DEVELOPMENT STRATEGY FOR A SHARED MINERAL RESOURCE AT TECK COAL LIMITED

by

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Abstract

Teck Coal Limited is the world's second largest exporter of seaborne steel-making coal. Teck Coal operates six mines in western Canada and two of the mines, Fording River Operations and Greenhills Operations, are in located adjacent to each other with both sites advancing on the same future mining area known as Greenhills Ridge. Steel-making coal is a bulk resource commodity, and Teck is a price-taker in the market. This paper will examine and evaluate, from an organizational and structural standpoint, how key the metrics of costs, flexibility, sustainability, efficiency, and dependability changes with increased levels of integration between the sites to determine if there is a preferred strategy to develop the ridge. Four scenarios will be examined, including the status quo of continuing to operate as independent mine sites. Key barriers will also be examined, with risks weighed against the benefits for each scenario. A path forward will be recommended, as well as a strategy for successful implementation.

Keywords: mining, steel-making coal, organizational structure, operational efficiency

Dedication

I dedicate this project to my family, my wife, Robyn, and my children Liam and Myles. I could not have achieved this goal without their encouragement, understanding and patience over the past few years.

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Foremost, I wish to thank Teck for providing me with the opportunity to participate in this program.

I also wish to thank my professors at Simon Fraser University for their knowledge and guidance. It was my pleasure to learn from such exceptional instructors.

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Glossary

Clean coal	Coal that has been processed or washed to separate from impurities, and is in a form for sale.
Hard coking coal	A type of metallurgical coal used primarily for making coke in integrated steel mills.
Highwall	Pit walls constructed in overburden or rock material exposed by the excavation of the pit.
Ore	Naturally occurring material from which minerals of economic value that can be extracted at a reasonable profit.
Raw coal	Coal that has been extracted from the pit but not yet processed through the wash plant.
Steel-making coal	Refers to the various grades of coal that are used in the steel-making process including both coals to produce coke and coals that are pulverized for injection into the blast furnace as fuel.
Strip ratio	The quantity of waste rock in bank cubic meters that must be mined to produce one metric tonne of clean (processed) coal.

1: Introduction

1.1 Industry Definition

Teck Coal Limited (Teck Coal) is the second largest exporter of seaborne steel-making coal in the world and owns and operates six coal mines – one in western Alberta and five in the Elk Valley in the southeast corner of British Columbia. The mines produce metallurgical or steel-making coal, which is used primarily for making coke and used by integrated steel mills in Asia, Europe and the Americas (Teck Resources Limited, 2014).

Coal mining in the Elk Valley region has been occurring since the late 1800's and initially took place using underground mining methods. Open-pit mining methods started taking place approximately 45 years ago. Teck's operations all currently employ large-scale, open-pit mining methods that are designed to operate 24 hours per day, 365 days per year. The overburden material, or waste rock, is drilled and blasted, then loaded by electric and hydraulic shovels into haul trucks and hauled to a dump. The coal is exposed whereupon it is loaded and hauled to the coal preparation or processing plant where it is washed using conventional coal-cleaning processes. The final product is processed to meet ash and moisture targets and blended to the proper specifications for the customers. The clean coal is then dried and conveyed to silos for storage and load-out to rail cars.

Teck's mines in the Elk Valley are serviced by the Canadian Pacific Rail Company (CPR) while the Cardinal River mine in Alberta is serviced by the Canadian National Railway Company (CNR). Some of the westbound coal from the Elk Valley is transported on CNR's line, wherein CPR interchanges with CNR at Kamloops, British Columbia. Most of the coal is transported westbound to three terminals on the west coast; Westshore, Neptune, and Ridley. From here the coal is loaded onto vessels and shipped overseas to customers. A small percentage of coal is railed eastbound to Thunder Bay, Ontario and eastern United States for customers in North America.

Coal seams possess different characteristics depending on the composition and deposition of the carbonaceous, organic material from millions of years ago and the geologic processes that have occurred since. Coal seam characteristics vary at the local, mine site level, regionally, and globally, but are not completely indifferent from each other. Customers desire certain product specifications and the methodology to achieve this is to blend various coal seams to achieve the desired specifications of the final product. Some of the main properties of coal seams that are controlled in the final product are the relative content of ash, phosphorus, sulphur, and volatile matter, as well as reflectivity and fluidity.

As stated in the most recent National Instrument 43-101 Technical Report for Fording River Operations, the site produces three main types of products which are categorized as Standard, Premium, and Eagle. In the past, FRO produced a small amounts of thermal coal which was either consumed in the coal-fired dryer or sold to the market (Teck Resources Limited, 2011), but FRO focuses on maximizing steel-making coal sales and the dryer has been converted to a natural gas system. Table 1.1 shows the respective ranges for the main quality parameters for FRO's coal products.

Table 1.1 – Fording River Steel-making Coal Product Specifications

Quality Parameter	**Unit**	**Product**		
		Standard	**Premium**	**Eagle**
Ash	% weight	9.5-10.0	8.75-9.25	8.5-8.7
Phosphorus	% weight	0.070	0.075	0.070
Sulphur	% weight	0.50-0.55	0.65-0.70	0.70-0.75
Volatile Matter	% weight	22.5-24.5	24.5-26.5	26.5-28.5
Reflectivity	RoMax[1]	1.17-1.27	1.07-1.17	1.03-1.13
Fluidity	ddpm[2]	50-250	200-500	100-850

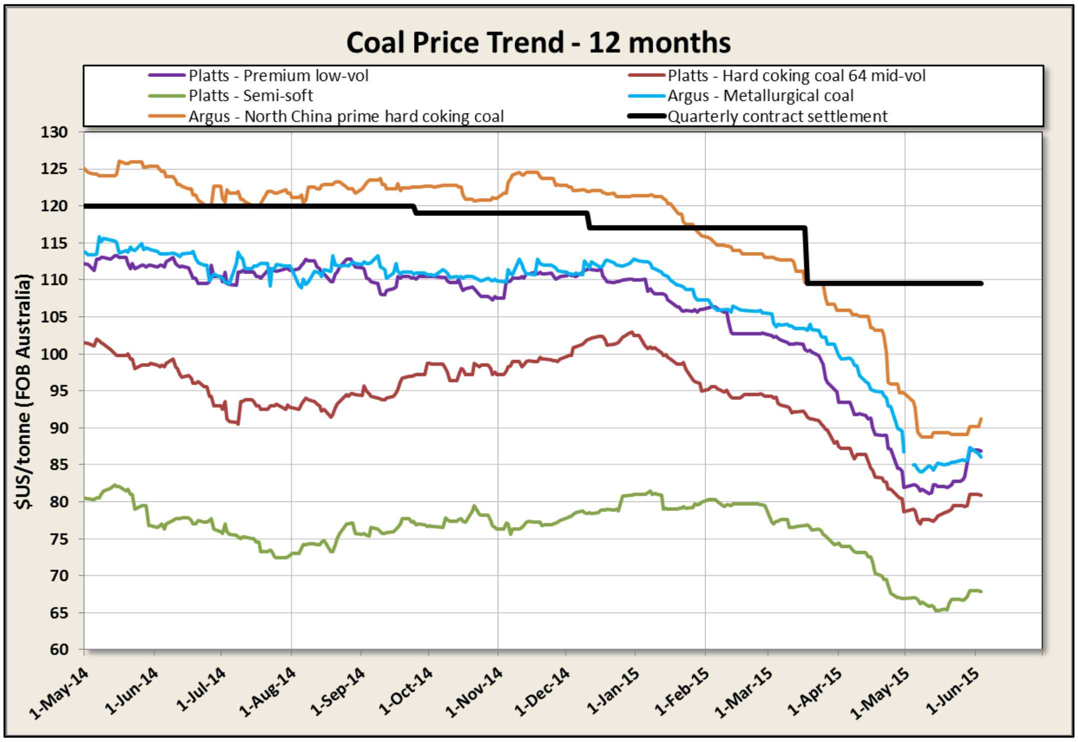
[1]RoMax – the mean maximum reflectance of vitrinite in oil of a coal sample (CoalTech, 2007)
[2]ddpm – dial divisions per minute of the Geiseler Plastometer Test (Pearson Coal Petrography)
Source: Reproduced from NI 43-101 Technical Report on Coal Resources and Reserves of the Fording River Operations, 2011.

Teck Coal's main competitors are other producers based in Australia and the United States (e.g. BHP Billiton, Rio Tinto), as well as some domestic producers in countries where customers are located (e.g. China). Teck's competitive position in the coal market is primarily determined by the quality of their various coal products, their reputation as a reliable supplier, and their production and transportation costs compared to other producers (Teck Resources Limited, 2014).

Teck Coal has the advantage of operating in Canada which is a developed, politically-stable country and is amendable to sustainable development of natural resources. Canada's political environment makes it easier and less risky to conduct business than in other countries where coal can be found, such as China or Mozambique. Teck Coal also has a logistical advantage in that five out of the six mines are located near each other in the Elk Valley, enabling the sharing of people and resources with relative ease, and centralization of some core business processes. Teck is a lower cost producer, and has relatively close access to ports for shipping their coal to market.

