must not be underestimated to drive Project Portfolio Management success. Trail's plan calls for full deployment over two years, with functional deployment occurring in a phased fashion. As new features go online, additional training materials and efforts will be required, not to mention revisions to initial training that that are required to support procedural maturity that will evolve over time. The system administrator will be responsible for developing and executing these training programs.

4: Project Portfolio Management Implementation Plan

The physical aspects of implementing Project Portfolio Management flow from the discussion in section 3. By grouping and sequencing the issues identified and working on a phased implementation approach, the following plan for the physical implementation has been developed:

PROJECT PORTFOLIO MANAGEMENT IMPLEMENTATION PLAN

Phase 1

1. Develop revised process workflows and Stage Gating.
 - a. Update and issue Trail Operations Stage Gate Process for projects,
 - i. Reflect Teck Corporate Stage Gate Process.
 - ii. Incorporate ‘Create’ and; Ready to Learn’ phases.
 - iii. Develop links to Technical and Business Development Stage Gate Processes.
2. Select a Project Portfolio Management system to support the process as much as possible,
 - a. Establish selection criteria to find a suitable solution.
3. Configure the tool with revised workflows and Stage Gate Processes;
 - a. Define attributes,
 - b. Load the existing ten year plan,
 - c. Test the ten year plan download.
4. Develop system support resources;
 - a. Identify specialist support for the implementation of the technology chosen,
 - b. Hire and assign a system administrator.
5. Test and confirm that the system operates to meet all requirements.

Phase 2

6. Establish data links to other systems as required.
7. Establish a Project Document Management System.

Phase 3

8. Develop evaluation criteria and configure.
9. Implement evaluation system.

The physical aspects of implementation flow directly from Section 3 but there are other aspects that need consideration when implementing the changes proposed. The other aspects are

not project process specific but related to the organizational environment and culture. The following section will develop an implementation plan to address the physical aspects identified and incorporate cultural change considerations.

4.1 Cultural Considerations and Implementation

One pitfall of implementing a Project Portfolio Management System is to focus too much attention on the Project Portfolio Management tool and not enough on the impact on the people involved in the change. The tool will drive more process formality and facilitate end user accountability, but in the process, it has the ability to frustrate users and turn them against the effort. The following comment by John P Kotter, one of the leading experts in organizational change that has studied a wide variety of organizational change efforts puts this requirement in perspective (my **emphasis**):

*“Our main finding, put simply, is that the central issue is never strategy, structure, culture, or systems. **All those elements, and others, are important.** But the core of the matter is always about changing the behaviour of people, and behaviour change happens in highly successful situations mostly by speaking to people’s feelings. ... In highly successful change efforts, people find ways to **help others see the problems or solutions in ways that influence emotions, not just thought**” (Kotter & Cohen, 2002, preface page x).*

At Trail Operations, the group of people involved to any extent in the project process is relatively small: eight senior managers, twenty eight in the projects group, two in finance, eight operating plant managers, and eight plant area representatives for a total of fifty four people. Sixteen of these people only provide approvals or review the reports from the system so only thirty eight people actually use the system regularly. All of these regular users have experienced issues related to the existing, or more to the point, lack of existing systems to make their work more efficient. While this may make generating support simpler because fewer people are involved it does not alter the fact that this effort is an organizational change and time is required for people to adjust.

“...the change process goes through a series of stages that, in total, usually require a considerable length of time. Skipping stages creates only the illusion of speed and never produces a satisfying result (Kotter, 1995).”

The detailed effort required to support the implementation of the Project Portfolio Management System has aspects of a business transformation. Literature allows an approach to the requirements from two directions: what are the *steps required to address the transformational issues* (Kotter, 1995) and what *errors have people made in the transformational process* (Kotter,

2002). These perspectives provide a good vehicle to identify what needs to be done to help personnel deal with the behavioural changes required (each point is titled with the *steps required to address the transformational issues* followed by the *errors have people made in the transformational process*):

1. Increase Urgency - Not establishing a great enough sense of urgency

The urgency for Project Portfolio Management at Trail Operations is clearly defined by the two major projects that are being described as key to Trail's future. Public meetings with the community and Teck Trail personnel have focused on the long term benefits and opportunities that these projects represent. Management at Trail has stated that these projects are critical to maintaining Trail's viability. The current plan is for the presentation of these projects to the board of directors in the late fall of 2011. For these projects to receive approval by the board of directors, one of the things Trail needs to be able to demonstrate is a comprehensive approach to project development and execution. Project Portfolio Management provides the multiyear expenditure projections that facilitate development of multiyear profitability plans that are required to offset these expenditures. It also provides the data to develop manpower and other resource plans and demonstrate Trail's ability to execute all identified projects appropriately.

The challenge to provide the supporting multiyear expenditure projections was presented to the Projects Group by the Controller, Trail Operations in 2010. This led to the effort to develop a ten year expenditure plan during 2010. Recognizing the existing ten-year plan as a good first step identifies the requirement for refinement and integration into the overall project process to ensure credibility. The Projects Group also recognizes that personnel involved in the use of the existing variety of systems to identify and develop projects have identified the inherent limitations and problems related to the continued use of those systems and have asked for improvements. Key to resolving these issues are improved access and functionality by active project process users.

2. Build the guiding team - Not creating a powerful enough guiding coalition

The Projects Group at Trail is responsible for the development of all expenditure proposals that require an appropriation requisition and approval by the Senior Management Team. Using Projects Group personnel, operating area employees, engineering consultants, technical specialists, and others address this responsibility. The personnel assigned the task of developing proposals turn to the Projects Group for support and assistance in working through the process. As a result, the Projects Group is leading the Project Portfolio Management System effort with active support from Trail Operations Senior Management Team. Plant representatives

and members of the finance department are active members of the guiding team. In summary, all fifty four previously identified participants are involved to varying degrees as part of the team in the project process. The thirty eight regular users are routinely involved in the Project Portfolio Management implementation process.

An important aspect of any software system implementation is the use of experienced consultants to assist in the initial configuration and definition of the system. Corporate and Trail Information Systems groups have been acquiring the services of many consultants to support their new technology efforts and have been able to provide appropriate resources to support this project.

3. Get the Right Vision - Lacking a vision

Creating a 'vision' is a necessary but difficult effort (Thomas, 2001). Trail Operations is proof of this statement. Changes at Trail traditionally have not had guiding visions. Changes to business processes are considered part of a continuous improvement effort and so the development of a vision statement is not applicable. Part of this approach is a concern that the 'vision' may be limiting and actually work against the effort defined in step 8: *Make it Stick - Not anchoring changes in the corporation's culture*. The attitude appears to be that when the process change is implemented appropriately there is no other option to getting the work done.

Concern about the lack of a specific 'vision statement' for the Project Portfolio Management project has led the team to link this effort to previous efforts. Over the past four years, Trail Operations has undergone a series of initiatives to develop 'best practice' processes in maintenance and operations. While not documented as such, the underlying 'vision' identified focuses on improving all business processes at Trail to a 'best practice' level. This impression is being used in the implementation of Project Portfolio Management System by stating that Project Portfolio Management System extends the vision into the project development and execution processes. The potential impact of the lack of a 'vision' is partially offset by the relatively small group of people actively involved in the project process. All of them have participated in the Project Portfolio Management effort and understand the objectives and the positive impact achieving them will have on their work.

