From the Ground Down – Developing a Geological Vision for the Fort Hills Oil Sands Project

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ABSTRACT

The proposed Fort Hills Oil Sands Project, located adjacent to the historic Bitumount site, is based on a confident assessment of 2.4 billion barrels of bitumen reserves on leases operated by TrueNorth Energy. The rapid evaluation of this resource, which has incorporated three phases of delineation drilling, presented several challenges to the team geologists. A variety of data types was required by a diverse group of stakeholders throughout the pre-feasibility, feasibility and permit application phases of the project. Critical issues were prioritized early in the evaluation and have been dealt with in a sequential manner to deliver assessments of risk with increasing degrees of confidence over time. This approach is part of a business model that balances an aggressive exploration approach with mine planning discipline. One of the project's key success measures was building a strong "Blue Chip" team early in the evaluation, and ensuring that the members of the multidisciplinary team have the appropriate incentives to be true stakeholders.

INTRODUCTION

The proposed Fort Hills Oil Sands Project is a surface mining and bitumen extraction operation situated 90 kilometres north of Fort McMurray. An aggressive program of lease evaluation, mining feasibility studies and public consultation over the past three years has resulted in a proposal to invest $2 billion in a project that will yield 95,000 barrels per day of transportable bitumen blend starting in 2005, increasing to 190,000 barrels per day in 2008. The remarkably rapid progress of this project owes much of its success to a business development model that balances an acquisitive exploration ethic with a disciplined mine planning approach.

The geologists who were members of the "Blue Chip" team providing services to the Fort Hills Oil Sands Project faced a number of unique challenges in order to meet the aggressive timeline. Managing the risk-reward relationship of capital investment in delineation drilling was just the first step of a sustained effort to provide appropriate volumes of critical data in a timely manner to a diverse group of stakeholders. That role will continue through the permit application and public consultation stages as public needs and concerns are identified, and on through the life of the mining operation. The lessons learned during the initial phases of the Fort Hills project have broad relevance to all geologists working on large-scale projects where tough economics collide with public interests.

HISTORICAL BACKGROUND

The Athabasca oil sands have been a part of Alberta's economy since the first Aboriginal inhabitants of the region used bitumen to seal the seams of their canoes. The stories of a Chipewayan trader named Wa-pu-su brought this valuable resource to the attention of the Hudson's Bay Company in the early 1700's, and a steady stream of European explorers and scientists soon began to take up the long, quixotic quest to commercially develop the tar sands.

During the heady days of the 1920's, a brash and determined promoter named Robert Fitzsimmons acquired a lease on the east bank of the Athabasca River, approximately 90 kilometres north of Fort McMurray, which he soon renamed Bitumount. In 1930, frustrated by conventional drilling results, Fitzsimmons' International Bitumen Company adapted the hot-water separation technology piloted by Dr. Karl Clark to build the world's first oil sands mining and extraction facility, reputedly using scavenged materials and $50 worth of equipment. His seven-man crew produced about 300 barrels of bitumen during the summer months.

The early, and frequently scandalous, days of small promoters like Robert Fitzsimmons have given way to the proud achievements of modern oil sands operators who now collectively produce over 325,000 barrels of synthetic crude oil and bitumen daily. By the end of this decade, production from oil sands mining and associated in-situ operations is planned to exceed 1 million barrels daily following investment of approximately $20 billion in an industry that employs tens of thousands of skilled workers.

When TrueNorth Energy purchased a 78 percent interest in Oil Sand Leases 5 and 52 in 1998 (and Lease 8 in 2000), it also acquired the heritage forged by Bitumount pioneers like Fitzsimmons, Clark, Lloyd Champion and Elmer Adkins. Their legacy is the foundation of the proposed Fort Hills Oil Sands Project, providing a balance of entrepreneurial drive, attention to technical and economic details, and commitment to stakeholders.

GEOLOGICAL SETTING

The Fort Hills site, comprising Oil Sands Leases 5, 8, and 52, is situated in Townships 96 - 98, Ranges 9W4 - 11W4, in the northern half of the surface mineable area of the Athabasca Oil Sands Area (Figure 1). Oil sands at the site are predominantly found within the Lower Cretaceous (Aptian) McMurray Formation of the Mannville Group. Minor oil sands are also present in the disconformably overlying Lower Cretaceous (Albian) Wabiskaw Member of the Clearwater Formation. Up to 30 metres of Clearwater Formation mudstones overlie the Wabiskaw Member, and the Clearwater, in turn, is unconformably overlain by up to 60 metres of Quaternary overburden. Near the banks of the Athabasca River, the McMurray oil sands are exposed at the surface. The McMurray oil sands unconformably overlie argillaceous limestones and lime mudstones of the Waterways Member of the Middle to Upper Devonian (Givetian to Frasnian) Beaverhill Lake Group. The log shown in Figure 2 is typical of the stratigraphy of the area.

