Cortex Consultants Inc.

Response to comments by J. Johnson, Pacific Analytics Inc. December 3, 2003

Reviewer comments are reproduced here verbatim.

1. **Comment:** Section 3.2.3 (page 14) discusses sensitivities, scifically regarding the change in harvest activity due to price changes (output elasticities). I find it somewhat remarkable (but perhaps not incorrect) that a fall in log price to 25% of price-cycle amplitude [1] will only cut harvesting by 50%. According to the 2003 Woodflow analysis by Pierce and Lefebvre,[2] 64% of the growing stock is Hemlock/Balsam.

   On page B5 of the Forestry Report, the price-cycle amplitude reported for H/B is $62 to $96. A 25% price cycle results in an average price of ($62 + .25*($96-$62) = $70.50. According to Figure B1 in Appendix B there is less than 5% of the operable land base that has Delivered Wood Costs under $70. Perhaps I don't understand the exact model structure properly, and therefore I don't understand how harvesting is allocated among woodsheds and species. However, since 64% of the land base is H/B and virtually none of this H/B could be harvested profitably, how is it possible, especially in the log run, to that harvesting would fall by only 50% with this price of $70.50 per m^3 ?

   Response: We differ with Pierce and Lefebvre in our estimate of area of H/B types in the CIT Central Coast Region: we find that 56% of the timber harvesting landbase is H/B. The remaining types—fir, cedar and spruce leading—attract higher prices. Furthermore, the average price calculated by the reviewer ($70.5 per m^3) is an average price—the actual price calculated for a stand depends on its grade distribution, which, in turn, is determined by the location (Woodshed) and origin (natural or managed) of the stand. Consequently, the 56% of H/B types is distributed around the mean price of $70.65 per m^3, and roughly half of it will attract a higher price. The reviewer is correct in that the reduction in harvest (50%) comes mainly from H/B types.

   As for the confusion about the definition of prices relative to the price cycle, we have clarified this in section 3.2.3 (p.14) and Appendix B-6.

2. **Comment:** On page 15, the report states that "stumpage is calculated as a fixed rate per m 3 and the return to enterprise determined by subtracting stumpage from net revenue". My understanding is that Net Revenue closely approximates Economic Rent (with some minor adjustments for other taxes). Theoretically, stumpage is suppose to extract all of the economic rent except for a portion left to the enterprise such that the enterprise earns a risk-adjusted "normal" rate of return on its assets (usually in the 8-12% range). The specification in the model therefore seems to be incorrect, and is the main reason why the profits to enterprise outlined in Table 3-3 are so high under the FE and EBM(H) scenarios (e.g., the five scenarios imply average return to enterprise over the first 20 years of $11.84, $47.78, $30.99, $28.49 and $22.30 per m^3 respectively). If returns to enterprise are abnormally high, then stumpage rates are likely to be adjusted to better collect economic rent Since return to government is a serious decision-influencing variable, this needs to be addressed. Note that it probably can be

adjusted outside the model, since I don't believe there is any feedback loop from stumpage and/or Net Revenues back to harvest activity.

Response: We agree with the reviewer. The fixed stumpage rate, based on the volume weighted average stumpage by management unit for years 2001-2002, was suggested to the project authors by MoF as the best measure of stumpage value. Under status quo management practices, it probably is, at least for the first decade. However, for radically different management (such as EBM) it makes much less sense. The Rothery stumpage method, which predated the Comparative Value Timber Pricing system that was introduced in 1987 and remained in place until this year, allowed 15% of total delivered wood cost for profit and risk, i.e., stumpage is calculated as the market value minus wood cost and minus profit and risk allowance .

We have now implemented a return to enterprise rate of 12% (profit ratio), the top end of the range suggested by the reviewer, but less than the Rothery rate of 15%. We have modified Table 3-3 to include both measures of stumpage, and the row "Profit to Enterprise" is now calculated as 12% of the sum of delivered wood cost and stumpage.

3. **Comment:** Section 3.5.2 provides mapping information for Delivered Wood Costs and Development Costs by woodshed area. A quick review of these maps suggests that both levels of costs are fixed over time, even though the size of a woodshed appears to be relatively large. My immediate question would be: is it not more reasonable to assume that, as more remote and inaccessible timber is harvested, costs would increase.

   Response: Woodshed boundaries were determined by an earlier study (Timberline 2000) such that all stands within a woodshed can be assumed to have common development costs (bridge and road construction, road reactivation and maintenance), haul-distance related costs (loading hauling costs, crew transportation), and water transportation costs (boom and barging costs). Other costs (tree-to-truck, reloading, dump/sort/scale, camp/accommodation, silviculture, and management overhead) are fixed per cubic metre. So, remote and less accessible woodsheds have higher costs associated with them, but within a woodshed, costs vary only by stand volume per hectare. Note that development costs decrease for second growth stands.

