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MEMO

DATE: October 7, 2003
TO: Professor A. R. Dobell
FROM: T. M. Power
RE: Review of CIT minerals documents

I have reviewed the *EGSA Minerals Sector Study* by BriMar Consultants Ltd. and Finisterre Holdings Inc. (March 2003) and the *EGSA Minerals, Oil and Gas Sector Study: Queen Charlotte/Hecate Basin Oil and Gas Potential* by BriMar Consultants Ltd (February 2003) as well as related documents and appendices, especially those of the British Columbia Geological Survey.

The charge with which you provided me was the following:

“...we are interested in your opinion as to the appropriateness of the procedures for translating from theoretical estimates of resource potential to concrete assessments of the value of deposits in the ground, for taking into account the relevant market prospects, and for representing the cost conditions in production so as to arrive at reasonable estimates of net values arising from exploitation of these subsurface resources relative to the possible values arising from other uses of the land.” [R. Dobell email to T. M. Power, September 8, 2003]

My professional evaluation of these two reports in response to the charge above is contained in the discussion below. As requested, I make the following declaration: By accepting to participate in this peer review process, I warrant that the opinions provided through peer review are my opinions as an independent expert in the field and that my opinions are not vetted or directly influenced by my employer, clients or another third party.

1. Summary

The character of these two reports and the charge given to do not coincide very well. Neither of the reports “take into account the relevant market prospects...and...the cost conditions in production so as to arrive at reasonable estimates of net values arising from exploitation of these subsurface resources relative to the possible values arising

from other uses of the land.” **These two reports were not designed to do this and did not claim to do this.**

Both of these studies diverge from the review criteria in two important ways. First, they do not attempt to provide a site specific evaluation of the economic potential. Instead they focus on estimates of physical potential expressed in dollar terms. Second, they do not focus on net economic values. Instead they focus on local economic impacts.

i. Physical versus Economic Potential

Rather than providing an estimate of the economic resource potential associated with subsurface mineral resources, the reports provided a probability weighted physical estimate of the mineral potential that largely ignored the local site-specific economic factors that would determine the likelihood of that resource was actually economically viable for development.

Although the authors were clear about what they were doing, readers may not be clear that these reports did not evaluate the economic potential of the subsurface resources. This potential confusion is due to the fact that the potential physical resource **was** multiplied by an assumed market value so that the physical resource could be expressed in dollar terms. This dollar value was explicitly labeled gross in place value (GIPV). “Gross” and “in place” refer to the fact that the costs of developing, extracting, processing, and refining the mineral, in general, were not included in the analysis. In that very important sense, GVIP does not represent the economic potential because costs of production are ignored. For instance, a very large low-grade deposit of a mineral that was not economic to produce could be assigned a very large GVIP even though its actual economic value was zero or negative.

Additional confusion about what the authors of these reports actually did may have been created when typical costs of developing, extracting, processing, and refining the minerals were used, not to evaluate the economic potential of the mineral, but to project the economic impacts (employment, payroll, royalties, taxes, etc.) **if** these resources were of sufficient economic value to develop. That is, the economic impacts of the projected physical resource were evaluated on the hypothetical assumption that the resource was economically viable.

As a result of these two sets of calculations, some readers might assume that the reports claim to have analyzed the economic potential of these subsurface resources. These reports did not do that and did not claim to have done that.

ii. Net Economic Value versus Local Economic Impacts

Both studies focus on calculating what is labeled the “economic gain” associated with the development of the potential mineral developments. This label is ambiguous. The economic “gain” that is evaluated is the employment, payroll, royalties, and taxes that might be associated with these physical resources if they were economic to develop.

These local “gains” are not the same as “net economic value.” Net economic value refers to the value of the resource less the costs associated with discovering, extracting, processing, refining, and transporting it to market. The costs must be subtracted from the gross value to arrive at net economic value. The economic costs include the costs of labor, the costs of inputs to the production process, and the costs of public infrastructure and public services. However, in the “economic gain” analysis, the **costs** of all of these are turned into **benefits**. That is, negative values are converted into positive values as the analysis turns away from net economic value towards local economic impacts. For instance, from an economic point of view, “payroll” is the cost of labor and taxes are the cost of public services. They are to be subtracted from the gross value of the mineral extracted. From a local economic impact point of view, payroll and taxes are treated as costless benefits.

This confusion of net economic value with local economic impacts prevents the analyses from being used for the purposes my charge laid out.

For both of these reasons, these reports do not lay the basis “to arrive at reasonable estimates of net values arising from exploitation of these subsurface resources relative to the possible values arising from other uses of the land.”

