PRELIMINARY ASSESSMENT
TECHNICAL REPORT

Idaho-Maryland Mining Corporation

SECTION 16

Mineral Processing and Metallurgical Testing

amec

16.0 MINERAL PROCESSING AND METALLURGICAL TESTING

16.1 Process Description

The overall process will utilize crushing and dry grinding of run-of mine (ROM) material to prepare it for the subsequent ceramics manufacturing process. The ceramics manufacturing process will utilize a new, patented and proprietary process known as Ceramext™ to produce high-quality ceramic tile products. The initial plant capacity will be 1,200 ton/d and will be expanded to an ultimate capacity of 2,400 ton/d. The overall process flowsheet is presented on Dwg. 100-N-0001 and the conceptual plant layout in Dwgs.100-M-0001 and 100-M-0002 in Appendix E.

16.1.1 Crushing, Drying, and Grinding

The crushing and grinding plant will utilize industry-proven technology and equipment for comminution. ROM industrial minerals mined during the driving of the access decline will be crushed in a mobile jaw crusher initially positioned on surface. Muck will be delivered to the crusher by the mine haul trucks. Once the decline has advanced 1,000 ft underground, the mobile crusher will be relocated underground and a conveyor installed to transport crushed material to the surface stockpiles.

Development of the industrial mineral mine will include installation of a permanent underground crusher adjacent to the industrial mineral mining areas. The project schedule calls for this crusher to be operational 3.5 years after the start of mine development. At that time, primary crushing will switch from the mobile crusher to the permanent crusher. This crusher will have a capacity of 2,400 ton/d to match the ultimate mine production rate. An underground storage bin with 2,000 tons of capacity will be developed ahead of the crusher to provide surge capacity.

ROM industrial minerals with a top size of 12" in x 12" x 18" will be trucked from the mine face and dumped into the ROM bin. The material will be drawn from the bin with an apron feeder and fed onto a grizzly ahead of the primary jaw crusher. Smaller material will pass through the grizzly directly onto the conveyor. Grizzly oversize material will feed into the jaw crusher and will be crushed to approximately 80% passing 4". Primary crushed ore and grizzly undersize will be transported on a belt conveyor to a coarse ore stockpile on surface adjacent to the process plant. There will be two stockpiles on surface, each with a total capacity of 8,500 tons. Coarse ore will be reclaimed from the stockpiles via apron feeders installed beneath them and be transferred onto a conveyor feeding onto a double-deck screen. Oversize material from the screen top deck will be fed to a secondary standard cone crusher where it will be crushed to 80% passing 1.0". The secondary crusher discharge will be conveyed back to the double-deck screen for classification. Mid-size material from the screen second deck will be fed to a tertiary short-head cone crusher where it will be crushed to 80% passing 3/8". The tertiary cone crusher discharge will be conveyed back to the double-deck screen for classification.

Screen undersize at 80% passing 3/8" will be fed to a natural gas-fired rotary kiln to reduce the moisture to 1%. The dried material will be conveyed to a high-pressure grinding roll, which will grind the material to 80% passing 150 µm, the particle size required for subsequent ceramics manufacture. The high-pressure grinding roll discharge will be conveyed to a dynamic, air-swept separator for size classification. Oversize material will be directed back to the high-pressure grinding roll, and final size product at 80% minus 150 µm will be transferred to a rotary kiln drier. Efficient operation of the air classification is dependent on a moisture content not exceeding 1%.

The dried ground material will be conveyed via a fully enclosed forced air system to a series of storage silos ahead of the ceramics manufacturing circuits. The dried material will be segregated into different silos based on mineralogical composition.

The primary underground crusher will operate on day shift only. The surface crushing, grinding and drying plant will operate 24 h/d.

The crushing and grinding processes may develop significant levels of dust. The crushing and grinding plant will incorporate an efficient dust collection system to control dust emission. Dust collected will be reintroduced to the circuit ahead of the ceramics manufacturing circuit.

16.1.2 Ceramics Manufacturing

The ceramics manufacturing process will utilize the proprietary Coramext™ process, which uses vacuum extrusion at elevated temperature to produce ceramic building products.

