Manitoba Hydro Undertaking #69

KPMG to provide a copy of the draft risk report reviewed by Manitoba Hydro.

KPMG Response

Please see attached report.

Table of Contents

Note to Readers

This is a draft document provided for a meeting of the Audit Committee of the Board of Manitoba Hydro on April 9, 2010.

The reader is cautioned to rely on the final document only because there may be changes between the draft and the final document.

Executive Summary

Formatted: Indent: Left: 0", First line: 0"

In 2005, Manitoba Hydro retained a consultant (the "Consultant") to assist with aspects of certain risk management practices. The Consultant's work led to a series of reports which contain assertions pertaining to Manitoba Hydro's export power sales and associated risk management practices.

KPMG LLP ("KPMG") was retained by the Board of Directors of Manitoba Hydro in November 2009 to carry out an independent assessment of its risk management practices ("Review") in its hydroelectric operations and to address the assertions raised by the Consultant.

KPMG is an audit, tax and advisory firm, and the Canadian member firm of KPMG International, a Swiss entity. KPMG International's member firms have 140,000 professionals in 146 countries. KPMG is an independent advisor with considerable experience in risk management practices in the public utility sector. KPMG has conducted many risk advisory engagements with leading organizations in this sector in Canada and around the world.

Scope of the Review

The scope of our review is as follows:

- review the assertions that have been made by the Consultant and the reports and services provided by the Consultant;
- identify the positions of Manitoba Hydro staff on each of the assertions and the services provided by the Consultant;
- perform a review and validation study of the merits of the Consultant's assertions and services; and
- prepare a report summarizing KPMG's findings.

KPMG's review examines certain risk management practices of Manitoba Hydro stemming from the assertions. Our scope is limited to key aspects of the hydroelectric operations of Manitoba Hydro and related corporate functions but does not include reviewing Manitoba Hydro's risk management practices as they apply to any other business products such as its natural gas operations, or to areas such as environmental and employee safety issues.

Background

The utility industry has undergone significant change in the last decade, including deregulation in some jurisdictions, the introduction of competitive energy markets across Canada and the United States, heightened environmental attention, fluctuating economic conditions and a continued focus on security of supply at reasonable prices for ratepayers. Taken together, these factors have significantly added to the complexity of managing risk. Most utilities are continually adapting their risk management practices to these changing circumstances.

Like its peers, Manitoba Hydro is subject to the impacts of these changes. Accordingly, Manitoba Hydro's operations have become, and will continue to be, more complex than ever before. This will continue to require further advancements in its modeling capabilities, export power sales practices, corporate risk governance, and power risk management practices. Manitoba Hydro has well established practices in place and a number of initiatives underway to improve its risk management practices. Many of our key findings reflect recommendations Manitoba Hydro should consider in further improving these practices.

Key Highlights

The Consultant has raised serious concerns as to the financial viability of Manitoba Hydro and the risk of major power outages related to its long-term export contracts. Further, the Consultant asserted in 2008 that Manitoba Hydro actions in the previous five years have cost the corporation in the range of $1 billion. Our approach has been to identify and analyze all of the alleged deficiencies in Manitoba Hydro's operations and have done so pursuant to our scope of work as detailed in the main report.

We are of the view that:

- there is no material risk that Manitoba Hydro is facing bankruptcy as a direct consequence of Manitoba Hydro's export sales practices;
- there is no material risk that Manitoba is facing power outages as a direct consequence of Manitoba Hydro's export sales practices;
- Manitoba Hydro's drought management strategies are prudent in the context of a hydro-based generation system;

- there is no evidence to support an assertion of losses approaching $1 billion in the five years cited, based on our analysis of Manitoba Hydro's modeling, export sales contracts and risk management practices;
- Manitoba Hydro has prudently utilized a strategy based on entering into long-term contracts and the securing of transmission rights in the development of its system; and
- Manitoba Hydro has operated in accordance with its legislative mandate.

Overall, in the context of its hydroelectric power operations, we are satisfied that Manitoba Hydro is following sound practices in its use of forecasting models, long-term power sales contracting, risk governance, and power risk management. Our report provides recommendations to Manitoba Hydro in order to continue to advance in these areas. Recommendations are contained within Chapters 3 to 6 of the main report and are summarized in the concluding Chapter 7.

Approach of the Review

KPMG's undertook the Review using a two-phased approach.

In Phase 1, KPMG undertook an initial assessment of assertions raised in the Consultant's Reports to identify the scope of the assertions and to develop an approach and work plan for the more detailed assessment that would be undertaken in Phase 2 of the Review. In Phase 2, KPMG undertook the work plan developed during Phase 1, and the results of conducting that work plan are reportedprovided in this report.

Phase 2 of the Review examined multiple lines of evidence for consideration, including:

- reviewing Manitoba Hydro documentation and data;
- interviewing Manitoba Hydro personnel;
- conducting analysis based on industry leading practices;
- conducting research of other electric utilities;
- consulting with specialized subconsultants;
- conducting literature reviews;

- analyzing third party data and reports;
- analyzing various financial and forecasting models used by Manitoba Hydro; and
- analyzing model runs conducted by Manitoba Hydro at KPMG's direction.

Issues and Themes

In undertaking the Review, KPMG analyzed the various assertions made by the Consultant in order to group related assertions that are within our scope into Issues. These Issues were then further grouped into four Themes. We define an Issue to be the components of an assertion(s) that reflect an alleged fundamental deficiency in Manitoba Hydro. The assertions made by the Consultant were considered in this process.

There are four Themes that were used in the conduct of our Review and the Issues within these Themes are outlined in the chart below:

- Forecasting models;
- Power sales management;
- Risk governance; and
- Power risk management.

The report contains a chapter on each one of the Themes. To appropriately assess the Issues contained within each Theme and to add value for Manitoba Hydro, our scope in certain instances extends beyond the matters addressed by the assertions.

Themes and Issues	
1. Forecasting models	
Issue 1	Appropriateness of inputs and model logic relating to pricing, water volume, key model parameters, lake water level balances and market rules
Issue 2	Treatment of optionality relating to plant cycling and storage
Issue 3	Validation of models
2. Power sales management	
Issue 4	Pricing methodology for firm power sales
Issue 5	Risk capital reserves
Issue 6	Long-term contracts structure
3. Risk governance	
Issue 7	Independence of the Middle Office function
Issue 8	Resourcing and authorities relating to energy risk management
4. Power risk management	
Issue 9	Treatment of risk (identification, measurement, treatment)

In this Executive Summary, for each of the four Themes, we have a section:

- identifying the Issues;
- providing operational context relevant to that Theme; and
- for each Issue, a summary of the Consultant assertions followed by KPMG's key findings.

These sections are followed by a brief conclusion.

Forecasting Models

We have reviewed the three key models (called HERMES, SPLASH and PRISM) used by Manitoba Hydro to support operations, capacity planning, and financial forecasting and budgeting processes. Of the three models reviewed, our focus was on HERMES because it plays the most important role with regards to the Issues pertaining to forecasting models.

We assessed the overall reasonableness of the modeling approach taking into account the use of the models, input assumptions, and evidence with respect to the models' effectiveness for their intended roles. Chapter 3 provides details on our analysis and findings.

Issues

With respect to forecasting models, KPMG addressed three Issues identified in the scope of work:

Issue 1: Appropriateness of inputs and model logic relating to: pricing, water volume, key model parameters, lake water level balances and market rules;

Issue 2: Treatment of optionality in terms of plant cycling and storage; and

Issue 3: Validation of models.

Operational Context

In evaluating the use of models at Manitoba Hydro, it is important to consider the context in which it operates and the types of decisions that the models are designed to support.

Water volumes at Manitoba Hydro are subject to wide swings from year to year. The year-to-year variation in water availability is much larger for Manitoba Hydro than for most other large hydroelectric utilities. The lowest flow year on record has less than 50% of the flow of the median year. The highest flow year is more than 50% greater than the median flow year. Hence the highest flow year is more than three times the level of the lowest flow year. The variability in water flows has important implications for the design of the system, Manitoba Hydro's export sale strategy, and the focus of modeling work.

Further, even within a year, future water flows are highly uncertain. Flow volumes can change dramatically based on the volumes of spring rain and, to a lesser degree, the extent of snow melt. Manitoba Hydro relies on its antecedent forecasting process in its production planning process, but the predictive power of this methodology is inherently limited. Antecedent forecasting uses regression analysis to predict future water flows based on current flows.

Uncertainty in water flows results in Manitoba Hydro selling much of its export power on a short-term basis in order to be highly confident that the power can be supplied. The percentage of Manitoba Hydro's export sales made on a short-term basis fluctuates year-to-year depending on water volumes, and is considerably higher in high flow years. For fiscal 2008/09, which had higher water flows than average, over one-half of sales were made in Real-Time or Day-Ahead markets as well as other short-term sales. For their spot market sales, Manitoba Hydro commits to deliver power, at most, one day ahead of time. Other opportunity sales are short-term, but are made outside of the spot market.

Manitoba Hydro also enters into long-term contracts which are serviced from "dependable energy". Dependable energy is the hydroelectric power available under the lowest river flow conditions in the historical record, and also includes energy sourced from wind and thermal as well as firm and contracted non-firm imports. (Although the definition of dependable energy contains a number of non-hydroelectric sources, these sources remain a very small share of Manitoba's total production.).)

To account for uncertainty in its water supply, Manitoba Hydro is conservative in its export sales strategy:

- Long-term sales are limited to those that can be supplied from dependable energy.

- Opportunity sales made beyond the day-ahead and real-time markets are limited to those that Manitoba Hydro is highly confident can be supplied based on current water conditions.

As a consequence of the reliance on spot sales, changes in forecasts of future longer term production, because of changes in parameters in HERMES, do not lead to shortfalls in Manitoba Hydro's market position. Manitoba Hydro does not commit to opportunity sales that are based on uncertain water flows, and consequently does not incur contractual or market losses when medium and long-term forecast water flows do not materialize. This is an important factor to consider in evaluating the risks of financial loss.

In general, forward opportunity sales are not made unless Manitoba Hydro has sufficient firm capacity and energy resources to serve the load 95% of the time. This means there is only a 5% chance that such firm resources will be inadequate. For drought management planning, the required level of confidence in planning energy supply increases to 99%. This risk target reflects the combined probability of a severe winter (defined as a one in 10 event) and water supply at the 5^{th} percentile level.

Models and their outputs are used as tools to support decision-making processes at Manitoba Hydro. The outputs from models do not directly lead to business or market actions and do not translate directly into financial profit or loss. For example, HERMES generates forecasts of available energy and suggested production schedules. These forecasts of available energy, however, are not translated directly by trading staff into forward market positions. Similarly, suggested production schedules produced by HERMES do not lead directly to control decisions at Manitoba Hydro hydroelectric facilities.

A key output of HERMES relevant to the scope of this review is a forecast of the amount of energy available for export within each segment of time modeled. This forecast is used as a reference point for assisting energy trading operations. Because of the priority of meeting domestic load before any energy export commitments, and due to the requirement to mitigate chances of there being insufficient resources to serve forecasted load, the Manitoba Hydro system is operated conservatively. Sales decisions are supported by various modeling tools within HERMES, such as load forecasting, water supply forecasting, capacity and reserve management, and deal analyzer modules.

Reliability issues are also addressed in model runs within HERMES. A standard run generates an economically optimal production schedule, based on its input assumptions. Manitoba Hydro then tests this projected production schedule against a scenario in which low water flows occur.

In the event that resources are projected to be inadequate to serve committed load, this will generally mean a draw-down in reserve storage levels, with a potential reduction in energy supply security in the second year of the projection horizon. In such event, water storage reserves will be replenished at the first opportunity, including from opportunity purchases and other non-firm sources.

Manitoba Hydro management has adopted a conservative management approach in recognition of the following:

- the duration and extent of a drought is not known in advance;
- it is normal for it to be very cold in the winter in Manitoba, which can cause loads to increase dramatically; and
- the societal and financial consequences of running short of energy during an extended period of drought (especially in the winter) can be enormous relative to the potential income that might be achieved by being less conservative.

Forecasting Models – Key Findings

This section outlines each issue and a summary of the Consultant assertions, followed by our key findings with respect to forecasting models.

Issue 1: Appropriateness of inputs and model logic relating to: pricing, water volume, key model parameters, lake water level balances and market rules

Pricing and Market Rules

The Consultant asserts that the HERMES model does not incorporate current market prices and that it needs to do so in order to serve as an appropriate basis for decisions made to release water. Specifically, the Consultant asserts that the prices used in the HERMES model should be updated regularly to reflect today's broker quotes and a true market environment. The Consultant asserts that not doing so prevents Manitoba Hydro from optimizing its financial performance in selling surplus power or buying hedges as these relate to decisions made to release water. The Consultant also asserted that the prices used in the Generation Estimate report and those used in the HERMES runs are inconsistent. It further noted that this exposes Manitoba Hydro to pricing error risks.

Findings

On pricing assumptions and market rules, we find the following:

- We have had extensive discussions with Manitoba Hydro staff on their approach for incorporating ~~prices~~pricing and market rules for power purchases and sales into their planning models. We found that they apply appropriate care and due diligence in this process.

- In incorporating market price inputs, Manitoba Hydro needs to account for the various factors that will influence the prices that it will actually receive. We have found that Manitoba Hydro puts significant analytical effort into assessing these factors and accounting for them in its ~~modelling~~modeling approach. Furthermore, the analysis of price patterns is updated as new market data is accumulated over time.

- KPMG has examined the Consultant's assertions regarding inconsistencies between the Generation Estimate report and HERMES and we conclude that, based on the sample of cases reviewed, the quoted data inconsistencies arise out of a misinterpretation by the Consultant of the data that were being presented.

- At KPMG's request, Manitoba Hydro undertook a number of special runs of the HERMES model. These runs indicate that inefficiencies in operating schedules that could potentially result from stale or inaccurate price inputs are likely to have only a limited impact on the financial results achieved. Variation in water flow has a much larger influence on optimal schedules (and on Manitoba Hydro's financial returns). Constraints on import and export transactions, and the primary need to meet domestic loads, also have significant influence on production schedules.

Water volumes

The Consultant asserts that Manitoba Hydro's models sub-optimize the treatment of water volumes. Specifically, the Consultant recommends improvements to Manitoba Hydro's method of antecedent flow forecasting (e.g., use of backtesting to validate the antecedent forecasting methodology). The Consultant also has concerns about the validity of using historical water flow data in the models. The Consultant identifies a number of years which mark the addition of gauging points and hence improvements in the quality of water data. As a consequence, the Consultant suggests that water flow data from prior to 1942 are unreliable.

Findings

With respect to flow forecasting and historical water flow data, we find the following:

- Manitoba Hydro's process for antecedent forecasting of water flows is reasonable. Underlying relationships used in this process are statistically significant. Moreover, linear regression, which is the basis of Manitoba Hydro's antecedent approach, has been a standard industry approach to seasonal stream flow forecasting for many years.

- For general forecasting and planning purposes, it is reasonable to rely on historical water flow data as model inputs. We found a number of other North American hydroelectric utilities that use a similar practice.

- Given the uncertainty of impacts from climate change, Manitoba Hydro may wish to formally examine the potential impact of changes in water flows from the historical pattern. Further, it may also wish to undertake scenario analyses to assess the financial impact of droughts worse than those found in the historical record.

  This type of scenario ~~analyses~~analysis can be used for the purpose of risk analysis, and does not necessarily need to be used as the basis of financial forecasts or for the determination of dependable energy. Manitoba Hydro's current approach to forecasting and to calculating dependable energy is reasonable and consistent with practices at other utilities.

- With respect to the Consultant's assertion that the water flow data prior to 1942 are unreliable, we found that the period prior to 1942 is characterized by lower estimated water flows relative to the full period. Hence, forecast production would be higher if these data were excluded from the water flow records. Including data from this earlier period adds an element of conservatism to Manitoba Hydro's financial forecasting process.

Key model parameters

The Consultant asserts that the SPLASH and HERMES models utilize different sets of internal model parameters (production coefficients) for the conversion of water flow to power at each hydro plant. The Consultant further noted issues regarding some approximations in the HERMES model as well as the use of "model adjustment factors" (which are sometimes manually changed). The Consultant recommended that Manitoba Hydro undertake on-going calibration and updates to both of these models.

Findings

With respect to the various matters raised by the Consultant regarding key model parameters, we find the following:

- We are satisfied that Manitoba Hydro has taken appropriate care and due diligence in modeling production coefficients in its modeling tools. Further, Manitoba Hydro carefully takes into account plant efficiency when optimizing the scheduling of its hydroelectric stations.
- We are satisfied that Manitoba Hydro has taken appropriate care and due diligence in developing, operating and maintaining the models. This relates to the approximations in the HERMES models, the use of adjustment factors, and the on-going calibration and updates to both SPLASH and HERMES. In the main report, we present recommendations for Manitoba Hydro to improve its maintenance of the models.

Lake water level balances

The Consultant notes that the SPLASH model assumes "perfect foresight" of water flows and hence assumes lake ending levels which in the real world are impossible to attain. This raises concerns with respect to the calculation of the costs of a drought. Also, the Consultant raised concerns about the reconciliation of lake level balances in the financial forecasting process.

Findings

With respect to these matters, we found the following:

- SPLASH is used for long-term forecasting purposes and to estimate the financial impacts to Manitoba Hydro of drought.
- There are a variety of factors that complicate the calculation of drought costs. On one hand, SPLASH is based on "perfect foresight" and will assume that energy stored in reservoirs is used to the fullest extent possible. In practice, Manitoba Hydro management will operate the system more conservatively than assumed by SPLASH. In doing so, Manitoba Hydro management will maintain reservoir levels at higher levels in order to address the fact that a drought may last longer than the historical record assumed within SPLASH. This may lead to

higher actual operating costs in the period of the drought than calculated by SPLASH. Higher costs are the result of scheduling additional imports and fossil fuel purchases (i.e., costs associated with not releasing water from storage at what might appear to be optimal times).

On the other hand, SPLASH may overestimate fossil fuel costs because it ignores the potential to import power on a non-firm basis. SPLASH assumes that imports only occur under Manitoba Hydro's Diversity Contracts, which are considered firm. The ability to schedule opportunity purchases through the spot market and from short-term contracts, thereby reducing fuel purchases, is not considered in SPLASH. In part, higher actual costs in the period of the drought as a result of conservative reservoir management just reflect the movement of costs for reservoir replenishment forward from future periods. However, there may also be opportunity costs associated with the increased risk of water spillage, in the event that water flows after the drought are very high.

- The impacts of these various factors on estimates of drought costs could be separately quantified by Manitoba Hydro staff in order to improve stakeholders' understanding of their implications. If a material result is identified, this can then be better communicated to users of the financial information.

- To address specific concerns of the Consultant about the reconciliation of lake level balances within HERMES, we also conducted an analysis of the financial impact of lake level discrepancies observed in the 2006 Generation Estimate Report ("lost water"). There were discrepancies in lake levels on eight of the 29 lakes modeled although the discrepancies were generally small. By applying factors representing the change in water storage with lake levels, the amount of energy per unit of water stored, and the market price of power, we estimate that projected revenues post-2006/07 were understated by about $0.98 million, because of "lost water". ~~While a concern, the~~The amount of the discrepancy was small (less than 0.2 percent) of total water in storage.

- We checked for similar discrepancies in the Generation Estimate reports supporting Integrated Financial Forecast ("IFF") processes for subsequent years. As at April 1st, 2008, discrepancies were even smaller than in 2007. At an estimated 2,800 MWh, the discrepancy had an estimated financial value of $140,000. The discrepancy at April 1st, 2009 was negligible. Such discrepancies, in addition to being small, have been significantly reduced over time.

Issue 2: Treatment of optionality in terms of plant cycling and storage

The Consultant notes a variety of deficiencies in the modeling of storage optionality, which is the financial value associated with the flexibility to change storage levels in a hydroelectric system. As a result, the Consultant asserts that Manitoba Hydro does not effectively capture or optimize the value of hydroelectric storage. In particular, the Consultant alleges a variety of deficiencies with respect to the modeling of storage in HERMES. The Consultant identifies, among other issues, differences between the HERMES and SPLASH models in their decision making with respect to the use of water in storage and in identifying target ending reservoir levels.

Findings

With respect to storage optionality and target lake ending levels, we find the following:

Formatted: Indent: Left: 0", First line: 0"

- Both HERMES and SPLASH use linear programming routines to identify optimal production decisions under input scenarios that specify loads and water resources, in addition to other production variables, over a planning horizon. Neither HERMES nor SPLASH-can explicitly address uncertainties in input variables during their optimization routines. As such, neither model captures the "option value" of storage.identifies the "option value" of storage. Rather, the models incorporate the value of storage under expected conditions in determining optimal production decisions. It is not necessary for the models to identify an explicit "storage option value" for the purpose of production scheduling.

  The HERMES system is used in the planning of operations over a short-term horizon, while SPLASH is used over a longer-term horizon to plan facility additions. Because HERMES is used to support current operational decisions, it has more detail with respect to system operations, and should produce aproduces financial forecasts that more accurate estimate ofaccurately reflect the realizable value of storage.

- Relative to SPLASH, the HERMES optimization approach appears to provideprovides for more explicit consideration in the production scheduling decisiondecisions of the economic value, relative to current sales, of greater or lesser ending storage levels. This seems appropriate given that HERMES is the tool that has the greatest impact on actual operations in the near term. Decisions in the near term, as supported by HERMES, can respond to prices that are currently observed in the market. As a longer-term tool, SPLASH has less need to adjust decisions based on current market data. Rather, it simply needs to capture the "average" or expected economics of a particular decision or sequence.

In summary, we note that neither HERMES nor SPLASH were designed to be financial trading models or to provide estimates of the market value of storage. Both HERMES and SPLASH are water management models designed to meet Manitoba Hydro's operational needs in serving its firm load.

Formatted: Font: Bold

Issue 3: Validation of models

Forecasts from models, such as HERMES and SPLASH, are based on inputs and model logic (i.e., the formulas and computational methods embedded in the model). Forecasts generated from models could conceivably be inaccurate either because of flaws in the model logic or errors in the inputs to the model (which are typically forecasts themselves).

Backtesting is a means by which errors in the inputs can be removed in order to verify the appropriateness of the model logic. The Consultant asserts that Manitoba Hydro does not back test its HERMES or SPLASH models. Accordingly, the Consultant argues that management decisions and reports based on the outputs of these two models may be flawed.

Findings

With respect to the validation of the HERMES and SPLASH models, we find the following:

- HERMES is the main tool used to support operations scheduling. Modules within HERMES represent the Manitoba Hydro system in a significant amount of detail. These modules have been developed and regularly updated over many years and reflect extensive work to calibrate model outputs to actual system performance and thereby continually validate the model.

- SPLASH is a simulation tool designed to support Manitoba Hydro's long-range system planning. The output from the SPLASH model provides information used to evaluate the economics of power resource options such as power export marketing contracts, system enhancements and surplus energy rate programs. SPLASH is also used to support financial forecasting. Similar to HERMES, SPLASH personnel validate the model by performing quality control checks with respect to actual system performance.

- In addition to the current validation procedures used for HERMES and SPLASH, Manitoba Hydro should consider incorporating backtesting practices to validate its models. ~~In any event, we~~We found no evidence that that there are any material errors or flaws in the management reports generated by using these two models.

- Given ongoing evolution in modeling, Manitoba Hydro should continue to examine potential alternative approaches to production and system planning. Consistent with this recommendation, Manitoba Hydro's plans for model development indicate that it is continuing to enhance the system over time. Formal peer review or benchmarking exercises might also help ensure that Manitoba Hydro benefits from experience gained elsewhere.

- Manitoba Hydro has developed its models in-house and thus has relied heavily on the internal expertise of a small group of skilled, experienced staff who are interested in improving the performance of the decision-support tools on an ongoing basis. A significant amount of their expertise is derived from on-the-job training and experience gained in using the models in a "live" environment. This creates some risks with respect to knowledge sharing and corporate exposure to the potential departure of key personnel.

- KPMG recommends that Manitoba Hydro develop more formal model documentation. Such documentation will reduce risks associated with the departure of key modeling personnel and it will help internal and external stakeholders better understand and accept model structure and logic. The development of documentation will require additional resources.

Power Sales Management

We examined key issues associated with Manitoba Hydro's practices of entering into long-term fixed price contracts for export power sales. Manitoba Hydro has and continues to enter into long-term fixed price contracts for export power sales primarily with counterparties in the MISO marketplace. Chapter 4 provides details on our analysis and findings.

Issues

With respect to power sales management, KPMG addressed three Issues identified in the scope of work:

Issue 4: Pricing methodology for firm power sales;

Issue 5: Risk Capital Reserves; and

Issue 6: Long-Term Contracts Structure.

Operational Context

In order to fulfill its legislative mandate, Manitoba Hydro has, by design, more installed capacity than Manitoba demand and therefore is in a position to produce electricity in excess of what is consumed in Manitoba. This is not a recent circumstance, but has been the case for much of Manitoba Hydro's history. For example, in fiscal 2008/09, Manitoba Hydro had an installed system capacity of 5,480 MW with a Manitoba firm peak demand (occurring in the winter) of 4,477 MW. In the same fiscal year, the total energy supplied by Manitoba Hydro's system (other than isolated generation capabilities in remote communities) was 34.5 TWh whereas Manitoba consumption was 21.3 TWh.

A key consideration in Manitoba Hydro's capacity planning process is the variation in water flows. For meeting its projected load, Manitoba Hydro relies only on dependable energy, which is the energy that will be available in the lowest flow year. Additional or surplus energy may be available in most years, but this cannot be counted on to meet Manitoba Hydro's firm loads and firm export commitments.

Because of the need to provide energy on a firm basis, the amount of dependable energy available, rather than the amount of installed capacity, becomes the key planning criteria. Another way of saying this is that the Manitoba Hydro system is energy limited, rather than capacity limited. In this framework, dependable energy is the energy metric of relevance.

The addition of new hydroelectric generating capacity generally increases the amount of dependable energy available. This reflects the fact that the installation of new hydro generating plants allows Manitoba Hydro to extract more energy from a given amount of water flowing into the Manitoba Hydro system. More precisely, the addition of a new hydroelectric plant allows Manitoba Hydro to capture additional "head", or energy from the drop in the elevation of water, as a unit of water flows down to Hudson Bay.

Although dependable energy is the key system constraint, Manitoba Hydro's financial plans need to take account of the fact that more energy will generally be available in anything other than a low-flow year. This additional energy is known as surplus energy. The amount of surplus energy available in any year varies widely. Financial plans are developed by averaging the results of alternative water flow scenarios. Water flow scenarios are based on the historical record of water flows. The average amount of surplus energy available across the various water flow scenarios can be referred to as the expected surplus energy. As described earlier, surplus energy has generally been sold on a short-term basis in export markets. These short-term sales, which are linked to surplus energy, are referred to as opportunity sales.

For capacity planning purposes, Manitoba Hydro has established the following power resource planning criteria:

- *Capacity Criteria — Manitoba Hydro will plan to carry a minimum reserve against a breakdown of plant and an increase in demand that is 12% above the Manitoba forecast peak demand each year plus the reserve required by any export contract in effect at the time.*

- *Energy Resource Planning — The Corporation will plan to have adequate energy resources to supply the firm energy demand in the event that the lowest recorded coincident river flow conditions are repeated. Planning studies, to meet the firm energy demand, may include up to a maximum of 10% of the energy demand in Manitoba to be supplied from the energy reserves on interconnected utilities, provided an energy purchase contract is or will be in effect during the time being studied.*

In addition to the surplus capacity required by Manitoba Hydro's power resource planning criterion, another key reason that Manitoba Hydro has surplus energy production capability is that hydroelectric plants tend to be built in "chunks", i.e., there are large capacity additions at a single point in time to take advantage of economies of scale in plant development, whereas Manitoba load tends to grow in a steady manner year over year. Thus, every time a plant is built, Manitoba Hydro will have excess dependable energy until such time that the incremental Manitoba load "catches up" to the incremental resources added to the system. This excess dependable energy can be used by Manitoba Hydro to generate firm energy that is surplus to Manitoba requirements and that can be exported.

At the extremes, Manitoba Hydro has two basic mutually exclusive options to sell its surplus energy in the export markets, each with its own risk-reward profile:

- Sell all the excess energy as spot sales (e.g., MISO DA and RT markets). Key risks that Manitoba Hydro takes on under this option include:
  - "missed opportunity regret" risk (spot prices may turn out to be below the price that would have been available under contract);

- spot price volatility risk resulting in revenue volatility and times when spot prices may drop resulting in a revenue deficiency relative to the fixed costs of Manitoba Hydro leading to a corresponding rate increase for Manitoba ratepayers; and
- sales volume risk (there may not always be enough transmission capacity south of the US border for the available excess energy).

Sell all the excess energy at fixed price short-term and/or long-term contracts. Key risks that Manitoba Hydro takes on under this option include:

- "sellers regret" risk (spot prices may turn out to be above the contractual fixed price);
- sales volume risk (there may not always be enough transmission capacity, especially for short-term contracts, or a drought results in Manitoba Hydro having to purchase replacement energy to fulfil its contractual obligations leading to a corresponding rate increase for Manitoba ratepayers); and
- amplified drought risk (to the extent contracts are for firm amounts of energy).

Manitoba Hydro has chosen to export market its surplus energy using a combination approach of spot sales and short-term/long-term contracts. Over the last decade, approximately 30 percent of Manitoba Hydro's hydroelectric production has been used for export, with slightly under one-half of those exports in contractual firm sales and slightly over one-half of those exports in opportunity sales, for example, spot sales on the day ahead and real time markets.

MISO on-peak prices declined significantly in 2009 relative to 2008. Average prices in 2009 are less than one-half of 2008 prices. The price decline reflects both a decline in natural gas prices, and a drop in electricity loads associated with the economic downturn.

The price decline highlights the risk for Manitoba Hydro in relying entirely on spot markets for its electricity sales. Revenues could decline dramatically in the event of a market downturn. This is particularly a concern where revenues are used to support investment in new hydroelectric generation. The capital costs and associated debt charges as a result of new generation are fixed in advance. This suggests that a portion of the revenue should also be fixed in advance, as Manitoba Hydro does.

Manitoba Hydro's rationale for entering into long-term fixed price contracts as part of its power sales mix can be summarized as:

- Risk mitigation;
- Securing access to firm transmission; and
- Lower rates for Manitoba ratepayers.

Prices, terms and conditions in a long-term firm power sales agreement are negotiated between the parties. Prices, terms and conditions, should generally reflect the allocation of risk under the contract as well as the value received by each party. Both parties to the contract will enter into the agreement only if they both perceive that there are "gains (financial and non-financial) from trade," meaning that the contract provides both parties benefits that they perceive are greater than the costs.

Were Manitoba Hydro to attempt to extract all of the gains from a trade, there would probably be no transaction because the counterparty would see no gains from trade. Such a result would likely harm the Manitoba ratepayers, as the counterparty would not undertake the investments in transmission on their side of the border, and the market access benefits as a result of increased market access in the event of drought would not accrue to Manitoba ratepayers. Manitoba Hydro has a number of existing and proposed long-term contracts, mainly with Northern States Power, Minnesota Power and Wisconsin Public Service.

Whether Manitoba Hydro has extracted all it could from its counterparties in negotiating long-term firm power sales contracts is easy to second guess. However, the existence of the contracts suggests that both counterparties (the seller and the buyer) saw some gain from trade in the deal; otherwise they would not have entered into the agreement.

Future market prices for power are always uncertain. Uncertainty stems from many sources, including the future electricity market structure, load growth, government regulation, capital costs for new generation, fuel costs, and emission costs. Despite these uncertainties, utilities make long-term resource commitments in the form of long-term contracts and construction of new generation facilities.

Manitoba Hydro policy considers these uncertainties as follows. First, a price based on the average of price forecasts purchased from multiple power price forecasting consultants is calculated. A [redacted] is then [redacted] to this result. Second, Manitoba Hydro policy calls for the calculation of the avoided cost of the potential counterparties as a benchmark against the long-term price forecast. Pricing a contract using counterparty's avoided cost is a well established pricing methodology in the utility industry. Developing these two price estimates provides an indication of the potential range of a contract's price.

Manitoba Hydro's "Diversity Agreements" are another aspect of its power sales risk mitigation strategy. Manitoba Hydro has significant surplus capacity in the summer season, when its energy requirements are low, but lower capacity in the winter season, when its energy requirements are high. To balance seasonal capacity and energy requirements, Manitoba Hydro has entered into a number of agreements to exchange capacity and associated energy with the counterparties that have power systems whose peak loads occur at different times in a year, i.e., Diversity Agreements.

Manitoba Hydro has a total of 500 MW of Winter/Summer Season capacity exchange available under Diversity Agreements. The Diversity Agreements also provide for certain energy guarantees which enable access to additional capacity in the event that Manitoba Hydro is experiencing adverse water conditions.

Power Sales Management – Key Findings

This section outlines each issue and a summary of the Consultant assertions, followed by our key findings with respect to power sales management.

Issue 4: Pricing methodology for firm power sales

The Consultant asserts that Manitoba Hydro is using incorrect pricing methodologies for the sales price in long-term energy contracts. Specifically, the Consultant asserts that Manitoba Hydro is not properly making use of current market price information and is not properly identifying and quantifying all the risks (e.g., liquidated damages, volumetric risk, etc.) associated with such long-term supply contracts. As a result, the Consultant asserts that Manitoba Hydro is not building in an appropriate premium in pricing these contracts.

The Consultant acknowledges the reasons cited by Manitoba Hydro as to why it was willing to sell power for less than its apparent market value in these long-term contracts (i.e., because of the creation of transmission capacity and access), but rejects these as being valid reasons for such pricing. In this context, the Consultant recommends an overhaul of the pricing methodology used in the long-term fixed price contracts for energy sales.

Findings

With respect to the Manitoba Hydro's methodology for firm power sales, we find the following:

- Prices in long-term contracts are a matter of negotiation between the parties, and must be acceptable to both parties for a deal to be done.
- In the course of negotiating these contracts, Manitoba Hydro develops reference prices based on the two methodologies described above. Developing these two price estimates provides Manitoba Hydro with an indication of the potential range of a contract's price. Based on this information and leveraging the considerable industry experience of the key Manitoba Hydro personnel involved with the negotiations, a mutually agreeable price is set in the term sheets for new long-term contracts.
- Based on our analysis of this pricing process, Manitoba Hydro has an appropriate methodology for arriving at the sales price in its long-term contracts. As mentioned previously, the pricing methodology explicitly incorporates relevant market pricing forecasts and, further, includes a [redacted] And as detailed in Chapter 4, long-term contracts mitigate Manitoba Hydro's market risk through diversification of its export sales mix, and mitigate its drought risk because of both the returns generated by the contracts and the creation of the transmission capacity.
- Related aspects of this Issue are addressed in Issue 9.

Issue 5: Risk Capital Reserves

As described in the Issue above, the Consultant asserts that Manitoba Hydro is using incorrect pricing methodologies for the sales price in long-term contracts and in particular is not properly identifying and quantifying all of the risks associated with having entered into long-term supply contracts. In that context, the Consultant asserts that Manitoba Hydro is also not reserving a sufficient amount of risk capital for the export sales business, in light of its drought risk. The Consultant recommends the immediate cessation of export power market sales under long-term contracts until Manitoba Hydro has an appropriate amount of risk capital reserved for this business.

Findings

- As stated in our findings related to Issue 1 and Issue 4, we are satisfied with the methodology used by Manitoba Hydro in arriving at the sales prices in its long-term contracts and in the treatment of lake water level balances in the quantification of drought risk.

- Further to the analysis described in Issue 1, KPMG asked for additional stress tests of Manitoba Hydro's preferred expansion plans (which include new long-term contracts) incorporating various drought scenarios and market price scenarios. KPMG also asked for corresponding stress tests to be conducted for an alternative expansion plan that did not include new long-term contracts. The results of these stress tests indicate that Manitoba Hydro's ability to withstand the financial impacts of a drought is improved under the expansion plan that includes new long-term contracts.

- To summarize, on the basis of the policy decisions in place with respect to risk tolerance, Manitoba Hydro quantifies its drought risk appropriately and currently provides for appropriate levels of reserves of risk capital against its projected drought risk.

Issue 6: Long-Term Contracts Structure

The Consultant asserts that Manitoba Hydro has suboptimized these arrangements due to the use of certain terms in the long-term contracts. The Consultant recommends: significantly shortening the duration of these contracts to two years at most; sharing of risk in the market prices and premiums being charged including index or floating price provisions; and increasing optionality to Manitoba Hydro's benefit.

Findings

- As with prices, contractual terms in long-term agreements are a matter of negotiation between the parties, and must be acceptable to both parties for a deal to be done.

- The provisions identified by the Consultant, as well as other comparable novel terms, change the nature of the commercial arrangement for Manitoba Hydro and the counterparty by either making the contract riskier for the counterparty or changing the nature of the product. Without knowing how the counterparties would value such changes, it is speculative to determine whether such provisions would help or hurt. It is clear, however, that Manitoba Hydro's costs would increase, potentially significantly increase, if it were to commit to multi-billion dollar capital investments with contractual sale commitments of onlyshorter durations (e.g., two years;), potentially rendering the projects infeasible.

- Optimal risk sharing in a contractual arrangement dictates that risk should be allocated to the party that is best able to manage that risk. In this context, as addressed in Chapter 4, many of the potential novel terms that could be considered in a long-term firm sales contract between Manitoba Hydro and a counterparty involve shifting a particular risk to the counterparty. In many cases, however, Manitoba Hydro would generally be in a better position to assess and/or manage the risk than the counterparty, and would therefore generally be better off in the long run if it retained the risk (e.g., by being compensated for retaining the risk or avoiding the costs associated with transferring the risk).
- Overall, we found no basis to conclude that Manitoba Hydro had suboptimized its contractual provisions.

Risk Governance

We reviewed risk governance at Manitoba Hydro. Risk governance addresses the roles, responsibilities, reporting relationships and policies to support decisions about risk that may enhance or threaten an organization's achievement of objectives. Our assessment of Manitoba Hydro's risk governance has been carried out with respect to its opportunity power sales risk management function. Chapter 5 provides details on our analysis and findings.