4. Communicate for Buy-in - Under communicating the vision

The kick-off of the effort to develop Project Portfolio Management was an all-day session with Projects Group personnel and active plant representatives to review the project process and establish requirements for change. This session discussed the 'vision' of this effort as an extension of the 'best practices' vision and confirmed the idea that Project Portfolio

Management was the next step in the evolution of projects at Trail Operations. The summarized result of that working session is in section 3.

Regular project development sessions are held with the software implementation consultant. These sessions include members of the active users group either directly or through consultation between sessions. Everyone realizes it is a balancing act between providing opportunities for meaningful involvement and not interfering in the ongoing work of the people involved. As progress occurs, care to control rising expectations to all levels of the organization is required. Each incorporated development provides a better understanding of the positive impact the final system will provide and the response has been very supportive.

5. Empower Action - Not removing obstacles to the vision

Regular demonstrations of the new system and its functionality improve understanding and increase buy-in. In addition, a ‘sandbox’ version of the system is available for personnel to use to experiment with its functionality and features, and raise issues when they encounter difficulties. This has resulted in changes to the configuration and definition of system attributes and support in the development of new process workflows and Stage Gate definitions.

System Attributes

The implementation of a Project Portfolio Management System requires the more thorough definition of a variety of attributes associated with the workflow and Stage Gate Processes. These attributes are mainly associated with details that were previously ‘understood’ but not clearly defined. First, a system of linking proposed projects to the area making the proposal is required. This was resolved by making use of the existing Operating area identifiers used in the financial accounting system. It breaks down each operating area to the smallest self-contained plant using a three alpha character descriptor.

Second, a unique project number was required to track a proposal from concept to completion. Past experience using project names had led to significant problems with duplication and name changes between names used at the identification stage and names used at the appropriation requisition stage. Once a project is in the execution stage, it is common to identify it by the construction charge code assigned but the code is not available until project approval for execution. This was resolved by using the three alpha Operating area identifier followed by five digits. The Project Portfolio Management System assigns the five digits sequentially when a project enters the multiyear plan phase. It is felt that five digits are more than sufficient to prevent duplications for even a 40 year expenditure plan.

Third, a project specific code of accounts is required for both the collection of expenditures through the various development stages and execution but also to collect benefits from identified sources. Consultation with the finance department resulted in a degree of enthusiasm for the Project Portfolio Management System and its potential for improved rigour and governance. The required code of accounts emerged with discussion on the future links between Project Portfolio Management System and general ledger accounts for automatic loading of actual expenditures.

Develop Revised Process Workflows and Stage Gating

A brainstorming session attended by representatives of the various involved organizations was used to layout the basis for the revised workflow and Stage Gate Processes. The current Trail Operations version of the Stage Gate Process is not perfect but it does provide a good foundation to build on. Trail management is familiar with the Trail Operation's Stage Gate Process and is aware that it requires modification to facilitate easier corporate review of major projects through better alignment with the corporate Stage Gate Process. Having a process in Trail that is more similar to the corporate process will simplify the presentation and approval of the recent opportunity projects.

The session with plant representatives allowed for a review of the various methods and processes used by each area to create and record new proposals. Discussion followed that defined the criteria and methods required to move the project onto the multiyear plan. The process to move from the multiyear plant and into the pre-scoping stage including required approvals was then defined.

Developing links to the Technical Development and Business Development Stage Gate Processes will proceed through consultation with those groups. Since they have existing Stage Gate Processes to develop their proposals, it will be relatively simple to blend their gates into the project process at appropriate stages of the processes. The urgency behind this effort is low.

Further definition of entry pages for each stage using the Gate criteria listings has allowed detailed information collection. The development of a translation process to provide for the transfer of project data from the existing ten-year plan into the Project Portfolio Management system is in progress. When the transfer completes thorough testing, the data will be loaded into the new Project Portfolio Management system and the results tested for completeness.

A repeated concern in Trail is that new computer systems invariably last a relatively short period of time and change when new standards are established. In this instance, initial efforts to ensure that the software is integral to the corporate and Trail Information Systems direction lower

this risk. The one area of remaining concern is the long term commitment of resources to maintain and support the Project Portfolio Management System. Trail management knows these concerns and efforts are in progress to resolve them.

6. Create Short Term Wins - Not systematically planning for and creating short-term wins

The Project Portfolio Management System phased implementation allows both control of demands on resources and opportunities to demonstrate the positive impact Project Portfolio Management System will have. The multiphase approach allows both short term wins and increased capability on the part of the users. In addition, the system is flexible enough that the implementation of the different aspects allows for change as needs develop. The first short term win was the selection of a Project Portfolio Management System tool.

Project Portfolio Management System Selection

The selection criteria were established during the previous mentioned sessions with users. The technology selection processes focused on addressing the identified needs and support the development that is indicated. Over a period of three months in early 2010, various Project Portfolio Management software systems were identified and evaluated. It was determined early in the effort that a Microsoft SharePoint version of software would be required to meet the Teck Corporate and Trail Operations Information Systems direction. It was during these discussions that a system called Microsoft Project Portfolio Manager 2007 was identified as a viable solution. There were some minor deficiencies but it met the main criteria in at least a rudimentary fashion.

In May of 2010, the Corporate Information Systems group informed Trail Operations that Microsoft would be releasing the 2010 versions of all of their SharePoint based software systems. In addition, Project Portfolio Management 2007 was being incorporated into the updated Project Server 2010 software and a supplement Financial Server package was available to enhance the financial capabilities of the Project Server 2010 system.

Detailed analysis of Project Server 2010 identified the following capabilities related to the established selection criteria:

1. System is based on a user defined project process workflows to operate:
 - Multiple workflows based on expenditure type can be accommodated,
 - Approvals are automatically requested and recorded at each stage,
 - Specific criteria responses can be required before moving to the next step,
 - Steps can be bypassed with appropriate approvals.
2. Capable of listing all project proposals at whatever stage of development.
3. Establishes minimal requirements for gate criteria to move to the next step:

- Can differentiate between project category, types of expenditure, etc.
 - Can require formal approval from identified individuals before moving forward,
 - Establishes minimum documentation requirements at each level of the process.
4. Financial server enhances existing cash flow reporting:
 - Budget, forecast and actuals are recorded,
 - Allows for the capture and reporting of both study and execution costs.
 5. Full scheduling capabilities of Microsoft Project are available.
 6. Built in analysis and evaluation capability can be implemented as required and includes:
 - Risk assessment.
 - Benefit identification.
 - Resource requirements.
 - Strategic alignment.
 7. Able to replace spreadsheet and reports:
 - Has facility to store all information currently on the spreadsheets,
 - Automatically generated Reports from information entered into the system.
 8. Fits with Corporate and Trail Information Systems direction:
 - SharePoint based software,
 - Links well with other Trail Operations systems.
 9. Each project assigned an individual SharePoint site for the storage of documents, estimates, reports, approvals, etc.

The system will generate all reports from data held in the system and available for viewing by appropriate personnel. Multiple levels of access control ensure that only responsible personnel can alter any data. The access control can restrict personnel to only their projects. In August of 2010, implementation of Project Server 2010 with Financial Server 2010 began with the establishment of the Create workflow in Figure 4. This effort continues and will be available for Beta testing in April 2011.

