The Role of QPs and Best Practices in Resource & Reserve Estimation

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REPORTING STANDARDS

Public Disclosure Requirements Governing Reporting of Exploration Results, Resources and Reserves

• Canada     NI 43-101     all categories, all public issuers
• Australia   JORC        all categories, all public issuers
• S. Africa   SAMREC      all categories, all public issuers
• U.S.        SEC Industry Guide 7 reserves only, all public issuers
Definition of QP

A “Qualified Person” means an individual who is an engineer or geoscientist with at least five years of experience in mineral exploration, mine development or operation or mineral project assessment, or any combination of these; has experience relevant to the subject matter of the mineral project and the technical report; and is a member or licensee in good standing of a professional association.

CIM NI 43-101 Standards for Reporting Mineral Resources and Mineral Reserves, 2010
# Accepted Foreign Associations and Membership Designations under NI 43-101

<table>
<thead>
<tr>
<th>Foreign Association</th>
<th>Membership Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Institute of Professional Geologists (AIPG)</td>
<td>Certified Professional Geologist (CPG)</td>
</tr>
<tr>
<td>The Society for Mining, Metallurgy and Exploration, Inc. (SME)</td>
<td>Registered Member</td>
</tr>
<tr>
<td>Mining and Metallurgical Society of America (MMSA)</td>
<td>Qualified Professional (QP)</td>
</tr>
<tr>
<td>Any state in the United States of America</td>
<td>Licensed or certified as a professional engineer</td>
</tr>
<tr>
<td>European Federation of Geologists (EFG)</td>
<td>European Geologist (EurGeol)</td>
</tr>
<tr>
<td>Institute of Geologists of Ireland (IGI)</td>
<td>Professional Member (PGeo)</td>
</tr>
<tr>
<td>Institute of Materials, Minerals and Mining (IMMM)</td>
<td>Professional Member (MIMMM), Fellow (FIMMM), Chartered Scientist (CSI MIMMM), or Chartered Engineer (CEng MIMMM)</td>
</tr>
<tr>
<td>Geological Society of London (GSL)</td>
<td>Chartered Geologist (CGeoI)</td>
</tr>
<tr>
<td>Australasian Institute of Mining and Metallurgy (AusIMM)</td>
<td>Fellow (FAusIMM) or Chartered Professional Member or Fellow (MAusIMM (CP), FAusIMM (CP))</td>
</tr>
<tr>
<td>Australian Institute of Geoscientists (AIG)</td>
<td>Member (MAIG), Fellow (FAIG) or Registered Professional Geoscientist Member or Fellow (MAIG RPGeo, FAIG RPGeo)</td>
</tr>
<tr>
<td>Southern African Institute of Mining and Metallurgy (SAIMM)</td>
<td>Fellow (FSAIMM)</td>
</tr>
<tr>
<td>South African Council for Natural Scientific Professions (SACNASP)</td>
<td>Professional Natural Scientist (Pr.Sci.Nat.)</td>
</tr>
<tr>
<td>Engineering Council of South Africa (ECSA)</td>
<td>Professional Engineer (Pr.Eng.) or Professional Certificated Engineer (Pr.Cert.Eng.)</td>
</tr>
<tr>
<td>Comisión Calificadoras de Competencias en Recursos y Reservas Mineras (Chilean Mining Commission)</td>
<td>Registered Member</td>
</tr>
</tbody>
</table>
Role of QP

Responsible for preparation or supervision of technical report to NI 43-101, JORC, SAMREC or other accepted mineral resource/mineral reserve reporting standard.

All written scientific or technical disclosure must be prepared or overseen by a QP.

As such the QP is a critical component in the mining regulatory regime.

QP involvement may be direct supervision of work or audit of work.

QP should ensure use of best practices at all stages of project:
- Exploration → PEA → PFS → FS → Production
Different QPs for Different Project Components and Project Stages

Early Stage Exploration: Geologists + Mineralogists key

Advanced Exploration: Geologists, Mineralogists, Metallurgists, Mining Engineers, Process Engineers, Environmental Experts

Prefeasibility/Feasibility Study: Mining Engineers, Process Engineers & Metallurgists, Environmental Engineers, Financial Planners, Market Experts

Importance of each will vary with stage of project.