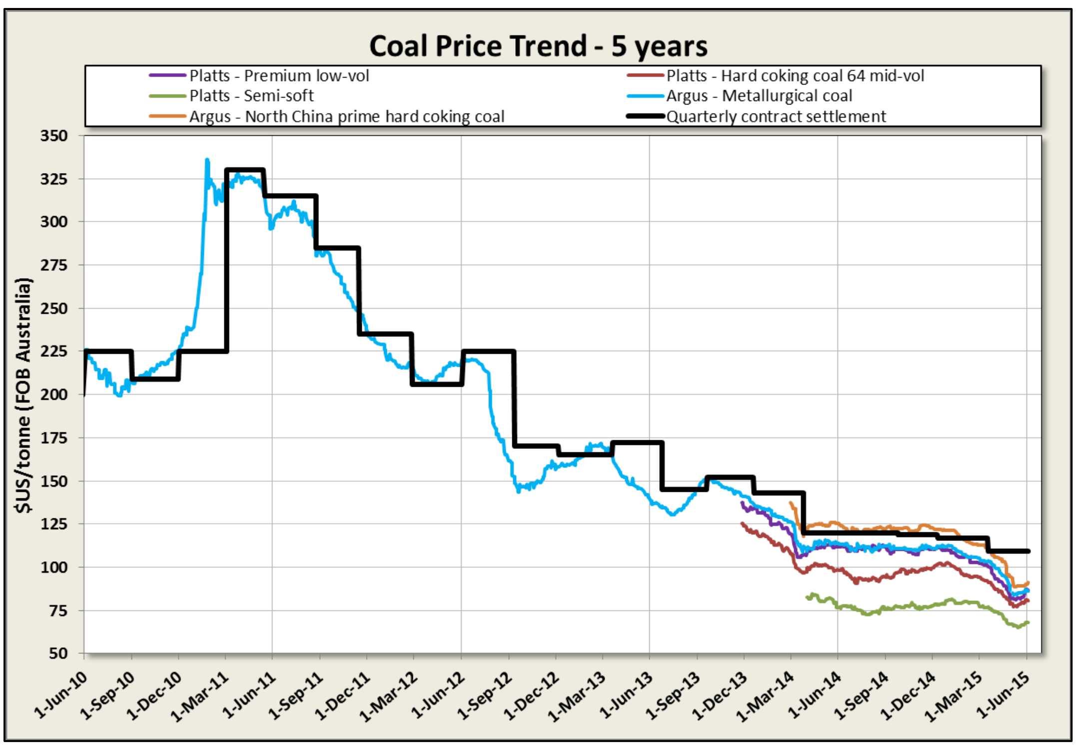
Metallurgical coal is a bulk resource commodity, and the industry is strongly governed by demand for steel products and coal export capacity. The coal market has been experiencing an over-supply since 2014. With little differentiation between Teck's products and those of other competitors and a lower position of market share, Teck is a price-taker in the market. Selling price for Teck Coal's contracted sales is determined as a percentage of the quarterly benchmark prices typically set by Australian producers. Coal also sells on the spot market, with prices below those of contracted sales. Select spot coal selling prices and the quarterly benchmark price are graphed in Figure 1.1 and Figure 1.2, which show the coal price trend for the previous twelve months and five years respectively. Therefore, it is very difficult for Teck to increase the customers' willingness to pay for their product to increase revenue or maintain margins, and must focus on minimizing costs to stay competitive and cash flow positive.

Figure 1.1 – Twelve Month Metallurgical Coal Price Trend



Source: Platts & Argus coal price indices; drawn by the author.

Figure 1.2 – Fiver Year Metallurgical Coal Price Trend



Source: Platts & Argus coal price indices; drawn by the author.

1.2 Problem Statement

Two of Teck Coal's mines in the Elk Valley, Fording River Operations (FRO) and Greenhills Operations (GHO), are within sufficient proximity such that the long-range plans are encroaching on the same potential coal resources in an area known as Greenhills Ridge. Refer to Figure 1.3 for an annotated map delineating the current operating areas of FRO and GHO, as well as Greenhills Ridge. As FRO and GHO currently operate independently, they each have their own critical infrastructure such as offices, maintenance shops, processing plant, rail load-out facility and power distribution network, as well as their own separate, organizational structure.

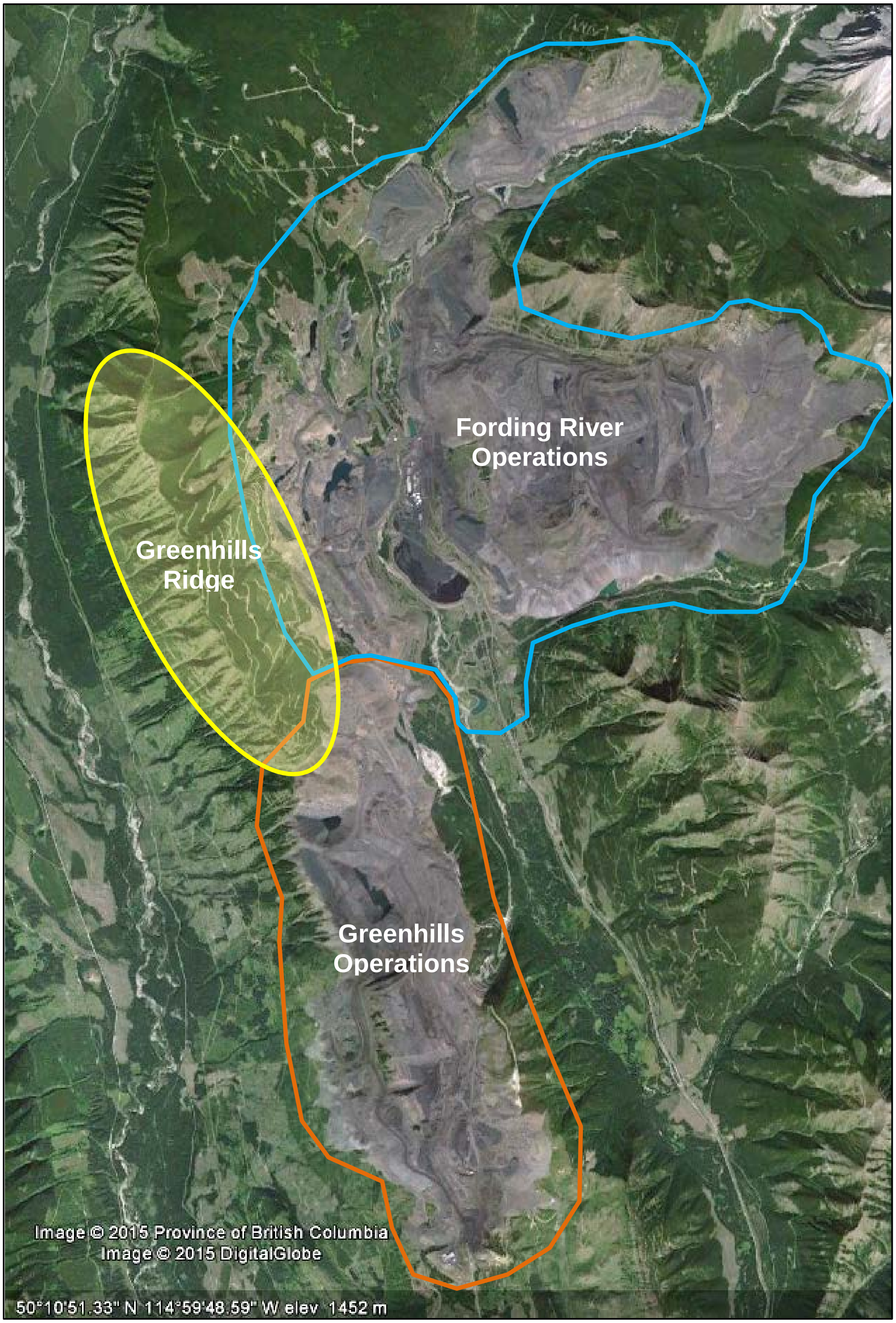
The December 31, 2014 year-end mineral reserves statement reports a potential reserve of 681 million tonnes of clean coal between the two sites. At a combined production rate of approximately 13.7 million tonnes of clean coal per year (FRO at 8.5 million tonnes per year, GHO at 5.2 million tonnes per year), the remaining combined mine life is approximately 50 years, including existing active mining areas (Teck Resources Limited, 2014).

For the coal resources and reserves in the Greenhills Ridge area, the primary challenge is to determine the ultimate size of the pit, which in turn influences the location of the waste dumps and the overall mining sequence and phasing strategy for the pit. This is an extensive, iterative process and consideration must be given to environmental impacts and ability to receive permit approvals from regulatory bodies. Fording River Operations submitted a National Instrument 43-101 Technical Report (NI 43-101) in 2011 that shows a potential mining area on part of the Greenhills Ridge known as the Swift Pit. An application for an Environmental Assessment Certificate was submitted to the British Columbia Environmental Assessment Office on January 26, 2015 for the FRO Swift Project (British Columbia Environmental Assessment Office, 2015). Mining on Greenhills Ridge, beyond the Swift Pit, by both sites could start within ten years, which is not much time considering that significant effort needs to occur in both mine engineering and permitting.

Presuming that a viable mining option exists, there may be a strategic opportunity to completely re-structure the two operations with the objective to preserve the long-term sustainability and viability of both operations and of Teck Coal as a stable, long-term supplier. Opportunities for operational efficiencies may exist, such as integration of the mine fleets to reduce haul distances and cycle times or delivering preferential coal to each processing plant to maximize product yield, which would subsequently lower operating costs and secure Teck Coal's position as a low cost producer.

This paper will investigate the organizational and operational benefits and impacts of various levels of integration of the Fording River and Greenhills mines, and recommend a preferred strategy and implementation plan.

Figure 1.3 – Map of Fording River Operations, Greenhills Operations, and Greenhills Ridge



Source: Image from Google Earth; boundaries approximated and drawn by author.

2: Internal Analysis

2.1 Existing Structure

As discussed previously, FRO and GHO are currently operated as separate mines, each with their own organizational structure. The key departments for a typical operating mine are mine operations, mine maintenance, processing and process maintenance, engineering, environment, business and financial, human resources and other staff functions.

