Mine feasibility studies are nearly as old as the industry itself. In the first recorded writing on mining by Agricola (1556), he gave many clues as to what to look for in evaluating a mine. Most mineral engineers, geologists, mineral company executives, and mineral development lending agencies think of the feasibility study as the formal methodology that brings the necessary information on a property’s raw mineralogical data through the feasibility and preliminary design process and to the point where a comparable economic analysis of the envisioned project can demonstrate financial viability. But the feasibility studies have to be completed by many people evaluating different commodities for many different types of mines and process plants in many different climatic, political, and social environments. Yet, in the end, all of the feasibility studies must accomplish the same thing: demonstrate comparable financial opportunity of investment potential. Thus, the need for a consistent, systematic methodology in performing evaluation and feasibility work is clear.

WHO SHOULD PERFORM FEASIBILITY/EVALUATION STUDY?
The first focus is who should do the feasibility study. Some might argue that the very people who found the resource obviously know the most about it and therefore those within the exploration group should perform the early feasibility study and even the early bulk sampling or test mining. However, there is no way that the discoverer of a new mineral resource can view the outcome of developing that resource with totally unbiased beliefs, any more than a mother could sit on the jury of her son being tried. This is not to say that the exploration group should not have a large role in the early input, but, from that point on, the project team must be organized with persons of multi-disciplinary backgrounds.

Building this multi-disciplinary project team will be discussed in a later section, but for now, consider the organization that has the responsibility of performing all of the project feasibility and evaluation studies. Sometimes referred to as project development or mine evaluation and development, this organization should perform—or supervise consulting organizations performing—evaluation studies of mineral deposits and mineral processing facilities for projects discovered or acquired, wherever that project is located. The assignment of evaluation studies of all types to a central headquarters has the following advantages:

- It ensures that all of the projects are studied and evaluated in exactly the same manner for that phase of the study and are treated uniformly and objectively.
- It ensures that all projects will have people of specific disciplines available to work on every aspect (thus each phase will be technically evaluated properly for that depth of study).
- It ensures centralized project planning and scheduling.
- It provides an experienced base group to consider the results of all candidate projects.

STAGES OF PROJECT
Because mining is a business that is constantly depleting assets, mining companies must constantly increase their mineral reserve assets through exploration or acquisition. This generally means that most successful companies will have numerous potential prospects that they are considering, either from a raw exploration point of view or through acquisitions. Thus a growing mining company might have between six and twelve active projects in its portfolio at various stages of exploration, evaluation, or development. These several projects to be evaluated:

- May be for different commodities;
- Will probably involve different individuals doing the evaluations;
- Will probably start at different times;
- Will most likely have unequal mine lives; and
- May be located in different countries.

The most important element in doing complete property evaluations for a company is that each one is done exactly like every other evaluation within that company so that a decision is based on comparable economics. Therefore, a company must put into place a system that will require different evaluators to follow the same procedures on different properties and develop equivalent feasibility studies that can be compared.
This is the single most important principle that must be faithfully followed by any company doing property evaluations. Likewise, it would help investment houses if all of their potential clients had projects that had equivalent feasibility studies that were more or less comparable, at least with respect to completeness. One of the primary purposes of this chapter is to instill in each reader the concept that there must be a strictly regimented method of complete property evaluations leading to feasibility reports.

WHAT MUST BE CONSIDERED FOR A PROPER FEASIBILITY STUDY?

For a properly documented property evaluation, quite simply everything must be considered. However, that does not really help much in knowing how to start and what to look for. More specifically, there must be an examination of the potential mineral operation, such as

- Determining the mineral resource (and reserve estimate, if there is one),
- Determining a mining method based on the measured and indicated resource,
- Reviewing the mineral extraction flow sheet,
- Performing a market analysis,
- Determining infrastructure needs,
- Quantifying the environmental and socioeconomic impacts and mitigation required,
- Estimating the costs of these factors, and then
- Performing an economic analysis of the assumed revenues versus the costs to determine if the project meets the company’s objectives.

Objectives of Mineral Property Feasibility Study

It is often assumed that the feasibility study’s objective is to demonstrate that the project is economically viable if it is developed and exploited in the manner laid out by the study. But this assumes that every mineral deposit evaluated can be profitable. Of course, this is not true; development of most of the earth’s mineral deposits is not currently viable.

So what should be the objective of mineral property feasibility study? It should be to maximize the value of the property to the company by determining either to exploit it, sell it, wait for a technology or market change, or do nothing. It should also be the objective to reach that decision as early as possible, with the least amount of money spent. But how can this be done? How does a person know when they have studied each of the hundreds of items of information enough so that they have confidence in the feasibility study and the economic analysis based on that study? One learns to perform a feasibility study by a phased approach to mine evaluation. Several authors (Hustrulid and Kuchta 1995; Gentry and O’Neil 1992; Stone 1997; Taylor 1977) and, in fact, most mineral companies take a similar approach to mineral property evaluation.

INDUSTRY APPROACH TO FEASIBILITY STUDIES

On rare occasions, the activities required in a feasibility study are often described as a single, continuous process—from the time the resource is identified until a decision can be made to develop the property. This one-step approach, in which single feasibility leads directly to development, may sometimes be correct for extremely high-grade ore bodies or if the company requires development for some reason in a specific time frame. But the one-step approach is risky from a technical and an economic point of view. Such methods will usually develop an operation that is, in fact, suboptimal, even though it still may meet the company’s needs. Furthermore, it may cost the company far too much money to find out that the project economics prove inadequate. Most companies and books on the subject recommend a phased approach to mineral property evaluation.

Content of Classic Three-Phased Approach

Lee (1984) describes a classic three-phased approach as follows:

Stage 1: Conceptual [Scoping] Study

A conceptual (or preliminary valuation) study represents the transformation of a project idea into a broad investment proposition, by using comparative methods of scope definition and cost estimating techniques to identify a potential investment opportunity. Capital and operating costs are usually approximate ratio estimates using historical data. It is intended primarily to highlight the principal investment aspects of a possible mining proposition. The preparation of such a study is normally the work of one or two engineers. The findings are reported as a preliminary valuation.

Stage 2: Preliminary or Prefeasibility Study

A preliminary study is an intermediate-level exercise, normally not suitable for an investment decision. It has the objectives of determining whether the project concept justifies a detailed analysis by a feasibility study, and whether any aspects of the project are critical to its viability and necessitate in-depth investigation through functional or support studies.

A preliminary study should be viewed as an intermediate stage between a relatively inexpensive conceptual study and a relatively expensive feasibility study. Some are done by a two- or three-man team which has access to consultants in various fields; others may be multi-group efforts.

Stage 3: Feasibility Study

The feasibility study provides a definitive technical, environmental and commercial base for an investment decision. It uses iterative processes to optimize all critical elements of the project. It identifies the production capacity, technology, investment and production costs, sales revenues, and return on investment. Normally it defines the scope of work unequivocally, and serves as a base-line document for advancement of the project through subsequent phases.

Frequent Problems in Classic Three-Phased Approach

However, some pitfalls are associated with using the classic approach. As used by much of industry, this approach is a nonuniform, nonsystematic, nonstandardized approach to feasibility.

Conceptual/Scoping Study

A conceptual or scoping study can be extremely misleading. Nearly every exploration project that is even slightly submarginal can be shown to be worthy of further development based on casual educated guesses and optimistic, simplified,
or even biased evaluations. Back-of-the-envelope approaches to a mine feasibility study need to stay on the backs of envelopes and out of formal, official-looking reports. At its worst, this type of report can be performed by the exploration firm or project sponsor to try to sell the project to someone else. However, when an independent third party does the conceptual/scoping study, it can be employed as a useful tool for the potential investing company to determine if it wishes to proceed to the next phase of feasibility study or to calculate what the project might be worth on the open market. Also, this approach might be appropriate when looking for commodity targets for the exploration group, but not for further in-house decisions to move the project to the next level, based on the exploration group’s mining and milling judgments.

This is not to say that conceptual, unclassified screening studies do not have their place in justifying other types of work, but care and caution are needed so the conceptual study is not dignified beyond its engineering basis. In fact, some countries’ security exchange agencies, such as the Canadian Securities Administrators (CSA), allow and specify such a preliminary study, which they call a preliminary assessment. As identified by the CSA, such a report includes a statement that this “assessment is preliminary in nature, that it includes inferred mineral resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the preliminary assessment will be realized; and states the basis for the preliminary assessment and any qualifications and assumptions made by the qualified person.” It is completed without substantial engineering studies.

In a conceptual or scoping study, the accuracy of the cost estimates are most often assumed. In fact, the accuracy of all levels of feasibility studies depends on how much good engineering has been performed on the specific project. If none, then the project’s related cost and economics are not likely to be accurate, and the study is likely to be misleading. Typically, at this stage, one might do 1% or 2% of the total engineering on the project. Bear in mind that, for a small project, this may amount to 1,800 to 2,400 hours of engineering work. But, for a large project, this percentage may amount to 9,000 to 18,000 hours of engineering work. Then, using good engineering judgment, experience, and cost on similar projects, the accuracy of the scoping study feasibility may be in the ±45% range. Other authors claim that an accuracy of 30% is achievable for a conceptual/scoping study (White 1997). However, this accuracy will likely not be achieved unless the project is being developed in an old district where a mine or plant has recently been built and the new installation is similar to the existing one. The 30% accuracy will only be attained after 10% to 12% of the engineering has been completed.

Prefeasibility Study
The problems that have been found with many prefeasibility studies that followed conceptual or scoping studies as outlined is that often this phase simply follows the path set by the conceptual study. There is a reluctance to spend the time and money for a feasibility team to go back and justify the concepts chosen for the mining method, processing method, necessary infrastructure, waste disposal method, and overall size of the operation. Likewise, there is a reluctance to spend the time to optimize any of the functional operations at a time when the project team is small.

Another observed problem is that some of the elements or activities of the prefeasibility study will be taken too far in application, and the project’s proponents will invariably proclaim to others in management and the investors that “the study is really more than a preliminary feasibility study.” Although this is probably not so, it will give members of management (and possible financiers) some unjustified overconfidence in the project.

Another critical failure that often occurs in this system of feasibility progression is that the preliminary study is the chance to find the “fatal flaws” of the project, if it has any. Sometimes this does not happen or the flaws may be found in the scoping study. One definitely does not want fatal flaw discovery after a large engineering group has been assembled to work on the final feasibility study, because by this time the project’s momentum is huge, and it will cost a lot to stop the project.

If the project is being undertaken by a company listed on the Canadian or U.S. stock exchange, then inferred mineral resources may not be used for mine planning purposes, except if a small zone of interburden exists between measured or indicated resource material that must also be mined.

Final Feasibility Study
When using the classic approach, by the time one gets to the final feasibility study, the project direction of each element has usually been set. For all aspects of the project to proceed at the same pace from this point, there is little opportunity to stop and examine the many interrelated operating variables that should have been examined at an earlier stage of the study. Thus it is likely that a nonoptimized design will emerge from this type of study. As a result, the mining industry is full of nonoptimized mines and plants that have been built because those optimization studies did not take place at the proper time, which in this case was during a prefeasibility study. Sometimes toward the end of a final study, the operating management realizes that certain aspects have not been optimized, and subsequently major last-minute adjustments are implemented in an attempt to mitigate these errors. Usually, such actions are based on less than the amount of engineering analysis that went into the original planning, and the accuracy of such last-minute changes and the ripple effect to all other aspects of the project (particularly the environmental and regulatory engineering) damage the credibility of the entire project.

RECOMMENDED APPROACH
Because of the problems outlined previously regarding industry abuses to the nonuniform, ill-defined, classical three-phased approach, a more rigid, uniform, engineered, and systematic three-phased approach to mineral property feasibility is recommended. In a more general way, this has been suggested by Hustrulid and Kuchta (1995) and by Gentry and O’Neil (1992), using the work of Gocht et al. (1988) and Taylor (1977). But what is considerably different as defined here than what has been suggested by others is the sheer magnitude of details enumerated by engineered task. Rigorously following the details—a description of which is contained in the iteration of each phase—that makes this method unique and bankable. Nowhere else has this amount of detail of the tasks required in a mineral property feasibility study been documented and published in publicly available literature. Many of the larger mineral groups, such as BHP Billiton, Rio Tinto,
and Anglo Gold, probably have equally as well documented activity lists for each step of the feasibility studies, but they have not been publicly published.

The need for such an approach was imperative because many companies have eight to twelve mineral project feasibility studies to manage at one time. It would not be unusual for such studies to address four or five different mineral commodities located in four or five different countries, all having different starting dates and mine life, and being studied at one time by several different project teams. It is only by formalizing the feasibility study process that management can be assured that items will not be left out or that some activities would not be studied in too much depth. Although some companies may not have a dozen projects going at one time under the conditions described, the established procedure will serve any user of the system well and yield project results that are comparable for financial decisions.

This chapter examines the engineered, systematic three-phased approach to a mine feasibility study. Although not the only system available, many believe it is the safest and most prudent method. As different situations arise on different commodities, the project manager may believe that some steps can and should be omitted. However, one must also be aware of the potential consequences when taking shortcuts, particularly if the company’s experience is weak in this type of new project. While looking at the details of the long lists of items that need to be studied in the different phases (described in the next section), the reader may believe there are far too many activities and the time and expense required to accomplish them is too great. Some may choose to combine many of the activities of the preliminary study with the intermediate study. This may be possible and is discussed later. However, one must be careful that this combination does not dilute the preliminary/intermediate study so that a financial decision can’t be made with confidence. Some may believe that items can be eliminated or that the study of certain items is not applicable. But a great amount of caution should be used in eliminating any study aspect unless the company has so much experience and data on that particular aspect that the study is simply not necessary.

The three steps of feasibility studies recommended here are

1. Preliminary (or conceptual) feasibility,
2. Intermediate (prefeasibility) feasibility, and
3. Final feasibility.

Although these appear similar to some of the systems previously mentioned, they are not the same. Learning the content of these three studies and how to apply the work from one level of effort to the next are important parts of this chapter. What will be covered is a brief description of the activities at each level of study and how to move a project from exploration through the feasibility phase and then to engineering design—or to the back burner or for sale.

Work Breakdown Structure

Another important aspect is to apply controls to portions of the study. To do this, one must first organize a list of work categories and assign numbers to them. This is known as a work breakdown structure (WBS). No two people will develop identical WBSs; the important thing is to get the work organized so that it can be tracked—both from an accounting and scheduling point of view—and to track it on a computer.

Table 4.7-1 Typical work breakdown structure numbering system

<table>
<thead>
<tr>
<th>Numbering Sequence</th>
<th>Project Study Level or Project Execution Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1XXXXX</td>
<td>Preliminary feasibility study</td>
</tr>
<tr>
<td>2XXXXX</td>
<td>Intermediate feasibility study (may include the test mine/bulk sample)</td>
</tr>
<tr>
<td>3XXXXX</td>
<td>Final feasibility study (including the design basis document)</td>
</tr>
<tr>
<td>4XXXXX</td>
<td>Engineering design (includes all preconstruction activities)</td>
</tr>
<tr>
<td>5XXXXX</td>
<td>Construction/mine development</td>
</tr>
<tr>
<td>6XXXXX</td>
<td>Mine/plant operations</td>
</tr>
</tbody>
</table>

Within each of the three levels of the feasibility study are 50 to 150 major activities. For each major activity, there are 10 to 20 elements, or work types. A large mining company trying to grow, or even holding on to its depleting asset, may have as many as eight to twelve projects going at any one time, at various levels of study. Because of the complexity of accounting for everyone’s time and charging expenses to ongoing work, a numbering system to keep track is essential. In addition to the billing and accounting, a robust WBS ensures that all activities can be handled and scheduled on a computer. This is no small task because many of the activities feed information to other activities before they can begin.

All major projects use such a system, and all U.S. government projects require a WBS. As defined by the American Association of Cost Engineers, a WBS is a product-oriented family tree division of hardware, software, facilities, and other items that organizes, defines, and displays all of the work to be performed in accomplishing the project objectives. An additional advantage is that if the WBS is written in a generic way, all of the projects within a single company can follow the same structure, thus ensuring comparable completeness for any future level of study.

The WBS method outlined in Table 4.7-1 is a generic WBS that could be used on any number of mineral projects. It also uses the project phase as part of the identification. Writing a WBS for each project is possible, but the comparison between all of the projects would be more difficult and possibly less accurate.

The WBS number system carries through the six steps from the preliminary study through the project design, construction, and into operations. The WBS illustrated here is in two parts: (1) in Table 4.7-1 where the first number of each line signifies the phase or step that the project is in when the activity occurred; and (2) in Table 4.7-2 where the numbers on each line refer to the various types of chargeable activities that occur in all of the phases. Thus, for a market investigation and planning activity in the mine/plant operation phase, the WBS number would be 61300, but if the market investment and planning study occurred in the final feasibility study, the WBS number would be 31300. It can be seen that a screening project is not included, because it only officially becomes a project when it passes a screening activity. Within each project phase, a further breakdown of the numbering sequence identifies major areas of work. An example of how this might be broken down is shown in Table 4.7-2.

