DETOUR LAKE
GOLD MINING PROJECT IN ONTARIO

Contributing to the richness of all Canadians

CANADIAN CONSULTING ENGINEERING AWARDS – 2014
Natural Resources, Mining, Industry & Energy Category

CANADIAN CONSULTING engineer

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

Engineering
for a changing world

bba.ca

TABLE OF CONTENTS

A) PROJECT INFORMATION

Project Name:	Detour Lake gold mining project in Ontario
Exact Location:	185 km northeast of Cochrane, Ontario
Completed by:	First gold pour in February 2013
Category:	E. Natural Resources, Mining, Industry & Energy
Entering Firm Name:	BBA Inc.
Role in the Project:	Prime consultant for the feasibility study and the detailed engineering.
Firm Address:	375 Sir-Wilfrid-Laurier Blvd. Mont-Saint-Hilaire, Québec J3H 6C3 T + 1 450.464.2111 F + 1 450.464.0901
Member of the ACEC?	Yes
Contact #1 (Marketing):	Caroline Auger +1 450.464.2111, ext. 8777 caroline.auger@bba.ca
Contact #2 (Management):	André Allaire, Eng., Ph. D. +1 514.866.2111, ext. 8721 andre.allaire@bba.ca
Contact #3 (Project Engineering Manager):	Guy Décoste, Eng. +1 514.866.2111, ext. 8095 guy.decoste@bba.ca
P. Eng.?	Yes

Detour Lake project – Development and expansion of a formely closed mine

B) PROJECT OUTLINE

SUMMARY

Detour Gold Corporation engaged BBA to complete a Feasibility Study, detailed engineering, equipment purchasing and technical support for an open pit gold mine complete with “greenfield” gold recovery process installations conceptualised to become the largest Canadian gold mine with a capital of $1.5B. BBA’s design exceeded operating expectations (55,000 tonnes per day of ore) and implemented industry-leading innovations while providing stellar environmental solutions. Today, the Detour Lake Mine is the largest regional employer, creating sustainable opportunities for the local communities and the region.

CONTEXT

In 2007, Detour Gold Corporation completed the acquisition of the Detour Lake property, which hosted the former open pit/underground Detour Lake Mine (1983-1999). Following a series of promising drilling campaigns and a positive pre-feasibility study, Detour Gold proceeded with a feasibility study, led by BBA.

BBA’s expertise was sought to guide the development of the low-grade, high tonnage gold operation following the completion of the feasibility study.

BBA’s expertise was sought to guide the development of the low-grade, high tonnage gold operation following the completion of the feasibility study. With all the prior infrastructures removed, BBA proceeded with the detailed engineering design of a new processing plant for the on-site gold recovery process. Standard mining practices had to be adapted—and new techniques innovated—in order to develop a robust design that would meet the required production goals, extend the mine’s operational life, respect Aboriginal communities, provide regional social and economic benefits, and minimize the environmental footprint. Detour Gold Corporation also benefited from a fast track construction schedule and tight cost controls to ensure financing conditions were met. This whole initiative was a tall order, but BBA forged a clear path forward.

The Detour Lake Project includes mining service buildings, waste tailings decantation and pumping and a high voltage 230 kV transmission line. The processing plant includes crushing and grinding circuits to feed ore at a nominal rate of 55,000 tonnes per day, an objective that BBA met and exceeded during the ramp-up on some daily periods, with a record day at 63,700 tonnes on November 16, 2013. Delivery of the raw ore to the crushing plant is provided by state-of-the-art mining trucks. The ore is then conveyed to a two line grinding circuit where the gold recovery process can begin.

Major equipment includes two 36 ft x 20 ft dual pinion SAG mills, two 26 ft x 40 ft ball mills, four 1,000 hp crushers (two pebble and two pre-crushing units) and twenty 19-metre diameter leach tanks.

The Project’s scale demanded that various scheduling, procurement, innovation and environmental initiatives be deployed, which stretched the limits of any previous design within the mining industry.

C) PROJECT HIGHLIGHTS

Primary crusher transport to site

1. INNOVATION

From an economical standpoint, BBA has brought a large number of technological innovations to the Project in order to exceed the design limits of similar gold processing operation.

