Response Papers of KM

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A

Addendum and Corrections.

KM would like to table a correction to a number in their Report and share a few additional calculations that were not included in the original report. This data was part of KM's response to IRR PUB 39 but is included here again for the benefit of those who might not have seen it.

KM estimated an annual AR(3) model to the 94 water flow years series provided by MH. The AR (3) model was simulated using re-sampled residuals for one million years. The probability that a randomly chosen year's water flow is less than the minimum year observed during the 94-year period is .00407 (one in 246). KM wish to correct this number in their Report where it was wrongly presented as 1 in 392 years (P. 191).

KM also estimate the cost of a five year drought with expected prices to exceed $3,342.5 million and that of 7 year drought with expected prices to be $4,548.3 million. These estimates are based on picking repeated samples of 5 year and 7 year low water flows from the AR (3) model. This way they capture the auto-correlation structure embedded in the water flow series. Thus, the 5 year low flow is not a multiple by 5 of a given low flow year; it is a five year group of low flow years. KM estimated the probability that a randomly chosen five-year period's average water flow is less than the average water flow observed during 1987-1991 to be .013833 (or a chance of occurrence of one in 72). Furthermore, KM estimated the probability that a randomly chosen five-year period's average water flow is less than the average water flow observed during 1937-1941 to be .008466 (or one in 118). As well, the probability that a randomly chosen seven-year period's average water flow is less than the average water flow observed during 1937-1941 is .012840 (or one in 78).

Response to Mr. P. Bowman and Mr. A. McLaren

InterGroup Consultants Ltd. represented by Mr. P.Bowman and Mr. A. McLaren (BM) have submitted to PUB on behalf of MIPUG Pre-Filed testimony in regard to MH 2010/11 and 2011/12 GRA.

In their testimony BM (P. 4 Lines 14) argue that the Board should not accept the suggestion of KM Report in regard to new added "water in storage" overrides, nor alterations to the "objective functions" in Hydro's short term scheduling model (MOST) (proposed by the KM Report to target minimized generation cost, as opposed to the current target of maximized net revenues) (P.4 Lines 15,16 and 17). They also argue that KM Report recommends what appears to be a materially higher target financial reserve level (approximately double the existing standard) (P.4 and Lines 31and 32). Further, BM argue that this recommendation is not consistent with any practice in Manitoba (P.4 Line 33; P.5 Line 1), or with the fundamental framework for public power development focused on the long-term, and as such should not be accepted by the Board (P.5 Lines 1 and 2).

BM base their arguments on their acceptance of ICF's and KPMG's estimates of what five and seven year droughts would cost (both ICH and KPMG, more or less, accept MH's estimates of $2.7 billion for a five year drought and a $3.5 billion for a 7-year drought). These expected losses are then compared to the level of retained earnings accumulated, or expected to be accumulated, and find them adequate (that is, of the same magnitude of the estimated drought losses).

KM have estimated the probabilities of a five and a seven year drought and have assigned expected values on these losses in the response to PUB's IRRS. KM filed these estimates on the 16th of November 2010. The magnitudes of expected losses from these droughts exceed the already accumulated retained earnings. When other possible adverse developments are factored in and their implications on net revenue losses estimated (high interest rates, high import prices and an appreciated Canadian dollar), the accumulated retained earnings are only a fraction of these estimated losses. This is why KM argued that for the sake of avoiding rate shocks and to ensure predictable rate adjustments other sources of funds (mitigation measures) should be drawn upon. This is the basis of the eclectic four sources suggested by KM to complement the reserves supplied by retained earnings.