The feasibility study definitions of each activity serve as a checklist and, with time elements applied to each activity and subactivity, form the basis for building a project schedule. Each project will have unique characteristics that will require
changes to the activities listed, but the general logic and activity identifications should apply to most mineral projects to be evaluated. The more consistent the approach, the more accurate the comparison in choosing between the various mineral projects. Using this numbering system and applying time elements to each activity by number allow a schedule network to be built on the computer.

**BREAKDOWN OF THE ENGINEERED, SYSTEMATIC, THREE-PHASED APPROACH**

This section and Appendices 4.7A–D provide a detailed description of the activities and sequences that are recommended to properly perform a mineral property feasibility study, with the expectation that the property, if developed, will perform at the levels predicted by the feasibility study. In the appendices, some numbers in the sequence appear to be missing to allow for future additions to the WBS system.

**Phase I: Preliminary Feasibility Study**

Although the objective of each phase of every mineral property feasibility study should be to maximize the value of the property to the company by determining how to proceed with it, more specific to the preliminary feasibility study is to consider those logical mining and processing methods (and other project elements) in just enough detail such that one can

- Determine that they will work together to meet the company’s objectives (which are usually financial); and
- Estimate the capital and operating cost, commensurate with the engineering that has been expended.

Depending on the country where the study is to be governed, the product must meet the standards of the U.S. Securities and Exchange Commission *Industry Guide 7* (SEC 2007); the Australasian Code for Reporting of Exploration Results, *Mineral Resources and Ore Reserves (The JORC Code)*, prepared by the Joint Ore Reserves Committee (AusIMM 2004); or Canada’s National Instruments 43-101 and 43-101CP.

The preliminary study is based primarily on information supplied through exploration. The company management should tell the exploration group that its report must contain the following information with appropriate maps and cross sections:

- Property location and access
- Description of surface features
- Description of regional, local, and mineral-deposit geology
- Review of exploration activities
- Tabulation of geologic resource material
- Explanation of resource calculation method, including information on geostatistics applied
- Description of the company’s land and water position
- Status of ownership and royalty conditions
- History of the property
- Rock quality designation (RQD) values, at the least, and any rock mass classification work that has been done
- Results of any special studies or examinations the exploration department has performed (metallurgical tests, geotechnical work, etc.)
- Report on any special problems or confrontations with the local populace
- Any other pertinent data such as attitude of local populace toward mining, special environmental problems, availability of water and hydrologic conditions in general, and infrastructure requirements

Ideally, a number of mining and processing alternatives will be examined as a screening process. Obviously these need not be in-depth studies, but most experienced mining engineers will quickly be able to determine what mining methods will be applicable and can then place costs on several alternatives for this application. Likewise, an experienced mineral processor can determine the candidate process flow sheets and can place costs on these alternatives.

At the same time, all the other elements of the project must be considered and studied in just enough detail to discover any fatal flaws or problems that need engineering mitigation. Certainly, environmental and socioeconomic issues need to be studied and scoped to the extent that any existing or expected problems will be detected. Then all of these items can be examined for future cost and work plans.

Costs and expenditure schedules will be based on industry-factoried historical experience. Major capital costs can be based on telephone quotes from suppliers or canned commercial programs built for this type of application. Usually, no field work or metallurgical testing will be conducted unless a definite metallurgical problem is recognized with the resource and suspected to be a fatal flaw, in which case it should be studied.

Depending on the complexities of the project, approximately 5,000 to 30,000 worker-hours of work is needed to complete these activities during the preliminary study. This description is written for a company or group that is prepared to perform most of the evaluation activities with various contractors. Thus for every task that is to be contracted:

1. A scope of work must be developed;
2. The industry needs to be surveyed for potential contractors;
3. Contractors must be evaluated to ensure they are qualified and likely to perform as expected;
4. A request for bid proposal documents needs to be prepared and sent out;
5. Bid documents must be evaluated and the award made;
6. Negotiations with the winning bidder may be necessary if there have been variances to its bid package, and adjustment made; and finally
7. The contractor can be mobilized.

All of these take a considerable amount of effort. If the work is to be done by experienced in-house engineers on the project team or from that function of an organization, then the contracting procedure does not apply. However, such activities as writing the scope of work should still be carried out by the central project team to make sure that potential challenges/problems are fully identified and that potential impacts are considered for all the other parts of the project.

The results of this preliminary study will be adequate for comparative screening of mining and processing alternatives, while an economic analysis will determine whether to proceed with (or reject) the project. A primary objective of the study is to plan and estimate costs for a further predetermination program if warranted. Approximately 4% to 8% of the project engineering will need to have been completed, in which case the probable error of cost estimates accuracy should be between 35% and 45%. If 10% to 12% of the total project hours have been completed in the study, the probable error should be between 30% and 35%, while contingencies of between 20% and 35% for capital costs will apply. An economic analysis will be performed, and the preliminary feasibility report will be fully documented. At this point, presentations to management will be made and, depending on the results of the economic analysis, approval to proceed to the next step of the project (or otherwise) follows.

Major Activities of the Preliminary Feasibility Study
A description of these preliminary study activities and tasks can be found in Appendix 4.7A. This generic list applies to all mineral properties but can be adapted with addition and deletions for a particular deposit. Remember, for any of these activities that need to be contracted, the seven contracting steps listed will consume a lot of time.

Phase II: Intermediate Feasibility Study
Based on results of the preliminary study showing that a project has the potential to achieve the desired company goals, the intermediate feasibility study should be initiated. The specific object for this study is significantly different than for the preliminary study. Now that it has been shown, by using at least one mining/processing system, that the mineral resource being examined has potential economic viability, the objective must now focus on methods to optimize each component mine/plant process, while at the same time taking an in-depth look at all of the project parameters briefly studied in the preliminary study.

At this time, accurate topography maps specific to the area must be generated, if not already available. Any shortcomings in the land and water status discovered in the preliminary study must be corrected at this point before investing any more money.

Mine design will be based on information from the early exploration (delineation) drilling program plus any additional exploration sampling done between the two phases. In some cases, bulk sampling may be required. Thus, if permits can be obtained, a test mine may be justified after this phase of the study. If further exploration drilling or trenching takes place during this phase, permits and contractor agreements must be prepared. Under the control of the project team, the sampling program must

- Prepare a sample flow chart,
- Prepare a chain-of-custody security procedure (if not already in place; designed to protect the integrity of the eventual sample analysis), and
- Procure and analyze the new samples.

The new geology and mineral information must be fed into the database and evaluated. After rebuilding and analyzing the new database and documenting the current reserves and resources, new reserve and resource maps can be constructed for mine planning.

Given the shape and character of the ore reserve identified to this point, the mine planning will begin. Only measured and indicated geologic resource material may be used for mine planning in the United States and Canada. Although those mining methods considered in the preliminary study may be reexamined, other methods should also be considered, since the ore body shape, size, character, and grade may have changed. The methods described in this text on mine planning and mining methods should be followed. But this time, after a rough screening of multiple mining methods, two or three of the most probable mining methods (or variations), which are considered safe and environmentally permissible and that will probably yield the lowest cost (or greatest recovery), should be carried through the study until an economic comparison can be made. Likewise, with the latest mineralogical data and mining methods, several mineral processing and waste disposal alternatives should be considered, and those that seem likely to yield the best economics should be carried through the study until a true economic comparison can be made between the methods.

Facilities siting and geotechnical investigations will need to be conducted. If competent personnel are not available within the company, contract preparation to cover the scope of work for the approximately 125 intermediate feasibility activities must be done. The same list of contracting activities must be completed that are shown in Appendix 4.7A for Phase I, the preliminary study, and time must be scheduled for all of this contracting effort. One must not underestimate the time it can take to perform these tasks: scopes of work, requests for proposals (RFPs), survey of industry contractors, obtaining a legal contract, allowing time for bids and evaluating the bids, and negotiating the contract details with the successful contractor.

This must be done for each contractor. It may take several months to get a contractor assessed and the details of their contract accepted. But with contractors on board, work can then begin with environmental baseline studies, impact assessments, and long lead time permit applications. Again, if competent personnel are not available within the company, contract preparation to cover the scope of work for these environmental activities must be done. Bidding lists must be prepared, RFPs issued, bid evaluation criteria written, and the bid evaluation administered. Finally, when negotiated details of the contract are completed, environmental contracts are awarded. Although the baseline studies take time, they should be completed by the time the intermediate feasibility study is
done, which will allow for this information to be submitted, along with the intermediate mining and process planning, to the permitting agencies.

Results of the intermediate study will be adequate for determining economic feasibility and defining additional predevelopment and/or metallurgical testing requirements. In many cases, the benefits and requirements for a test mine or bulk sampling will be fully recognized and defined at this point. In most cases, specific permitting will be required, and this will require time to receive such permits.

The costs estimates for the (two or three) alternatives developed during this phase should be based on detailed functional analysis of the mining and processing methods of each operation, on suppliers’ written quotes, and on bench-scale metallurgical testing. By the end of the intermediate study, the engineering on the project should be between 12% and 15% completed. The probable error of cost estimates should be 15% to 20%, while contingencies of between 15% and 20% will apply. Economic analysis will be performed on the favorable sets of alternatives selected. Usually, no more than three sets of alternatives will be evaluated. When the intermediate feasibility report is fully documented, presentations to management will be made and, depending on the results of the economic analysis, approval to proceed to the next step of the project (or otherwise) will follow.

**Major Activities of Intermediate Feasibility Study**

A description of these intermediate study activities and tasks can be found in Appendix 4.7B. This generic list applies to all mineral properties but can be adapted with addition and deletions for a particular deposit. For any of these activities that need to be contracted, the seven contracting steps listed in the preliminary feasibility discussion apply and will consume a lot of time.

**Need for a Test Mine**

Many times the feasibility team will not be able to obtain enough ore quality and geotechnical information working with just exploration sampling. In these cases a test mine must be considered. The test mine may come after the intermediate feasibility study or during the final feasibility study. The advantages of a test mine are as follows.

- **From a mining perspective.** Verifies the expected ore continuity, thus eliminating disastrous surprises; accurately assesses the rock strength, allowing prudent planning and sizing of the commercial mine opening; verifies mining efficiency and productivity as it relates to drilling, blasting, and materials handling; determines from reliable water studies the nature of mine water inflows, thus allowing for adequate water-handling procedures to be installed before problems are encountered; better quantifies the mine ventilation friction factors and requirements; and confirms the character of the waste product and how it will be handled in the commercial operation.

- **From a metallurgical perspective.** Verifies and optimizes the metallurgical flow sheet with a pilot-plant process that is continuous lock cycle testing; determines what size and type of equipment will be optimal for the metallurgical recovery; determines what type and amount of reagents will lead to the best recoveries and concentrate grades; determines the required amount of water and how to achieve a water balance; provides a more accurate prediction of concentrate grade, moisture content, and impurities; and provides a much better assessment of the work index from a bulk sample than from small samples.

- **From an environmental perspective.** Demonstrates the ability to control the operation in such a manner that it will not harm the environment; allows the project team to completely study the waste characterization and determine any future problems; and, if water discharge is involved, allows the project team to study the difficulty of settling the discharged water and determine what is necessary to mitigate future problems and determine if zero discharge is possible.

- **From an engineering design perspective.** Improves the ability to make more accurate cost estimates, because of better knowledge of the abrasivity of the rock and of the ground/slope control of the stopes/pit walls, which could lower the cost estimate because less contingency may be needed; improves labor estimates because of a better understanding of the productivity of each unit operation; predicts a more accurate schedule, because of better understanding of the unit productivities; and lowers the overall risk of the project in every aspect.

- **From the perspective of expediting later mine development.** Shortens the overall schedule from the end of the feasibility study to the end of construction, because of early access to develop the commercial mine, and completely utilizes the openings as part of the commercial mine operation; because access to the underground opening already exists, some shafts may be able to be raise bored and then expanded by mechanical excavation rather than by the more expensive conventional shaft sinking methods; and finally, the test mine may be an ideal training facility prior to the commercial mine start-up.

Activities related to the test mine are found in Appendix 4.7C.

**Phase III: Final Feasibility Study**

The final feasibility study should be initiated when results from the intermediate study show that the project still has the potential to achieve the desired company goals. The objective, as in the first two phases, is still to determine the potential value of the property to its owners—either by determining the optimum method of developing it, by selling it, or by doing nothing further at the moment. However, more specific to the final study, the objective now becomes one of mining refinements to all of the details of the intermediate study that yielded results that met the company objectives. This is designed to optimize the return on the future investment. The final feasibility study will be prepared during the permitting time schedule for the project, since final project features must be reflected in the permits to accurately assess impacts and mitigation for the agencies, commentators, stakeholders, nongovernmental organizations (NGOs), and community. Assuming that this project still shows favorable results at the end of this phase of study, the design parameters set in the final feasibility study will feed into the design basis report, which guides the project into the design and construction phase, and finally into operations.

If test mining with bulk sampling and pilot-plant testing has not been completed, it now becomes part of the final feasibility study. Mine and process facilities will be further studied, and the best alternative developed in the intermediate study will be optimized. Using the latest exploration and
metallurgical test data, probably from the test mine bulk sample, the reserves will be updated and the metallurgical flow sheet will be optimized. Final environmental impacts will be determined following prescribed guidelines. Applications for construction and operating permits will usually be made early in this phase of study (subject to later modification). Mine and process operating cost estimates will again be made by performing a functional analysis. Capital cost will be refined by again soliciting written quotes from vendors. By the end of the final study, the engineering should be 18% to 25% completed. The probable error of cost estimates should be 10% to 15% of the total cost estimate, with a contingency of 10% for most engineered structures. Other less well-defined aspects of the project (e.g., mine development) should have contingencies of at least 15%. An economic analysis will be performed, with the final feasibility report fully documented. At this stage, presentations are made to management, and, depending on the results of the economic analysis, it will give approval to proceed to the design and construction phase of project development and for the associated budget.

**Major Activities of Final Feasibility Study Plan and Budget**

A description of these final feasibility activities and tasks can be found in Appendix 4.7D. This generic list applies to all mineral properties but can be adapted with addition and deletions for a particular deposit. For any of these activities that need to be contracted, the seven contracting steps listed in the preliminary feasibility discuss apply and will consume a lot of time.

**Combining Classic Approach with Recommended Approach**

Because there are good reasons (as outlined at the beginning of this chapter) to sometimes utilize the nonuniform classic conceptual/scoping study approach, if the decision is made to move the project to the next level of study, one should convert to the engineered, systematic three-phased approach. In this case, the conceptual/scoping study should be compared with the details of the engineered, systematic, phased preliminary study. Whereas in the classic scoping study only 2% of the engineering may have been done for the first phase, in the engineered, systematic preliminary study as much as 4% to 8% of the engineering would be completed. This means that if one is now going into the intermediate feasibility study in the engineered, systematic three-phased approach, the extra work to be done in the intermediate study must be planned so that by the end of the intermediate study, all of the reasonable functional alternatives of the operation should have been examined, the optimal method selected, and 12% to 15% of the engineering work completed before going into the final feasibility study.

Most mine management people believe that the final feasibility study is the final document of the feasibility process. Unfortunately, with this in hand, most management teams will head for the bank or a joint venture partner and on to a design contractor without fully documenting everything that went into the full feasibility study. This includes not only a description of the geologic reserves, mine and plant facilities, and hardware, along with the positive economic picture, but all of the company design and operating philosophy that is so important when the build-and-operate stage is reached. The plans on how to execute the project and how to operate the completed facility are equally as important to the design contractor, the banker, and the potential joint venture partner. If all important activities through to the final operation have not been examined and then documented, the project is not ready to move forward.

**PROJECT DESIGN BASIS REPORT PREPARATION**

With project approval, the course of action will either be to go directly into the project execution phase or possibly seek out a joint venture partner. In either case, the design basis report (DBR, sometimes called a design basis memorandum or design basis document) needs to be prepared. The approved project feasibility report will be presented in sufficient detail to produce a DBR, which is the document that will guide the project through the next step: designing the project based on the preceding studies.

**Why a DBR Is Needed**

The primary purpose of the DBR is to be able to convey to future design engineers a consolidated document in which all the needed information is contained in a condensed version. But it can also serve to inform others, such as financial organizations, construction personnel, or persons who may be interested in a joint venture. Although much of the information is also contained in the final feasibility study, this document is written more for the purpose of documenting (for management) that the project is indeed both feasible and economically viable. In contrast, the DBR is written to convey all of the technical information that will be needed by the architect/engineering (A/E) design organization, which has already been developed by the owner’s project feasibility team. It contains all of the drawings prepared during the final feasibility study, plus any others required to convey the needed technical information to the A/E organization for the project, and will be used as a basis for the final bids by the various A/E organizations.