Issues

With respect to risk governance, KPMG addressed two Issues as identified in the scope of work:

Issue 7: Independence of the middle office functions; and

Issue 8: Resourcing and authorities relating to energy risk management.

Operational Context

Risk governance has become increasingly important to power utilities for reasons such as the introduction of competitive markets, the recent turmoil experienced in financial markets and complex capital projects.

The power sales risk management functions may be divided into long-term sales and opportunity sales, which is the topic of this chapter of the report.

Manitoba Hydro's business model is built on a combination of domestic Manitoba sales, long-term contracts to export customers, and opportunity sales to extraprovincial and export customers. Opportunity sales are the responsibility of the Power Sales & Operations Division ("PS&O"), with day-to-day oversight from the Middle Office.

Manitoba Hydro's approach to power sales is that they are asset backed. That is, the water resources needed to generate the power are known to exist (with a high level of confidence) prior to the actual sale of the energy. Opportunity sales do not characteristically present high levels of risk for electric utilities, as they are made on a real-time basis, or day-ahead basis. Some volatility may exist on price, but the supply of, and demand for, the energy is known by Manitoba Hydro staff with a high degree of certainty.

This contrasts with a speculative trading business model that trades energy and holds open positions, based on a market view. Manitoba Hydro is not a trader of energy that takes speculative positions into the future. Manitoba Hydro's primary business objective is to provide low cost and reliable energy services to its domestic customers and optimize its assets and excess energy supply.

The risk management activities related to opportunity export power sales are transactional in nature – and within the purview of the PS&O Division. It is these transactions that the Middle Office is focused on monitoring to ensure that they are made in compliance with Manitoba Hydro policies and procedures.

Risk Governance – Key Findings

This section outlines each issue and a summary of the Consultant assertions, followed by our key findings with respect to risk governance.

Issue 7: Independence of the middle office functions

The Consultant asserts that, as Manitoba Hydro integrates risk management into its corporate framework, it is imperative to segregate the duties involved in calculating and reporting the risk and financial exposure of Manitoba Hydro from the business units responsible for operating level decisions, trading and opportunistic deals. The Consultant asserts that segregation of these duties is an important internal control element of compliance programs because it mitigates errors and opportunities for corporate fraud and misstatement of financial earnings. The Consultant's assertion is that it is important for the middle office function to have an independent reporting relationship.

Findings

- The Export Power Middle Office (EPMO) is a single, independent, risk management function. It reports to the manager of Corporate Risk Management, who in turn reports to the Chief Financial Officer. It is independent from the business unit of Power Sales and Operations (PS&O) Division. It is steadily progressing in terms of its responsibilities for measuring, monitoring, controlling, and reporting the risks associated with PS&O's transacting activity. The progress made by the EPMO is consistent with the pace of change identified at other electric utilities in our case study research and continued progress is suggested.

Formatted: No bullets or numbering

Issue 8: Resourcing and authorities relating to energy risk management

The Consultant asserts that the energy risk management function of Manitoba Hydro does not meet best practices. Specifically, the Consultant notes that there are limited risk management policies with inadequate ability for the Middle Office to perform an oversight role over PS&O and trading transactions. The Consultant infers that relevant risk management reports are not being utilized in the management of risk at Manitoba Hydro. The Consultant argues that it is common industry practice for risk management to monitor on a regular basis market price and hedging valuations in order to manage corporate performance in line with the achievement of the IFF.

Findings

- Manitoba Hydro's risk power sales governance practices compare favourably for the most part to leading practices. Based on the nature of its asset backed power sales business model, the risk governance practices at Manitoba Hydro are, for the most part, appropriate. The comparative analysis conducted by KPMG to other electric utilities demonstrates that Manitoba Hydro's risk management practices are consistent with other utilities of similar size.

- Based on the size and nature of the asset backed power sales strategy adopted by Manitoba Hydro, the independent reporting relationship of the Export Power Middle Office to Corporate Risk Management and the Chief Financial Officer is in keeping with leading practice.

- The power sales risk management policy framework substantially meets the leading practice.

- Manitoba Hydro should continue to institutionalize the policy setting roles of the Export Power Middle Office and fully align its power sales risk management policies with leading practices for market, credit and contractual risk management. The current middle office structure partially meets the leading practices.

  In order to fully meet the leading practice, credit risk analysis should report directly to the Middle Office. The market risk quantification capabilities of the Middle Office should be enhanced. The HR and technology resources of the Export Power Middle Office to conduct independent risk assessments of power sales partially meets the leading practice.

  Manitoba Hydro should also continue its efforts to enhance the resources of the Middle Office through the addition of a market risk analyst. The credit risk analyst positions which currently report to the Contracts Administrator within the Export Power Marketing Group should report directly to the Middle Office. For operational efficiencies continued effective working relationships within the Export Power Marketing Group, these positions could continue to physically reside within PS&O.

  Manitoba Hydro should also continue to actively define its functional requirements (including risk metrics) and continue its efforts to acquire a risk analysis software tool to enhance the analytic capability of the Middle Office.

Power Risk Management

Our analysis of power risk management examined issues in the context of a risk management framework with the following elements: risk identification; risk measurement; risk control; and risk reporting. Chapter 6 provides details on our analysis and findings.

Issues

With respect to power risk management, KPMG addresses the Issue identified in the scope of work:

Issue 9: Treatment of risk (identification, measurement, treatment).

Operational Context

Our approach to assessing power risk management at Manitoba Hydro is based primarily on the following:

- review of how power risk is managed at Manitoba Hydro;
- review of risk management leading practices in the energy industry; and
- review of applicable risk management practices from other electric utilities.

It is important to note that leading practices are aspirational, continue to evolve and are subject to limitations. Leading practice is a directional compass for an organization's risk management development. However, the development and implementation of such practices does not assure that risk control objectives will always be achieved. Many leading practices are adopted from the requirements of organizations that primarily transact and manage risk in the more traditional financial markets. Requirements of organizations transacting in the energy markets can be different, and in this context, leading practices should be modified accordingly. In addition, the adoption of leading practices should be considered in the context of costs versus benefits.

Our analysis of power risk management examined issues in the context of a risk management framework with the following elements:

- risk identification;
- risk measurement;
- risk control; and
- risk reporting.

Risk identification is a requisite component of an effective risk management framework. Before a company can begin managing its inherent risks, the risks must be identified and defined. Management consensus on key risk categories (e.g., market, credit, operational, regulatory, legal, environmental, reputational, etc.) and corresponding definitions establishes the company's risk taxonomy. The area of Manitoba Hydro's power risk management where risk identification is critical relates to its export power sales. This is because non-export sales are made in the context of a regulated utility environment. Within export power sales, it is primarily long-term contracts that raise issues related to risk identification (and measurement and mitigation) because short-term contracts are low risk. This is where we focused our analysis.

Risk measurement refers to a company's quantification of its risk exposures. Risk measurement is a prerequisite step to risk mitigation and hedging, and should be comprehensively applied to firm-wide risks. However, not all risks are readily quantifiable. In circumstances where quantification is not a feasible option, qualitative measures are a suitable alternative. In power sales, risk measurement is primarily tied to the assessment and reporting of fair value (mark-to-market) and risk exposure (at-risk measures, stress testing) amounts associated with an organization's open commodity positions. Risk measurement leads to financial performance measures to mitigate earnings volatility, evaluate profit drivers, manage credit risk, assess hedge effectiveness and efficiently allocate risk capital.

Risk control is a set of tools to manage risks associated with energy transacting activities in a prudent manner. It is an important distinction to understand that risk controls do not, in themselves, reduce risk. Instead, controls represent how much risk an organization is willing to accept. Controls are a direct reflection of a company's risk tolerance defined as the "acceptable level of variation relative to achievement of a specific objective."

We assessed two common risk controls: risk limits and transaction processing controls. Risk limits are designed to manage the magnitude of variance in market and credit exposure. Transaction processing controls are designed to manage the magnitude of variance in operational costs associated with human error.

Risk reports are regularly disseminated throughout an organization to convey exposures and business unit performance to executive management, the risk management committee and the Board of Directors. A meaningful package of risk reports summarizes portfolio positions, market and credit exposures against limits, financial performance and probabilistic risk measurement. Risk reports are typically generated and prepared by an independent function in order to ensure objectivity and accuracy.

Effective risk reports are in a format that can be easily read and understood by executive management and the Board. A timely, comprehensive suite of risk reports are designed to help management monitor and make informed decisions regarding market, credit, drought and operational exposures.

Manitoba Hydro is a unique utility holding a natural long position in energy supply. Manitoba Hydro's experience transacting in the extraprovincial wholesale electricity business initiated with the first transmission interconnection in 1958. Short-term trading began in 2001. ~~Manitoba Hydro's core business objective is to provide its domestic customers low cost and reliable energy services.~~

~~Consistent with this objective,~~ Manitoba Hydro participates in the wholesale energy markets by exporting surplus power only to capture market opportunities, generate incremental income, and to ensure market access for current and future domestic needs.

Formatted: Bullet 1,Bullet for no #'s

The overall breadth of Manitoba Hydro transacting activities are low risk in nature due to the short duration of the majority of ~~their~~its power trading activities. Coupling the low risk with the conservative risk management practices in place, Manitoba Hydro manages its market, credit and volume risks in a prudent manner.

In essence, the analysis and recommendations consist of comparing Manitoba Hydro's practices with leading practices (and case study information where applicable) in order to identify gaps and opportunities for improvement, and as such, are tactical in nature.

Power Risk Management – Key Findings

This section outlines the issue and a summary of the Consultant assertions, followed by our key findings with respect to power risk management.

Issue 9: Treatment of risk (identification, measurement, treatment)

The Consultant asserts that Manitoba Hydro is not adequately analyzing its risks associated with export power sales by breaking the risks into its component sub-risks and using a structured framework for assessment. The assertions relate to risk identification, risk measurement, risk control and risk reporting.

Findings

In the context of risk identification:

- While Manitoba Hydro has documented contract review procedures, they do not explicitly include risk identification, assessment and risk mitigation strategies. Manitoba Hydro should consider expanding these procedures to include these items.

- Major export contracts undergo extensive review by internal stakeholders prior to executing binding term sheets. We suggest that the Middle Office also be involved in the review of export contracts.

In the context of risk measurement:

- Manitoba Hydro should consider extending its current practices of using Mark-to-Market (MTM) methodologies to measure and monitor its short-term physical transactions and its credit risk exposures (i.e., replacement cost);

- Manitoba Hydro quantifies drought risk using a non-probabilistic stress test, an appropriate measure. Manitoba Hydro should also consider developing a probabilistic stress test to further assist management decision-making.

In the context of risk control:

- Manitoba Hydro has specified risk limits limited to "Power Related Transactions" in the area of Merchant Transactions (Related or Pure Merchant) and Customer Credit. Manitoba Hydro continues to enhance its limit structure, for example, by recently establishing Stop Loss Limits. We recommend that Manitoba Hydro continue developing further limits such as Value-at-Risk (VAR) limits for ~~related~~Related Merchant Transactions.

- Manitoba Hydro employs a wide range of control mechanisms to mitigate operational risk throughout the transaction process in a reasonable manner. Based on our experience with peer utilities, Manitoba Hydro transaction controls are consistent with prevalent practices.

In the context of risk reporting:

- Manitoba Hydro risk reporting is generally consistent with leading practice except in the area of "Exposure vs. Limits" reports. We recommend Manitoba Hydro expand its report suite to include this key report.

- Variance reports are produced at Manitoba Hydro to compare actual against forecasted data for all of its forecasted data and in adequate detail and structure.

Conclusion

- Manitoba Hydro is subject to the impacts of ongoing changes in the utility industry. Accordingly, Manitoba Hydro's operations have become, and will continue to be, more complex than ever before. This will continue to require further advancements in its modeling capabilities, export power sales practices, corporate risk governance, and power risk management practices.

- With respect to the modeling approach at Manitoba Hydro, we find:

– Manitoba Hydro has developed a suite of models that capture the key characteristics of the Manitoba Hydro system. These models are used to help optimize system operations and to support long-term capacity planning.

– We are satisfied that Manitoba Hydro has taken appropriate care and due diligence in developing and maintaining these models and in using them in its operations planning process.

– Manitoba Hydro's current approach to forecasting and to calculating dependable energy appears reasonable and is consistent with practices at other North American hydroelectric utilities. It is reasonable to rely on historical flow data for estimating dependable energy.

- With respect to long-term contracting for export power sales, it is our opinion that:

– Manitoba Hydro has made appropriate strategic choices in entering into long-term fixed price contracts for export power sales;

– Manitoba Hydro has appropriately established the firm export volumes in these contracts; and

– Manitoba Hydro has an appropriate methodology for arriving at the sales price in such contracts.

Also, we find that Manitoba Hydro continues to improve its contractual documentation to more effectively mitigate the risk exposure from entering into long-term fixed price contracts for the sale of firm energy. On the basis of the policy decisions in place with respect to risk tolerance, Manitoba Hydro'sHydro quantifies its drought risk appropriately and currently provides for appropriate levels of reserves of risk capital against its projected drought risk.

- In terms of risk governance, we conclude the following:

– Manitoba Hydro's power sales are asset backed. These sales are generally low risk and the Manitoba Hydro risk governance policies and reporting relationships, including the role of the Middle Office, are evolving appropriately.

– The Export Power Middle Office is a single, independent, risk management function. It is steadily progressing in terms of its responsibilities for measuring, monitoring, controlling, and reporting the risks associated with PS&O's opportunity power sales activity.

- The Export Power Middle Office is undertaking an initiative to improve its risk analytics capabilities. It requires further resource(s), supported by risk analytics software that is integrated with Manitoba Hydro's energy transaction management system (WebTrader). The timeliness of this risk monitoring will continue to improve with added analytical resources and related technology.

- With respect to power risk management, we conclude that Manitoba Hydro demonstrates prudent risk management with the following risk management practices:

- Extensive corporate oversight and a deliberate internal review process related to major export contract term sheets;
- Conservative stress testing assumptions and methodology;
- Transaction processing controls consistent with prevailing practices to mitigate human error and operational risk;
- Compliance and risk monitoring performed by an independent middle office; and
- Comprehensive suite of management and performance reports.

In light of these prudent practices, Manitoba Hydro will continue to strive to keep pace with the dynamic energy markets and will identify opportunities to improve ~~their~~its risk management capabilities. Manitoba Hydro may consider the following recommendations:

- Revise long-term contract policies stipulating Middle Office participation in the internal review process of major export contract term sheets;
- Develop formal identification of all significant risks in policies and procedures;
- Measure market risk exposure for short-term physical positions in its trading portfolio and evaluate the benefits associated with valuing its long-term contracts;
- Consider a probabilistic measure (e.g., Revenue-at-Risk) as an alternative tool to further understand potential drought exposure;

- Develop risk limits commensurate with authorized trading activities and products; and
- Develop risk exposure monitoring reports for compliance purposes.

A key benefit of adopting of the above recommendations would be better information to decision makers on the optimal capital structure of Manitoba Hydro. To be clear, onOn the basis of reviewing PUB Board Orders and based on information from Manitoba Hydro personnel, there has been considerable attention paid to the company's capital structure. This has led to a policy of targeting a 75:25 debt to equity ratio to help ensure that Manitoba Hydro maintainingmaintains sufficient equity to act as a buffer against the inherent volatility of its business.- As of fiscal 2008/09, Manitoba Hydro has builtprimarily through building up its retained earnings to $2.1 billion, providing an equity buffer against risk. Manitoba Hydro has achieved the 75:25 debt to equity ratio target.

Accordingly, its capital structure and its risk management practices are linked. ToGoing forward, the extent that Manitoba Hydro is ableadequacy of a 75:25 debt to improve its risk management practicesequity ratio should be regularly reviewed, particularly in light of the future, doing so may affect its optimal capital structure.substantial capital expansion plans for Manitoba Hydro's generation and transmission system. Accordingly, the appropriate capital structure for Manitoba Hydro will likely continue to be an ongoing issue for the company, its regulator, its shareholder, ratepayers and lenders.

Formatted: Font: Bold, All caps

Our report focused on the Manitoba Hydro's risk management practices specifically in the areas of forecasting models, long-term power sales contracting, risk governance, and power risk management. Overall, in the context of the nature, size and business model of its hydroelectric power operations, we are satisfied that Manitoba Hydro is following sound practices in these areas.

1. Introduction

The utility industry has undergone significant change in the last decade, including deregulation in some jurisdictions, the introduction of competitive energy markets across Canada and the United States ("US"), heightened environmental attention, fluctuating economic conditions and a continued focus on security of supply at reasonable prices for ratepayers. Taken together, these factors have significantly added to the complexity of managing risk. Accordingly, Manitoba Hydro ("MH") retained a consultant (the "Consultant") to review specific aspects of certain risk management processes. The Consultant's work led to the generation of a report in December 2006, and later work of the Consultant led to the generation of subsequent reports (collectively, the "Consultant's Reports"; listed in section 1.3.2 of this report).

The Consultant's Reports contain a series of assertions made by the Consultant pertaining to MH's export power sales and associated risk management practices. KPMG LLP ("KPMG") was retained by MH in late 2009 to perform an independent review (the "Review") of its risk management practices in light of the assertions raised by the Consultant. This report describes the Review undertaken by KPMG.

1.1 Scope and Nature of the KPMG Review

KPMG was retained by the Board of Directors of Manitoba Hydro in November 2009 to carry out an independent assessment of risk management practices in the hydroelectric operations and to address the assertions raised by the Consultant.

1.1.1 Scope of the Review

The scope of the Review is as follows:

- review the assertions that have been made by the Consultant and the reports and services provided by the Consultant.
- identify the positions of Manitoba Hydro staff on each of the assertions and the services provided by the Consultant.
- perform a review and validation study of the merits of the Consultant's assertions and services.

- prepare a report summarizing KPMG's findings.

As a consequence of the above, KPMG's review is limited to certain risk management practices of MH stemming from the assertions. Our scope is limited to key aspects of the hydroelectric operations of MH and related corporate functions but does not include reviewing MH's risk management practices as they apply to any other business products such as its natural gas operations, or to areas such as environmental and safety issues.

KPMG has developed this report, which documents the findings of the Review, for use by its client, Manitoba Hydro, but understands and acknowledges that the report may be provided to The Public Utilities Board of Manitoba ("PUB") pursuant to regulatory proceedings related to MH's risk management practices.

1.1.2 Phasing of the Review

KPMG undertook the Review using a two-phased approach.

In Phase 1, KPMG undertook an initial assessment of assertions raised in the Consultant's Reports to identify the scope of the assertions and to develop an approach and work plan for the more detailed assessment that would be undertaken in Phase 2 of the Review. The Phase 1 report was delivered to the Audit Committee on December 4, 2009 and is included in this report as **Appendix B.**

In Phase 2, KPMG undertook the work plan developed during Phase 1.

1.1.3 Reliance on MH Information

In the conduct of the Review, KPMG relied on a range of documentation provided to us by MH personnel as well as discussion with MH management. MH has confirmed to KPMG that:

- The information provided to KPMG was true and correct in all material respects, and did not and does not contain any untrue statement of a material fact in respect of MH and does not omit to state a material fact in respect of MH necessary to make the information not misleading in light of the circumstances under which the information was made or provided;
- MH has reviewed the draft of this report dated March 31, 2010 and has confirmed that it has no information or knowledge not disclosed to us which

would reasonably be expected to affect our comments, observations, or conclusions;

- MH has no knowledge of the existence of any other reports in the possession of MH prepared by the Consultant for MH regarding its risk management practices other than those listed in KPMG's report; and

- Since the dates on which the information was provided to KPMG, except as disclosed in writing to KPMG, there has been no material change in the information provided regarding MH and no material change has occurred in the information or any part thereof which would have or which would reasonably be expected to have a material effect on KPMG's Review.

KPMG reserves the right, but is under no obligation, to review or modify our analysis or report in light of any additional information that may become available subsequent to the date of this report.

1.2 Conceptual Framework

In order to help us communicate clearly in this report, KPMG has employed some basic concepts and defined various terms and concepts which are capitalized throughout the report and presented in the glossary which forms **Appendix A** to this report. This Section 1.2 provides a brief overview of key concepts underlying our work.

1.2.1 Issues and Themes

In undertaking the Review, KPMG analyzed the various assertions made by the Consultant in order to group related assertions into Issues and identify those which are outside of our scope.

As described more fully in the Phase 1 report, we define an Issue to be the components of an assertion(s) that reflect an alleged fundamental deficiency in MH. To help organize our approach for the conduct of the Review, KPMG also grouped related Issues (9) into Themes (4) as shown in Exhibit 1-1.

Exhibit 1-1: Themes and Issues

Themes and Issues
1. Forecasting models
Issue 1 Appropriateness of inputs and model logic relating to
1.1 Pricing
1.2 Water volume
1.3 Key model parameters
1.4 Lake water level balances
1.5 Market rules.
Issue 2 Treatment of optionality
2.1 Plant cycling
2.2 Storage.
Issue 3 Validation of models
2. Power sales management
Issue 4 Pricing methodology for firm power sales
Issue 5 Risk capital reserves
Issue 6 Long-term contracts structure.
3. Risk governance
Issue 7 Independence of the Middle Office function
Issue 8 Resourcing and authorities relating to energy risk management.
4. Power risk management
Issue 9 Treatment of risk (identification, measurement, treatment)

The Themes and Issues presented in Exhibit 1-1 represent the structure used for the conduct of Phase 2. Our Phase 1 work contemplated that the version of this structure developed during Phase 1 would be subject to change during Phase 2 and indeed three adjustments were made:

- Theme 4 was renamed from power resource management to power risk management to more accurately reflect the nature of the Issues contained therein.

- For ease of presentation, the theme regarding portfolio monitoring and reporting that was included in the Phase 1 work was merged into Theme 4 and the order of the Themes was changed.

- The issue regarding Power Sales' Requests for Proposals ("RFP") process in Phase 1 was dropped as a separate Issue. It stemmed from assertions by the Consultant regarding the process by which MH places RFP's into the market. During the conduct of Phase 2, KPMG was advised that MH does not issue RFP's to either procure or sell power (and has only responded to one RFP in which the process was established by the issuer of the RFP). Since the premise of the assertions underlying this Issue is incorrect, it was decided to drop this Issue (and deal with that one RFP response as part of our analysis of Theme 1).

These changes are essentially administrative, and do not impact the nature or scope of the work undertaken in Phase 2 of the Review.

In assessing the Issues, we took the approach that our work would not necessarily result in a total concurrence with or rejection of the assertions underlying an Issue; in some instances, we have found that we concur with some elements of an assertion and reject other elements. Accordingly, we would suggest that readers of this report focus on the analysis of the Issues as well as any recommendations that relate to the Issues, rather than focusing on whether we concur with or reject any particular assertion.

In utilizing the approach of grouping related assertions into Issues and then addressing the Issues, our scope in certain instances extends beyond the specific matters addressed by the assertions. In general, we applied this general approach for the following two reasons:

- ***to appropriately address an Issue:*** Our analysis in certain circumstances had to consider the overall context of the matter in question in order to appropriately address an Issue. For example, if an Issue addresses certain aspects of MH's middle office and if the appropriate analysis of that Issue requires examination of selected aspects of both the front office and the back office, we would examine those selected aspects for both the front office and the ~~middle~~back office. This general approach is designed to allow us to address the root causes of an Issue rather than just its consequential or symptomatic aspects.

  This general approach has been applied to the analysis of an Issue and also to the development of our recommendations; and

- ***to add value for MH in instances where it was efficient to do so.***

1.2.2 Concept of Risk

As mentioned, KPMG has been retained to perform an independent review of MH's risk management practices. At the core of this review is the concept of risk. For the purposes of our work, we looked to a number of leading international risk management bodies and based our work on the following concept:

Risk is defined as the likelihood and severity of an event or action that will adversely affect the company's ability to achieve its business objectives and execute its strategies successfully.

In general, an organization will apply this concept to fit its particular circumstances and needs. An effective risk management framework assesses risk in terms of its key components, and how they affect the organization. In the context of a hydroelectric utility, key components of overall risk include:

- regulatory risk;
- volume risk (both resource and load);
- market risk;
- credit risk;
- operational risk; and
- financial risk.

1.3 Approach to Phase 2 of the Review

1.3.1 Multiple Lines of Evidence

Phase 2 of the Review examined multiple lines of evidence for consideration, including:

- reviewing MH documentation and data;
- interviewing MH personnel;
- conducting analysis based on industry leading practices;
- conducting research of other electric utilities;
- consulting with specialized subconsultants;
- conducting literature reviews;
- analyzing third party data and reports;

- analyzing various financial and forecasting models used by MH; and
- analyzing model runs conducted by MH at KPMG's direction.

See **Appendix C** for a listing of the documentation provided to us by MH.

Additionally, KPMG reviewed the Consultant's Reports not considered in Phase 1 and other documents to help ensure that no new Issues and Themes should be considered.

1.3.2 Review of Consultant's Reports

As mentioned previously, KPMG conducted a comprehensive review and analysis of the assertions made by the Consultant in the Consultant's Reports, which are listed below:

- "Manitoba Hydro Risk Review 0708", dated December 4, 2006 (42 pages);
- "Risk Management Response", dated January 2008 (204 pages);
- "Top 20 Risk Management Issues", dated June 6, 2008 (40 pages);
- "Long Term Contracts Risk Report", dated October 2008 (45 pages); and
- "Long Term Contracts Executive Summary Middle Office Objectives – Action Plans", dated November 5, 2008 (18 pages);

For all but the "Top 20 Risk Management Issues", KPMG went through them line by line and allocated each sentence into Themes and Issues[1] or into a grouping indicating that the sentence was outside of our scope.[2] The results of this process are presented in **Appendix D**.

1.3.3 Communications with the Consultant

In Phase 1 we contemplated communicating with the Consultant to potentially improve our understanding of the assertions raised by the Consultant. We nonetheless anticipated that we could face challenges to being able to arrange any such communication and to incorporating it in a timely manner, and proceeded as though

[1] *Using the structure of Themes and Issues from Phase 1 as outlined in Section 1.2.1.*
[2] *This process was not conducted for the "Top 20 Risk Management Issues" report because it represented the key issues of information that had been presented in previous reports. As mentioned, this report was reviewed as part of our Review.*

we would need to develop our own evidence path independent of any communication with the Consultant.

During the conduct of Phase 2, we made the decision not to approach the Consultant to initiate such communication. Shortly after the commencement of our Phase 2 work, the Consultant wrote to KPMG asking that the firm "cease and desist" any use of materials prepared by the Consultant which have been provided to KPMG by MH in connection with a complaint which has been filed under the Public Interest Disclosure (Whistleblower Protection) Act. In particular, in the Consultant's "cease and desist" letter, the Consultant wrote that "it would be inappropriate for me to transfer and explain any materials ...directly to KPMG", for KPMG "to stop use of and to not received any materials prepared by my firm that you may be in possession of" and "to return such materials promptly to Manitoba Hydro and make no further use of them", and that "release of my reports, findings and any materials involve a breach of contract between myself and Manitoba Hydro and would place KPMG also liable for using inappropriately disclosed materials". Further, the Consultant stated that it "would be serving an injunction against all parties for any violations of our confidential information."

Subsequently, MH commenced a legal proceeding between the Consultant and itself in order to be in a position to release our Phase 2 report.

Accordingly, after considering the above – especially the fact that the Consultant explicitly indicated in the "cease and desist" letter that it would be inappropriate for it to explain any of its materials to KPMG – and considering that we, after having already completed a detailed review of the Consultant's Reports and other documents, were confident that we understood sufficiently the assertions made by the Consultant to be able to carry out a high quality review, we made the decision not to initiate communication with the Consultant.

1.3.4 Time Frame of the Assertions and Impact on This Review

The Consultant Reports contain assertions regarding MH's risk management practices over a relatively discrete time period (i.e., primarily 2006 but with some reference to past practices in some previous years). In this Review, KPMG considers the evolution of certain MH risk management practices both at the time when the Consultant's assertions were made, as well as MH current and evolving risk management practices.

The approach that we have undertaken in conducting our Review has been to focus on an *ex ante* rather than an *ex post* analysis – i.e., looking at appropriateness of the processes that were utilized at the time a decision was made rather than whether a decision turned out after the fact to be a good decision or not.

Further, during the conduct of the Review, we were aware that various initiatives were ongoing within MH regarding its risk management processes. Depending on when it is read, this report may not necessarily reflect MH's most current risk management practices in all respects, but believe that we have reasonably captured MH's circumstances as of the first quarter of calendar 2010. Further, as mentioned above, MH has represented to us that there has been no material change in the information provided regarding MH which would have or which would reasonably be expected to have a material effect on our Review.

1.3.5 Case Studies of Other Power Utilities

KPMG conducted a series of case studies about other electric utilities to provide additional context for the conduct of our work. The purpose of the case studies was to obtain current industry comparables and review how other utilities have adjusted and implemented strategies to adapt to changing market conditions.

Electric utilities were identified from KPMG's knowledge, input from MH, and industry research Selection criteria included:

- considerable hydro power generation;
- government-ownership;
- participation in power markets;
- geographic relevance;
- comparable size; and
- relevance to at least one of the Themes being addressed.

The focus was North America, reviewing key Canadian electric utilities and a geographic mix of U.S. utilities as well as some international utilities that met at least some of the selection criteria. In total, 14 utilities were reviewed, five in Canada, seven in the United States, one in South America and one in New Zealand.

The information collected on each utility included publicly available data, regulatory filings and direct interviews with an appropriate representative(s). General background information on each utility was collected in order to understand the context in which the utility company operates.

In addition to contextual information, the questions posed to these utilities were based on the Themes being addressed by KPMG.

Further details regarding the case studies are available in **Appendix E**.

1.3.6 Use of Subconsultants

KPMG engaged National Economic Research Associates, Inc. ("NERA") and CDDHoward Consulting Ltd. ("CDDHoward") as subconsultants to supplement KPMG's expertise in specific technical matters.

The scope of NERA's work included commenting on:

- certain economic matters relevant to MH's planning practices;
- principles of risk management as applied to power export sales;
- business strategy for expansion and export contracts;
- the terms and conditions of export power contracts;
- sufficiency of long-term contract prices;
- methodologies to measure risk capital and its applicability to MH; and
- weather derivatives.

The scope of CDDHoward's work included commenting on:

- hydrologic forecasting; and
- model production coefficients.

1.4 Organization of Phase 2 Report

The remainder of this report is structured as follows:

- Chapter 2 provides a brief overview of Manitoba Hydro, its mandate, electricity operations, financial and operating results, and capital structure in order to establish context for subsequent chapters.
- Chapters 3 to 6 each provide the results of the analysis of the separate Themes by:
  - providing background information on the Theme and its Issue(s);
  - outlining the scope of the analysis of the Theme;
  - documenting the approach and methodology used for the analysis of that Theme;
  - presenting the results of the analysis for that Theme; and
  - outlining the findings and conclusions as well as offering recommendations.

Specifically:

- Chapter 3 (Forecasting Models) examines key issues related to certain models used by Manitoba Hydro for supporting operation decisions and financial forecasting and budgeting.
- Chapter 4 (Power Sales Management) examines key issues associated with Manitoba Hydro's practice of entering into long-term fixed price contracts for export power sales.
- Chapter 5 (Risk Governance) examines risk governance practices at Manitoba Hydro.
- Chapter 6 (Power Risk Management) examines key issues associated with Manitoba Hydro's power risk management practices.

Certain topics (e.g., drought risk) are, by necessity, dealt with in more than one chapter. Doing so was necessary when a particular topic falls within the scope covered by more than one Theme in order that the Phase 2 results are presented in a structured and logical manner. Chapter 7 provides a brief Conclusion that integrates the summary conclusions of the previous chapters of the report.

2. Overview of Manitoba Hydro

To provide context for the detailed analysis which follows in subsequent chapters, this chapter provides a high level overview of MH, outlining its history, legislation and mandate, electric operations, financial and operating results, and capital structure.

2.1 Historical Overview and Legislative Mandate

During the first half of the 1900's, various companies in Manitoba developed hydroelectric generating stations, transmission and distribution systems to serve their existing and projected future needs. This led to the development of a decentralized system that suffered from lack of coordination. As a result in 1949, the *Manitoba Hydro-Electric Board Development Act* (the "MHEBDA") was passed by the provincial legislature "to provide for the continuance of a supply of power adequate for the needs of the province, and to promote economy and efficiency in the generation, distribution and supply of power". The MHEBDA was a major initiative to help consolidate and modernize Manitoba's power generation and distribution, an initiative which culminated with the passing of the *Manitoba Hydro Act* (the "MHA") on April 1, 1961. Under the MHA, Manitoba Hydro, a Crown Corporation, became solely responsible for the provision of electrical services in the province, except for the central portion of the City of Winnipeg which was served by Winnipeg Hydro until its acquisition by MH in 2002.

According to Section 2 of the *Manitoba Hydro Act, C.C.S.M. c. H190*, the Mandate of MH is to:

> *"provide for the continuance of a supply of power adequate for the needs of the province, and to engage in and to promote economy and efficiency in the development, generation, transmission, distribution, supply and end-use of power and, in addition, are:*
>
> *(a) to provide and market products, services and expertise related to the development, generation, transmission, distribution, supply and end-use of power, within and outside the province; and*

(b) *to market and supply power to persons outside the province on terms and conditions acceptable to the board."*

Key aspects of this Mandate are:

- It provides a focus on the continuance of a supply of power adequate for the needs of the province;
- It requires MH to promote economy and efficiency in its activities; and
- It contemplates exporting of power to users outside the province.

Given the economics of power generation facilities and the need to plan for future demand, MH has built, and expects to continue to build new hydro generation and transmission facilities to provide capacity beyond immediate need in the province. This excess energy can then marketed outside the province. A detailed analysis of the strategies used by MH in this regard is contained in Chapter 4.

According to its terms of reference, the Board of Directors "*is charged with the responsibility to carry out the duties, powers and functions of MH as set out in The Manitoba Hydro Act. The corporation is charged with responsibilities which include, ensuring a safe, reliable and economical supply of energy for Manitoba. The corporation operates in an environmentally responsible manner, consistent with the principles of sustainable development. It earns revenues to keep rates low for Manitobans through the export of power and the provision of energy-related services. The Board has the statutory authority and obligation to oversee the management of the business and affairs of the Corporation and to ensure that the Corporation fulfils its statutory objectives in the public interest.*"

2.2 Overview of Electricity Operations

MH's electricity generation is virtually all from renewable hydro power. MH has 14 hydroelectric generating stations on the Nelson, Winnipeg, Saskatchewan and Laurie rivers that represent over 5,000 MW of MH's 5,490 MW of net capability.

These hydroelectric generating stations account for about 98% of the company's total power produced annually. The remaining amount of the company's total production is generated by two thermal generating stations (Brandon and Selkirk) and four remote diesel generating stations. Power is also purchased from an independent wind farm (*Manitoba Hydro 2009 Annual Report*, p.2).

In the mid-1960s, provincial power planners made a fundamental long-term decision on the future supply of electricity for Manitoba, which led to the construction of three major generating stations along the lower Nelson River, and a high voltage direct current (HVDC) transmission system to carry electricity to southern centres. Nearly 80 percent of Manitoba's electricity is produced by the major generating stations on the Nelson River. Lake Winnipeg Regulation, completed in 1976, enabled Lake Winnipeg to be regulated within certain limits allowing greater flows into the Nelson River when needed. The Churchill River Diversion, completed in 1977, redirects most of the flow of the Churchill River at Southern Indian Lake eventually through the generating stations on the lower Nelson River. The diversion increases the power producing potential of the lower Nelson River by as much as 40 percent.

MH is a significant exporter of electricity, and approximately one-third of electricity produced is exported annually. The term "export" refers to power sales outside of the province of Manitoba, i.e., extraprovincial sales and exports are used interchangeably. The United States has been and continues to be MH's primary export market. In fiscal 2008/09, MH revenues from electricity sales to the United States were $491 million, representing 79% of MH's extraprovincial revenues (*Manitoba Hydro 2009 Annual Report, p.72*). United States sales typically represent over 80% of MH's exports. Manitoba and U.S. utilities have traded electricity since transmission lines first linked Manitoba and the United States nearly 40 years ago. MH has transmission lines connecting with Minnesota, North Dakota, Ontario and Saskatchewan.

Currently, there are nine formal long-term export trade agreements with six US electric utilities and many short-term agreements with electric utilities and marketers in the mid-western US, Ontario and Saskatchewan/Alberta. With the Midwest Independent Transmission System Operator (MISO) market launch in 2005, MH buys and sells energy in one of the largest electricity markets in North America.

2.3 Financial and Operational Overview

The following table (Exhibit 2-1) provides an overview of select financial and operational statistics over the past ten fiscal years from MH. Revenues have shown relatively steady and modest growth since 2004 (except for a decline in fiscal 2006/07). Net income has fluctuated significantly over the past ten years. In the past two fiscal years, net income was $298 million in 2008/09 and $346 million in 2007/08, significantly increasing the corporation's retained earnings and equity ratio. The impacts of the 2002-2004 drought period adversely impacted extraprovincial sales and net income, particularly in 2002/03 and 2003/04. System capacity has remained virtually unchanged since 2003. System generation loads, system demand, and peak demand have experienced modest growth over most of the past ten years.