The McMurray oil sands are situated in a regionally northwest trending paleovalley that extends from the Primrose area north through the Bitumount Basin (Keith, et al., 1988). The formation is typically subdivided into a lower fluvial member, a middle estuarine member, and an upper marginal marine member (Wightman and Pemberton, 1997). A proprietary sequence stratigraphic analysis of the McMurray Formation at the Fort Hills site, which goes beyond the scope of this discussion, suggests that at least seven depositional sequences are represented in the project area, and that the conventional tripartite subdivision of the McMurray approximately reflects the retrogradational stacking of sequence sets.

EVALUATION PROGRAM

At the time TrueNorth Energy acquired its interest in the Fort Hills area, an initial assessment of available data indicated some glaring deficiencies in the types, quality and density of information that could be used to conduct a pre-feasibility study. Setting aside very poor quality data from drilling efforts prior to 1960, the existing data consisted of electrical logs and core assay data from the CanStar corehole programs of the early 1980's and a highly localized set of logging and assay results from the Solv-Ex corehole and auger program of 1995-96. Very few viewing portions of these cores were preserved, presenting a challenge to developing an adequate depositional model and stratigraphic framework. In addition, the CanStar data was spaced on approximately 800 metre centres (160 ac spacing), but TrueNorth and its partner, UTS Energy, felt that data on 400 metre (and locally 200 metre) spacing were required to develop adequate confidence in the resource to proceed with a project. The quality of some of the older assay and log data was also questioned based on preliminary core-log correlations.

Several immediate challenges were apparent to the geological team. The key geological issues that required immediate attention included achieving reasonable (+/- 20%) confidence regarding resource size, average grade and ore distribution. These factors would determine the “mineability” of the deposit through determination of stripping ratio, TV/BIP (total volume to bitumen-in-place ratio), and grade continuity. At the same time, geotechnical and hydrogeological issues required enough attention to reveal any “red flag” issues such as undesirable aquifer size and composition or poor slope stability. Finally, the evaluation program needed to be designed to achieve the initial program objectives with a minimum of coreholes in order to control exposure of risked capital.

Using the CanStar data to provide an initial “snapshot” of the property, a 70-corehole program was designed through an iterative optimization process. The coreholes were focused on an area near the southeast corner of Lease 5 that was highgraded as having the highest mining potential based on the legacy data. A number of the legacy locations were twinned during the first phase of evaluation to validate the data quality from the CanStar program, but most of the new coreholes were spaced such that the combination of legacy and new holes would provide a grid of data on 400 metre spacing. More than half of the coreholes were preceded by overburden auger holes, designed to locate corepoint immediately above the top of the McMurray Formation as well as providing samples of the overburden material for preliminary geotechnical data. Piezometers were installed at 12 locations to provide preliminary hydrogeological data for McMurray aquifers as well as aquifers in the Quaternary overburden. The corehole locations were cored continuously from the top of the McMurray ending about 10 metres into the Devonian subcrop. All holes were logged with a standard suite of resistivity and neutron-density logs, and 4-arm dipmeter logs were run on 43 of the locations. Except for the piezometer locations, all holes were abandoned and sites were reclaimed.

A large volume of data was generated during the first phase of evaluation in 1999. In addition to coring records, drilling reports and well logs, virtually all generated core assay results, core photographs and graphic core descriptions were captured digitally. A significant effort was undertaken to incorporate the coring results into an integrated sequence stratigraphic framework. The first part of this effort required the development of an objective lithofacies classification scheme comprising lithological, sedimentological and ichnological components. Recurring successions of lithofacies were categorized into seven facies associations, and these aided in identifying key bounding surfaces. Ultimately, a product emerged that linked every core assay point with a stratigraphic unit, facies association and lithofacies code. These digital data files constitute the backbone of the preliminary mine plan for Fort Hills.

Although the initial phase of evaluation drilling focused on a small portion of the Fort Hills leases, a parallel effort developed to address the issue of growing the opportunity. By adopting a more aggressive exploration mentality, this effort used regional scoping and prospecting techniques to rapidly identify areas both on and off the existing leases that held high potential for future expansions in surface mining as well as shallow in-situ recovery projects. Significant leads were identified on Lease 52 as well as on adjoining lands that were unavailable at the time due to a regional moratorium on land sales pending resolution of federal issues. By blending the results of the preliminary mine planning project with regional exploration mapping, large opportunities emerged to greatly expand the scope of operations at Fort Hills. Planning a second phase of delineation drilling began before the results of the preliminary feasibility study were completed.