In the introduction, the writer should define the purpose and use of the DBR. At a minimum, the DBR serves several purposes. The DBR

- Defines the technical basis for project design and construction so that basic, detailed engineering downstream can proceed;
- Provides the basis for a coordinated review by the organizational entities involved—the future operations group, the engineering group, management, and the future A/E team;
- Provides documentation for the technical basis and facilities description from the final feasibility study cost estimates; and
- Conveys the company’s construction and procurement philosophy to the future A/E team.

The DBR is usually written in several volumes (in the case of the following example, five volumes were produced). Rather than describing in specific detail what should be written under each section and subsection of each volume, a brief description is given here concerning the general content of that volume with a generic outline of items given in Appendix 4.7E.

**Volume 1: Management Summary**

The management summary, prepared by the project executive or project manager as applicable, summarizes the project objectives, the assumptions that were made, the work that has been completed, the economic analysis and associated risk,
and the recommendations of the project team. Other items that should be covered (if studied by the project team) include project funding and the business plan with market and competition analysis and strategies. Any outstanding major issue involving government agencies related to utilities, transportation, land, royalties, or potential project partnerships must also be mitigated. At the end of the summary are the conclusions and recommendations, with discussions on the reserves, the feasibility of the project, the market, the schedule of the design, construction and start-up as planned in the feasibility study, any preappropriation work contemplated, and needed funding. An example outline of the information that is contained in Volume 1, Management Summary, is shown in Appendix 4.7E.

**Volume 2: Project Economics**
Prepared by the project executive or project manager, project economics summarizes the capital and operating costs, project schedule, market forecasts, inflation projections (if constant dollar analysis was not used), and other factors that affect the total erected cost and project economics. Identified project risks and the measures needed to mitigate those risks should be documented. An example outline of the information that is contained in Volume 2, Project Economics, is shown in Appendix 4.7E.

**Volume 3: Technical Narrative**
Prepared by the project team, the technical narrative describes the technical basis for the project and lists the design considerations and constraints. This is the technical meat of the project. The narrative must convey to the future A/E contractor exactly what is to be built and exactly what the A/E constructor is to do and precisely how it will accomplish that. Nothing can be left out. For this reason, all of the drawings prepared during the final feasibility stage, plus whatever drawings are necessary to convey the message to the A/E organization, must be in the DBR. The better defined the project is in the DBR, the more accurate the cost will be to the bid estimates, and the fewer exceptions that will have to be negotiated. An example outline of Volume 3, Technical Narrative, is found in Appendix 4.7E.

**Volume 4: Project Execution Plan**
This document, prepared by the project team, defines the real and potential problems in the detailed engineering, procurement, and construction of the project. Furthermore, it goes on to describe the best plans to ensure that these problems are mitigated or at least minimized. The recommended contracting plans are spelled out, as are the plans for engineering and design, procurement, and construction. An example content outline of Volume 4, Project Execution Plan, is in Appendix 4.7E.

**Volume 5: Operating Plan**
Prepared by the company’s operations department, the operating plan explains how to minimize the impact for identified potential problems in start-up and continuing operations. Although much of the company’s operating philosophy should already have been placed into the design as presented in the final feasibility study, the writers of the operating plan should again emphasize the company’s attitude toward mechanization and automation, and what they are willing to pay for it; and its policy on safety and environmental issues and maintenance and contracting. Such issues as labor recruitment and training will be planned, scheduled, and budgeted. Learning-curve estimates will be applied toward the production buildup, so the estimated production will be on schedule and project economics will be preserved. An example outline of Volume 5, Operating Plan, is found in Appendix 4.7E.

It is this DBR document that is used as the basis for the subsequent engineering design. Not only does it contain the technical data and information decided on by the company during the final feasibility study but also the project execution plan for contracting, building, and constructing the mines of the project. It also contains the operating plan, which will guide the engineers and builder to construct the mine/plant so the operating philosophy of the company can be quickly achieved and maintained.

Historic information on the activity duration that goes into the project schedule and the functions that will be performed in the engineering design and final constructed project is included in the next section. It often appears to laypeople that building mines and plants takes much too long and costs too much, but this is not the case. What is true is that the expectations based on most of the final feasibility studies are overoptimistic, and thus the project begins badly. Data from case histories are presented in the next section showing what should be expected.

### FEASIBILITY AND PROJECT TIMING, AND SCHEDULE

The time it takes between the discovery of a resource that may be a potential ore body and when the ore body is brought into production can vary significantly. Obviously, with an extremely high-grade ore body, it may take significantly less time to identify enough ore to start mining. Likewise, if money can be made no matter how you mine it, then the company may not want to spend a lot of time optimizing the mining and milling methods (though this could and has proved to be a mistake in the past). On the other hand, it may take many years to define large, marginal mineral resources and to optimize every aspect of the study in order to turn the resource into a viable reserve.

Technological changes over time may also allow the property to be developed after many years of study. The other factor is the ever-changing environmental permitting, which can vary significantly: Although a small punch coal mine in Appalachia can take less than a year, the development of a world-class zinc/copper mineral resource in Wisconsin (United States) was stopped for 20-plus years and finally terminated, even though it can be demonstrated that the underground mine can be built and operated in a manner that would be environmentally acceptable anywhere else. Overall it usually takes from 2 to 6 years just to complete the mineral property feasibility evaluation study.

The overall time from find-to-mine is logically divided between the classical phases of mineral development:

- Preliminary exploration and discovery
- Land and water acquisition commitment
- Exploration
- Feasibility studies/environmental permitting
- Final engineering
- Development and construction
- Start-up to full production

All of these activities vary greatly in length. In this chapter, only the length of the feasibility studies and environmental permitting will be considered.
Nelson & Associates (Nelson 1979) conducted a study for the U.S. Bureau of Mines on the duration of these phases of mineral development for four mining projects in Wisconsin and Minnesota (United States). (Three were operating and one was being considered.) Because these states have strict systems of environmental permitting for new mine development, it is not surprising that the Nelson study found that permitting time for a metal mine in Wisconsin was, by hindsight, more than 100% optimistic. For example, the following information comes from Nelson’s Summary of Time table:

- Environmental monitoring: 2.18 years
- Environmental impact report evaluation: 4.85 years
- State permits: 5.25 years
- Local permits: 3.25 years
- Environmental impact report preparation: 1.55 years
- Wisconsin Department of Natural Resources (WDNR) for the Wisconsin Environmental Protection Agency: 3.90 years
- Federal environmental impact statement (EIS): 3.05 years
- Master hearings: 1.16 years
- Other WDNR permits: 3.05 years

In reality, some of these activities can go on simultaneously or overlap. But even the most optimistic schedule to receive permits in Wisconsin for a metal mine was 10 to 12 years.

In addition, in the same report, Nelson also developed a time estimate, based on these four major projects, for feasibility studies as 8 years, which seems too long. However, this information came from four major projects done by four different major mining companies. Although it certainly can take 8 years to do a complete mineral property feasibility study for many projects, it is not necessarily true for all of them. Table 4.7-3 is taken from one mineral company’s estimates of the average time expected to complete the feasibility/evaluation on 10 (small to large) projects.

However, this schedule overlaps all activities possible on maintaining a high level of engineering standards (the approximate 300 total activities listed previously, completed mostly by contractors). Depending on the size, grade, location, ownership of the project, and how much financing the owner needs, these times can change radically. The total worker-hours to complete a feasibility study from the conceptual study through the final feasibility study will vary from 50,000 worker-hours to more than 100,000 worker-hours. By the time the final feasibility study is finished, 18% to 25% of the total engineering for the project will have been completed.

In contrast to these long time estimates, Cusworth, (1993) presented the estimates for Australia as typical durations for feasibility studies:

- Scoping study: 7 to 9 months
- Prefeasibility study: 9 to 13 months
- Feasibility study: 12 to 17 months

Therefore, it could be concluded from Cusworth that all projects in Australia vary only from a total of 28 to 39 months. Unfortunately, no details are given as to what was actually covered during these periods. It would have to be assumed that much of the difference between the United States and Australia is the U.S. environmental agencies’ red tape. But two other factors may play a significant role: (1) Probably more virgin deposits were being discovered in 1993 in Australia than in the United States, which might tend to be of a higher grade; and (2) Australians tend to turn everything over to contractors, which, with their larger staffs, can usually perform faster than their U.S. counterparts.

Scheduling of each project element must be done from the beginning. This is one of the important reasons to document in advance all of the activities of each feasibility level phase. Then estimated worker-hours of labor time must be assigned to each of these hundreds of project activities and subactivities. Setting up and maintaining the schedule of even a medium-sized project is a major task involving thousands of activities.

### ORGANIZING THE PROJECT TEAM

There are many ways to organize a project team, depending on:

- Phase of the feasibility study,
- Size and complexity of the project,
- Location of the project, and
- Size and experience levels within the parent company.

First, the talent that is needed either part-time or full-time on a project feasibility team must be considered. Certainly, the team needs people who understand and can perform project management, as well as costing and scheduling for the project. In addition, every technical discipline that has been considered in the evaluation must be populated. This includes the fields of geology, geostatistics, mining, metallurgy, environmental consideration, hydrology, geomechanics, civil infrastructure, and economic evaluation. But there must also be people who can provide and evaluate legal, land, water, public relations, socioeconomic, marketing, tax, and financial information. Depending on the size of the parent company, it must either build the organization within the company structure or depend on the consulting industry to supply the needed talent.

Taking the in-house approach, the company must form a project management and development organization whose staff will be assigned to the project management nucleus of each project. In addition, technical specialists are assigned from a technical support organization on an as-needed basis to perform the multitude of technical activities that will be required. By approaching the problem in this fashion, and using proper labor scheduling, many projects can be handled simultaneously. This approach works well on small- to medium-sized projects up through the intermediate feasibility phase of study; for large or mega-projects, it would probably only work in the preliminary phase.

Taking the consultant approach, the company should still form a project management organization to manage each project but then contract to either one large multidisciplined consultant organization or individual discipline consultants to perform the various technical tasks of each project. The consultant approach will not be discussed in detail, since the A/E consultant normally supplies all the organization’s needs.

<table>
<thead>
<tr>
<th>Project Evaluation Phase</th>
<th>Time Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>7.5 months (156 working days)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>2 years, 8 months (666 working days)</td>
</tr>
<tr>
<td>Final</td>
<td>2 years, 10 months (709 working days)</td>
</tr>
<tr>
<td>Total</td>
<td>6 years, 1.5 months (1,531 working days)</td>
</tr>
</tbody>
</table>
In-House Project Teams
Two basic management philosophies must be considered: functional matrix or line/staff organizations. This operating philosophy goes beyond the consideration of managing projects but is the means by which all supplied labor report to the company’s various functional departments. There will be a considerable difference in how the project teams are made up, depending on whether the company operates as a line/staff organization, a functional/matrix organization, or a hybrid of the two.

It is difficult to generalize, but if the company is running several small- to medium-sized projects, which are in the preliminary or even the intermediate feasibility study phase, it is more cost-effective to organize a core group—consisting of the project manager and a project cost and schedules coordinator—and temporarily assign experts from the matrix technical organization rather than organize several line/staff organizations for each project. By allocating work in this manner, each discipline can usually handle several projects at one time with proper scheduling. It can usually work well through the intermediate level of feasibility, particularly if the projects are located in the same country as the home office mine evaluation and development group. However, when the project is overseas or if it is a large project, the amount of field work required during the intermediate and final studies mandates that it is usually best to move the dedicated project team to a location near the site.

At such time as the magnitude and importance of a project justifies it, a separate project team organization is established. This would normally occur at the end of either the preliminary or intermediate study phase when the cost, duration, level of staffing, or overall importance indicates that a separate project team should be created. At this point, the team would be transferred to a location close to the site of that project but still functioning under the project development group. It is also worth noting that in some countries there is little or no technical mineral engineering base on which to draw for a staff and one must be literally imported.

At the conclusion of the preliminary or intermediate study phase and when it is determined that a separate project organization should be established, an independent project team is organized and works through the local organization as determined by management and coordination with the affiliate or country manager. In such cases, the project may have a project executive who also serves on the local country management committee or staff.

ACKNOWLEDGMENTS
The author acknowledges the contributions of W.J. Bulick and G.D. Mittelstadt for the original work they completed in 1977 wherein they developed the detailed “Recommended Approach” for the three-phased feasibility study methodology described in this chapter.

REFERENCES

APPENDIX 4.7A
PHASE I: PRELIMINARY FEASIBILITY STUDY COMPLETE ACTIVITY DEFINITIONS

<table>
<thead>
<tr>
<th>Activity No.</th>
<th>Activity Title and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10100 Public Affairs</td>
<td></td>
</tr>
<tr>
<td>• Do in-house determination of public affairs’ perceived responsibility and identify company official to serve as spokesperson for the project.</td>
<td></td>
</tr>
<tr>
<td>• Inform state government officials if the mineral resource is a new major discovery, prior to official public announcement of the discovery. Then prepare and disseminate initial press release announcing discovery.</td>
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<tr>
<td>• Identify statewide media editors and set up proper liaison and method of briefings.</td>
<td></td>
</tr>
<tr>
<td>• Identify concerns of local, regional, and state population, and prepare proactive response demonstrating how each concern will be mitigated. As more data are received, update these proactive responses to the public.</td>
<td></td>
</tr>
</tbody>
</table>
10101 Review Exploration Report
Review report prepared at end of exploration phase. Report should contain information on:
- Mineral deposit,
- Property location and access,
- Area surface features,
- Exploration activities completed and planned,
- Geology (regional, local, and deposit),
- Potential ore reserves,
- Company’s land and water position,
- Property ownership and royalties,
- Property history,
- Special studies performed or environmental problems noted, and
- General data.
Review should include trip to project site to familiarize team members with site and area.

10102 Prepare Preliminary Study Plan and Budget
Prepares preliminary feasibility study schedule, with labor and cost budgets necessary to complete preliminary study. Prepare schedule to show activities and time for remainder of project phases:
- Intermediate and final studies
- Design, construct, and develop (through start of production)

10103 Present Preliminary Study Plan and Budget to Management
Present schedule, plan, and budget for review.

10104 Obtain Approval of Preliminary Plan and Budget
Obtain approval from appropriate levels of management to proceed with preliminary feasibility study outlined in schedule, plan, and budget.

10201 Review Land and Water Status
Review land ownership and water rights, control, royalty, and lease situation developed during exploration phase. Project team members should review land status with personnel in the company’s land office or its land agent.

10301 Assemble and Edit Drill-Hole Data
Assemble drill-hole data pertaining to deposit. Audit data for correctness and completeness.

10302 Check and Approve Preliminary Reserves
Check and modify or approve preliminary reserves calculated by exploration group.

10303 Document and Review Geology and Reserve Data
Write report documenting drill-hole and reserve data. Report should contain appropriate tables, maps, sections, and written information concerning mineral inventory and reserve data, regional and local geology, and other pertinent information. Review assembled information with appropriate levels of management. Write report in style and format suitable as chapter in preliminary feasibility study report.

10304 Prepare Intermediate Predevelopment Plan and Budget
Develop scope of work, schedule, and budget for pre-development drilling program for next phases of work.

10401 Develop Environmental Work Specifications
Define scope of work for an environmental overview of project and surrounding area.

10402 Develop Environmental Overview
Develop general environmental plan for protecting quality of water, land, ecology, cultural resources, and socioeconomics of project area during construction and operation. Determine costs, if applicable, to prevent or mitigate environmental damages and return area to near original condition at project end. Costs should have accuracy of +30%.

10403 Document and Review Environmental Results
Write report documenting environmental overview. Review results of study with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility report.

10501 Develop Geotechnical Work Specifications
Develop scope of work necessary for siting, soils mechanics, rock mechanics, and hydrology studies.

10502 Perform Geotechnical Overview
Examine drill cores or send cores for testing, if necessary, to determine unusual characteristics that may impact mining costs. Evaluate potential problems and associated costs. Perform field reconnaissance, with appropriate lab and field tests if necessary, to determine soils and surface hydrology conditions in and around potential mine, mill, tailings, and surface facility sites. Evaluate potential problems and associated costs.

10503 Establish Tentative Siting Preferences
Select tentative mine, mill, tailings disposal, and surface facilities sites based on preliminary evaluation of costs, soils mechanics, surface hydrology, and general environmental conditions. Costs should have accuracy of +30%.

10504 Document and Review Geotechnical Results
Write report documenting geotechnical and siting overview. Review results with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

10601 Develop Permit Application Specifications
Develop scope of work necessary to determine governmental agencies involved and permits required for every stage of project through design/construct and into operation.