Exhibit 2-1: Select Manitoba Hydro Financial and Operational Statistics

Manitoba Hydro 10-Year Financial and Operational Overview										
Fiscal year ended March 31st.	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Financial Statistics										
Total Revenue (Smillions)	2,364	2,250	2,140	2,345	2,017	1,781	1,869	1,864	1,773	1,391
Domestic Electrical Revenues (Smillions)	1,161	1,097	1,040	1,001	954	936	891	797	789	746
Extraprovincial Electrical Revenues (Smillions)	623	625	592	827	554	351	463	588	480	376
Net income (Smillions)	298	346	122	415	136	(436)	71	214	270	152
Total Assets (Smillions)	12,341	11,766	10,922	10,482	9,952	9,903	10,234	10,405	9,966	8,692
Long-term debt (Smillions)	7,661	7,218	6,822	7,051	7,048	7,114	6,925	7,123	6,968	6,611
Retained earnings (Smillions)	2,120	1,822	1,407	1,285	870	734	1,170	1,302	1,088	818
Contributions in Aid of Construction (Smillions)	296	300	298	297	296	274	264	281	281	275
Interest Coverage[1]	1.58	1.69	1.23	1.77	1.25	0.17	1.14	1.42	1.62	1.35
Equity Ratio[2]	0.25	0.24	0.20	0.19	0.15	0.13	0.20	0.23	0.20	0.17
Capital Coverage[3]	1.81	1.62	1.10	2.28	1.20	(0.32)	1.10	1.67	1.18	1.28
Operating Statistics										
System Capability (000 kW)	5,480	5,465	5,461	5,469	5,470	5,471	5,464	5,230	5,210	5,116
Manitoba Firm Peak Demand (000 kW)	4,477	4,273	4,184	4,054	4,169	3,959	3,916	3,760	3,637	3,524
Total Energy Supplied (000 000 kWh)	34,541	35,366	32,144	37,632	31,559	19,349	29,178	32,643	32,697	30,155
Load at Generation (000 000 kWh)	24,298	23,997	23,339	22,634	22,463	21,918	21,976	20,529	20,133	19,110
System Demand (000 000 kWh)	21,266	21,109	20,555	19,976	19,781	19,323	18,953	16,958	16,698	15,820
Net Metered Interchange (Exports-Imports)	9,589	10,590	8,217	13,706	8,213	(2,578)	6,378	10,911	11,247	9,906
Number of Electric Customers	527,472	521,599	516,861	509,791	505,666	501,650	497,725	405,535	403,040	402,023

1 Interest Coverage represents net income plus interest on debt divided by interest on debt.
2 Equity ratio represents equity (retained earnings plus contributions in aid of construction) divided by equity plus debt (long-term debt plus notes payable minus temporary investments).
3 Capital Coverage represents internally generated funds divided by capital construction expenditures.
Source: Manitoba Hydro 2009 Annual Report

2.3.1 Background Information on MH's Capital Structure

This discussion provides an important context on the relationship of risk and capital structure, as MH's capital structure has been an ongoing issue at MH and the Public Utilities Board over many years. In this section, we summarize some of the background considerations that address MH's capital structure.

Capital intensive industries such as electric utilities typically use greater leverage and have relatively high debt to equity ratios compared to most industries. In particular, a regulated utility with significant tangible assets and stable, relatively predictable future earnings will tend to use more debt financing and can take on higher debt than most companies in other industries. The more debt it can take on in its capital structure, the lower the overall cost of capital as the cost of debt is lower than the cost of equity. A regulated utility tries to balance its capital structure and mix of debt and equity with the needs of its shareholders, ratepayers and bondholders. For utilities, equity, through retained earnings, provides confidence to financial markets and aids in securing financing at attractive interest rates, and provides increased assurance of future rate stability and a cushion against risk.

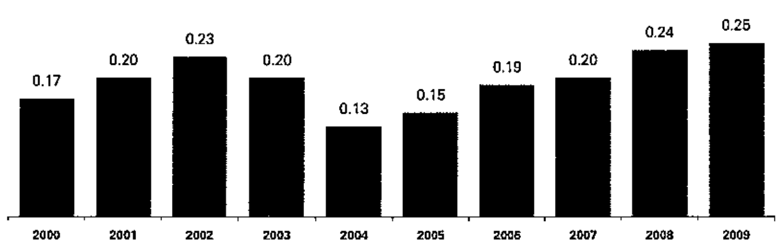
As evidenced in its most recent annual report, MH currently has established a minimum target equity ratio of 25% (or a debt to equity ratio of 75:25):

"Manitoba Hydro manages its capital structure to ensure sufficient equity to enable the Corporation to absorb the financial effects of adverse circumstances and to ensure continued access to stable low-cost funding for the Corporation's capital projects and its ongoing operational requirements. The Corporation monitors its capital structure on the basis of its equity ratio. Manitoba Hydro's current target is to maintain a minimum equity ratio of 25%" (Manitoba Hydro 2009 Annual Report, p.114).

Noteworthy is that MH's long-term debt is guaranteed by the Government of Manitoba (with the exception of $77 million in bonds issued for mitigation projects) (*Manitoba Hydro Consolidated Financial Statements for the year ending March 31, 2009, Note 11*).

As indicated in Exhibit 2-2 which shows equity ratios over the past decade, MH has significantly increased its equity ratio in recent fiscal years, eventually meeting its target in 2008/09.

Exhibit 2-2: MH Equity Ratios 2000 - 2009



Source: Manitoba Hydro 2009 Annual Report

Note: Equity ratio represents equity (retained earnings plus contributions in aid of construction) divided by equity plus debt (long-term debt plus notes minus temporary investments).

The capital structure of MH has been a long standing issue that has drawn much attention in the regulatory hearings of the Public Utilities Board of Manitoba.

In September 1995, MH adopted a target to achieve and maintain a minimum debt to equity ratio of 75:25 by no later than 2006. In 1996, MH had a debt to equity ratio of 91:09, but managed to reduce it to 80:20 in 2001. In the PUB's Board Order 7/03, February 3, 2003 (p.13) it was noted that MH stated that the current target would not be attainable.

In the PUB Board Order 101/04, July 28, 2004 (p.15), it was noted that the 2002-2004 drought made it more difficult to achieve Manitoba's debt to equity target and the loss associated with the drought pushed back the date of realizing a 75:25 debt to equity ratio by several years.

As mentioned above, the drought of 2002-04 had a significant impact on MH's ability to achieve its targeted debt to equity ratio. In the context of MH's hydro-based system, drought risk is clearly a key operational risk of the company. In the PUB Board Order 7/03 under "Risks" (p.88), the PUB's view was that a five-year drought represents the greatest threat to MH's financial position. PUB Board Order 7/03 (p.88) noted that MH's net revenues are subject to vagaries of weather and water flows and establishing an adequate [retained earnings] reserve level is an appropriate strategy to mitigate the financial impact of a drought.

As a hydro-based system, drought periods have a significant adverse impact on power sales through reduced exports and consequently on net income. Conversely, high water flow periods contribute to more surplus power and export sales and higher net income and retained earnings.

MH has identified and quantified its major risks, which includes drought risk (*Source: Manitoba Hydro 2009 Annual Report, p.81*).

The financial effects of a drought were evidenced by the 2002-2004 drought, where the effects were first felt in 2002/03 in reduced net income, and more fully realized in 2003/04 with MH incurring a loss of $436 million. The drought resulted in MH's decision to import power and led to reduced export sales in order to ensure that the needs of its domestic market were met, and both factors led to the financial loss.

Prior to the drought, MH had built up its retained earnings to $1.3 billion in 2001/02. This equity provided a buffer for the financial impacts of the drought experienced in 2002/03 and 2003/04. Without sufficient equity, MH would have had to turn to the Government of Manitoba as its shareholder and/or its ratepayers to cover the large loss in 2003/04.

In 2004, the PUB further outlined its view on MH's debt to equity financial target.

"Achieving a debt:equity level of 75:25 would provide increased rate stability benefits, and hold down financial charges. The 75:25 benchmark represents a modest target, one comparable with the current debt:equity ratios of similar Crown hydroelectric utilities in other Canadian provinces (B.C. Hydro and Hydro Quebec). In summary, meeting this target within a reasonable period of time would reduce long-term pressure on domestic electricity rates, better assure bondholders and thus constrain financial charges and provide a hedge against a future drought." (PUB, Board Order 101/04, July 28, 2004, p.31)

Subsequent PUB Board Orders (2004 through 2008) reiterated the PUB's concern about MH's overall debt level and the need to achieve the debt to equity target of 75:25 as quickly as possible. In these orders, the PUB Board called for faster progress towards the 75:25 debt to equity target. This has been one of the primary drivers of MH rate increases in recent years.

"The Board notes the reported improvement in Manitoba Hydro's actual and forecast debt:equity ratio, and understands the improvement is largely attributable to two factors, the rate increases approved by the Board and recent favourable river flows bringing additional export revenues." (PUB Board Order 32/09, March 30, 2009, p.14).

In fiscal 2008/09, primarily through building up its retained earnings to $2.1 billion, Manitoba Hydro achieved the 75:25 debt to equity ratio target.

While MH has met its debt to equity ratio target ~~in the short-term~~, a deterioration of that ratio is expected with the planned debt financing of the construction of new generation and transmission projects (*PUB Board Order 32/09, p.31*).

~~The~~ In summary, the level of equity and debt to equity ratio ~~is~~provides an important context for a review of risk issues. ~~From~~On the ~~excerpts~~basis of ~~the~~reviewing PUB Board Orders presented above and based on information from ~~our discussions with~~ MH ~~management, it is clear that~~personnel, MH operates under a policy of maintaining sufficient equity and it does so to promote stability by providing an equity cushion against inherent volatility of the business, in particular MH's exposure to periods of drought.

~~In summary, the capital structure of MH provides an important context to discussions of risk, in that the equity of MH provides a buffer against risk.~~ While it is very difficult to peg a single optimal capital structure for any corporation, the appropriate balance and mix of debt and equity has, and will likely continue to be, an ongoing ~~critical~~ issue for MH, its regulator, its shareholder, ratepayers and lenders.

Formatted: Body Text

Formatted: English (Canada)

Formatted: English (Canada)

Formatted: English (Canada)

Formatted: English (Canada)

Formatted: English (United States)

3. Forecasting Models

In this Chapter, we address various issues related to three models used by Manitoba Hydro for supporting operations, capacity planning, and financial forecasting and budgeting processes. As described in Chapter 1 of this report, the issues we have identified are based on various assertions raised by the Consultant. In the Consultant's report, there were various assertions related to the deficiencies in the models used by MH, specifically the HERMES (Hydro Electric Resource Management Evaluation System), SPLASH (Simulation Program for Long Term Analysis of System Hydraulics), and PRISM (Power Risk System Model) models.[3]

This Chapter is organized under the following headings:

- 3.1 Scope of our Review
- 3.2 Key Findings
- 3.3 Approach and Methodology
- 3.4 Overview Models
- 3.5 Review of HERMES – Model Validity
- 3.6 Review of HERMES – Model Operations
- 3.7 Review of HERMES – Model Assumptions and Data
- 3.8 Review of HERMES – Sensitivity Analysis on Price Inputs
- 3.9 Review of HERMES - Conclusion and Recommendations
- 3.10 Review of SPLASH
- 3.11 Review of PRISM
- 3.12 Review of the Issue of Multiple Models
- 3.13 Conclusion.

3.1 Scope of Our Review

In Phase 1 of the review as shown on Exhibit 1-1, KPMG identified three Issues within the Theme of Forecasting Models. The three Issues and along with a summary of the Consultant assertions of each Issue are as outlined below.

[3] *For ease of reference, we have referred to HERMES as a model although MH considers it to be a decision support system that includes a number of individual models and analytical tools.*

- Issue 1 – Appropriateness of inputs and model logic relating to:
  - Pricing and market rules

The Consultant asserts that the HERMES model does not incorporate current market prices and that it needs to do so in order to serve as an appropriate basis for decisions made to release water. Specifically, the Consultant asserts that the prices used in the HERMES model should be updated regularly to reflect today's broker quotes and a true market environment. The Consultant asserts that not doing so prevents MH from optimizing its financial performance in selling surplus power or buying hedges as these relate to decisions made to release water. The Consultant also asserted that the prices used in the Generation Estimate report and those used in the HERMES runs are inconsistent. It further noted that this exposes MH to pricing error risks.

  - Water volume

The Consultant asserts that MH's models sub-optimize the treatment of water volumes. Specifically, the Consultant recommends improvements to MH's method of antecedent flow forecasting (e.g., use of backtesting to validate the antecedent forecasting methodology). The Consultant also has concerns about the validity of using historical water flow data in the models. The Consultant identifies a number of years which mark the addition of gauging points and hence improvements in the quality of water data. As a consequence, the Consultant suggests that water flow data from prior to 1942 are unreliable.

  - Key model parameters

The Consultant asserts that the SPLASH and HERMES models utilize different sets of internal model parameters (production coefficients) for the conversion of water flow to power at each hydro plant. The Consultant further noted issues regarding some approximations in the HERMES model as well as the use of "model adjustment factors" (which are sometimes manually changed). The Consultant recommended that MH undertake on-going calibration and updates to both of these models.

  - Lake water level balances

The Consultant notes that the SPLASH model assumes "perfect foresight" of water flows and hence assumes lake ending levels which in the real world are impossible to attain. This raises concerns with respect to the calculation of the costs of a drought. Also, the Consultant raised concerns about the reconciliation of lake level balances in the financial forecasting process.

- Issue 2 – Treatment of optionality related to plant cycling and storage

The Consultant notes a variety of deficiencies in the modeling of storage optionality, which is the financial value associated with the flexibility to change storage levels in a hydroelectric system. As a result, the Consultant asserts that MH does not effectively capture or optimize the value of hydroelectric storage. In particular, the Consultant alleges a variety of deficiencies with respect to the modeling of storage in HERMES. The Consultant identifies, among other issues, differences between the HERMES and SPLASH models in their decision making with respect to the use of water in storage and in identifying target ending reservoir levels.

- Issue 3 – Validation of models

Forecasts from models, such as HERMES and SPLASH, are based on inputs and model logic (i.e., the formulas and computational methods embedded in the model). Forecasts generated from models could conceivably be inaccurate either because of flaws in the model logic or errors in the inputs to the model (which are typically forecasts themselves).

Backtesting is a means by which errors in the inputs can be removed in order to verify the appropriateness of the model logic. The Consultant asserts that MH does not back test its HERMES or SPLASH models. Accordingly, the Consultant argues that management decisions and reports based on the outputs of these two models may be flawed.

In order to address the Issues identified in Chapter 1, we have conducted a detailed review of the HERMES models. We have also conducted a high level review of the SPLASH and PRISM models. Our approach in this report is to address the Issues covering the specific assertions of the Consultant. However, given the technical nature of the modeling issues, we have provided direct responses for certain Consultant's assertions relevant to an Issue.

We did not undertake an audit of the models or verify their computational accuracy. Rather, we assessed the overall reasonableness of the modeling approach, taking into account the use of the models, input assumptions, and evidence with respect to the models' effectiveness for their intended role.

We focused on HERMES because it was the subject of the largest number of assertions by the Consultant. Of the three systems reviewed, HERMES also plays the most important role in determining plant production schedules and the amounts of power available for export transactions in the near term (i.e., over the next several months). HERMES is therefore a key tool for managing the risks of energy shortfalls in the near term and the risks associated with transactions in the MISO power market.

Although we focused on HERMES, SPLASH is the key tool used to evaluate the benefits and costs associated with long-term firm sales contracts and new capacity additions. It is also used to estimate the cost of drought events. In examining SPLASH, we therefore examined issues related to its calculation of the amount of Dependable Energy available to support long-term contracts and Manitoba load and its approach to calculating the costs of drought.

3.2 Key Findings

This section outlines our key findings with respect to forecasting models.

On pricing assumptions and market rules, we find the following:

- We have had extensive discussions with MH staff on their approach for incorporating ~~prices for prices~~pricing and market rules for power purchases and sales into their planning models. We found that they apply appropriate care and due diligence in this process.

- In incorporating market price inputs, MH needs to account for the various factors that will influence the prices that it will actually receive. We have found that MH puts significant analytical effort into assessing these factors and accounting for them in its ~~modelling~~modeling approach. Furthermore, the analysis of price patterns is updated as new market data is accumulated over time.

- KPMG has examined the Consultant's assertions regarding inconsistencies between the Generation Estimate report and HERMES and we conclude that, based on the sample of cases reviewed, the quoted data inconsistencies arise out of a misinterpretation by the Consultant of the data that were being presented.

- At KPMG's request, MH undertook a number of special runs of the HERMES model. These runs indicate that inefficiencies in operating schedules that could potentially result from stale or inaccurate price inputs are likely to have only a limited impact on the financial results achieved. Variation in water flow has a much larger influence on optimal schedules (and on MH's financial returns). Constraints on import and export transactions, and the primary need to meet domestic loads, also have significant influence on production schedules.

With respect to flow forecasting and historical water flow data, we find the following:

- MH's process for antecedent forecasting of water flows is reasonable. Underlying relationships used in this process are statistically significant. Moreover, linear regression, which is the basis of MH's antecedent approach, has been a standard industry approach to seasonal stream flow forecasting for many years.

- For general forecasting and planning purposes, it is reasonable to rely on historical water flow data as model inputs. We found a number of other North American hydroelectric utilities that use a similar practice.

- Given the uncertainty of impacts from climate change, MH may wish to formally examine the potential impact of changes in water flows from the historical pattern. Further, it may also wish to undertake scenario analyses to assess the financial impact of droughts worse than the historical record.

  This type of scenario analyses can be used for the purpose of risk analysis, and does not necessarily need to be used as the basis of financial forecasts or for the determination of dependable energy. MH's current approach to forecasting and to calculating dependable energy is reasonable and consistent with practices at other utilities.

- With respect to the Consultant's assertion that the water flow data prior to 1942 are unreliable, we found that the period prior to 1942 is characterized by lower estimated water flows relative to the full period. Hence, forecast production would be higher if these data were excluded from the water flow records. Including data from this earlier period adds an element of conservatism to MH's financial forecasting process.

With respect to the various matters raised by the Consultant regarding key model parameters, we find the following:

- We are satisfied that MH has taken appropriate care and due diligence in modeling production coefficients in its modeling tools. Further, MH carefully takes into account plant efficiency when optimizing the scheduling of its hydroelectric stations.

- We are satisfied that MH has taken appropriate care and due diligence in developing, operating and maintaining the models. This relates to the approximations in the HERMES models, the use of adjustment factors, and the on-going calibration and updates to both SPLASH and HERMES. In the main report, we present recommendations for MH to improve its maintenance of the models.

With respect to lake water level balances, we found the following:

- SPLASH is used for long-term forecasting purposes and to estimate the financial impacts to MH of drought.

- There are a variety of factors that complicate the calculation of drought costs. On one hand, SPLASH is based on "perfect foresight" and will assume that energy stored in reservoirs is used to the fullest extent possible. In practice, MH management will operate the system more conservatively than assumed by SPLASH. In doing so, MH management will maintain reservoir levels at higher levels in order to address the fact that a drought may last longer than the historical record assumed within SPLASH. This may lead to higher actual operating costs in the period of the drought than calculated by SPLASH. Higher costs are the result of scheduling additional imports and fossil fuel purchases (i.e., costs associated with not releasing water from storage at what might appear to be optimal times).

  On the other hand, SPLASH may overestimate fossil fuel costs because it ignores the potential to import power on a non-firm basis. SPLASH assumes that imports only occur under MH's Diversity Contracts, which are considered firm. The ability to schedule opportunity purchases through the spot market and from short-term contracts, thereby reducing fuel purchases, is not considered in SPLASH. In part, higher actual costs in the period of the drought as a result of conservative reservoir management just reflect the movement of costs for reservoir replenishment forward from future periods. However, there may also be opportunity costs associated with the increased risk of water spillage, in the event that water flows after the drought are very high.

- The impacts of these various factors on estimates of drought costs could be separately quantified by MH staff in order to improve stakeholders' understanding of their implications. If a material result is identified, this can then be better communicated to users of the financial information.

- To address specific concerns of the Consultant about the reconciliation of lake level balances within HERMES, we also conducted an analysis of the financial impact of lake level discrepancies observed in the 2006 Generation Estimate Report ("lost water"). There were discrepancies in lake levels on eight of the 29 lakes modeled although the discrepancies were generally small. By applying factors representing the change in water storage with lake levels, the amount of energy per unit of water stored, and the market price of power, we estimate that projected revenues post-2006/07 were understated by about $0.98 million, because of "lost water". While a concern, theThe amount of the discrepancy was small (less than 0.2 percent) of total water in storage.

- We checked for similar discrepancies in the Generation Estimate reports supporting Integrated Financial Forecast ("IFF") processes for subsequent years. As at April 1st, 2008, discrepancies were even smaller than in 2007. At an estimated 2,800 MWh, the discrepancy had an estimated financial value of $140,000. The discrepancy at April 1st, 2009 was negligible. Such discrepancies, in addition to being small, have been significantly reduced over time.

With respect to storage optionality and target lake ending levels, we find the following:

- Both HERMES and SPLASH use linear programming routines to identify optimal production decisions under input scenarios that specify loads and water resources, in addition to other production variables, over a planning horizon. Neither HERMES nor SPLASH can explicitly address uncertainties in input variables during their optimization routines. As such, neither model captures the "option value" of storage.identifies the "option value" of storage. Rather, the models incorporate the value of storage under expected conditions in determining optimal production decisions. It is not necessary for the models to identify an explicit "storage option value" for the purpose of production scheduling.

  The HERMES system is used in the planning of operations over a short-term horizon, while SPLASH is used over a longer-term horizon to plan facility additions. Because HERMES is used to support current operational decisions, it has more detail with respect to system operations, and should produce aproduces financial forecasts that more accurate estimate ofaccurately reflect the realizable value of storage.

- Relative to SPLASH, the HERMES optimization approach appears to provideprovides for more explicit consideration in the production scheduling decisiondecisions of the economic value, relative to current sales, of greater or lesser ending storage levels. This seems appropriate given that HERMES is the tool that has the greatest impact on actual operations in the near term. Decisions in the near term, as supported by HERMES, can respond to prices that are currently observed in the market. As a longer-term tool, SPLASH has less need to adjust decisions based on current market data. Rather, it simply needs to capture the "average" or expected economics of a particular decision or sequence.

In summary, we note that neither HERMES nor SPLASH were designed to be financial trading models. or to provide estimates of the market value of storage. Both HERMES and SPLASH are water management models designed to meet MH'sManitoba Hydro's operational needs in serving its firm load.

Formatted: Font: Bold

With respect to the validation of the HERMES and SPLASH models, we find the following:

- HERMES is the main tool used to support operations scheduling. Modules within HERMES represent the MH system in a significant amount of detail. These modules have been developed and regularly updated over many years and reflect extensive work to calibrate model outputs to actual system performance and thereby continually validate the model.

- SPLASH is a simulation tool designed to support MH's long-range system planning. The output from the SPLASH model provides information used to evaluate the economics of power resource options such as power export marketing contracts, system enhancements and surplus energy rate programs. SPLASH is also used to support financial forecasting. Similar to HERMES, SPLASH personnel validate the model by performing quality control checks with respect to actual system performance.

- In addition to the current validation procedures used for HERMES and SPLASH, MH should consider incorporating backtesting practices to validate its models. In any event, weWe found no evidence that that there are any material errors or flaws in the management reports generated by using these two models.

- Given ongoing evolution in modeling, MH should continue to examine potential alternative approaches to production and system planning. Consistent with this recommendation, MH's plans for model development indicate that it is continuing to enhance the system over time. Formal peer review or benchmarking exercises might also help ensure that MH benefits from experience gained elsewhere.

- MH has developed its models in-house and thus has relied heavily on the internal expertise of a small group of skilled, experienced staff who are interested in improving the performance of the decision-support tools on an ongoing basis. A significant amount of their expertise is derived from on-the-job training and experience gained in using the models in a "live" environment. This creates some risks with respect to knowledge sharing and corporate exposure to the potential departure of key personnel.

- KPMG recommends that MH develop more formal model documentation. Such documentation will reduce risks associated with the departure of key modeling personnel and it will help internal and external stakeholders better understand and accept model structure and logic. The development of documentation will require additional resources.

3.3 Approach to Our Review

In light of the number and breadth of the Consultant's assertions, KPMG attempted to first gain a broad understanding of the key models used by Power ~~Supply~~Sales and Operations ("PS&O") for planning and operating purposes. This included MH's approach to operating the models, its framework for quality control and risk management, and strategies for updating the models over time.

The three models that were the focus of our examination are:

- HERMES
- SPLASH
- PRISM

Descriptions of these models are provided in Section 3.4.1.

To support our review, KPMG undertook the following tasks over the course of our engagement:

- We had numerous meetings with MH staff responsible for development and operation of the models.
- We reviewed documentation with respect to these models, including sample outputs.
- We posed questions to MH staff, leading to their formal responses on specific issues.
- We performed our own calculations to assess estimates made by the Consultant.

- We sought input from an independent consulting engineer with expertise in hydrological modeling and optimization of hydroelectric dams.

A key element of our work involved gaining a good understanding of the MH system, including its operating constraints and key value drivers. This background work helped to set the context for assessing model issues.

In conducting our review, we have considered a number of general factors:

- Various assumptions appear to have been made by the Consultant on how the results of the models are used. The Consultant appears to have assumed that the forecasts produced by the models are directly used by MH in operation and power trading decisions without further judgment and/or oversight applied. Some of the Consultant's assumptions are incorrect and as a result the implications identified are not meaningful.
- Many of the risk numbers or metrics identified by the Consultant were created by the Consultant, rather than being information that is tracked and/or used by MH.
- In assessing any alleged deficiency, it is important to recognize that models are inherently imperfect. Models simplify reality in order to make problems manageable. They are a decision-making tool rather than a perfect representation of reality. Simplifications may also arise because of deficiencies in source data, limitations in the analytical approaches that are available, or limitations on the amount of resources that can be applied to an issue. A key issue in evaluating any model is thus whether the approximations that are inherent in them are appropriate in the circumstances.
- All forecasts are subject to error. Errors should be minimized but they cannot be eliminated.

Further specific factors that we have considered are described in the individual topic areas discussed later in this Chapter.

3.3.1 Approach in Review of HERMES

For the review of HERMES, our work included examination of the following three components: model concept and logic, model assumptions and data, and model operation and oversight.

3.3.1.1 Model Concept and Logic

In this component, the focus of our review is determining whether the model is a reasonable representation of the actual situation and can be used for the intended purpose. The specific questions that we have addressed in this component are:

- Does the model have a clear and logical structure?
- Does the model capture the variables and the relationships that are expected to affect the outcomes to be modeled?
- Are the concepts and relationships used in the model to link variables and outcomes easily understandable and theoretically sound?
- Did the model developers possess the training and experience needed to develop the model? This is a factor to be considered given that significant judgment is typically required in the development of complex models and that the ability to make appropriate trade-offs among modeling approaches depends on the training and experience of the model developer.
- Was the model reviewed by an independent expert?
- Was the model validated by testing against actual outcomes?

3.3.1.2 Model Assumptions and Data Used

This component of our review is focused on the data and assumptions used in the model. The data and assumptions used in the model have a direct impact on the results of the model, and hence it is important to assess their accuracy and reliability.

In the case of HERMES, there is an extensive array of data and assumptions that are used as model inputs. We have concentrated our efforts on those assumptions that were identified as deficiencies in the Consultant's report.

The specific issues addressed in our review are:

- model optimization method;
- antecedent forecasting of water flow;
- power price forecasting;
- market developments;
- potential errors in price inputs;

- data on historical flow record;
- lake level balances;
- lake level balances discrepancies;
- production coefficient data;
- storage option modeling techniques; and
- volume risk.

When identifying concerns with the data and assumptions in MH's models, the Consultant in many cases quoted financial values associated with "model risks" or "operational errors". It is not always clear what these values are intended to represent. Depending on the context, each value may represent one or more of the following:

- An estimate of the risk associated with forecast financial results or, in other words, the potential variability in results from the expected value.
- An estimate of the direct financial losses incurred by MH relative to the results that it would achieve if not for the operational errors.
- A measure of the capital that needs to be set aside as a result of a particular activity to cover the potential variability in financial results and to ensure MH's financial solvency.
- A measure of the variation in market value (e.g., for a contract) that may occur with changes in market conditions or prices. Such changes in market value may not represent an immediate financial loss, although they may represent an opportunity cost. For example, the decline in market value of a long-term contract may represent the change in the present value of future expected earnings from the contract, relative to spot market sales, but not an immediate cash loss.

The nature of the "model risk" will determine the implications of that risk for MH.

It should also be noted that model forecasting errors do not lead directly to "operational errors". The models that we reviewed are used for planning. They support management decision making but are not used for operational purposes. Operational factors that are ignored in the models may still be taken into account in day-to-day operations.

It is beyond the scope of our review to review all the values presented in the Consultant's report. We have, in selected instances, attempted to replicate the

Consultant's estimates in order to understand the nature of the Consultant's assertion regarding deficiencies in MH's models. Our focus is on understanding the substance of the Consultant's assertions and determining whether the assertions have merit.

3.3.1.3 Model Operation and Oversight

This component of our review focused on how the model is operated and used. The specific questions we seek to address are:

- Is there a process in place to guide the day-to-day operation and revision of the model?
- Are there quality assurance procedures in place to ensure that the model results are reliable (e.g., checking of data inputs, review of results, report signoff)?
- Do constant revisions in the forecasts as a result of weekly updates create additional risks for MH?
- Do model results take into account risks in forecasts and assumptions?
- Are model results and limitations appropriately communicated to management?
- Are there policies and guidelines for the use of models?
- Are the responsibilities for model development, operation, and validation clearly defined?
- Is the model properly documented to enable knowledge retention in the event of loss of key modeling staff and to facilitate independent review, training of new staff, and verification?
- Does management apply reasonable care and due diligence in the use of the model results in decision making? (This is also addressed in Chapter 6).)
- How are results interpreted and used in decision making? Do users understand the inherent uncertainty in the results of the model and not over rely on the model? (This is also addressed in Chapter 6).)
-

Formatted: No bullets or numbering

3.3.2 Approach in our Review of SPLASH and PRISM

For SPLASH, we conducted a high-level review of the following:

- concept and logic used in the model;
- consistency of assumptions and modeling approach with those of HERMES;
- the issue of perfect foresight;
- conceptual issues in the modeling of drought risk
- observations on the limitations and use of the model; and

For PRISM, we conducted a high-level review consisting of the following:

- concept and logic used in the model;
- the use of current data inputs;
- similarity of assumptions and modeling approach with those of HERMES and SPLASH;
- observations on the limitations and the use of the model; and
- suggestions on improvements.

3.3.3 Other Approach Comments

Our review of the models consisted of examining the three components identified above, namely model concept and logic, model assumptions and data use, and model operations and oversight. We have not, however, attempted to comprehensively verify the data and assumptions used in the model.

Because MH operates in an uncertain environment and because models inevitably have limitations, it is expected that MH will make decisions that, in retrospect, are not optimal. As an example, the Consultant notes that the antecedent forecasting process, used to estimate near term water flows, has sometimes resulted in the release of water that would have better been kept in storage. It is beyond the scope of this review to determine, with the benefit of hindsight, whether individual decisions made by MH management were optimal. Rather, our focus has been on assessing whether the modeling approach is reasonable and appropriately takes into account information that is available at the time of a decision.

3.4 Overview of Models

In this section we provide a brief description of each of the three models and how they are used by MH. The descriptions are based on documentation provided by MH and the findings of our interview process.

3.4.1 Description of Models

3.4.1.1 HERMES

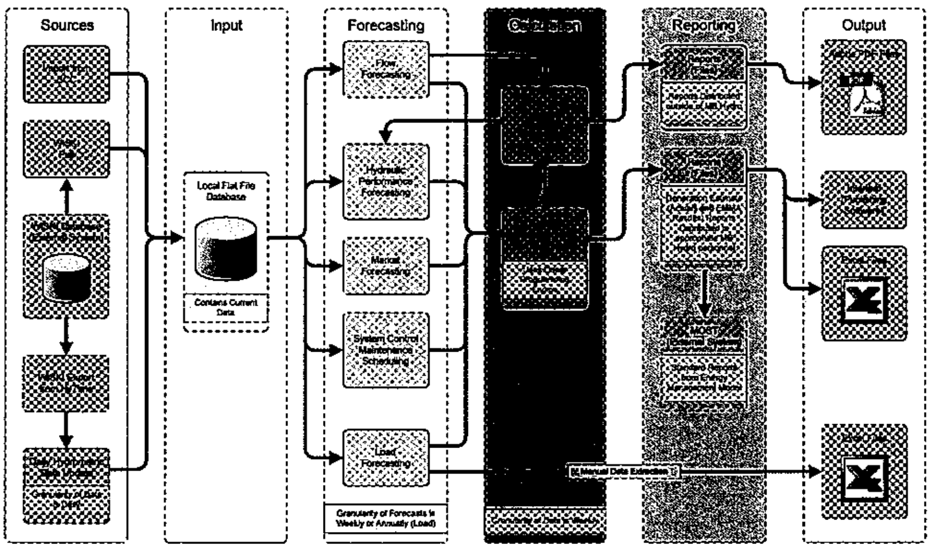
HERMES (Hydro Electric Resource Management Evaluation System) is a planning tool and decision support system used by the Power Sales and Operations group to support hydraulic operations planning. It provides a suggested water release schedule and associated production estimates over the planning horizon of 12 to 16 months. While management uses HERMES as a support tool in making water release decisions, these decisions incorporate broader considerations. HERMES can also be used to identify the probable cost of serving proposed sale transactions.

HERMES takes into consideration a broad set of data in order to model the state of the system. Input data to HERMES includes:

- hydrologic information;
- hydraulic system characteristics;
- generation maintenance schedule;
- load requirements;
- export/import contracts;
- export/import power prices; and
- internal and external transmission characteristics.

Exhibit 3-1 provides a graphic representation of HERMES.

Exhibit 3-1: HERMES Application Architecture



Source: Manitoba Hydro

There are two key calculation modules in HERMES that are used to produce the various reports to support operations, power contracts and trading decisions. They are:

- EMMA (Energy Management and Maintenance Analysis) is the key operations planning module used to derive the operating plan to manage the system of reservoirs, generation stations and transactions with neighbouring utilities over a time horizon of up to one year.

- QSIM (or the Flow Simulation Model) is the module for deriving daily flow and elevation values along the hydraulic network affecting the MH generating system. QSIM complements EMMA by providing daily flow estimates compared to weekly and monthly estimates.

EMMA is an optimization model using linear programming approximations to minimize net system costs while meeting firm load requirements. The model operates in one-week and one-month intervals and typically produces one-year runs. EMMA is deterministic (one outcome given one set of assumptions) as opposed to stochastic (a range of outcomes based on a set of inputs with probability distributions). EMMA is run weekly and thus provides a forecast of future production that is continually updated to reflect new information on water flows and market prices.

QSIM is used to provide daily flow forecasts at most hydro sites and along rivers affected by MH operations. Flow forecasts are converted to energy production. This information is used by Power Trading for managing short-term (within the next week) energy supply in the system. More specifically, the information is used by Power Trading in maintaining desirable levels on Stephens Lake, which is the reservoir immediately upstream of the bulk of MH's generation.

HERMES, and in particular the EMMA model, is the main tool for medium-term power resource management. EMMA outputs are discussed at weekly resource planning meetings at which weekly production scheduling and weekly operating plans are determined. EMMA is also used in the preparation of Generation Estimate reports, which are in turn used to support MH's annual Integrated Financial Forecasts ("IFFs"), that are submitted to the PUB. EMMA, in contrast to SPLASH, includes representation of demand requirements and capacity constraints in the MH system. This reflects the fact that it explicitly models peak demand periods.

For short-term and real-time operations, MH uses a commercial hourly operations model plus other internal planning tools to maximize available resource utilization and minimize cost of meeting assumed obligations. These other tools are beyond the scope our report because they were not the focus of the Consultant's assertions.

3.4.1.2 SPLASH

SPLASH (Simulation Program for Long Term Analysis of System Hydraulics) was developed by the Resource Planning and Market Analysis Department between 1990 and 1996. The purpose was to provide a computational tool that can be used to study the economics and adequacy of various expansion scenarios and to evaluate the options and opportunities available in the electric power market. More specifically, SPLASH is to be used in generation expansion studies.

The output from SPLASH provides information to evaluate the economics of power resource options such as power export marketing contracts, system enhancements, and integration of non-hydraulic resource options such as wind energy and gas-fired combustion turbines.

The output from the SPLASH model provides information used to evaluate the economics of power resource options such as power export marketing contracts, system enhancements and surplus energy rate programs, as well as the integration of non-hydraulic power sources such as thermal (gas-fired and coal-fired) generation and wind-based power. As well, the system is capable of analyzing and incorporating regulatory restrictions and license constraints for the operation of the reservoirs, producing outputs for use in analyzing environmental impacts on river systems and water regimes.

One of the uses of SPLASH is to model the firm, or dependable, energy supply that will be available to service the Manitoba domestic load and contractually committed power export agreements. Firm, or Dependable Energy supply, is dependent on the volume of water flow during periods of drought, and therefore the firmness of the hydraulic supply is the first priority of system operating decisions in SPLASH. Thereafter, the system's linear programming logic is designed to maximize net revenues. This optimization of net revenues considers the economic opportunities associated with surplus hydro energy that is available for flows greater than the drought flows.

SPLASH is used to support financial forecasting. Within the IFF, SPLASH is used to generate production cost estimates for years beyond the forecasting horizon of HERMES.

A typical SPLASH run generally requires several hours of computer time, and involves solving the linear programming system through a series of iterations, with each simulation involving monthly time steps over a 40 year period and utilizing the entire historical flow record of 94 years.

3.4.1.3 PRISM

The length of time for a SPLASH run, and the deterministic nature of SPLASH logic, led to the demand for PRISM (Power Risk System Model), which provides more flexibility for doing multivariate scenario analyses.

For screening and preliminary analysis purposes, PRISM is a simplified tool used by the Export Marketing Department to analyze the financial impact of variations in a number of factors that affect Manitoba Hydro's operations. These factors include: water conditions, expected load, gas and electricity prices, export sales, transmission access, and wind energy. PRISM was first employed as a tactical tool for evaluating short-term hedging options under drought conditions. As a screening model, PRISM is designed to provide an initial estimate rather than a precise analysis, and is used to identify possible outcomes associated with fixed, pre-defined scenarios. Since it is a screening tool, strategies selected for further analysis or implementation will typically be subject to more detailed analyses using SPLASH, HERMES or other tools.

PRISM was initially recommended and developed by an external consultant (RiskAdvisory). PRISM provides the Export Marketing Department with a forecast of net revenue over five years, given inputs of domestic load, hydro and wind generation, electricity export prices and natural gas prices.