With environmental compliance and sustainability being other important aspects, BBA has thus provided environmentally driven solutions to mitigate the inherent risks, enhance performance and minimize the environmental footprint of the Project.

1.1 INNOVATIVE TECHNOLOGIES FOR PROCESS

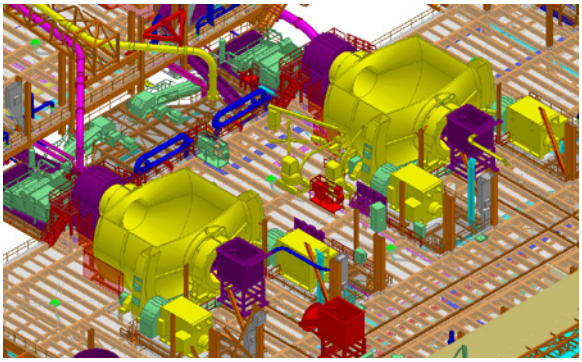
This low-grade, high-tonnage project was economically possible only through the application of important innovations. BBA implemented multiple solutions for the Detour Lake Project, surpassing the typical capacity of similar mining operations:

- The process development approach integrated the results of initial ore quality testing, which were then scaled up to achieve the best gold recovery and processing throughput. This procedure was crucial to transfer the optimized gold leaching parameters that, combined with the ore hardness challenge (very limited availability of industrial benchmarking data), needed to be met to maximize revenues and minimize operating costs.

- The ore analysis concluded that pre-crushing was required in the design. Higher process efficiencies, lower operating costs, and lower energy consumption were all realized by requiring less grinding energy with the two stages of pre-crushing compared to industry standard crushing methods (a first on such a large scale).

- The leaching process utilized the latest pump cell technology for carbon-in-pulp processing. Compared to the conventional carbon-in-pulp processing, the improved procedure facilitated an environmental footprint reduction for this area and resulted in a reduced installation cost. The process also resulted in an improved operating and maintenance environment because the equipment was installed inside the process plant—an important factor considering the cold northern location.

- The leaching process utilized 20 large tanks of a 19-meter diameter and a 20-meter height. Bolted tanks were selected to reduce construction time. The standard air injection was replaced by oxygen to increase the gold leaching kinetics, which reduced the required residence time and eliminated the use of four leach tanks, thus reducing the environmental footprint by a further 20% for the leach area. Shorter residence time also resulted in lower cyanide consumption, which is another environmental and operating cost benefit.



3D plan of process plant facing NW

Process plant

Processing plant facing SW

- State-of-the-art, electric variable speed drives for the grinding mills were utilized. These drives are the largest low speed drives in the world for dual pinion grinding mills and are rated at 20,000 hp, feeding two motors per mill, each at a 10,000 hp capacity. The energy transmission between the motors and mill ring gears was achieved through a pinion gear section of 1 m in length, reaching the highest limit of mechanical achievement to date of 10,000 hp per motor at 180 RPM.

1.2 SOLUTIONS FOR REDUCING ENVIRONMENTAL FOOTPRINT

A major project complexity was the significant muskeg and sensitive wetlands of the area. BBA utilized the following construction innovations to minimize the impact on the environment, as well as meet the project schedule and remain on budget:

- Site design utilized existing footprint area and maximized design, based on geo-technical data, sited the crushers and mills on bedrock to make foundations construction faster and at lower cost.

- Recovering energy from process equipment, mill drives and motors for heating buildings resulting in:
  - An energy recovery peak design capacity of ≈ 5 MW;
  - An estimated energy recovery of ≈ 15,000,000 kWh per year;
  - Savings on propane consumption with energy recovery of ≈ 2,100,000 L per year.

- Using water from the reclaim return system to cool equipment.

- Heating mining services facilities by burning waste oil from trucks and avoiding the disposal of waste oil outside the mine site. Approximately 230,000 L per year of recycled waste oil is used to heat the buildings.

- Honouring a zero water discharge to the environment by recycling the process water (nominal reclaim water flow from PFD: ≈ 2000 m^3/h). This eliminated the need to construct a pipeline to extract water from a nearby river, which avoided any negative impact on lichen feeding ground consumed by local fauna and thereby avoided endangering the area's woodland caribou.