7. Don't Let Up - Declaring victory too soon

The use of Project Portfolio Management System will evolve into 'the way we do our jobs' over time and as experience grows with its capabilities. The 'victory' will be declared when key opportunity projects are approved with little basic questioning related to the project development process by the Board of Directors of Teck Resources. The phased approach while allowing for short term successes also ensures that everyone understands that the stages of

development extend over a period of years. The testing of phase one implementation followed by the phase 2 and 3 implementations lead up to a final ‘victory’ for the new project process.

Phase 1: Test and confirm Project Portfolio Management System

Some of the required testing is taking place as attributes are established and workflows implemented. The phased download of data from the existing spreadsheets will begin with projects that are not yet in the execution phase. Plant area representatives have agreed to perform Beta testing of the system and provide feedback on any issues they identify. The initial download of proposed projects in early April requires thorough testing; the current projects, those in the execution stage, will be downloaded and both the old and new systems run in parallel until the end of 2011. If no problems are identified the new Project Portfolio Management system will replace the existing spreadsheets in 2012.

Phase 2 Implementation:

There are two functions planned for implementation in Phase 2; establishing data links to other systems and establishing a Project Document Management System. These functions are only being delayed due to the lack of resources available during phase one. Ongoing efforts to communicate the project status and encourage user involvement have identified a concern that these functions are not planned until phase two. Some recent developments have indicated a possible approach to move them into phase one in response to the wishes of the finance department for an ‘enter once’ approach to cost data and a desire by members of the Projects Group and the plant area representatives to have a facility to store project information.

Phase 3 Implementation:

Phase three will see the development and implementation of the project analysis and evaluation system in the Project Portfolio Management System. Centralizing the analysis and evaluation function in the Project Portfolio Management System, with predefined selection criteria, will allow the Senior Management Team to assess and optimize the portfolio of projects to maximize benefits for all of Trail Operations, and in support of Trail Operations strategy. The Project Portfolio Management System has provision for all the ranking aspects but does not require all of them to be in place at the same time to allow the system to work. This provides an opportunity to phase the implementation of these features on an as required basis. The current plan sees this functionality added on an as requested basis until 2012.

8. *Make it Stick - Not anchoring changes in the corporation's culture*

Once Project Portfolio Management System is implemented there will be no other process available to move projects forward. The Project Portfolio Management System does not allow the bypassing of workflow phases without Senior Management Team approvals which prevents the inappropriate use of “workarounds”. The Project Portfolio Management team with close support of the Trail Information Systems group has defined the role of a Project Portfolio Management system administrator and developed a job posting for the position. The labour requisition for this position is with the Senior Management Team for approval prior to advertising for applicants.

As indicated in the above comments, the efforts associated with each aspect are not a onetime event. Rather the efforts, particularly related to communicating, are ongoing as opportunities arise. The intent is to encourage active ongoing participation in the implementation process and not allow any issues or concerns to develop to the point where they manifest themselves in inappropriate ways.

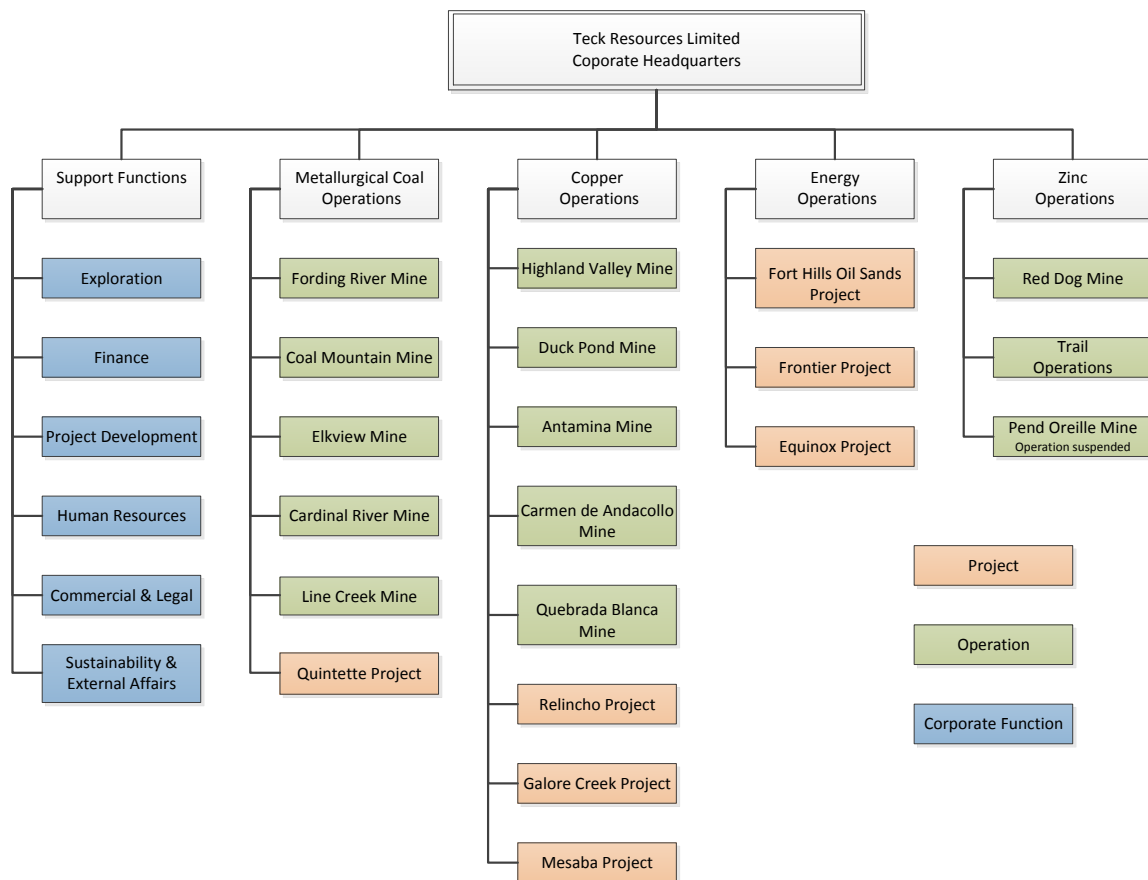
5: Conclusion

Trail Operations has experienced a great deal of change since the dramatic turndown of 1992. Until the early 2000's the facility was in a retrench mode that focussed everyone's efforts on making sure the business survived. Subsequent efforts aimed at increasing the viability of the facility through judicious investment in improving plant availability, effectiveness, and efficiencies. Now new opportunities involving new processes and markets have been identified. This project is critical for the new opportunities to proceed by providing a closer alignment with Teck Corporate practices.

This project is considered a key next step in the evolution of Trails project capabilities. It addresses recognised issues by expanding functionality and techniques while providing opportunities to reduce individual workloads. A conscious decision was made to provide support through an automated tool to assist personnel in their efforts to comply with the new and revised policies and procedures. Project Portfolio Management (PPM) provides a demonstration of Trail Operations capabilities in a variety of ways. For example; having a projection of the expenditures required over a number of years to maintain the operation at current levels, making full use of the annual budgets for expenditures that are authorized, minimizing the incidents of cost or schedule overruns, and providing a measure of the impact those expenditures are having on improving the operation.