The sites reside under the umbrella of the coal business unit of Teck Resources Limited and as a result of efforts to foster efficiencies and synergies, many aspects of the operations are already similar in terms of overall structure, standards, processes, and sharing of best practices amongst the departments with corporate groups providing oversight to most areas. The nature of the mining business means that each site is unique in its own way, driven mainly by the size of the operation, the orientation of the ore body and the surrounding topography, and legislated permit requirements. This uniqueness leads to site-specific features, designs, practices and procedures which can differ from other sites. The mine sites can revise their standards and procedures as deemed necessary, for the overall efficiency and safety of the operation.

Teck Coal operates at the site level, meaning that each site is responsible for achieving production and cost targets, and generating positive cash flow. It has not yet come to the point where Teck Coal has operated more towards the business unit level, where it has intentionally or strategically operated a site a loss (in a high strip ratio, high cost year for example), but still maintained positive cash generation for the business unit as a whole.

In the past at FRO and GHO, coal has been hauled from one site to another via an existing connector road. This was performed to take advantage of available excess processing capacity at the receiving site. When this transfer of raw coal occurs, the site that mined the coal receives credit for the production and associated revenue from the sale of the product, but is charged the cost of processing by the site that processed the coal through its plant.

There are two major differences between FRO and GHO:

1. The FRO hourly employees are unionized under United Steelworkers Local 7884, while GHO is the only Teck Coal operation not to have a union.

2. GHO operates under a joint venture agreement with POSCO Canada Limited (POSCAN) of which POSCAN has 20% interest and Teck has 80% interest. GHO and POSCAN share the assets, capital costs, and expenses according to their joint venture interests. Teck Coal acts as the operator and manager of the mine (Teck Resources Limited, 2014).

These differences are further described in Section 3.3 Barriers.

2.2 Evaluation Criteria

This section will describe the criteria in which the feasibility of combining the Fording River and Greenhills operations will be ranked against, and will serve as a guide to highlight the key objectives for analysis.

2.2.1 Costs

As with all other mining companies in commodity industries, Teck Coal is challenged by the cyclical nature of the industry with the rise and fall of commodity prices. The commodity cycles are unpredictable, and are largely dependent on the demand for steel products. The main driver for steel products in recent years has been the rate of development or urbanization of emerging countries such as China and India. High commodity prices are great for generating cash flow, but rigid mine plans and fleet sizes can make it difficult to capitalize on these high points of the cycle. The most important trait for a company is to be able to survive during the downturns in the cycle when prices are low, and this is where it is important for a producer to be operationally and cost efficient.

Teck Coal needs to ensure that its operating costs remain low such that it can remain cash flow positive in times when coal prices are low. There are two main factors that contribute to operating costs at Teck Coal's mines:

1. Strip ratio – the amount of waste rock that must be mined in order to produce a unit of ore. For Teck Coal, this is expressed as bank cubic meters of waste rock per metric tonne of clean (processed) coal, or bcm/mtcc. The strip ratio for the entire mine plan in FRO's National Instrument 43-101 (NI 43-101) technical report from 2011 was 12.7 bcm/mtcc (Teck Resources Limited, 2011, pp. 16-3).
2. Haul distance –the distance that waste and ore must be hauled by the fleet of haul trucks. Building on the note above regarding the strip ratio, the waste haul distance to the waste dump is a much larger cost driver compared to the coal haul distance to the processing plant, as there is approximately twelve times as much waste to haul than coal. The longer the haul distance, the more trucks are required per loading unit to maintain production levels, which in turn increases costs. A graphical representation of Teck Coal mining costs is provided in Appendix A.

Determination of ultimate pit limits for a deposit are typically established by using the Lerchs-Grossman (LG) algorithm, which aims to maximize the difference between the value of the recovered ore against the combined costs to mine the waste and ore based on certain geometrical parameters. The algorithm uses known or estimated values for revenues and costs at each point in the deposit, and leads to the generation of cash flows or undiscounted profits (International Mining, 2015). From the cash flows, a net present value for the pit size can be determined, and after generating a series of various pit sizes by varying the selling price, costs, or both, the pit with the highest net present value is generally selected for further optimization, with consideration given to other operational factors or access constraints during detailed design.

Cost inputs into the LG algorithm are the direct mining costs, which are the costs associated with direct mining activities such as loading ore and waste, hauling ore and waste, and support activities for auxiliary equipment such as road grading, and dozing. Loading costs remain constant as there is minimal variability in this activity. Hauling costs have large variability and are determined based on the distance from the pit to the dump, including the grades of the road network in between. Haul trucks travel slower travelling uphill which affects the time to drive to the dump and reduces the productivity of the truck fleet. The lower the productivity of the truck fleet, the more trucks are required to maintain production levels, which in turn increases hauling costs. Shorter haul distances will either lead to a larger economic pit limit that will have more reserves for a certain operating cost, or a smaller economic pit limit which will have fewer reserves but at a higher margin and revenue.

2.2.2 Flexibility

For the purposes of this analysis, flexibility refers to the flexibility in the organizational structure to react to changing conditions. The nature of the commodity cycle leads to periods of high selling prices and periods of low selling prices. In times of high prices, it is important to be able to react accordingly to be able to maximize production and take advantage of the higher margins. This would mean that the mine plan would need to identify a sequence and schedule to deliver a higher volume of product to the plant using the same amount of equipment and resources, because due to long lead times for major equipment it is not possible to immediately purchase new equipment. Hiring contractors to perform some of the mining work is an option, but at a higher cost. Downstream and peripheral departments would also need to react accordingly, such as processing and maintenance to support the increased production and activity.

Conversely, in times of low coal prices, it is important to merely survive which means maintaining positive cash flows and having lower costs than those of competitors. Reducing production is generally a last resort as this could mean losing market share. Ultimately, this signifies that the mine must be able to produce the targeted levels of production but at a lower cost. Some ways costs can be reduced are by optimizing the mine to shorten haul distances, shut down higher cost equipment, and eliminate or defer capital projects and associated expenditures.

The mine must also be flexible in the products that it is able to produce. As discussed in Section 1.1, FRO's three main categories of product are Standard, Premium and Eagle. Flexibility in this regard is governed by the quantity of seams readily available in the pit or in stockpiles that can be sent to the processing plant, and in sufficient volumes to produce the quantity needed for the customer. Robust mine plans develop multiple areas of the deposit to achieve this flexibility and this is easier to accomplish when the pits are larger and can support multiple working areas. A flexible operation is able to react quickly to changing circumstances, which in turn saves time and increases dependability to the customers.

2.2.3 Sustainability

A sustainable company is one that can balance economic, environmental, and social interests, also known as the triple bottom line (Slack, Brandon-Jones, & Johnston, 2011). This means being able to generate sufficient profits while minimizing impacts to the environment and improving the welfare of people and communities of interest that are affected by the business.

For this paper, sustainability of the operation refers primarily to the long-term viability of the operation, which also allows time for the company to work towards achieving sustainability targets. Teck has six key focus areas for sustainability: community, people, water, biodiversity, energy, and materials stewardship, and has set goals in each of these areas with strategies and plans to achieve them (Teck Resources Ltd., 2015).

If the mines were to unfortunately shut down sooner than expected due to poor commodity prices and the inability to achieve positive cash flows, Teck will start bearing the costs for closing the mine, or placing it under care and maintenance. In any regard, this would have downstream effects of losing market share due to reduced production and laying off most of the workers at the site. If the mines were forced into closure, and coal prices increased in the future, it would be very challenging to resurrect the workforce and find the properly skilled workers, particularly technical staff and tradespeople, to return the sites into operation.

2.2.4 Efficiency

Efficiency is measured by how much the mine can produce with the resources, infrastructure, and people it has at its disposal. Productivity is part of this metric, and is affected by size of equipment, strip ratio, haul distance, mechanical availability and utilization of the equipment, and quality and skill level of the workforce.

Employee engagement and morale also factor into this metric, and refers to the engagement level of the workers and how well they buy in to the strategies set by management. An engaged work force is more productive than a work force that resists new initiatives, as it tends to go above and beyond the normal work requirements and creates a culture of doing what is right. This reflects the culture of the operation, and reflects management styles and how employees are treated, motivated, and developed.

2.2.5 Dependability

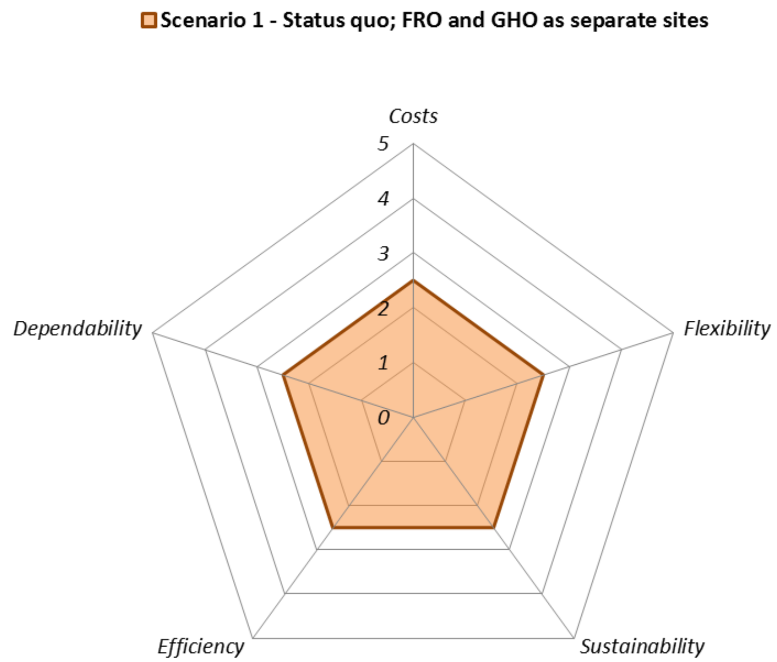
Dependability is important in terms of the operations ability to reliably supply customers with the products they requested and in a timely manner. Steel mills prefer to have a coal product with specifications that are as consistent as possible from shipment to shipment to inhibit variability in their steel-making processes. The ability to regularly meet the needs of customers is instrumental in developing good rapport with them and credibility towards being a preferred supplier. Customers do not want to do business with mines that are at risk of closing or are continually shutting down and reopening, which can happen with high cost producers.