Inputs into PRISM come from approved MH resources, including the outputs of both the HERMES and SPLASH computer models. It uses these inputs to run a Monte Carlo simulation analysis of 1000 iteration runs, and reports a probability distribution of net revenue. (Monte Carlo simulation software takes inputs as random or stochastic variables and calculates a distribution of outcomes based on multiple runs, where each run reflects an outcome based on one sample of inputs.) Scenarios that have been analyzed using PRISM include low water conditions, high gas and electricity prices, variations in forward contract commitments, addition of gas and wind generation capacity, and changes in the operating licenses of generating stations.

3.4.2 Operational Context for Models

In evaluating the use of models at MH, it is important to consider the context in which it operates and the types of decisions that the models are designed to support.

3.4.2.1 Reliance on Short-Term Sales

Water volumes at MH are subject to wide swings from year to year. The year-to-year variation in water availability is much larger for MH than for most other large hydroelectric utilities. The lowest flow year on record has less than 50% of the flow of the median year. The highest flow year is more than 50% greater than the median flow year. Hence the highest flow year is more than three times the level of the lowest flow year. The variability in water flows has important implications for the design of the system, MH's export sale strategy, and the focus of modeling work.

Further, even within a year, future water flows are highly uncertain. Flow volumes can change dramatically based on the volumes of spring rain and, to a lesser degree, the extent of snow melt. MH relies on its antecedent forecasting process in its production planning process, but the predictive power of this methodology is inherently limited. Antecedent forecasting uses regression analysis to predict future water flows based on current flows.

Uncertainty in water flows results in MH selling much of its export power on a short-term basis in order to be highly confident that the power can be supplied. The percentage of MH's export sales made on a short-term basis fluctuates year-to-year depending on water volumes, and is considerably higher in high flow years. For fiscal 2008/09, which had higher water flows than average, over one-half of sales were made in Real-Time or Day-Ahead markets as well as other short-term sales. For their spot market sales, MH commits to deliver power, at most, one day ahead of time. Other opportunity sales are short-term, but are made outside of the spot market. A sales breakdown is provided in Exhibit 3-2.

Exhibit 3-2: Breakdown of 2008/09 Export Sales

Sales Category	Volumes (MWh)	Percentage
Opportunity Spot (DA and RT)	5,131,178	51%
Opportunity Term	904,036	9%
Dependable	4,087,093	40%
Total	10,122,307	100%
Hydraulic Generation in 2008/09 as % of Hydraulic Generation in an Average Flow Year	114%	

Source: derived from Manitoba Hydro

MH also enters into long-term contracts which are serviced from "Dependable Energy". Dependable energy is the hydroelectric power available under the lowest river flow conditions in the historical record, and also includes energy sourced from wind and thermal as well as firm and contracted non-firm imports. (Although the definition of dependable energy contains a number of non-hydroelectric sources, these sources remain a very small share of Manitoba's total production.).

To account for uncertainty in its water supply, MH is conservative in its export sales strategy:

- Long-term sales are limited to those that can be supplied from dependable energy.

- Opportunity sales made beyond the day-ahead and real-time markets are limited to those that MH is highly confident can be supplied based on current water conditions.

As a consequence of the reliance on spot sales, changes in forecasts of future longer term production, because of changes in parameters in HERMES, do not lead to shortfalls in MH's market position. MH does not commit to opportunity sales that are based on uncertain water flows, and consequently does not incur contractual or market losses when medium and long-term forecast water flows do not materialize. This is an important factor to consider in evaluating the risks of financial loss.

3.4.2.2 Model Projections are Support Tools and Do Not Translate Directly Into Financial Results

Models and their outputs are used as tools to support decision-making processes at MH. The outputs from models do not directly lead to business or market actions and do not translate directly into financial profit or loss. For example, HERMES generates forecasts of available energy and suggested production schedules. These forecasts of available energy, however, are not translated directly by trading staff into forward market positions. Similarly, suggested production schedules produced by HERMES do not lead directly to control decisions at MH hydroelectric facilities. This is elaborated upon further below in the section outlining the HERMES model.

3.4.2.3 Mandate to Support Load

A key output of HERMES relevant to the scope of this review is a forecast of the amount of energy available for export within each segment of time modeled. This forecast is used as a reference point for assisting energy trading operations. Because of the priority of meeting domestic load before any energy export commitments, and due to the requirement to mitigate chances of there being insufficient resources to serve forecasted load, the MH system is operated conservatively. Sales decisions are supported by various modeling tools within HERMES, such as load forecasting, water supply forecasting, capacity and reserve management, and deal analyzer modules.

In general, forward opportunity sales are not made unless MH has sufficient firm capacity and energy resources to serve the load 95% of the time. This means there is only a 5% chance that such firm resources will be inadequate. For drought management planning, the required level of confidence in planning energy supply increases to 99%. This risk target reflects the combined probability of a severe winter (defined as a one in 10 event) and water supply at the 5^{th} percentile level.

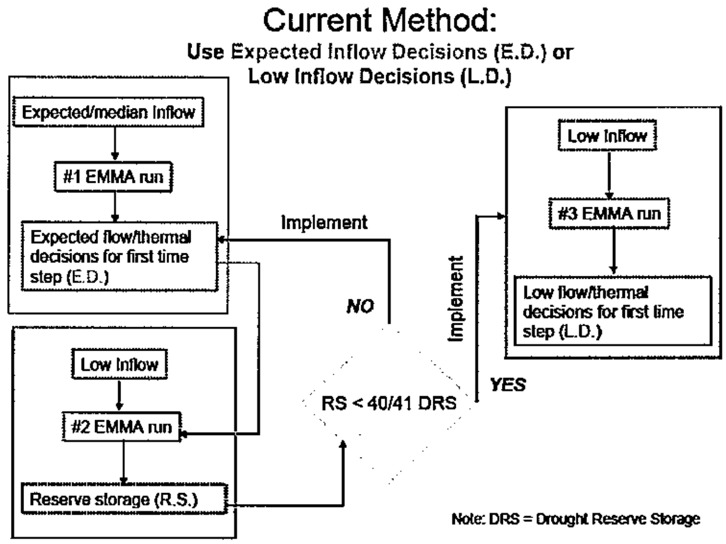
In the event that resources are projected to be inadequate to serve committed load, this will generally mean a draw-down in reserve storage levels, with a potential reduction in energy supply security in the second year of the projection horizon. In such event, water storage reserves will be replenished at the first opportunity, including from opportunity purchases and other non-firm sources.

MH management has adopted a conservative management approach in recognition of the following:

- the duration and extent of a drought is not known in advance;
- it is normal for it to be very cold in the winter in Manitoba, which can cause loads to increase dramatically; and
- the societal and financial consequences of running short of energy during an extended period of drought (especially in the winter) can be enormous relative to the potential income that might be achieved by being less conservative.

Reliability issues are also addressed in EMMA model runs within HERMES. As noted elsewhere, a standard EMMA run generates an economically optimal production schedule, based on its input assumptions. MH then tests this projected production schedule against a scenario in which low water flows occur. MH checks whether, under this low flow scenario, lake levels fall below Drought Reserve Storage ("D.R.S.") levels, which are the levels required to cover a repeat of 1940/41 drought flows. If not, then the optimal production schedule is implemented. If levels fall below D.R.S. levels, then the schedule is readjusted (see EMMA run #3 in Exhibit below) to ensure that the D.R.S. level constraint is not violated. Reserve Storage levels are those that ensure all firm commitments will be met even under historically observed low-flow conditions. This process is outlined in Exhibit 3-3 provided below.

Exhibit 3-3: EMMA Model Runs Related to Inflows



Source: Manitoba Hydro

It should be further noted that the implementation of a production schedule, in practice, involves a commitment for only the next week planning horizon. The EMMA model is run weekly, so updated forecasts are available with new information in the following week.

Production decisions taken for the current week will influence future production schedules because of the impact of these decisions on water levels at the beginning of the next week. (Greater production this week will mean less water in "inventory" next week.) Hence, decisions are linked in time. For any period, shortfalls in water inflows relative to forecast will inevitably lead to variances in financial results relative to forecast. Absent changes in the "spilling" of water, production scheduling decisions influence only the timing of the production shortfall and, hence, the timing of the revenue shortfall. (The magnitude of revenue shortfalls will be influenced, in addition, by differences in prices across periods.)

3.5 Review of HERMES - Model Validity

In this section, we present our analysis and conclusions to the component of our review addressing model concept and logic, as identified in Section 3.2.1.

Does the model capture the variables and the relationships that are expected to affect the outcomes to be modeled?

HERMES' primary use is to generate a suggested production schedule that will meet load requirements while maximizing net export revenues and minimizing production costs, given various input assumptions.

At a conceptual level, we would expect the model to incorporate data and assumptions from the following categories of inputs: power demand, lake levels, water flow, production capacity, import/export of power, product costs, and import/export prices.

In practice, there are significant challenges in modeling an interconnected hydroelectric system, particularly in the case of the MH system. These challenges include:

- The production characteristics of the system are complex and change continuously. First, the capacity of individual hydroelectric plants varies with current water levels (which affect both achievable flow rates and water head) and ice conditions. Further, for given input water level conditions, both turbine efficiencies and effective water head vary with the volume of water flows. These changes in system parameters are much more difficult to model than those associated with a thermal-based system.
- Many hydroelectric stations are interconnected – the water leaving one plant flows into other plants downstream.
- Models need to account for the travel time of water between plants and for the attenuation of water flows, or the smoothing of water flows from unit release patterns.
- The value of retaining water in storage depends on future water flows, demand and electricity prices, which are difficult to predict in advance. There are techniques available to consider uncertainties in these future conditions in identifying optimal generation decisions, but these entail additional computational complexity.

- While the ability of computer models to incorporate various factors has grown with technology advancement, even very complex models must introduce simplifications to keep the problem manageable. It is not practical for a model to capture all possible variables and relationships. It is important to consider the overall reasonableness of the modeling approach taken, i.e. the simplifications employed.

HERMES was developed internally to capture the unique characteristics of the MH system. A large number of variables have been captured, including: power price, flow, load growth, temperature, generation capacity (representation, outage), market access (transmission, market limit), and regulatory (licenses, reliability). The "bespoke" nature of HERMES is consistent with practices in the sector. One industry consultant notes: "Decision support systems are usually site specific and not readily transferable from one hydroelectric system to another." *(Source: C.D.D. Howard, Hydroelectric System Operations Optimization, Great Wall World Renewable Energy Forum and Exhibition, October, 2006.)*

Based on our review, the variables and relationships captured by HERMES appear to be consistent with the variables that one would expect to affect net export revenues and production costs.

Was the model reviewed by an independent expert?

An independent review is a review conducted by a party who was not involved in the development of the model. An independent review can be performed by in-house staff (e.g., Internal Audit) or by external reviewers. An independent review can help identify potential model deficiencies and enhance the credibility of the model.

Based on our discussions with MH staff, it appears that no structured independent review has been performed on HERMES. However, Operations Planning staff believes that HERMES is a reasonable representation of the MH system based on the long history of use.

On a periodic basis, Operations Planning staff presents the concepts and methodologies used in HERMES at industry forums for general comments. Examples of participation in these forums include a Hydro Workshop in Oslo in 2001 and the CEATI Hydro System Workshop in Vancouver in 2001. However, while participation in industry forums may enhance the knowledge of MH staff, it does not address the need for independent review.

Was the model validated by testing against actual outcomes?

Model validation is the process of comparing the outputs of a model with actual outcomes. Such a process is used to establish the reliability of a model. In general, if the forecasts produced by a model are reasonably close to the actual values, this increases confidence in the reliability of the model.

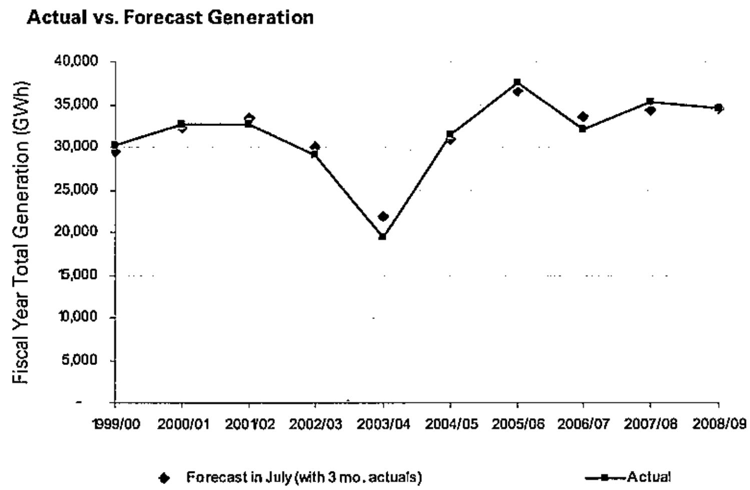
Fundamentally, HERMES consists of a number of forecasting modules (e.g., flow forecasting and load forecasting) and an optimization module to find the production schedule that minimizes production costs and maximizes net export revenues.

Based on our discussion with MH staff, it appears that no systematic validation has been performed on the forecasting modules.

While validation of individual forecasting modules has not been performed on a systematic basis, MH has compared key outputs of HERMES with actual data. Exhibit 3-4 below presents a comparison prepared by MH of forecast and actual generation for a fiscal year. The forecasts for each year are prepared in July of that year, and thus include actual data for 3 months. MH uses forecasts as at July for the comparison because these forecasts are generally the basis of the IFF for each year. IFF's are prepared in late summer. July is also a good point at which to forecast future production. It comes after the spring season, which is marked by rain and spring run-off and, hence, marks the point at which MH has a good view of its water inventory for the balance of the year.

As shown in Exhibit 3-4 the actual generation values are reasonably close to the forecasted generation values. Since actual generation is largely dependent on actual water flows and lake levels, Exhibit 3-4 indicates that the forecasting modules used in HERMES can take the data set available in July and produce realistic production plans for the remainder of the fiscal year.

Exhibit 3-4: Actual versus Forecast Generation



Source: Manitoba Hydro

The accuracy of financial forecasts is likely to be less than the accuracy of power production forecasts. The accuracy of financial forecasts depends on a variety of other factors in addition to water flow and power production. These other factors include import/export power prices, load, transmission constraints, and natural gas prices.

While it appears that the information available in July can be used to produce realistic production plans for the remainder of the fiscal year, MH staff has indicated that the situation is less ~~favourable~~predictable earlier in the year. This is because in February and March, the amount of ~~late~~ spring rainfall is not yet known and the predictability of rainfall beyond the very short term is low.

Based on the above, the reliability of the forecasts produced by HERMES varies significantly depending on when in the hydrological year the forecasts are prepared. While MH management already takes this variability into consideration in making operation and business decisions, it would be beneficial to clearly communicate ~~it implications~~the amount of uncertainty to all recipients of HERMES outputs.

3.6 Review of HERMES - Model Operations

In this Section, we discuss the following related to the operations of the model:

- model operation;
- model revision process;
- model accountability and model use;
- proposed model enhancements, and
- model documentation.

3.6.1 Model Operation

HERMES is a "live" modeling system and is being run on a regular (at least weekly) basis. Up-to-date input data (on parameters such as water flows) are continuously entered into the system. Certain inputs are calibrated to ensure that actual observed measurements are incorporated into the model. Examples of inputs requiring calibration include powerhouse efficiency relationships and tailwater and lake outlet rating curves. Power efficiency relationships are updated following a physical change to the facility, such as a turbine replacement. Rating curves are generally reviewed weekly during the winter to ensure that they reflect changing ice conditions, which can impact water flows. Calibration requires continuous cross-checking by knowledgeable staff of data from various points in the system.

As indicated previously, the model is not operated in a purely mechanical manner. Operations Planning engineers apply professional judgment in the process to help ensure that the inputs and results are reasonable. For example:

- Operators select among a number of functional forms in selecting equations for the forecasting of water flows. Selection is based on an evaluation of "best fit". The review of the functional form may be done more or less frequently depending on the season, the stability of forecast relationships, and changes in inflow data.

- In developing forecasts of water flows, management may take into account information that is external to the modeling tools. Thus, while water flow forecasts are generally based on the forecasting equations, management may use data on snow accumulation to adjust the forecast above or below the median expected value generated by a forecasting equation.

- The EMMA model within HERMES requires projections of future market prices. While data on future market prices are purchased from an external consultant, management on at least one occasion adjusted those forecasts downward when it believed that the price forecasts were overly optimistic.

- Model reviews are conducted internally in Hydraulic Operations, frequently involving PS&O management. Depending on the topic, staff from other areas of MH may be involved in concept reviews (e.g., Hydraulic Operations and Resource Planning and Market Analysis of the Power Planning Division).

The logic of the models does not generally capture management judgment. Management judgment is applied either in the use of the model outputs or in the development of input assumptions. This is appropriate given that the models are a decision-support tool rather than a direct means of operating the business.

3.6.2 Model Revision Process

The core framework of HERMES has not changed since its original development. Incremental changes have been made to ensure the model continues to represent current operations.

According to MH staff, adjustments to the model generally involve the following steps:

- identification of a driver for change (e.g., change from bilateral market to open MISO market);

- Operations Planning team conceptualizes and develops solution;

- coding changes made in "Development" and "Test" environment to test for robustness and reasonableness;

- new executable program is deployed during a low use period;

- Operations Planning staff evaluates incremental changes through review of relevant reports;

- affected groups are notified of the change;

- details of code changes are documented; and

- previous versions of code and database are backed up daily.

We consider the process as outlined by MH to be reasonable. The model revision process is managed by the Operations Planning section within Hydraulic Operations, the primary group responsible for HERMES. There is, however, no formal requirement for an independent or internal review of how the model revision process was followed. While we understand that HERMES is a "live" model and is being run and calibrated weekly, and hence problems are likely to be identified quickly, a structured review of the model and related processes on a periodic basis (e.g., once a year) would improve stakeholders' confidence in the credibility of the model and help to manage modeling error risks.

3.6.3 Model Accountability and Model Use

MH does not have a specific policy statement on the development and use of modeling tools. Modeling tools are managed through the application of existing approval and risk management policies and procedures. Modeling tools are developed within business units to meet specific needs.

For HERMES, the Operations Planning section within Hydraulic Operations is the primary group responsible for database updates, calibration, maintenance and use of the HERMES model. This group also leads model changes.

Other business units provide inputs and data updates. Model maintenance and code changes are implemented with the support of a dedicated Senior Applications Support staff member in the Market Process & Technology department. The Power Trading Supervisor in the Power Trading department is responsible for updating and ensuring that the export contract commitments are updated in the HERMES system.

Engineering staff in Operations Planning is responsible for model maintenance and calibration. Through regular weekly updates, senior engineering staff reviews HERMES outputs, typically in an integrated manner by reviewing results of the EMMA model, which is driven by the other modules in HERMES.

On a weekly basis, inputs and results of HERMES are reviewed at Production Scheduling Meetings participated in by Hydraulic Operations staff, Power Trading staff, Senior Risk Management Officer, Short Term Generation Scheduling, and Mitigation Department staff. This ensures that results are discussed with key operational personnel.

An important factor to note is the "live" nature of the HERMES model. As indicated previously, the model is continuously updated with new data and recalibrated. This process can be expected to improve the accuracy of the forecasts. However, this also means that the forecasts will be changing continually. We do not consider that this continuous update process presents an additional modeling risk in itself. However, it is important for users of forecasts from HERMES to recognize the fact that forecasts continually evolve, especially for staff outside of Operations Planning who use the information.

Projects for model development require line management approval and, depending upon size, may require Executive Committee approval. Requests in Power Supply for models that require major commitments of resources are prioritized through the Power Supply IT Coordinating Committee before being forwarded to Corporate IT for inclusion in the Corporate priority setting and approval process. At the point in time when models are recognized and incorporated into major business processes, a capital budget item is raised and, if greater than $2 million in projected cost, is approved by the Executive Committee. Corporate IT and PS&O utilize a project development and management process called Macroscope which follows the project through its life cycle.

The staff members responsible for maintenance and operation of the HERMES modules typically have graduate-level degrees in engineering. Staff appears highly motivated and interested in improving the performance of the system on an ongoing basis. The complexity of the MH system and of the optimization issues offer significant scope for ongoing analysis and improvement.

Our understanding from discussions with management is that it takes a long time for new recruits to fully understand and appreciate the characteristics of the Manitoba ~~hydro-electric~~hydroelectric system and its representation in HERMES. Accordingly, management puts significant effort into on-the-job training and coaching of new hires by more senior personnel. Management typically also hires additional staff at the junior level to account for the fact that some may leave the organization or fail to develop the required competencies. Succession planning is thus implicitly an important element of MH's process for model management and upkeep.

The movement of staff within the organization provides some benefits in terms of knowledge transfer and sharing. Staff members have moved from the SPLASH team to the HERMES team or vice versa or have rotated into or out of positions in the MH control center. This helps to ensure that the various models are consistent and capture relevant aspects of company operations.

As noted elsewhere, MH has developed its main modeling tools in-house and has thus relied heavily on internal expertise. One potential weakness of this approach is that staff members may have had limited direct exposure to modeling practices at other agencies or utilities. Formal peer review or benchmarking exercises would help ensure that MH benefits from experience elsewhere. It would also ensure that potential alternative modeling approaches are fully considered.

3.6.4 Proposed Model Enhancements

MH has a number of active or planned initiatives to enhance the HERMES system.

3.6.4.1 System Representation

MH is planning changes to the representation of certain system characteristics within the model. It proposes to change the approach to representing the power curve (i.e. the power versus flow relationship) within the Linear Programming formulation. The change will be from an iterative approach to one in which the relationship is found directly within the LP formulation. This model change is expected to yield improved solution stability and increased accuracy of absolute results. MH is also modifying the approach to modeling rating curves, which capture non-linear reservoir storage versus outflow relationships. This enhancement is expected to decrease the size of the LP formulation.

3.6.4.2 Stochastic "Tree" Model

As a longer-term project, MH is planning the implementation of a stochastic decision support model that incorporates water supply, energy market, and Manitoba load uncertainty within the optimization. The EMMA model will be configured to step through time and recommend release decisions for key reservoirs at that point in time, given a multitude of possible future input conditions. This model will allow consideration of uncertainty within a linear planning framework.

3.6.2.3 Model Renewal

In the coming year, Power Sales & Operations will be developing a plan to renew the HERMES system. Potential changes include: a new LP solution engine; change from a flat file to a relational database; improved interface capability with supporting systems; enhanced GUI; and assessment of human resource requirements for model maintenance and development from an engineering aspect and also from information technology point of view.

3.6.5 Model Documentation

The operation of the HERMES system requires highly specialized skills and knowledge in the operations of the MH system. Training is based on the transfer of expertise by senior engineers on the proper use of the models and interpretation of the results to trainees on a one-on-one basis.

Documentation on specific modules or aspects of the model is prepared to assist in knowledge transfer on an ad hoc basis. No detailed user's manual or comprehensive model documentation has been developed. MH considers that there is only a very limited number of staff with responsibility to operate the model who would need that documentation.

KPMG recommends that MH develop more formal model documentation. Such documentation will reduce risks associated with the departure of key modeling personnel and it will help internal and external stakeholders better understand model structure and logic. The development of documentation will require additional resources.

3.7 Review of HERMES – Model Assumptions and Data

HERMES requires a large array of data and assumptions in order to carry out the calculations and produce the required outputs. In this section, we provide our analysis on the topics identified previously in Section 3.3. These topics are:

- model optimization method;
- antecedent forecasting;
- pricing data inputs;
- market developments;
- potential errors in price inputs;
- data on historical flow record;
- lake level balances;
- lake level balances discrepancies;
- production coefficient data;
- storage option modeling techniques; and
- volume risk.

3.7.1 Model Optimization Method

3.7.1.1 Linear Programming Approach

One of the key assumptions in the HERMES system is that the operations problem can be represented with a linear programming formulation. Linear programming methods have been accepted in the electricity industry as a useful means of solving large hydro-scheduling problems. *(Source: A.J. Wood and B.F. Wollenberg, Power Generation, Operation, and Control, John Wiley & Sons, 1996, p. 250.)* Advantages to linear programming include its ability to efficiently solve large-scale problems, its ability to converge to global optimal solutions, and the ease of problem setup and solution. *(Source: J. Labadie, "Optimal Operation of Multireservoir Systems: State-of-the-Art Review", Journal of Water Resources Planning and Management, March/April 2004, p.97.)*

At their core, both the HERMES and SPLASH models have a linear programming routine to optimize production schedules, taking into account system constraints and the need to serve customer loads. The linear programming logic identifies the production schedule that results in the lowest net system costs, or, in other words, the lowest value for production costs less net export revenues. The optimization approach is deterministic. This means that at the starting date, all of the various parameters (e.g., prices, flows, load) are assumed to be known and are taken into account to optimize the production schedules during the optimization period. (It should be noted that SPLASH performs this optimization process for each of the 94 flow cases that are available as inputs. This allows consideration of flow uncertainty in the computation of expected results. For each iteration, however, flows are assumed to be known.)

To illustrate this point, for example, a suggested water release schedule for January will be included in a solution provided by a model run in December. This solution will be established using forecast information for water inflows in the following months. However, in real life there is uncertainty around these forecasts. In light of this uncertainty, it is not possible to make "perfect" or optimal decisions, even though it may be possible to make decisions that have a higher *expected* value than other decisions. This is what is referred to as the perfect foresight issue by the Consultant.

Issues arising from perfect foresight are likely to be more significant in extreme flow scenarios (drought or flood years). Under these conditions, the optimization model may recommend extreme decisions "knowing in advance" that a drought or flood will materialize. The model also "knows in advance" when the flood or drought will end. In real life, it would be impossible to know in advance the timing of those events and management will not, in practice, make these extreme decisions. Overall, it is likely that the HERMES and SPLASH models may then give more optimistic results than what would actually happen in real life under a flood or a drought scenario. By optimistic, we mean that it will tend to understate the actual costs incurred.

In HERMES, risks associated with the perfect foresight assumption are mitigated by testing any given production schedule against a low flow scenario. In other words, when a solution (e.g., a water release schedule for each period) is found through the HERMES model, the release schedule found is then run through the worst flow year on record. If the ending reservoir levels, using the optimal release schedule and the low flow year inputs, are below the minimum level required at the end of the planning horizon for reliability purposes, the release schedule is not implemented and another optimization is performed. This test was discussed in more detail in Section 3.4.2. This process counters the fact that the deterministic solution approach could lead to insufficient water levels in low flow years in the event that such low flows were not forecast in advance.

3.7.1.2 Alternative Optimization Approaches

MH staff are aware that algorithms in the scheduling models take inputs as known events and therefore do not account for forecast uncertainty. MH is also aware that there are other ways to deal with the optimization problem that do not assume perfect foresight. For example, there is an optimization approach called dynamic stochastic programming that can deal with optimization under uncertainty.

The basic working of dynamic stochastic programming is to perform a step-by-step optimization (for example, using a monthly time step) while taking into account the variability of all the parameters at the next step. Therefore the information about the state of the system is revealed step-by-step. The inputs entered into the model would no longer be a single forecast but could be a range of forecasts designed to represent the distributions of the outcomes possible for variables such as electricity prices, natural gas prices and water inflows.

The optimization criteria could also be modified. For example, it could be to maximize the expected value of the revenues, or to maximize the minimum revenue obtained in the worst case scenario (min-max optimization).

There are several examples in the utility sector where optimization under uncertainty has been applied to mid-term forecasting problems. FPL Energy Main (FPL) has reportedly developed a decision support system that includes, among other things, a stochastic mid-term inflow forecast module and a module for stochastic storage optimization including energy price forecasts. Bonneville Power Administration (BPA) is developing a mid-term (52-weeks) stochastic optimization model. For both FPL and BPA, short-term models remain "deterministic". *(Source: C.D.D. Howard, Hydroelectric System Operations Optimization, Great Wall World Renewable Energy Forum and Exhibition, October, 2006.)*

However, the dynamic stochastic programming approach, while addressing issues of uncertainty, also has its own limitations. The most important limitation is called the "curse of dimensionality". Given its step-by-step nature and the fact that it explores alternative states of one or more of the variables, the number of calculations required can multiply rapidly as the number of variables and states grows. This is a particular issue in the case of MH because MH has an extensive hydroelectric system with significant interaction among its components. For the kind of problem that MH needs to solve, the number of variables, states and constraints could be large. As a result implementing dynamic stochastic programming could be a very challenging undertaking for MH and, hence, a major investment.

3.7.1.3 Modeling Improvements

Based on our review and on discussions with Operations Planning staff, the optimization approach used by MH appears reasonable and logical. There are other optimization approaches that could be used, but it is beyond the scope of our work to assess whether these would yield materially better results.

Our discussions with MH staff show that they are aware of the limitations of the current approaches, of possible alternative approaches, and of the limitations or difficulties in implementing these alternatives.

Given ongoing evolution in optimization approaches, however, MH should continue to examine potential alternative approaches to production and system planning. Plans for model development, noted earlier in this Chapter, indicate that MH is continuing to enhance the system over time.

MH currently has no plans to change to a different solution algorithm, such as the use of dynamic stochastic programming. However, MH is consistently improving its current approach to deal with known issues. To explicitly address forecast uncertainty, MH is exploring some new methods, such as the development of a stochastic "tree" model. (This model was discussed earlier in 3.6.4) This model may be used to test alternative decision rules under multiple flow scenarios. In this way, optimal decision-making approaches under uncertainty can be found.

Within the last three years, HERMES has been upgraded to facilitate the analysis of multiple water flow scenarios. Thus, the storage value function for lake water levels is developed by testing the impact of different lake levels on net export revenues and costs over the following two year period. This allows storage values to be calculated within HERMES. Formerly, these values were calculated in SPLASH and transferred to HERMES.

MH can also now set its models to use particular scenarios for water flows, such as the lowest flows on record, in generating forecasts of financial and operating results. This allows MH to identify the impact of these scenarios, and therefore get an understanding of the potential variance in outcomes relative to expected values. This helps to address the fact that HERMES and SPLASH do not allow full "Monte Carlo" or multivariate stochastic analysis.

3.7.2 Antecedent Forecasting of Water Flow

3.7.2.1 Concept of Antecedent Forecasting

MH uses a methodology called "antecedent forecasting" in the projection of water flows. The antecedent forecasting methodology is a statistical approach that assumes that current water flows have predictive value in forecasting future water flows. MH applies this methodology primarily in forecasting water flows in the remaining months of the current hydrological year (April 1 to March 31). Around December of each year, the forecast is extended to cover both the remaining months of the current hydrological year and the next hydrological year. In general, if current water flows are higher than historical average, the methodology predicts that future flows in the remaining hydrological year will also be higher than average. The antecedent methodology is applied using regression analyses. Relationships between water flows in future periods of a hydrological year and the current flows are developed using historical flow data.

The concept behind the relationship between future water flows and current water flows is based on the dynamics of water flow in the hydrological system. For systems that are relatively shallow and have features such as marshes and swamps, which is the case for MH's system, water flows following precipitation events tend to be delayed and attenuated. In these systems, a sudden inflow of water into a water basin, such as from a large rainstorm, will not immediately result in a corresponding flow increase in the associated river. Some of the water inflow will be stored in the ground or in intervening tributaries and will take some time to flow out into downstream rivers and streams. As a result, the water flows are "smoothed" over a long period. Because of this smoothing effect, water flows measured in a given week or month are expected to be correlated to future weeks and months.

Based on our review of MH data and conversations with MH personnel, it is clear that the predictive value of antecedent forecasting varies over the course of the hydrological year. By its nature, the predictive power of antecedent forecasting declines for time periods further in the future. In addition, among the months, March has the lowest predictive value. Our understanding is the major influence on water flows later in the year is the amount of rain in late spring. In March water flows do not yet reflect the impact of the spring rain. As a result of this factor, the hydrological year is set by MH to begin in April 1 of each year.

In the course of our benchmarking process, we found that New York Power Authority also uses an antecedent, or regression-based, forecasting approach. A document from the New York Power Authority (NYPA) notes: "The St. Lawrence River flows are forecasted using seasonal regression models. Variables used for prediction are the Niagara River flow the current month, the St. Lawrence River flow last month and the time of year." *(NYPA's Hydro Generation Forecast, Rich Mueller, January 2006, as quoted in letter addressed to Mr. Arnold Bellis, from PACE Global Energy Services, April 21, 2006, p. 11 of 12.)* The same document also indicates, however, that NYPA uses meteorological data, and modeling of physical parameters such as lake evaporation, in its forecasting of Niagara River flows.

MH management indicates that antecedent forecasting is an appropriate approach for MH for the following reasons:

- The water basin for MH's system is large and shallow. Much of the water that will flow into MH's generation stations in the near future is already in the ground or in rivers and streams upstream of its system. This water will arrive over time and the current measured flows represent part of that water.
- Forecasting future water flows based on weather forecasts may not be appropriate for MH because MH requires forecasts for months ahead and weather forecasts that far ahead are not be very reliable. Also, collecting weather data for a large system such as MH's would require significant resources. The large size of MH's catchment area means that input from a very large number of precipitation gauges would be required to accurately monitor precipitation in the catchment area. In many areas, particularly in the north, there may be relatively limited number of stations for monitoring such precipitation.

- Further, even if good data were collected, it is not a straightforward exercise to model how such precipitation will be translated into future water flows. For example, significant amounts of snowfall may sublimate (transform back into water vapour) without resulting in additional water flows in downstream rivers and lakes. For snow that does result in run-off, the timing of this run-off is highly uncertain. Modeling difficulties are increased by the large watershed area.

KPMG recognizes that the forecasting methodology should fit the uniqueness of the system. These arguments provided by MH management are reasonable. We have not investigated whether another forecasting approach, such as using weather and detailed hydrologic forecasting would provide more reliable or accurate forecasts. Based on our research, however, there is a considerable body of knowledge around weather and hydrological forecasting for hydro utilities. This body of knowledge will continue to evolve and MH will need to actively monitor developments to assess when implementation of new approaches becomes appropriate.

3.7.2.2 Issues with Antecedent Forecasting

In its reports, the Consultant raises issues regarding the antecedent forecasting process and the use of the antecedent forecasts (*Consultant's Report, December 2006*). Specific points raised were:

1. "The antecedent forecasting method adds a layer of modeling assumptions and operational errors to forecasting."

2. "...the antecedent forecasting can lead to a mistimed anticipatory release of water, or reduction and lowering of lake levels which is an operational mismanagement decision as opposed to a true volumetric risk."

With respect to the first point on an additional "layer" of modeling assumptions, we are unclear as to Consultant's preferred alternative. However, based on nearby references in the document to "baseline volume risk" and "deviations from median or average expected flows", one interpretation is that the Consultant believes that the historical median or average flows should be used as the baseline forecast instead of the results of the antecedent process. Alternatively, the Consultant may simply believe that, in the event that antecedent forecasts continue to be used, risks associated with this methodology should be separately quantified. This reflects the fact that, because MH uses a different forecast from the historical median or average, there is conceivably an additional layer of risk that has been introduced. With respect to these interpretations, we note:

- From a risk quantification perspective, it may make sense to measure pure water flow variability around historical median or average values. However, the main purpose of the HERMES system, and hence the need for flow forecast, is as a tool to assist in operational planning. For this purpose, MH requires forecasts that can best predict the future. In this context, one would use all available information to improve the accuracy of the forecast, including current flows if appropriate.

- From an operations perspective, it is not clear what practical benefit would be obtained from precisely measuring the quantum of risk associated with antecedent forecasting. To the extent that such forecasting improves results on average, it should result in a reduction in risk overall, even though it may have led, in certain instances, to incorrect decisions (which can only be determined with the benefit of hindsight). Based on our analysis below, there is good reason to believe antecedent forecasts do improve decisions and therefore reduce risks overall.

We have conducted a limited review of the regression data that underlie the antecedent forecasting used by MH. The following table presents the R-square, t-statistics and p-values of the regression between the energy-equivalent of flows in a month and the energy-equivalent of flows in the remaining hydrological year. T-statistics and P-values are presented for the coefficient that relates flows in the remainder of the year to the current month. Flow data from all inflows are converted to energy using production coefficients and added up to yield the total available energy in the system.

Exhibit 3-5: Regression Analysis of Water Inflows

Current month	Remaining period in hydrological year	R-sq	*t Stat* *(Slope Coefficient)*	*p-value* *(Slope Coefficient*
March	April to March	0.25	5.40	5.7E-07
April	May to March	0.35	6.84	1.1E-09
May	June to March	0.37	7.12	2.9E-10
June	July to March	0.44	8.27	1.4E-12
July	August to March	0.53	9.92	5.9E-16
August	September to March	0.36	7.04	4.2E-10
September	October to March	0.52	9.71	1.5E-15
October	November to March	0.50	9.37	7.8E-15
November	December to March	0.65	12.74	1.4E-21
December	January to March	0.81	19.42	2.2E-33
January	February to March	0.71	14.42	8.6E-25
February	March	0.53	9.91	6.2E-16

Source: derived from Manitoba Hydro data

As shown in Exhibit 3-5, the relationship between inflows in a month and inflows in the remaining months of the hydrological year appears to be meaningful at a reasonable level of confidence, with p-values below 0.001. (In statistical hypothesis testing, a p-value is the probability of obtaining a test statistic as least as extreme as the one that is actually observed assuming that the null hypothesis of no regression relationship is true.)

It is beyond the scope of this review to determine whether the antecedent forecasting used by MH is the best methodology. We do, however, observe that there is statistical basis for the use of antecedent forecasting. Given this statistical significant relationship, it can be expected that antecedent forecasting would provide a better prediction of future flows than simply using long-term historical median flows as the predicted flows. Linear regression has been a standard approach to seasonal streamflow forecasting for almost a century. *(Andrew Wood and John Schaake, "Correcting Errors in Streamflow Forecast Ensemble Mean and Spread", Journal of Hydrometeorology, 2008, Volume 9, p. 132.)*

With respect to the second point on "leading to operational mismanagement", it is certainly true that antecedent forecasting can lead to operational decisions that will prove to be incorrect. However, this is true for all forecasting methodologies, antecedent or otherwise. Compared to using simple historical averages as forecasts, antecedent forecasting is expected to be more accurate on average and hence lead to better operating decisions over time.

3.7.2.3 Potential Alternative Methodologies

An alternative approach to forecasting water flows based on current observed flows is to develop a model that takes actual precipitation data, and potentially also forecasts of future precipitation, and projects future water flows based on full modeling of the flow of water through the environment. Our understanding, based on discussions with an expert in the field, is that this is becoming more practical with the increasing use of satellites to assist in the collection of rainfall data. *(Conversation with C.D.D Howard, February, 2010.)* Satellites can receive data from remote monitoring stations and, ultimately, may be able to measure rainfall directly.