The Phase 2 drilling, undertaken in the winter of 1999 - 2000, had similar objectives to the Phase 1 program, but now included a few new twists. Out of the 114 coreholes in the program, a number were designed to infill the grid in the original highgraded area. Downspacing the grid to 200 metre centres was required for several reasons. The computer block model used to generate the preliminary mine plan has a tendency to average between data points. Variability in ore grade and thickness over a range of 400 metres can be high, and such averaging introduces significant uncertainties to the resulting reserves determination. Infilling the grid helps to mitigate this uncertainty, while also providing valuable refinements to the mine plan. In one specific circumstance, infill drilling was used to delineate a mudstone-filled channel that traversed an area with some of the richest average ore grades. In addition to reducing uncertainties, some of the program in the southern highgraded area was targeted to provide better geotechnical and hydrogeological data for the mine plan. Another unique aspect of delineating a surface mine is the determined effort to demonstrate the absence of mineable ore in areas designated for surface facilities. This was addressed in a follow-up program beginning later in 2000.

A significant proportion of the Phase 2 program was designed to delineate exploration leads in the north half of Lease 52, with the goal of creating an extended grid of reliable data on 800 metre centres. While much of the program was defining surface mining potential, a portion of the program was dedicated to delineating shallow in-situ opportunities. Ultimately, the Phase 2 program accomplished two main goals. Confidence in the southern mine project was substantially improved, and the potential for a second northern mine of equal or greater magnitude was demonstrated.

The success of the Phase 2 program created a serious dilemma. TrueNorth and UTS were committed to an aggressive timeline that would lead to mine operations in 2005. The potential for a second mine raised serious questions regarding placement of surface facilities and sequencing and placement of initial pit openings. The delineation program required to address these concerns demanded the drilling of at least an additional 350 coreholes, a program more than double the size of Phase 2. Facing a target date for submission of permit applications in the spring of 2001, the geological team was gravely concerned whether these coreholes could all be drilled and assimilated into the mine plan by the deadline. The solution was to undertake a summer drilling program, thus breaking a long-held paradigm restricting all delineation programs to the winter months following freeze-up. By working diligently with the drilling contractor and field operations coordinator, over 125 locations were initially identified that could support the coring rig. Building on initial successes, this approach evolved into a virtually continuous field operation that would result in the projected total corehole count building to approximately 660 locations drilled since the winter of 1998-99.

ORGANIZATIONAL STRUCTURE

The success of the Fort Hills evaluation program reflects, in large part, the potent capabilities of organizational effectiveness. Attracting and integrating an effective multidisciplinary team has been an overarching theme for the Fort Hills Oil Sands Project since its inception. The notion of assembling a “Blue Chip” team stemmed from the realization that the complexities of a large-scale oil sands mining operation far exceeded the internal capabilities of all but the largest organizations, particularly in light of the grave public responsibilities that attend such an undertaking.

In addition to a small core team of TrueNorth employees, talented individuals from a variety of respected organizations have become committed stakeholders in the project. They have contributed expertise in the areas of drilling, mining, processing, environmental impact assessment, socio-economic impact, regulatory matters and a host of other disciplines (TrueNorth, 2001).

As part of a large multidisciplinary team, geologists involved in the Fort Hills project are required to provide a broad range of data types to a diverse group of coworkers. The mining group is primarily interested in assay, facies, stratigraphic and geotechnical data while the processing experts require fines data and bitumen and other chemical analyses. The environmental impact team, on the other hand, needs reliable measurements of hydraulic head and aquifer composition. All of these data needs must be incorporated into the evaluation program plan to minimize both costs and environmental disturbance. In return for this responsibility, the geologist receives the benefits of drawing on the experiences of the larger group to assist in planning efficient field operations. Working with a clear understanding of the larger context of the project also aids significantly by clarifying the risk to reward relationships of each program element.

CONCLUSIONS

Over a course of three years, the geologists working on the Fort Hills Oil Sands Project have successfully contributed large volumes of critical data to support an aggressive business development timeline. Working in close consultation with mine planning experts, the team has developed a two-train mine plan based on a reserves assessment of 2.4 billion barrels of recoverable bitumen. The confidence in the reserves assessment and associated mine plan has increased with each subsequent phase of delineation drilling on the three leases comprising the project. Exposure of capital at risk has been managed by prioritizing critical evaluation goals, and by scaling up the scope of drilling programs as key risks are addressed.