Ceramic feed material will be drawn from the silos and conveyed to a set of blenders used to mix predetermined quantities of feed material for different end products. From the blenders, the feed material will be conveyed to screw feeders used to meter feed material to a bank of pre-heaters. Each pre-heater will feed multiple ceramic manufacturing lines and will serve to drive off remaining moisture as well as heating the material for the ceramics process. Upon exiting the pre-heaters, the material will be fed into the extrusion and forming process. From the extrusion and forming process, the shaped pieces will be directed to a glazing process or to the cooling furnaces. The cooling furnaces provide a controlled temperature environment to reduce the ceramic product to ambient temperature.

From the cooling furnaces, products will be machine stacked. Flat tile products will be boxed, strapped, and palletized. Shaped tile products, brick, pavers, and block will be strapped and palletized. All packaging operations will be fully automated. Packaged products will be moved to either indoor or outdoor storage areas to await customer delivery

The ceramics manufacturing process will incorporate a number of parallel circuits to produce 1,200 ton/d of ceramic product. The exact number of circuits will be determined during the detail engineering phase. The product mix will include brick, floor, roofing, and decorative tiles as dictated by market requirements at the time of manufacture.

16.1.3 Gold Processing Plant *(Future)*

Depending on the success of the gold exploration activity, a gold processing plant may be added in the future to treat gold ore from the Idaho-Maryland mine. The gold processing circuit will utilize the same crushing, drying, and grinding circuit initially installed for the ceramics process. The gold ore will be crushed and ground to 80% passing 150 µm prior to gold extraction. Industry-proven technology and equipment will be used for gold extraction and recovery.

The grinding circuit product at 80% minus 150 µm will be fed into an agitated tank and mixed with water to form a slurry of approximately 50% solids by weight for subsequent processing. The slurry will be pumped to a centrifugal gravity concentrator to recover gold to a gold-rich concentrate. Tailings discharge from the gravity concentrator will be pumped to a flotation circuit for additional recovery of fine gold particles in the flotation concentrate.

The flotation and gravity concentrates will be combined and pumped to an intensive cyanidation circuit where the gold will be leached into solution. The gold-bearing leach solution will be pumped through an electrowinning circuit where the gold will precipitate onto cathodes. At scheduled intervals, the gold-rich cathodes will be removed and stripped of the gold-bearing sludge. The sludge will be filtered and dried and then be smelted on site in a furnace to produce doré containing approximately 70% to 85% gold. The doré will be transported to a custom refiner to produce refined bullion. The barren solids residue remaining after completion of the intensive leach process will be rinsed to remove any remaining cyanide solution, and then discharged to a holding bin. This material will be transported offsite for treatment. Based on historical gold recovery data and the application of modern gold recovery technology, it is anticipated that overall gold recovery of 95% would be achievable.

The flotation tailings will be pumped to a thickener for dewatering. Process water reclaimed form the thickener will be recycled for re-use in the process. The thickened tails will be fed to a pressure filter for additional dewatering and then fed to the rotary kiln for drying. Dried material will be conveyed to the storage silos ahead of the ceramics circuit.

All material that has come into contact with cyanide will be treated in a cyanide destruction circuit. The cyanide-free slurry or solution is then pumped to the thickener for dewatering.

Gold process tailings not required for underground backfill would be blended into ceramics production. A cemented paste backfill plant will produce fill for the mined stopes.

16.2 Development Plan and Production Rate

16.2.1 Equipment Capacity

Owing to the extensive mine development plan, the production rate of the mine will increase in stages. Accordingly, installation of the surface plant facilities will also be staged to a certain extent to parallel the mine development.

The initial mobile jaw crusher, secondary and tertiary crushing and screening circuits, will have a capacity of 100 ton/h, which will be adequate to crush all material mined during the driving of the access decline. As the mine production capacity expands from 1,200 to 2,400 tons/d, additional drying and HPGR equipment will be installed.