It should be noted that development of such an approach would be a major undertaking and would take a major investment in system development. There are grounds to believe that this approach will be more challenging for MH than for other hydroelectric utilities. This reflects the following:

- The watershed of MH covers a particularly large area, meaning that a very large number of monitoring stations is required.
- The nature of the terrain (flat and relatively porous) means that there may be significantly lags in the flow of water through the environment, which increases the challenges of correctly ~~modelling~~modeling the translation of precipitation into stream flows.
- Our understanding is that models used in this approach need to be continually calibrated and this will require resources for ongoing model update. In addition, the skills and expertise may not be currently available within MH.

Below we summarize our observations on the use of antecedent forecasting by MH:

- There is statistical validity in the use of antecedent forecasting.
- Antecedent forecasting is used by other hydro utilities including New York Power Authority (NYPA).
- There are other ways to forecast flows such as the use of precipitation and topographic data.
- It is beyond our scope to determine whether the use of antecedent method by MH is the best approach among the available alternatives.

3.7.3 Power Pricing Data Inputs

In this Section, we discuss the issues related to the pricing data inputs to HERMES.

We have a number of general observations with respect to this issue:

- Since the Consultant's initial report, MH has updated its process for incorporating market price outlooks into the production planning process. MH purchases price forecasts for the next 12 months on a monthly basis and uses these forecasts to update hourly pricing assumptions within HERMES. At the time of the Consultant's initial report, the link between model price assumptions and purchased forecasts was less clear.
- MH is involved in an ongoing effort to evaluate market price patterns and, in the period since the Consultant's initial report was written, has taken significant care to analyze and account for the factors that influence the prices associated with export and import transactions. As discussed more fully below, it is not sufficient for MH to have up-to-date data on expected spot market prices in MISO. MH needs to account for the various factors that will influence the prices that MH will actually receive. We have found that MH puts significant analytical effort into assessing these factors and accounting for them in its ~~modelling~~modeling approach. Furthermore, the analysis of market pricing is updated as new market data is accumulated over time.
- This ongoing effort enables MH to monitor and respond to changes in market price patterns as a result of market shifts. Significant changes in market price patterns have occurred recently, for example, in response to the increase in wind generation in MISO and as a result of the economic downturn.

- Changes in market price patterns are only part of the uncertainty that MH must address. MH maintains that, in practice, uncertainty related to water flows and domestic load have a greater impact on optimal operation of its hydroelectric system than changes in market prices.

- In certain instances, the Consultant's assertions of price discrepancies appear to result from its mis-interpretation of model outputs. This issue is discussed in 3.7.5 on differences in prices in fiscal 2006/07.

3.7.3.1 Future Prices

While MH staff put significant effort into modeling future prices and price relationships (e.g., peak/off-peak differentials and nodal price differences), MH management maintain that market price changes have only a limited impact on optimal production schedules. This reflects the following:

- There are a number of system constraints that limit MH's ability to change production patterns. One constraint is the need to maximize outflows from Lake Winnipeg during winter months to meet temperature-related demand and to offset the impact that winter ice cover has on hydroelectric production capacity. Lake levels must also be maintained within limits set by licensing requirements. Another constraint is the limits on transmission capacity to the US, which restricts MH's ability to reschedule electricity transactions in the MISO market.

- Variability in water inflows and temperature related-load have much more significant impact on optimal production schedules than market price variation.

In allocating its modeling and analytical resources across various issues, MH management believes that it has put an appropriate emphasis on price issues relative to other factors. Based on our review of the models, their outputs, and the context in which they are used, MH's assertion that price has a limited impact on optimal production schedules generated by the model appears reasonable.

While these factors support the idea that price is not the most important factor in making operating decisions, it would be beneficial to have more formal analysis and documentation that market prices have a limited impact on optimal production schedules. This will provide additional comfort to stakeholders that this balance has, in fact, been reached. To this end, we asked MH to undertake the runs discussed in 3.8. These runs provide some evidence that changes in production schedules as a result of different price forecasts will have only a limited financial impact.

We also note that:

- Real-time trading decisions are made outside of the EMMA module of HERMES. EMMA provides suggested production schedules on a week by week basis, but operators can shape production within the next week using shorter-term planning models such as QSIM. QSIM helps operators manage forebay levels at dams on the Lower Nelson, giving MH additional flexibility in responding to market price shifts that occur within the next week. (Forebay refers to the water immediately upstream of a dam or control structure.)

- As noted elsewhere, MH sells a very limited proportion of its surplus energy beyond Day Ahead (DA) and Real Time (RT) markets. Hence, MH does not commit in advance to specific export quantities for the majority of its surplus energy production. This limits the financial risks that will accrue from shifts in production relative to plan.

3.7.3.2 Required Adjustments to Price Data

As noted above, significant adjustment is required to translate estimates of future MISO prices into estimates of the MISO prices that MH will actually receive for export sales (or of the MISO prices that MH will actually pay for purchased imports). MISO price data is most relevant for opportunity transactions, which generally occur in MISO day-ahead and real-time markets.

The need for adjustment arises from the following:

- Estimates of future MISO prices, whether from futures markets or purchased forecasts, are generally in the form of an average price over the peak periods within a month. For planning purposes, MH needs to have a means of modeling price variation within the month, both during peak and off-peak periods.

- Available price forecasts are generally for a key MISO hub, such as MINN (the Minneapolis node). MH transacts at the MHEB node, which is a node at the US/Canada border. MH needs to account for differences in prices between these hubs. MH has provided us with data that indicates that these nodal price differences can vary widely both across months and across hours within a month. In off-peak periods, MH transactions (and whether it is exporting or importing) appear to affect MISO prices and/or nodal differences, while these affects are much less pronounced during on-peak periods.

- In any particular period (such as a month), MH may be transacting in only a subset of the hours. MH traders will try to make transactions in the hours within the period that have the most favourable prices (i.e., the highest prices for sales and the lowest prices for purchases). However, because they do not have perfect foresight and because there may be limitations in tie-line or generating capacity, MH traders will not be able to transact consistently in the most favourable hours. Model assumptions must be (and are) calibrated to capture these affects.
- The EMMA model requires prices that are expressed in Canadian dollars and that take into account transmission losses that are charged against any particular transaction. Although the required adjustments are relatively straightforward, they introduce differences that need to be taken into account when comparing data from different sources.

We have had extensive discussions with MH staff on their approach for incorporating prices into their planning models and find that they apply significant care and due diligence in this process.

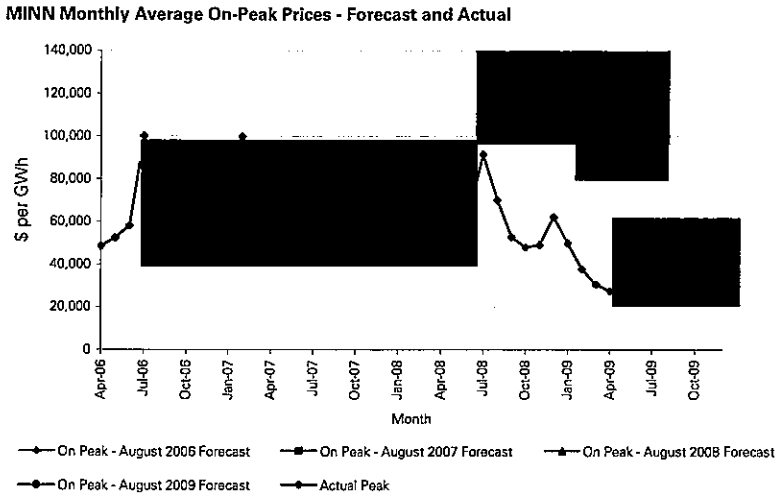
3.7.23.3 MH's Use of External Price Forecasts and Market Data

MH purchases price forecasts for MISO on a monthly basis. These forecasts provide projections of the MINN spot price in each month over the following year, averaged over the standard 5x16 on-peak period. MH uses these forecasts to update the pricing assumptions within EMMA. As MH sells the majority of its opportunity export sales in the cash market in MISO, the forecast of MISO spot price is an appropriate price signal for allocating MH surplus energy in and out of storage.

As noted earlier, however, MH management applies judgment when entering projected market prices into HERMES. Management may adjust prices downward if they believe the forecasts are too optimistic. Management reports that they did this in preparing the IFF for fiscal 2008/09.

Exhibit 3-6 indicates that this adjustment was warranted. Price forecasts provided by MH's pricing consultant in July 2008 for the following 12 months were substantially higher than the MISO prices that were actually observed. This is illustrated in Exhibit 3-6.

Exhibit 3-6: Forecast Versus Actual Prices



Source: derived from Manitoba Hydro data

MH has not done an analysis of whether quoted futures prices would be a better predictor of future spot prices than the forecasts purchased from the external forecasting firm. One rationale for using quoted future prices as a forecasting tool is that they represent the actual preferences of market participants, as evidenced by these participants' willingness to enter into forward trades at the prices quoted. Factors that may reduce the effectiveness of futures prices as a basis for forecasting spot prices may include a lack of liquidity in the futures market and limits on the number of market participants willing to hedge their future production or demand. Comparing the effectiveness of alternative forecasting approaches would improve the confidence in MH's current price forecasting process.

3.7.4 Market Developments

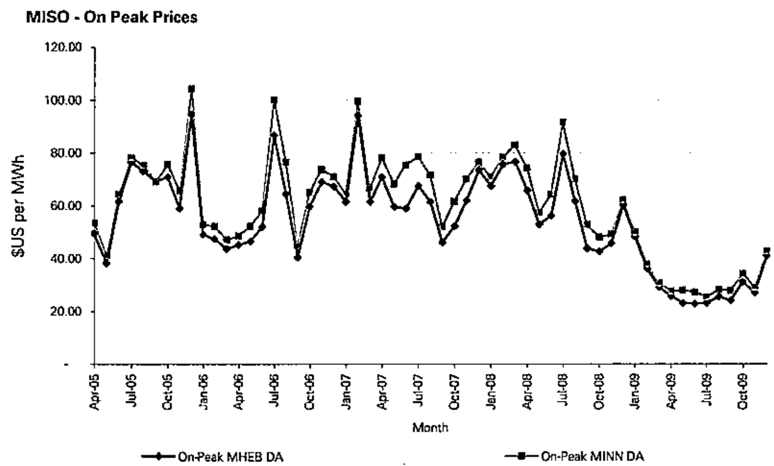
In this section, we review developments in electricity markets. These developments have a bearing on MH's proposed long-term contracts for the sale of power and on its approach to modeling operations.

Exhibit 3-7 indicates monthly on-peak electricity prices at two key nodes within MISO:

- The MHEB node at the Canada-US border where MH conducts most of its transactions in the spot market; and
- The MINN hub at Minneapolis, a major load point within MISO.

The MINN hub is a good reference point for the value of power to MH's major export customers.

Exhibit 3-7: On Peak Pricing at MINN and MHEB



Source: derived from Manitoba Hydro data

We have a number of observations with respect to price developments. These are outlined below.

3.7.4.1 Prices Have Declined

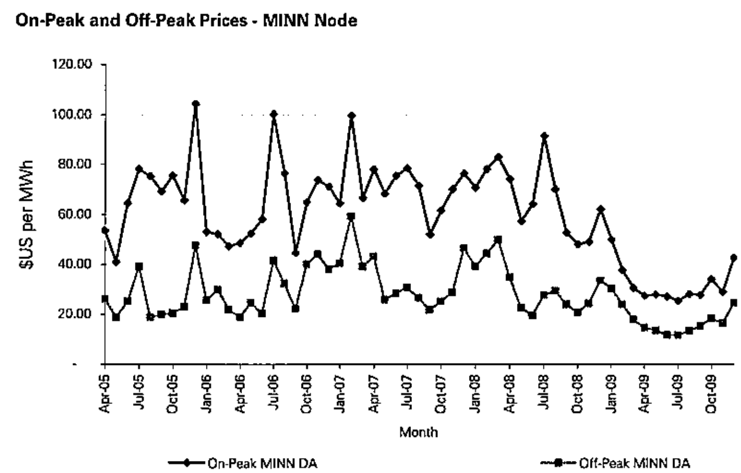
On-peak prices declined dramatically in 2009 relative to 2008. Average prices in 2009 are less than one-half of 2008 prices. The price decline reflects both a decline in natural gas prices, often the input fuel for generating plants on the margin, and a drop in electricity loads associated with the economic downturn.

The price decline highlights the risk for MH in relying entirely on spot markets for its electricity sales. Revenues could decline dramatically in the event of a market downturn. This is particularly a concern where revenues are used to support investment in new hydroelectric generation. The capital costs and associated debt charges as a result of new generation are fixed in advance. This suggests that a portion of the revenue should also be fixed in advance.

As noted elsewhere, aside from its long-term fixed contracts, MH sells much of the surplus energy associated with its new generating assets in a short-term basis.

As shown in Exhibit 3-8 below, prices in the off-peak period have fallen by less than prices in the on-peak period, based on monthly data for MINN. This has reduced the differences between peak and off-peak prices. This has reduced the ability of MH to profit from its hydroelectric storage capacity by taking advantage of such price differences.

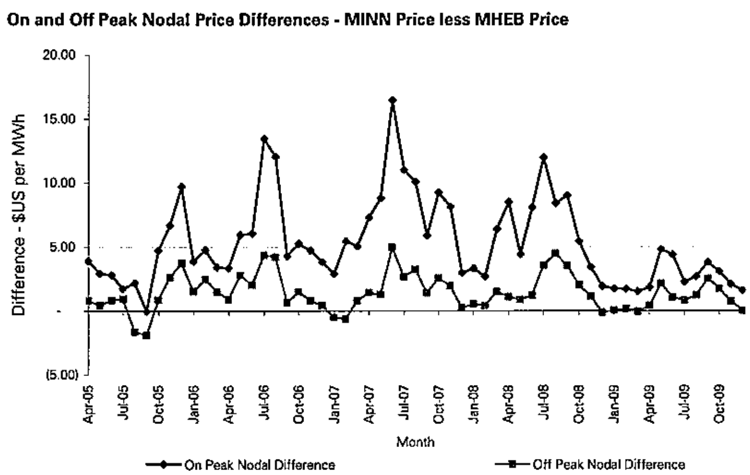
Exhibit 3-8: On-Peak versus Off-Peak Pricing at MINN



Source: derived from Manitoba Hydro data

The downturn in the electricity market has also reduced the spread between the MHEB and MINN hubs, both in on-peak and off-peak periods. Nevertheless, MHEB consistently trades at lower prices than MINN, which reduces the value that MH receives from opportunity sales. On a monthly average basis, the price discount at MHEB has been as high as $15 per MWh. Nodal price differences are illustrated in Exhibit 3-9 below. Nodal price differences result from transmission constraints in the MISO system. Excess supply at the MHEB node, which can result from MH export sales, will tend to reduce prices at MHEB relative to prices at MINN. Excess demand at MHEB (for example from MH import purchases) will tend to increase prices at MHEB relative to MINN. The presence of significant price differentials on an on-going basis suggests that transmission congestion is already an important issue for MH in its export transactions. Without an increase in transmission capacity, these price differences would likely increase in the future with increases in MH exports from new plant additions.

Exhibit 3-9: Nodal Price Differences – On and Off Peak



Source: derived from Manitoba Hydro data

3.7.5 Potential Errors in Price Inputs

In its report, the Consultant makes a general observation that prices used in the Generation Estimate report and those used in the HERMES runs are inconsistent, and therefore expose Manitoba Hydro to pricing error risks. The Consultant believes that these inconsistencies arise out of a lack of discipline or a lack of "checks and balances", and as the price inconsistencies have not been detected to date, they constitute a substantial financial risk for Manitoba Hydro.

KPMG has examined these assertions and we conclude, for the cases that we reviewed, the quoted data inconsistencies arise out of a mis-interpretation by the Consultant of the data that is being represented. This section describes our analysis.

Example #1 – Alleged price discrepancy between Generation Estimate reports and HERMES outputs.

On page 117 of the Consultant's Report of January 2008 second report, the Consultant notes a price discrepancy between certain prices shown in the Generation Estimate report for fiscal 2006/07, and those used in the supporting HERMES simulation runs. The apparent discrepancies relate to projected prices for April 2007. The Consultant quotes a differential between peak and off-peak prices of **(-$13.27)** from the 2006/07 Generation Estimate report, and compares this to the price differential of **$38.49** observed in the "price prices_risk.xls" file from the HERMES run of August 22, 2006.

The Consultant points to the differences in peak/off-peak price spreads and notes: "These are internal department errors in market pricing and fall short of best practices in control governance" *(Consultant's Report, January 2008, pg. 118)*. The Consultant then goes on to note that they had observed "other vast price inconsistencies". *(Consultant's Report, January 2008, pg. 118)*

Based on a review of the circumstances regarding this assertion, we have found that the Consultant misinterpreted the various price figures. The figures quoted inby the Consultant from the Generation Estimate report reflect actual average prices that were projected forobtained by MH for import/export transactions in April 20072006, taking into account the timing of these transactions within the peak and off-peak periods. In contrast, the prices quoted from the HERMES run reflect price inputs for April 2007, and were average time-weighted prices for on-peak and off-peak periods. In addition, there are differences in the definitions of on-peak and off-peak times for the numbers quoted. This is more fully documented below.

Detailed Findings

To reach this conclusion, KPMG has taken the following steps:

- Reproduced the findings of the Consultant to confirm the calculation methodology.
- Looked into the assumptions underlying the numbers that the Consultant is referencing to ensure consistency.
- Assessed the general applicability of making the comparisons that the Consultant is trying to make.

With respect to reproducing the findings of the Consultant, KPMG has observed the following:

- [redacted]
- [redacted]
- From this, KPMG calculates the same figure as the Consultant's **(-$13.27)** for the on-peak/off-peak differential.
- [redacted]
- [redacted]
- The calculated differential in the "price-risk.xls" file for these two prices is **$38.49.**

The mechanics of the Consultant's price calculation therefore appear to be correct.

With respect to assumptions underlying the two sets of numbers, we have consulted with Manitoba Hydro and note the following:

1. The numbers represent different things

The numbers quoted by the Consultant from the Generation Estimate Report are actual data for April 2006, while the numbers taken from the "prices_risk" report are forecast data for April 2007. Thus, the numbers from these sources are for periods that are one year apart, and are therefore not the exact same month. Even if they were for the same month and the same year, the prices would not be comparable. Prices in the "prices_risk" report represent forecasts of the average MISO price for the whole time duration of an individual strip. (A strip is a defined time period within the week. Strips are used in the modeling of demand fluctuations.) The "prices_risk" values for on-peak and off-peak are the time-weighted average prices for the strips making up the on-peak and off-peak time periods. (The definition of on-peak within this file corresponds to two time-strips, while off-peak corresponds to the remaining three time-strips.)

Prices in the Generation Estimate report, in contrast to those in the "prices_risk" file, represent the forecast average prices received or paid for sale and purchase transactions for the transaction amounts recommended by EMMA. ~~These prices~~ (The exception is that prices for the months already passed within the 2006/07 period reflect actual rather than forecast data.) The prices forecast by EMMA for April 2007 with respect to on-peak spot market sales were $59.51/MWh. The forecast prices for off-peak spot purchases were $22.98/MWh. Thus, the forecast differential between peak and off-peak prices for April 2007 is $36.53, which is close to the differential of $38.49 observed by the Consultant within the "prices_risk" report.

The reason that the differentials are not exactly the same is the fact that prices forecast by EMMA reflect the distribution of prices within a strip as more fully outlined below.

2. Aggregation and mapping of a point price forecast to market curves

Each of the strips used in the EMMA module has a market curve that is modeled by blocks, and these are based on historical pricing patterns within the strip. Each projected transaction will have a forecast price that depends on the projected point along the curve that a transaction occurs. In particular, if only a few transactions are projected within a strip, these might show a much higher price (e.g. for sales) because the model accounts for MH's ability to concentrate these sales in a few high-priced hours. Similarly, the timing of purchase transactions may be constrained to a few high-priced hours because of transmission constraints or other capacity conditions (e.g. the need to meet demand fluctuations across the strips making up the on-peak or off-peak periods and/or within a particular strip making up these periods.)

As noted above, the Consultant highlightedobserved off-peak purchases of 7 GWh at a price of $50.22/MWh. in April 2006. It is interesting to note that, for the same month, EMMAthe Generation Estimate report showed that Manitoba Hydro had forecast 282 GWh of off-peak *sales* at a price of $15.41 (in addition to the similar amount of *on-peak* sales also noted.)). On a volume and total dollar basis, these sales are much more important significant than the small amount of purchases. Having off-peak exports and imports in the same month does not indicate any modeloperational errors, but rather highlights the level of detail at which the model operates. While overall net exports were positive in off peak hours, the comparatively small amount of high priced imports is a consequence of the overall optimization process and the need to meet demand requirements and manage load variation and operating constraints in various on a real-time periods. basis. More generally, it should be noted that it can be misleading to look at individual data points in isolation.

3. Aggregation of price strips to on-peak and off-peak

Different assumptions also underlie the definition of on-peak and off-peak with respect to how the price data in the strips is aggregated. The Consultant uses an on-peak definition of 5x16 hours, while the EMMA module uses 6x16 (adding Saturday to the calculation of peak hours).

Based on these observations, KPMG notes that the values reported in the Generation Estimate report cannot be compared to numbers in the "price_risk.xls" file. It is therefore reasonable that numbers reported may not match even thoughif they appear to beare compared for the same time periods. The fact that these numbers are different does not in any way indicate errors in the HERMES optimization process.

Example #2 – Alleged Incorrect Peak Off-Peak Correlations

The Consultant asserts that pricing inputs to the HERMES model incorrectly assumed a 100% correlation between peak and off-peak prices. We have reviewed pricing inputs to HERMES runs in the fall of 2006 and found that peak and off-peak price inputs for fiscal 2007/08 had, in fact, a correlation of about 0.59 to 0.62, depending on whether price assumptions for import purchases or export sales are used.

Actual market data, obtained *ex post*, show correlations of 0.81 to 0.84 for the MHEB node (Exhibit 3-10). Correlations were calculated from monthly average prices, rather than from hourly prices. This contrasts to the Consultant's assertion that MISO data show correlations at 40% at the MISO node.

Exhibit 3-10: Peak and Off-Peak Correlations in 2007/08 at MHEB Node

	Peak–Off-Peak Correlations
Real Time	0.81
Day-Ahead	0.84

Source: data from MH and KPMG Analysis

3.7.6 Data on Historical Flow Record

The Consultant expresses concerns that the hydrological data used by MH in its planning processes is flawed. The key concerns relate to the quality of the historical data that are used. As you go farther back in time, the number of gauging points for which data are available is reduced and, accordingly, estimates of overall flow volumes become less reliable. Overall flow estimates for the historical period require interpolations and adjustment of the data from those gauging points that are available.

It is reasonable to have concerns about the quality of hydrologic data. However, it is not clear what MH should be doing differently as a result of these concerns. MH cannot change the fact that gauging data is unavailable. It seems reasonable to attempt to estimate water flows on the basis of the data that is available, in part to get a sense of longer term trends.

The Consultant identifies a number of years which mark the addition of gauging data and hence improvements in data quality: 1942, 1974, and 1989. We examined the impact of using each of these dates as starting points for the historical record rather than using 1912, which is the starting point used by MH in SPLASH. To do this analysis, we used aggregate data on overall water flows as indications of potential hydroelectric production.

For the full historical record from 1912, average flow measured as at Conawapa is 113.11 kcfs. Using different starting points has the following impact:

- Starting at 1942 results in a flow average of 116.13 kcfs, which is 2.7% higher than the estimate derived from the full record.
- Starting in 1974 results in a slightly lower average flow figure of 113.06 kcfs, or 0.04% less.
- Starting in 1989 results in a flow average that is 0.72% higher than that for the full period.

These figures are summarized in Exhibit 3-11.

Exhibit 3-11: Impact of Start Date on Calculated Average Flow

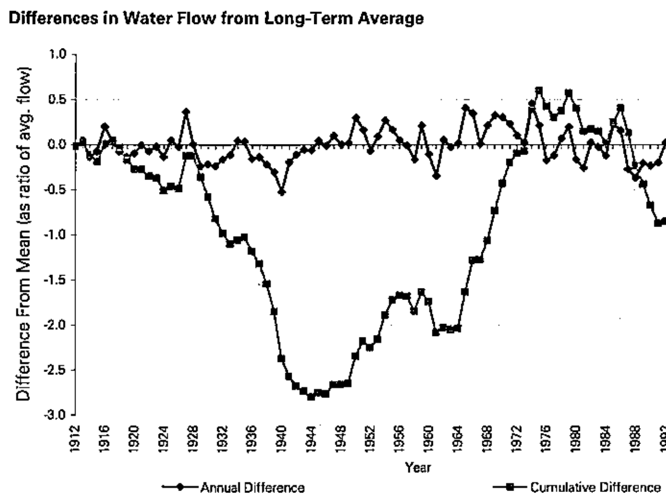
Beginning Year	Calculated Average Flow @ Conawapa (kcfs)	Difference from Full Data Set
1912 *(Full Data Set)*	113.11	0%
1942	116.13	+ 2.7%
1974	113.06	- 0.04%
1989	113.93	+ 0.72%

Source: derived from Manitoba Hydro data

Excluding data prior to 1942 has, in particular, a large impact on calculated average flows. Estimated flows in the period prior to 1942 were low relative to the average over the full flow period. Including data prior to 1942 adds an element of conservatism, even if they are based on less extensive gauging data.

Another way of looking at the data is to graph the difference between annual flows and the long-term average flow over the 94 year-period. Differences from the average flow can be graphed on both an annual and cumulative basis. This is done in Exhibit 3-12 below.

Exhibit 3-12: Annual Flows – Difference from Long-Term Mean



Source: derived from Manitoba Hydro data

The large cumulative difference in water flows (from the mean level of flows) in the period leading up to 1944 highlights the relatively low water flows in the first part of the past century.

3.7.6.1 Operational Risk

The Consultant quotes risk figures associated with MH flow data as follows:

"There is a degree of operational risk in the median/average forecasting process, alongside the statistical adjustments, that needs to be accounted for in risk capital adequacy process.

"Using the modeling discrepancies from utilizing historical averages and the Hermes flows, has operational model discrepancies measured to the forecasted P&L results in an order of magnitude risk of $50 MM to Hydro's forecasted P&L." (*Consultant Report, December 2006, p.21*).

We have interpreted this text to mean there is uncertainty in MH's earnings that is associated with uncertainty over the true underlying value for expected water flows. To the extent flow data over or under-estimate the true underlying average value of water flows, MH's earnings are consistently under or over-forecast. We have further interpreted the above quote to mean that MH needs to set aside reserves to cover this uncertainty in its capital adequacy process.

It is certainly true that expected earnings will be under or over-stated to the extent that historic water flow data provide an incorrect view of expected future water flows. Based on a number of simplifying assumptions, we could produce an estimate of earnings uncertainty as a result of uncertainty in water flow data that is similar to that reported by the Consultant. We do not know, however, if the approach that we used was similar to that used by the Consultant.

Whatever assumptions were used to calculate the Consultant's figure of $50 million, a more important question relates to its practical significance. If we are correct in our assumption that the figure relates to earnings risk, it is not clear what MH needs to do as a result of this risk measure. MH cannot change actual future flow amounts, even if it has incorrect estimates of their long-term expected values based on imperfect gauge data. MH could increase its risk capital, adjust rates, and/or alter its calculation of Dependable Energy. However, none of these steps will directly influence the amount of energy that MH can or will produce from future water flows.

3.7.6.2 Longer Term Records

A broader question relating to flow data is the representativeness of the past 97 years for the purpose of forecasting likely future flows. Two issues are relevant to consideration of this matter:

1. There is some evidence that worse droughts have occurred in MH's prairie watershed in the centuries preceding the past one. This issue was recently raised in a McCullough Research paper (*McCullough Research, Review of the ICF Report on Manitoba Hydro Export Sales, December 2, 2009, pg. 5*).

2. Climate change may change future water flow patterns relative to those of the past.

These issues may be more significant to MH's financial planning process than imperfections in available flow data.

In his paper, McCullough indicates that data from tree ring samples suggest that dependable energy might be 400 MWa lower than the 2,400 MWa figure calculated by MH in its power resource plans. Such long-term data suggests that it may be prudent to examine water flows that are lower than the historical record as part of some scenario analyses.

Flow estimates derived from tree-ring data would involve many more estimates and assumptions than were used to derive MH's 94 year hydrological record. As noted elsewhere, the Consultant had concerns about the validity of some of the estimates that MH uses in deriving its existing historical flow record. As a result, it is probably more appropriate to use water flow scenarios based on tree-ring data for risk analyses than as the basis of base case financial forecasts.

3.7.6.3 Practices at Other Utilities

For long-term forecasting and planning purposes, it is reasonable to rely on historical flow data for estimating dependable energy. We found a number of other major North American hydroelectric utilities that use a similar practice. Although other utilities may consider the potential impact of flows outside the historical record in specific runs undertaken to support scenario analyses, they do not appear to use such cases in their base case financial forecasting processes.

MH management have noted that:

- There is no indication to date that the long-term average flow is decreasing.
- Any impact from climate change on future average flows is likely to occur relatively gradually.
- Climate change may have more impact on future customer loads than on future water flows. To the extent winter heating loads are decreased, these impacts will help to offset any decreases in energy available that result from changes in water flow patterns.

Details on forecasting practices at some other major utilities are provided below.

BC Hydro

BC Hydro uses a 60-year flow record to establish firm energy available from its hydroelectric system. A BC Hydro document notes:

"Firm energy for the hydroelectric system is the energy capability of the system under the most adverse sequence of stream flows within the adopted period of historical record (critical water). Currently the most adverse set of stream flows is that which occurred from October 1940 to April 1946." (*BC Hydro 2006 Integrated Electricity Plan and Long Term Acquisition Plan, p. 29*).

During the course of an oral hearing, counsel for the British Columbia Utilities Commission (BCUC) suggested that the date points of 1945 and 1946, when evaluated against a normal distribution, appear as statistical outliers and should therefore be removed. Removal of these data points would increase calculated firm energy by almost 2,000 GWh/year (from 42,600 GWh). BC Hydro resisted this proposal, noting that this would increase the risk of energy shortfalls, and there was no basis to remove or modify this portion of the data set.

Bonneville Power Administration

In its risk assessment process, the Bonneville Power Administration (BPA) uses hydro generation data estimated from monthly streamflow patterns observed from October 1928 through September 1978. This provides a 50-year record. As with MH models, data are taken in sequence in the risk simulation process. Different start points are used to generate different test flow patterns (*Bonneville Power Administration, Risk Analysis Study, WP-07_FS-BPA-04, July 2006, p. 13*).

Puget Sound Energy

As part of its Integrated Resource Plan, Puget Sound Energy (PSE) assumes that hydropower generation is based on average stream flows for the 50 historical years of 1929 to 1978. Monthly average historical data is used to account for seasonal variability in hydropower availability. *(Puget Sound Energy, 2009 Integrated Resource Plan, Appendix I – Electric Analysis, p. I-15).*

US Bureau of Reclamation

For its Environmental Impact Statement for the Lower Colorado Basin and related dams, the US Bureau of Reclamation forecasts its future inflows using the existing historical record of natural flows from 1906 through 2005. The historical data is run through a resampling technique that the Bureau refers to as the "Indexed Sequential Method" (ISM). The ISM sampling approach appears to be identical to that used at MH. The simulation program cycles through the historic water flow record by using different flow years for the initial year. Subsequent flow years are then assumed in sequence. Whenever the end of the flow record is reached during the process of creating a particular run, the model returns to the initial year of data to continue the process. The Bureau notes: "The result of the ISM is a set of probabilistic future hydrological conditions, based on the hydrological variability over the historical record. ISM is well-documented and has been widely accepted by Colorado River stakeholders." *(Final EIS – Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead).*

In its Final EIS, the Bureau acknowledges that tree-ring data show that hydrologic variability, over a long period of time, is greater than that observed in the gauged record. The Bureau therefore uses such paleoclimatic data as the basis of some sensitivity analyses. It notes:

"Although paleoclimatic information may not represent future climate scenarios, this information may be useful in framing assumed variability in future hydrologic sequences, particularly with respect to drought potential." *(Final EIS – Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, p.4-13.).*

3.7.7 Lake Level Balances

In its first report, the Consultant observed a decline in projected lake level balances as at April 1st, 2007 in HERMES model runs done in the fall of 2006 *(Consultant's Report, December 2006, p.8).* The Consultant correctly observes that declines in lake level balances as at April 1st, 2007 imply a reduction in expected MH earnings in fiscal 2007/08. This reflects the lower availability of energy in storage at the beginning of the year, hence lower than expected export sales and/or increased reliance on thermal generation and imports. In addition, there is a potential increase in earnings volatility, since lower lake level balances imply less "cushion" to absorb potential future variances in water inflows.

It is important to note that HERMES runs provide a suggested production schedule that optimizes earnings, taking into account all production constraints and costs, expected inflows, and market prices in different periods. Lake level balances at any particular point are an output, rather than an input, to the HERMES optimization process. (Lake level balances on controlled reservoirs are, however, subject to constraints that set minimum, or floor, levels to ensure reliability targets are maintained.) Accordingly, changes in lake levels in HERMES runs reflect a change in the level that is estimated as optimum, rather than a specific management decision.

The Consultant reports a MTM valuation impact, as a result of changes in lake levels, of negative $78 million between the period August 4th, 2006 and November 13th, 2006. We have not been able to duplicate the Consultant's exact calculation but it appears broadly plausible. We have been able to obtain a similar number making some simplifying assumptions.

The Consultant had a concern that the IFF for 2007/08, which was produced in late summer of 2006, was not updated in late fall to reflect the change in outlook. This concern was reasonable. We note that MH now produces a report titled "Supply Value at Risk Variance Analysis", that provides management with updates to the IFF when required as a result of changes in the forecast outlook. In addition to providing updated forecasts at median flows, it also indicates results under low and high-flow scenarios. It thus provides an indication of the range of possible outcomes taking into account potential water flow variation and updated lake level balances.

3.7.8 Lake Level Balance Discrepancies

In its first report, the Consultant alleges that HERMES runs made during 2006 had, on a number of occasion, lake level balances in the start of fiscal 2007/08 that were different from, and therefore disconnected from, ending lake level balances in fiscal 2006/07. We have reviewed the runs provided to the Consultant and observed these types of discrepancies.

MH's response to these discrepancies is as follows:

- The files for fiscal 2007/08 were provided at the request of the Consultant and were not used for operations planning or for financial forecasting.
- Runs for the next fiscal year (e.g., data for 2007/08 produced during runs done in 2006) are only used once a year to provide input to the official Generation Estimate Report. This report is generally prepared in August of each year. For these runs, ending and starting lake levels are matched at the time of final submission. Future fiscal year runs produced at other times of the year, and thus not used in preparation of the Generation Estimate report, are not used for operations planning purposes.

Further to MH's response, we conducted an analysis on the financial impact of the lake level discrepancies. We examined starting and ending lake levels in the 2006

Generation Estimate Report. Exhibit 3-13 summarizes lake levels as published in the 2006 Generation Estimate report. There are discrepancies in lake levels on eight of the 29 lakes modeled. The discrepancies are generally small. By applying factors representing the change in water storage with lake level and the amount of energy per unit of water stored, we estimate that the total discrepancy in this year amounted to about 20,000 MWh. Assuming a market value of $50 per MWh, this amounts to a potential understatement of revenues post-2006/07 of $0.98 million, because of "lost" water. While a concern, theThe amount of the discrepancy is small in light of total average storage at fiscal year end, measured over a period of 26 years, of about 10 TWh, or 10 million MWh. Thus, the discrepancy is less than 0.2 percent of total water in storage.

Formatted: Body Text

Exhibit 3-13: Analysis of Lake Level Discrepancies – April 1st, 2007

Formatted: Font: Bold

Elevation (ft)	2006/07 Ending	2007/08 Starting	Difference	Storage/ft kcfs*days/ft	Prodn Coeff. MW/kcfs	MWh
Limestone Forebay	278.50	278.50	-		7.90	-
Long Spruce Forebay	361.30	361.30	-		14.10	-
Stephens Lake	459.60	459.60	-		21.55	-
Split Lake	549.81	549.58	(0.23)	38.8	21.55	(4,618)
Thompson Seaplane Base	619.28	619.28	-		21.55	-
Kelsey Forebay	603.50	603.50	-		25.40	-
Sipiwesk Lake	611.27	611.19	(0.08)	98.5	25.40	(4,801)
Cross Lake	680.67	680.65	(0.02)	92.0	25.40	(1,122)
Jenpeg Forebay	705.10	705.10	-		27.50	-
Lake Winnipeg	712.52	712.52	-		27.50	-
Cedar Lake	834.00	834.00	-		36.29	-
Pine Falls Forebay	751.66	751.66	-		30.17	-
Great Falls Forebay	811.74	811.74	-		33.96	-
Lac Du Bonnet	835.68	835.68	-		35.55	-
Natalie Lake	899.30	899.30	-		39.67	-
Slave Falls Forebay	933.20	933.20	-		41.65	-
Pointe Du Bois Forebay	980.00	980.00	-		44.76	-
Sand Lake	1,036.80	1,036.80	-		44.76	-
Lake Of The Woods	1,057.60	1,057.60	-		44.76	-
Rainy Lake	1,105.15	1,105.15	-		44.76	-
Namakan Lake	1,113.25	1,113.25	-		44.76	-
Lac La Croix	1,182.69	1,182.28	(0.41)	17.5	44.76	(7,689)
Umfreville Lake	1,043.90	1,043.90	-		44.76	-
Separation Lake	1,046.02	1,046.03	0.01	20.9	44.76	225
Ball Lake	1,050.88	1,050.87	(0.01)	22.4	44.76	(240)
Pakwash Lake	1,135.67	1,135.67	-	20.9	44.76	-
Lac Seul	1,164.00	1,164.00	-		44.76	-
Lake St Joseph	1,220.49	1,220.47	(0.02)	62.7	44.76	(1,348)
Laurie River Forebay	212.50	212.50	-		28.21	-
	29			8		
Total MWh						**(19,592)**
Value per MWh						50
Total $s						**(979,597)**

Source: derived from Manitoba Hydro data

We checked for similar discrepancies in the Generation Estimate reports supporting IFF processes for subsequent years, as indicated in Exhibits 3-14 and 3-15. As at April 1st, 2008, discrepancies were even smaller than in 2007. At an estimated 2,800 MWh, the discrepancy has a financial value of $140,000, at an assumed $50 per MWh value for electricity. The discrepancy at April 1st, 2009 was negligible. Errors, in addition to being small, have been significantly reduced over time.