Lead QP will change over time
• QPs may be independent or company staff
• NI 43-101 requires independent QPs under certain circumstances (list is not comprehensive):
  Becoming a reporting issuer in Canada
  A valuation report required under securities legislation
  First time disclosure or PEA of material property
  Issuance of securities as part of a take over bid, property acquisition by way of securities issue, or a rights issue
  Valuation report required by securities legislation
  +100% change in most recently reported mineral resources/mineral reserves
  Any other written disclosure that constitutes a material change in resources or results of a PEA
Resource/Reserve Classification
A **Mineral Resource** is “a concentration or occurrence of diamonds, natural solid inorganic material, or natural solid fossilized organic material including base and precious metals, coal, and industrial minerals in or on the Earth’s crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge.”

- Mineral Resources are sub-divided into **Inferred**, **Indicated** and **Measured** categories.

Increasing level of geological knowledge and confidence
Mineral Reserve – NI 43-101

• A Mineral Reserve is “the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined.”
  – Mineral Reserves are sub-divided into Probable Mineral Reserves and Proven Mineral Reserves.
Resource Classification and QPs

INFERRED RESOURCES

Inferred Resources are too uncertain to allow the meaningful application of technical and economic parameters or to enable an evaluation of economic viability worthy of public disclosure.

INDICATED RESOURCES

The Qualified Person must recognize the importance of the Indicated Mineral Resource category to the advancement of the feasibility of the project. An Indicated Mineral Resource estimate is of sufficient quality to support a Preliminary Feasibility Study which can serve as the basis for major development decisions.
Resource Classification and QPs

MEASURED RESOURCES

Mineralization or other natural material of economic interest may be classified as a Measured Mineral Resource by the Qualified Person when the nature, quality, quantity and distribution of data are such that the tonnage and grade of the mineralization can be estimated to within close limits and that variation from the Estimate would not significantly affect potential economic viability.

This category requires a high level of confidence in, and understanding of, the geology and controls of the mineral deposit.
Issues Specific to NI 43-101

REPORTING OF INDUSTRIAL MINERALS

When reporting Mineral Resource and Mineral Reserve estimates relating to an Industrial mineral site, the Qualified Person(s) should be guided by the Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines for Industrial Minerals.

Factors to consider include:

• Specialized tests required to establish resource volume/tonnage, recovery and quality
• Market size, market concentration and ability of new producer to capture market share, logistics
• Required minimum quality specifications for product
• Pricing mechanisms
Reserve Classification and QPs

A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined.

Mineral Reserves are those parts of Mineral Resources which, after the application of all mining factors, result in an estimated tonnage and grade which, in the opinion of the Qualified Person(s) making the estimates, is the basis of an economically viable project after taking account of all relevant processing, metallurgical, economic, marketing, legal, environment, socio-economic and government factors. Mineral Reserves are inclusive of diluting material that will be mined in conjunction with the Mineral Reserves and delivered to the treatment plant or equivalent facility.

The term ‘Mineral Reserve’ need not necessarily signify that extraction facilities are in place or operative or that all governmental approvals have been received. It does signify that there are reasonable expectations of such approvals.
Reserve Classification and QPs

Probable Mineral Reserve
A ‘Probable Mineral Reserve’ is the economically mineable part of an Indicated and, in some circumstances, a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified.

Proven Mineral Reserve
Application of the Proven Mineral Reserve category implies that the Qualified Person has the highest degree of confidence in the estimate with the consequent expectation in the minds of the readers of the report. The term should be restricted to that part of the deposit where production planning is taking place and for which any variation in the estimate would not significantly affect potential economic viability.
Best Practice Guidelines

CIM Resource/Reserve Classification system requires the use of Best Practices in resource/Reserve Reporting and NI 43-101 Reporting

Best Practice Guidelines apply to:

- Exploration Practices and Management
- Estimation of Mineral Resources and Mineral Reserves

Specific Best Practice Guidelines for:
- Diamonds (hard rock), Coal, Potash, Laterites (Ni-Co, Mn, Bauxite), Lithium Brines, Uranium, Industrial Minerals, Placer Deposits
- Mineral Processing
Exploration Best Practices and QP Responsibility