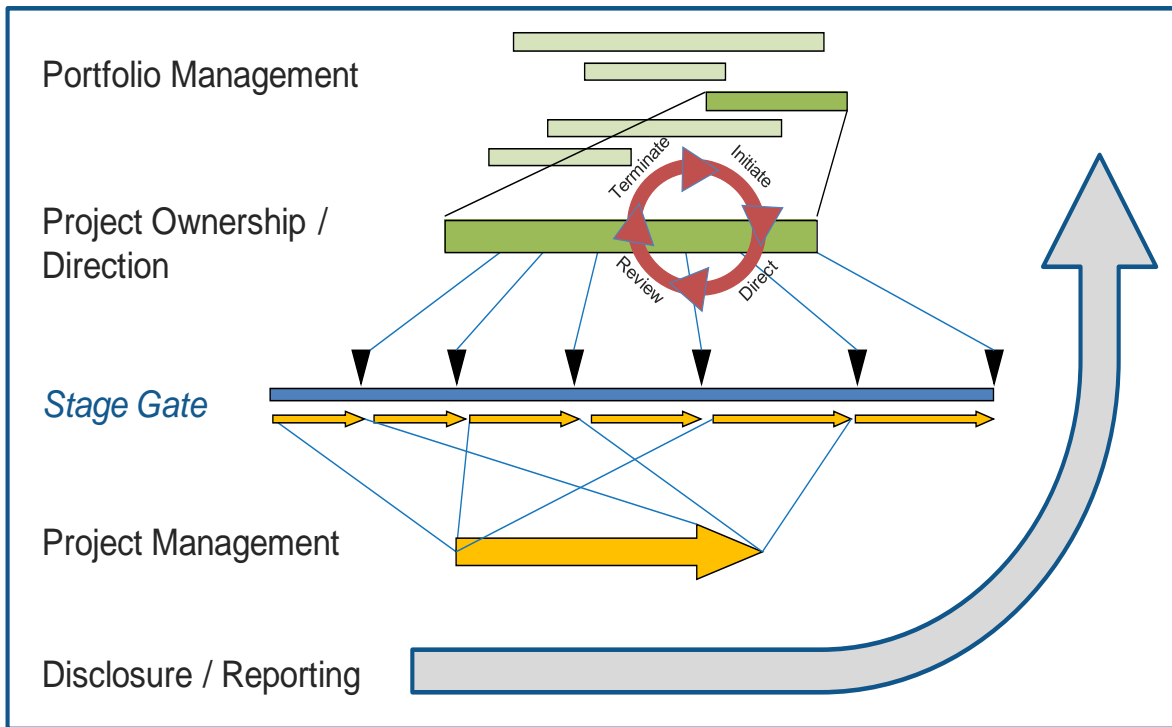
6: Figures

Figure 1 Teck Resources Limited Structure of Operations.



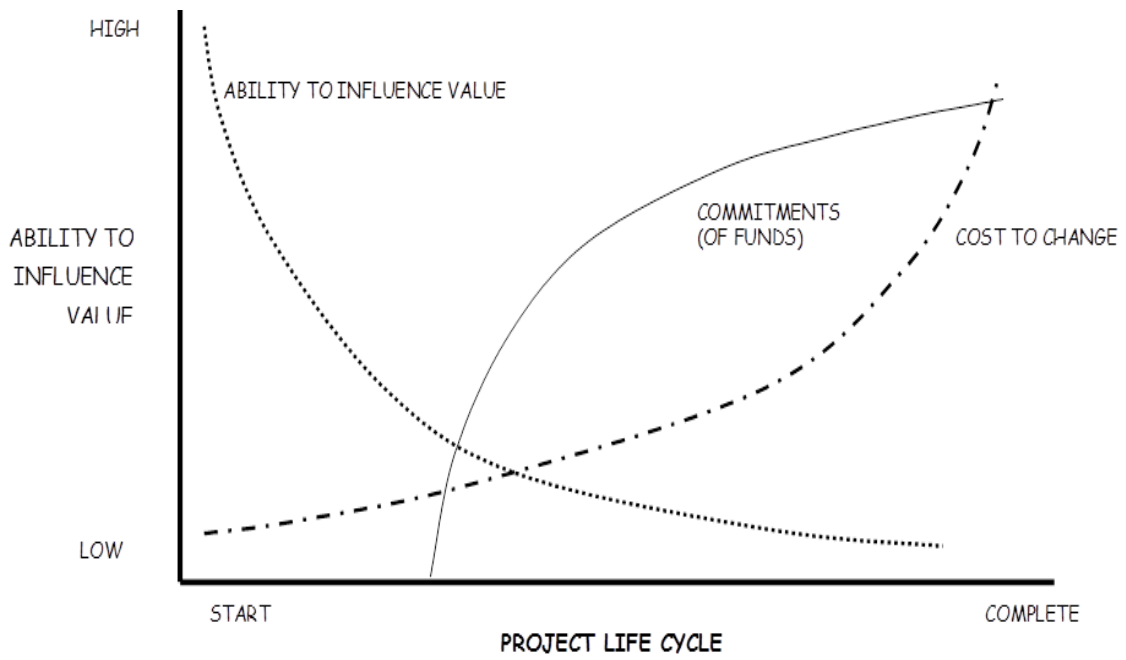
Source: Developed by the author from information in Teck Resources Limited 2010 Annual Report

Figure 2 Core Business Processes Supporting Effective Project Governance.



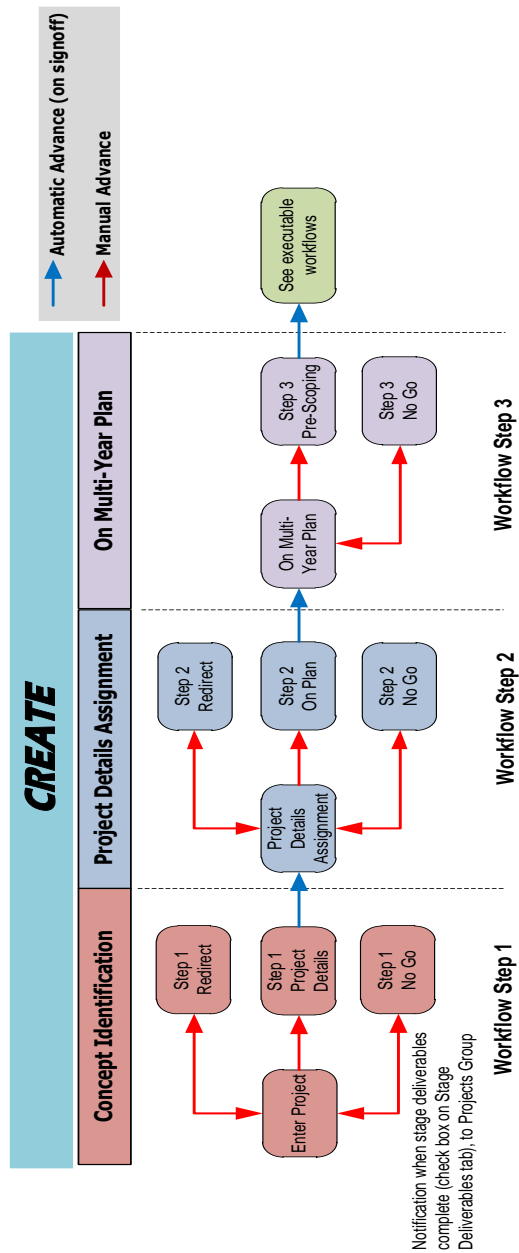
Source: Property of Teck Resources: Document PDG200; Project Development Framework; Revision B, Approved: June, 2010; Page 5.