First, KM argue for rate overrides that will provide a transparent mechanism for inviting consumers to share explicitly in the mitigation of these risks. Second, KM propose a more conservative management by MH of water level and balances (energy in storage). This energy in storage has value and it ensures that MH shares in this risk mitigation strategy by behaving more conservatively than a revenue maximization strategy would require. Third, the retained earnings are a major component of this mitigation strategy, but they should not be the only one. Retained earnings play many roles. One of these is to act as a cushion that could help to persuade lenders and counter parties of the financial viability and health of the utility. These retained earnings are also a crucial component of

several indicators of financial health (Interest Coverage Ratios, Investment Coverage Ration and Debt/Equity Ratio). It is not advisable to restrict their use to self-insurance against drought risks. Fourth, KM argue for prudence in raising debt. The issue of debt avoidance is limited here to drought risk mitigation. KM did not argue that MH should refrain from raising debt for long term investment purposes.

KM did indeed argue for cost minimization objectives and still do. Rate increases approved by PUB assume that MH has done its best to control costs; otherwise these rate increases would reward inefficiencies. Restructuring not only MOST but HERMES and SPLASH to minimize costs is advisable and makes sense. First, MH is a public utility and not a private corporation. Private corporations maximize profits and that is acceptable. It is not acceptable for regulated natural monopolies to seek profit maximization. Second, MH has to meet domestic load and is tied to meet firm long term exports. It does not choose the price it charges in the domestic market, nor does it really do so in the export market. For all practical purposes it is a small operator in the export market and is a price taker. Given these constraints, it makes sense to minimize the cost of what it has to generate to meet these commitments. To suggest that it can maximize net revenues is not realistic or credible. These considerations are not dependent on the time horizon as BM suggest; they are based on the structure of the markets within which MH operates.

C

Response to Mr. J. Wallach

Mr. Wallach ("Wallach") argues that the KM Report recommendations of rate increases and other measures to increase retained earnings and build an emergency reserve fund as a buffer against potential drought-related financial losses would be "premature" to adopt before Manitoba Hydro's new risk model is fully implemented as part of the Company's resource planning and corporate risk management processes. Wallach further argues that before taking such measures and thereby increasing costs to consumers, the Company should determine the likely magnitude of expected financial losses, the likelihood of more severe losses than expected, and the extent to which forecasted losses would fall within tolerance limits. Moreover, to the extent that risks are deemed unsustainable, the Company should examine whether there are opportunities for directly *reducing* risk – such as diversification of the resource portfolio into energy efficiency, renewable energy sources, or efficient thermal generation – that are less expensive than measures such as those proposed in the KM Report to *buffer* risks. Subsequently Wallach added the argument that this portfolio diversification would not only reduce exposure to drought-related financial losses, but might also reduce earnings volatility and reduce the Company's overall cost of capital.

Response: KM see their proposal for developing the four eclectic measures to deal with drought losses and other contingencies as a complement and not as a substitute for developing a diversified portfolio of renewable energy sources, and implementing efficiency augmenting measures of all MH's activities and operations, etc. KM are happy to agree that MH could and should explore the development of this portfolio and expand its DSM systems. The real issue with Wallach's argument, however, is the extent to which the portfolio measures would be sufficient and in time to mitigate drought and other serious risks and the extent to which these energy supplies have a low covariance with other hydro resources. Wallach's recommendation requires some empirical assessment of these considerations to evaluate their sufficiency and efficacy.

Wallach also argues that the KM Report does not directly address the reasonableness of the Company's single-factor sensitivities, but does find that ICF underestimated the probability of recurrence of a five-year drought. However, the KM Report does not indicate whether ICF's underestimate of drought probability undermines that report's finding that a sensitivity that combined drought risk with other risk factors would be unreasonably stressful.

Response: KM criticized ICF on account of its formulation of the likelihood of joint drastic events (drought and high import prices or high interest rates or an appreciated dollar). ICF assumed that these events are independent of each other and that they have equal probability (1/2) of occurring and not occurring (binary) making the probability of occurrence of any combination of difficult events very unlikely. It is correct that KM stopped at criticizing this ICF formulation without assigning probabilities to joint events but KM went on to estimate the cost of these bundled occurrences using a Monte Carlo probabilistic approach.