Smaller mines with smaller pits may not have enough diversity in their coal seams to produce a wide variety of products and may be more susceptible to not meeting demands of customers. Conversely, larger mines with multiple active mining areas and many coal seams would be able react to changing circumstances and more reliably meet customer demands and product specifications.

2.2.6 Polar diagram

The criteria described in the above sections can be represented graphically with a polar diagram. The polar diagram in Figure 2.1 depicts a representation of the current structure for FRO and GHO, with their relative significance shown from zero (least impact) to five (greatest impact). For the purposes of this paper and for comparison, each of the five criteria for the base case scenario were given a ranking of 2.5, which presumes that all areas are functioning well at the average.

Figure 2.1 – Polar Diagram for Status Quo - Existing Structure for Fording River and Greenhills Operations



DRIVER	CONTEXT
Costs	maintain profitiability; continually optimize to reduce costs
Flexibility	react to market conditions; product variation
Sustainability	long-term viability; triple bottom line; meet sustainability objectives
Efficiency	equpiment & personnel productivity; employee morale & engagement
Dependability	deliver on spec and on time, preferred supplier

Ranking:
0 – Low impact
5 – High impact

Source: Drawn by author

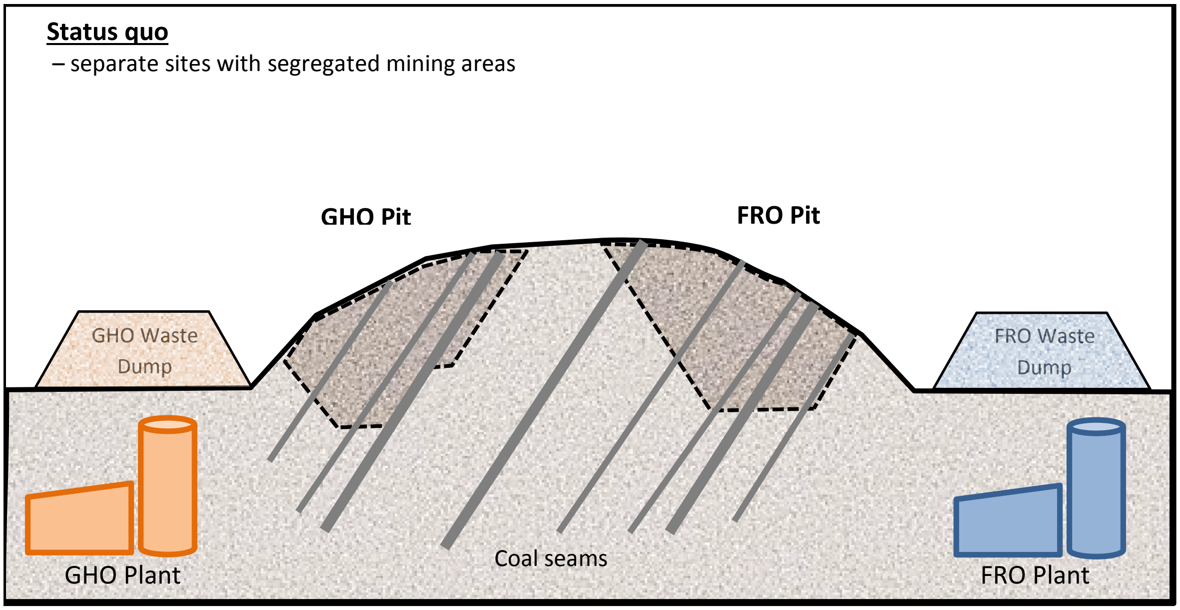
3: Options Analysis

3.1 Identification of Scenarios

Four possible scenarios have been identified to analyze increasing levels of integration between FRO and GHO:

1. Maintain the status quo – This is the base case scenario and is included as a point of reference for comparison. In this scenario, the two operations remain as separate entities in their current state. In the mine design, a possible outcome may feature a physical boundary on Greenhills Ridge, such as a highwall in the mine design or a property fence line, to avoid interaction amongst the mine operations. This option presents the simplest and easiest solution but may result in a lost opportunity by not maximizing the potential of the reserve and the longevity of the mine lives. Accordingly, the separate organizational structures would be maintained and no significant sharing of equipment or processing of coal between sites is assumed.

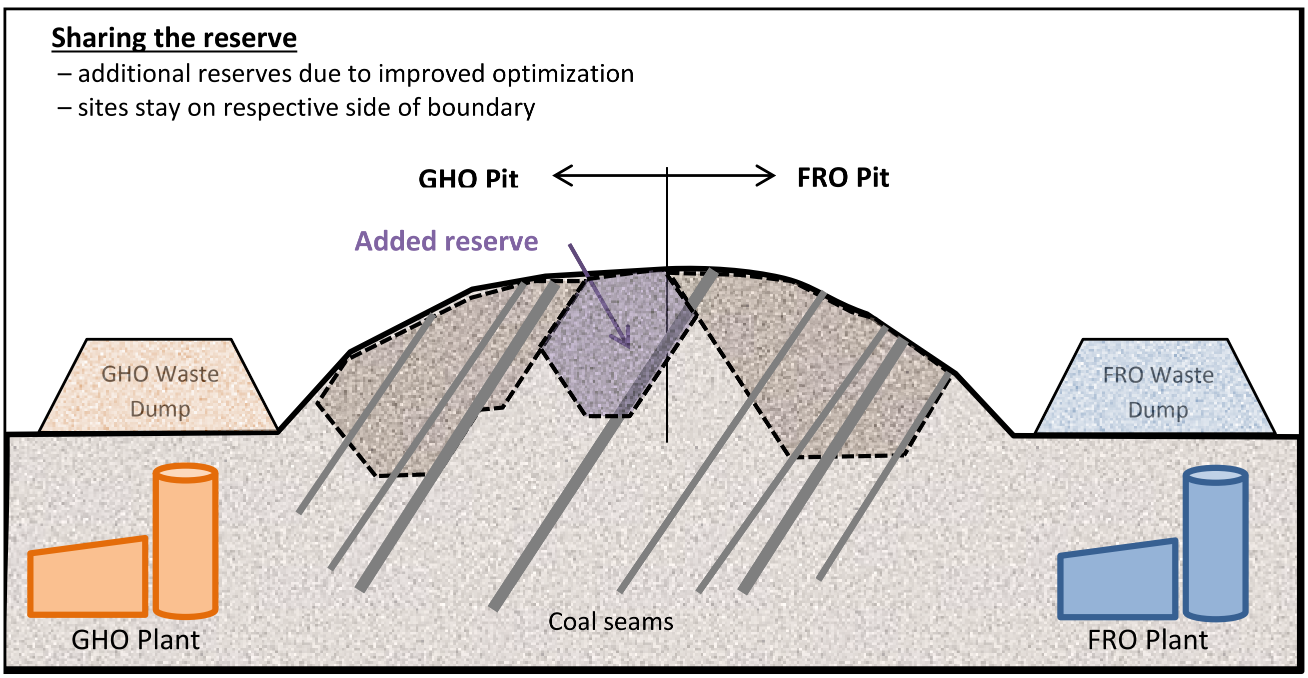
Figure 3.1 – Schematic for status quo scenario



Source: Drawn by author

2. Share the reserve – This scenario is similar to Scenario 1 described above, but instead of setting a physical barrier such as highwall or fence line, this scenario is more akin to 'drawing a line in the sand'. During the mine optimization and LG analysis, synergies and efficiencies may be identified that may facilitate the economic viability of mining of a larger pit. However, on the operational side, the equipment and personnel from the respective sites would be restricted to their side of the line. Accordingly, the separate organizational structures would be maintained and no significant sharing of equipment or processing of coal between sites is assumed.

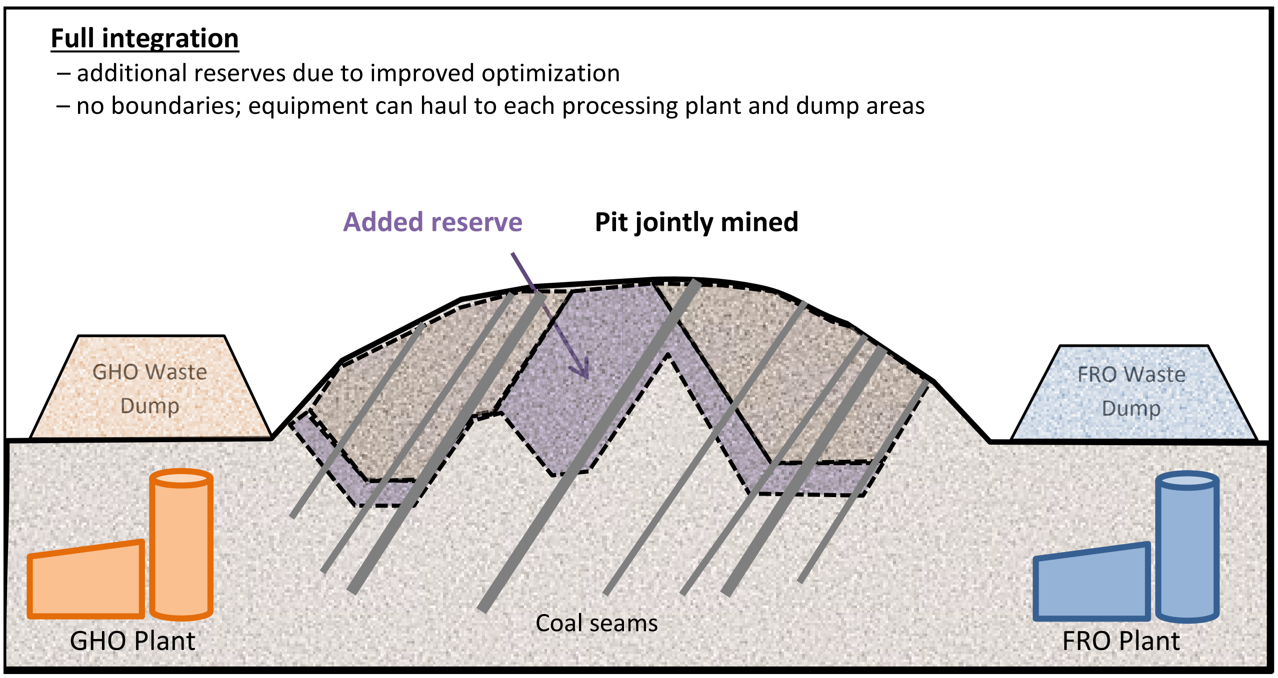
Figure 3.2 – Schematic for sharing the reserve scenario