10602 Conduct Preliminary Permit and Agency Overview
Conduct literature search and telephone conversations to determine permits required to develop, construct, and operate project. Determine local, state, and federal agencies involved. Evaluate the time and cost of permits and bonds needed. These costs should have an accuracy of ±30%.

10603 Document and Review Permit and Agency Results
Write report documenting results of permit and agency overview study. Review with appropriate levels of
management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

10701 Develop Mine Work Specifications
Develop scope of work necessary for conducting mining evaluation studies.

10702 Conduct Mining Literature Search
Review available literature involving mining methods and schemes for deposits of similar nature. This activity could involve visiting similar operations to gather data pertaining to mining methods, equipment, personnel, and costs.

10703 Identify Possible Mining Methods
Through literature search, personal knowledge, mine visitations, and discussions with other people, identify technically feasible mining methods applicable to this type of deposit.

10704 Develop Tentative Layout for Each Mining Method
Lay out preliminary mine plan for each technically feasible mining method considered.

10705 Evaluate Alternative Mining Methods
Perform rough capital and operating cost calculations for each technically feasible method selected. Evaluate several production rates. Perform quick discounted cash-flow analysis and rank methods in order of economic preference. Eliminate alternatives with little or no chance of economic success. Determine production rates that will satisfy market conditions and give best economic rate of return.

10706 Perform Mine Preliminary Functional Analysis
Evaluate operational cycles and requirements for labor, equipment, and supply for each mining function and for each alternative selected in Activity 10705 based on mine engineer’s experience. The functions include drilling, blasting, loading, hauling, scaling, bolting, ground control, hoisting, primary crushing (if underground), maintenance, supply/debris handling, pumping, and other support services. Prepare cost and operational cycles for each function.

10707 Develop Mine Capital and Operating Cost Estimates
Estimate capital requirements necessary to bring mine on stream. Estimate operating costs required to produce ore. Estimate costs for two to four mining methods and production rates selected for study. Costs should have accuracy of ±35% to 40% (depending on method of functional analysis and geologic definition). List costs in format for financial analysis.

10708 Document and Review Mine Results
Write report documenting mine study work performed. Review results with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

10801 Develop Mill Work Specifications
Develop scope of work necessary for conducting milling evaluation studies.

10802 Determine Tentative Mill Process Requirements
Use literature search, company personnel experience and discussions with others to determine feasible process methods. Determine processing requirements for each alternative. Activity may require input from bench tests performed during exploration phase or during preliminary study phase.

10803 Prepare Mill Flow Sheet
Prepare flow sheet for each process alternative. Flow sheet should contain sufficient detail to allow selection and sizing of equipment. Perform capital and operating cost calculations for each technically feasible method. Perform quick discounted cash-flow analysis and rank methods in order of economic importance. Eliminate alternatives with little or no chance of economic success.

10804 Perform Preliminary Mill Functional Analysis
Evaluate operational cycles and requirements for labor, equipment, and supply for each milling function and for each alternative selected in Activity 10803 based on the metallurgical engineer’s experience. The functions include stockpiling/reclaiming, crushing, grinding, screening, concentrating, classifying, clarifying, tailings/waste disposal, concentrate handling at the mill site, maintenance, supply/debris handling, and other support services. Prepare cost and operational schedules for each.

10805 Evaluate Custom Milling Alternatives
Investigate opportunities for selling run-of-mine (ROM) material. Determine sales price and charges associated with selling ROM (if a reasonable alternative). Investigate opportunities for tolling ROM material. Determine custom mill capacity, timing, and costs. Costs should include capital and operating expenses for everything associated with tolling. These include transportation of product to custom mill, losses/deducts for processing, tolling charge, sampling methods, transportation of concentrate, and personnel requirements.

10806 Develop Mill Capital and Operating Cost Estimates
Determine capital and operating cost estimates for all milling operation alternatives and different production rates. Costs should have accuracy of ±30%. Put costs in format suitable for financial analysis.

10807 Document and Review Mill Results
Write report documenting mill study work performed. Review results with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

10901 Develop Smelter/Refinery Work Specifications
Determine general requirements for smelting and/or refining mill concentrates. Define and document the scope of work for the custom refining study.

10902 Evaluate Custom Smelter/Refining Alternatives
Do preliminary investigation of opportunities for custom smelting and/or refining project concentrate. Determine custom refining capacity, timing, and costs.
Costs should include capital and operating estimates for everything associated with custom refining. These include transportation of concentrate to refinery, transportation losses (where applicable), smelting/refining charge (consider deducts and/or credits), transportation of refined product, and personnel requirements. Costs should have accuracy of ±25%.

10903 **Document and Review Refinery Results**
Write report documenting refinery work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11001 **Develop Surface Facilities Work Specifications**
Develop scope of work and schedule necessary for study of project surface facilities not connected with mine and mill studies.

11002 **Determine Tentative Surface Building Requirements**
Make preliminary estimate of surface buildings required for project operation. Include buildings that serve support function for mine and mill but not buildings directly related to mining and milling activities. Types of buildings include ambulance garage, administration/office, dry/changehouse, guardhouse, security fence, service shops, and port facilities (if applicable). Include concentrate storage and loading facilities capital and operating costs at shipping docks. These can run into millions of dollars if you have to supply them.

Determine operating and maintenance personnel and equipment requirements (includes shop, office, and dry equipment).

11003 **Determine Tentative Surface Utilities Requirements**
Make preliminary estimate of utilities required for project construction, development, and operation. Study does not include power distribution within facilities included in mining and milling studies. Utilities include electric power (including internal switching and transformers), fuel for buildings and fuel storage for operating equipment, communications (radio, voice/data telephone system, and GPS), potable water, water for dust control, water and system for fire protection, sewage system, and garbage/trash/solid waste removal and disposal area and system.

Determine operating and maintenance personnel and equipment requirements.

11004 **Determine Tentative Surface Transportation Requirements**
Make preliminary estimate of transportation needs for moving equipment, supplies, material, and mine/mill product into and out of project area during project construction, development, and operation. Study should include alternative transportation method such as truck, rail, ship/barge (if feasible), and air haulage (if feasible), combinations of above, and personnel transportation.

Study should determine access road, personnel, and equipment requirements.

11005 **Determine General Surface Facilities Arrangement**
Make preliminary estimate of requirements for
- Internal road for surface facility, plant, and disposal area(s) (does not include haulage roads for open-pit mine but does include equipment for maintaining auxiliary roads);
- Parking areas;
- Construction laydown area(s); and
- Storage area(s).

Prepare preliminary plot plan showing arrangement of all surface facilities, including the listed items, water facilities, mine, mill, and tailings facilities. Determine maintenance material and supply requirements for these areas.

11006 **Determine Surface Mobile and Miscellaneous Equipment Requirements**
Make preliminary estimate of equipment requirements not covered under other activities. This includes equipment for ambulance(s); road and yard area maintenance; supervisor pickups/car(s); maintenance personnel pickups and trucks; loader(s)/backhoe(s); forklift(s); crane(s)/cherry picker(s); portable welder(s), compressor(s), generator(s), and light set(s); small rear-dump truck(s); and crawler tractor(s) with dozer. Determine operating and maintenance personnel and equipment requirements.

11007 **Develop Surface and Ancillary Facilities Capital and Operating Cost**
Determine capital requirements necessary to build surface and ancillary facilities. Determine operating costs associated with surface facilities, including personnel, supplies, office, and safety equipment. List the costs in spreadsheet format suitable for financial analysis.

Costs should have accuracy of ±30%.

11008 **Document and Review Surface Facilities Results**
Write report documenting results of surface facilities studies. Review results with appropriate levels of management and other personnel. Write report in format and style suitable as chapter in preliminary feasibility study report.

11101 **Determine General Personnel Requirements**
Determine approximate administrative and management personnel requirements, and operating, maintenance, support, and supervisory personnel requirements developed in preceding activities. Split requirements into salaried exempt, salaried non-exempt, and hourly classifications. Develop labor buildup schedules for each classification.

11102 **Determine Approximate Administrative Costs**
Determine salaries and wages of personnel identified in Activity 11101. Determine payroll burden associated with salaries and wages. Determine cost, type, and quantity of office equipment and supplies required for all offices, including administration, mine, mill, maintenance, and others. Prepare costs in form suitable for financial analysis. Costs should have accuracy of ±20%. Include costs for relocation and salaried personnel.
11103 Document and Review Organization and Administration Results
Write report documenting administrative costs and personnel requirements. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11201 Assess Miscellaneous Labor-Related Cost Factors
Assess impact and cost of factors affecting labor recruiting, hiring, and retention. Factors include incentive system, labor setting, recruiting, training, retention, performance, and cost. Factors may also include employee housing and company-supplied transportation. List costs in spread format suitable for financial analysis. Costs should have accuracy of ±20%.

11202 Document and Review Labor-Related Results
Write report documenting labor-related studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11301 Conduct Preliminary Market Studies
Perform market studies to determine selling price of salable products and probable product sales potential. Estimate price ranges for life of project (in terms of constant dollar, not inflation). If changes in product sales potential are identified for the future, they should be included as sensitivities. Prepare expected sales of products in format suitable for financial analysis.

11302 Document and Review Marketing Results
Write report documenting marketing studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11401 Develop Tax Overview Specifications
Develop scope of work and schedule necessary for conducting study of taxes applicable to project.

11402 Conduct Tax Overview Study
Make preliminary study of taxes applicable to project and their cost and impact on construction, development, and operation of project. Prepare tax rates in form suitable for financial analysis.

11403 Document and Review Tax Study Results
Write report documenting tax studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11401 Develop Preliminary Financial Analysis Criteria
Develop criteria for performing preliminary financial analysis. Criteria should include overall project schedule (includes intermediate and final evaluation, design, construction, development, and startup); mine and production estimated production; capital and operating costs estimates; royalties; escalation factors (only if this is not a constant dollar analysis); corporate overhead allocation; working capital; property acquisition costs; mill recovery; depreciation methods; depletion allowance; tax rates; weighted contingency for unforeseen factors if not included on every capital cost item; capitalization factor; salvage values; working capital; sensitivity analysis; and project alternative comparisons.

11402 Conduct Financial Analysis
Conduct financial analysis for total project using Apex or other suitable computer program. Print results of economic analysis.

11403 Conduct Financial Sensitivity Studies
Evaluate risk sensitivity of project to key factors such as operating costs, capital costs, reserves, grade, production sales, mill recovery, royalties, taxes, and other items with high degree of uncertainty. Conduct sensitivity analysis using computer program that will perform Monte Carlo simulation, which will assess combined risk sensitivities. Print results of the sensitivity analysis.

11404 Document and Review Financial Results
Write report documenting financial analysis and sensitivities. Review results of work with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in preliminary feasibility study report.

11601 Prepare Intermediate Study Plan and Budget
Update intermediate feasibility study plan and schedule using formalized scheduling techniques. Update budget for intermediate study, including any additional exploration or sampling needed. Schedule and budget should conform to the activities outlined in Activity 10304 and used in financial analysis (11401).

11602 Prepare Preliminary Report
Prepare formal report detailing preliminary study work performed. Prepare report in style and format that is suitable for presentation to management, suitable for use by other project teams, and containing history and results of work performed.

11603 Present Preliminary Report Plan and Budget to Management
Present all data generated during preliminary study, plus plan and budget for intermediate study, to management for review. Present information in meeting(s) with hard copies of reports, schedules, and data. Distribute report at least 1 week prior to meeting to allow personnel time to read and review.

APPENDIX 4.7B
PHASE II: INTERMEDIATE FEASIBILITY STUDY COMPLETE ACTIVITY DEFINITIONS
Activity No. (from WBS) Activity Title and Description

20100 Public Affairs
• As soon as company management approves the intermediate feasibility study plan and budget, notify state government officials that the project will proceed to the next level of examination.
• Brief the media on the decision to proceed to the next level, making sure the media understand that the next level of decision making is many months away and that the final decision of whether or not to build a mine is probably years away.
• Set up in-house means to directly respond to questions from the public by disseminating information as it becomes available and presenting speeches at professional, civic, and labor organization meetings. This may also be done by mineral industry audiovisual presentations tied in with the local settings and issues.
• Conduct meetings to help determine the needs of the area, which will promote sustainable development and lead to a social license to operate.

20201 Get Management Approval of Intermediate Study Plan and Budget
Get approval from appropriate levels of management to proceed with intermediate feasibility study outlined in plan, schedule, and budget submitted to management for review at end of preliminary study.

20202 Review Land and Water Status
Review land and water ownership, control, royalty, and lease situation developed during exploration phase and updated during preliminary study (if any work done). Project team should review land status and water with personnel in company land office and other appropriate individuals with respect to site locations identified during preliminary study. All related water rights should be determined.

20203 Develop Topographic Map Work Specifications
Develop scope of work and schedule necessary for topographic mapping. Prepare request for proposal (RFP) to send to contractors capable of performing the work. RFP should include draft of proposed contract.

20204 Prepare Topographic Maps
Notify contractor to proceed with work required by contract. Obtain prepared maps and other data from contractor.

20205 Negotiate Land and Water Acquisition Requirements
The company land office should start negotiating options on land and water requirements identified in the preliminary study. Requirements should include alternatives, because generally the final mine, plant, tailings sites, and so forth are not yet identified at this stage of project evaluation. This probably means optioning some land not needed for final selected sites.

20206 Update Land and Water Acquisition Requirements
Land and water requirements should be updated as intermediate study progresses and project team learns more about requirements. This may allow land personnel to drop negotiations on certain pieces not needed for project. This updating will not normally select final land sites required for project development, construction, and operation.

20207 Determine Land and Water Acquisition Costs
Land personnel should determine approximate costs of buying and/or leasing land and acquiring water necessary to construct, develop, and operate project. Costs will become part of intermediate study financial analysis, so accuracy should be within ±15% to 20%. Put costs in format suitable for financial analysis.

20208 Document and Review Land and Water Situation
Write progress report documenting results and costs of land and water negotiations to date. Review results of negotiations with appropriate levels of management and other personnel. Prepare risk analysis and mitigations for land and water satisfactory procurement. Write report in style and format suitable as chapter in intermediate study feasibility report.

20301 Develop Predevelopment Drilling Work Specifications
Evaluate exploration report and data. Develop scope of work and schedule necessary to perform predevelopment drilling activities. This activity assumes no exploration drilling was performed during or after the preliminary study and additional drilling is required to bring the reserve accuracy to range to within ±15% to 20%.

20302 Prepare Predevelopment Drilling Permit Applications
Gather data required to prepare applications for permits to do predevelopment drilling field work. Prepare applications.

20303 Procure Predevelopment Drilling Permits
Submit completed applications for permit to appropriate governmental agencies. Wait for agencies to approve applications. Obtain approved permits.

20304 Perform Predevelopment Exploration Drilling and Other Field/Lab Work
Notify contractor(s) to proceed with work required by contract(s). Do other geologic field work as required. What is needed is sufficient drilling and field work to get reserve estimates within ±15%–20% accuracy range. Assay drill-hole samples and/or log drill holes and obtain rock quality designations (RQDs).

20305 Prepare Test Drill Sample Flow Chart and Chain of Custody
Prepare flow chart (listing) of drill cores required for various tests (e.g., metallurgy, rock mechanics, porosity, permeability, density, and moisture). Chart should identify size and amount of cores required, location of procured cores (area of deposit), purpose of cores, place cores sent for testing, types of tests, method of assay, number of duplicate tests, number of blind tests, number of tests on standards, and core storage instructions. Establish a mandatory chain-of-custody protocol with proper check points and sign-offs.

20306 Develop Mineral Inventory Work Specifications
Develop scope of work and schedule necessary to determine deposit mineral inventory. Determine data requirements for computerized and/or hand-calculated mineral inventory system. In addition to mineral and geologic data, RQD must be developed. Inform data gatherers of required data format.

20307 Procure Other Drill Samples
Other core samples are necessary for porosity, permeability, Cerchar abrasivity, density, and moisture
determinations. Other means samples needed for tests other than metallurgy and rock mechanics.

20310 Analyze Other Drill Samples
Send other core samples to appropriate lab or testing facility(ies). Analyze and test core samples for porosity, permeability, density, and moisture. Send test data to project team and other interested parties.

20311 Assemble and Edit Drill-Hole Data
Assemble drill-hole data pertaining to deposit. Edit data for completeness and completeness.

20312 Build Drill-Hole Computer File
Prepare mineral inventory data for entry in computer system. Build drill-hole files in computer. Types of data to include: identification; geologic parameters; RQD values for each interval of the mining horizon and 20 ft above and below; collar coordinates and elevation; assay values and intervals; hole depth, dip, and direction; and hole completed.