Figure 3 Cost of Change.



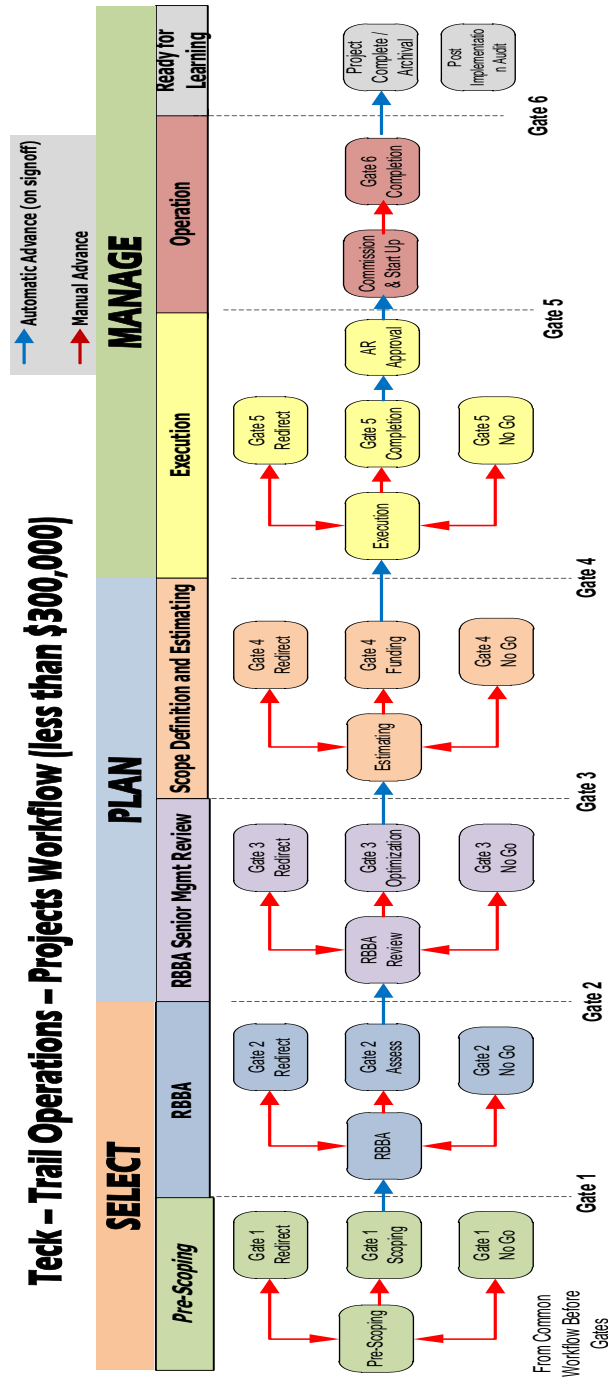
Source: Property of Teck Resources: Document PDG200; Project Development Framework; Revision B, Approved: June, 2010; Page 8.

Figure 4 Trail Operations Project Create Workflow (before formal gates).



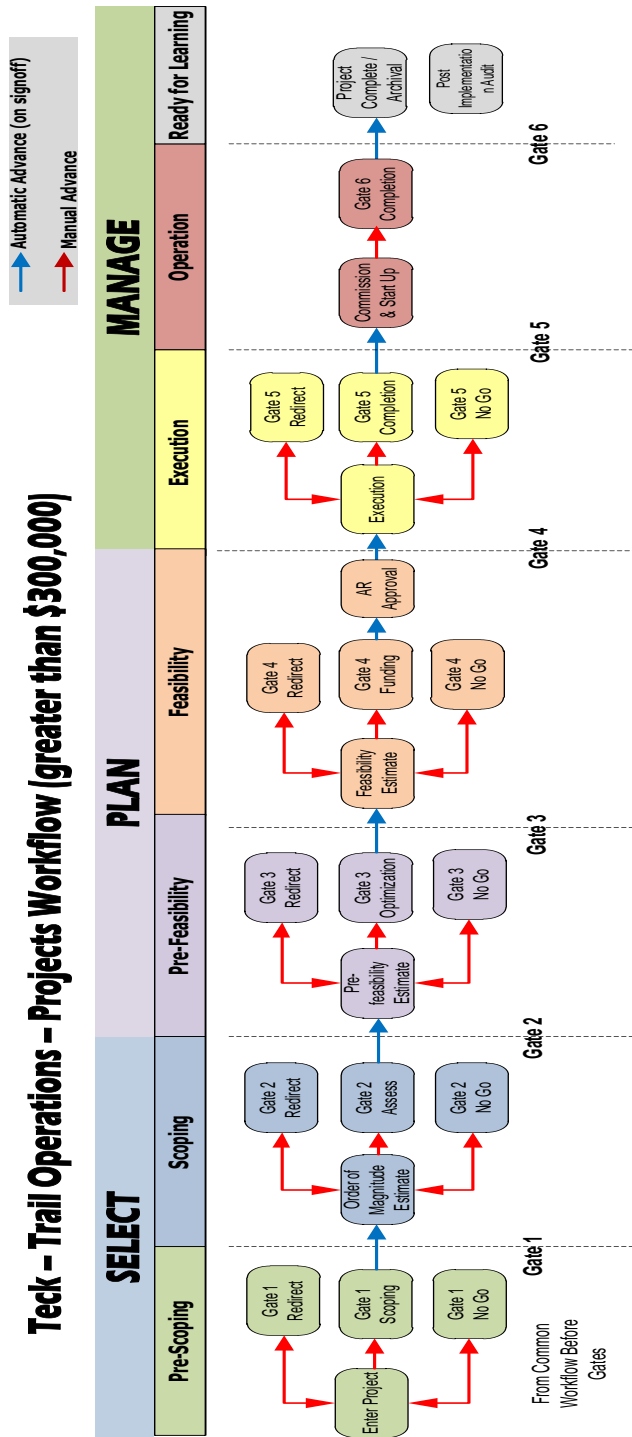
Source: Developed by the author: based on Controlled Document 5424 (Teck Trail Operations, 2009)

Figure 5 Trail Operations Project Workflow (<\$300K)



Source: Developed by the author: based on Controlled Document 5424 (Teck Trail Operations, 2009)

Figure 6 Trail Operations Project Workflow (>\$300K)



Source: Developed by the author: based on Controlled Document 5424 (Teck Trail Operations, 2009)

Appendices

Appendix A: Risk Based Benefit Analysis (RBBA)

An RBBA is a spreadsheet based project development tool developed at Trail Operations and usually used during the pre-scoping and scoping gates. This tool is an attempt to standardize the development, documentation, and analysis of lower cost (<\$ 300,000) projects. The RBBA is a process that uses a group of personnel knowledgeable about the situation to develop the following aspects of the project:

- **Problem Definition:** Identify the problem to solve, identify why it is now a problem, and develop a clear definition of the problem or opportunity being addressed. This should include an analysis to establish the root cause of the problem. The root cause of the problem may be obvious or may require another tool such as a root cause analysis or a Hazard Risk Assessment. The objectives of the project should go in this section and cover cost, schedule, and quality. The objectives will need modification as the process continues.
- **Functionality of Equipment/System:** Describes the purpose of the Equipment or system in sufficient detail that a person unfamiliar with the plant can understand the problem, the impact of equipment failure and how it fits into the larger picture. This section should be completed before the solution is identified.
- **Equipment/System Information:** Describe the Equipment or system that has the problem; include things like age, level of obsolescence, operating rates, required availability, and opportunities.
- **Failure Modes:** A group of knowledgeable stakeholders describe all identified failure modes; list all the ways the equipment can break or fail to perform the required task. Use the guide o failure modes provided and complete all of the columns that apply. More than one column is

usually completed but in the end, one factor outweighs the others. Don't be afraid to put down the same problem twice with different failure scenarios. For example, a fan blade breaking and damaging the fan housing might have a high likelihood but low consequences. The same failure could damage another piece of equipment with high consequences and low likelihood.

- **New Modes:** Once a solution is determined review any possible new ways the project could fail. For example if a tank is currently mixed using an air lance and the determined solution is mechanical agitation consideration of something like, did the process need the air for oxidation and what if the mixer breaks down?
- **Recommended Solution:** The solution must come from the problem and address the root cause if possible; avoid starting with a solution and adjusting the RBBA to support it.
- **Cost of Solution:** Develop a rough estimate based on past experience with similar installations. For projects that are more complicated an engineered estimate may be required.
- **Reference/Background/Supporting Information:** Document any previous attempts to solve the problem, the results of engineering studies on the problem, a breakdown of cost information to support the significance of the problem.
- **Potential consequence of doing nothing:** Document the impact of doing nothing to resolve the problem; increased maintenance costs, lower production levels, lower on line time, or lower product quality.
- **Other Solutions Considered:** when management reviews the project it is important to have considered all alternatives and be able to explain why the recommended solution is the most cost effective way to address the problem. Doing nothing may be an alternate solution.
- **Scope:** The scope should be clearly defined and detailed enough to allow the development of a cost estimate and schedule. The Projects Group can provide criteria that ensure a thorough scope is established
- **Photo or General Arrangement:** The objective of a photo or general arrangement is to give anyone unfamiliar with the issue a visual overview. Drawings generated as part of the estimating effort should be included.
- **Cost Estimate:** Simple equipment replacement projects can use vendor quotations and previous experience from similar jobs. Projects that involve installation that is more complex or that are close to the \$300,000 upper limit should use a formal engineering study to confirm costs.

Projects over \$300,000 must follow the Stage Gate Process of engineering studies and estimates. The objective for an RBBA is a cost estimate at the +or- 40% level.

- **Schedule:** The depth of schedule will be related to the complexity of the project. It can be very basic for simple equipment replacement jobs but more detailed for complex projects requiring plant shutdowns or interruptions. For jobs that require gating the schedule must include when each gate will be reached, and the duration for engineering, procurement, and construction.
- **Constructability Review:** Before the work can begin, identify the need for equipment draining, cleaning, lockouts, and confined spaces. In complex cases, a Hazard Risk Assessment may be required. Identify the equipment, roads, services, and utilities that require shut down for the work to be completed. Consider all potential environmental and safety issues and develop plans to mitigate them. Review the work with plant maintenance, Maintenance support and contractors to determine which group will perform which tasks. Plant and Maintenance Services crews may be less expensive but availability can become a problem even with careful scheduling. All of these restrictions can have a bearing on cost and schedule.

Appendix B: Trail Operations Stage Gate Criteria

Page 1 of 2

Trail Operations Stage Gate Criteria	Stage Gate 1 Criteria - Pre-Scoping Level	Stage Gate 2 Criteria - Scoping Level	Stage Gate 3 Criteria - Pre-Feasibility Level	Stage Gate 4 Criteria - Feasibility Level
Issue	General Criteria	General Criteria	Pre-Defined Criteria	General Criteria
General				
Business Objective	general	preliminary definition	defined	confirmed
Strategic Intent/Fit	in-line with strategy	intent identified	strategy and fit confirmed	confirmed
Scope Definition	conceptual	project outline	overall project - preliminary	overall project - detailed
Project Criteria	general	outline	preliminary	detailed
Project/Property Ownership	known	Confirmed	confirmed	confirmed
Investment potential/alternatives	conceptual	negotiated, draft agreement(s)	confirmed	confirmed
Project Team	undefined, adhoc	adhoc, part time manager identified	dedicated manager identified	dedicated project team identified
Project Organization	not defined	supported from departments	project team / dept. support	personnel seconded to project
Process Plant				
Process Feed Stock	assumed	assumed	defined & evaluated	confirmed
Production Rate	assumed	preliminary	fixed, preliminary schedule	frozen and scheduled
Process Flowsheets	not defined	block diagram, major process equip	detailed flowsheets, all process equip.	final flowsheets, all process & support equip
Mass Balance	not defined	basic	detailed preliminary	final
Water Balances	none	none	basic	detailed
Heat Balance	none	preliminary for pyro process	detailed for pyro process	detailed
P&IDs	none	none	none	preliminary
Major Equipment	assumed	preliminary	sized & selected	final (vendors identified)
Long Delivery (critical) Equipment	not defined	not defined	identified	bid, ordered, LOI
Minor Equipment	not defined	not defined	preliminary	sized & selected
Process Design / Criteria	production rate	basic process criteria, description	detailed process design criteria	design criteria - all disciplines
Infrastructure				
Site Investigation	photos/drive thru	preliminary inspection	drilling & test pits	detailed
Access Roads/Yards	assumed	assumed	preliminary layout	detailed
Administration/Shops/Warehouse	assumed	assumed	preliminary drawings	detailed
Power Supply	assumed	assumed	identified	LOI / supply contract
Water Supply	assumed	prel. assessment of water	water source identified	confirmed
Fuel	assumed	assumed	capacity defined	preliminary
Environmental Facilities	existing liabilities	assumed	alternatives evaluated	alternatives selected
Engineering				
Site Layout	not defined	general site plan, sketches	preliminary	detailed and near final
General Arrangements	none	none/sketches	preliminary (composite plans & sections)	detailed - multiple plans & sections
Civil	none	none	sketches (GA's)	partial design, preliminary
Structural	none	none	sketches (GA's)	partial design, major steel
Mechanical	none	none	sketches (GA's)	preliminary, GA's advanced
Piping	none	none	none	preliminary
Architectural	none	none	none	preliminary
Electrical	none	none	Primary single lines, sub-station GA's	Detailed single lines, preliminary design
Instrumentation	none	none	scope definition / control philosophy	preliminary P&ID's
Environmental	identify fatal flaws	none	preliminary design parameters	detailed design criteria
Waste Management				
Water management				
Water Management Plan	assumed	assumed	preliminary	complete, peer reviewed
Water Quality	assumed	assumed	baseline quality, prel. ARD	water quality model
Water Quantity	assumed	assumed	baseline quantities, prel. water balance	detailed water balance
Treatment	assumed	assumed	prel. treatment concepts	treatment testing/ prel. design
Environmental Plan	identify fatal flaws	notional	preliminary monitoring plan	detailed monitoring plan
Solid waste (garbage)	assumed	assumed	assumed	quantities identified, management plan
Sewage	assumed	assumed	assumed	quantity identified, treatment selected
Hazardous & Dangerous Waste	assumed	assumed	major types identified	management plan developed
Air Emissions	assumed	regulatory framework understood	major air emissions identified	Emission model, controls identified
Environmental				
EHS Policy	Trail Operations guidelines	Trail Operations guidelines	Trail Operations guidelines	Trail Operations guidelines
EHS Management System	Trail Operations EH&S Program	Trail Operations EH&S Program	Trail Operations EH&S Program	Trail Operations EH&S Program
Regulatory Framework	assumed	key regulations reviewed with EH&S dept	regulations understood in detail, design implications considered	planning proceeding within EHS
Mitigation Plan	not defined	conceptual	potential mitigation strategies identified	mitigation integrated into the development plan
Risk Assessment	Identify unacceptable risks, pre-existing conditions or liabilities	preliminary high level risk assessment	risk assessment updated with mitigation measures	risk assessment updated, peer reviewed
Operations Monitoring Program	not defined	not defined	plan developed	implemented - ongoing
Health & safety programs	Trail Operations H&S Program	Trail Operations H&S Program	Trail Operations H&S Program	Trail Operations H&S Program
Emergency Response Plan	Trail Operations ERP Followed	Trail Operations ERP Followed	Trail Operations ERP Followed	Trail Operations ERP Followed
Energy & Greenhouse Gases	not defined	Identify key energy/GHG risks	estimate of energy use & carbon footprint	Update energy use & carbon footprint,
Social/Political				
Socioeconomic Policy	Trail Operations guidelines	preliminary concepts	outline, site specific	detailed, site specific
Government Engagement	Trail Operations guidelines	preliminary - initial introductions	engaged - assess governance capacity	fully engaged
Community Engagement	initial contact	prel. consultation	preliminary engagement (Socioec team)	fully engaged consultation process
Socioeconomic Mitigation	not defined	conceptual mitigation plan	prelim mitigation plan	mitigation integrated into development plans
Communications Plan	prelim. strategy	develop protocols & outline plan	preliminary plan	detailed plan / implemented
Conflict Management Plan	prelim. strategy	develop protocols & outline plan	prelim. plan	detailed / implemented
Community Response Plan	not defined	none	planning, preliminary negotiations	MOU & implementation started
Marketing				
Product- Quantity, Quality	assumed	preliminary	updated estimates by year	detailed final, max-min by year
Product Transportation	assumed	assumed	preliminary evaluation	detailed evaluation/quotation / LOI
Post production treatment	Trail Operations guidelines	Trail Operations guidelines	Trail Operations guidelines	detailed evaluation, LOI, performa contract
Product supply/demand	preliminary study	preliminary study	preliminary study	in-depth study
Product pricing	assumed	prelim. evaluation	evaluation	final evaluation & Trail Operations buy-in
Product Stewardship	not defined	preliminary	final	final