Source: Drawn by author

3. Full integration – This scenario maintains the sites as separate entities but would see full interaction amongst the equipment and personnel between both sites, with the objective to maximize operational efficiencies, such as sharing dump space to reduce haul distances and sending coal to each plant to improve product yield and quality. Improved efficiencies would result in lower costs and could lead to mining a larger pit. In this scenario, the separate FRO and GHO organizational structures are maintained.

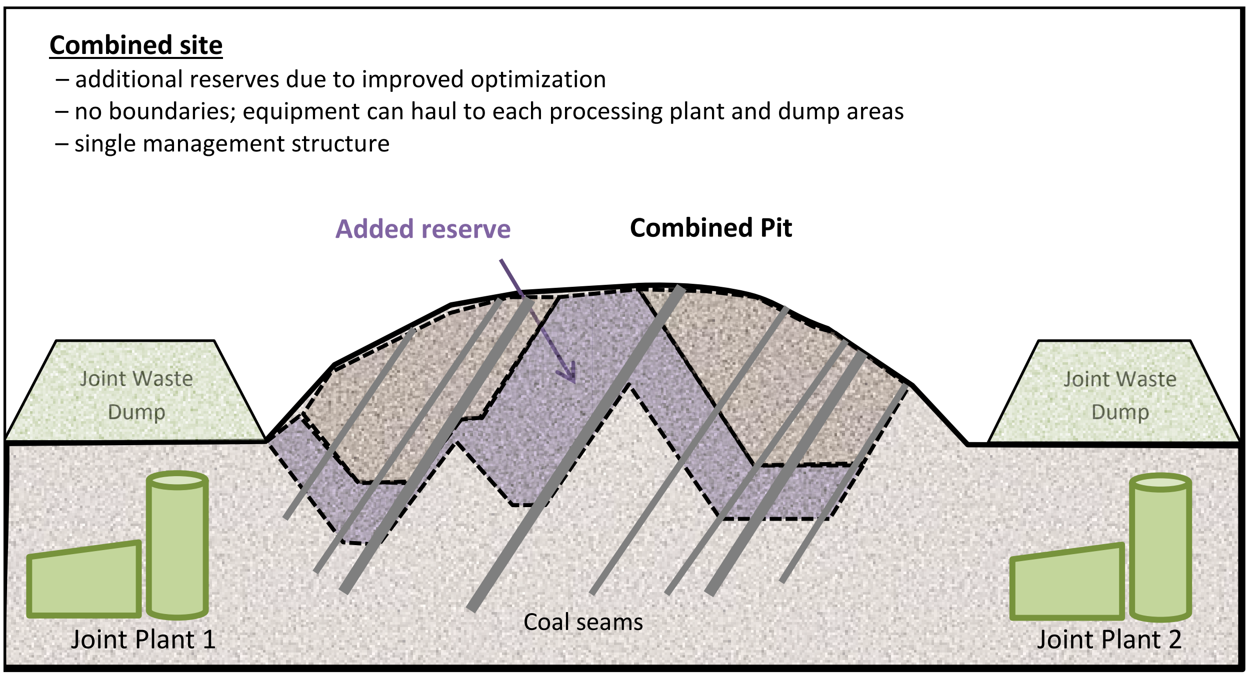
Figure 3.3 – Schematic for full integration scenario



Source: Drawn by author

4. Merge into a single operation – This scenario is the same as Scenario 3 but with the distinct change of combining FRO and GHO into one operation with one organizational structure. The improved efficiencies and lower costs identified in Scenario 3 hold true for this scenario, as well as mining a larger pit. However, instead attempting to execute one plan by two sites, which could pose some significant challenges, this scenario combines the organizational structures and business entities for the purpose of providing a more streamlined structure and ability to communicate direction and strategy.

Figure 3.4 – Schematic for combined site scenario



Source: Drawn by author

The differences in the scenarios are summarized in Table 3.1

Table 3.1 – Summary of Integration Scenarios

Scenario	**1. Maintain status quo**	**2. Share the reserve**	**3. Full Integration**	**4. Merge into single operation**
Operate as separate sites	✓	✓	✓	
Physical boundary	✓			
Non-physical boundary		✓	✓	
Share processing capacity			✓	✓
Share waste dump capacity			✓	✓
Equipment fleet interaction			✓	✓
Equipment fleet sharing			✓	✓
Single management structure				✓

3.2 Application of Theory

Evaluating the integration of FRO and GHO is predominantly looking at changing the structural organization of the two sites, and it is important to think about why the sites are set up the way they currently exist. FRO and GHO were formed under separate companies which explains the current separate structures. GHO was initially part of Westar Mining but went bankrupt in 1991. FRO, which was part of Fording Coal Limited at the time, who purchased the interests of GHO in 1992. Mining has progressed independently at each site over the years, and both operations are beginning to exhaust their reserves in their active mining areas. FRO and GHO are both looking towards Greenhills Ridge to provide for their respective futures.

Organizations exist to achieve established goals and objectives, and structures must be designed to fit an organization's current circumstances, including its goals, technology, workforce and environment (Bolman & Deal, 2008, p. 47). Teck's goals are to remain competitive and profitable in the steel-making coal market for the long term. As Teck is a price-taker, proper structure is essential to foster an efficient operation to deliver product at the lowest possible cost. Restructuring of an organization is initiated when the environment shifts, technology changes, organizations grow, or leadership changes (Bolman & Deal, 2008, p. 89). Current circumstances suggest that the structure may need to be adjusted to ensure the lowest operational costs, driven largely by the shift in the coal market environment and changes to leadership now that both sites reside under Teck Resources Limited.

To remain competitive in the steel-making coal markets in the future, it is important to think strategically about what this could mean for Teck Coal. Four phases of strategy have been defined by Pankaj Ghemawat (Ghemawat, 2010):

1. Financial planning – meeting the annual budget
2. Forecast-based planning – predicting the future
3. Externally-oriented planning – thinking strategically
4. Strategic management – creating the future

Teck is a publicly traded company and regularly holds investor conference calls reporting on forecasted sales volumes and company performance, so it can be presumed that Teck is at least engaged in forecast-based planning. Teck may be able to leverage the opportunity at the FRO and GHO sites to take a more active approach in strategic management to create the foundation for their sustainable future, profitability growth, and market share. This could be something similar to re-structuring the FRO and GHO mines or adopting new technologies employed at the mines.

Combining the FRO and GHO mines may not be a strategic move as defined by Michael Porter (Porter, 1996). In Porter's view, joining the operations is seen as a decision to improve operational effectiveness, as it involves performing mining activities faster, more efficiently and at a lower cost. These types of practices can be easily adopted by the competition which ultimately results in an outward advancement of the productivity frontier, with the outcome being a convergence of costs and value. Strategy, on the other hand, is defined by Porter as finding a sustainable competitive advantage by focusing on what is unique to the company and doing things differently compared to the competition. This is difficult to do in a natural resource commodity industry, but joining the FRO and GHO sites would provide advantages in possessing dual processing plants with the ability to set up each plant for specific products, as well as overall mine plan flexibility and efficiency, which typical mines may not possess.

Merging the sites may be viewed as a transformational change at the site level, as it could have big impacts to those who are involved directly at the sites. This would in fact be an incremental change in the overall business unit, as only an innovation in process/operations is being undertaken, and no innovations with respect to product, position, or paradigm.

Incremental changes occur a little at a time, and exert themselves through results of continual improvement and operational excellence programs. These changes target an increased level of efficiency by defining ways to do things better, faster, or at a lower cost, thereby reducing risk. Incremental changes are more easily adoptable by the company and its workers, as opposed to transformational changes which cause instability through radical changes to the business processes and structure.

3.3 Barriers

3.3.1 Labour Union

One major barrier for integrating the FRO and GHO sites is that FRO has a labour union and GHO does not. This presents numerous legal, operational and logistical challenges when evaluating opportunities for operational efficiencies.

Unions are governed by collective bargaining agreements (CBAs) of which the terms are negotiated between the union and the company. CBAs outline all aspects of the interactions between the union and the company, including management rights, obligations and business of the union, safety and health, grievance procedure, hours of work, wage levels and rates, vacation entitlement, benefits, and pension. Negotiating CBAs is very time consuming and frustrating at times, and when discussions stall and the agreement lapses, then union can vote to take strike action. FRO has a collective bargaining agreement in place which expires in May 2016, and the agreements are typically five years in duration (Teck Coal Limited Fording River Operations and USW Local 7884, 2011). GHO workers are not covered under a CBA but are governed by human resource policies for the site.