It is possible that the British Columbian government and local business interests are not interested in net economic values and are only concerned about local economic impacts. If that is the case, then the charge with which I was provided was not appropriate. As an economist, however, I would worry that if the creation of net economic value is abandoned for the pursuit of local economic impacts, gross economic inefficiency and waste that ultimately impoverishes the citizens of British Columbia will be the result. Such a focus tends to turn the entire economy into a wasteful “make work” project.

In the discussion below, I focus on the first of the above points: The focus on physical resources expressed in dollar terms rather than on actual economic potential.

2. *The EGSA Minerals Sector Study*

The EGSA Minerals Sector Study proceeded by estimating the economic impacts (as represented by nine different economic effects) associated with seven different types of successful mines. High and low values for the nine economic effects were estimated and the mid-point between these two was used.

The BC Geological Survey data on the estimated distribution of deposits of different types of mineral was used. Expert opinion was used to distribute these estimated deposits over sub-tracts, attaching a probability to the likelihood of a particular type of deposit occurring. Using market prices to value the estimated physical resource, the gross value in place for different types of minerals in each sub-tract were aggregated. This information was used to indicate the size of a potential mineral operation and the

local economic effects were estimated based on the size and character of that potential mining operation.

Note that the costs associated with actually developing any of these estimated mineral deposits were not analyzed to determine the likelihood of these deposits actually being developed. Instead, it was simply assumed that over a 50 year period half of the estimated deposits would be discovered and, once discovered, half would be profitably developed. In effect, it was assumed that over a 50 year period, a quarter of all of the estimated mineral deposits would be profitably developed. Note that this was just a broad, subjective judgment that was not based on any cost information. Nice round numbers were used: half of a half. As the report said:

It is of obvious note that the numbers of the EGSA's [Economic Gain Spatial Analysis] for each tract, and values associated with them, will be highly dependent on the probabilities of discovery and development that are used. These are subjective figures.

The estimates of "economic gain" were reported graphically by using the mean value across all sub-tracts as a reference point and then showing those areas with well below and well above average values. This converts the "economic gain" results into relative gains, showing those areas where, if a mine were to be developed, the local effects might be well about average and those areas where the effects might be well below average, etc. These maps or indices could be interpreted as showing the sub-tracts with "higher mineral economic potential," but it must be borne in mind that the "high" is relative to the average which might well have a very low probability of occurring. The "high" does not refer to any absolute reference point that has been shown to be "likely" in any sense.

This is a perfectly reasonable way to "ball park" the potential size of the local economic effects of possible mineral developments. It does not, however, provide an empirical estimate of the actual economic mineral potential or of the actual economic effects of that economic mineral potential being realized. It is a purely hypothetical result that allows one to explore whether mineral development might have a large, very large, or only a small local impact.

The BC Geological Survey, in contrasting the difference between Gross Value in Place and actual economic potential, laid out the additional considerations that were necessary to move beyond GVIP to actual economic potential:

So while the relative deposit rank of metallic deposits is based solely on the value of contained metals or the "gross in place value" (GIPV) industrial mineral deposit relative rankings consider the following characteristics:

- ❖ commodity unit-value,
- ❖ size and location of potential market,

- ❖ deposit grade and size,
- ❖ transportation costs,
- ❖ existing infrastructure, and
- ❖ extraction costs.

(“Level 2 Mineral Resource Assessment, Coastal British Columbia-- Methodology and Results” MacIntyre, D.G., Massey, N.W.D and Kilby, W.E., p.7)

These are the standard considerations necessary to estimate economic potential rather than physical presence of any mineral regardless of whether it is a metallic mineral or an industrial mineral.

The uncertainties associated with evaluating whether a particular mineral deposit is likely to be developed were well laid out in the ESGA Mineral Sectors report:

“The conversion of information on the levels of occurrence of undiscovered mineral deposits and mineral inventories into EGS (Economic Gain Scenarios) variables can only be undertaken using probabilistic methods for the following reasons.

1. The occurrence of undiscovered deposits is itself provided in terms of a probability distribution, as mentioned previously.
2. Even if the number of mineral deposits in a subsector were known with certainty, there is significant uncertainty associated with the size of the deposits.
3. Even if the size of the deposit were known, there is uncertainty with respect to the location and depth of the deposit. This affects the type of mining method and metal recovery process used, the capital and operating costs of a mine development, and the cut-off grade (which is based on operating costs). Hence, the size of the economically exploitable portion of the deposit is also uncertain.
4. Even if the locations of all deposits, and all of the engineering and development cost parameters of these deposits, were known at a given point in time, the economic impacts would still be uncertain due to the variability of metal prices, and to shifts in future metal markets. Changes in metal markets over time will change the potential revenue streams and cut-off grades of the deposits. This will impact the economics of any future mine developments.
5. Even if all information relating to potential mineral deposits and their development were known with certainty based on our current understandings, changes in future uses for metals and minerals, or new technologies, could create new demand for minerals which are currently beyond the scope of our knowledge at present. In addition, future research may change our understanding of mineral deposit occurrences,

and this could change our concept of the potential numbers, types or locations of mineral deposits. “

This is a good summary of why much more detailed analysis in a particular real world market setting is necessary before the actual economic potential of a mineral deposit can be estimated. The report did not attempt such an analysis.