The initial ceramic manufacturing plant capacity will be 1,200 ton/d with capacity expanded to 2,400 ton/d in year 4. The ceramic manufacturing equipment has a much smaller unit capacity, and so multiple manufacturing lines will be required. In this case, the most cost effective approach is to install only the number of lines required initially to support a feed rate 1,200 ton/d and then install the additional lines at the time of expansion.

16.2.2 Materials Handling – Surface

The initial mine plan calls for production to be ramped up from an initial 300 ton/d to 2,400 ton/d over a four-year period. The initial plant capacity will be 1,200 ton/d followed by an increase to 2,400 ton/d at the start of Year 4. Driving of the access decline will start at the same time as construction of the ceramics plant, resulting in a requirement to stockpile crushed material on surface in a temporary stockpile until the process plant is commissioned. It is estimated that approximately 175,000 tons will be placed in the temporary stockpile. The stockpile would be limited to a maximum height of 12 ft, and would cover an area of 325,000 ft^2.

The initial capacity of the process plant will exceed the mine production capacity; hence, a shortfall in mine production will be made up by drawing from the temporary surface stockpiles. The material will be reclaimed from the temporary stockpile by front-end loader and dumped into haul trucks, which will haul the material to the one of the two smaller stockpiles adjacent to the crushing plant. This material will be drawn from the stockpile and conveyed to the secondary crushing plant.

The surface site has a designated area of 885,000 ft^2 available for ceramic tile storage. Prior to commissioning of the process plant, this area will be available for temporary storage of crushed rock from underground. The crushed material will be transported from the mine to the stockpile by haul truck.

Once the process plant is commissioned, crushed rock from underground will be conveyed directly to one of two smaller permanent stockpiles adjacent to the surface crushing plant. This material will be drawn from the permanent stockpile and fed to the secondary crushing plant.

16.3 Metallurgical and Process Testwork

16.3.1 Feed Material Evaluation for the Ceramext™ Process

A substantial number of materials from the Idaho-Maryland geotechnical drilling program and from surface exposures have been evaluated for their suitability for commercial exploitation using Ceramext™ technology. These evaluations have included historic Idaho-Maryland mine tailings and a variety of metavolcanic and intrusive rocks derived from the core samples and other exploration work. In addition to historic mine tailings, 25 different rock samples and a composite judged to be representative of the industrial minerals resource were included in the evaluation. The goal was to determine which of the materials produced during mine development and potential future gold processing is suitable for use in manufacturing ceramic products.

An extensive evaluation of the feed materials has been carried out. Each material has been subjected to whole rock chemical analysis, while X-ray diffraction (XRD) has been used to determine the crystalline phases present in the raw materials and resulting ceramic products. Evaluation has also included extrusion of ceramic billets processed at elevated temperatures using Ceramext™ technology. Physical properties of these billets have been measured, including density, porosity, water absorption, and strength. Strength was measured via modulus of rupture (MOR), using ASTM- based (American Society for Testing and Materials) test procedures. Most of the evaluation work was carried out using laboratory-scale Ceramext™-based equipment. In addition, initial work has been done to process materials in a second generation Ceramext™ extruder, which demonstrates continuous production processing on a pilot scale.

All of the raw materials processed and evaluated by Idaho-Maryland appear fully suitable for commercial use in the Ceramext™ process. Testing has shown that materials can be produced with high strength and low porosity, both of which properties are important for high-quality ceramic products. It must be pointed out that the optimum processing conditions for each composition and material tested have not been fully determined as yet, with the exception of the composite blend. Processing conditions were close to the optimum, but each material requires slightly different processing parameters because of slight differences in composition and mineralogy. The fact that superior ceramic materials have been produced even without this optimization is important. As mentioned, the optimum processing temperature was determined for a composite of the rock types expected from the industrial minerals resource mine development. The composite was blended to approximate the expected overall composition of the feedstock resource. Finally, the pilot-scale, continuous extruder produces ceramic materials with superior properties for any given raw material type as compared to processing in the lab-scale system. Only historic mine tailings have been processed in this pilot-scale unit to date.