- Integrating containment areas into the site design to capture and reclaim possible spills and/or leaks of equipment operating outside the process plant.

Construction of the high voltage power line

- Accelerating the electrical power line construction schedule by one year by pre-purchasing material and executing construction in parallel with engineering. By utilizing a winter construction period, any disturbance to the muskeg was mitigated. This also allowed for the use of utility power during construction as opposed to diesel fueled temporary generators, which resulted in a reduction of 4,500,000 L of diesel over one year and further minimized greenhouse gas emissions.

Mining Fleet CAT795F

320 tonnes off-road haul trucks

The mine is fed through a 230 kV, 180 km-long power transmission lline.

Line built during winter due to important musked and sensitive wetland features.

2. COMPLEXITY

The Project site was a former mining operation with existing excavation, both open pit and underground. The swampy overburden conditions and remote location were additional factors contributing to the Project's complexity. Many scheduling, procurement and innovation initiatives had to be deployed that stretched the limits of any previous design within the mining industry.

Construction during the winter months had to be accelerated to gain access to the remote site and to avoid soil damage. Modular worker camps acquired from the 2010 G7 Summit were used, and the integration of used equipment allowed BBA prepare the site to quickly mobilize construction workers.

2.1 WINTER WORKS FOR HIGH-VOLTAGE ELECTRICAL LINE

The high-voltage power line was initially connected at 115 kV in order to provide power for construction and start-up services. Upon final construction of the 180 km power line, a connection to 230 kV for full ramp up was completed. The high-voltage transmission line had to be installed during the winter to facilitate access for construction machinery while also minimizing disturbances to wildlife, vegetation and waterways.

Notable project complexities included:

- Fast track mode—90% of the materials were purchased before the design and construction drawings were issued to the contractor in a just-in-time mode;
- Construction of 180 km of lines in seven months—140 km in the winter of 2011 and 40 km in the spring of 2012;
- Construction of a 149 km winter road and installation of 2,250 wood poles and 920 km of cable for the power line.
- The power line project underwent numerous government reviews including: requiring its own environmental assessment, Ontario Energy Approval, Independent Electrical System Operator – System Impact Assessment(s), and engineering partnership with Hydro One Networks. BBA was the technical lead on each of the approvals.

Site services including emergency response vehicles


Temporary construction camp

2.2 IMPLEMENTATION CHALLENGES

BBA completed the early work infrastructure, a remote camp to house 1,400 workers, twelve months ahead of the required construction schedule thus providing great flexibility in the construction ramp up. Site services included site power supply, emergency services (e.g., First Aid, ambulances and firefighters), communications, permanent housing, parking and recreational facilities.

A unique telecommunications system was fully integrated from day one to serve the client's construction site, Cochrane project office and Toronto head office. Leveraging BBA's integrated telecommunications kits, the just-in-time implementation mode supported safe, effective communication for emergency responses and contributed to workforce retention due to the video and voice-calling enhanced technology.

The custom-made system was developed within six months—compared to two years for a similar telecommunications shelter—and included a construction facility with pretested equipment, a 150 foot antenna and a 12 foot dish, which brought telephone, network and Internet access to all workers and is today the permanent official site network. Finally, installing all facilities on a "brownfield" site, taking into account the presence of possible acid-generating rock, required BBA and Detour Gold Corporation to develop a backfill material sampling system. This new tool took into consideration the probable acid-generating rock areas in the pit and quantified the material in order to find the non-acid generating and competent rock material needed to build the base for the plant facilities.

BBA's integrated telecommunication kits (left and right view).


Construction of a 150 ft. antenna and a 12 ft. dish

Detour Gold teepee at dusk

National Aboriginal Day site celebration

3. SOCIAL AND ECONOMIC BENEFITS

Detour Gold Corporation is proud to have successfully engaged local communities for the Project's design and construction, and particular care was given to respecting Aboriginal rights and the social and economic impacts on the region.

Four agreements with Aboriginal groups define how they participate in the environmental management of the Project and benefit through training, jobs and contracting. To date, local Aboriginal members account for approximately 24% of the Detour Gold Corporation workforce.