One of the differences between the two sites is the variation of job levels and hourly wage rates. The FRO collective bargaining agreement stipulates specific job titles and corresponding wage rates while GHO is based on broader, generic categories and wage levels may not be aligned. Worker pensions are also different as FRO has a defined benefit plan while GHO has a defined contribution plan.

Unions are heavily based on worker seniority which means when a new position becomes available, the person with the most time with the company will be selected for the position. This is not the case for GHO because they do not have to select the person who has been employed the longest, but can choose the person who is best suited for the job, giving GHO a productivity advantage.

Proceeding with Scenario 4 implies that Teck Coal would be accepting of the likelihood that the GHO workers would unionize, and this would be a difficult decision for Teck Coal to make. Given the stringent labour codes in place today that did not exist in the early days of the mining industry, such a n action could be seen as a step backwards in terms of the culture Teck Coal has worked to create and the productivity levels it strives to achieve.

When accidents or incidents occur, investigations are undertaken on site to discover the root cause, whether due to mechanical failure of the equipment, human error, or lack of management controls. Unionized environments require a union representative, or steward, to be present at all investigations when a unionized worker is involved or under investigation. As these stewards are also workers, the result can be a loss in production as both the employee under investigation and the steward are not productively working during this time.

In a unionized environment, management actions tend to be regularly questioned and scrutinized, when compared against the wording in the collective bargaining agreement. There is also less flexibility to release poor performers because the union will challenge such a decision on the grounds of wrongful dismissal. This inhibits the goal to achieving highest possible productivities when there are weaknesses with under-performers in the department.

3.3.2 POSCAN Joint Venture

In the joint venture agreement, Teck Coal acts as the operator and manager of the mine. GHO and POSCAN share the assets, capital costs, and expenses according to their joint venture interests, with GHO at 80% and POSCAN at 20%. Under the agreement, POSCAN has a right to 20% of the coal produced during the operational phase of the joint venture which is approximately one million tonnes of clean coal (mtcc) per year. The terms of the agreement are scheduled for renewal in 2015, 2018, and 2022. Should GHO and POSCAN disagree on the continuation of the terms of the agreement then the operational phase will end (Teck Resources Limited, 2014).

The joint venture agreement between POSCAN and the Greenhills mine would complicate the merger of FRO and GHO. If GHO and FRO merged, it is unlikely that POSCAN would want to maintain their current 20% interest in the joint venture, as this would result in their share of coal increasing to over 2.7 million tonnes which is likely too much for their needs. POSCAN’s share of the capital costs would also increase, and this could be a deterrent in wanting to continue the agreement. There is the possibility that POSCAN would want to maintain their current share of the tonnage that they currently experience. At the combined production of 13.7 million tonnes per year, POSCAN’s interest would be reduced to approximately 7% in order to maintain their one million tonnes of clean coal production. This seems like a more plausible way to simplify the contract and a reasonable potential outcome should the operations merge.

As for Teck's position on this matter, the agreement essentially guarantees one million metric tonnes of clean coal shipments to POSCAN along with payment of 20% of the capital and operating costs. POSCAN is a strategic long-term customer who purchases an additional three million tonnes of coal beyond their 20% stake in GHO. When coal prices are at the upper end of the commodity cycle, Teck would rather sell the coal to the open market as the large margins would easily help carry the extra 20% of the costs. However, it is in these times of high prices that POSCAN would want to ensure that they secure their entitled portion of the coal production to avoid having to pay higher prices on the open market. Generally, it appears that the existing joint venture agreement works well for both parties, but Teck would not want to concede 20% of the FRO production to POSCAN. Ceasing the agreement would create complications because Teck and POSCAN have joint ownership over all site assets and Teck would have to purchase POSCAN's interest which could be a significant financial burden. Generally, it appears that the agreement is working well for both parties, and some minor re-negotiation would be required if the sites decided to merge.

3.4 Detailed Analysis

The following sections will take a high level overview of some of the benefits and risks for the scenarios identified for mining Greenhills Ridge by both sites.

3.4.1 Scenario 1 – Maintain the status quo

No additional risk to the operations would be introduced with this scenario. Each site would continue to operate separately, while optimizing their own plans to meet targets. This remains a viable option because the sites have been operating for decades and have robust processes in place and can continue to find ways to survive when coal prices are low. Another benefit of this option is that no extra effort would be required to communicate plans and directives at the operational level as each site would not have to worry about what the other site is doing at any given point in time.

The potential downfall of this option is that there may be a lost opportunity for mining a larger reserve and prolonging the mine lives and sustainability of the operations. Decisions will need to be made by senior management to determine a logical transition point or boundary between the two sites which, for fairness, could be based on calculating similar mine lives (total reserves divided by annual production for each site), net present value of the plans, and operating costs and margins for each plan. Ideally, mine planning and geology would have input into this decision to avoid further loss of reserve potential.

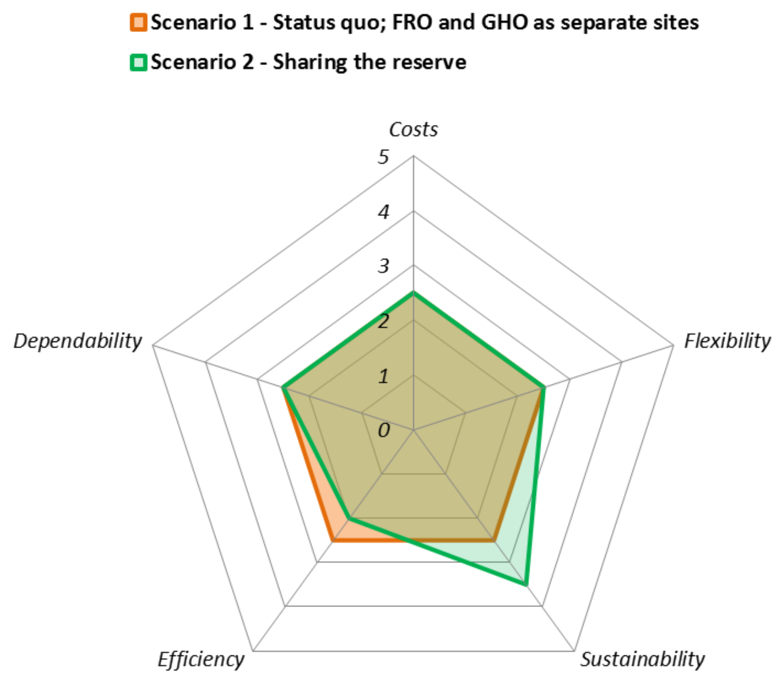
3.4.2 Scenario 2 – Share the reserve

The main objective of this scenario is to jointly mine a larger reserve by coordinating the mine design and sequence of development so that both sites can take advantage of operational efficiencies. This is the first step of moving towards evaluating the mining potential cooperatively, and would result in equipment and personnel from both sites operating in the same pit but with no integration with the equipment and personnel from the other site.

This option would introduce a small increase in the day to day interactions of the sites. While each site would stay within their respective property limits, this option would necessitate some increased level of integration at these boundaries. For instance, if both sites were concurrently mining in an area, they would need to be aware of each as they operate at these boundaries as there could be risk to equipment and personnel. A good example of this is when blasting occurs; the blast clearance area could infringe on adjacent areas at the other site and could cause delays and loss of production if not well communicated and coordinated.

Comparing this scenario to Scenario 1, there would be an overall increase in sustainability from being able to mine a larger pit with a longer mine life. Costs, flexibility, and dependability would not see a significant change as each site would still be constricted to their operational boundaries, and therefore are considered to remain unchanged. Due to the need for increased interaction with the other site while still being constrained to the operational boundary, efficiency is presumed to decrease slightly; this may be a short term issue until new processes and procedures are developed to improve this metric. The differences between Scenario 2 and Scenario 1 are represented graphically in the polar diagram in Figure 3.5.

Figure 3.5 – Polar diagram of Scenario 2 versus Scenario 1



DRIVER	CONTEXT
Costs	maintain profitiability; continually optimize to reduce costs
Flexibility	react to market conditions; product variation
Sustainability	long-term viability; triple bottom line; meet sustainability objectives
Efficiency	equipment & personnel productivity; employee morale & engagement
Dependability	deliver on spec and on time, preferred supplier

Ranking:
0 – Low impact
5 – High impact

Source: Drawn by author

3.4.3 Scenario 3 – Full integration

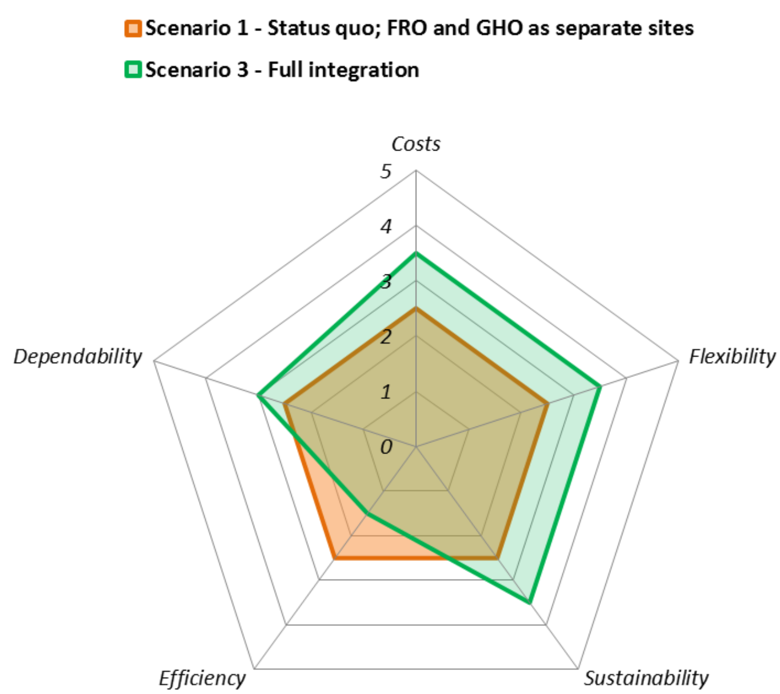
The premise behind this option is that a larger pit and volume of reserves could be mined through efficiencies gained by fully integrating the resources and infrastructure of the two sites. One such operational opportunity could be shorter haul distances to the waste dumps. Waste dump locations are driven by topography and accessibility, and as an example, one site may have a short-haul option to a dump at a certain point in their mine plan while the other site only has a long-haul option. If the site with the long-haul option could haul shorter and cheaper to a dump at the other site then significant savings in operating costs would be realized. Other opportunities include blending of coal seams from both sites, balancing of strip ratio amongst the mining areas, and increased productivity through improved utilization of equipment (i.e. larger shovels in wider waste headings).