Exhibit 3-14: Analysis of Lake Level Discrepancies – April 1st, 2008

Elevation (ft)	2007/08 Ending	2008/09 Starting	Difference	Storage kcfs*days/ft	Prodn Coeff. MW/kcfs	MWh
Limestone Forebay	278.50	278.50	-		7.90	-
Long Spruce Forebay	361.30	361.30	-		14.10	-
Stephens Lake	459.60	459.60	-		21.55	-
Split Lake	550.01	550.01	-		21.55	-
Thompson Seaplane Base	616.99	616.99	-		21.55	-
Kelsey Forebay	603.50	603.50	-		25.40	-
Sipiwesk Lake	611.38	611.38	-		25.40	-
Cross Lake	681.35	681.35	-		25.40	-
Jenpeg Forebay	705.10	705.10	-		27.50	-
Lake Winnipeg	714.00	714.00	-		27.50	-
Cedar Lake	837.00	837.00	-		36.29	-
Pine Falls Forebay	751.66	751.66	-		30.17	-
Great Falls Forebay	811.74	811.74	-		33.96	-
Lac Du Bonnet	835.68	835.68	-		35.55	-
Natalie Lake	899.30	899.30	-		39.67	-
Slave Falls Forebay	933.20	933.20	-		41.65	-
Pointe Du Bois Forebay	980.00	980.00	-		44.76	-
Sand Lake	1036.75	1,036.75	-		44.76	-
Lake Of The Woods	1058.50	1,058.50	-		44.76	-
Rainy Lake	1105.15	1,105.15	-		44.76	-
Namakan Lake	1113.25	1,113.25	-		44.76	-
Lac La Croix	1182.75	1,182.75	-		44.76	-
Umfreville Lake	1043.90	1,043.90	-		44.76	-
Separation Lake	1047.18	1,047.18	-		44.76	-
Ball Lake	1051.74	1,051.74	-		44.76	-
Pakwash Lake	1135.67	1,135.67	-		44.76	-
Lac Seul	1165.50	1,165.50	-		44.76	-
Lake St Joseph	1221.72	1,221.92	0.20	62.7	44.76	2,808
Laurie River Forebay	212.50	212.50	-		28.21	-
	29			1		
Total MWh						**2,808**
Value for MWh						50
Total $s						**140,394**

Source: derived from Manitoba Hydro data

Exhibit 3-15: Analysis of Lake Level Discrepancies – April 1st, 2009

Elevation (ft)	2008/09 Ending	2009/10 Starting	Difference	Storage kcfs*days/ft	Prodn Coeff. MW/kcfs	MWh
Limestone Forebay	278.50	278.50	-		7.90	-
Long Spruce Forebay	361.30	361.30	-		14.10	-
Stephens Lake	459.60	459.60	-		21.55	-
Split Lake	550.44	550.44	-		21.55	-
Thompson Seaplane Base	619.25	619.25	-		21.55	-
Kelsey Forebay	603.50	603.51	0.01	3.067	25.40	0.78
Sipiwesk Lake	611.28	611.28	-		25.40	-
Cross Lake	681.39	681.39	-		25.40	-
Jenpeg Forebay	705.10	705.10	-		27.50	-
Lake Winnipeg	714.07	714.07	-		27.50	-
Cedar Lake	832.25	832.25	-		36.29	-
Pine Falls Forebay	751.66	751.66	-		30.17	-
Great Falls Forebay	811.74	811.74	-		33.96	-
Lac Du Bonnet	835.68	835.68	-		35.55	-
Natalie Lake	899.30	899.30	-		39.67	-
Slave Falls Forebay	933.20	933.20	-		41.65	-
Pointe Du Bois Forebay	980.00	980.00	-		44.76	-
Sand Lake	1036.50	1,036.50	-		44.76	-
Lake Of The Woods	1057.71	1,057.71	-		44.76	-
Rainy Lake	1105.15	1,105.15	-		44.76	-
Namakan Lake	1113.25	1,113.25	-		44.76	-
Lac La Croix	1182.63	1,182.63	-		44.76	-
Umfreville Lake	1043.90	1,043.90	-		44.76	-
Separation Lake	1047.77	1,047.77	-		44.76	-
Ball Lake	1052.81	1,052.81	-		44.76	-
Pakwash Lake	1135.34	1,135.34	-		44.76	-
Lac Seul	1164.35	1,164.35	-		44.76	-
Lake St Joseph	1220.79	1,220.79	-		44.76	-
Laurie River Forebay	212.50	212.50	-		28.21	-
	29			1		
Total MWh						**0.78**
Value for MWh						50
Total $s						**39**

Source: derived from Manitoba Hydro data

3.7.9 Production Coefficient Data

The Consultant alleges that there are differences between HERMES and SPLASH in the production coefficients used. (*Consultant Report, December 2006, p. 23*) Further, the Consultant asserts that the SPLASH model has a superior (or "visibly more robust") approach to specifying production coefficients.

Production coefficients are the numerical parameters used in the calculation of power production. For each plant and for a particular level of output, the production coefficient captures the relationship between water flow and electricity generation as follows:

Electricity Output = Production Coefficient (MW/kcfs) x Water Flow (kcfs)

The appropriate "Production Coefficient" to use for any facility varies over time as a result of a number of effects.

The head at each generating station decreases with increasing flow through the plant, since increasing flow results in increasing elevation of the tailwater level. This is a particularly important effect for MH stations relative to those of many other hydroelectric utilities because MH has a system with relatively large water volumes but low heads. Relatively small increases in tailwater level can result in relatively large decreases in output.

The efficiency of the generating turbine varies with water flow (efficiency is calculated as the actual electricity output versus the theoretical maximum based on water flow and head). The efficiency can vary from about 78% to 92%, and may peak at flow that is 70% to 80% of the maximum flow without spillage.

Power flow can be characterized through the following engineering relationship:

P (Power) = [Fb – Tw (DSE, Q_T)] x e (Head, Q_P)/11.8[4] x Q_P

Where:

Fb = forebay elevation

Tw = tailrace elevation (a function of downstream elevation (DSE) and total water quantity (Q_T)

e = efficiency [a function of Head (which equals forebay elevation (Fb) less tailrace elevation (Tw)) and Q_P, which is the water quantity through the powerhouse.]

Quantity through the powerhouse (~~Q_t~~Q_p) differs from the total water quantity (~~Q_p~~Q_T) by the amount of spill.

The relationship above on power flow can be simplified into the following relationship:

Electricity Output = Production Coefficient (MW/kcfs) x Water Flow (kcfs)

[4] *11.8 is a constant that applies when imperial units of flow and head are used.*

In this simplified representation, the Production Coefficient thus captures the following elements of the detailed equation:

[Fb – Tw (DSE, Q_T)] x e (Head, Q_P)/11.8

The simplified representation is used within the HERMES and SPLASH models in order to facilitate the calculation of results within a Linear Programming ("LP") framework. In applying this simplified equation, however, MH needs to account for the fact that the Production Coefficient varies, as discussed above, with water flow. Thus, the LP algorithm calculates results using an iterative process. An initial estimate (based upon maximum head which minimizes reservoir releases) for the production co-efficient is used to calculate an initial estimate of flow and output. These estimates are refined until production coefficients and flow converge to numbers that are consistent with the production coefficient function.

Data provided to us by MH show that the Production Coefficient for a representative station increases rapidly with small amounts of flow from a value that is near zero, but over the usual range of production can vary by up to 25% of its maximum value. Thus, it is clearly important, as the Consultant asserts, that an appropriate value for the Production Coefficient be used within the planning models.

3.7.9.1 Findings

Based on our discussions with MH personnel and a review of the materials they provided, we are satisfied that they have taken appropriate care and due diligence in modeling production coefficients. They take into account plant efficiency when attempting to optimize the scheduling of their hydroelectric stations.

There may appear to be differences in production coefficients between the models as a result of the optimization approach used within each model. This is discussed further in the section below.

3.7.9.2 Differences between HERMES and SPLASH

There are valid reasons why coefficients observed within HERMES and SPLASH for the same period may be different.

As discussed elsewhere, HERMES takes a more "granular" approach to modeling time. Within a three-month time horizon, HERMES generally operates with a weekly time-step. Each one-week period is divided into five sub-periods. After three months, HERMES moves to a monthly time step, also with five sub-periods.

In contrast, SPLASH operates with a monthly time step over its full forecasting range, and each such month is divided into peak and off-peak periods.

In summary, HERMES has more detail with respect to its modeling of the system. Differences in forecast water flow among time periods will cause the production coefficient that should be assumed in each such time period to vary. SPLASH will use an average value for a broader period, while HERMES will use values appropriate to each sub-period.

The Consultant alleges that the "problem referred to by engineers with the HERMES systems is that it uses a uniform plant averaging which does not take into consideration accurately the degrading incremental slope" (*Consultant Report, January 2008, p.70*). In its first report, the Consultant alleges that SPLASH and HERMES use different assumptions with respect to plant production coefficients (*Consultant Report, December 2006, p. 23*).

Based on our discussions with operators of the HERMES system, a review of documentation with respect to model structure, and a review of the outputs of this model, we believe that the Consultant's characterization is inaccurate. It appears that modeling within HERMES does carefully take into account changes in production coefficients with flow. This may not have been apparent to the Consultant from the outputs that it reviewed.

In comparing HERMES and SPLASH, it is important to note that neither are used in the "fine tuning" of production decisions. Thus, whatever these models predict, MH operators will adjust actual schedules to meet load variation within the time steps, to optimize plant gate settings, and to address flow constraints. Both HERMES and SPLASH are not sufficiently detailed or real-time to mirror actual operations. Hence, actual production coefficients achieved will reflect considerations beyond HERMES and SPLASH.

3.7.9.3 Estimates of Error

The Consultant calculates a $2.2 million difference between HERMES and SPLASH in outputs for a representative winter month. (*Consultant Report, January 2008, p.67*).

This amount is the product of the following inputs:

- [redacted]

- [redacted]
- [redacted]
- [redacted]

The Consultant then multiplies this figure by 12 months to obtain an annual "operational error" of $26.4 million.

As discussed above, it appears that MH takes considerable care to calculate production coefficients. Accordingly, we do not believe that there is a consistent error of the magnitude noted. Nevertheless, we consider the potential implications of any possible errors in the section below.

3.7.9.4 Impact of Forecast Error

Even if we were to assume that the HERMES model did have incorrect assumptions about underlying equipment performance, and these in turn yielded incorrect estimates of future production, it is not clear that these errors would result in any actual financial losses for MH. Actual production will ultimately reflect the true underlying coefficient and, in general, there will be no loss in actual electricity production relative to that which was achievable. MH will have, however, been out in its forecast. We do not wish to minimize the undesirability of producing incorrect forecasts, but do want to be clear on the actual effects of the error. Hence, we will elaborate on this conclusion below.

If coefficients in HERMES were, in fact, incorrect, MH could prepare an incorrect forecast of future production at a given facility. Differences in actual results versus forecast would result from either:

- More or less water used than forecast to produce a given amount of electricity output.
- More or less electricity production than forecast for a given amount of water flow.

At the time of actual production, the scenario above that would apply will depend on whether system operators hold electricity production or water flow to the values in the forecast.

In the event that operators hold production constant, and less water was used than forecast to produce a given amount of electricity, it is conceivable under certain circumstances that the remaining water could not be stored effectively because of limitations in reservoir levels and would ultimately be "spilled". Thus, errors in coefficients could potentially, in certain circumstances, lead to direct losses. Without such limitations leading to spillage, however, errors in the forecast would simply mean either that more or less water is used, or more or less electricity is generated. Since actual production will reflect the actual physical characteristics of the plants, however, there is no shortfall relative to what is actually achievable, only a shortfall relative to a flawed forecast.

To the extent that production coefficients are incorrect in their forecast, financial losses could also accrue because of sub-optimization. Thus, incorrect coefficients could cause HERMES to suggest a production schedule that allocates production across time periods in a sub-optimal manner. This reflects the fact that HERMES takes into account production coefficients, among other factors, in the optimization process. However, it is reasonable to assume that this risk would be small. Production schedules are much more likely to be affected by forecasts of water flow, power prices and load variation than by the impact of slight, and possibly incorrect, differences in production coefficients across time periods.

We note, however, that this discussion is purely theoretical, because we have seen no evidence that production coefficients are, in fact, inaccurate.

We also do not want to imply that consistent errors in forecasting, if present, would be unimportant. They would represent a concern that should be addressed. However, we have seen no evidence that there are systematic errors in the forecasting undertaken.

In this context, it should be noted that EMMA runs provide MH management with suggested parameters for operation of the MH system, including suggested schedules for the release of water. Each EMMA run provides a suggested production schedule for the entire time horizon of the run.

MH management takes this suggested schedule into account when making actual production decisions, but actual system operation will differ from the suggested schedule for the following reasons:

- From a particular EMMA run, it is the suggested production in the next period that is most relevant for operational planning. Since EMMA is run on a weekly basis, managers making operational decisions further in the future will instead rely on subsequent EMMA runs to inform their decision making. In other words, EMMA runs evolve over time, and subsequent runs will incorporate new information.

- Decisions on the use of certain storage facilities are actually made on a daily basis, and reflect influences other than just the current EMMA run. For example, forebay storage is managed to optimize hourly production and to capture or take advantage of price arbitrage opportunities within the day (e.g., peak/off-peak differentials). Thus, MH can respond to market opportunities that appear in the short term but that are not captured in the most recent EMMA model run. Hence, additional value may be obtained from storage than is forecast by EMMA.

- Actual decisions on production are influenced by operational considerations that may not be reflected in EMMA. Actual water releases are influenced by a variety of factors, including consideration of impacts on local community groups and operational issues not captured in model logic. These factors may cause adjustments to the schedules suggested by MH's modeling tools.

The significance of the above factors is that the actual value achieved from storage is not just a function or product of the modeling tools used.

3.7.10 Storage Option Modeling Techniques

The Consultant alleges that HERMES and SPLASH entail differences in the modeling of option value associated with storage. Further, the Consultant states that "an annualized option value difference of $14.2 million annually is observed between the two systems". The SPLASH system "utilizes a better and more efficient valuation of storage." (*Consultant's Report, December 2008, p. 27*)

To address this assertion, we will first consider the nature of the two systems. When we discuss HERMES, we are generally referring to EMMA (Energy Management Model) within HERMES.

Both EMMA and SPLASH use linear programming routines to identify optimal production decisions under input scenarios that specify loads and water resources, in addition to other production variables, over a planning horizon. Neither EMMA nor SPLASH ~~can~~ explicitly address uncertainties in input variables during their optimization routines. Thus, loads and water resources in any particular period are both handled as fixed inputs by the linear programming algorithms. ~~Thus, the~~The models do not allow modeling of input variables as stochastic functions (with the exception of the 94 flow years that are modeled in SPLASH). As such, neither model ~~captures~~identifies the "option value" of storage.

By option value, we mean the additional value associated with an asset as a result of its operating flexibility, in an environment where there is uncertainty about future events. Rather, the models consider and optimize the value of storage under the expected regime for water flows, market prices, load and other factors. EMMA and SPLASH produce estimates of revenue and net production cost for the overall system that reflect the value of storage capability. ~~However, the models do~~It is not ~~report specific figures~~necessary for the ~~"~~models to identify an explicit "storage option value" for the purpose of ~~storage capability.~~production scheduling.

The EMMA system is used in the planning of operations over a short-term horizon, while SPLASH is used over a longer-term horizon to plan facility additions. Because EMMA is used to support current operational decisions, it has more detail, as discussed earlier, with respect to system operations:

- EMMA uses a weekly time-step over a three-month horizon, and then a monthly horizon thereafter. SPLASH, in contrast, models monthly periods for the full projection period.
- EMMA divides weekly or monthly time-steps into five periods. Because it divides the time-step into five increments, EMMA has more detail with respect to load and price variation within each time-step than SPLASH, which simply divides each monthly time-step into peak and off-peak periods.
- The additional detail within EMMA also means that it has much more detail with respect to system constraints, such as tie-line flows and plant capacity. This may result in a lower forecast of the value to be obtained from storage in EMMA relative to SPLASH, since the additional constraints will limit EMMA's ability to use storage to optimize electricity production across time periods. These limits reflect actual limits associated with operation of the MH system. To the extent that these limits govern the value that can be obtained from storage in practice, the fact that they have better representation in EMMA will tend to mean that EMMA will provide a more accurate, albeit lower, forecast of storage value.

Documentation for SPLASH specifically notes that with a monthly time step, it does not capture "the cycling of flows at a hydro plant over the hours of a week". Thus, in producing forecasts, SPLASH will capture very little of the~~ option~~ value associated with using hydro storage to arbitrage pricing differences between daily on-peak and off-peak periods. EMMA may capture more of this value in its forecast because of its breakdown of the time step into multiple on-peak and off-peak periods. This modeling difference will tend to produce higher values for storage in EMMA than SPLASH. Since this effect is of a different direction than that resulting from the modeling of constraints, the net impact on forecast values (i.e., does SPLASH or EMMA produce a higher forecast with respect to the value of storage?) is unclear. EMMA will, however, produce a more accurate estimate of the value of storage.

3.7.10.1 Estimates of Error

The Consultant maintains that there is $14.2 million difference in the storage value produced by HERMES versus SPLASH and that this represents "an operational reduction" on its "P&L". The Consultant also identifies the $14.2 million as an "operational risk", and as a "real economic value reduction". Although the precise meaning of the Consultant's assertion is unclear, we have interpreted it to mean that MH income may be $14.2 million lower annually because of differences in modeling approaches between HERMES (i.e., EMMA) and SPLASH.

We have not been able to duplicate these Consultant's calculations and, further, do not know the basis upon which they were derived. Based on our review of the models and of MH's approach to operating its generation facilities, we do not believe that there are any operational losses that arise as a result of modeling differences between HERMES and SPLASH.

In summary, we note that neither HERMES nor SPLASH were designed to be financial trading models or to provide estimates of the market value of storage. Both HERMES and SPLASH are water management models designed to meet Manitoba Hydro's operational needs in serving its firm load.

3.7.11 Drought Risk

For MH, the Consultant calculates the value of volume risk over a one-year period of $293 million. By assuming time independence, the Consultant estimates a volume risk of $0.65 billion over a five-year holding period. *(Consultant's Report, December 2006, pg. 33).*

The assumption of time independence by the Consultant is flawed. It is clear that there is serial correlation in the water flow data. This has the effect of expanding the quantum of volume risk, since there is a greater risk that drought conditions will persist than will be calculated under an assumption of time independence.

In the Consultant's Report of January 2008, the Consultant states that the $2 billion drought risk number quoted by MH to the PUB has "an infinitesimally small likelihood" of occurrence equivalent to a one in 6.9 billion year probability. *(Consultant's Report, January 2008, pg.11.)* The one in 6.9 billion year figure appears to be calculated as (1/93)^5. Thus, it is the probability of an event that has one in 93 chance of occurring in one year, occurring 5 years in a row.

The calculation is appropriate if:

- Future water flows in any given year are obtained by drawing from among the 93 values observed in the past 93 years.
- Each year's flows are independent of the prior years' flows.
- We are only concerned with a scenario in which one of the observed low flow years is repeated five years in a row. (Thus, we are not concerned about the impact of other relatively low-flow years.)

The Consultant used this figure in its first report to argue that MH was over-estimating drought risks to the PUB.

In the Corporate Risk Management Report filed in the current rate application, MH quotes the financial impact of drought as $2.4 billion. This is calculated by assuming that water flows during the period April 1987 through March 1992 are repeated. It further states that drought costs would be higher if the larger 1936-1943 drought was used as the basis of the estimate.

The Consultant appears to be underestimating drought risk probability by a large margin. If MH's analysis is based on actual flow patterns observed in the recent past, this suggests that the probability of reoccurrence is much higher than one in 6.9 billion years.

The Consultants figure is appropriate for the repeat, five years in a row, of a given level of flows with a probability of one in 93 of occurring. However, this is not an appropriate measure of the risk associated with low water flows because:

- Water flows are serially correlated, and low flow years are likely to be followed by additional low flow years.
- Drought risks do not just arise from a single case of the lowest annual flow in the past 93 years happening 5 years in a row. The next lowest flow years are all relatively close together. Even if we accepted the Consultant's assumption of

time independence, the probability of drought risks would depend on the various permutation and combinations of all of the relevant low flow years, and this would be much higher than just the single case of the worst year happening 5 years in a row.

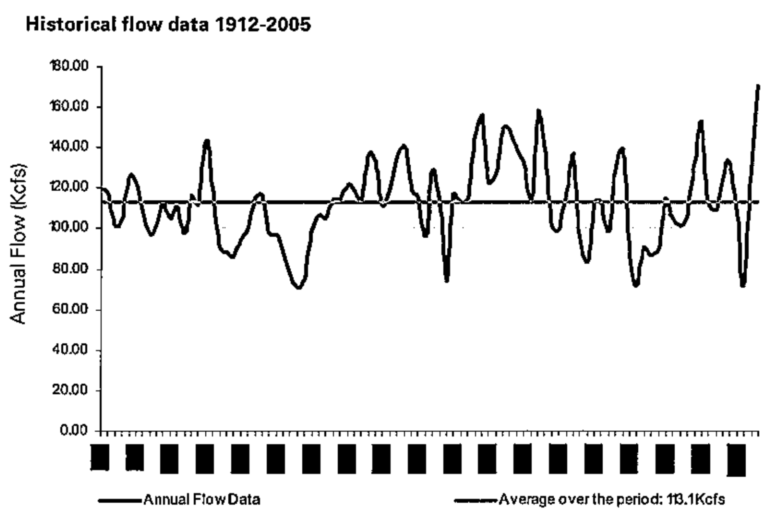
MH's use of actual flow sequences to measure drought risk is consistent with practices at other utilities and avoids the need to develop statistical models of underlying water flow processes.

3.7.11.1 Analysis of Flow Data

In this section, we analyze the statistical properties of MH flow data. This supports our finding that the Consultant did not account for key statistical features of MH's water flow record.

In order to assess drought risk, we analyzed the historical data to see whether low flow years happen independently of each other or in clusters. The data we used is the weighted average annual flow from 1912 to 2005. The initial graph of the data is displayed in Exhibit 3-16.

Exhibit 3-16: Historical Flow Data 1912-2005



Source: Manitoba Hydro

The mean over the period is 113.1 Kcfs and the standard deviation is 20.73 Kcfs.

From a visual analysis, we can infer that, indeed, low flow years and flood years tend to come in clusters. (For this purpose, we consider low flow years to be those years where the flows are below the average, and flood years the years where the flows are above the average.)

To confirm our visual impression, we performed serial correlation (or autocorrelation) tests on the data. Serial correlation is defined as the correlation of the variable with itself over successive time intervals. It is a statistical tool for finding time-series patterns. A positive serial correlation means above average values in one period tend to be associated with above average values in the following period. Similarly, below average values in one period will be associated with below average values in the following period.

Negative autocorrelations lead to the opposite conclusion (values that are above average in one period tend to be associated with below average values in the next). Like correlation values, autocorrelations are values between -1 and 1.

The order of an autocorrelation number is the time interval between the values for which the autocorrelation is computed (for example, autocorrelation of order 3 measure the correlation between a given year value and the value 3 years later)

We computed the autocorrelations of order 1 to 5 on the data. The results are given in Exhibit 3-17 below:.

Exhibit 3-17: Autocorrelations of Water Flow Data

Order	Value
1	0.488
2	0.090
3	0.236
4	0.297
5	0.132

Source: KPMG calculations from Manitoba Hydro data

We observe that the autocorrelation values are positive (which means that high or low values tend to come in clusters). We are mainly interested in the autocorrelation of order 1 and we want to test if it is statistically different from zero.

There are several methods to perform that test. We chose the method where we establish a regression relation between the standardized values of flow in a given year against the standardized value of the previous year (standardized values are calculated by subtracting the mean from the data point and dividing the result by the standard deviation). The slope of that regression relation is an alternative estimate of the autocorrelation number. We can estimate the regression parameters and build a confidence interval around the slope parameter to check if it is significantly different from zero.

We conducted the analysis for the auto correlation of order 1 and the regression results are outlined in Exhibit 3-18.

Exhibit 3-18: Autocorrelations of Order 1

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.0125	0.0902	0.1383	0.8903	-0.1666	0.1916
X Variable 1	0.5326	0.0941	5.6576	0.0000	**0.3456**	**0.7196**

Source: KPMG calculations from Manitoba Hydro data

The 95% confidence interval (0.3456 to 0.7196) around the autocorrelation estimate, which is the coefficient for the X-variable, shows that the estimate is significantly different from zero.

The autocorrelation coefficient derived from the regression analysis is slightly higher than that determined from the first methodology because the regression approach uses one less data point (2005). The difference is noticeable in this case because 2005 is a year of very high flow.

3.7.11.2 Average Drought Length

Using the same data set, we also computed the average length of a drought period. As an initial step, we defined a drought period as consecutive years where the annual flow is below the average over the entire period (113.1 Kcfs). Exhibit 3-19 displays these results as well as the average length at the end of the table.

Exhibit 3-19: Drought Periods with Below Average Annual Flows

Drought #	Start year	End year	# years
1	1914	1916	2
2	1918	1925	7
3	1926	1927	1
4	1929	1934	5
5	1936	1945	9
6	1952	1953	1
7	1958	1959	1
8	1960	1962	2
9	1976	1978	2
10	1980	1983	3
11	1984	1985	1
12	1987	1992	5
13	1993	1996	3
14	1999	2000	1
15	2002	2004	2
TOTAL			**45**
AVERAGE			**3**

Source: derived from Manitoba Hydro

If we define drought period as periods with at least two consecutive years below average, we have the results as shown in Exhibit 3-20.

Exhibit 3-20: Drought Periods Defined as Below Average Flows for Two Consecutive Years

Drought #	Start year	End year	# years
1	1914	1916	2
2	1918	1925	7
3	1929	1934	5
4	1936	1945	9
5	1960	1962	2
6	1976	1978	2
7	1980	1983	3
8	1987	1992	5
9	1993	1996	3
10	2002	2004	2
TOTAL			**40**
AVERAGE			**4**

Source: derived from Manitoba Hydro

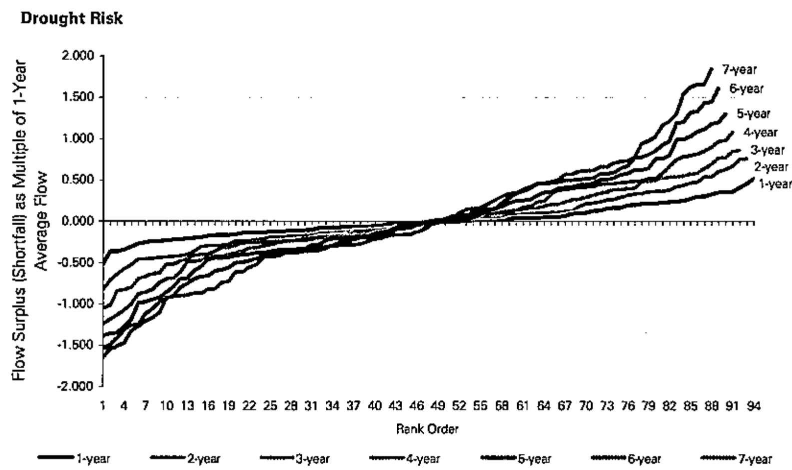
Therefore depending on how we define a drought period, it lasts on average three to four years.

In conclusion, the flow data does not seem to be serially independent and low flow years tend to be followed by low flow years and similarly, high flow years tend to be followed by high flow years. In addition, drought periods tend to last on average three to four years depending on the definition used for a drought periods. This information may be useful when assessing drought risk.

3.7.11.3 Drought Severity

Drought severity can be analyzed by looking at the total shortfall in water flows, relative to average flows, for different time periods. Exhibit 3-21 analyzes periods of from 1 to 7 years in length within the 94 year water flow record. It ranks periods of equal length in terms of the total shortfall in water flows. Shortfalls over the period are measured in terms of the volume of water in one year of average flow.

Exhibit 3-21: Flow Surplus (Shortfall) for Different Time Periods



Source: derived from Manitoba Hydro data

Exhibit 3-21 provides an indication of how drought risk, meaning the cumulative energy shortfall for a drought period, has varied for different time periods over the historical record. As shown in the Exhibit, the worst single year on record has flow that is just below one-half of the average or mean annual flow over the historical record. The worst 7-year period has a total shortfall in flow that is equal to 1.65 times the flow in an average year, or about 3 times the shortfall in just a 1 year period. Periods from 4 to 7 years in length are relatively close together in terms of the shortfall associated with the worst period on record. Thus, the increase in drought risk for longer holding periods levels off after four years or so.

3.8 Sensitivity Analysis – Impact of Price Inputs on HERMES

KPMG asked Manitoba Hydro to examine the impact that different price forecasts can have on MH production decisions. MH did this through a series of special runs within HERMES.

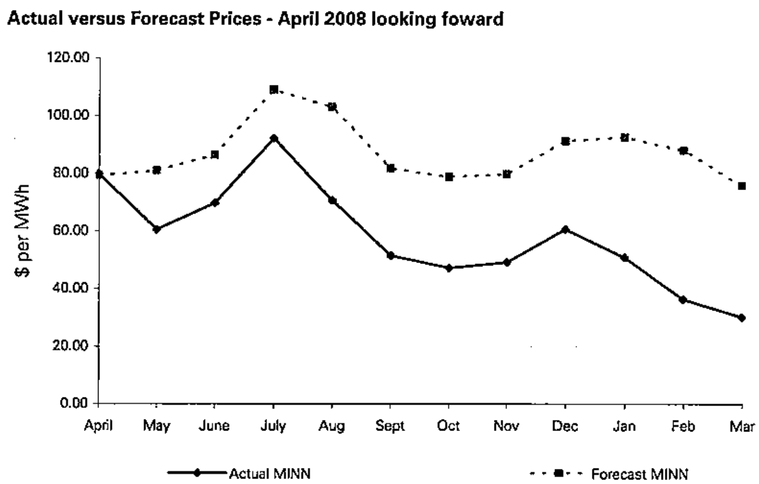
The runs were designed to keep factors other than price constant across various scenarios. Accordingly, differences between the runs were only due to differences in price forecasts and were not the result of other factors. The runs were "artificial", in that they involved a number of unrealistic and arbitrary assumptions, but they can reasonably be considered to provide an upper bound on the losses that MH could incur from having poor price forecasts or from being negligent in incorporating up-to-date market data. The runs undertaken are more fully described below.

3.8.1 Initial Run Set and Optimal Run

3.8.1.1 Common Elements

The runs were undertaken for the system looking forward from April 2008. This is a point at which purchased price forecasts for the following 12 months were relatively optimistic, relative to the actual prices that were ultimately observed. Not unexpectedly, the divergence between forecast and actual MISO prices was greater for points further into the future. This is illustrated in Exhibit 3-22.

Exhibit 3-22: Actual versus Forecast Prices – April 2008 Forward



Source: derived from Manitoba Hydro data

The model was run so that ending lake levels were common across the runs. For the initial set of runs, ending lake levels at Lake Winnipeg were set to 713.1 feet. In normal HERMES runs, ending lake levels are determined by an optimization process that takes into account prices during the year and ending values for the water in storage. For these runs, this optimization process was over-ridden. Unless it was over-ridden, differences in prices through the year across the runs could result in different ending lake levels, given common assumptions for the value of water in storage at the end of the year.[5] If we allowed lake levels to differ for the runs, then financial comparisons would be affected because different runs would have different total volumes of energy production within the year, rather than just differences in when this production was scheduled.

MH loads were the same across all runs. This means that differences in production schedules translate into differences in import and export transactions. Changes in thermal production schedules are minor, because thermal is generally a high cost source relative to potential spot market purchases. Thus thermal plants usually only operate when there are constraints on import capacity.

---

[5] *A run with higher prices in the optimization period than another run will generally have lower ending lake levels, because the model sees relatively greater value from selling energy in the optimization period relative to saving it as ending "inventory".*

3.8.1.2 Run with Perfect Foresight (Optimal Run)

For each comparison or run set, the first run is one in which HERMES has perfect foresight with respect to both water flows and future prices. We call this the Optimal Run. Thus, the inputs to the EMMA model were the prices that were ultimately observed at MISO, and median water flows. (Water flows were based on the median level from historical records.)

The Optimal Run provided us with an estimate of operating results for MH, under a median flow scenario, in the case in which MH had perfect knowledge with respect to MISO prices, and hence potential export revenues (and import costs) in each time period. By operating results, we mean net export revenues less generation costs.

3.8.2 Run Based on External Forecast (Forecast Run)

For each comparison, in the second run, HERMES was given external forecast prices as an input to its optimization process. We will call this the Forecast Run. As noted above, the external forecasts substantially overestimated the price levels that were ultimately observed.

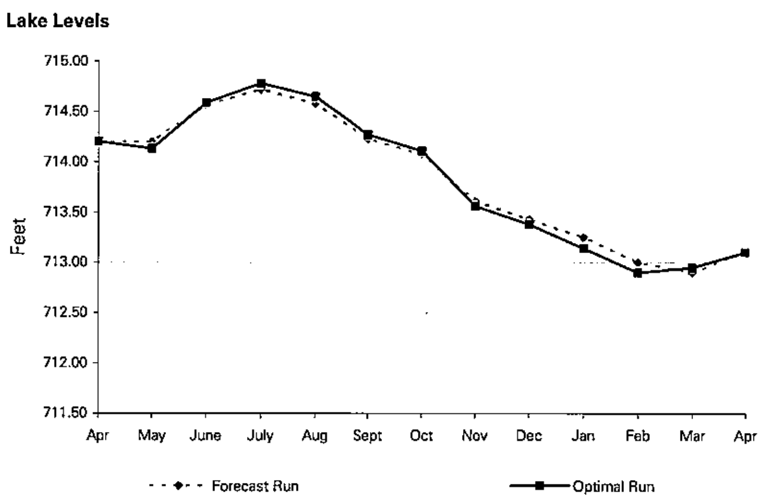
As in the Optimal Run, the inputs to this model included median water flows. As a first step in the Forecast Run, EMMA was used to create an operating plan for MH based on forecast prices. By operating plan, we mean a schedule for the operation of MH generating plants, and for interruptible purchases and sales, to meet firm MH loads. Firm MH loads under the Optimal and Forecast Runs were identical, and included both domestic load and net commitments under long-term firm contracts.

To obtain operating results for the Forecast Run, the operating plan obtained immediately above was "locked in" for the full 12-month projection period. This plan was then applied to the market environment in which actual MISO prices were realized. This run thus provided us with an estimate of operating results for MH, under a median flow scenario, in the case in which MH had optimized production schedules based on PIRA forecasts, and then rigidly applied this schedule under actual market outcomes.

As expected, operating results for MH under this scenario, in terms of net export revenues less operating costs, were less favourable than under the Optimal Run. For our first set of runs, the Forecast Run had operating results that were $25.3 million less favourable than the Optimal Run.

Exhibit 3-23 shows monthly levels at Lake Winnipeg for the two runs. The two runs show very similar levels, which shows that the optimization process is affected to only a limited degree by price levels. The drop in lake levels in the latter part of the year relative to the summer is driven by the need to meet MH domestic loads, which are temperature related.

Exhibit 3-23: Lake Level Comparison

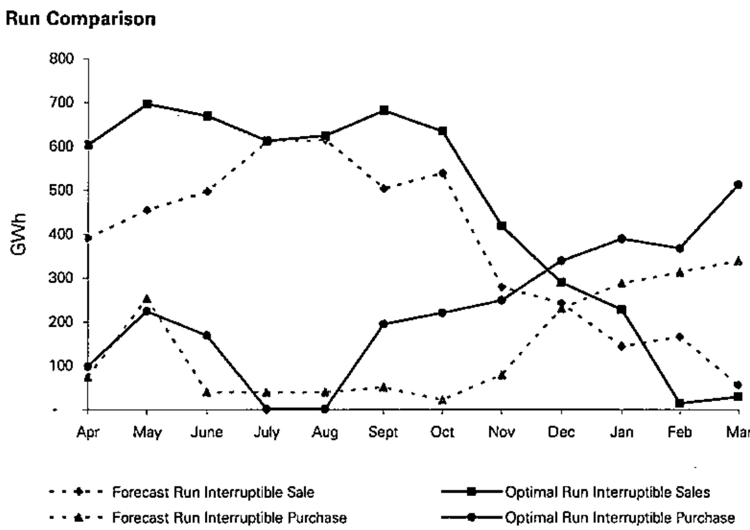


Source: sensitivity analysis runs applied to Manitoba Hydro data

The dotted line, which represents the operating regime under the Forecast Run, shows higher levels at later points in the year. The model keeps higher levels in order to minimize market purchases later in the year. This reflects the fact that it expects these prices to be higher than the Optimal Run.

Differences in operation are shown in Exhibit 3-24. The Forecast Run reduces sales in the spring and in the fall in order to reduce the reliance on purchases later in the year to meet winter loads (when it expects prices to be high).