Insert Project Name	Stage Gate 1 Criteria - Pre-Scoping Level	Stage Gate 2 Criteria - Scoping Level	Stage Gate 3 Criteria - Pre-Feasibility Level	Stage Gate 4 Criteria - Feasibility Level
Issue	General Criteria	General Criteria	Pre-Defined Criteria	General Criteria
Economic Evaluation				
Capital Cost Estimate				
Basis of estimate	comparative, similar projects	capacity based, factored	preliminary estimates & budget pricing	detailed from MTO's & definitive pricing
Construction Labour Cost	N/A	assumed	built-up, average all trades	detailed, built-up by trade
Civil	N/A	factored	prelim. quantities & unit prices	partial MTO's / unit pricing
Structural/Architectural	N/A	factored	prelim quantities & unit prices	partial MTO's / unit pricing
Mechanical	N/A	factored	budget quotes, factored install costs	detailed, firm pricing, installation est.
Piping	N/A	factored	factored	partial MTO's, partial factored
Electrical	N/A	factored	prelim supply est./factored dist'n	detailed supply & HV dist'n, factored LV
Instrumentation	N/A	factored	factored	control system pricing, factored field inst.
Construction Indirects	N/A	assumed / factored	preliminary estimate	detailed estimate
EPCM	N/A	factored	factored	estimated, drawing count & hours
Transportation/Logistics	N/A	assumed	preliminary estimate	detailed estimate based on defined routes
Owners Costs	N/A	percentage	preliminary build-up	detailed build-up
Contingency	N/A	assumed	estimated by trade	probability risk assessment
Sustaining/Replacement	N/A	factored	preliminary estimate	detailed estimate
Escalation	none	none	none	included
Estimate accuracy	-50% / +100%	-30% / +50%	-20% / +25%	-15% / +20%
Operating Cost Estimate				
Basis of estimate	Comparative, similar projects	capacity based, factored	preliminary, first principles	detailed, first principles
Manpower	N/A	typical manpower & salaries	manpower build-up, typical salaries	manpower & salary build-up
Consumables	N/A	major - book prices, minor - factored	estimated units, budget quotes	estimated units, firm pricing
Op & Maint. Supplies	N/A	factored	factored	estimated & factored
Power	N/A	factored	estimated consumption/utility prices	estimated consumption/negotiated price
Outside services	N/A	assumed	estimated & assumed	estimated, quoted, LOI
Transportation & Logistics	N/A	assumed	preliminary estimate	detailed estimate based on defined routes
Environmental costs	N/A	assumed	preliminary estimate	detailed
Contingency	N/A	assumed	global % included	estimated, included
Economic modeling				
Economic Evaluation Parameters	not defined	assumed	Trail Operations guidelines	developed/confirmed
Production Schedule	Assumed - straight line	preliminary	detailed - draft	detailed - final
Capital Expenditure Schedule	not defined	notional	preliminary estimate	scheduled, detailed
Operating Cash Flow	straight line	preliminary	detailed - draft	detailed - final
Working Capital	Assumed	assumed	product inventory, receivables, payables	product inventory, receivables, payables
Taxes, Royalties		preliminary	country tax code	detailed project specific taxes
Depreciation schedule	straight line	straight line	depreciation by asset type	full depreciation schedule
Sensitivity analysis	price, grade	price, capex, opex	price, capex, opex, grade, throughput	detailed, multi-component
Project Execution				
Project execution strategy/plan	none	preliminary strategy, outline plan	final strategy, preliminary plan	final, detailed plan
Master schedule	conceptual	outline	preliminary, in-progress	detailed, final
Project Budget	preliminary outline	preliminary	detailed - draft	detailed - final
Engineering				
Engineering plan	none	RFP, consultant(s) selected	preliminary plan and schedule	detailed plan & schedule
Engineering resources	not defined	identified	availability confirmed	eng. team confirmed, mgr-guaranteed
Project Procedures Manual	none	none	summary level, in-progress	detailed, implemented
Project services plan	none	none	preliminary	detailed plan, resources identified
Procurement				
Purchasing Plan	none	none	preliminary	detailed
Logistics / transportation plan	none	none	preliminary	detailed
Construction Management				
Construction Management Plan	none	none	preliminary	detailed & near final
Construction Execution plan	none	none	preliminary	detailed & near final
Contracting plan	none	none	preliminary	preliminary
Resource plan	none	none	preliminary - source, cost & productivity	detailed - source, cost & productivity
Security Plan	none	none	define requirements	detailed, ready to implement
Health and safety Plan	none	none	none	detailed, ready to implement
Environmental Protection Plan	none	none	alternatives identified	evaluated and defined
Mitigation Plan	none	none	alternatives identified	evaluated and defined
Operations				
Staffing Plan	none	none	preliminary, Sr. staff scheduled	detailed hiring schedule
Training Plan	none	none	none	outline, schedule & budget
Commissioning Plan	none	none	defined	preliminary
Start-up Plan	none	none	none	outline
Ramp-up Plan	none	none	preliminary	plan and schedule
Transition Plan	none	none	none	outline
Risk Assessment				
Overall Project Risk Assessment	existing liabilities	high level risk identification,	informal qualitative risk review, preliminary risk register	formal, qualitative risk review, updated risk register
Hazard Assessment	none	none	preliminary hazard analysis	preliminary hazops
Operability Assessment	none	none	preliminary engineering	engineering, operations and maintenance review
Constructability Assessment	none	none	overview	preliminary
Technical				
Resource	n/a	overview	preliminary, internal peer review	detailed, external peer review
Mining	n/a	overview	major risks identified	detailed, peer review
Metallurgical	n/a	considered	preliminary	detailed, peer review
Social				
Environmental	identify existing liabilities	preliminary	qualitative, internal peer review	qualitative & quantitative risk assessment, 3rd party peer review
Socioeconomic	n/a	overview	preliminary	detailed
Political	country risk	overview	preliminary	detailed
Financial				
Capital Cost	n/a	none	preliminary	quantitative risk assessment, 3rd party peer reviewed
Operating Cost	n/a	none	preliminary	detailed, peer reviewed
Product Price	preliminary	preliminary	preliminary	final
Business				
Reputation	Is this a business we want to be in?	detailed	confirmed	reconfirmed
Legal	Is the deal structure acceptable?	final	confirmed	reconfirmed
Product Stewardship	Is this a product we want to make?	preliminary	detailed	confirmed