The scenario also creates the ability to utilize both processing plants, so in the event of an unplanned downtime event coal could still be fed to the other site's plant. Or on the other hand, planned maintenance could be scheduled to ensure that one of the plants is always operational. The processing plants could also be configured to produce certain product types in order to maximize yield and revenue. For instance, the FRO plant could be set to produce mainly Premium product while the GHO plant would produce mainly Standard product.

While this scenario could be feasibly modelled and evaluated in a mine optimization exercise, it would be very difficult to execute. First, it would be challenging for front-line supervisors to manage and supervise a fleet of mobile equipment that is operating in both mining areas, such as a truck being loaded at one site's pit but dumping at the other site's dump. The supervisors would not have true authority over the other site's workers, therefore necessitating supervisors from both sites which would cause some redundancy. Other issues would be difficulty in effectively communicating the plan to both sites and would lead to mixed messages being received at the operational level. Conflicting priorities may arise and some crews may act in a self-serving manner to make sure that they achieved their own goals while perhaps doing a disservice to the other site. Tracking of volumes and revenues for each site could also prove challenging and could be based either on the site at which the coal was mined/dumped or at the site where it was processed through the plant. These and other inefficiencies could erode the potential value that was hoped to be gained through increased integration.

Comparing this option to Scenario 1, the evaluation criteria for costs, flexibility, sustainability, and dependability would improve due to mining a larger pit with more active mining areas and associated ability to reduce haul distances and improve product yield. Note that the 'costs' metric in the polar diagram improves (gets larger) when mining costs are improved (lowered). Overall efficiency would not realize a similar positive result due to potential issues identified. While the inefficiencies described are moderate in nature it is assumed that they would not entirely take away from the gains achieved in other evaluation criteria. The differences between Scenario 3 and Scenario 1 are represented graphically in the polar diagram in Figure 3.6.

Figure 3.6 – Polar diagram of Scenario 3 versus Scenario 1



DRIVER	CONTEXT
Costs	maintain profitiability; continually optimize to reduce costs
Flexibility	react to market conditions; product variation
Sustainability	long-term viability; triple bottom line; meet sustainability objectives
Efficiency	equipment & personnel productivity; employee morale & engagement
Dependability	deliver on spec and on time, preferred supplier

Ranking:
0 – Low impact
5 – High impact

Source: Drawn by author

3.4.4 Scenario 4 – Merge into a single operation

This scenario serves to eliminate some of the challenges identified in Scenario 3 by combining FRO and GHO into one operation with one organizational structure. Merging the sites into a single operation would facilitate the clearer communication of strategies and directions, and enable supervisors to have full authority of their work areas and crew. This option still has the benefit of having two plants for processing coal and opportunities for reducing haul distances, balancing strip ratio and blending of coal seams. Costs and revenues would be easier to track as there would be no need to determine the split amongst the sites. Further savings could be gained by evaluating the organizational charts to identify and remove any redundant positions.

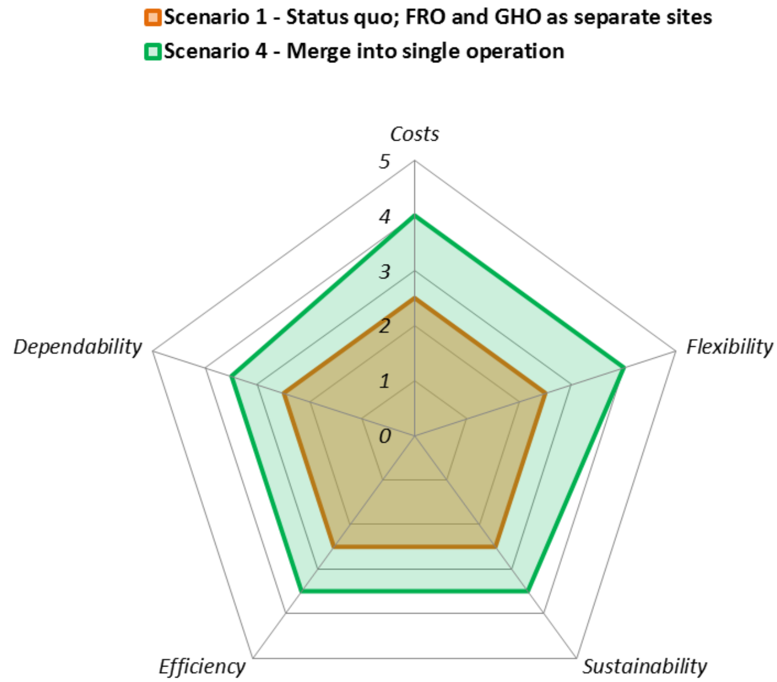
The arrangement of the offices and personnel could be re-structured to keep departments together as much as possible. Currently each site has their own administration, engineering, accounting, mine operations, maintenance and processing departments and it may make sense, for example, to have all mine engineering services based in one building at the FRO site while all of accounting could be moved to the offices at GHO. Each maintenance shop and processing plant would still require the appropriate staffing levels to maintain operations, but could be configured to specializing in certain types or brands of equipment.

This would be a big step change for the business unit and could be met with resistance by loyal employees that would not want to see a merger take place. The impact to the agreement with POSCAN would have to be investigated, as potential outcomes could range from nullification of the agreement entirely to renegotiation in order to maintain a reduced percentage of ownership based on similar volume of the tonnage produced. A single site would likely not operate with a mixed unionized and non-unionized workforce and it is unlikely that the FRO union will dissolve; therefore it can be presumed that the entire labour force at the combined site would become a single union and Teck would have to decide if this is something that they would want to entertain. A larger union would exert more bargaining power which in turn could increase worker wages and costs, and the possibility and ramifications of work stoppages.

There may also be some significant legal and government hurdles to overcome, as the government would want to make sure that all of Teck Coal's commitments and legacy issues from the individual sites are carried forward to the combined site. This would involve a substantial amount of effort to transfer the numerous licenses and permits to the new operation.

Comparing this scenario to Scenario 1, all five evaluation criteria would see an improvement over the current structure. Costs would be reduced through the ability to optimize the mine plan for Greenhills Ridge. Note that the ‘costs’ metric in the polar diagram improves (gets larger) when mining costs are improved (lowered). Sustainability would improve through the increased reserves and longer mine life. Flexibility and dependability would improve as a result of the ability to develop various mining areas to expose the coal seams required to for the desired product, and improved reaction time to changing conditions. This scenario would see a marked improvement in efficiency which the other scenarios cannot achieve. The improvement in efficiency is due to moving to a single management structure which would be able to provide a clearer strategy and direction to the workers. The differences between Scenario 4 and Scenario 1 are represented graphically in the polar diagram in Figure 3.7.

Figure 3.7 – Polar diagram of Scenario 4 versus Scenario 1



DRIVER	CONTEXT
Costs	maintain profitiability; continually optimize to reduce costs
Flexibility	react to market conditions; product variation
Sustainability	long-term viability; triple bottom line; meet sustainability objectives
Efficiency	equipment & personnel productivity; employee morale & engagement
Dependability	deliver on spec and on time, preferred supplier

Ranking:
0 – Low impact
5 – High impact

Source: Drawn by author

3.5 Analysis Summary

The scenarios have been summarized in Table 3.2, which shows the relative differences of Scenarios 2, 3, and 4 versus Scenario 1. The differences are the same as shown on the respective polar diagram comparisons. A positive relative difference corresponds to an improvement of the criteria, while a negative relative difference corresponds to a deterioration of the criteria. Note that the 'costs' metric in the polar diagram improves (gets larger) when mining costs are improved (lowered). Also shown in the table are the barriers discussed in Section 3.3; the risks associated with the union at FRO and the joint venture agreement with POSCAN at GHO.

Table 3.2 – Scenario Analysis Summary

	Operational Benefit						Barriers	
Scenario	Relative Difference					Total	Risk	
	Cost	Flexibility	Sustain-ability	Efficiency	Depend-ability		Union	Joint Venture
2 vs. 1	-	-	+1.0	-0.5	-	**+0.5**	Low	Low
3 vs. 1	+1.0	+1.0	+1.0	-1.0	+0.5	**+2.5**	Moderate	Low
4 vs. 1	+1.5	+1.5	+1.0	+1.0	+1.0	**+6.0**	High	Moderate

By summing the changes in the relative differences of the performance criteria, it is possible to get a sense of the value or benefit from the various scenarios. Scenario 2 results in the smallest benefit with an overall improvement of +0.5 and has the least amount of risk associated with it since minimal interaction would occur between the sites there is very little risk to jeopardizing the joint venture agreement or the desire to unionize the GHO site. The benefit improves slightly with Scenario 3 with an overall improvement of +2.5 but along with this improvement comes the increased levels of interaction between the unionized FRO site and the non-unionized GHO site. Scenario 4 achieved the highest benefit with an overall improvement of +6.0, albeit with the highest amount of risk for the likelihood of the GHO site becoming unionized and the endangerment of the joint venture agreement.