Exhibit 3-24: Expected Imports and Exports



Source: sensitivity analysis runs applied to Manitoba Hydro data

3.8.3 Alternative Run Set

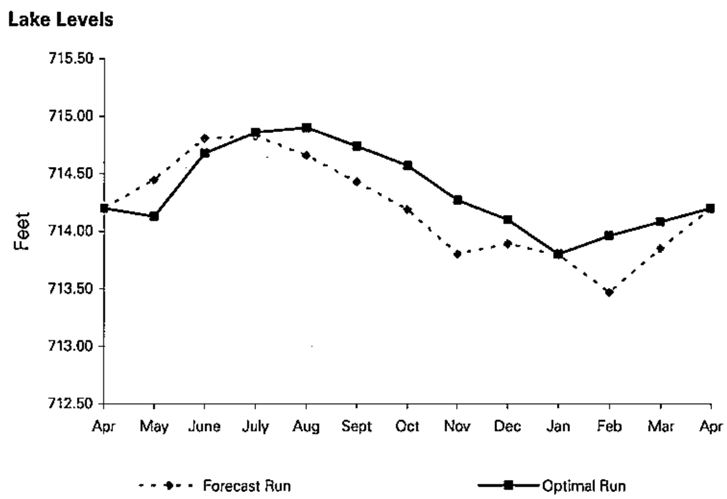
In the initial set of runs outlined above, lake levels declined over the course of the year. The initial lake level was 714.2 feet, reflecting relatively high actual water levels in spring 2008. The ending lake level (which was forced) was set to 713.1 feet, which reflects a level that is closer to the historical average ending levels.

Under the Alternative Run Set described below, MH tested a scenario in which lake levels were maintained at the same high level relative to the historic average. This allowed us to examine the impact that alternative ending lake levels could have on the results.

Under a scenario where high water levels are maintained, less energy is available from hydroelectric generation in the course of the year. Under this set of runs, differences between the Optimal and Forecast Runs were found to be greater. This reflects the fact that the system has more surplus export capacity than scenarios with higher production. This means, in turn, that the system can shift more production from one time period to another within the year when it tries to optimize against a particular price forecast. Because the system is selling less energy into export markets and is trying to focus on the highest price periods, there is more impact from moving this energy from one period to another.

Lake levels under the alternative run set are shown in Exhibit 3-25 below. As expected, ending lake levels are the same as starting lake levels for both the Optimal and Forecast Runs.

Exhibit 3-25: Lake Levels Comparison – Maintain Lake Levels



Source: sensitivity analysis runs applied to Manitoba Hydro data

Under the Alternative Run set, differences between Optimal and Forecast Runs were higher than for our Initial Run Set, resulting in about a $45 million difference in net revenues. This compares to a difference of $25.3 million from the Initial Run Set described previously.

MH also tested a scenario in which lake levels were set to decline to 712.0 feet. Under this scenario, in which additional generation is available, the difference between the Optimal and Forecast Runs was much smaller, at only $5.6 million in net revenues.

3.8.4 Findings

As outlined above, the hypothetical scenarios outlined above suggest that price inputs, if incorrect or "stale", could influence operating results by as much as $45 million.

There are a number of reasons to believe that the value of $45 million significantly overestimates the potential losses, or foregone revenues, that MH would experience in the event that prices were inaccurately entered into the HERMES system. These reasons are:

- The runs assume that production schedules must be locked in one year in advance. In practice, HERMES is run weekly, so that the model is updated on a rolling basis. Price information can be updated with each weekly run, meaning that divergence in price information should be less than that assumed in the test. As a result, the divergence in production schedules should also be less.

- The run was done for a period in which the divergence between the two potential forecasts (the external forecast and a "perfect" forecast) was relatively large.

- The Optimal Run, which was our benchmark for comparison, assumed perfect foresight of actual prices. In practice, this degree of forecasting accuracy cannot be achieved. A more realistic comparison would be between a schedule developed for one forecast and a schedule developed for a "better", rather than a perfect forecast.

- The runs assume perfect foresight with respect to both loads and water flows. Under actual operating conditions, uncertainty with respect to these other parameters may further reduce the value that can be obtained from better information on price.

In summary, these runs suggest that inefficiencies in operating schedules that could result from stale or inaccurate price inputs are likely to have only a limited impact on financial results achieved. Variations in water flow are likely to have a much larger influence on optimal operating schedules (and on MH's financial returns). Constraints on import and export transactions, and the need to meet domestic winter loads, also have significant influence on production schedules.

3.9 Review of HERMES – Conclusions and Recommendations

In this Section, we present a summary of our conclusions and recommendations related to HERMES based on the analysis in the previous sections.

3.9.1 Conclusion

As described earlier, HERMES is a complex set of data and tools. It was developed some 30 years ago but has been evolving over time. By necessity, HERMES is a large and complex model. It has to model a large and complex system with a high degree of detail.

The following are our conclusions with respect to HERMES.

- The overall model logic appears to be appropriate. It relies on linear programming, which is an accepted methodology for utility operations planning.
- The model captures all of the key factors that influence optimal production schedules.
- A high degree of technical expertise and specialization is required to operate the models.
- Model operators appear knowledgeable.
- Formal model documentation appears to be very limited. For example, there is no user's manual.
- Operation of the model is very reliant on the knowledge of a few highly specialized individuals.
- While the basic structure of the model is not changed, the forecasting equations are continuously fine-tuned. This continuous fine-tuning of the forecasting equations relies on the judgment of the model operators.
- There appears to be limited formal or documented validation of individual components of the model. At the overall level, however, HERMES appears to produce estimates of production that are close to actuals.

- The skills required to operate HERMES are derived on-the-job training and experience. The nature of this process is that it has not been highly reliant on formal documentation or training courses. While this is understandable in the circumstances, it creates some risks with respect to knowledge sharing and corporate exposure to the potential loss of key personnel.
- Lack of formal documentation, oversight or validation also creates a risk that the overall model is seen as a "black box" to outside stakeholders, both within and outside the company.
- MH would benefit from more formal documentation and oversight of the modeling process. However, MH must also be aware that such documentation and oversight will require additional resources without necessarily producing an immediate financial return in terms of improved forecasting performance.

3.9.2 Recommendations

As indicated previously, it is beyond the scope of our review to determine whether HERMES is the best model for MH. Nonetheless, we have identified a number of areas which may be worthy of further investigation by MH management.

3.9.2.1 Flow Forecasting

As noted in our discussion on antecedent forecasting in 3.6.2, other utilities and government agencies are exploring the use of full hydrologic models that predict water flows based on input data on actual or forecast precipitation over a watershed. Advancements in remote sensing technology may increase the feasibility of this approach, even for MH's large watershed. MH should continue to monitor developments in the field to take advantage of new methodologies that become available.

Given the uncertainty of impacts from climate change, MH may also wish to formally examine the potential impact of changes in water flows from the historical pattern. Thus, it should undertake scenario analyses to assess the financial impact of droughts worse than the historical record.

This type of scenario analysis can be used for the purpose of risk analysis, and does not necessarily need to be used as the basis of financial forecasts or for the determination of dependable energy. MH's current approach to forecasting and to calculating dependable energy appears reasonable and consistent with practices at other utilities. Additional scenario analyses, however, will provide information to stakeholders regarding the financial implications of potential developments that are outside of the historical record.

MH has undertaken an analysis of the impact on financial results if there is a gradual change in average streamflows over a 35-year period. This analysis, which was undertaken in 2004, assumed that there would be either a 20% increase or a 20% decrease in expected streamflows by the 2039 end date. Streamflow changes were assumed to take effect gradually over the intervening period. Under the low-flow scenario, annual domestic rate increases were 0.7 percentage points higher than under a scenario with no water flow change. *(MH Briefing Note: Economic and Financial Impacts of Changes to Manitoba Hydro's Water Supply from Climate Change, 2004 08 24)*

We understand that MH is engaged in rainfall run-off modeling for the entire Churchill Nelson basin as part of climate change studies. These calibrated models have the potential to assist MH in the area of short-term water supply forecasting.

MH reviewed a number of climate change models as part of its examination of the environment impacts of the Wuskwatim Generating Station. Its review noted that 18 out of 20 global climate change models forecast an increase in precipitation in the Wuskwatim region as a result of climate change. This review also cautioned, however, that increases in precipitation would not necessarily translate into increases in runoff and water flows. Impacts are uncertain because increased precipation could be offset by changes in evaporation, evapotranspiration, land cover, and wind. Furthermore, there is uncertainty about the intensity, duration and seasonal variability of precipitation. *(Evidence Presented at Clean Environment Commission Hearings on Environmental Impacts of Wuskwatim Generating Station.)*

3.9.2.2 Model Review

While comprehensive independence may not be practicable, the policy should explicitly provide for an effective communication process between modelers and decision markers. Technical complexity should not liberate model builders from the responsibility for providing clear and informative descriptions of modeling assumptions and limitations to senior management.

3.10 Review of SPLASH

This section provides a review of the SPLASH model, its conceptual and empirical validity, optimization approach and operations.

3.10.1 Model Overview

SPLASH (Simulation Program for Long Term Analysis of System Hydraulics) was developed by the Resource Planning and Market Analysis Department between 1990 and 1996. The purpose was to provide a computational tool that can be used to study the economics and adequacy of various expansion scenarios and to evaluate the options and opportunities available in the electric power market. More specifically, SPLASH is to be used in generation expansion studies.

SPLASH was designed as an energy balancing model to simulate the long-term operation of the hydroelectric energy supply system over a wide range of potential stream flow conditions for a specific load growth and system expansion scenario.

The output from SPLASH provides information to evaluate the economics of power resource options such as power export marketing contracts, system enhancements, and integration of non-hydraulic resource options such as wind energy and gas-fired combustion turbines.

There is no direct reconciliation between results from SPLASH and HERMES. The reason cited by MH personnel was that the data inputs and disaggregation are different and so the results are not easily comparable. However, both SPLASH and HERMES are calibrated to actuals by averaging over the modeling timesteps.

3.10.2 SPLASH Model Validity

3.10.2.1 Conceptual Validity

As noted earlier in the discussion on the modeling of the value of storage, SPLASH assumes perfect foresight with respect to future water flows. This means that the model provides a more optimistic view of operating results than will actually be achieved in times of drought.

The operators of SPLASH maintain that this aspect of the model has limited impact on the usefulness of SPLASH in its major role – to examine the relative value of different development sequences. (A development sequence is a particular scenario for the build-out of new generating capacity. Development sequences are generally designed to accommodate a particular forecast of load growth.) The assertion that perfect foresight is not important to economic evaluation reflects the fact that the assumption of perfect foresight should have a similar impact on different development sequences, and therefore should not affect the relative ranking of these sequences. While this assertion seems plausible, it would be desirable to have a more formal demonstration that perfect foresight does not limit SPLASH's usefulness as a ranking tool.

KPMG has a concern that the assumption of perfect foresight will tend to understate operating costs when the model is used to generate forecasts of future financial results. MH management maintains that they offset this bias in the model calibration process, but it would be useful to have separate quantification of the impact of the perfect foresight assumption. (Model calibration is required with respect to a number of inputs. For example, market pricing curves translate assumptions about expected average price levels to estimates of the price received in individual time periods and for individual transactions. The calibration of these types of inputs can be done in such a way as to offset the optimism bias.)

3.10.2.2 Drought Estimates

In addition to being used to prepare financial forecasts, SPLASH is used to estimate the financial impacts to MH of drought. As discussed in the section on drought risk, SPLASH outputs tend to underestimate the financial impacts of drought during the period of the drought. This reflects the fact that the model assumes that reservoirs will brought to minimum levels of storage during the course of a drought, since the model "knows" when the drought will end. In actual practice, management at MH will operate the system more conservatively, and will maintain reservoir levels above the levels predicted by SPLASH in order to address the fact that the drought may last longer than the historical record assumed within SPLASH. This will lead to higher operating costs in the period of the drought as a result of additional imports and fossil fuel purchases.

The issue of ending reservoir balances raises a conceptual issue with respect to the measurement of drought risk. With an assumption of declining reservoirs to the end of a drought, some of the losses associated with a drought will implicitly be carried forward into future periods. Future periods will have less hydroelectric energy than they would otherwise because they will need to build reservoir levels back up to their "normal" levels. This will lead to some combination of reduced exports, increased imports and/or increased fossil generation in these future periods. The associated costs will not be included in the financial impacts (in terms of a reduction in net income) that are reported for the drought period alone.

Management's tendency to operate the system more conservatively than SPLASH assumes simply works to bring back some of these future costs into the period of the drought. The period following the drought will have more water in storage than assumed by SPLASH, reducing future costs for imports and thermal generation. (For the moment, we are assuming that prices are constant across time; costs may differ across time periods in the event that market prices vary over time and affect the costs of imports and exports. MH maintains that overall MISO prices are not affected by drought in Manitoba, since MISO is largely a fossil-based system. Prices at the MHEB node, however, may be affected by the shift from sales to purchase in the event of a drought.)

As a partial offset to the factors noted above that result in an understatement of drought costs, SPLASH will overestimate certain costs because it ignores the potential to import power on a non-firm basis. SPLASH only assumes that imports occur under MH's Diversity Contracts, which are considered firm. The ability to schedule opportunity purchases through the spot market and from short-term contracts is ignored. To meet drought conditions, SPLASH will generally therefore assume that more use is made of MH's relatively inefficient thermal generating plants. In practice, less costly power is generally available from MISO and this tends to reduce the costs of the generation needed to cover the shortfall in energy from hydroelectric sources.

There is an additional complication that should be acknowledged in our discussion of this issue. This is the fact that management's tendency to maintain higher water levels will result in somewhat greater risk of the "spill" of water in subsequent periods. The risk of spill is greatest if the drought is followed by a period of very high precipitation. The "spill" of water is a true economic cost, since the value of energy production from the associated water is foregone. The risks of higher costs from spill may be well worth taking, given the potential for very high costs in the event that the utility is short of power as a result of maintaining low reservoir levels. Stakeholders would also benefit from explicit quantification or discussion of this issue.

The impacts of these various factors do not appear to be well documented or communicated. MH should explicitly quantify the extent to which SPLASH may underestimate operating losses in the period of the drought as part of its presentation of drought costs. This would facilitate greater understanding of the economic implications of the drought and of the modeling approach.

3.10.2.3 Optimization Approach

There are some differences between SPLASH and HERMES in their approach to modeling and optimization. For example, SPLASH assumes an optimal lake ending position of 713.2 ft for Lake Winnipeg. The Consultant refers to this as a "risk neutral" position. Our understanding is that this level was determined through some scenario analyses done previously, in which different lake levels were tested and an optimal level found that balances the risks of spill (which increase with higher lake levels) and the costs of additional imports and fossil fuel purchases (which increase with lower lake levels). The optimization process assumes very little economic value for water levels higher than the target ending position. Below the target level the model maximizes the use of thermal sources and imports in order to support moving to the target level. In its economic run, SPLASH optimizes within each 12 month window.

HERMES, in contrast, does not have an assumed optimal lake ending level. Rather, it determines an optimal ending lake level in the course of any run based on the expected market prices during the optimization period and a function for the value for water in storage at the end of the period. The value of water in storage at the end of the period is a function of ending storage levels. This storage value function is generated within HERMES based on an analysis of the expected value of water in storage across 33 water flow scenarios (based on the last 33 years of actual water flow data), and looking forward for a 2-year period.

In summary, the HERMES optimization approach appears to provide for more explicit consideration in the production scheduling decision of the economic value, relative to current sales, of greater or lesser ending storage levels. This seems appropriate given that HERMES is the tool that has the greatest impact on actual operations in the near term. Decisions in the near term, as supported by HERMES, can respond to prices that are currently observed in the market. (Although, as noted earlier, prices have a relatively limited impact on production decisions relative to other factors such as water flows.) As a longer-term tool, SPLASH has less need to adjust decisions based on current market data. Rather, it simply needs to capture the "average" or expected economics of a particular decision or sequence.

Our understanding is that MH does not usually commit all of the system's dependable energy to serving Manitoba load or long-term contracts. MH tries to maintain some surplus dependable energy to deal with uncertainty in the rate of domestic load growth or in other factors.

3.10.2.4 Empirical Validity

Since SPLASH was implemented in 1996, MH indicated that results from numerous studies have been reviewed to confirm that model outputs are representative of system characteristics. In particular, price and volume relationships used to model market transaction are periodically calibrated to ensure that they match actual outcomes.

A limited peer review was commissioned by Manitoba Water Stewardship in 2005 in connection with the consultation process related to the Wuskwatim hydroelectric project. In that peer review, three separate consultants were asked to provide their opinions on the adequacy of the SPLASH model. The peer review concluded that the SPLASH model is sufficiently accurate to represent the change of the water regime caused by the addition of the Wuskwatim power plant to the Manitoba Hydro system. The scope of this review was relatively limited. Hence, MH would benefit from a more comprehensive review to ensure that the model is appropriate for evaluating the economics of larger additions such as Keeyask and Conawapa, and associated contracts for the long-term sale of firm power.

3.10.3 SPLASH Model Operations

Personnel in the Resource Planning and Market Analysis Department perform quality control checks on the SPLASH output data with respect to other resource planning studies and to available actual operational data.

As noted previously, there is currently no specific corporate policy statement on the development and use of modeling tools and risk management. These tools are managed through the application of existing approval and risk management policies and procedures.

SPLASH is designed for carrying out "individual" resource planning studies. Data inputs from the annual Power Resource Plan (PRP), such as Manitoba load forecast, fuel prices and market energy prices, are input into SPLASH in April/May to serve as the baseline for studies through the rest of the planning year. As noted elsewhere, SPLASH takes a significant amount of time to complete a run.

The use of SPLASH requires an understanding of MH's overall system operations and interactions with interconnected utilities and markets.

As with HERMES, a small group of experts are responsible for the operation of the model.

3.11 Review of PRISM

3.11.1 Model Overview

As noted in Section 3.4 of this Chapter, PRISM is a simplified tool designed to be used by the Export Marketing Department for tactical use to analyze the financial impact of variations in a number of factors which affect Manitoba Hydro's operations, including water conditions, expected load, gas and electricity prices, export sales and forward contracting risk, transmission access and wind energy. It is an energy balancing model designed to measure MH's risks under lower than average flow conditions.

PRISM is implemented using @Risk, which is a risk analysis and simulation add-in for Microsoft Excel.

3.11.2 Assumptions and Data

PRISM is a highly simplified representation of the MH system. It has a number of key limitations:

- The model breaks the year up into only four discrete time periods: the summer and winter season, and within each, peak and off-peak. This means that the system has limited to no representation of demand and capacity issues.
- The model operates over only a five-year horizon. Thus, it can provide analysis of yearly impacts over the short term, but cannot evaluate long-run economics.
- The model uses assumed distributions for input prices, rather than using actual price patterns derived from analysis of past market activity.

We have one suggestion for improvement of this model. Electricity and natural gas prices are modeled with a normal distribution. There is good evidence, however, that energy prices are not normally distributed, with prices showing more extreme values than would be obtained from a normal distribution *(Dragana Pilipovic, "Energy Risk – Valuing and Managing Energy Deriatives", McGraw-Hill, 1998, p.26)*. MH may wish to explore alternative distributions as inputs to the PRISM model.

PRISM is used as a screening tool, and must be evaluated in this context. Its limitations appear acceptable if it is used simply as a screening tool, and more detailed analyses are done prior to implementation of any strategy that may be under review.

3.12 Review of the Issue of Multiple Models

Some concerns have been raised that MH has multiple models. Concerns associated with multiple models include the following:

- It becomes more difficult to ensure that models use common assumptions and logic.
- Additional effort is required for oversight and monitoring of model operations.
- There may be unnecessary duplication of effort.

Despite these concerns, there are a number of factors that drive utilities to have a variety of models. The key factor is that models are used for different purposes. Each of these purposes has different requirements with respect to time horizon, level of detail, accuracy, the nature of scenarios to be analyzed, interface with other systems, and accessibility to potential user groups. Separate models may also develop simply as a result of how needs were addressed in the past.

Our research into practices at other utilities established that it is common for utilities to use a relatively small portfolio of models. For example, a number of utilities use a different model for short-term power utilization and long-term resource planning. Some utilities also run external price forecasting models that get integrated as components of their internal models.

MH takes reasonable care to ensure that models are used in a consistent manner across the corporation and incorporate common assumptions or methodologies. For example:

- The HERMES model develops detailed load forecasts (which are disaggregated into weekly time segments) which are consistent with MH's annual corporate load forecast.
- Each of the operating models are updated to ensure that they include required information with respect to MH import and export contracts.
- The models use the actual historical record for water flows at MH in generating hydrologic scenarios.

3.13 Conclusion

With respect to the modeling approach at Manitoba Hydro, based on our analysis, we find:

- MH has developed a suite of models that capture the key characteristics of the MH system. These models are used to help optimize system operations and to support long-term capacity planning.
- We are satisfied that MH has taken appropriate care and due diligence in developing and maintaining these models and in using them in its operations planning process.
- MH's current approach to forecasting and to calculating dependable energy appears reasonable and is consistent with practices at other North American hydroelectric utilities. It is reasonable to rely on historical flow data for estimating dependable energy.

4. Power Sales Management

This chapter examines key issues associated with Manitoba Hydro's practice of entering into long-term fixed price contracts for export power sales.

This chapter is organized under the following headings:

- 4.1 Scope of our Review
- 4.2 Key Findings
- 4.3 Approach and Methodology
- 4.4 Rationale for Exporting Power
- 4.5 Rationale for Long-Term Contracts
- 4.6 Long-term Contract Pricing
- 4.7 Sales Volumes Commitments
- 4.8 Contract Structure
- 4.9 Manitoba Hydro's Risk Mitigation Strategies for Power Sales
- 4.10 Drought Risk Analysis of MH's Preferred Development Sequence
- 4.11 Quantification of Drought Risk and Associated Risk Capital Reserves
- 4.12 Conclusion.

4.1 Scope of Our Review

In Phase 1 of the Review as shown on Exhibit 1-1, KPMG identified three Issues within the Theme of Power Sales Management. The three Issues and along with a summary of the Consultant assertions of each Issue are outline below.

- Issue 1 – Pricing methodology for firm power sales

The Consultant asserts that MH is using incorrect pricing methodologies for the sales price in long-term energy contracts. Specifically, the Consultant asserts that MH is not properly making use of current market price information and is not properly identifying and quantifying all the risks (e.g., liquidated damages, volumetric risk, etc.) associated with such long-term supply contracts. As a result, the Consultant asserts that MH is not building in an appropriate premium in pricing these contracts.

The Consultant acknowledges the reasons cited by MH as to why it was willing to sell power for less than its apparent market value in these long-term contracts (i.e., because of the creation of transmission capacity and access), but rejects these as being valid reasons for such pricing. In this context, the Consultant recommends an overhaul of the pricing methodology used in the long-term fixed price contracts for energy sales.

- Issue 2 – Risk capital reserves

As described in the Issue above, the Consultant asserts that MH is using incorrect pricing methodologies for the sales price in long-term contracts and in particular is not properly identifying and quantifying all of the risks associated with having entered into long-term supply contracts. In that context, the Consultant asserts that MH is also not reserving a sufficient amount of risk capital for the export sales business, in light of its drought risk. The Consultant recommends the immediate cessation of export power market sales under long-term contracts until MH has an appropriate amount of risk capital reserved for this business.

- Issue 3 – Long-term contracts structure

The Consultant asserts that MH has suboptimized these arrangements due to the use of certain terms in the long-term contracts. The Consultant recommends: significantly shortening the duration of these contracts ~~to two years at most~~; sharing of risk in the market prices and premiums being charged including index or floating price provisions; and increasing optionality to MH's benefit.

In addressing these three Issues, we assess the following:

- MH's rationale for entering into long-term fixed price contracts;
- Its pricing of the power sold under such contracts;
- The sales volume commitments in such contracts in the context that over-committing its firm dependable energy production through these contracts could unnecessarily expose MH to volume risk;

- MH's structuring of contractual terms to mitigate the risks associated with long-term fixed price sales; and
- Its quantification of drought risk and its risk capital reserves in the form of equity reserved against such risk.

4.2 Key Findings

This section outlines our key findings with respect to power sales management.

With respect to the MH's methodology for firm power sales, we find the following:

- Prices in long-term contracts are a matter of negotiation between the parties, and must be acceptable to both parties for a deal to be done.
- In the course of negotiating these contracts, MH develops reference prices based on the two methodologies described above. Developing these two price estimates provides MH with an indication of the potential range of a contract's price. Based on this information and leveraging the considerable industry experience of the key MH personnel involved with the negotiations, a mutually agreeable price is set in the term sheets for new long-term contracts.
- Based on our analysis of this pricing process, MH has an appropriate methodology for arriving at the sales price in its long-term contracts. As mentioned previously, the pricing methodology explicitly incorporates relevant market pricing forecasts and, further, includes a premium. And as detailed in this chapter, long-term contracts mitigate MH's market risk through diversification of its export sales mix, and mitigate its drought risk because of both the returns generated by the contracts and the creation of the transmission capacity.
- Related aspects of this Issue are addressed in the Issue related to treatment of risk in Power Risk Management (Chapter 6).

With respect to risk capital reserves, we find the following:

- As stated in our findings related to Forecasting Models (Chapter 3) and the Issue above related to pricing methodology for firm power sales, we are satisfied with the methodology used by MH in arriving at the sales prices in its long-term contracts and in the treatment of lake water level balances in the quantification of drought risk.

- Further to the analysis described in Chapter 3, KPMG asked for additional stress tests of MH's preferred expansion plans (which include new long-term contracts) incorporating various drought scenarios and market price scenarios. KPMG also asked for corresponding stress tests to be conducted for an alternative expansion plan that did not include new long-term contracts. The results of these stress tests indicate that MH's ability to withstand the financial impacts of a drought is improved under the expansion plan that includes new long-term contracts.

- To summarize, on the basis of the policy decisions in place with respect to risk tolerance, MH quantifies its drought risk appropriately and currently provides for appropriate levels of reserves of risk capital against its projected drought risk.

With regard to long-term contracts structure, we find the following:

- As with prices, contractual terms in long-term agreements are a matter of negotiation between the parties, and must be acceptable to both parties for a deal to be done.

- The provisions identified by the Consultant, as well as other comparable novel terms, change the nature of the commercial arrangement for MH and the counterparty by either making the contract riskier for the counterparty or changing the nature of the product. Without knowing how the counterparties would value such changes, it is speculative to determine whether such provisions would help or hurt. ~~It is clear, however, that~~ MH's costs would increase, potentially significantly ~~increase~~, if it were to commit to multi-billion dollar capital investments with contractual sale commitments of ~~only~~shorter durations (e.g., two years~~,~~), potentially rendering the projects infeasible.

- Optimal risk sharing in a contractual arrangement dictates that risk should be allocated to the party that is best able to manage that risk. In this context, as addressed in Chapter 4, many of the potential novel terms that could be considered in a long-term firm sales contract between MH and a counterparty involve shifting a particular risk to the counterparty. In many cases, however, MH would generally be in a better position to assess and/or manage the risk than the counterparty, and would therefore generally be better off in the long run if it retained the risk (e.g., by being compensated for retaining the risk or avoiding the costs associated with transferring the risk).

- Overall, we found no basis to conclude that MH had suboptimized its contractual provisions.

4.3 Approach and Methodology

To assess these issues, we have used the following approach and methodology:

- interviewing senior MH management with direct knowledge of and input into MH's decision to enter into long-term contracts;
- examining relevant MH policies and documents related to various aspects of long-term contracting (e.g., pricing, approvals);
- reviewing MH's long-term contracts and term sheets;
- industry research;
- consulting with one of the specialist sub-consultants that KPMG engaged (NERA) to augment our analysis of MH long-term contracting; and
- conducting scenario analysis from special runs of MH models.

Note that our analysis and observations on MH's long-term export power sales contracting strategy is partially based on the use of MH's modeling tools, especially for hydrological modeling and dependable energy estimation. Chapter 3 examines the various aspects of MH's modeling tools.

4.4 MH's Rationale for Exporting Power

In order to fulfill its mandate, MH has, by design, much more installed capacity than Manitoba demand and therefore is in a position to produce electricity in excess of what is consumed in Manitoba. This is not a recent circumstance, but has been the case for much of MH's history. For example, in fiscal 2008/09, MH hydro had an installed system capacity of 5,480 MW with a Manitoba firm peak demand (occurring in the winter) of 4,477 MW. In the same fiscal year, the total energy supplied by MH's system (other than isolated generation capabilities in remote communities) was 34.5 TWh whereas Manitoba consumption was 21.3 TWh *(Source: Manitoba Hydro 2009 Annual Report).*

A key consideration in MH's capacity planning process is the variation in water flows. For meeting its projected load, MH relies only on dependable energy, which is the energy that is projected to be available in the lowest flow year. Additional or surplus energy may be available in most years, but this cannot be counted on to meet MH's firm loads and firm export commitments.

Because of the need to plan to provide energy on a firm basis, the amount of dependable energy available, rather than the amount of installed capacity, becomes the key planning criteria. Another way of saying this is that the MH system is energy limited, rather than capacity limited. In this framework, dependable energy is the energy metric of relevance.

The addition of new hydroelectric generating capacity generally increases the amount of dependable energy available. This reflects the fact that the installation of new hydro generating plants allows MH to extract more energy from a given amount of water flowing into the MH system. More precisely, the addition of a new hydroelectric plant allows MH to capture additional "head", or energy from the drop in the elevation of water, as a unit of water flows down to Hudson Bay. MH defines dependable energy as the hydroelectric power available under the lowest river flow conditions in the historical record, and also includes energy sourced from non-hydroelectric sources, including MH thermal stations, wind farms with long-term contracts, and energy imports. (These other energy sources remain a very small share of Manitoba's total production).

Although dependable energy is the key system constraint, MH's financial plans need to take account of the fact that more energy will generally be available in anything other than a low-flow year. This additional energy is known as surplus energy. The amount of surplus energy available in any year varies widely. Financial plans are developed by averaging the results of alternative water flow scenarios. Water flow scenarios are based on the historical record of water flows. The average amount of surplus energy available across the various water flow scenarios can be referred to as the expected surplus energy. Surplus energy has generally been sold on a short-term basis in export markets. These short-term sales, which are linked to surplus energy, are referred to as "opportunity sales".

In high flow years, MH may have insufficient capacity to use all of the available water flow. This can lead to the "spill" of some of the water now flowing, where such water bypasses the generating equipment. Generating capacity is not generally a constraint in meeting MH winter loads. The objective of having sufficient dependable energy resources has led to an amount of installed capacity that is greater than current winter loads in Manitoba.

For capacity planning purposes, MH has established the following power resource planning criteria *(Source: Manitoba Hydro Policy G195, Generation Planning)*:

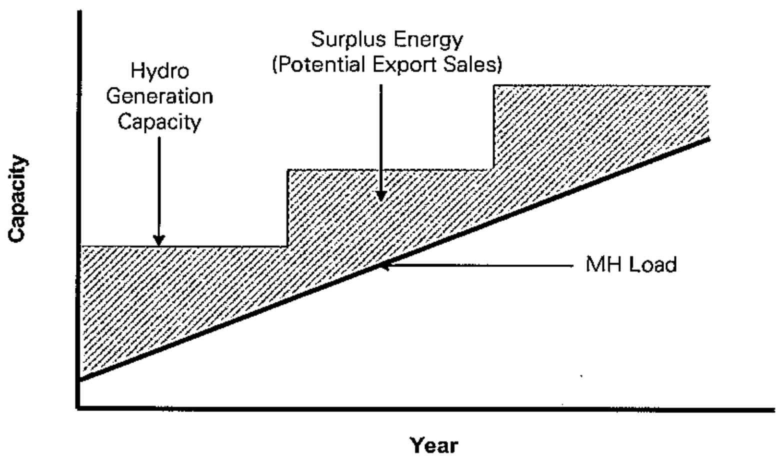
- *"Capacity Criteria — Manitoba Hydro will plan to carry a minimum reserve against a breakdown of plant and an increase in demand that is 12% above the*

Manitoba forecast peak demand each year plus the reserve required by any export contract in effect at the time. (E.M.C. 73.03)

- *Energy Resource Planning — The Corporation will plan to have adequate energy resources to supply the firm energy demand in the event that the lowest recorded coincident river flow conditions are repeated. Planning studies, to meet the firm energy demand, may include up to a maximum of 10% of the energy demand in Manitoba to be supplied from the energy reserves on interconnected utilities, provided an energy purchase contract is or will be in effect during the time being studied. (E.M.C. 177.05)"*

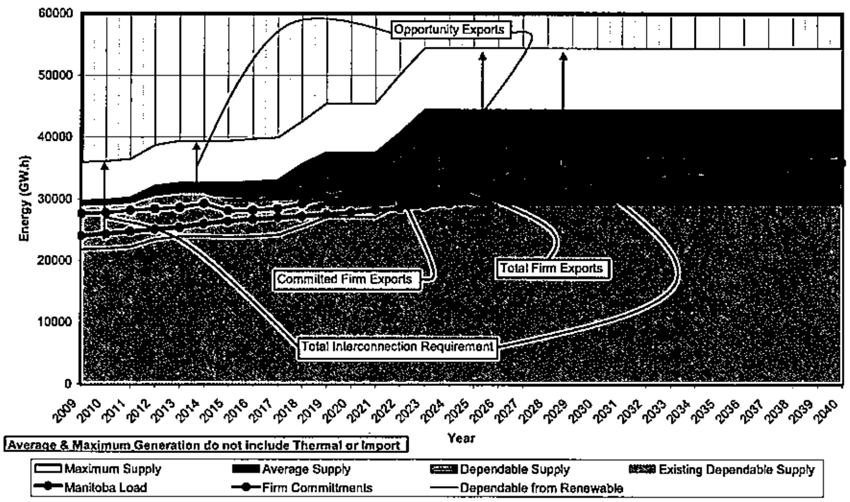
In addition to the surplus capacity required by MH's power resource planning criterion, another key reason that MH has surplus energy production capability is that hydroelectric plants tend to be built in "chunks", i.e., there are large capacity additions at a single point in time to take advantage of economies of scale in plant development, whereas Manitoba load tends to grow in a steady manner year over year. Thus, every time a plant is built, MH will have excess dependable energy until such time that the incremental Manitoba load "catches up" to the incremental resources added to the system. This excess dependable energy can be used by MH to generate firm energy that is surplus to Manitoba requirements, and that can be exported, as illustrated in the graph below.

Manitoba Hydro Generation Energy vs. Load



Accordingly, a key consideration for MH in planning new generation capacity additions is finding a market for the surplus dependable energy that will be generally available for an initial period, as well as for the surplus energy that will be available on an ongoing basis. The magnitude of this issue can be appreciated from the following Exhibit 4-1 reproduced from MH's 2009/10 resource plan.

Exhibit 4-1: System Energy Supply



Source: Manitoba Hydro 2009/10 Power Resource Plan

As shown in Exhibit 4-1, the projected Manitoba load (i.e., the red line) is significantly below the maximum potential supply (i.e., the topmost line). The maximum potential supply reflects the energy available in a high flow year.

Note that Exhibit 4-1 compares supply and demand for energy on an annual basis. To gain a further understanding of MH's potential for producing energy in excess of Manitoba needs, it is necessary to also consider Manitoba's system characteristics. Key factors in this regard are:

- Average demand is much lower than peak demand. For example, in 2009, average domestic demand was only 2,426 MW or 54% of peak. (Average domestic demand is calculated as annual domestic energy demand/all hours.) Thus there are large time periods within a year when MH has excess capacity which is available for export energy production.

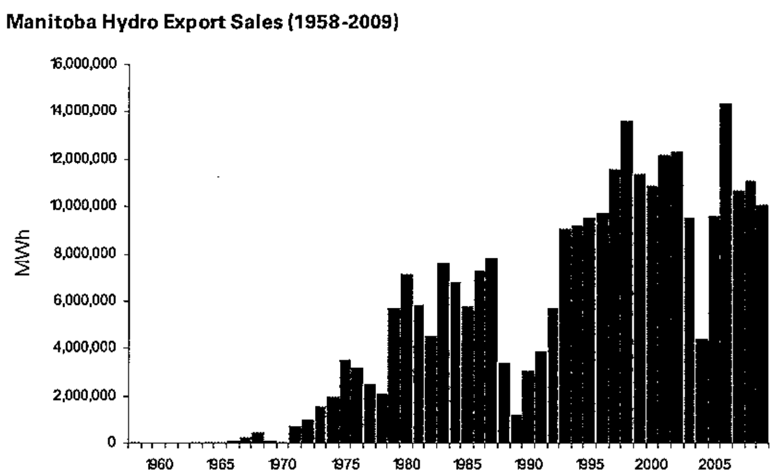
- MH's summer peak is significantly lower than its winter/annual peak and since MH's principal export market of MISO faces its peaks in the summer, there is potential for diversity exchange related export sales (in which MH buys energy in its peak winter season from a counterparty and sells energy back to the counterparty in the counterparty's peak summer season).

- MH has limited water storage capacity relative to its variability in water flows as compared to other major hydro-based Canadian electric utilities such as BC Hydro and Hydro Quebec. This is primarily a function of geography and is due to the relative topographical uniformity of the Manitoba terrain.

Accordingly, due to these system characteristics, MH has considerable potential to generate surplus energy for which it either has to find an export market or spill water to the extent it cannot.

MH export sales are managed by Power Sales and Operations (PS&O) and are a significant source of income for MH. In fiscal 2008/09, export sales totaled $623 million with 79% derived from sales to the US market (primarily to entities in the MISO market) and 21% from sales to Canadian markets (primarily Ontario and Saskatchewan/Alberta). In fiscal 2008/09, export sales comprised 35% of MH's total electricity revenues (*Source: Manitoba Hydro 2009 Annual Report*). Exhibit 4-2 illustrates MH's historical export volumes.

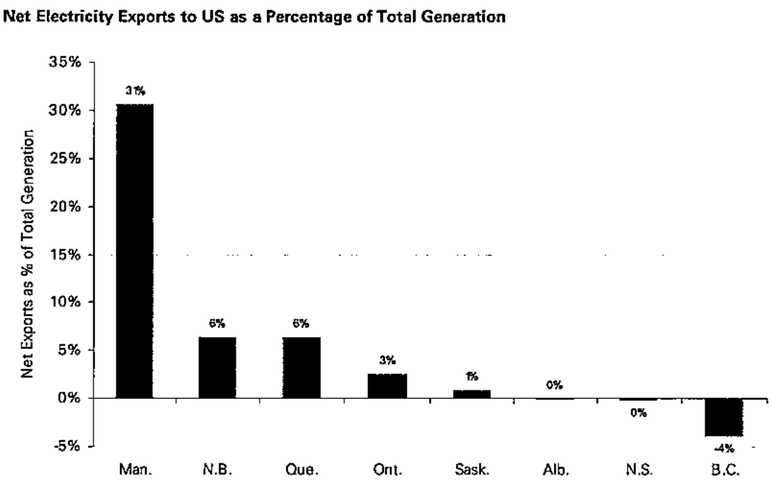
Exhibit 4-2: Manitoba Hydro Export Sales



Source: Manitoba Hydro data

MH is not alone in this regard; other Canadian utilities are also major exporters. MH's largest export markets are customers in the United States (US). Though the US is a key export market for other major Canadian utilities as well (e.g., Hydro Quebec and BC Hydro through Powerex), as shown in Exhibit 4-3, exports to the US represent a considerably larger share of total generation for MH than for other major Canadian utilities.