D

Response to Rebuttal of Manitoba Hydro

KM will address briefly the response of MH to their report as presented in MANITOBA PUBLIC UTILITIES BOARD IN THE MATTER OF *The Crown Corporations Public Review and Accountability Act* AND IN THE MATTER OF the Manitoba Hydro filing in respect to Increase Electric Rates for 2010/11 2011/12 REBUTTAL EVIDENCE OF MANITOBA HYDRO. KM will not address all issues raised, but will concentrate on the most relevant issues and concerns in the order they were raised by MH.

Manitoba Hydro's Risk Tolerance is Aligned with that of its Ratepayers [p.2 of Rebuttal]

1) KM did not suggest that this misalignment is on account of MH trying "to enrich a select group of shareholders." This misalignment arises simply because MH's appetite for risk is not necessarily the same as that of its rate payers.

2) KM are aware that many oversight bodies in Manitoba are interested and have ample opportunities to assess MH's performance in managing its risks and ensure that it provides value to its customers. KM single out PUB as the most directly involved body in overseeing and assessing the implications of this performance on rate payers and rate setting. This focus on PUB is not meant to exclude and underestimate the role and responsibilities of the other oversight bodies.

There are No Additional Benefits of RSR's, Variance Accounts or Special Rate Riders [p.8 of Rebuttal]

KM argued for an eclectic approach to insure MH and rate payers against all kinds of risks that may involve large losses and may require large rate increases and/or borrowing. KM are concerned that over –reliance only on retained earnings may not be the most appropriate strategy especially given the intention of MH to undertake an ambitious capital expansion program in the near future. Given the amount of uncertainty it is only prudent to diversify the options and sources that can be marshalled to deal with any contingency.

KM were also suggesting the creation of a sharing structure and transparent mechanism for risk mitigation. Bringing in the rate payers as partners in this mitigation strategy can be achieved through visible rate riders (Ontario collects from rate payers the debts of Ontario Hydro through this mechanism). The government of Manitoba is already a partner in guaranteeing MH's debt but it would make sense to define a government guaranteed borrowing target for risk mitigation purposes. KM are suggesting two things, one, that MH only use a part of its retained earnings, in order to leave another part that can be used for interest and investment coverage, and second, to impose a more conservative regime on water storage. The experience of 2003/04 argues for prudent reserves and mitigation options.

Maximizing Net Revenues versus Minimizing Costs [p.58 of Rebuttal]

KM argued that MH is a price taker and is quantity constrained in the domestic market. KM has always accepted that MH is committed to meet its domestic load first. KM also recognizes that the combination of uncertainty and profit maximization in the export market could expose MH to possible trade-offs that may not be intended. For example, water can be released from storage for opportunity sales at a time when it may not be appropriate if sufficient rainfall is not guaranteed in subsequent periods. This is not in the realm of potential occurrences; this actually happened in 2003.

Furthermore, given that MH is a price taker and is quantity constrained in the domestic market and is also price and quantity constrained in the firm export market, it would make more sense for MH to strive to minimize the cost of its entire generation and delivery than to maximize net revenues on a small segment of its entire operations in the opportunity market.

Drought is Not an Emergency at Manitoba Hydro [p.59 of Rebuttal]

KM inappropriately used the word emergency to characterize a drought but still insists that a Drought Preparedness Plan (DPP) be instituted in MH's operational planning and risk mitigation strategies, precisely because the onset of a drought is not typically foreseeable. Continuous monitoring of precipitation and other key variables remain necessary and advisable but more appropriately a set of action-triggers are needed. KM argued that there are many lags that characterize any decision-making system dealing with droughts. There are awareness lags, identification lags, decision lags, implementation lags and result lags. These lags can be crucial and long. They need to be shortened. A DPP can help do that.