20313 Prepare Geologic Maps
Prepare necessary drill-hole maps and cross sections, with computer and/or by hand, to help evaluate the mineral deposit.

20314 Delineate Mineral Zones
Identify and delineate mineralized zones. Delineate by computer from drill-hole files and/or by hand.

20315 Compute Potential Mineral Reserves
Build computer block model and compute mineral reserves with various cutoff grades, mining heights, waste thicknesses, and so forth. Calculate reserves by hand if computer block model is not developed. Prepare a risk analysis and mitigation plan for the mineral reserve tabulated.

20316 Document and Review Mineral Inventory Results
Write report documenting results of Phase I development program. Report should contain data on geology, field work, and reserves. Review results with appropriate levels of management and other personnel. Write reports in style and format suitable as chapter in intermediate feasibility study report.

20401 Develop Environmental Work Specifications
Develop scope of work and schedule necessary for environmental baseline studies, environmental impact analyses, and environmental control plans required for project analysis and costs. Work will serve as database for project permit applications.

20404 Perform Air Quality Baseline Study
Conduct literature search to determine amount and value of air quality and meteorological data available in project area(s). Establish project site monitoring stations to gather air quality, including radiological (if required) and meteorological baseline data. Gather data over required period of time.

20405 Perform Water Quality Baseline Study
Conduct literature search to determine amount and value of surface and groundwater quality data in project area(s). Gather and analyze samples of surface water in the area(s) over required period of time, generally on performing hydrology studies (Activity 20508).
may include requirements for employee housing; medical and dental facilities; schools; community utilities (power, water, sewer, etc.); community services; skills and occupational training other than for the operation; recreational activities; and potential sustained development infrastructure. Estimate capital and operating costs to implement the plans and put costs in format suitable for financial analysis. Cost accuracy should equal ±15%.

20415 Document and Review Environmental/Socioeconomic Study Results
Write report documenting environmental and socioeconomic work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractors should submit report in draft form for project team review before finalizing. Prepare risk analysis and mitigation plan for environmental and socioeconomic concerns.

20501 Develop Siting and Geotechnical Work Specifications
Develop scope of work and schedule necessary for siting, rock mechanics, soils mechanics and foundation, and hydrology studies.

20504 Prepare Hydrology Permit Applications
Prepare necessary permit application(s) to perform hydrology studies of groundwater and surface water quantities and qualities. Permits are needed primarily to drill test wells.

20505 Conduct Siting Studies
Conduct studies to determine suitable locations of all surface facilities for the mine, plant, roads, tailings disposal, and surface facilities. Identify several sites.

20506 Procure Hydrology Permits
Submit permit application(s) to appropriate governmental agency(ies). Wait for permit approval. Get approved permit(s).

20507 Prepare Soils Mechanics Permit Applications
Prepare necessary permit application(s) to conduct soils and foundation investigations. Permit(s) are likely needed for test pits and test borings.

20508 Conduct Hydrology Studies
Conduct studies to collect groundwater quantity and quality data. This usually requires drilling and pump-testing wells to determine amount and quality of water expected during mining and amount and quality of water required for makeup. Conduct studies to determine surface water flow patterns and amounts to expect during possible maximum flood and 100-year-flood periods. Send study data to project team in report form. Contractor should submit report in draft form for review by project team before finalizing.

20509 Procure Rock Mechanics Samples
Procure drill-core samples to use for rock mechanics tests. Drilling is usually performed as part of predevelopment drilling program.

20510 Procure Soils Mechanics Permits
Submit permit application(s) to appropriate governmental agency(ies). Wait for permit approval. Get approved permit(s).

20511 Procure Soils Mechanics Samples
Procure soils samples to use for soils mechanics tests and foundation analyses. Procure samples in areas preferred for plant and surface facilities construction and tailings disposal. Samples usually consist of test borings and test pits.

20512 Conduct Rock Mechanics Tests
Ship rock mechanics samples to testing laboratory. Conduct appropriate tests to determine strength of rock. Analyze test results to determine size of openings and pillars in underground mine or pit slope angles (stability) in open-pit mine. Send test results in report form to project team. If rock appears to be applicable to mechanical excavation methods, send rock samples for Cerchar abrasivity tests. Develop rock mass rating designation and/or Barton’s Q designation. Contractor should submit report in draft form for review by project team before finalizing.

20513 Conduct Soils Mechanics Tests
Ship soils mechanics samples to testing laboratory. Conduct appropriate tests to determine physical and chemical properties affecting building foundations and tailings disposal areas. For open-pit mines, tests are needed to determine slope stability. Conduct appropriate field tests to determine above-soils properties and water flow characteristics. Analyze test results. Field tests could include location of suitable construction materials. Send test results in report form to project team. Contractor should submit report in draft form for review by project team before finalizing.

20514 Establish Siting Preferences
Rank sites selected in Activity 20505 in order of preference. Consider factors such as relationship to existing facilities, capital and operating costs, environment, land position, topography, accessibility, capacity, surface water flow patterns, soils mechanics data, and relationship to mineral deposit. Perform ranking using matrix evaluation procedures.

20515 Document and Review Siting and Geotechnical Results
Write report documenting siting and geotechnical work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractor should submit report in draft form for review by project team before finalizing. Prepare a risk analysis and mitigation plan for the siting, geotechnical, and hydrological information used in the design.

20601 Develop Agency Reconnaissance, Government, NGO, and Public Relations Work Specification
Develop scope of work and schedule necessary for agency reconnaissance, government relations, non-governmental organizations (NGOs), and public relations studies and/or work.
20604 **Conduct Agency and NGO Reconnaissance Literature Search**

Search literature to get overview of permits required by various government agencies, which may affect design, construction, development, and operation of project. Study area projects and identify active NGO groups in the area.

20605 **Identify Involved Government Agencies**

Conduct telephone conversation and personal visits to update data on government agencies having jurisdiction over design, construction, development, and operation of project. Determine all legal and political jurisdictions and all laws, regulations, and legislative codes at the federal, state, and local levels that are applicable to the process of mine/mill planning and operation. The following must also be identified:

- List all political jurisdictions in which the mining operation will exist.
- Obtain copies of all federal and state laws and codes relating to the state and country in which you want to construct a mining operation.
- Obtain a list of all mining permits required and a description of the regulatory processes involved in obtaining the permits.
- For properties within the United States, request determination from the district engineer of the U.S. Army Corps of Engineers (and other federal agencies if federal lands are involved) on its possible involvement and the necessity for a federal environmental impact statement (EIS) under the National Environmental Policy Act.
- If federal EIS is required, determine if state environmental impact report may be used as database or whether operative federal agency will require more, less, or other data than that collected for the state agency.
- Participate in any hearings on any federal statement or actions that occur independent of the state.
- Determine with the state environmental agency which state laws will be applied to the mine development under its jurisdiction. Obtain in writing the rationale for elimination of any potentially applicable laws.
- Inventory other state laws, permits, and permissions applicable to a mine in that state.
- Obtain copies of county zoning codes, sewerage codes, and information on which districts, special assessment districts, or other subjurisdictions of the county may be influenced by the mine.
- Determine each code and jurisdiction that may be encountered and the responsible local administrators. Obtain requirements to be fulfilled under each code.
- Obtain copies of all codes and rules applicable in the township or incorporated area, especially zoning and those related to utilities, waste disposal, and highways.

20606 **Determine Agency Regulations**

Conduct telephone conversations and personal visits to update data on government agency regulations affecting design, construction, development, and operation of project.

20607 **Determine Agency Permit Requirements**

Conduct telephone conversations and personal visits to update data on government agency permit requirements affecting design, construction, development, and operation of project.

20608 **Develop and Implement Government, NGO, and Public Relations Programs**

Develop program(s) to keep government, NGOs, and public informed of nature and status of project. Implement one or more of the programs.

20609 **Document and Review Agency, NGO Reconnaissance Results**

Write report documenting agency and NGO’s reconnaissance work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractor should submit report in draft form for review by project team before finalizing.

20610 **Document and Review Government, NGO, and Public Relations Programs**

Write report documenting government and public relations programs developed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility report. Develop a risk analysis and mitigation plan for the government, NGO, and public relations programs.

20701 **Develop Mine Work Specifications**

Develop scope of work and schedule necessary for conducting mining evaluation studies.

20704 **Update Mining Literature Search**

Review company, contractor, and general available literature published about mining deposits of similar nature. Search should identify and benchmark mine data related to the mining method, unusual characteristics, types of equipment, potential problems, and so forth. Search may include visits to operating properties of similar nature.

20705 **Identify Possible Mining Methods**

Identify mining methods suitable for developing and producing deposits of this nature. Use combination of literature search and experience of company personnel and contractor personnel. List and define the potential methods. Consider range of production from the various methods.

20706 **Develop Tentative Layout for Each Mining Method**

Prepare tentative mine development and production layouts for each possible mining method identified. Prepare layouts with sufficient detail and accuracy to allow comparisons of capital and operating costs.

20707 **Evaluate Alternative Mining Methods**

Evaluate operational characteristics of each possible mining method. Perform comparative capital and operating cost analyses, using present worth techniques. Identify other factors influencing selection of preferred mining method(s) such as environment, safety, hydrology, recoveries, rock mechanics,
potential for mechanical excavation, dilution, and production limitations.

Rank alternatives in order of preference using matrix system and considering all listed factors and others, if applicable. Select two or three best methods for more detailed evaluations.

20708 Refine Mine Layouts and Develop Mine Plans
Prepare mine layouts for chosen alternatives in sufficient detail to allow development of mine plans. Five-year mine plan and life-of-mine plan will be based only on proven and probable reserves for all properties within the United States and Canada or where the ownership stock is listed in those two countries. Mine plans should have an accuracy of ±15% to 20%. Mine plans should include layouts and schedules for head frame, shaft, stations, preproduction development, underground service area development, production, various sizes of underground storage, and the cost benefit of each size and continuing production development.

20709 Perform Mine Functional Analyses
Calculate operational and development cycles, labor requirements, equipment requirements, and supply requirements for each mining function and for each alternative selected in 20707 based on mine industry experience in these mining methods. The functions include drilling, blasting, loading, hauling, scaling, bolting, ground control, mine backfill (if needed) hoisting, primary crushing (if underground), maintenance, supply/debris handling, pumping, and other support services. For each function, develop personnel productivity learning curves and prepare cost and operational schedules for each.

20710 Develop Mine Capital and Operating Cost Estimates
Develop cost estimates for total mining operation and alternatives. Costs should have accuracy of ±15% to 20%. Because costs will become part of intermediate financial analysis, put in format suitable for financial analysis.

20711 Document and Review Mine Results
Write report documenting mine study work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractor should submit report in draft form for review by project team before finalizing. Prepare a risk analysis and mitigation plan on the proposed mining operation. At this point, try to locate and evaluate mining contractors and perform a cost comparison analysis.

20801 Develop Mill Work Specifications
Develop scope of work and schedule necessary for process, milling, waste rock storage, and tailings disposal studies.

20804 Conduct Milling Literature Search
Review company, contractor(s), and general available literature published concerning processing material of similar nature. Search should identify and benchmark some possible processing methods, types of equipment, potential problems, and so forth. Search may include visits to operating properties using processes of similar nature.

20805 Procure Metallurgical Samples
Procure drill-core samples to use for metallurgical testing. Drilling may be performed as part of predevelopment drilling program. Make sure that the samples represent the ore body. Large core samples for autogenous grinding test may be needed.

20806 Conduct Metallurgical Tests
Ship metallurgical samples to testing laboratory. Conduct appropriate tests to determine comminuting characteristics (work index); separation and concentration characteristics of all types of ores; reagent consumption; heads, tails, and concentrate analyses; process flow sheet; environmentally harmful gaseous, liquid, and solid products produced; complete waste characterization of all waste products; long-term leachability of metal ions from tailings; and areas of uncertainty. Send test results to project team in report form. Contractor should submit report in draft form for review by project team before finalizing.

20807 Determine Mill Process Requirements
Evaluate metallurgical testing results. Use test results, literature search, company experience, and contractor experience to select two or three best process variation methods. Determine processing requirements for each alternative.

20808 Prepare Milling Flow Sheet
Prepare flow sheet for each process alternative. Flow sheet should contain sufficient detail to allow selection and sizing of equipment and show material balance.

20809 Perform Mill Functional Analyses
Calculate the operational cycles and labor, equipment, and supply requirements for each milling function and for each process alternative selected in 20807 based on the various sizes of production from the mine and industry experience. The functions include stockpiling/reclaiming (size of storage), crushing, grinding, screening, concentrating including heap leaching (if applicable), classifying, clarifying, tailings disposal, concentrate handling, maintenance, supply/debris handling, and other support services. Prepare cost and operational schedules for each.

20810 Investigate Custom Milling Alternatives
Investigate opportunities for selling run-of-mine (ROM) material. Determine sale price and charges associated with selling ROM. Investigate opportunities for tolling mine-produced material. Determine custom mill capacity, timing, and costs. Costs should include capital and operating estimates for all associated tolling activities such as mill expansion costs to company (if any), transportation of product to custom mill, losses/deducts for processing, tolling charge, sampling methods, transportation of concentrate, and personnel requirements.

20811 Determine General Mill Plant Arrangement
Determine arrangement of mill facilities, including tailings, for each alternative. Prepare design basis and general arrangement drawings.
Develop Mill Capital and Operating Cost Estimate
Develop cost estimates for total milling operation alternatives. Costs should have accuracy of ±15%. Because costs will become part of intermediate financial analysis, put costs in format suitable for financial analysis.

Document and Review Milling Results
Write report documenting milling and metallurgical work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractor should submit report in draft form for project team review before finalizing. Prepare risk analysis and mitigation plan for the metallurgical processing.

Develop Refinery Work Specifications
Develop scope of work and schedule necessary for custom smelting/refining studies.

Investigate Custom Smelting/Refining Alternatives
Investigate opportunities for custom smelting and/or refining project concentrate. Determine custom refining capacity, timing, and costs. Costs should include capital and operating estimates for everything associated with custom refining such as transportation of concentrate to refinery, refining charge (considered as a cost, not a revenue); transportation of refined product, and personnel requirements.

Document and Review Custom Smelting/Refining Results
Write report documenting smelting/refinery work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Contractor should submit report in draft form for project team review before finalizing. Prepare risk analysis and mitigation plan of the smelting/refining process.

Develop Surface Facilities Work Specifications
Develop scope of work and schedule necessary for study of project surface facilities not connected with mine and mill studies.

Determine Surface Building Requirements
Determine surface buildings required for project operation. Include buildings serving support function for mine and mill but not buildings directly related to mining and milling activities. Types of buildings include ambulance garage, fire-fighting facility, administration/office, dry/changehouse, guardhouse, and surface shops. Determine operating and maintenance personnel and equipment requirements (including shop, office, and dry equipment). Prepare design basis and general arrangement drawings. Develop capital and operating cost estimates with ±15% accuracy to include in intermediate financial analysis. Put costs in form suitable for financial analysis.

Determine Surface Utilities Requirements
Determine utilities required for project construction, development, and operation. Study does not include power distribution inside mine and mill battery limits distribution within facilities included in mining and milling studies. Utilities include electric power; fuel for buildings and fuel storage for operating equipment; communications (radio, telephone, and computer networks required); potable water; fire protection; sewage system; and garbage, trash, and solid waste removal and disposal. Determine operating and maintenance personnel and equipment requirements. Develop applicable piping and instrumentation diagram/drawing (P&ID) and line drawings. Develop capital and operating cost estimates with ±15% accuracy to include in intermediate financial analysis. Put costs in form suitable for financial analysis.

Determine Surface Transportation Requirements
Determine transportation needs for moving equipment, supplies, material, and mine/mill product into and out of project area during project construction, development, and operation. Study should evaluate alternative transportation methods such as truck haulage; rail haulage (both off-site and in-plant); ship/barge haulage and port facilities (if needed); air haulage (if feasible); and combinations of these methods. Study should determine access road requirements and costs, capital and operating costs, personnel and equipment requirements, and other costs associated with each feasible transportation system. Develop capital and operating costs with ±15% accuracy to include in intermediate financial analysis and put costs in form suitable for financial analysis.

Determine Surface Mobile and Miscellaneous Equipment Requirements
Determine the surface mobile and miscellaneous equipment requirements not covered under other activities. This includes equipment for emergency medical and safety; road and yard area maintenance; supervisor pickups and car(s); maintenance personnel pickups and trucks; loader(s)/backhoe(s); forklift(s); crane(s); cherry picker(s); portapale welder(s)/compressor(s)/generator(s); small rear-dump truck(s); and crawler tractor(s) with dozer. Determine operating and maintenance personnel and equipment requirements. Develop capital and operating cost estimates with ±15% accuracy to include in intermediate financial analysis. Put costs in form suitable for financial analysis.