QP(s)s responsible for:
• design of exploration program
• design/oversight of QA/QC program
• oversight of exploration methods and data collection
• oversight of data records and data verification
• design/management/supervision of sampling programs
• supervision of drill program design and management
• design/oversight of sample security program
• design/oversight of sample preparation methods
• review/analysis of assay methods, laboratory selection
• review of assay results and assay QA/QC program
• design/oversight of metallurgical test work
• mineral resource/reserve estimate and classification
• adherence to safety, environmental and community relations requirements
Factors Specific to Salars

• Type of salar: mature halite versus immature clastic/sedimentary. Not all salars are equal

• Need to define type and nature of aquifer and controls on aquifer hydrology, brine volume, brine flow, brine chemistry

• Variability in brine composition both horizontally and vertically

• Response of brine body to extraction

• Impact of multiple operations on same salar

• Impact of brine chemistry on recoverable volumes of valuable salts

• Need to differentiate between in-situ resource and economically extractable reserve
Distinguishing Reporting Levels

- **Preliminary Economic Assessment (PEA) or Scoping Study** – Should determine whether you have a project and should outline at least one of the opportunities to develop the deposit.

**Role of QP(s):**
- Indicate, at least on a conceptual basis, the amenability to a certain processing method and a generic level of recovery,
- Indicate the form and quality of the products (both valuable and waste), the capital cost of the processing facilities, and the process operating cost
- Identification of potential fatal flaws,
- Indicate scope and provide cost estimate of future test work.

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.

ROLE of QP(s)

- Define what portion of the mineral resources can be classified as mineral resources,
- Indicate the method and projected levels of recovery for a deposit, including evaluation of alternatives,
- Provide an assessment of variability of the deposit on recovery
- Identify major unit operations and their contributions to process objectives
- Indicate the factors influencing throughput, recovery, capital and operating costs,
- Indicate scope and provide cost estimate of future test work 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.

• 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.

• FS not only defines the process but also the level of recovery continuity across the deposit.

• Delineates the influences of variability of recovery response and plant performance and cost to grade, domain and spatial location in the deposit of the material to be processed.

• Delineates the level and nature of the waste products being produced by the process and their disposal to an appropriate facility.
Securities Regulators, PEAs and QPs

PEAs are not proxy’s for Prefeasibility Studies. Do not state the PEA has been done to a standard close to a Prefeasibility Study or that the PEA demonstrates the economic viability of your project. PEAs are conceptual and can only demonstrate the potential viability of a project.

Use cautionary language when describing the results of a PEA.

Do not use overly optimistic price or cost assumptions.

Do not incorporate by-product credits unless the by-products are included in the resource estimate.