Manitoba Hydro's Dependable Resources are Adequate [p.61 of Rebuttal]

KM did not confuse cost for availability. The issue here is dependability. Wind energy is not dependable because it is not dispatchable. FERC in the USA does not qualify wind as reliable energy for precisely this reason.

Manitoba Hydro's Estimate of the Financial Impact of Drought is Reasonable [p.62 of Rebuttal]

KM were happy to conclude, having considered a broader sampling of water flows, that MH's working principle for dependable energy is satisfactory. KM made this assertion having found that water flows under the most severe drought in the 94 water flow series are not significantly different from the average of the water minimums in repeated samples of 94 year draws. The fact that SPLASH uses this configuration of water flows in the worst years is not a problem.

The real problem is two-fold. First is the assumption of perfect foresight which allows

the water flows to represent the maximum (minimum water storage) flows. Second, KM argued that using exactly the same pattern represented by the autocorrelation of flows in the 1940s to remain in effect in the 5 years and the 7 year drought cases is itself a source of underestimation. KM argued that using these two assumptions would lead to underestimation of drought costs because both assumptions reduce the need to import more expensive energy or produce energy domestically using higher cost generation, and also because the recovery in the five and seven year that actually happened were higher than the 5 and 7 year patterns displayed in the 5 and 7 year samples picked randomly.

Whether or not the word "drastic" is appropriate or not does not detract from these considerations.

Manitoba Hydro's Suite of Computer Models Serve Their Purposes Well [p.65 of Rebuttal

It is correct that KM found the MH models to be on the whole satisfactory but this is not an argument that they cannot and should not be improved. It is also true that the costs of these improvements should be balanced against expected benefits.

MH argues that "it has a suite of computer models (MOST, HERMES and SPLASH) used in operating and planning the Manitoba Hydro generating system. Each of these models has a different function and each fits into a hierarchy of time horizons. Consequently, each model considers factors that are important in that time horizon. Each of these models utilizes a linear programming formulation to optimize the operation of the system within the corresponding time horizon. Each model resides on different computer platforms within different divisions of the Corporation." It is exactly these considerations that prompted KM to argue that they should be integrated and should be on the same computer platform using the same solvers. Having separate uses and users is not a compelling reason to have separate models. The fact that they are all linear programming systems is enough grounds to harmonize them and integrate them on a common platform. They could be based on data and coefficients that are consistent across models. The different users can learn and support each other. A pool of talent would be available for all divisions.

The Role of PRISM at Manitoba Hydro [p.68 of Rebuttal

KM recognize that PRISM is an on going project; it is subject to revisions, upgrading and fine-tuning. It is KM's understanding that PRISM has been useful in evaluating the cost of several risk factors and that one of them is low water flows. The results of this assessment are displayed in the document "Risk Analysis Using PRISM". It is also true that Real Advisory calculations of drought cost used @RISK which is the same system used in PRISM.

Hydrological Modeling at Manitoba Hydro [p.69 of Rebuttal]

KM did not argue for replacement of antecedent forecasts in HERMES by hydrological modeling. Rather KM argued that hydrological variables (e.g., precipitation) can be added to improve these forecasts. Using a single variable in some of the antecedent equations is not sufficient. A number of equations have low R^2 and other poor statistical indicators.

KM have not argued for replacement of historical forecasts; KM actually generalized them. KM are arguing for a more nuanced augmentation of hydrological variables in this area.

MH has produced evidence that the forecasting accuracy of modeling precipitation is low. The issue here, however, is whether the accuracy of the antecedent forecasts without precipitation is higher or lower. This is a matter that needs to be tested empirically before a judgment to discard precipitation is reached.

Use of Linear Programming Instead of Non-linear Programming [p.71 of Rebuttal]

KM have suggested the use of nonlinear optimization systems based on their understanding that the underlying structure of water flow rates, volumes and head are interdependent. That is, a given flow rate will influence head and the two variables are jointly determined.