4: Recommendation

Evaluating the benefits of the various scenarios and weighing against the risks of the two major barriers, the author recommends a two-staged approach to developing a strategy for mining the Greenhills Ridge:

1. Proceed forward with Scenario 2 and develop a strategy to share the reserve amongst the sites. Although this option may not reap substantial savings in operating costs it is the lowest risk and increases the longevity of both sites by developing a larger reserve. This option is the least disruptive to the existing structures, systems, and processes and given the poor market situation being experienced in 2015, remaining competitive through minimizing operating costs is paramount. In the author's opinion, Teck would prefer it if the GHO employees did not unionize, either on their own or with the FRO union, as this would create a larger bargaining power of a greater collective union.
2. Under the current market conditions, it is unlikely that Teck would want to invest time, money, and resources into pursuing Scenarios 3 and 4 at this time, but the author believes that Scenario 4 is worth investigating further based on the potential benefits; it is important to know what is on the table before one can walk away from it. Therefore, Teck should commission a team to evaluate the economic potential of developing Greenhills Ridge under the premise of operating as a combined, single site. This could be a viable option if the value gained outweighs the cost of making such a big step change for the operations, risks to GHO employees unionizing and impacts to the POSCAN joint venture agreement. This scenario would become more attractive should the GHO employees become unionized before significant development occurs on Greenhills Ridge.

5: Implementation Plan

For the first stage of the recommended path forward, proceeding with Scenario 2, the implementation plan is primarily an exercise in mine engineering. GHO and FRO, along with guidance and support from the business unit, should commission a team dedicated to finding the best solution for mining the ridge for both sites. The analysis would consist of applying the Lerchs-Grossman (LG) algorithm to the geological model with appropriate cost and revenue assumptions. The initial cost assumptions would need to estimate the respective costs for each site, based on a high-level mine plan. Although the LG process is automated in available mining software packages, it is still a very iterative process due to the numerous options to simulate stemming from the many variables that can be changed, such as annual production rate, selling price and exchange rate, pit and dump geometry. For instance, the boundary, or the 'line in the sand', between the two sites could be located in many different locations and configurations resulting in a unique mine plan for each one. All of these mine plans would need to be evaluated as reasonably as possible.

The evaluation of the mine plans would ultimately be based on the operating costs of the plan, and preferred options would have the lowest costs and, correspondingly, the highest margins. Other factors that should be considered are the feasibility of achieving the plan, safety and environmental risk factors, and capital expenditure requirements. For fairness, both sites would receive mine plans with similar outcomes, such as overall cost per tonne of clean coal, net present value, and mine life.

It is presumed that any proposed development on Greenhills Ridge would need to be reviewed under the British Columbia Environmental Assessment Act (BCEAA) to determine if there are potential impacts to valued components in disciplines such as terrestrial, biodiversity, fish and fish habitat, socio-economic, water quality and human health. The environmental assessment process can take many years to complete, as baseline conditions must first be established, impact assessments conducted, and mitigation plans proposed and satisfactorily met by regulators. Upon successful review, the project would receive an Environmental Assessment Certificate and would need to secure appropriate provincial permits before mining can commence.

A project of this nature should take a stage-gate approach, with a defined organizational structure including a project owner, a project board to provide direction and approvals, and in this case, an environmental advisory group to provide guidance and support related to permitting. The recommended stages are pre-scoping, scoping, pre-feasibility, feasibility, and execution, with major decision gates occurring between the stages. The degree of certainty in costs, schedule, and engineering detail increases with each stage. The project cannot advance to the next stage until all requirements are met and deliverables completed for the current stage, and the project of course still remains viable. The project board would make the ultimate decision on whether the project should go ahead. It would be prudent to determine the date that mining would ideally start, based on when new pits would be required in the existing mine plans, and work backwards to determine when permitting activities should commence, while also accounting for pre-development construction to be completed.

Prior to execution, detailed plans and procedures would need to be drafted to define protocols for situations where increased interactions between the two operations may occur, such as the blasting example described previously. Front-line workers, supervisors, and site management would have to be trained in these new procedures to ensure the safety and efficiency of the operations.

For the second stage of the recommended path forward, evaluating the potential of Scenario 4, the implementation plan is similar to the plan described above and is primarily an exercise in mine engineering and economic analysis. Again, numerous iterations of the LG simulations would need to be run and evaluated. For Scenario 4, the objective would be to identify lower cost mine plans by taking a more unconstrained approach to the process. Ideally, by merging the sites, the dump locations and geometry could be redesigned to better optimize haul distances and reduce operating costs. Also, assumptions could be made to haul certain coal seams to specific processing plants to improve product yield and revenue. Should the outcome of this analysis work result in significant economic improvements over the existing plan, then further work should be conducted to identify the costs, risks, and effort to merge the operations, including the likelihood of the GHO workforce becoming unionized. This work should also follow a stage-gate process with the findings put forth to the project board for the final decision.

Lastly, should the project board decide that the sites should indeed merge into a single operation, it would be vital to have a robust change management plan in place to ensure that the strategy is implemented as seamlessly as possible with buy-in from management and employees at all levels. Kotter suggests eight steps for successful implementation of change (Kotter, 2007):

1. Establish a sense of urgency
2. Form a powerful guiding coalition
3. Create a vision
4. Communicate the vision
5. Empower others to act on the vision
6. Plan for and create short-term wins
7. Consolidate improvements and produce more change
8. Institutionalize new approaches

These steps from Kotter’s work should be followed to successfully make the step change of combining the operations.

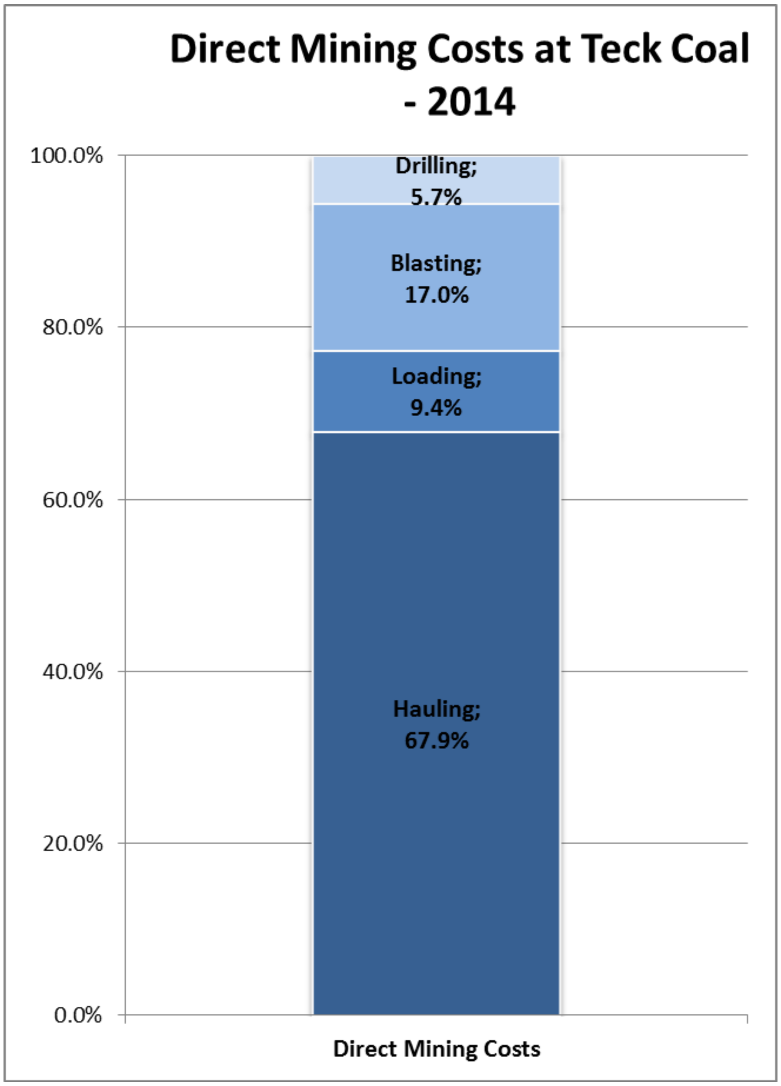
6: Conclusion

Teck Coal has a vast amount of resources in an area known as Greenhills Ridge, and both Fording River Operations and Greenhills Operations could logically mine the deposit. Operational efficiencies may exist to mine the coal deposits concurrently by the sites. Haulage costs are the largest component of direct mining costs at Teck Coal, and small gains in optimizing this can reap big returns.

Given the variability and uncertainty in the coal markets, Teck should take a more cautious approach to develop Greenhills Ridge. The ridge should be evaluated based on both sites sharing the reserve as this would optimize the extraction of the resource and limit sterilization of the coal if evaluated independently. At this time, with the current low coal prices, Teck should not look at integrating the sites any further, such as mixing of the GHO and FRO fleets, as this would incur inefficiencies in the near term at a minimum resulting in increased costs.

Merging the sites should still be seriously considered as there is potential for operational benefits to be gained. A pre-scoping and scoping-level evaluation would enable a high level look at the benefits and costs without investing too much money and resources. Consultation with the various general managers, business planning, corporate development, and environmental managers would be essential for assessing the risks associated with combining the sites.

Appendix A – Direct Mining Costs at Teck Coal



Source: Teck Coal Limited, (2014) Mines Comarison Report December 2014.

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