Develop Water Management Plan and Costs
Determine requirements for total project water management system. This will require evaluating one or more alternatives for mine, mill, tailings disposal, potable, fire protection and other water usage requirements; mine dewatering and pumping requirements; project water balance (identify all water sources and losses); makeup water requirements and source (if water short); water treatment, disposal, or evaporation system (if excess water); potable water system (include source, treatment, storage, and distribution); fire protection system (include source, treatment, storage, and distribution); and dust control water requirements. Determine operating and maintenance personnel and equipment requirements, including buildings or structures to house facilities. Develop P&ID. Develop capital and operating cost estimates with ±15% accuracy to include in intermediate financial analysis.
financial analysis. Put costs in form suitable for financial analysis.

21009 Determine General Surface Facilities Arrangement
Determine requirements for surface facility, plant, and disposal area(s) internal road (does not include haulage roads for open-pit mine); parking areas; construction lay-down area(s); and storage area(s) (including mine waste).
Prepare plot plans showing alternatives for arrangement of all surface facilities including listed items, water facilities, mine, mill, and tailings facilities. Rank alternatives in preference order using matrix system to evaluate factors such as facility spacing and location, environment, accessibility, utilization, capital cost of each alternative, and operating costs (if different and applicable).
Choose best alternative. Prepare design basis and general arrangement drawings. Show the capital costs of areas selected from the preceding matrix analysis. Determine operating and maintenance equipment and personnel requirements for areas identified in 21007, and maintenance material and supply requirements for areas listed in 21009.

21103 Determine Administrative Costs
Determine salaries and wages of personnel identified in 21101; payroll burden associated with salaries and wages; and cost, type, and quantity of office equipment and supplies required for all offices including administration, mine, mill, maintenance, and others. Prepare costs in form suitable for financial analysis. Costs should have accuracy of ±15%.

21004 Document and Review Organization and Administration Results
Write report documenting administrative costs and personnel requirements. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report.

21201 Develop Labor Plan
Develop plan, with alternatives, for attracting and keeping productive, qualified personnel. Items to investigate include recruiting, training, absentee and turnover projections, commuting/fly in–fly out work force, community development, salaries/wages, fringe benefits/payroll burden, incentive system, and union/nonunion considerations.

21202 Prepare Labor-Related Cost Estimates
Identify personnel and equipment requirements for plans developed. Prepare capital and operating cost estimates associated with plans developed. Costs should have accuracy of ±15%. Put costs in format suitable for financial analysis.

21203 Document and Review Labor-Related Results
Write report documenting labor-related studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Prepare a risk analysis and mitigation plan for all administrative and labor-related issues.

21301 Conduct Intermediate Market Studies
Update market studies to determine product requirements, supply and demand forecast, selling price and marketing strategy of salable products, and position relative to competitors. Review metallurgical results of most recent testing against product sales specifications. Estimate price ranges for life of project. Prepare prices in format suitable for financial analysis.

21302 Document and Review Market Study Results
Write report documenting marketing studies listed in 21301. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Prepare a risk analysis and mitigation plan for all aspects of marketing the product.

21401 Develop Intermediate Financial Analysis Criteria
Develop criteria for performing intermediate financial analysis. Criteria include overall project schedule (includes final evaluation, design, construction, development, and start-up), capital and operating costs, royalties; escalation factors (though the analysis will probably be done in constant dollars), tax rates, working capital, property acquisition costs, mine and mill.
recovery, revenues, depreciation methods and depletion allowance, allowance for unforeseen factors, capitalization factors, salvage values, corporate overhead allocation, sensitivity and risk analysis (see 21403), and project alternative comparisons.

21402 Conduct Financial Analysis
Conduct analysis for total project using a suitable computer program. Print results of economic analysis.

21403 Conduct Financial Sensitivity Studies
Evaluate sensitivity/risk of various key factors. Also, quantify the degree of risk and perform Monte Carlo risk analysis on the collective factors: operating costs, capital costs, reserves, grade, mill recovery, royalties, taxes, and other items with high degree of uncertainty. Print results of sensitivity/risk analysis.

21404 Document and Review Financial Results
Write report documenting financial analysis and sensitivities. Review results of work with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Prepare a risk analysis and mitigation plan for the techniques used in the financial analysis.

21501 Develop Tax Study Specifications
Develop scope of work and schedule necessary for conducting study of taxes applicable to project.

21502 Conduct Intermediate Tax Studies
Update tax studies to determine taxes applicable to project. Analyze taxes to understand how they affect construction, development, and operation of project. Prepare tax rates in format suitable for financial analysis.

21503 Document and Review Tax Studies
Write report documenting tax studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in intermediate feasibility study report. Prepare a risk analysis and mitigation plan related to the taxing of future property and production.

21601 Prepare Final Study Plan and Budget
Update final feasibility study plan and schedule using formalized scheduling techniques. Update budget for final feasibility study. Schedule and budget should conform to those used in financial analysis (Activity 21401).

21602 Prepare Intermediate Report
Prepare formal report detailing intermediate study work performed. Prepare report in style and format that
• Is suitable for presentation to management,
• Is suitable for use by other project teams,
• Contains history and results of work performed, and
• Has a composite table of all the risk factors analyzed in the report.

21603 Present Intermediate Report, Plan, and Budget to Management
Present all data generated during intermediate study, plus plan and budget for final study, to management for review. Present information in meeting(s) with hard copies of reports, schedules, and data. Distribute report at least 1 week prior to meeting to allow personnel time to read and review.

APPENDIX 4.7C ADDITIONAL TESTING ACTIVITIES (SUCH AS A TEST MINE OF BULK SAMPLE)

Activity No. (from WBS) Activity Title and Description

30301 Perform Final Exploration Drilling and Other Field Work
Continue work outlined under predevelopment drilling contracts (Activity 20306). Do other geologic field work as required. Final exploration means sufficient drilling and field work to get reserve estimates within ±10% accuracy range. Assay drill-hole samples and/or log drill holes.

30302 Assemble and Edit Drill-Hole Data
Assemble drill-hole data pertaining to deposit. Edit data for correctness and completeness. Types of data included: identification; geologic parameters; collar coordinates; assay values and intervals; hole depth, dip, and direction; and date hole completed.

30303 Update Drill-Hole Computer File
Prepare mineral inventory data for entry in computer system. Add to existing data to update drill-hole files in computer.

30310 Prepare Geologic Maps
Prepare necessary drill-hole maps and cross sections to help evaluate the mineral deposit. Prepare maps with computer and/or by hand.

30311 Delineate Mineral Zones
Identify and delineate mineralized zones by computer from drill-hole files and/or by hand.

30312 Compute Potential Mineral Reserves
Build computer block model and compute mineral reserves with various cutoff grades, mining heights, waste thicknesses, and so forth. Calculate reserves by hand if block model not developed.

30313 Document and Review Mineral Inventory Results
Write report documenting results of predevelopment program. Report should contain data on geology, field work, and reserves. Review results with appropriate levels of management and other personnel. Write study in style and format suitable as chapter in final feasibility study report.

30710 Develop Test Mine Work Specifications
Develop scope of work and schedule necessary for designing, constructing, developing, and operating test mine (assuming that test mine is needed). Prepare request for proposal (RFP) to send to contractors capable of performing the work. RFP should contain draft of proposed contract.

30711 Determine Test Mine Permit Requirements
Identify permits required to design, construct, develop, and operate test mine. Refer to work performed under Activity 20607. Recheck with government agencies for new or different requirements.
30712 **Plan Bulk Sampling Program**
Calculate amount of bulk sample required for pilot-plant testing. Evaluate geologic and reserve data to choose test mine bulk sampling areas representative of deposit. Interface bulk sampling plan with test mining plan, Activity 30713. Modify bulk sampling plan and areas based on realistic mining plan, time schedule, and budget. Select pilot plant to run bulk sample(s). Plan metallurgical tests required. Determine requirements for sample(s) handling and transportation and sampled material disposal.

30713 **Plan Test Mine Program**
Develop a mine plan to select layout and development necessary for the following: metallurgical bulk sampling program (underground [UG] and open pit [OP]); predevelopment drilling program (UG); test mining program; rock mechanics tests (UG and OP); pillar, drift, and stope size evaluations (UG); drilling and blasting or mechanical excavation tests (UG and OP); ground support tests (UG); slope-stability tests (OP); and materials handling tests (UG and OP). Design required test mine surface facilities, access system and development (surface mine stripping or underground mine station[s], and level[s]) needs. Develop schedule and budget for test mine activities. Prepare construction contractor bid package.

30714 **Prepare Test Mine Permit Applications**
Prepare permit application(s) necessary to perform test mining program.

30715 **Procure Test Mine Permits**
Submit permit application(s) to appropriate government agency(ies). Wait for permit approval(s). Obtain approved permit(s).

30716 **Management Approval of Test Mine**
Get approval from appropriate levels of management to proceed with test mining as outlined in budget and schedule developed under Activity 30713.

30717 **Locate, Evaluate, and Select Test Mine Contractor**
Identify contractors capable of performing the work. Send each contractor copy of bid package developed in 30713. Evaluate bids received, contractor’s financial status (Dun & Bradstreet report if required) and other pertinent data. Select preferred contractor, preferably using matrix evaluation if low bid is not only selection criterion. Inform contractor(s) of its selection. Give notice to proceed. Revise, if necessary, scope of work and contract to reflect information contained in bids.

30718 **Prepare Test Mine Contract**
Write contract, with assistance from law office and controllers. Get necessary company approvals. Send contract to contractor for signature. Get approved contract from contractor and review for signature correctness. Some delay can occur if contractor wants to negotiate terms before approving.

30719 **Mobilize Test Mine Contractor**
Require time for contractor to arrive on-site and set up once notified to proceed.

30720 **Construct Test Mine Surface Facilities**
Build or erect surface facilities necessary for construction, development, and operation of test mine, including hoisting facilities, shaft collar, and headframe for an underground test mine.

30721 **Perform Test Mine Access and Level Development**
For underground test mine, sink shaft (or other method of access), excavate, and construct station(s) and perform necessary level development. For open-pit test mine, strip necessary overburden and waste material.

30722 **Perform Test Mining**
Conduct mining tests as outlined under Activity 30713.

30723 **Procure Test Mine Bulk Samples**
Procure test mine bulk sample(s) as planned under Activity 30712 in intermediate study. (In many cases, this activity and 30724 occur between the intermediate and final feasibility study.)

30724 **Perform Test Mine Predevelopment Work**
Perform test mine drilling and other geologic work as outlined under Activity 30713.

30725 **Update Potential Mineral Reserves**
Update mineral reserve calculations using drilling, assay, and geologic data gathered during test mining (Activity 30724).

30726 **Update Engineering Data**
Update all previously acquired engineering data with the data gathered during test mine operation.

**APPENDIX 4.7D**
**PHASE III: FINAL FEASIBILITY STUDY COMPLETE**
**ACTIVITY DEFINITIONS**

<table>
<thead>
<tr>
<th>Activity No.</th>
<th>Activity Title and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30100</td>
<td><strong>Public Affairs</strong></td>
</tr>
<tr>
<td></td>
<td>As soon as the company management approves the final feasibility study plan and budget, notify state government officials that the project will proceed to the next level of examination. Brief the media on the decision to proceed to the final feasibility study, making sure to emphasize that the final decision of whether or not to build a mine is probably many months or even years away. Continue the dissemination of information as it becomes available and continue presenting speeches at local and state meetings. Set up local town meeting where stakeholders can question firsthand what will take place if a mine is built. Address their remaining concerns and the company’s plans to mitigate their concerns.</td>
</tr>
<tr>
<td>30101</td>
<td><strong>Management Approval of Final Study Plan and Budget</strong></td>
</tr>
<tr>
<td></td>
<td>Get approval from appropriate levels of management to proceed with final feasibility study outlined in plan, schedule, and budget submitted to management for review at end of intermediate study (Activity 21603).</td>
</tr>
<tr>
<td>30201</td>
<td><strong>Review Land Status</strong></td>
</tr>
<tr>
<td></td>
<td>Review land ownership, control, royalty, and lease situation updated during intermediate study. Project</td>
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</tbody>
</table>
team should review land status with personnel in company’s land office, and other appropriate individuals with respect to site locations identified during intermediate study.

30202 **Finalize Land Acquisitions and Costs**
Land personnel should determine final costs of buying and/or leasing land necessary to construct, develop, and operate project. Commitments for land are probably required at this time. Costs will become part of final study financial analysis so accuracy should be within ±10%. Put costs in format suitable for financial analysis.

30203 **Document and Review Land Situation**
Write report documenting results and costs of land negotiations. Review results of negotiations with appropriate levels of management and personnel. Complete all land maps. Write report in style and format suitable as chapter in final feasibility study report.

30304 **Develop Core Drilling Work Specifications**
Develop scope of work and schedule necessary for core drilling program to obtain samples for the following tests: metallurgical (may not need if test mine program planned), rock mechanics (may not need if test mine program planned), Cerchar abrasivity, density, porosity, permeability, and miscellaneous. This program may be accomplished with regular predevelopment drilling program or as separate program.

30307 **Prepare Test Core Sample Flow Chart**
Prepare flow chart (listing) of drill cores required for various tests (e.g., metallurgy, rock mechanics, porosity, permeability, density, moisture). Chart should identify size and amount of cores required, from where cores procured (area of deposit), purpose of cores, where cores are sent for testing, types of test, and core storage instructions.

30308 **Conduct Core Drilling Program**
Perform the field core drilling program as planned and scheduled under Activity 30307.

30309 **Analyze Other Core Samples**
Send other core samples to appropriate lab or testing facility(ies). Analyze and test core samples for porosity, permeability, density, and moisture. Send test data to project team and other interested parties.

30401 **Develop Environmental Work Specifications**
Develop scope of work and schedule necessary for environmental impact analyses and environmental control plans required for project analysis and costs. Work will serve as base data for final feasibility costs and probable update data for permit applications. Prepare request for proposal (RFP) to send to contractors capable of performing the work. RFP should include draft of proposed contract.

30404 **Assess Environmental Impacts**
Reassess impact to baseline environment caused by construction, development, and operation of mine, plant, tailings disposal, and surface facilities. This should include input from the final feasibility study of mine, mill, tailings, and surface facilities.

30405 **Finalize Air Quality Plan and Costs**
Finalize chosen plan to maintain air quality in and around project area. Update effects caused by construction, development, and operation of mine, plant, tailings disposal, and surface facilities. Complete design basis drawings. Estimate capital and operating costs to implement the plans. Put costs in format suitable for financial analysis. Cost accuracy should equal +10%.

30406 **Finalize Water Quality Plan and Costs**
Finalize chosen plan to maintain surface water quality in and around project area. Update effects caused by construction, development, and operation of mine, plant, tailings disposal, and surface facilities. Estimate capital and operating costs to implement the plans. Complete design drawings. Put costs in format suitable for financial analysis. Cost accuracy should equal +10%.

30407 **Finalize Ecological Plan and Costs**
Finalize chosen plan to mitigate ecological disturbances caused by effects of construction, development, and operation of mine, plant, tailings disposal, and surface facilities. Estimate capital and operating costs to implement the plans. Put costs in format suitable for financial analysis. Cost accuracy should equal +10%.

30408 **Finalize Reclamation Plan and Costs**
Finalize chosen plan to reclaim land disturbed by effects of construction, development, and operation of mine, plant, tailings disposal, and surface facilities. Estimate capital and operating costs to implement the plans. Complete design basis drawings. Put costs in format suitable for financial analysis. Cost accuracy should equal +10%.

30409 **Finalize Socioeconomic Plan and Costs**
Finalize chosen plan to estimate requirements for community development. Plan should include requirements for the following: employee housing, medical and dental facilities, schools, community utilities, community services, and recreational activities. Estimate capital and operating costs to implement the plans. Put costs in format suitable for financial analysis. Cost accuracy should equal +10%.

30410 **Document and Review Environmental Study Results**
Write report documenting environmental work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report. Contractors should submit report in draft form for project team review before finalizing.

30501 **Develop Siting and Geotechnical Work Specifications**
Develop scope of work and schedule necessary to finalize siting, rock mechanics, soils mechanics and foundation, and hydrology studies. Prepare RFP to send to contractors capable of performing the work. RFP should contain draft of proposed contract.

30504 **Prepare Hydrology Permit Applications**
Prepare necessary permit applications to perform hydrology studies of groundwater and surface water
quantities and qualities. Permits are needed primarily to drill test wells.

30505 **Procure Hydrology Permits**
Submit permit application(s) to appropriate governmental agency(ies). Wait for permit approval. Get approved permit(s).