This interdependence among variables is not restricted to water flow rates and heads. Such being the case it makes sense to use nonlinear programming to capture these nonlinear relationships. Iterative solutions can be used to simulate a solution if convergence is guaranteed. However, the underlying generation system is continuous in time while the linear system is discrete. A continuous specification is a more accurate representation of this system. It would make more sense to flow time continuously rather than the current practice of solving for a year at a time as is the case in SPLASH.

KM are aware that solutions to nonlinear optimization problems are far more complex than those of linear systems. That is why KM have recommended exploring the use of some of the new solvers that allow quick and efficient solutions of large nonlinear systems. It does not make sense to argue against exploring the benefits of the non-linear system simply on the basis that it may take more time.

Currently SPLASH runs take a good chunk of time to solve. Some of the new solvers, such as GAMS and AIMMS, are quite efficient even for large non-linear systems. In the final analysis the taste of the pudding is in the eating. This issue can be settled by trial examination of these solvers.

HERMES Errors are Not Large [p.73 of Rebuttal]

KM stand by their assessment of what they consider relatively high forecasting errors in

a set of key variables in the first forecasts from HERMES. These forecasting errors were actually supplied by MH. We also stand by our appreciation that the second forecasts' errors are made with more information about precipitation and are significantly lower than those of the first forecasts.

Actually the fact that this difference seems so sensitive to information about precipitation is exactly what prompted KM to suggest that MH should rely more extensively on hydrological variables than simply lags in flows.

HERMES and SPLASH Results do Not Include Forecasts of Domestic Revenues [p.75 of Rebuttal

KM recognize that SPLASH and HERMES do not maximize net total revenues but net export revenues. However, net total revenues are sensitive to the domestic load forecast; both HERMES and SPLASH use this domestic load forecast and this forecast value of the load underpins the estimation of total net revenues.

The response of KM to RCM/TREE was about whether or not the calculation of total net revenue involves the forecast value of domestic load, no more and no less. There was no suggestion that HERMES or SPLASH maximize net total revenue.

Production Coefficients are Not Different in HERMES and SPLASH [p.76 of Rebuttal]

KM agreed with the claim that there are different production coefficients in HERMES and SPLASH. But these differences arose on account of the difference in timing used in these models. Their impacts of the differences had negligible effects on net revenues.

Placing Models on a Common Platform is Unwarranted [p.78 of Rebuttal]

KM are aware of the different uses of the various MH models. KM also recognize the different mandates of these systems. KM still feel that there are good reasons for integrating these models on a common platform precisely because of the many elements and components they share—all are linear programming models, they use common data sets, they have and must have common coefficients, they profile the same stream flows and generating stations and transmission capacities, etc.

There are many other grounds that could be used in support of this recommendation. **First**, it is possible to create a common talent pool within MH that can be drawn upon by all using divisions. In the present circumstance it appears that a small group of staff is responsible for its own "model"; broadening this base can be to the advantage of MH. **Second**, there is always the question whether the system is coherent and consistent; putting the system on a common platform would end this concern. **Third**, there are economies of scope and scale that can arise from integrating the three models. **Fourth,** a common solver can easily be used and maintained instead of having to contend with different solvers and different computers as is currently the case. **Fifth**, staff can learn

from each other and a modeling community can be developed around this common system. It is much easier to develop this community around a single system than when there are many different systems. **Sixth**, the different uses (operations and planning) and perspectives (time steps and windows) can easily be handled in the integrated system. **Seventh**, any updates and extensions would go to the benefit of all users simultaneously, maintaining the integrity of the system. **Eighth**, oversight and validation are easier to exercise over one common system than over three different systems.

Manitoba Hydro Open to Demonstration of SPLASH [p.79 of Rebuttal]

Dr. Kubursi was able to see a demonstration of the SPLASH model on January 15, 2011, and notes with satisfaction that the demonstration clarified many issues and increased the level of comfort with the system. KM still stand by their recommendations for documenting and integrating SPLASH with other MH systems.

