

Appendix A – Use of Supporting Studies in Process for NI 43-101 Documentation

Foreword

Appendix A serves as support documentation within the Best Practice Guidelines for Mineral Processing (BPGMP). It supplements the Principles of Process Support for Mineral Resources/Mineral Reserves Estimation. The application of the recommendations presented below is restricted to those issues relevant to the process component of the NI 43-101 Technical Report. The table serves only as a guideline as the nature of mineral deposits can vary significantly in terms of tonnage, grade, continuity and complexity. It is the role of the QP to make the assessment of the proper level of work appropriate to the mineral deposit and consider what would be appropriate in the judgment of his peers.

As the categories of resources are improved to the reserve category, a large amount of work must be performed in order to support the upgrade. In addition to the use of drilling and other geological methods and geochemical analysis to improve the category, engineering studies must be completed to provide both technical and economic assessments of the mineral deposit. The level of work within these studies impacts the level to which the categories are enhanced within the resulting NI 43-101 report. After the initial identification of the resource, typically three levels of investigation are used to improve the categories. The process involvement in these studies generally begins with a very basic assessment or scoping study, then advances to a prefeasibility study and finally to a feasibility study, where there is an increasing degree of project definition at each stage. Of particular importance in the upgrading of resources to reserves is the use of the prefeasibility study as noted within the CIM Best Practice Guidelines.

Given the importance of these engineering studies as supporting documents, a general definition of the contents relevant to the development of the selected metallurgical and process-associated contributions is warranted. This definition is provided in the tables below.

In general, the level of detail increases with the progression of the study stages. Definition at each succeeding level is built on the work of the previous stage. From a process viewpoint, these studies typically contain the following content and objectives (for the overall definition, the reader is referred to the definitions contained within the CIM Standards):

- **Preliminary Assessment (PA) or Scoping Study** – should determine whether you have a project and should outline at least one of the opportunities to develop the deposit. Due to the early stage of this study, it is recognized that it may be difficult to develop extensive engineering data. However, it should be possible for an experienced QP to indicate, at least on a conceptual basis, the amenability to a certain processing method and a generic level of recovery, an indication of the form and quality of the products (both valuable and waste), the capital cost of the processing facilities, and the process operating cost. The QP needs to identify the potential fatal flaws, indicate scope and provide cost estimate of future testwork. It is important to emphasize the low level of confidence of the estimates as the resource and representativity of the samples are not well defined at this stage.

- **Prefeasibility Study (PFS)** – the primary goal of the PFS is to define the project, the type of mining extraction method that will be applied, how the processing will be performed, the areas of risk, the permit requirements, and a gap analysis for the next level of study. It is a comprehensive study of the viability of the mineral project, allowing the QP to define what portion of the mineral resources can be classified as mineral resources. In process terms, a PFS should indicate the method and projected levels of recovery for a deposit, including evaluation of alternatives, and an assessment of variability of the deposit on recovery. The study should delineate the major unit operations and their contributions to process objectives. The study should indicate the factors influencing throughput, recovery, capital and operating costs, as well as indicate scope and provide cost estimate of future testwork and identify opportunities for further process optimization.
- **Feasibility Study (FS)** – is a comprehensive study of the mineral deposit that would reasonably serve as the basis by a financial institution to finance the development of the deposit to mineral production. The FS builds upon the previous PFS work by increasing the level of detail and definition of engineering in order to provide an increased level of confidence in the capital and operating costs for the deposit which meet the requirements for bankable financial project evaluation. In addition, the FS not only defines the process but also the level of recovery continuity across the deposit. A feasibility study typically delineates the influences on plant performance. In order to manage or mitigate risk, it is important to delineate variability of recovery response and cost to grade, domain and spatial location in the deposit of the material to be processed. The FS also delineates the level and nature of the waste products being produced by the process and their disposal to an appropriate facility.

