SCOPE

Baffinland Iron Mines Corporation (BIM) was developing the Mary River iron ore mine located 520 km north of the Arctic Circle on Baffin Island. A port in Steensby Inlet (Foxe Basin) and 145 km of connecting railway, were required to ship the high-quality ore.

Since 2005, SYSTRA Canada (formerly CANARAIL) had been BIM’s railway consultant of choice for all railway phases of the project, including a Scoping Study, a Definitive Feasibility Study, and Detailed Design which was put on hold in December 2008 due to international economic conditions, a Revised Feasibility Study, a Design Optimisation exercise and Fast Track Detailed Design in 2011-2012.

PROJECT MANDATES

Scoping Study

Two potential port sites had been identified to export up to 10 MTPA of iron ore.

SYSTRA Canada was asked to evaluate the proposed railway routes to serve each of the ports. Alternative routes to each port were identified during a general route evaluation exercise and site visit.

The scoping study provided:

- A subgrade design suitable for permafrost zones with varying depths of active layer;
- Plans and profiles at a pre-feasibility level for 4 potential routes;
- Material quantities and construction costs for each route;
- An outline of construction plans and schedules for use as the basis for construction cash flows;
- Operating plans and fleets for an isolated stand-alone railway operation with a limited number of operating days, due to the extreme climatic conditions;
- Annualised labour and material requirements for the project’s life cycle;
- An estimate of annual cost of transport, per tonne of ore, including the capital costs annualized over the 35 years of the projected mine life;
- Feasibility study for the electrification of the railway on the northern and southern routes.

CONFIDENCE MOVES THE WORLD
Definitive Feasibility Study

The Definitive Feasibility Study required a cost estimate to ± 15% accuracy including a railway design that addressed issues relating to permafrost and an operating environment further north and colder than any other railway in the world.

A LIDAR survey was commissioned, and plan and profile alignments were developed for both the north and south routes. The Preliminary Design of six major bridges and numerous structures was completed and track, drainage, signalling, telecommunications, maintenance equipment, facilities, and rolling stock were specified. Optimum operational parameters, including fleet size, were defined for transporting 18 MTPA with consideration for a future increase to 30 MTPA.

Railway operations were modelled in conjunction with stock pile sizes due to the limited size of suitable areas for stockpiling, and port operations that varied by 100% from the slowest month to the busiest, due to the impact of sea ice on shipping schedules.

The proposed railway (southern route) comprised over 195 km of track, including sidings and yards and involved moving more than 12 million m$^3$ of earth and rock. The project had to also comply with the regulations from 19 separate approval agencies.

Detailed Design

The project’s main design challenges were directly related to the remoteness of the site, the limited window for fieldwork, and the extreme climate.

Information for the permit process and specifications for long-lead items required a basic railway design early in the project time line. The design work included:

- Close coordination with the port and mine design teams ensuring compatibility of services and elimination of duplicated facilities; Site specific design criteria to meet the unique environmental constraints on construction and operation; Limited cuts in thaw sensitive soils; Minimising fill into waterways that provided fish habitat; and Avoidance of areas of archaeological interest.

Bridge designs were developed with standardised modular sections for the steel spans and the precast elements of the substructures in response to the logistical issues of a very remote site:

- Track materials were specified for their performance the extreme cold; Signalling and telecommunication systems’ design was dependant on operational and construction requirements; The railway maintenance building layout was optimised to minimise its size without jeopardising its ability to meet functional requirements; Specifications for locomotives and freight cars were subject to specific requirements for cold weather operation; An access road was designed to provide vehicular access for the construction of the railway; The work of each engineering design team was prioritised to meet a fast-tracked construction schedule and a limited season for the shipping of supplies. The project was suspended due to the economic situation in 2008.
EIS Preparation

Plan and profile drawings of the railway and access road designs, as they were in the 2008 Detailed Design, were prepared to meet the environmental team’s specific requirements for presentation purposes in the Environmental Impact Statement Report.

Revised Feasibility Study and Design Optimisation

Based on further geotechnical investigations undertaken in 2011, including a detailed study of the tunnel sites and areas exposed to the risk of rock-fall, the design requirements for cuts and fills, were redefined to be specific to the many different geotechnical regimes. SYSTRA Canada combined this with the knowledge acquired from the 2008 geotechnical investigation and the detailed design work completed in 2008 to optimise and redesign the railway mainline.

SYSTRA Canada also relocated and redesigned the yards at the mine and port in response to the optimised design of the mine and port facilities. An updated operating plan provided revised labour, rolling stock, and equipment requirements for the project financial analysis.

A radio propagation study was conducted to further the Signalling and Telecommunication Systems Design; specifications were developed for the tendering of the telecommunications system.

SYSTRA Canada also provided technical support during the Environmental Impact Review process before the Nunavut Impact Review Board and other government agencies.

Fast Track Detailed Design

SYSTRA Canada developed the detailed design of the railway yards, the functional layouts of the workshops, and issued preliminary technical specifications for rolling stock and track maintenance equipment. This work included:

- Evaluation of various terminal redesigns, specifically their ability to cope with longer trains to accommodate a future ramp up of mine production; Development of a functional layout of the maintenance workshop to accommodate railway vehicles including locomotives, ore cars, and track maintenance vehicles (road and rail bound), and vehicles and equipment needed for the operation of the port; Final alignment design for yards and terminals including crucial drainage analysis to keep switches clear of ponding water during the first rainstorms of spring which fall on frozen ground and freeze overnight (this required modelling the surface flow of rainwater); Hydrological and hydraulic studies were reviewed and adjusted on the basis of the results of a risk analysis of the project; The railway component of the project was suspended due to the 2012 economic situation.