3. EGSA Minerals, Oil and Gas Sector Study: Queen Charlotte/Hecate Basin Oil and Gas Potential Report

The Oil and Gas Sector Study begins with a series of categorical disclaimers that would appear to explicitly state that the results of the study cannot be used to evaluate the economic oil and gas potential of the tracts that were studied.

This paper contains some estimates of the crude oil and natural gas potential of the Queen Charlotte/Hecate Basin that should be considered to be entirely speculative at this time. These estimates are provided only for the purposes of illustrating a methodological approach to estimating potential oil and gas values. **They should in no way be interpreted as either accurate or reliable estimates of potential economic value....**

Estimates of potential oil and gas values based upon just one set of assumptions are presented for illustrative purposes only. These estimates should be interpreted to be entirely speculative, and **no special significance should be placed upon them.** (p. 1)

.....
The potential for significant discoveries of oil and gas within the Queen Charlotte/Hecate Basin is large. However, since one is here dealing with what the geologists call *conceptual resource plays*, **rather than resources that are anywhere close to being proven**, the risks associated with exploration activity are also large. (p. 2)

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However, the Ministry of Energy and Mines does not have sufficiently detailed information pertaining to the spatial location of potential hydrocarbon resources to allow polygons of high, medium and low potential to be drawn within the larger horizon-specific polygons. Information on potential *hot-spots* either does not exist, or is kept confidential by companies that are in possession of thirty-year-old seismic and exploratory drilling data. As a result, analysis of the oil and gas potential of the Queen Charlotte/Hecate Basin must largely be based on an aggregative approach, without much spatial detail. Major uncertainties with respect to both potential in-place volumes of crude oil and natural gas and recoverability factors in any case pervade the aggregative approach. (p. 3)

.....
Based upon a number of comparable situations, the following cost-price breakdowns **might be assumed** to apply to the economic gain scenarios

for offshore oil and offshore gas, respectively. However, while these cost-price breakdowns are reasonably representative of the B.C. segment of the WCSB at the present time (and assume the existing B.C. fiscal regime), **they may bear no relationship to the cost-price situation** that might prevail down the track for the B.C. offshore, should the moratorium be lifted. (p. 6)

.....
If any credibility could be placed on these NPV estimates, they would suggest that **there may be** significant resource rental values, for both the private and the public sectors, associated with the development of the hydrocarbon resources that are projected to exist within the Queen Charlotte/Hecate Basin... The illustrative NPV estimates are, of course, based upon only one of many possible development scenarios for the Queen Charlotte/Hecate Basin. **They make no allowance for the huge geological and economic uncertainties involved**, and the substantial limitations of the information that is currently available. Different estimates of recoverable volumes, alternative production profiles, re-specified price-cost accounting frameworks, and higher or lower discount rates, would all lead to different estimates for private and public resource rental values. (p.7)

(Emphasis added in all of the above quotations.)

Given that this oil and gas report does not claim to provide an evaluation of the economic oil and gas potential, I assume the question I have been asked to evaluate is: ***If accurate data were available to allow an accurate estimate of the economic oil and gas potential on these lands***, would the approach taken to estimating the local economic impacts be accurate and appropriate?

The answer to this question is also no since the approach taken was “the method of analogy.” As the report stated:

The activity measures provided in Appendices B, C, and D may be used to provide a comparative framework for assessing the probable employment creation and income generation effects that could be associated with B.C. offshore hydrocarbon development. Essentially, **the analysis would proceed by way of analogy**, using empirical data drawn from offshore experience in Atlantic Canada. **However, since geological, geophysical and other conditions differ between the East and West Coasts, differences in development technologies (and associated crew sizes) would need to be taken into account.** (p. 8, emphasis added)

The report is careful at every step to underline the speculative, tentative, and illustrative character of its findings. The report, however, asserts that the results do suggest that there may well be a substantial economic oil and gas resource the development of which could have significant local economic impacts. In that sense, this report, like the

EGSA Mineral Sector report, evaluates “the size of the potential ball park.” It finds it of sufficient size to justify additional detailed study. That, however, is not the same as “concrete assessments of the value of deposits in the ground, for taking into account the relevant market prospects, and for representing the cost conditions in production so as to arrive at reasonable estimates of net values arising from exploitation of these subsurface resources relative to the possible values arising from other uses of the land.” The oil and gas report represents simply an initial reconnaissance of the potential values to see if further analysis is justified.