Level of Verification

FACTOR	SCOPING LEVEL	PREFEASIBILITY	FEASIBILITY
Intent of Sample Representativity	Indicative	Representative	Comprehensive
Sample Types	Point Samples	Point Samples & Domain Composites	Domain Samples and Variability Samples (either point or composite).
Identification of Samples in the Report	List to identify sample source and attributes. The QP should comment on how representative the sample is believed to be in terms of grade and domain.	List to identify sample source and attributes. For composites, there should be an explanation of how these are derived. Sample attributes should be reconciled to the resource model to describe the limits of the influence of the sample.	List identifying sample source and attributes. Sample sources typically located on diagram of the deposit.
Information Supporting Process Concept	Concept developed from mineralogy, typical practice for the type of deposit investigated, and selected bench-scale tests on samples.	Concept developed from previous information and optimization factor testing of domain composites. On large or complex deposits, key unit operations or novel process steps may be pilot tested under simulated plant conditions. Testing of the impact of grade variance is typically included in the testwork. Testing of metallurgical variance by domain is also a necessary task especially for complex deposits.	Concept brought forward from previous studies and performance confirmed by additional testwork. Key unit operations or novel process steps should be pilot tested under simulated plant conditions. Variability due to grade, domain, and spatial location is determined.
Definition of Saleable Product	Product output must match process selected. Marketability of the product is indicated.	Actual product(s) are produced by testing and marketability is assessed. Identification of deleterious components must be performed and the impact identified.	Building upon prior work, there is a further demonstration that a product of acceptable quality produced regardless of feed variability. Produced products should undergo market assessment with the exception of bullion products.
Testing QA/QC	Chain of sample custody is demonstrated. Credibility of testing lab is assessed.	Internal QA/QC procedures in testwork should be explained. The ability to duplicate the results of the primary process (es) should be demonstrated.	Internal and external QA/QC procedures in the testwork program are explained. Key tests are duplicated by a reference lab to demonstrate consistent results. Where duplication of tests is not possible, the alternative is an independent peer review.

Level of Design Definition

FACTOR	SCOPING LEVEL	PREFEASIBILITY	FEASIBILITY
Process Design Criteria (PDC)	Preliminary design criteria used to support resource/reserve modelling are required. These should include tonnage, feed grade, recovery, and major design parameters considered important in the judgment of the QP.	In addition to process design criteria, major design selection criteria for equipment (size, power, type) are established.	Design criteria for process, major equipment and support systems (water, air, HVAC, etc.) are established.
Process Flow Diagram (PFD)	A block flow diagram of the major unit operations showing significant flows is sufficient.	The PFDs indicate the major inputs and outputs of the major unit operation equipment components.	The PFDs show the process flow diagrams of major and minor equipment including bleed and intermittent streams. For large complex projects, P&IDs may be necessary in order to allow for a HAZOP review.
Process Description (PD)	The process should define the concentration or extraction method	Selection of candidate process flowsheet should be confirmed and selection explained. Major components and sizing influences should be described.	Details of major and minor processes within process are provided. This includes major components, power draws and sizing influences.
Equipment List (EL)	Type of equipment is indicated.	Major equipment components are identified.	Major equipment and supporting equipment are identified and power requirements are indicated.
Control & Operations Strategy	None is required.	Basic description should be provided.	The control and operating strategy including strategy in dealing with ore variability should be described.
Material Balances (MB)	A simplified MB should be provided.	A plant MB of the major flows complete with stream densities is provided.	A plant MB of major and minor flows complete with stream characteristics (pH, densities, etc.) product and intermediate grades, is provided.
Energy Balances (EB)		A preliminary energy balance should be constructed indicating ability to source power and the level of consumption.	A detailed energy balance should be constructed indicating ability to source power and the level of consumption.