Modulus of rupture (MOR), which is a measure of mechanical strength, was measured for ceramic billets representing the different types of rock. A wide range of values was exhibited, dependent primarily on processing conditions. Measured values are comparable or higher than most commercial tile and brick materials on the market. The lower strength materials had MOR values generally around 3,000 to 4,000 psi, and the strongest materials produced MOR values comparable to or higher than ceramic porcelain, the premier material for ceramic tile products. Historic mine tailings processed using the second-generation continuous extruder had MOR values averaging 8,600 psi. This is a significant result, since this extruder mimics the operation of eventual production units. Water absorption values for the other bodies tested were in the 15% range for the lowest strength materials and around 2% to 3% for the strongest materials. Materials processed through the continuous pilot unit had water absorption values averaging 0.6%. With optimization of the pilot-scale processing, even higher strength and lower water absorption values can be expected.

An outline of the sampling and testing protocol has been prepared by Dr. Frahme, and is included in Appendix D.

16.3.2 Gold Recovery Testwork

Preliminary level gold gravity recovery tests utilizing both Knelson and Falcon lab concentrators were performed on several samples of old Idaho-Maryland tailings and highly mineralized material found on waste rock dumps. Test recoveries were generally in the range of 70% to 80%. This gravity testwork is of interest because it indicates that new gravity technology may be more efficient than the methods used during the historical operation; however, it is not possible to accurately correlate the origin of the samples with respect to the mine workings, and so the value of these initial results are limited. Once a gold resource is defined, additional gravity and general metallurgical testwork would be required to fully characterize the metallurgical response and gold recovery to be expected.

16.4 Process Operating Basis

The process operating basis is presented in Table 16-1. The criteria for crushing, grinding, and the future gold process are based on information supplied by Idaho-Maryland, typical industry practice, AMEC in-house data, and historical operation at the Idaho-Maryland mine.

Table 16-1: Process Operating Basis

Detail	Units	Initial Plant	Expanded Plant
Plant capacity	t/d	1,200	2,400
Plant operation	h/d & d/yr	24/340	24/340
ROM moisture (est)	%	5	5
Primary U/G Crusher			
Primary U/G crusher	h/d	10	10
Crusher type		Jaw	Jaw
Feed top size	in x in x in	12 x 12 x 18	12 x 12 x 18
Product size	80% pass, inches	4	4
Stockpile			
Stockpile feed	h/d	10	10
Capacity	t	2 x 8,500	2 x 8,500
Secondary/Tertiary Crusher			
Secondary/tertiary crusher	h/d	24	24
Availability	%	80	80
Crusher type		Cone	Cone
Sec crusher product	80% pass, inches	1.0	1.0
Tertiary crusher product	80% pass, inches	0.375	0.375
Circuit configuration	-	Closed	Closed
Classification	-	Vibrating Screen	Vibrating Screen
Drying			
Drier feed moisture	%	5	5
Drier product moisture	%	1	1
Drier type	-	Horizontal Rotary Kiln	Horizontal Rotary Kiln
Grinding Circuit			
Grinding circuit	h/d	24	24
Availability	%	90	90
Feed size	80% pass, inches	0.375	0.375
Product size	80% pass, µm	150	150
Work index	kWh/ton	18	18
Circuit configuration	-	closed	Closed
Classification	-	Dynamic Separator	Dynamic Separator
Ceramics Plant			
Plant operation	h/d	24	24
Plant availability	%	90	90
Process	type	High temperature vacuum extrusion	High temperature Vacuum extrusion
Process LOI	%	8	8
Ceramics production	ft^2/yr	160,754,000	321,507,000

The process design criteria for the Ceramext™ process are proprietary and confidential and have not been released to AMEC. As such, AMEC cannot confirm if the design criteria are achievable or appropriate for the process. Dr. Carl Frahme, an independent consultant and the Qualified Person for the ceramic portion of the project, has evaluated the design criteria for the entire production-scale Ceramext™-based system. He has concluded that these criteria are achievable and present mostly straightforward, solvable engineering challenges. He also has concluded that the fundamental science and technology underlying this novel process is sound and that the technology of continuous hot extrusion of ceramic materials has been validated and demonstrated by the pilot plant testwork.

16.5 Equipment List

The process equipment list for the crushing, grinding, and ceramics manufacture is presented in Appendix E.