Ensure that the QP signing off on the PEA has the requisite knowledge and experience of the commodity, type of deposit and mineral style, and mineral processing and other key relevant factors.
<table>
<thead>
<tr>
<th>FACTOR</th>
<th>SCOPING LEVEL</th>
<th>PREFEASIBILITY</th>
<th>FEASIBILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent of Sample Representativity</td>
<td>Indicative</td>
<td>Representative</td>
<td>Comprehensive</td>
</tr>
<tr>
<td>Sample Types</td>
<td>Point Samples</td>
<td>Point Samples &amp; Domain Composites</td>
<td>Domain Samples and Variability Samples (either point or composite)</td>
</tr>
<tr>
<td>Identification of Samples in the Report</td>
<td>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.</td>
<td>List identifying sample source and attributes. For composites, there should be an explanation of how these are derived.</td>
<td>List identifying sample source and attributes. Sample sources typically located on diagram of the deposit.</td>
</tr>
<tr>
<td>Information Supporting Process Concept</td>
<td>Concept developed from mineralogy, typical practice for the type of deposit investigated, and selected bench-scale tests on samples.</td>
<td>Concept developed from previous information and optimization factor testing of domain composites. On larger 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.</td>
<td>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.</td>
</tr>
<tr>
<td>Definition of Saleable Product</td>
<td>Product output must match process selected. Marketability of the product is indicated.</td>
<td>Actual product(s) are produced by leaching and marketability is assessed. Identification of deleterious components must be performed and the impact identified.</td>
<td>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.</td>
</tr>
<tr>
<td>Testing QA/QC</td>
<td>Chain of sample custody is demonstrated. Credibility of testing lab is assessed.</td>
<td>Internal QA/QC procedures in testwork should be explained. The ability to duplicate the results of the primary process(es) should be demonstrated.</td>
<td>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.</td>
</tr>
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<tr>
<td>Process Design Criteria (PDC)</td>
<td>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 OP.</td>
<td>In addition to process design criteria, major design selection criteria for equipment (size, power, type) are established.</td>
<td>Design criteria for process, major equipment and support systems (water, air, HVAC, etc.) are established.</td>
</tr>
<tr>
<td>Process Flow Diagram (PFD)</td>
<td>A block flow diagram of the major unit operations showing significant flows is sufficient.</td>
<td>The PFDs indicate the major inputs and outputs of the major unit operation equipment components.</td>
<td>The PFDs show the process flow diagrams of major and minor equipment including bleed and intermittent streams. For large complex projects, PSIDs may be necessary in order to allow for a HAZOP review.</td>
</tr>
<tr>
<td>Process Description (PD)</td>
<td>The process should define the concentration or extraction method.</td>
<td>Selection of candidate process flowsheet should be confirmed and selection explained. Major components and sizing influences should be described.</td>
<td>Details of major and minor processes within process are provided. This includes major components, power draws and sizing influences.</td>
</tr>
<tr>
<td>Equipment List (EL)</td>
<td>Type of equipment is indicated.</td>
<td>Major equipment components are identified.</td>
<td>Major equipment and supporting equipment are identified and power requirements are identified.</td>
</tr>
<tr>
<td>Control &amp; Operations Strategy</td>
<td>None is required.</td>
<td>Basic description should be provided.</td>
<td>The control and operating strategy including strategy in dealing with core variability should be described.</td>
</tr>
<tr>
<td>Material Balances (MB)</td>
<td>A simplified MB should be provided.</td>
<td>A plant MB of the major flows complete with stream densities is provided.</td>
<td>A plant MB of major and minor flows complete with stream characteristics (pH, densities, etc.) product and intermediate grades is provided.</td>
</tr>
<tr>
<td>Energy Balances (EB)</td>
<td>A preliminary energy balance should be constructed indicating ability to source power and the level of consumption.</td>
<td>A detailed energy balance should be constructed indicating ability to source power and the level of consumption.</td>
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</tr>
<tr>
<td>Level of Design Definition</td>
<td>Factor</td>
<td>Scoping Level</td>
<td>Preliminary</td>
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<tr>
<td>----------------------------</td>
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<tr>
<td><strong>Level of Capital Expenditures (Capex)</strong></td>
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<tr>
<td>Operating costs can be developed by benchmarking for very early stage studies. Where a higher level of category above is applied, an effort must be made to derive major costs (labour, power, etc.) as would be applied locally to the deposit.</td>
<td>Operating cost can be 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.</td>
<td>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 is identified. Supply costs are from local creditable suppliers capable of providing the supplies.</td>
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<tr>
<td>Accuracy is from ±25 to ±35%.</td>
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<td>Accuracy is from ±15 to ±19%.</td>
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Caesar's Palace Las Vegas
## Process Risks

<table>
<thead>
<tr>
<th>FACTOR</th>
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</thead>
<tbody>
<tr>
<td>Orebody Complexity</td>
<td>Influence of mineral deposit complexity (mineralogically complex ores, variances in hardness, etc.) upon the process should be identified.</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Flowsheet Complexity or Novelty</td>
<td>It should be indicated whether the process is novel or to a common process involving well known techniques for this sort of mineralogy.</td>
<td>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.</td>
<td>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.</td>
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## Other Risks

<table>
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</thead>
<tbody>
<tr>
<td>Tailings Disposal</td>
<td>The nature of the tailings should be indicated and the form of disposal being contemplated.</td>
<td>An appropriate level of detail should go into the definition of plant emissions and how they will be handled in an appropriate manner.</td>
<td>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 environmental issues. Appropriate control and disposal.</td>
</tr>
<tr>
<td>Health and Safety</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
</tr>
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</table>
|-------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
| Interactions with Other Disciplines | Influence of non-process factors (weather, location, potential ARD, etc.) should be identified if they are likely to impact the process. | In addition to factors indicated as problems at the scoping level, water supply and quality is an especially critical process factor and comments should be made regarding any potential difficulties. | Impact from other areas on the process and plant design should be indicated, and described. In particular, the 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. |
For Further Information on NI 43-101, the role of QPs, reporting standards and best practices

www.cim.org
www.osc.gov.on.ca
www.bcsc.bc.ca
www.lautorite.qc.ca