Benefits of Additional Reservoir Storage Already Effectively Captured [p.80 of the Rebuttal]

KM recommended that MH designate a higher volume of water in storage than is required for optimization of net export revenues as a sort of an insurance premium. MH is already doing so, perhaps for a different reason. Whatever the reason, KM believe that this is a prudent risk mitigation strategy for MH to implement and adhere to.

The Value of Seasonal Diversity Contracts [p.82 of Rebuttal]

KM are well aware that summer diversity contracts are not mandatory. KM apologize for any mix up on this matter.

The Accuracy of Data in KM Table 6.1 [p.83 of Rebuttal]

KM used public information published by Statistics Canada. MH's disagreement is not with KM but with Statistics Canada ("SC"). It would make sense to consult with SC before any judgment is reached on whether this data is accurate or not. It is important to recognize that SC data is on a calendar year basis whereas IFF is on a fiscal year basis. This could perhaps be part of the difference, but definitely SC should be consulted on the claims made by MH about the accuracy of this data.

KM Quantification of Risks Is Not Reliable [p.85 of Rebuttal]

The issue of accuracy of data can not be settled independent of Statistics Canada. KM have produced the sources of the data and, as much as the data reflect accurately what is reported by SC, the confirmation of the inaccuracy of this data should be made in consultation with SC.

KM wish to address the claims of MH that KM's methodology is flawed. KM list below the claims in the sequence they were raised by MH and then address each claim in sequence.

MH claims that even if KM had used the correct Manitoba Hydro data, results would still be unreliable due to flawed methodology. This is because of the following:

1) According to MH it is not appropriate to utilize a short period of seven years in order to derive a representative probability distribution function. These are not representative of the full range of possibilities since they are relatively high flow years for the most part and this would bias the results.

Response: The seven years are the most up-to date available and they cover the drought years of 2003 and 2004 as well as high water years. Therefore, it is not true that they only cover relatively high flow years.

2) Secondly, KM have fit probability distribution functions to factors that are not random variables but that are outputs from a complex process that has random variables as an input. An example of such outputs is the quantity of opportunity export energy which is not a random variable but is dependent on water flows and firm load demand.

Response: These are indeed random variables because they are determined by inputs that are themselves random variables.

3) The sample of seven Manitoba domestic loads is not the product of a stationary process since there is inherent load growth during the period. Furthermore the quantities of export and import energy are not random variables and there is a correlation between these quantities due to flow conditions and load demands. For example, high flows result in large quantities of opportunity energy which results in a lower average price because more of the energy must be sold at lower off-peak prices. Similarly, high flows result in lower quantities of import energy at low prices because they can be purchased during off-peak periods.

Response: The variables considered by KM are subject to uncertainty and therefore are random. The fact that they could be correlated does not disqualify them from being random. What MH may be confusing here is that these variables are connected (jointly determined) with them not being random.

4) MH claims that given the great inaccuracies demonstrated in the Table 6.1 data, any definitive conclusion given in the KM Report based upon this analysis is flawed and should be set aside. Such an analysis, to be reliable, would require verified Manitoba.

Response: KM have used published SC data in their Report. KM have relied in the past and continue to rely on the high reputation of SC's data. KM cannot dismiss the accuracy of this data without giving the chance for SC to explain the differences MH have noted.

5) Hydro data and would be required to take into consideration all relevant factors, including, for example, physical system capabilities (e.g. tie-lines, generation capacity), the effects of load growth, new contracts, new generation, changes in market rules, the effects of regulatory changes on operations (e.g. Brandon Unit #5), and correlations between parameters. These examples are not an exhaustive list, but are illustrative of the wide range of variables which must be considered to undertake a fulsome analysis and from which definitive conclusions could be drawn.

Response: One of the major reasons why KM have relied on SC is KM's desire to use publicly disclosed information and to avoid the disclosure of any confidential data. KM would very much like to use MH's data and have in the Report used MH data when it was available.