Due to the successful execution of a business plan that integrated the geological evaluation with the diverse efforts of a blue chip team of consultant stakeholders, the Fort Hills Oil Sands Project is on schedule to commence production of 95,000 barrels per day of bitumen in 2005, adding a second train bringing production to 190,000 barrels per day by 2009. Construction of the project will require an investment of approximately $2 billion between 2003 and 2005. Annual operating expenses at peak production are estimated to $390 million.

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Figure 1 Location Map - Fort Hills Oil Sands Project

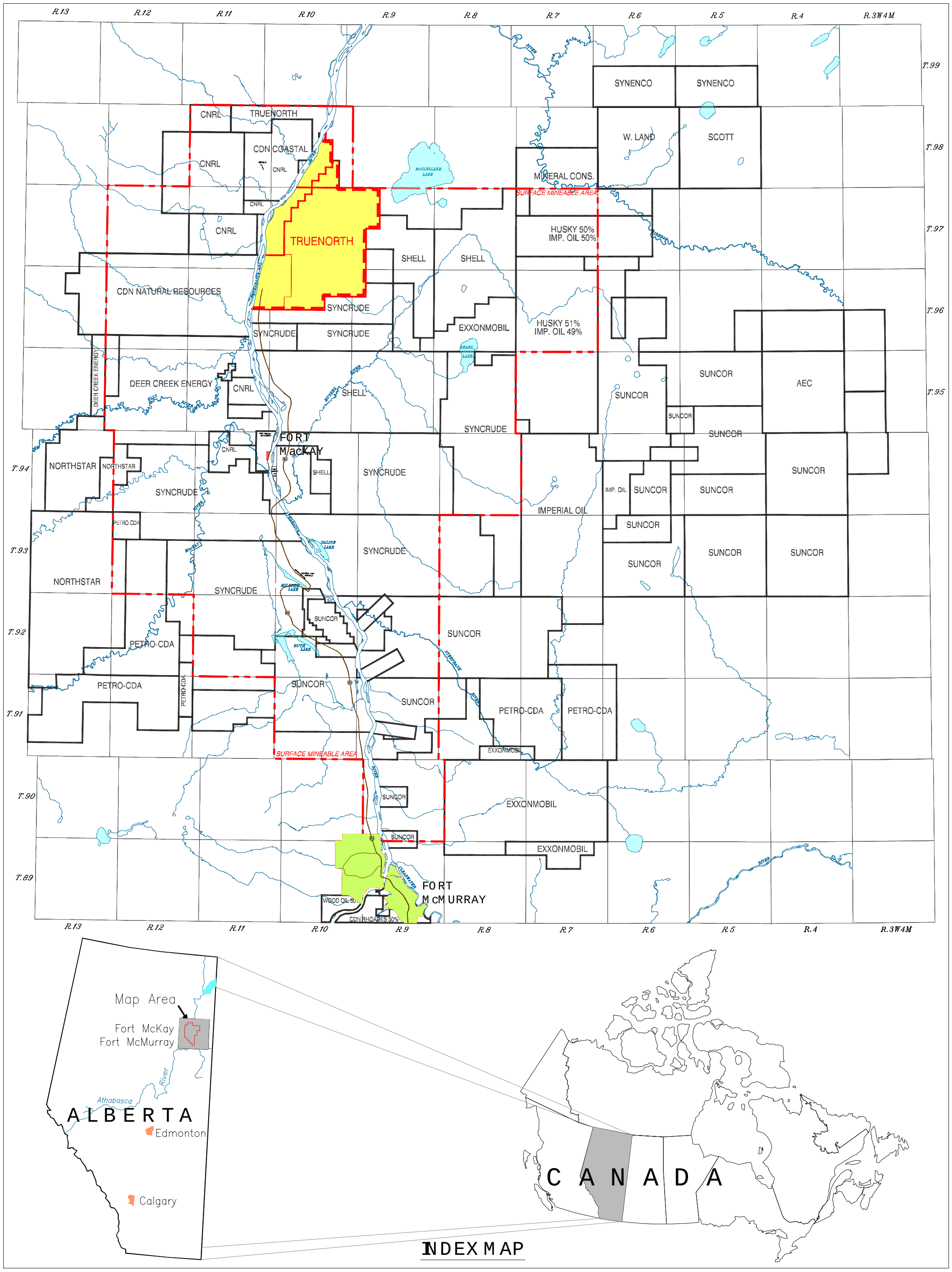

Figure 2 **Type Log – Fort Hills Oil Sands Project**