4. **Comment:** Section B.1 defined the total (projected) delivered wood costs (DWC) as a function of four costs: Development Costs (bridge construction, road building and maintenance, etc.), Haul-Distance Related Costs (loading hauling costs, crew transportation), Water Transportation Costs (boom and barging costs) and Other Costs (tree-to-truck costs, reloading, silviculture, etc.).

   Development Costs are assumed to be fixed within a woodshed and therefore the development costs per 000 m^3 will vary by the rate of actual harvest. I am not clear as to how this assumption is specified in the model structure itself, but the theoretical implication is that, if the development costs of harvesting really are fixed, then the marginal development cost of cutting an additional 1000 m^3 is zero. Thus, theoretically the assumption leads toward cutting greater quantities of timber when in reality the likely response will be to forego development of the watershed.

Both Haul-distance Related Costs and Water Transportation Costs are defined in a similar manner, that is, as fixed per woodshed, and therefore the problem of marginality is duplicated. There is another concern here, however, and that is there is no real reason to believe that these cost should be fixed. Rather, one would expect that say, loading and hauling costs would be a function of the number of trees hauled and loaded and, in addition, that as harvesting moves further away from, say, accessible waterways, that these costs should also increase. If true, then the model is under-estimating DWC which would make marginal timber profitable. Correcting this would result in lower harvests and lower Net Revenues.

Response: We agree with the reviewer that marginal development costs within a woodshed are not captured and do not influence harvesting behaviour in the model. The cost model underlying the woodshed study, and supplied as input to this study, simulates the Coast Appraisal System where development costs are amortized over "tributary volumes". A significant difference is that for actual appraisals, roads and drainage structures are amortized over the volume scheduled to be harvested from the next few cutblocks accessed by the road/drainage infrastructure, while the woodshed model treats the entire harvestable volume from the woodshed as tributary to the entire infrastructure of the woodshed. In other words, every m^3 bears the same development cost.

However, we do not agree that total delivered wood costs (DWC) are significantly understated due to this lack of resolution in the cost mode. Development costs are a small proportion of the total delivered wood cost—75% of modeled development costs are < 6 $/m^3$, and total DWC are between 100-110 $/m^3$. However, the cost model and, in particular, the modeling of marginal harvesting decisions within woodsheds, was the subject of much discussion during the course of the project. Regrettably, the project schedule and budget did not allow investigation of a more satisfying approach.

The truck and water haul costs (including loading) are treated exactly as documented in the appraisal manual (as a cost per unit volume), and capture the average haul distance within each woodshed and from each woodshed to water access (log dump). One the logs are in the water or on the barge, the haul cost to the point of appraisal (Gambier Island) is tabulated for each point of origin in the Central Coast LRMP area.

5. **Comment:** The most serious concern with the costing methodology is its abstraction from employment income (page 15) and consequently labour productivity. If labour productivity associated with harvesting continues to fall as has been the record of the last years (see my discussion of Appendix C below), then one would expect that many harvesting costs would also increase. Increasing harvesting costs would, ceteris paribus, reduce the operable land base and indeed could also increase average development costs, further reducing the operable land base. Harvest consequently would be lower as would Net Revenues.

   Response: We chose to implement the approach taken in the socio-economic analyses associated with the Timber Supply Review (TSR) for the region, which holds labour productivity constant. We did this, in part, to ensure comparability with the TSR base case, but we were also limited by the budget for the project—the additional scenarios required to explore the implications of alternative labour productivity schedules would have been too costly. That said, the reviewer is, of course, correct in his general assertion that more interesting long-term scenarios would be generated with a cost model that was driven (in part) by trends in factor costs such as labour.

6. Comment: The model also assumes that Development Costs will decline in the future as second growth takes over. But the second growth will not be available for 80-120 years (page 86). So the question is: are annual maintenance costs in already-cut areas embedded in the model? If not, is it reasonable to assume that the 100 year old infrastructure would still be useable? Again, if the decline in Development Costs is not as great as anticipated, projected harvesting should be slightly lower. .

Response: Annual maintenance costs are not included, and it is unlikely that 100 year-old infrastructure will be usable. However, much of the costliest investment will not degrade (e.g., the rockwork for roads), major bridges will be maintained, and the cost model (and the Coast Appraisal System) adjustment for second growth accounts for the costs of reconstruction and replacement.

7. Comment: In Section B.2, the report states that the current mature inventory was estimated from "cutting permit-specific appraisal data". This, to me, is unlikely to represent the average inventory of an entire woodshed, since it is likely (at least theoretically) that each company would have requested cutting permits for the most highly valued (net) timber. As such, the remaining inventory is likely of a lesser quality and therefore of lower value (e.g., lower value species or lower value quality – sawlog/pulp log mix). This would result in lower unit revenues and would reduce the overall operable land base.