30506 **Conduct Hydrology Studies**
Conduct studies to finalize groundwater quantity and quality data. This usually requires drilling and pump testing wells to determine amount and quality of water expected during mining and amount and quality of water required for makeup. Conduct studies to determine surface water flow patterns and amounts to expect during possible maximum flood and 100-year-flood periods. Send study data to project team in report form. Contractor should submit report in draft form for review by project team before finalizing.

30507 **Prepare Soils Mechanics Permit Applications**
Prepare necessary permit application(s) to finalize soils and foundations investigations. Permit(s) probably necessary to dig test pits and do test borings.

30508 **Procure Soils Mechanics Permits**
Submit permit application(s) to appropriate governmental agency(ies). Wait for permit approval. Get approved permit(s).

30509 **Procure Soils Mechanics Samples**
Procure soils samples to finalize soils mechanics tests and foundation analyses. Procure samples in areas preferred for plant and surface facilities construction and tailings disposal. Samples usually consist of test borings and test pits. Samples will serve as basis for buildings, dams, shafts, and other foundation design specifications.

30510 **Conduct Soils Mechanics Tests**
Ship soils mechanics samples to testing laboratory. Conduct appropriate tests to finalize physical and chemical properties affecting building foundations, tailings disposal areas, and shaft collars. For open-pit mines, tests are needed to determine slope stability. Conduct appropriate field tests to determine above-soils properties and water flow characteristics. Analyze test results. Field tests could include location of suitable construction materials. Send test results in report form to project team. Contractor should submit report in draft form for review by project team before finalizing.

30511 **Procure Rock Mechanics Samples**
Procure drill-core samples to finalize rock mechanics properties. Drilling is part of core drilling program (Activity 30310).

30512 **Conduct Rock Mechanics Tests**
Ship rock mechanics samples to testing laboratory. Conduct appropriate tests to finalize strength of rock. Analyze test results to finalize size of openings and pillars in underground mine or pit slope angles (stability) in open-pit mine. If applicable, test for the application of mechanical excavation. Send test results in report form to project team. Contractor should submit report in draft form for review by project team before finalizing.

30513 **Finalize Siting Preferences**
Determine the final location of all surface facilities. This includes shaft and other mine facilities, mill and processing facilities, tailings facilities and pipelines, and surface ancillary facilities such as roads, buildings, power lines, gas lines, storage areas, waste disposal areas, parking areas, and construction lay-down areas. If an open-pit mine, this would include location of pit. Locate all sites within a few feet of their planned constructed location. Complete design basis drawings. Final facilities location selection should include factors such as the following: facility spacing and location, environment, accessibility, utilization, capital cost, and operating costs (if different and applicable).

30514 **Document and Review Siting and Geotechnical Results**
Write report documenting siting and geotechnical work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report. Contractor should submit report in draft form for review by project team before finalizing.

30601 **Develop Permit Application Work Specifications**
Develop scope of work and schedule necessary for preparation of permit applications. Prepare RFP to send to contractors capable of preparing permit applications. RFP should contain draft of proposed contract.

30604 **Prepare Permit Applications**
Procure necessary forms and formats for all permits required to construct and operate project. Complete all permit applications as required by local, state, and federal agencies. Submit applications to appropriate governmental agencies.

30605 **Procure Construction and Operating Permits**
Wait for various governmental agencies to approve permit applications. Get approved applications from agencies. This task could require some application rewriting or amending if one or more agencies need data not presented in original application.

30606 **Expand Government and Public Relations Programs**
Expand and update program(s) to keep government and public informed of nature and status of project.

30607 **Document and Review Government and Public Relations Programs**
Write report documenting status of government and public relations programs. Review results of programs with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility report.

30701 **Develop Mine Work Specifications**
Develop scope of work and schedule necessary for conducting final mine evaluation study. Prepare RFP to send to contractors capable of performing the work. RFP should contain draft of proposed contract.
30704 Develop Final Mine Layout
Prepare final mine development and production layouts. Prepare layouts with sufficient detail and accuracy to develop mine plans and allow estimating capital and operating costs, and development and operating schedules to accuracies of ±10% to 15%.

30705 Develop Final Mine Plan
Mine plans should include layouts and schedules for headframe, shaft, stations, preproduction development, underground service area development, production, and continuing production development. Complete design basis drawings. Develop life-of-mine production plans as well as detailed 5-year mine production plans. Mine plans should have an accuracy of +15%.

30706 Perform Mine Functional Analyses
Calculate operational cycles, and labor, equipment, and supply requirements for each mining function. Refine the functions analysis made earlier to include drilling, blasting, loading, hauling, scaling, bolting, ground control, mine backfill (if needed), hoisting, primary crushing (if underground), maintenance, supply/debris handling, pumping, and other support services. For each function, develop personnel productivity learning curves and prepare cost and operational schedules for each.
Use personnel productivity learning curves developed in intermediate feasibility study for each function. Prepare cost and operational schedules for each.

30707 Develop Mine Capital and Operating Cost Estimates
Develop cost estimates for total mining operation. Costs should have accuracy of ±10% to 15% and will become part of final financial analysis. Put costs in format suitable for financial analysis.

30708 Develop Mine Design Specifications
Develop design specifications for competitive bidding of mine design, construction, and development work. Prepare bid packages. Design specifications for an underground mine should include systems for mine access, materials and personnel handling, ventilation, communications, electrical, mine dewatering, and fuel storage and handling; maintenance and warehousing facilities; explosives handling and storage facilities; crushing facilities; and sewage system.
Design specifications for an open-pit mine normally include communications system(s); sewage system; electrical system; mine dewatering system; fuel storage and handling system; oil, lubrication, and anti-freeze system; and explosives handling and storage facilities.

30709 Document and Review Mine Results
Write report documenting mine study work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report. Contractor should submit report in draft form for review by project team before finalizing.

30721 Perform Test Mine Access and Level Development (if not yet completed)
For underground test mine, sink shaft (or other method of access), excavate and construct station(s), and perform necessary level development. For open-pit test mine, strip necessary overburden and waste material.

30722 Perform Test Mining (if not yet completed)
Conduct mining tests as outlined under Activity 30713 in intermediate study.

30723 Procure Test Mine Bulk Samples (if not yet completed)
Procure sample(s) as planned under Activity 30712 in intermediate study. (In many cases, this activity and 30724 occur between the intermediate and final feasibility study, in which case these activities would be omitted here.)

30724 Perform Test Mine Predevelopment Work (if not yet completed)
Perform test mine drilling and other geologic work as outlined under Activity 30713 in intermediate study.

30725 Update Potential Mineral Reserves (if not yet completed)
Update mineral reserve calculations using drilling, assay, and geologic data gathered during test mining (Activity 30724).

30726 Document and Review Test Mine Results (if not yet completed)
Write report documenting test mine work performed. Review results of test mining with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

30801 Develop Mill Work Specifications
Develop scope of work and schedule necessary for final process, milling, and tailings disposal studies. Prepare RFP to send to contractors capable of performing the work. RFP should contain draft of proposed contract.

30804 Procure Metallurgical Samples
Procure drill-core samples to use for metallurgical testing. Drilling is usually performed as part of predevelopment drilling program. This activity may be unnecessary if bulk sample is obtained from test mine.

30805 Conduct Metallurgical Testing
Ship metallurgical samples to testing laboratory or pilot mill, if bulk sample for test mine is used. Conduct appropriate tests to determine final metallurgical data and design specifications for comminuting characteristics; separation and concentration characteristics of reagent consumption; heads, tails, and concentrate analyses; process flow sheet; environmentally harmful gaseous, liquid, and solid products produced; and areas of uncertainty.
Send test results to project team in report form. Contractor should submit report in draft form for review by project team before finalizing.
30806 Finalize Mill Process Requirements
Evaluate metallurgical testing results. Use test results, literature search, company experience, and contractor experience to determine the best process method. This method, and other technical data gathered, will serve as basis for mill design.

30807 Prepare Milling Flow Sheet
Prepare flow sheet for chosen process. Flow sheet should contain sufficient detail to allow selection and sizing of equipment.

30808 Perform Mill Functional Analyses
Calculate the operational cycles, and labor, equipment, and supply requirements for each milling function and the process method used in Activity 30807. The functions include the following: stockpiling/reclaiming (size of storage), crushing, grinding, screening, concentrating including heap leaching (if applicable), classifying, clarifying, tailings disposal, concentrate handling, maintenance, supply/debris handling, and other support services. Prepare cost and operational schedules for each.

30809 Develop Mill Design Specifications
Develop specifications for competitive bidding of mill and tailings facilities design and construction. Prepare bid packages. Complete design basis drawings and basic engineering drawings.

30812 Develop Mill Capital and Operating Cost Estimates
Develop estimates for total milling operation. Costs should have accuracy of +10%. Costs will become part of final financial analysis. Put costs in format suitable for financial analysis.

30813 Document and Review Milling Results
Write report documenting milling and metallurgical work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report. Contractor should submit report in draft form for project team review before finalizing.

30901 Develop Refinery Work Specifications
Develop scope of work and schedule necessary for finalizing custom refining plans.

30902 Finalize Custom Refining Contract
Start finalizing contract terms with custom refinery(ies) suitable for processing mill concentrates. Finalize with custom refinery(ies) quantities of material for processing, timing, and costs. Costs need to include capital (if required) and operating estimates for everything associated with tolling such as transportation of concentrate to refinery, refining charge (consider deducts and/or credits), transportation of refined product, and personnel requirements. Costs should have accuracy of +10%.

30903 Document and Review Refining Results
Write report documenting refinery work performed. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31001 Develop Surface Facility Work Specifications
Develop scope of work and schedule necessary for final study of project surface facilities not connected with mine and mill studies. Prepare RFP to send to contractors capable of performing the work. RFP should contain draft of proposed contract.

31004 Finalize Surface Building Requirements
Finalize surface buildings required for project operation. These include those serving support function for mine and mill but not buildings directly related to mining and milling activities. Types of buildings include ambulance garage, administration/office, dry/changehouse, guardhouse, and surface shops. Finalize operating and maintenance personnel and equipment requirements (including shop equipment, office, and dry equipment). Complete design basis drawings. Develop capital and operating cost estimates with +10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31005 Finalize Surface Utilities Requirements
Finalize utilities required for project construction, development, and operation. Study does not include power distribution inside mine and mill battery limits (distribution within facilities included in mining and milling studies). Utilities should include electric power; fuel for buildings and fuel storage for operating equipment; communications (radio and telephone); potable water; fire protection, sewage system, and garbage/trash/solid waste removal and disposal. Finalize operating and maintenance personnel and equipment requirements. Complete design basis drawings. Develop capital and operating cost estimates with +10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31006 Finalize Surface Transportation Requirements
Finalize transportation method chosen in intermediate study for moving equipment, supplies, material, and mine/mill product into and out of project area during project construction, development, and operation. Methods evaluated include haulage by truck, rail, ship/barge (if feasible), and air (if feasible), or combinations of these.

Finalize access road requirements and costs, capital and operating costs, personnel and equipment requirements, and other costs associated with transportation system. Develop capital and operating costs with +10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31007 Finalize Surface Mobile and Miscellaneous Equipment Requirements
Finalize requirements not covered under other activities. This includes equipment for medical emergencies, road and yard area maintenance, supervisor pickups/car(s), maintenance personnel pickups and trucks, loader(s)/backhoe(s), forklift(s), crane(s)/cherry picker(s), portable welder(s)/compressor(s)/generator(s), small rear-dump truck(s), and crawler tractor(s) with dozer. Finalize operating and maintenance personnel and equipment requirements. Develop capital and operating cost estimates with
+10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31008 Finalize Water Management Plan and Costs
Finalize requirements for total project water management system. This includes the following: mine, mill, tailings disposal, potable, fire protection and other water usage requirements; mine de-watering and pumping requirements; project water balance (identify all water sources and losses); makeup water requirements and source (if water short); water treatment, disposal, or evaporation system (if excess water); potable water system (include source, treatment, storage, and distribution); fire protection system (include source, treatment, storage, and distribution). Finalize operating and maintenance personnel and equipment requirements, including buildings or structures to house the water-related facilities. Complete design basis drawings. Develop capital and operating cost estimates with +10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31009 Finalize General Surface Facilities Arrangement
Finalize requirements for surface facility, plant, and disposal area(s); internal road (does not include haulage roads for open-pit mine); parking areas; construction lay-down area(s); and storage area(s).

Prepare plot plans showing final arrangement of all surface facilities, including items in list, water facilities, mine, mill, and tailings facilities. Finalize capital costs of these surface facilities. Determine operating and maintenance equipment and personnel requirements under preceding surface activities (31004 to 31009). Finalize maintenance material and supply requirements for areas identified in list. Complete design basis drawings.

31010 Finalize Warehouse Requirements
Finalize size of warehouse and storage yard facilities; amount of warehouse inventory; equipment (mobile and stationary) necessary to store warehoused items, load and unload supplies, and move supplies within confines of project area; and operating personnel requirements. Complete design basis drawings. Finalize capital and operating costs with +10% accuracy to include in final financial analysis. Put costs in form suitable for financial analysis.

31011 Develop Surface Building Design Specifications
Develop design specifications for competitive bidding of design and construction. Buildings are identified under Activity 31004. Prepare bid package(s).

31012 Develop Surface Utility Design Specifications
Develop design specifications for competitive bidding of design and construction. Utilities are identified under Activity 31005. Prepare bid package(s).

31013 Develop Surface Transportation Design Specifications
Develop design specifications for competitive bidding of design and construction. Facilities are identified under Activity 31006. Prepare bid package(s).

31014 Develop Water Facilities Design Specifications
Develop specifications for competitive bidding of design and construction. Facilities are identified under Activity 31008. Prepare bid package(s).

31015 Develop Surface Facilities Capital and Operating Cost Estimates
Assemble capital and operating cost estimates for surface facilities. Costs should have accuracy of +10%. As costs will become part of final financial analysis, put costs in format suitable for financial analysis.

31016 Document and Review Surface Facilities Results
Write report documenting surface facilities studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report. Contractor should submit report in draft form for review by project team before finalizing.

31017 Develop Environmental Monitoring Plan (EMP) for Proposed Operation
Now that all of the mine/plant facilities are defined, complete design basis drawings, specify the labor disciplines, the types and requirements of the monitoring program, the inspections to be required, and the method whereby corrective action and compliance will be achieved.

31018 Define Cost of EMP
All professional and staff personnel cost and their equipment must be included. Also include allowances for outside testing on a scheduled basis.

31019 Amend All Permit Applications to Include Aspects of EMP That Pertain to Various Permits
Return to the various permit applications and insert those actions and plans that the operating company will take to monitor and control all aspects of the operation to remain in compliance with various regulators’ requirements.

31020 Define General Personnel Requirements
Finalize administrative and management personnel requirements; and operating, maintenance, support, and supervisory personnel requirements developed in preceding activities. Split requirements into salaried exempt, salaried nonexempt, and hourly classifications. Finalize labor buildup schedules for each classification.

31021 Update Organization Charts
Finalize organization charts showing the project organization. Charts should show lines of authority and responsibility.

31022 Define Administrative Costs
Finalize salaries and wages of personnel identified in 31101; payroll burden associated with salaries and wages; and cost, type, and quantity of office equipment and supplies required for all offices including administration, mine, mill, and maintenance. Prepare costs in form suitable for financial analysis. Costs should have accuracy of +10%.
31104 Document and Review Organization and Administration Results
Write report documenting administrative costs and personnel requirements. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31201 Refine Labor Plan
Finalize plan for attracting and keeping productive, qualified personnel. Plan should include items such as recruiting, training, absentee and turnover projections, commuting (including fly-in–fly-out), community development, salaries/wages, fringe benefits/payroll burden, incentive system, and union/nonunion considerations.

31202 Refine Labor-Related Cost Estimates
Finalize personnel and equipment requirements and capital and operating cost estimates for the plan developed. Costs should have accuracy of ±10% and be in format suitable for financial analysis.

31203 Document and Review Labor-Related Results
Write report documenting labor-related studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31301 Conduct Final Market Study
Update market studies to determine selling price of salable products. Check product specifications of final metallurgical test with required product specifications. Estimate price ranges for life of project and prepare prices in format suitable for financial analysis.

31302 Document and Review Market Study Results
Write report documenting marketing studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31401 Develop Financial Analysis Criteria
Develop criteria for performing final financial analysis. Criteria should include overall project schedule (design, construction, development, and startup), ore production and final production schedule, capital and operating costs, royalties, escalation factors, tax rates, working capital, property acquisition costs, mill recovery, depreciation methods, depletion allowance, allowance for unforeseen, capitalization factors, sensitivity and risk analysis (see 31403), salvage values, and corporate overhead allocation.

31402 Conduct Financial Analysis
Conduct financial analysis for total project using a suitable computer program. Print results of economic analysis.