4. The Approaches to Estimating Local Economic Impacts

Both reports combine two sets of information. The first is the geological information on what mineral resources may lay beneath the surface. The second is the likely local economic impacts if those mineral resources were actually developed. What is missing is the information that links these two: data on whether the economic characteristics of the resource in place, the national and international markets, and the local infrastructure, make it likely that the resource would actually be developed.

Even if that crucial information is not available, it is still possible to ask whether the approach to evaluating the local economic impacts is appropriate and would generate reliable results if the missing information were available. It is to that question that I now turn.

The Oil and Gas report is the more careful of the two reports in how it deals with the likely employment and income impacts. The mineral extraction industry is capital and skilled labor intensive. It also requires many more resources for exploration and development than it needs for production. These economic characteristics have several important implications:

First, many or most of the skilled workers needed in the exploration and development and a significant number of those needed for production, will not come from a local labor pool. They will migrate in from other mineral development areas, work on this particular field or deposit, and then move on to new sites. Second, the size of the production work force will be quite small compared to the total economic value being produced. Third, the combination of a potentially large temporary and external exploration and development workforce with a rather small permanent workforce may well be disruptive to local communities. Fourth, much of the equipment and machinery and most of the capital will have to be imported into the region and into the province from the outside. This represents substantial “leakage” of the economic value ultimately produced that substantially reduces the “multiplier” effects. The Oil and Gas report acknowledges all of these aspects of the local employment and income effects (pp. 5, 9 and 10). The report concludes: “In sum, although the income generation potential of oil and gas activity in the CIT *Area of Interest* is large, for both the private and the public sector, **the employment creation potential could be relatively limited.**” (p. 5, emphasis added)

On the other hand, the flow of revenues to government agencies in the form of royalties and taxes can be sizeable. The Crown, as owner of the mineral resources, is, in effect, a partner with the mineral developers and shares in the economic rents associated with the minerals. The potential for these public revenue flows may be more important in motivating exploration and development than the value of the potential jobs and payrolls for local residents.

The ESGA Minerals Sector Study is less careful about characterizing the employment and income potential associated with mineral development. It asserts that operating mines are “large generators of employment. (p. 6)” and “[l]arge mining operations are huge generators of employment and income, creating hundreds of jobs and hundreds of millions in annual revenue. (p. 12)” “Large” and “huge” of course are subjective terms unless some reference is provided. Modern mines employ on the order of about 300 workers, a number the report confirms. This employment level is down dramatically from the thousands of workers that were employed at large mines as late as the middle of the 20th century. Metal mining in British Columbia and Canada as a whole provide about one out of every thousand jobs. Mining certainly can contribute significantly to employment, but in contemporary settings it is rarely a dominant source of employment.

The Mineral Sectors Study tables (3,4, and 9) states mine employment not in annual job terms, which is how ongoing employment is usually stated, but in terms of man-years over the life of the mine. Using this approach a mine that provides 200 jobs for a 15 year period is described as providing 3,000 man-years of employment. This is not useful information; it exaggerates the apparent employment impact.

“Those mining operations that are located relatively close to communities can expect to have a great impact on the local economy, stimulated by increased demands for goods and services generated by the mine and by its employees, most of who will choose to live nearby. (p. 12)” This is not the pattern found in the United States. Miners are very mobile and tend not to invest in homes near the mine for fear that when the mine shuts down the value of the home will decline. They may also be concerned that the environmental damage caused by the mine will threaten home values. In any case, miners often live a substantial distance from the mine and commute to work, causing the local impact to be reduced because the high pay associated with the mining activity does not flow through the local community.

Any analysis of mineral industry employment and income should at least make reference to the fact that mineral towns are rarely prosperous places despite the high wages paid by the mineral industries. British Columbia, the Yukon, Alaska, and the Western United States have many examples of depressed mining towns or “ghost towns.” The American mining regions (Appalachia, Ozarks, Upper Peninsula of Michigan, Mesabi Range in Minnesota, the copper and silver towns of Montana, Idaho, New Mexico, and Arizona, etc.) are all economically depressed regions. This is a dramatic, disturbing, and puzzling characteristic of communities that rely on mining. There are many explanations for this: The instability of world commodity prices, the adoption of labor displacing technologies, the environmental damage done by mining to

the surrounding landscape, labor-management disputes, competition with developing nations, etc. But it would seem incomplete when seeking to characterize the impact that mineral development may have on a region to remain entirely silent on this salient feature of past mineral dependence on mining. Such silence does not prepare either citizens or governments to deal with some very real economic results of mineral development.