<p>Level of Capital Expenditures (Capex)</p>	<p>Capex is by factored comparison to similar project in similar location taking into account site location impacts (e.g. elevation, geography). Capex may also be by major equipment quotes and factoring from this basis. Accuracy is from ±25 to ±50%.</p>	<p>Capex is determined with major equipment by budgetary quotations, minor equipment from database, and installation costs by factoring. The basis of estimate is developed from database information. Material take-offs developed or indicated as not developed. Accuracy is ±20%.</p>	<p>Capex is determined with major equipment by budgetary quotations, minor equipment from database, and installation costs by factoring. The basis of estimate is developed from database information. Material take-offs developed as support. The basis of estimate is developed from local information. Construction and logistical execution plans are developed and support the design. Accuracy is ±15%.</p>
<p>Level of Operating Costs (Opex)</p>	<p>Operating cost can be developed by benchmarking for very early stage studies. Where a higher level of category above inferred is being considered, an effort must be made to derive major costs (labour, power, etc.) as would be applied locally to the deposit. Accuracy is from ±25 to ±35%.</p>	<p>Operating costs in process are developed from testwork (reagent and energy consumption) and database costing of labour and reagents relevant to the locale. Cost of power is an especially important local cost and its derivation must be identified. Accuracy is from ±25 to ±15%.</p>	<p>Process operating costs are developed from testwork (reagent and energy consumption) and database costing of labour and reagents relevant to the locale. Cost of power is an especially important local cost and its derivation must be identified. Individual influence of major operating costs components identified. Supply costs are from local creditable suppliers capable of providing the supplies Labour rates for locals and expatriates must be realistic. Influence of ore variability upon operating costs is identified. Influence of variable operating costs in the financial model is identified. Accuracy is from ±15 to ±10%.</p>

Process Risks

FACTOR	SCOPING LEVEL	PREFEASIBILITY	FEASIBILITY
Orebody Complexity	Influence of mineral deposit complexity (mineralogically complex ores, variances in hardness, etc.) upon the process should be identified.	Influence of orebody complexity on recovery or product quality must be indicated. Indicate if this complexity has been taken into account with the process design.	Influence of orebody complexity upon the process should be assessed. The impact of this complexity on recovery and ability to produce a marketable product should be indicated. Explains how the process design deals with orebody complexity.
Flowsheet Complexity or Novelty	It should be indicated whether the process is novel or is a common process involving well known techniques for this sort of mineralogy.	Where either complexity or novelty is present, bench scale testwork confirming proof of concept is necessary. Where the process has not previously been implemented on an industrial level, pilot plant testing should be carried out.	Pilot plant or demonstration scale work has been conducted for novel processes. Variances in performance should be confirmed and explained. Typically an independent peer review process should be performed.

Other Risks

Tailings Disposal	The nature of the tailings should be indicated and the form of disposal being contemplated.	An appropriate level of detail should go into the definition of plant emissions and how they will be handled in an appropriate manner.	At this level, consideration should be made of the impact of ore variability on the ability to provide proper tailings disposal. Process is typically involved with environmental experts in the review of tailings disposal and other emissions to ensure their appropriate control and disposal.
Health and Safety	It should be indicated where the process involves the use of potentially hazardous processes or chemicals and the level of risk which might be encountered.	In delineating the process, accommodation must be made for the appropriate control of worker health and safety risks. Where a hazardous process is envisaged there must be consideration as to how uncontrolled incidents will be managed	At this level, the presence of hazardous processes or chemicals requires plans indicating how these issues will be dealt with. In particular there needs to be a response plan in the event of an uncontrolled incident.
Interactions with Other Disciplines	Influence of non-process factors (weather, location, potential ARD, etc.)	In addition to factors indicated as problems at the scoping level, water supply and quality is an especially critical	Impact from other areas on the process and plant design should be indicated, and described. In particular, the

	should be identified if they are likely to impact the process.	process factor and comments should be made regarding any potential difficulties.	plans for storage of tailings and release of excess water to the environment should be reviewed and commented on in light of the local environmental regulations.
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