Source: Developed by the author from PDG211 Project Specific Criteria Original (Teck Resources , 2010)

Bibliography

Works Cited

Association for Project Management; *A guide to governance of project management*; Association for Project Management; High Wycombe, 2005

Brache, Alan P.; *How Organizations Work, Taking a Holistic Approach to Enterprise Health*; John Wiley & Sons; New York; 2002

Buttrick, Robert; *The Interactive Project Workout*; Financial Times Prentice Hall; 2nd Edition; 2000

Cooper, Robert G., Edgett, Scott J. and Kleinschmidt Elko J.; *Optimizing the Stage-Gate Process: What Best Practice Companies do-I* ; Industrial Research Institute Inc.; September-October; 2002a

Cooper, Robert G., Edgett, Scott J. and Kleinschmidt Elko J.; *Optimizing the Stage-Gate Process: What Best Practice Companies do-II*; Industrial Research Institute Inc.; November-December; 2002b

Cooper, Robert G.; *How Companies Are Reinventing Their Idea-to-Launch Methodologies*; Industrial Research Institute Inc.; March-April; 2009

Cooper, Robert G.; *Stage Gate systems: A New Tool for Managing New Products*; Business Horizons; May/June 1990

Donaldson, Lex; *The Contingency Theory of Organizations*; Sage Publications, Inc: 2001

Kerzner, Harold; *Project Management, A Systems Approach to Planning, Scheduling, and Controlling*; Tenth Edition; John Wiley and Sons; New York; 2009

Kotter, John P., Cohen, Dan S.; *The Heart of Change*; Harvard Business School Publishing; Boston; 2002; Preface page x

Kotter, John P.; *Leading Change: Why Transformations Fail*; Harvard Business Review; March – April; Boston; 1995; 59 to 67

Longman, Andrew, Mullins, John; *The Rational Project Manager, A Thinking Teams Guide to Getting Work Done*; John Wiley & Sons; Hoboken, New Jersey; 2005

Makieff, Gil, Angelino, Mauro; *A Proven Paradigm for Creating Enterprise Project and Portfolio Management Adoption roadmaps that Work!* ; Whitepaper; UMT Consulting Group; 2008

McCarthy, Ian P., Lawrence, Thomas B., Wixted, Brian, Gordon, Brian R.; *A Multidimensional Conceptualization of Environmental Velocity*; Academy of Management Review; 2010; P604 – 636

McCarthy I. P., Tsinopoulos C., Allen P.M & Rose-Anderssen C. 2006. *New Product Development as a Complex Adaptive System of Decisions*; Journal of Product Innovation Management, 23(5): 2006; P437-456

Nicholas John, Steyn Herman; *Project Management for Business, Engineering, and Technology*; 3rd Edition; Butterworth-Heinemann; Burlington, MA; 2008

Project Management Institute; *A guide to the project management body of knowledge (PMBOK® Guide)* – Third edition; Newtown Square, PA: Project Management Institute; 2004

Sanwal, Anand; *Optimizing Corporate Portfolio Management, Aligning Investment Proposals with Organizational Strategy*; John Wiley & Sons Inc.; 2007

Soodek, Andy; *Project Portfolio Management Tool Selection and Implementation Considerations*; Project Management Institute Virtual Library© 2008

The Enterprise Portfolio Management Council; James Pennypacker and San Retna, editors: *Project Portfolio Management; a View from the Management Trenches*; John Wiley & Sons; 2009

Thomas, Stephen J.: *Successfully Managing Change in Organizations: A User's Guide*; Industrial Press Inc.; New York; 2001

Toney, Frank; *The Superior Project Organization*; Marcel Dekker Inc; New York; 2002

Public Documents

1. Teck Resources Limited 2010 Annual Report
2. Engineering and Mining Journal; Special edition: “Cominco: modern, resourceful, successful”; Reprinted in Canada, February, 1975

Company Documents

1. Don Lindsey, President and CEO; Overview and Strategy Presentation; Page 12; Investor Presentation, November 2, 2010
2. Doug Horswill, Senior Vice President, Sustainability & External Affairs Presentation; Page 31; Investor Presentation, November 2, 2010
3. Greg Belland, Manager, Operations; Trail Ops. Long Term Planning Presentation, Page 17, 19; December 16, 2010
4. Teck Resources Document PDG200; Project Development Framework; Revision B, Approved: June, 2010

5. Teck Resources Document PDG211: Project Specific Criteria Original; Revision C, Approved: Feb 2010
6. Trail Operations Controlled Document 5424: Capital Project Stage Gating Process, Approved: May 5, 2009

Websites Reviewed

Gordon Marshall: "[contingency theory.](#)" ;A Dictionary of Sociology; 1998. *Encyclopedia.com*: 25 Feb. 2011; <<http://www.encyclopedia.com>>

www.gartner.com; *Magic Quadrant for IT Project and Portfolio Management*; Daniel B. Strang, Michael Hanford; June 2, 2010

www.apm.org.uk; A guide to governance of project management; Association for Project Management; 150 West Wycombe Road, High Wycombe, Buckinghamshire HP12 3AE

www.microsoft.com/project/en/us/project-server-2010-product-guide.aspx