31403 Conduct Financial Sensitivity Studies
Evaluate sensitivity/risk of various project key factors. Also, quantify the degree of risk and perform Monte Carlo risk analysis on the collective factors, including operating costs, capital costs, reserves, grade, mill recovery, royalties, taxes, and other items with high degree of uncertainty. Conduct sensitivity analysis using a suitable computer program. Print results of sensitivity analysis.

31404 Document and Review Financial Results
Write report documenting financial analysis and sensitivities. Review results of work with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31501 Develop Tax Study Work Specifications
Develop scope of work and schedule necessary for finalizing study of taxes applicable to project.

31502 Conduct Final Tax Study
Update tax studies to finalize taxes applicable to project. Analyze taxes to understand how they affect construction, development, and operation of project. Prepare tax rates in format suitable for financial analysis.

31503 Document and Review Tax Studies
Write report documenting tax studies. Review results of studies with appropriate levels of management and other personnel. Write report in style and format suitable as chapter in final feasibility study report.

31601 Prepare Design, Construction, and Development Schedule and Budget
Update and expand plan and schedule using formalized scheduling techniques. Update budget for project design, construction, and development. Schedule and budget should conform to those used for final study financial analysis (Activity 31401).

31602 Prepare Final Study Report
Prepare the design basis memorandum documenting all of the technical parameters in a single document. Prepare formal report detailing final study work performed. Prepare report in style and format that is
• Suitable for presentation to management,
• Suitable for use by other project teams, and
• Containing history and results of work performed.

31603 Present Report, Plan, and Budget to Management
Present all data generated during final study, plus plan and budget for design, construction, and development phase to management for review. Present information in meeting(s) with hard copies of reports, schedules, and data. Distribute report at least 1 week prior to meeting to allow personnel to read and review.

APPENDIX 4.7E
OUTLINE OF DESIGN BASIS REPORT SECTIONS

VOLUME 1: MANAGEMENT SUMMARY
INTRODUCTION AND SUMMARY
Technical feasibility
• Ore deposit
• Facilities
• Viability
Economic feasibility
• Investment and capital cost
• Economic analysis
• Sensitivities
Operating cost
Sales price and operating profit
Construction and life of mine schedule

Product market analysis
Competitive situation
Market development activities
Execution plan
Project execution responsibility

Division of project execution (if applicable)
Line of reporting
Planned method of contracting
Construction plan
Construction labor buildup

Business plan
Objectives
Demand for finished or refined product

Product market analysis
Competitive situation
Market development activities

Market strategy
Outstanding issues
Country mining law and code
Potential project partner (if being considered)
Land purchase from the local government

Purchase of private land and rights-of-way
Interface with country agencies
Reestablishment of contractual basis
Project mobilization
Construction and operating permits
Power supply agreements
Concentrate transport rail agreement concentrator water supply agreement

CONCLUSIONS AND RECOMMENDATIONS
Conclusions
Reserves
Feasibility
Market
Preappropriation work funding
Recommendations

VOLUME 2: PROJECT ECONOMICS
FOREWORD
SECTION 1: OVERVIEW
Project schedule
Capital cost estimate
Operating cost estimate
Marketing
Business climate and investment outlook
Economic analysis
Finance/funding

SECTION 2: SCHEDULE
Project schedule
Schedule basis and assumptions

SECTION 3: CAPITAL COST ESTIMATE
Capital cost estimate summary
Initial facilities
Deferred/replacement capital
Owner’s costs
Facilities cost estimate basis
Schedule basis
Sources of cost information
Escalation basis (if used)
Direct materials basis

Direct labor basis
Construction indirect costs
Contractor engineering cost basis
Contractor’s fee basis
Project contingency cost basis

SECTION 4: OPERATING COST ESTIMATE
Summary
Operating cost estimate basis
Production schedule
Sources of cost information
Escalation (if used)
Operating labor
Operating supplies
Repair and maintenance material
General and administrative cost
Other costs
Operating cost contingency
Projected first year operating costs
Production factors
Project timing
Business factors

Position of this property in world seriatim of industry
Comparison with other mine candidates for development
Comparison with existing and potential mine producers

SECTION 5: MARKETING
Summary
Overview of the commodity market
Commodity demand
Commodity mine supply/demand balance
Commodity price
Market analysis
Commodity concentrate market
Commodity finished product market
By-product market
Marketing and business strategy

SECTION 6: BUSINESS CLIMATE AND INVESTMENT OUTLOOK
Summary
Political outlook
Economic outlook
Investment climate
Microeconomic outlook

SECTION 7: ECONOMIC ANALYSIS
Summary
Basis of analysis
Capital costs
Operating costs
Working capital
Production data
Revenue
Escalation
Tax
Economic results
Sensitivities
Revenue and cost

SECTION 8: FINANCIAL STRATEGY
Financial strategy objectives
Financing plan

VOLUME 3: TECHNICAL NARRATIVE
(For subcategories in Volume 3 marked with an asterisk, there should be a summary, the technical design basis for that item, the design considerations and assumptions that were made for
that item, the technical system description of the components of that system within a subcategory, environmental control systems, and, finally, the equipment list for the subcategory. Although these items are not repeatedly listed under each subcategory, each must be documented.)

SECTION 1: OVERVIEW
Introduction
Mine
Primary crushing
Concentrating/cleaning
Waste disposal
Offsites
Waste dump leaching (if applicable)
Leachate recovery plant (if applicable)
Plans for future expansion (if applicable)
Design basis
Production rates
Start-up scheduled
Production buildup schedule
Objectives of each operational function in design

SECTION 2: MINE AND PRIMARY CRUSHING
General summary
Geology, exploration, resource, and reserve description
Mining
Mining plan
Layout of mining facilities
Description and site conditions
Design considerations
Plot plan
Type of building and construction
Civil works related to mining
Summary
Site investigations
Site preparations
Miscellaneous civil works
Primary crushing and storage facilities
Maintenance facilities
Auxiliary mine buildings
Utilities
Summary
Water supply
Fire protection
Power
Compressed air
Fuel oil and lubrication handling facility
Communications
Industrial wastewater collection, treatment, and disposal
Other environmental control systems
Warehousing and supplies handling
Discussion of pre-engineering trade-off studies

SECTION 3: ORE CONVEYANCE SYSTEM
(Whatever system is to be used must be fully described. Whether a mine hoisting shaft, a slope conveyor system, overland conveyor system, slurry pipeline, truck or rail system, etc., the design basis must be given.)

SECTION 4: CONCENTRATOR OR PROCESS CLEANING
General summary (battery-limits)
Layout and civil considerations
Location map
Plot plan
Site considerations
Course product storage
Communities circuit(s)
Mineral extraction circuit(s)
Thickening, filtering, and drying
Chemical storage, preparation, and distributions
Sampling and process control
Utilities and yard facilities
Yard and plant piping
Maintenance facility for process plant
Warehousing and handling of supplies of processing plant
Auxiliary processing buildings
Environmental control systems
Any product expansion plans

SECTION 5: WASTE DISPOSAL AND WATER RECOVERY/TREATMENT
General summary (battery-limits)
Waste system pipeline
Waste disposal area description
Summary
Site selection
Regional topography and geology
Local site geology
Hydrology (groundwater)
Meteorology
Hydrology (surface water)
Seismicity
Operation of waste disposal area
Summary
General features
Description of proposed deposition system
Completion plans
Seepage mitigation plans
Dust control plans
Waste dam construction
Summary future work
Waste dam design basis (specify waste compaction if required)
Waste dam details
Stability analysis
Construction materials specification and placement procedures
Quality control plans
Staged dam construction sequence
Equipment list
Reclaim water system
Seepage water recovery
Waste utilities and services
Waste pond area civil works and buildings
Maintenance of waste facilities
Other environmental control systems

SECTION 6: OFFSITES
General summary
Facilities
Product storage, transport, and shipping
Freshwater supply
Electric power supply
Access roads
Communications
Fire protection
Mine area drainage and waste treatment plant
Solid waste collection and disposal plans
Plant security
Product transport, storage, and shipping
Water supply*
Electrical power supply*
Access roads*
Communications system*
Security facilities
Mine area drainage treatment plant*
Solid waste collection and disposal*
Other environmental control systems
SECTION 7: DUMP OR PAD LEACHING (if applicable)
Summary
Design basis
Metallurgical process
Operating schedule
Projected tonnages and analysis
Process flow sheet and mass balance
Leaching parameters
Reagent requirements
Environmental requirements
Design considerations
Process design support documents
Factors considered
Environmental considerations
System description
General description
Leach area preparation
Pregnant leach solution collection
Leach solution distribution
Raffinate and pregnant leach
Solution pumping
Emergency discharge handling
Electrical system description
Plant heating, ventilation, and air conditioning
Control and instrumentation
Sampling and analytical control
Environmental safeguard description
Equipment list
Mechanical process equipment
Electrical equipment
Solution diversion system*
Waste diversion system*
SECTION 8: DOWN STREAM EXTRACTION
(Any and all downstream extraction processes, such as SX/EW or metals smelting and refining must be fully described.)*
VOLUME 4: PROJECT EXECUTION PLAN
SECTION 1: INTRODUCTION
Objectives and purpose
- Clearly convey to company management how project will be executed.
- Clearly convey to future A/E and construction contractors how project will be executed.
- Provide organizational structure and divisional responsibility for project.
- Complete safe, operable mine/plant, on schedule, within budget.
- Complete mine/plant, meeting all country and government regulations.
- Identify major outstanding issues and action that must be addressed prior to execution.
- Define complete basis to enable project to mobilize and accelerate critical early activities to achieve earliest project completion.
Conclusions

SECTION 2: BACKGROUND
Project history
Project general description
Mine
Process plant
Infrastructure/offsites
Other facilities
Project milestones
Guidelines to use of country resources
SECTION 3: PROJECT ENVIRONMENT CONTROLS AND BUSINESS ENVIRONMENT
Concerns and interest of country government
Environmental protection required and permits needed
Water supply (construction)
Water supply (operations)
Waste disposal impoundments
Roads, electrical power, and communication
Concentrate transportation
Mine
Process plant
Land acquisition
Country taxes
Labor market
General
Market mechanism
Subcontracting labor supply
Direct hire
Employment requirements
Competition for resources during project period
Country economy
Resources of concern
Public relations
Company public relations plan
Project team public relations plan
Contractors and subcontractors public relations
SECTION 4: PROJECT EXECUTION ORGANIZATION
Overall project organization
Engineering, procurement, and construction coordination
Company project organization
Project executive’s organization
Contractor(s) project organization expected
Deputy project director in home country
Deputy project director in country of project
Deputy project director of engineering
Deputy project director of procurement
Deputy project director of construction
Project control director
Finance director
Human resource director
Turnover and replacement organization
SECTION 5: SCHEDULES AND LABOR REQUIREMENTS
Schedules
Mine engineering
Mine procurement
Mine construction
Process plant engineering
Process plant procurement
Process plant construction
Infrastructure/offsites engineering
Infrastructure/offsites procurement
Infrastructure/offsites construction
Labor distribution to all areas in all phases

SECTION 6: PROJECT ENGINEERING EXECUTION
BASIS (assuming appropriation approval)

Objectives
Detailed work plan for contract engineering
  Methodology execution
  Division of work
  Amount of work in the home country
  Amount of work in the foreign project country (if applicable)
  Engineering personnel orientation
  Orientation meetings
  Site orientation and description
  Mine description
  Process plant description
  Infrastructure/off-site
  Other facilities
  Planned organization
  Project basic documentation and references
  Engineering documents

Standards and criteria to be used
Engineering quality control
Quality assurance achievement expected
  Purpose
  Scope
  Audit methodology expected
  Contractor
  Company

SECTION 7: PROJECT PROCUREMENT EXECUTION
BASIS
Procurement organization, functions, and responsibilities
  Scope and policy
  Organization
  Responsibilities and functions
Procurement procedures and documentation
  Procedures expected
  Documentation expected
  Country vendor survey information
Available materials in country or nearest available
Available fabrication facilities in country or nearest available
Available subcontracting services in country or nearest available

SECTION 8: PROJECT CONSTRUCTION EXECUTION
BASIS
Construction management
  Project organization
  Construction management procedures
  Reporting
  Construction expected
  Construction management interfaces project management
Preappropriation activities (as applicable)

Labor
  Craft supply plan
  Logistics of labor source
  Supervision required
  Safety organization
  Expatriate housing (if applicable)
Construction equipment, tools and consumables in general
  Major equipment
  Procurement sources
Transportation of equipment, tools and consumables
  Maintenance program expected
  Tools
Consumables
  Fuel
  Aggregate
  Concrete
Construction facilities

VOLUME 5: OPERATING PLAN
SECTION 1: INTRODUCTION
SECTION 2: OWNER
Local organization
  Location
  Description of staff
  Type of management
Management committees (if applicable)
Business interfaces
  Transportation company
  Utility companies
  Adjoining property agreements
  Operating consulting agencies (if applicable)
  Government regulatory, licensing and permitting agencies

SECTION 3: OPERATING DEPARTMENTS
General
  Operating schedule
  Mine camp (if applicable)
  Personnel transportation
    Staff
    Hourly
  Food service (if applicable)
  Medical facilities
Functional department and interrelationships
Mining department
  Mine operation
  Geological/surveying
  Mine engineering
  Mine and field maintenance
  Electrical
  Primary communication
  Other functional operating group specific to this property
Concentrator/cleaning plant department
  Plant operation
  Metallurgical/process engineering
  Maintenance
  Electrical
  Process control and instrumentation
  Central maintenance and fabrication department
  Transportation department
Other operating department specific to this property
SECTION 4: RECRUITING
Labor needs
  Staff (by function)
  Hourly (by function)
Manning plan buildup estimate
  Staff (by function)
  Hourly (by function)
Availability of personnel labor pool
  Staff (by function)
  Hourly (by function)
SECTION 5: TRAINING
Training objectives
  Initial training
  Ongoing training
Management and professional development
Mineral Property Feasibility Studies

Training program
Job positions to be trained to match job descriptions
Training organizations
Use of outside institutions
Vendors training
Inside training
Initial training time estimated

SECTION 6: START-UP
Basis of start-up philosophy
Who will participate
Who will be in charge of start-up plan
Mining department’s plan
Concentrator/process plant’s plan
Transportation facilities’ plan (if applicable)
Organization for start-up
Mine
Concentrator/process plant
Transportation
Start-up assistance
Operational staff
Architect/engineering contractor
Vendors and other consultants (if applicable)
Time and budget estimate for start-up

SECTION 7: INFRASTRUCTURE AND SUPPORT
SERVICES (any auxiliary operations that support the main production operations)
Housing (if applicable)
Food service (if applicable)
Personnel transportation (if applicable)
Power system
Power generation
Acquired power
Water system
Tailings/waste disposal system

SECTION 8: MAINTENANCE
Company philosophy and policies
Maintenance control programs
Work control system
Preventive maintenance
Maintenance planning and scheduling
Maintenance management reports
Job priorities
Downtime analysis philosophy
Backlog reporting system
Numbering control system
Warehouse and inventory control system
Other tasks
Maintenance work requirements
Collection and cataloging of equipment information
Develop equipment
Identification codes
Develop preventive maintenance schedules
Develop maintenance forms
Execute contracts for rebuild and repair components

SECTION 9: ROAD MAINTENANCE
Description of road system to be maintained
Responsibilities for specific areas to be maintained

SECTION 10: ENVIRONMENTAL
Company policy and objectives
Present conditions by areas
Source of pollution by areas
Assessment of hazards from above sources
Objectives of monitoring program
Monitoring program recommended responsibilities
Internal responsibilities
Consultant responsibilities

SECTION 11: ADMINISTRATION AND SUPPORT
SYSTEM
Purchasing department
Controllers department
Financial control
Registration and depreciation of property and materials
Accounting system
Financial reporting
Cost accounting and cost distribution
Capital and expense budgets
System development
Marketing
Marketing philosophy of major products
Marketing philosophy of by-products

SECTION 12: COMMUNICATIONS
Company philosophy
Organization
Central database system
Computer applications support
Ore resource management and information
Operation production modeling and automation
Personnel
Management
Capital/financial
Equipment
Communication systems
Mine systems support (including GPS)
Plant systems support
Office systems support

SECTION 13: SAFETY
Company philosophy
Training
Safety protective equipment policies
Fire protection
Mine fire protection
Plant fire protection
Other surface area protection
Interrelationships between operations and safety/health and first-aid clinics

SECTION 14: SECURITY
Company philosophy (this section dependent on geographic and political location of operation)
Organization required
Internal organization
Contracted organization
Function of organization
Areas of security concern
Mine
Plant
Transportation of product
Other surface facilities

APPENDICES
Organization charts
Condensed job descriptions of all jobs
Maintenance management control system
Description and forms
Business control system description and forms
Environmental monitoring programs details
Personnel training module details