Response: We interpret the reviewers comment above to mean that *grade distributions* for mature inventory are derived from recent cutting permits, and he is correct. The bias that the reviewer identifies, whereby the industry selects high net value stands, probably exists. However, this bias is tempered by the industry's lack of freedom to choose stands for harvest purely on the basis of financial return. The industry's choice of stands is dictated largely by its current network of roads and its Forest Development Plans. Note also that if the Chief Forester determines that the industry is avoiding a low-value component of the inventory, he will remove it from the AAC, so there is incentive for the industry to "cut the profile".

8. **Comment:** The implication of all of these points (4-7) is that the model input specifications seem to bias costs downward and bias unit revenues upward. The inference is that harvesting activity has been over-estimated. What is not clear is whether these cost and revenue implications are linear, that is, affect all scenarios equally, or whether the impact on one scenario could be greater. This could be a very important question, since it may be that the difference (that is, the loss in activity) between the Base Case TSA output and the EBM outputs could be significantly lower than otherwise suggested in this Forestry Report.

Response: We have dealt with each of the points (of bias) that the reviewer identifies. Based on our experience with this model and others, we don't believe that cumulative bias (derived from our cost and value models) is an issue of concern. We are more concerned with the adequacy of the cost model for capturing the accelerated development costs and ongoing maintenance costs associated with EBM. EBM will distribute the harvest spatially across the landbase more widely than present methods, and require the road network to be developed more rapidly and kept open longer (perhaps permanently). Therefore we arrive at the opposite conclusion—EBM may involve higher operating costs that will reduce the operable landbase, and thus impacts may be higher.

9. **Comment**: The raw data used (Statistics Canada data, footnoted page C-1) to estimate labour productivity and the trends in labour productivity are NOT, as indicated in the report "for the entire Coast". Rather, the data are for the entire province of BC. As labour productivity in the Interior is acknowledged as being much higher than on the Coast, the point estimate for 2003 (0.17 jobs per 1000 m^3) is likely much lower than the labour productivity actual found on the Central Coast. The significance of this is that the employment and employment income these assumptions would generate will be projected at much too low a value. If, as discussed earlier, employment income should be linked to harvesting costs, then these assumptions will project harvesting at too high a level.

   Response: The reviewer has identified an error in the report and is correct in his assertion that the time series of coefficients is for the entire province, and not specific to the coast. However, these coefficients, and the trend line in particular, were not used in the study. The three trend lines (optimistic, most likely, and pessimistic) were requested by CIT management committee as input to a subsequent study. The employment coefficients implemented in the EGSA-Timber study were obtained from the socioeconomic analyses conducted for the management units of the region as part of the TSR.

   We have corrected in the text the description of the time series used to correct the trend in labour productivity, and clarified the relationship between Figure C.1 and Table C.1.

10. **Comment**: The projected trend in labour productivity is based on an historic (1964 – 1997) trend of an "annual loss of 0.006 jobs per 1000 m^3 ". Three important observations:

    - Productivity gains over the historic period were likely higher in the Interior since it is the Interior where the greatest increase in mechanizing harvesting has taken place.
    - Productivity gains in the BC logging industry have reversed themselves significantly in the latter 1990s. Using the same data sources as the report, the three year average 1995 – 97 was approximately 0.269 jobs per 1000 m^3 whereas the three year average 1988 – 1990 was 0.235 jobs per 1000 m^3. This represents a loss in labour productivity of roughly 14 percent over the period or an annual gain of roughly 0.005 jobs per 1000 m^3 over the same period.
    - The data sourced in the Forestry report stop at 1997. In the Pierce Lefebvre report, their data go to 1999, and they suggest that productivity may have increased between 1996 and 1999. Using gross data from BC STATS [4] productivity was lower in 2000 (when production peaked) than in 1998, but was lower in 2001 (when production had fallen somewhat) than in 1998.

    The significance of these points is that the projected labour productivity estimates to be used in the subsequent analysis to generate projected employment and employment income may be much too low for the start period and furthermore, that the projected trends in productivity may be over-estimating what will likely happen. The consequence of this is that projected employment and employment income should be higher, and with projected higher employment income, the operable land base should be smaller that what will be generated using the productivity numbers in the Forestry Report.

Response: We agree—but consideration of trends in labour productivity were beyond the scope of this study. Please see our response to (9).