The broader community has also reaped benefits, including targeted hiring and infrastructure investment, such as offices, lay-down yards and housing, all of which increase the municipal tax base and thereby bolster the provision of social and economic opportunities. Hiring success has ensured that over 53% of the workforce is from the local Cochrane area—the Detour Gold Project has significantly reduced the regional unemployment rate.

Local businesses are growing, and new jobs have been created. For example, the new testing laboratory in Cochrane created 35 new jobs, and local businesses have benefited from construction and operation contracts with the mine.

Detour Gold housing complex development

Detour Lake scene – Fox

4. ENVIRONMENTAL BENEFITS

When Detour Gold Corporation decided to rehabilitate a shut-down mine, they took on a whole new set of environmental challenges, as well as risks.

Comprehensive environmental assessments and studies were conducted to ensure adherence to responsible-development requirements set by provincial and federal environmental assessment acts.
Detour Gold Corporation sought the involvement of local communities and Aboriginal groups throughout the Project. Prior to construction, tours of the old mine site were arranged for key stakeholders to help them understand how the closed mine could be revitalized. All environmental materials were publicly posted in the regional municipal offices and libraries, and multiple open houses and community meetings were held to seek input on the proposed environmental mitigation.

Meetings were held with chiefs, mayors, municipal councils, emergency responders and social service agencies to ensure they were prepared for Cochrane's imminent economic growth and to inform them of any environmental issues as they arose.

During each stage of the Project, every effort was made to reduce the environmental impact, including:

- Recovering energy from process equipment, mill drives and motors;
- Using waste oil from equipment to heat buildings;
- Reclaiming return water used to cool equipment;
- Honouring zero water discharge to the environment by recycling process water;
- Installing power lines only during winter months to mitigate impacts on muskegs and local wildlife populations and prior to the site construction period to allow for utility power usage rather than diesel-fueled generator usage.

Closed mine – Detour Lake site – August 1, 2007

New process plant area

5. MEETING CLIENT'S NEEDS

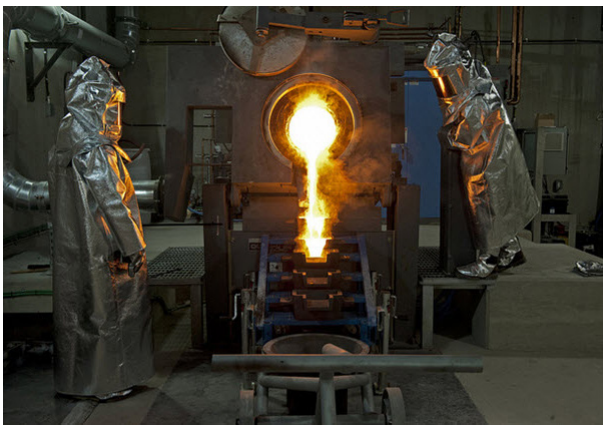
5.1 MULTIFACETED OBJECTIVES

Detour Gold Corporation's goal was the successful development of its flagship asset, the Detour Lake Mine located in northeastern Ontario. Success can be described as a financially viable, efficient mine and processing plant that meet social and environmental responsibilities, including creating sustainable opportunities for local communities and Aboriginal groups.

BBA worked closely with the client to meet the multifaceted objectives of building Canada's largest gold mine. The firm incorporated leading-edge technologies and innovations into the design and delivered highly efficient, economical solutions. BBA's engineering team selected strategies that enriched productivity and minimized energy consumption to reduce the overall environmental impact.

5.2 ON-TIME, WITHIN-BUDGET

The Project delivery plan and early work preparation to accommodate the 1,400 construction workers and the client's management team made it possible to complete the Project within budget and on time with a 27-month fast-track schedule. Local contractors were involved early in the construction of the power line, the camp and other necessary infrastructure. The consideration given to site water management, winter construction, and the reuse of waste material from former site operations, among other strategies, enhanced the environmental acceptability of the Project and met the client's expectations.



First pour - February 18, 2013

Great team work

On February 18, 2013, thanks to an amazing team effort by many hard-working Canadians, Detour Gold Corporation was pleased to announce the pouring of the first four gold bars, comprising approximately 2,000 ounces of gold, at its Detour Lake Mine. This event was a remarkable milestone in Detour Gold Corporation's transition from a young exploration company to an innovative, industry-leading gold producer.


BBA