11. **Comment**: Table C-1 highlights the employment coefficients used in the present analysis. One assumes that the "jobs within CIT CC area" are logging jobs and therefore are analogous to the figures in Figure C-1. This presents some problems. Mid-Coast, for example, is estimated at 0.28 which, although higher than the estimated trend in Figure C-1, is more-or-less the same value as for all BC for the years 1996 and 1997 (equal to 0.279). More important, it appears that the figures in Table C-1 are fixed over the entire projection period, 5 even though recent productivity trends are negative. If negative trends were introduced into the model, the projected employment and employment income would be higher than stated in the report. Of course, if productivity is expected to rise over time, then the Report is understating harvesting activity in the future. in the future, the operable land base may be overestimated; •Stumpage does not appear to be defined correctly; could be of lesser quality than supposed in the Report; •Price sensitivities may have peculiar results. 5 This seems to be confirmed after viewing the Wood Cost Maps.

    Response: As noted in (9), the employment coefficients implemented in the study were obtained from the socioeconomic analyses conducted for the management units of the region as part of the TSR and are unrelated to Figure C-1. Productivity trends are not included in the model and we agree with the reviewer's description of the relationship between labour productivity, harvest costs, and rate of cut.

Cortex Consultants Inc.

Response to comments by J. Nelson, Faculty of Forestry, University of British Columbia. December 17, 2003

Reviewer comments are reproduced here verbatim.

In his review, Dr. Nelson has identified some errors of presentation in the draft document and has made many suggestions that will help to interpret our results. We have corrected the errors which he identified and adopted many of his suggestions for presentation.

There are five comments that we wish to respond to explicitly.

1. **Comment:** I generally follow the treatment of development costs, but similar to Mr. Johnson, I am confused about whether roads and bridges are expected to last 100-200 years or if maintenance costs include some form of capital replacement. The other area I find confusing is whether cost trends have been applied in the analysis. I think not, but there are comments that refer to declining costs in second-growth, and Footnote 8 (p B-6) that confuse the issue. Perhaps the trends are for development cost adjustments related to lower volumes. If this is the case, I suggest using "adjustments" rather than "trends". The end result is that it becomes difficult to identify the "base case cost model " that is referred to in Appendix D tables describing the scenarios.

   Response: Further to our response to Mr. Johnson on this issue (comment 6), no, roads and bridges are not expected to last 100-200 years. There are "reactivation" development costs associated with second growth which are less than the initial development costs, because it is assumed that the major roads and bridges on a timbershed will be maintained in the future, and that their cost of maintenance will be covered by road maintenance charges as per the appraisal system and as captured in the cost model.

   This issue has been clarified in the report.

2. **Comment:** I am curious as to why the EBMPH scenarios have a non-declining even-flow constraint while the FE scenario is a strict even-flow constraint? A little text on the impacts of non-declining even-flow versus even-flow constraints might add to the report.

   Response: The financial efficiency (FE) scenario and the EBMPH scenarios are all strict even flow. The description of the EBMPH scenario has been corrected in the text.

3. **Comment** Are the region/landscape level constraints (old) actually applied as constraints or are they simply tracking these indicators? When I look at Fig 3.8 and 3.9 in the main report, I see the amount of violation in the old forest occasionally increasing. If the harvest is truly constrained, and there is no natural disturbance modeled, this shouldn't happen – violations can only stay constant for a while and ultimately they must decline. Somewhere, there appears to be an old-growth "leak". It might be caused by the definition of these constraints (p. D-7 - …account for 95% of the area…)? I am guessing that the old-growth violations in Fig 3.8 and 3.9 never reach zero because the model has only been run for 200 years, and the

definition of old-growth is 250 years (e.g. stands aged 0 at year 0 are only 200 years old at the end of the simulation).

Response: The old-forest constraints were implemented as goals, as the forest is already in violation of the EBMPH retention rules. A penalty weight forces the model to reduce violations over time. As the reviewer notes, in some scenarios and in some decades the degree of violation actually increases. This is due to an insufficient penalty weight—the model traded-off a small increase in violation in order to meet some other objective. We explore the sensitivity of harvest levels to penalty weights—and therefore, violations of retention constraints—in Haida Gwaii/Queen Charlotte Islands portion of this study.

4. **Comment:** I agree with Mr. Johnson that the conversion return is not properly split between the land owner (stumpage) and the industry (profit to enterprise). As he points out, beyond a fair return to enterprise, the residual belongs to the land owner.

   Response: We agree. Please see our response to Johnson, comment 2.

5. **Comment:** Using a "crisp" 250+ age definition for old-growth stands certainly will influence harvest projections and residual forest conditions. The initial forest cover inventory often lumps vast areas of forest into a common age (e.g. 251 years or 235 years) and this can immediately affect the seral constraints within the model, and/or lead to periods when the seral constraints are binding. The authors should comment on whether this was the case in the scenarios they modeled. In future work, you might consider formulating "fuzzy" seral definitions that allow for a gradual transition from on seral stage to the next. This will reduce sudden jumps in the amount of old forest as stands age from 249 years to 250 years.

   Response: Yes, we used the "crisp" definition of the old-forest constraint. Given that we were measuring impacts relative the TSR base case—which employs the crisp definition—we believe that it was the right choice.