Exhibit 4-3: Electricity Exports to the US as a percentage of Total Generation



Source: Statistics Canada, 2007 Electric Power Generation, Transmission and Distribution Report.

The considerably higher proportion of export sales to the US for MH reflects the following:

- The variability in MH's water volumes, which results in surplus energy that must generally be sold in export markets given the fact that it cannot be relied upon to serve MH firm loads.
- MH's practice of pre-building required capacity additions in order to earn incremental earnings that can be used to offset MH's domestic rates.
- The large size of new capacity additions relative to load growth in any given year, which results in additional surplus energy in the initial years of a new facility's operation.

Accordingly, the question is not whether MH should participate in the export sales markets but how it should participate. The next section analyzes MH's export sales strategy, focusing in particular on the rationale for using long-term sales contracts.

4.5 Manitoba Hydro's Rationale for Long-term Contracts

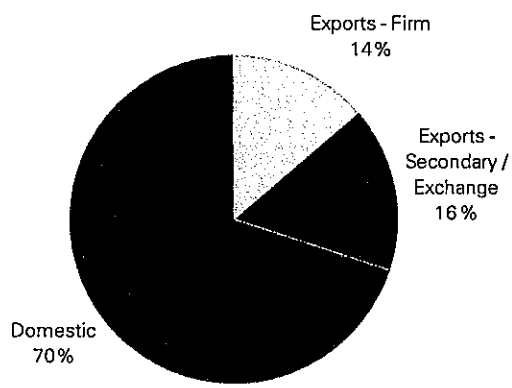
At the extremes, MH has two basic mutually exclusive options to sell its surplus energy in the export markets, each with its own risk-reward profile:

- Sell all the excess energy as spot sales (e.g., MISO DA and RT markets). Key risks that MH takes on under this option include:
  - "missed opportunity regret" risk (spot prices may turn out to be below the price that would have been available under contract);
  - spot price volatility risk resulting in revenue volatility and times when spot prices may drop resulting in a revenue deficiency relative to the fixed costs of MH leading to a corresponding rate increase for Manitoba ratepayers;
  - sales volume risk (there may not always be enough transmission capacity south of the US border for the available excess energy);
  - credit risk; and
  - foreign exchange risk (for cross-border sales).
- Sell all the excess energy at fixed price short-term and/or long-term contracts. Key risks that MH takes on under this option include:
  - "sellers regret" risk (spot prices may turn out to be above the contractual fixed price);
  - sales volume risk (there may not always be enough transmission capacity, especially for short-term contracts, or a drought results in MH having to purchase replacement energy to fulfil its contractual obligations leading to a corresponding rate increase for Manitoba ratepayers);
  - credit risk;
  - foreign exchange risk (for cross border sales); and
  - amplified drought risk (to the extent contracts are for firm amounts of energy).

Combinations of the two basic options (e.g., a combination of spot market and fixed price short-term/long-term contracts) are also available. Key MH's risks in doing so would fall somewhere in between the risks of the two above options based on the actual combination.

MH has chosen to export market its surplus energy using a combination approach of spot sales and short-term/long-term contracts. Over the last decade, approximately 30 percent of MH's hydroelectric production has been used for export sales as shown in Exhibit 4-4, with slightly under one-half of those exports in contractual firm sales and slightly over one-half of those exports in opportunity sales.

Exhibit 4-4: Manitoba Hydro's Average Sales Distribution 2000-2007 (GWh)

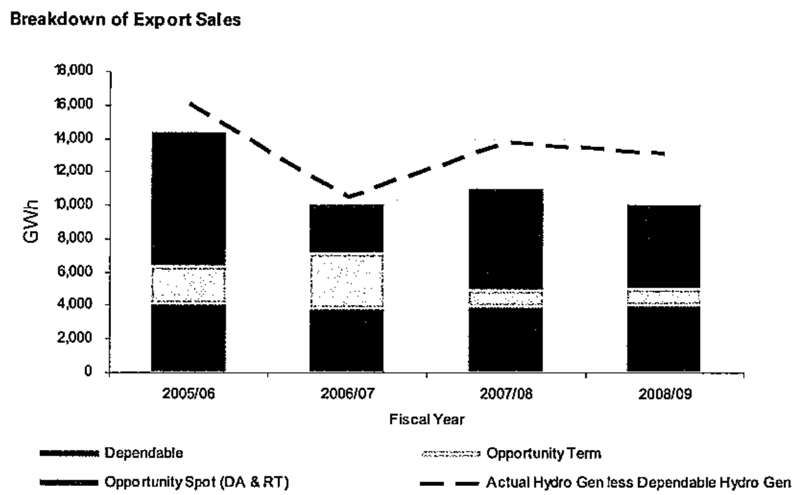


Source: Statistics Canada, 2000-2007 Annual Electric Power Generation, Transmission and Distribution Reports.

Note: Exports-Firm approximately correspond to MH's contractual firm sales while Exports-Secondary/Exchange roughly correspond to opportunity sales, for example, spot sales on the day ahead and real time markets.

A further breakdown of MH export sales is provided in Exhibit 4-5.

Exhibit 4-5: Breakdown of Manitoba Hydro's Export Sales 2005/06 to 2008/09



Source: derived from Manitoba Hydro data.

As illustrated in Exhibit 4-5 above, actual hydro generation from 2005/06 through to 2008/09 was always greater than dependable hydro generation and in all years long-term sales represented 40% or less of the total export sales.

MH's rationale for entering into fixed price firm long-term sales commitments as part of its power sales mix can be summarized as:

- Risk mitigation;
- Securing access to firm transmission; and
- Lower rates for Manitoba ratepayers.

We have obtained this understanding through our review of documents and interviews with MH personnel, case studies of other utilities, use of one of our sub-consultants and our industry knowledge. The remainder of this section assesses MH's rationale.

4.5.1 Risk Mitigation

One of the main elements of MH's rationale for entering into fixed price firm long-term sales commitments is that doing so represents effective risk mitigation.– In assessing this element of the rationale, the following are addressed in this section:

- Risk mitigation through the use of long-term contracts;
- Assessment of risk mitigation using long-term contracts; and
- Alternatives to long-term contracts to mitigate risk.

4.5.1.1 Risk Mitigation through the Use of Long-term Contracts

The argument that MH's long-term contracts help mitigate its risks is essentially as follows:

- *Stability and matching of cash flows* – MH has long-term financing needs for its capital-intensive system expansion. These financing obligations, primarily long-term fixed-rate debt, give rise to significant fixed-debt service requirements. The relatively predictable, steady long-term revenue derived from long-term sales contracts matches this need. Said differently, having a relatively predictable and steady revenue stream reduces MH's revenue volatility which, in a capital-intensive industry, is an especially desirable outcome to pursue in that it can reduce the risk of having "liquidity events" (e.g., severe drought leading to cash flow dropping below debt service requirements). When a liquidity event occurs, it may not be possible to rely on internally generated funds and it may be extremely costly to fund with external financing sources (if they can be funded at all); as a result, MH should manage the risks of liquidity events to minimize their likelihood and the stress of trying to access external financing sources when the firm is at its most vulnerable.

- *Diversification* – By including long-term contracts, MH is able to diversify its export sales mix and thus reduce its risk of over-reliance on a more limited set of markets (i.e., MISO spot markets and the use of short-term contracts). There is considerable finance literature with arguments supporting diversification and diversification is well established as a desirable risk management outcome.

- *Foreign exchange risk hedge* – The revenue derived from long-term sales contracts is US dollar denominated. It thus serves as a natural hedge to the foreign exchange risk arising from the portion of MH's long-term debt that is US dollar denominated.

4.5.1.2 Assessment of Risk Mitigation using Long-term Contracts

In assessing MH's rationale for entering into long-term contracts to help mitigate risk, KPMG has reached the conclusion that it concurs with MH's view that long-term contracts can serve as an element of an effective risk mitigation strategy.

Were all of MH's surplus energy sold in short-term increments, the price received for that power would be highly uncertain and volatile, thus exposing the Manitoba ratepayer to potential rate shock in low export price periods. Exhibit 4-6 illustrates the considerable annual volatility in recent market prices. Prices for the period 1997 to 2005 are for the Mid-Continent Area Power Pool (MAPP); prices since are from MISO.

Exhibit 4-6: U.S. Midwest Power Prices 1997-2009

Annual Wholesale Power Prices, 1997 - 2009				
Year	On Peak Power Prices (Nominal US$)	Spot Prices (2009 US$/MWh)		
		On-Peak	Off-Peak	All-Hours
1997	22.1	29.7	14.4	21.6
1998	29.2	38.3	15.1	26.1
1999	39.5	50.6	13.9	31.2
2000	39.0	48.7	18.5	32.0
2001	37.5	45.7	18.5	31.3
2002	27.8	33.0	16.8	24.4
2003	44.7	51.8	20.6	35.3
2004	46.6	52.7	23.3	37.1
2005	58.9	65.0	23.1	42.5
2006	54.3	58.4	29.5	42.9
2007	62.4	65.6	34.1	48.8
2008	59.6	61.1	29.3	44.1
2009	29.6	29.6	15.6	22.1
Standard Deviation	**13.4**	**12.6**	**6.5**	**8.9**
Average Price (1997-2009)	**42.4**	**48.5**	**21.0**	**33.8**
Average 1997-2004	**35.8**	**43.8**	**17.6**	**29.9**
Average 2005-2009	**52.9**	**55.9**	**26.3**	**40.1**

Source: 1997-2004 ICF Independent Review of Manitoba Hydro Export Power Sales and Associated Risks (2009 09 11); 2005-2009 MHEB RT Monthly Average Prices

We have also examined what others have said on this topic. Many electric utilities need to consider the role of long-term contracts in risk mitigation and the issue has been studied. In particular, KPMG notes an Amicus Curae brief[6] by twenty prominent economists, including Nobel Prize winner Vernon L. Smith that discusses, among other things, the role of long-term contracts in mitigating risks for utilities.

In this brief, opining on the California electricity crisis of 2000-2001, these economists argue that long-term contracts are key risk management tools writing that:

"commodity buyers and sellers often enter into long-term forward contracts to manage risk. A forward contract is an agreement for the delivery of a commodity in the future at a specified price... By agreeing to a fixed price ahead of time, rather than waiting to purchase the commodity at some unknown price in the spot market, buyers can "hedge" their financial risks... Sellers correspondingly gain the certainty of a guaranteed income stream regardless of changes in demand... Forward contracts thus are all about providing certainty—avoiding risk—for both sides. Because risk avoidance is desirable in its own right, firms will often enter into long-term contracts even where the contracts are not expected to save the purchaser money in comparison to buying exclusively on the spot market. Indeed, if firms are sufficiently risk averse, they may be willing to pay more under a long-term contract than they expect to pay on the spot market."

The economists further state that the need to manage risk by ensuring contract certainty is particularly important in the energy industry:

"Energy markets are inherently volatile. Because dramatic price swings threaten substantial financial risks for buyers and sellers, enforceable forward contracts are particularly important to hedge risk in those markets."

They continue their argument as follows highlighting the volatile nature of electricity spot markets:

"Multiple factors contribute to that volatility. Unlike other commodities, energy cannot be economically stored in large quantities.... As a result, supply and demand must be in constant equilibrium—there is no electricity inventory that could be used to meet sharp increases in demand. Additionally, the demand for electricity is

[6] *Amicus Curae brief Nos. 06-1457, 06-1462, in the Supreme Court of the United States in the matter of Morgan Stanley Capital Group Inc., Petitioner, v. Public Utility District No. 1 of Snohomish County, Washington, et al., Respondents, and Calpine Energy Services, L.P., et al., Petitioners, v. Public Utility District No. 1 of Snohomish County, Washington, et al., Respondents.*

extremely inelastic in the short term, even though a wide variety of unpredictable factors such as temperature may cause wild fluctuations in usage. As a result, a "properly functioning, fully-competitive electricity market is likely to yield market prices that vary by a factor of ten or twenty to one in a single day... Long-term contracts are essential to allow electricity providers to weather the uncertainties of the inherently volatile market in which they participate. Reflecting that, forward contracts "represent the majority of instruments used for risk management" in the electricity market.... The need for contract certainty to deal with price volatility has been amplified by the shift toward a market based pricing regime. In a cost-based regime, energy suppliers have little incentive to reduce costs or limit production to the level of consumer demand, and accordingly often have excess capacity.... That excess capacity imposed wasteful costs that were passed on to consumers..... Market based regimes reduce those inefficiencies by inducing suppliers to calibrate supply to demand more closely. One result of that efficiency improvement, however, is that there tends to be less excess capacity to dampen volatility. Long-term contracts allow firms to manage the greater volatility that accompanies market-based pricing by guaranteeing that at least part of their needs will be met at a fixed price regardless of short-term conditions."

Entering into long-term contracts mitigates price risk but may expose MH to other risks. The primary risk in doing so is volume risk.

Volume risk refers to the risk that MH commits to selling firm energy in a long-term contract that it may be unable to deliver (e.g., due to a drought). We understand that MH addresses its volumetric risk by not committing the bulk of its export sales volumes until it is reasonably sure the water will be available[7]. It would be risky to promise these volumes to the market in the absence of reasonable certainty. However, as illustrated in Exhibits 4-1 and 4-4, substantial energy volumes have been and are projected to be available for export sales in almost every year.

[7] *This appears to be true for both decisions to commit to new long-term firm power sales as well as for short-term surplus energy sales. For long-term firm power sales, our understanding is that MH does not enter agreements above the level of dependable energy it has calculated for the system. On the short-term power sale side, it appears that MH is risk averse in the manner by which it calculates the amount of surplus energy available and the timing of commitment to selling that surplus energy.*

4.5.1.3 Alternatives to Long-Term Contracts to Manage Risk

One could argue that MH could use financial instruments such as weather derivatives, and other types of options, and power contracts that settle financially rather than physically to hedge its price risk. It is fairly common for integrated electric utilities to use financial engineering tools to manage price risks. However, the use of financial instruments is complex and their use by electric utilities needs to be quite specific to the application and to the utility. For example, one must decide between standardized contracts which have greater liquidity but (in general and definitely for MH) increased basis risk, and custom products which have less basis risk but high transaction costs. Hence, there is no standard practice in hedging power market risks financially for electric utilities.

Of particular relevance to MH is its potential ability to manage its drought risk using weather derivatives. However, managing drought risk with weather derivatives is fraught with liquidity risk for MH. Further, even the most liquid weather derivatives available may not be suitable for MH's purposes.

Weather derivatives are primarily sold in the Over-the-Counter (OTC) markets in the form of swaps or options. OTC market participants include trading groups, insurance and reinsurance companies, brokers, and end-users. Although most trading in the weather market is still over-the-counter, standardized weather derivatives contracts are now listed on the Chicago Mercantile Exchange (CME), the Intercontinental Exchange (ICE) and the London International Financial Futures and Options Exchange (LIFFE). In consultation with our sub consultant NERA, at the present time we find weather derivatives to be illiquid in both OTC markets and Exchanges. For example, for the period April 2008 to March 2009, the notional amount of weather derivatives traded on the CME fell by 53% ($15BN from $32BN). With such limited trading volume, the CME cannot support a highly liquid marketplace at all traded locations. Further, we note that the CME weather markets for Canadian locations never garnered a liquid and transparent market. For example, on and around February 22, 2010, there was no transaction activity and no open weather derivatives at any CME Canadian location.

Further, we find that though weather derivatives can be based on natural phenomena such as the amount of precipitation, snowfall and outdoor temperature, the majority of derivative options available for purchase on OTC and Exchange markets are options on outdoor temperature levels. For example, while there is a snowpack derivative product offered for Minneapolis-St. Paul, there are no recent transactions and the market is effectively moribund. Thus, for MH's purposes of managing volume risk, there is no liquid weather derivative available.

Other financial instruments, such as electricity futures and options, pose their own set of challenges and liquidity requirements. For example the requirement for parties to post collateral, and that collateral requirement do change as either market prices move or the credit quality of the party changes. The liquidity of such financial instruments, purportedly one of their main benefits, can be questionable as well although perhaps not to the same extent as for weather derivatives. Based on our analysis, liquidity in standardized electric power financial products is a relative term, as it is particularly difficult to find counterparties for even 12 to 36 month deals. These financial markets have waxed and waned in their liquidity. In recent years, investment banks provided much of the trading counterparties to these deals, but many of these banks have recently left the market.

Overall, we therefore do not find that MH could credibly use financial instruments such as weather derivatives, and other types of options, and power contracts that settle financially rather than physically to hedge its price risk.

In summary, our assessment of MH's rationale that entering into long-term contracts represents effective risk mitigation leads us to the conclusion that MH has been prudent from a risk management perspective by using long-term contracts to align the cash outflows associated with constructing, operating and financing the new facilities with the cash inflows from such long-term contracts and by diversifying its export sales mix.

4.5.2 Securing Access to Firm Transmission

One of the main elements of MH's rationale for entering into long-term contracts is that it provides MH access to firm transmission capacity within the jurisdiction served by the counterparty and the network to which it belongs. In the context of the long-term contracts with US counterparties (which are the only counterparties with whom MH has long-term contracts), this capacity is within the MISO footprint. MH argues that access to firm transmission serves both as an effective risk management strategy and helps keep rates low for Manitoba ratepayers because:

- Firm transmission brings with it increased capacity to import power from MISO in a drought situation. Since MISO has primarily thermal generation, it remains largely unaffected by a drought in terms of energy production. Thus MH argues that it can reduce its drought risk by:

- accessing the MISO marketplace to import electricity to offset the hydroelectric energy that is not available within its system as a result of a drought, and/or

- importing power from MISO at a lower cost than running its own thermal units (the MISO market "heat rate" is generally lower than the heat rate of MH's thermal plants). All of the potential output from a thermal plant is included in the definition of dependable energy. However, this output is not generally required except in cases of low flow. In practice, when low flow occurs, the cost of running these plants can often be avoided by opportunity imports in the event that transmission capacity is available.

- potentially avoiding some of the capital costs associated with additional thermal generation or hydro generation[8] that is required to provide back-up or firming capacity.

Further, increased import capability helps MH mitigate the risk of power shortages in Manitoba if the Provincial north-south transmission capability fails (e.g., ice storms).

- Firm transmission provides MH increased ability to sell surplus power in on-peak hours. Transmission is typically congested in on-peak hours leading to non-firm transmission being increasingly curtailed by MISO through TLR orders (Transmission Loading Relief orders). This increasingly shifts MH surplus sales into off-peak hours where transmission congestion can be less. Since on-peak prices are typically higher than in off-peak hours, access to firm transmission in on-peak hours means MH can earn comparatively higher revenue from its surplus power sales.

4.5.2.1 Assessment of risk mitigation through securing access to firm transmission

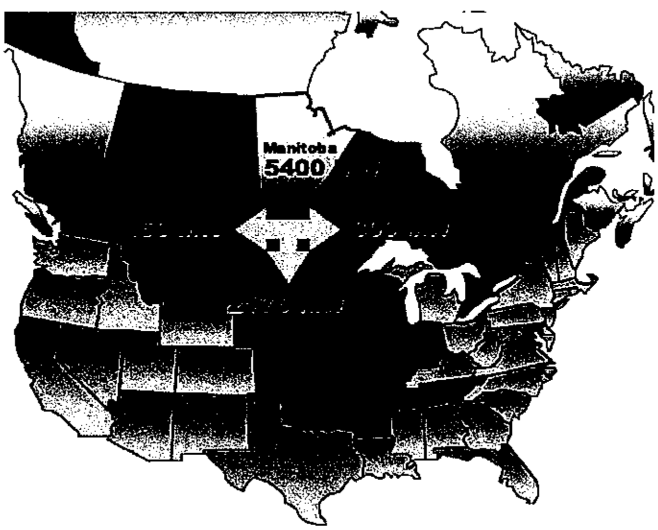
In assessing this element of MH's rationale for entering into long-term contracts, KPMG has reached the conclusion that it concurs with MH's view that providing access to firm transmission capability serves as an effective risk management strategy.

[8] *In the event of a drought, adding more hydro plants on a river system mitigates the impact of the drought by allowing the system to capture more of the potential water head.*

As described above, MH argues that access to additional firm transmission is a significant benefit to MH[9]. We understand that extra-provincial sales or purchases of electricity are achieved at Manitoba's borders through a number of two-way transmission connections to the US, Ontario, and Saskatchewan.

The maximum MW capability of this transmission is as shown in Exhibit 4-7.

Exhibit 4-7: Maximum MW Transmission Capability

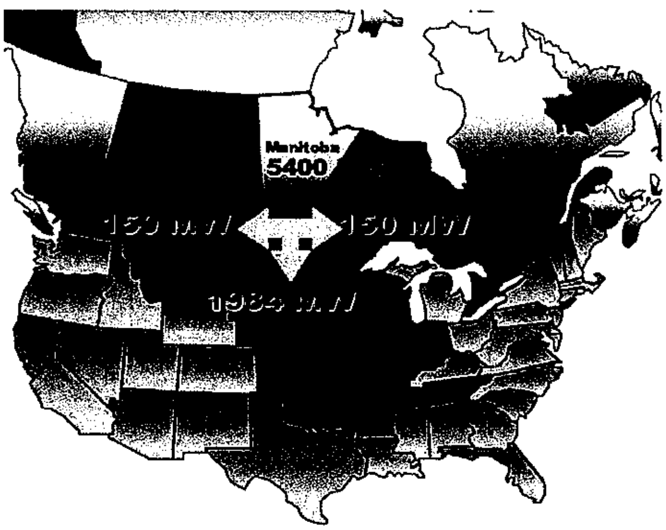


Source: Manitoba Hydro Division Manager, Power Sales and Operations, presentation "New Hydro ... Part of the Solution", Slide 10.

[9] *See Appendix F for a MH document on this issue titled "Now is the time – A strategic Opportunity".*

However, in practice, MH has indicated that actual transmission availability is lower for a variety of technical reasons. Exhibit 4-8 shows the summer scheduling on the transmission interconnects.

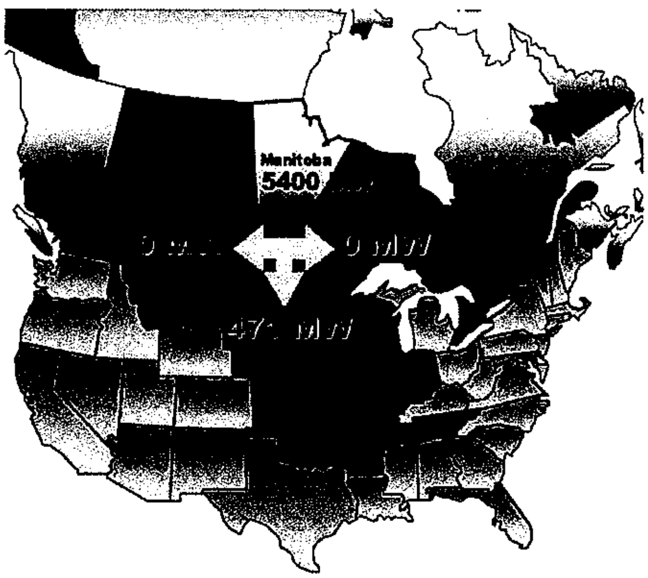
Exhibit 4-8: Summer Scheduling Transmission Interconnect Availability



Source: Manitoba Hydro Division Manager, Power Sales and Operations, presentation "New Hydro ... Part of the Solution", Slide 11.

Moreover, MH has indicated that it has limited control over transmission scheduling outside Manitoba as illustrated in Exhibit 4-9.

Exhibit 4-9: Transmission Scheduling Control

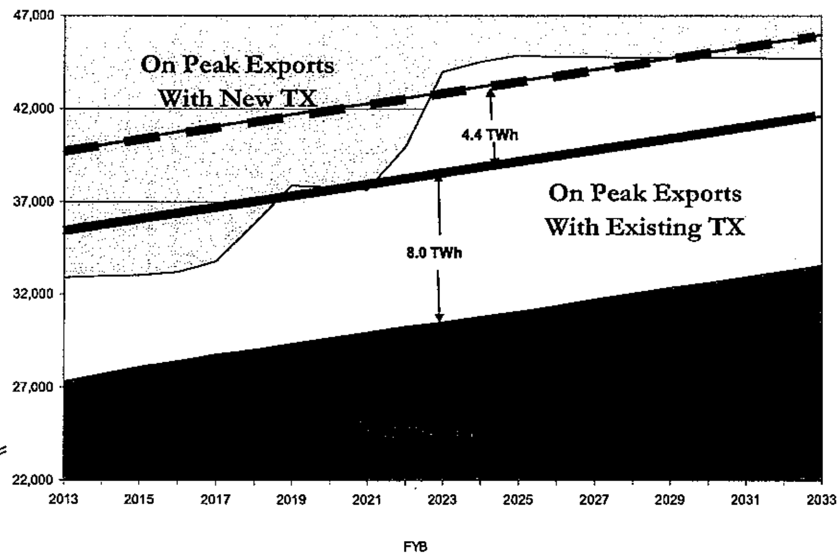


Source: Manitoba Hydro Division Manager, Power Sales and Operations, presentation "New Hydro ... Part of the Solution", Slide 12.

As illustrated in Exhibits 4-7 to 4-9, MH's theoretical transmission interconnect capacity is not only reduced by technical reasons but also due to lack of scheduling control outside of its service territory. For example, MH has 100% control over the transmission to the US border but just over 20% of the theoretical interconnect capacity south of the border. Since there is no load at the border itself, MH export sales into MISO largely depend on being able to secure firm transmission to a load center (e.g., MINN hub - Minneapolis).

Exhibits 4-7 to 4-9 represent MH's current circumstances. As MH adds hydro capacity, it will require increasing access to firm transmission in order to export surplus energy. Lack of firm transmission does not preclude export sales but exposes MH to the risk that it may not have sufficient transmission to sell its power at load centers, e.g., through TLR orders. Exhibit 4-10 illustrates MH's increasing new interconnection requirement based on median water flows and further illustrates that in the absence of adding additional transmission capacity, a considerable amount of MH's potential export sales are at risk due to insufficient transmission capacity.

Exhibit 4-10: Manitoba Hydro Interconnection Requirements



Source: Manitoba Hydro Division Manager, Power Sales and Operations, presentation "New Hydro ... Part of the Solution", Slide 13.

Long-term contracts facilitate access to firm transmission within MISO. As a condition of entering into long-term contracts backed by power produced from new hydro facilities, MH's counterparties are required to invest in new transmission from the Manitoba border into the MISO market and further to grant MH firm transmission rights on the incremental transmission capacity.

4.5.3 Lower Rates for Manitoba Ratepayers

Another element of MH's rationale for entering into long-term contracts is that they generate economic returns that will benefit Manitoba ratepayers, through lower rates. In particular, economic returns result from MH's ability to sell additional energy in export markets, often at premium prices. Long-term contracts, which can be written against the dependable portion of additional energy available, benefit the economic case for a new hydroelectric plant through two mechanisms:

- Energy under contract should receive a higher price than energy from spot market sales. This reflects the value of firm supplies and price certainty to potential contract counterparties.
- The presence of long-term contracts facilitates MH's ability to get external debt financing. This financing is likely to be available in more quantity and/or at lower cost than in the absence of long-term contracts. This may improve the economic case for a new hydroelectric dam, in addition to improving MH's ability to fund the project and/or advance its construction relative to an alternative scenario in which contracts are not established.

The economic benefit of a new hydroelectric facility is established by analysis of the impact of the facility on net system costs at MH. Net system costs reflect costs borne by MH ratepayers, taking into account net revenues from export activity. Economic benefits are quantified in net present value (NPV) terms.

4.5.3.1 Assessment of lower rates for Manitoba ratepayers

In assessing this aspect of MH's rationale for entering into long-term contracts, KPMG concurs with MH's view that entering into long-term contracts can provide net benefits to MH and therefore lower rates to Manitoba ratepayers.

Hydro power development of the scale planned by MH is very capital intensive. Financing to support capital development of this scale is subject to very rigorous due diligence by prospective lenders. In doing so, a key aspect of the project that lenders assess is the security of the projected revenue stream. A long-term contract with a credit worthy buyer willing to pay firm prices and committing to purchase specified energy volumes provides lenders with considerably greater security than a projected revenue stream from spot sales in which both price and volume are uncertain. As detailed in Chapter 6, MH's long-term contracts to date have been with credit worthy regulated utilities.

KPMG also notes that the 20 economists referred to earlier in this section address this topic in their brief. Specifically, they wrote that *"The energy industry, moreover, is exceedingly capital intensive, requiring enormous outlays for infrastructure development that may take years or decades to recoup. Contracts—particularly long-term forward contracts—are indispensable to provide the certainty necessary to encourage such enormous long-term investments."*

They further observe that *"Vast outlays of financial resources are required for electric power production and delivery. Generation, transmission, and distribution all require years of investment in infrastructure. Those investment costs may not be recouped for decades, particularly in light of the fluctuating "boom" and "bust" cycles that characterize the industry... Electricity producers will not invest the extraordinary resources needed to develop new energy sources without some assurance that they will recoup their investment. Contracts that guarantee future revenue streams can provide that assurance..."*

KPMG also notes a report by the US Congressional Budget Office on the California electricity crisis that stated *"Long-term contracts play a critical role in infrastructure development in other ways as well. A generator of electricity faces high sunk costs upon entering the markets. Long-term contracts... may be used to obtain credit..."*

4.6 Pricing of Power Sold under Long-term Contract

Prices and terms and conditions in a long-term firm power sales agreement are negotiated between the parties. Prices, and terms and conditions, should generally reflect the allocation of risk under the contract as well as the value received by each party. Both parties to the contract will enter into the agreement only if they both perceive that there are "gains (financial and non-financial) from trade," meaning that the contract provides both parties benefits that they perceive are greater than the costs.

Were MH to attempt to extract all of the gains from trade by only selling at the current market price, there would be no transaction because the counterparty would see no gains from trade. Such a result would likely harm the Manitoba ratepayers, as the counterparty would not undertake the investments in transmission on their side of the border, and the market access benefits as a result of increased market access in the event of drought would not accrue to Manitoba ratepayers.

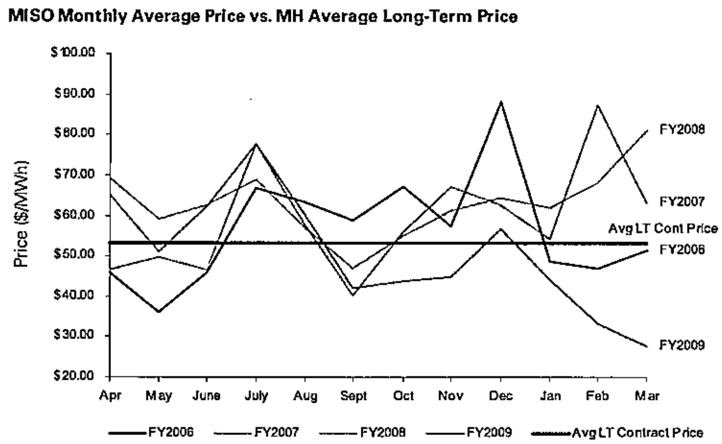
MH has a number of existing and proposed long-term contracts, mainly with Northern States Power (NSP, Xcel Energy), Minnesota Power (MP) and Wisconsin Public Service (WPS)[10]. In these, MH appears to have been generally successful in extracting gains from trade.

In our review of contracts, we found that the revenue earned under MH's existing long-term firm contracts averaged $53/MWh over the period 2005-2009. This is about equal to the average MISO Real Time on-peak price over the same period (at the MHEB node). This close relationship is noteworthy given that some of MH's contracts were signed in the mid-1990s when wholesale prices in MAPP (a predecessor market) were lower. While spot prices have exceeded realized contract prices at certain points in time, a long-term perspective gained through a comparison of average prices better captures the benefits and costs of contracting, particularly since the goal of contracting is to reduce revenue volatility. Because of the recent sharp decrease in market prices in MISO, the benefit of long-term contracting was particularly apparent in the latter part of 2009. Market prices remain low in early 2010.

Exhibit 4-11 summarizes the average historical MISO prices since inception of the MISO market to the average long-term contract prices realized by MH. Exhibit 4-11 also serves to once again demonstrate the historical variability in MISO prices.

[10] *~~Please refer~~Refer to Appendices G and H for summaries of Manitoba Hydro's existing and proposed long-term contracts.*

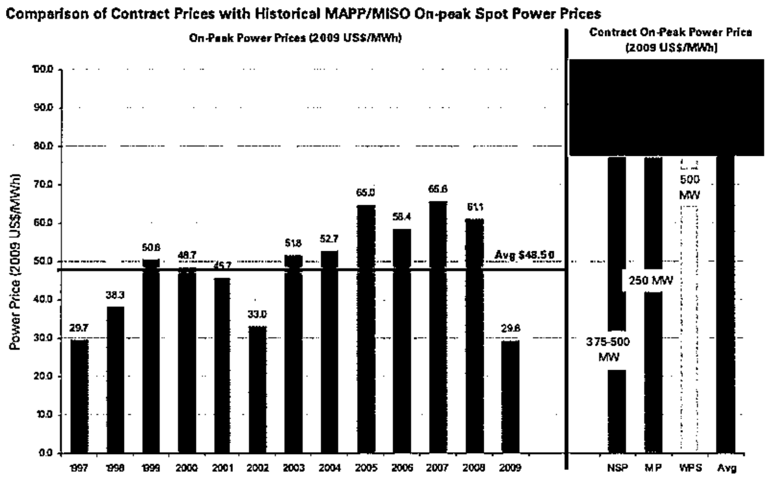
Exhibit 4-11: MISO Monthly On-Peak Prices versus MH Average Long-term Contract Price



Source: KPMG prepared historical MISO MHEB RT price data and MH realized long-term contract average prices.

MH also appears to have been generally successful in extracting a substantial portion of the gains from trade in its proposed long-term contracts as evidenced by a comparison of proposed major long-term contract prices to MISO real time on peak price in the Exhibit 4-12.

Exhibit 4-12: Comparison of Contract Prices with MAPP/MISO On-peak Prices



Source: 1997-2004 ICF Independent Review of Manitoba Hydro Export Power Sales and Associated Risks (2009 09 11); 2005-2009 MHEB RT Monthly Average Prices.

As shown in Exhibit 4-12, the proposed export contract prices are well above historical spot prices [redacted] MWh versus $49/MWh). Whether MH has extracted all it could from its counterparties in negotiating long-term firm power sales contracts is easy to second guess. However, the existence of the contracts suggests that both counterparties (the seller and the buyer) saw some gains from trade in the deal; otherwise they would not have entered into the agreement. Whether the buyer would have paid more is a question that cannot be resolved. Clearly, there is some price at which the counterparty would simply walk away rather than do the deal. What price is too high is a question that cannot be easily answered.

Future market prices for power are always uncertain. Uncertainty stems from many sources, including the future electricity market structure, load growth, government regulation, capital costs for new generation, fuel costs, and emission costs. Despite these uncertainties, utilities make long-term resource commitments in the form of long-term contracts and construction of new generation facilities. As MH is negotiating long-term power sales agreements, both it and its counterparties may have differing views on these uncertainties, as well as on the risks they pose. In negotiating the terms and price in an agreement, each counterparty is looking to find common ground (a set of terms and price) that allow a deal to be done. MH needs to understand the likely view of the counterparty so they can negotiate price and terms that result in a division of the gains from trade advantageous to both parties.

MH policy considers these uncertainties as follows. First, a price based on the average of price forecasts purchased from multiple power price forecasting consultants is calculated. A premium is then added to this result. Second, the MH policy calls for the calculation of the avoided cost of the potential counterparties as a benchmark against the long-term price forecast. Pricing a contract using a counterparty's avoided cost is a well established pricing methodology in the utility industry. Developing these two price estimates provides an indication of the potential range of a contract's price.

4.6.1 Long-Term Contract Pricing

The following is a summary of MH's Pricing of Long-Term Export Contracts and how risk factors such as drought risk are addressed in the MH's pricing regime (*Source: Pricing of Long-Term Export Contracts, provided by Manitoba Hydro*).

- *"Long-term electricity price forecasts and market analyses are usually purchased annually from a group of industry consultants (for the 2008 forecast 5 expert consultants were used). The forecasts are adjusted to a common Canada-US border pricing point and are aggregated on a weighted basis following a detailed analysis and consideration of the fundamental assumptions that influence each of the electricity price forecasts.*

- *A* [redacted] *of approximately* [redacted] *is* [redacted] *to the 'on peak' price forecast for dependable energy to reflect the expectation that a* [redacted] *will be willing to* [redacted] *over the long-term. This* [redacted] *reflects MH's historical experience in selling a high value, long-term product backed from MH's dependable energy resources.*

- *MH's Electricity Export Price Forecast is used among other things as a benchmark for the setting the minimum offer prices for long-term export sales. MH's actual offer prices may be higher reflecting the customer's alternative cost of supply and perceived demand for MH product. Final contract prices may reflect additional value provided to the customer or MH following negotiation, such as more favorable escalation terms, ownership of environmental attributes and an appropriate sharing of transmission costs.*

- *MH's long-term export product usually consists of surplus accredited capacity and surplus dependable energy delivered in the 16 peak hours of each day, Monday to Friday. Dependable energy is energy available even under a repeat of the lowest historic river flow conditions and may include energy sourced from hydro, wind, coal and gas fired turbines and from market purchases.*

- *Factors that create risk for MH are considered in the product offering. These factors include;*
  - *Price – Real price increases over the term of the contract are reflected in the forecast in order to capture the expected real growth in electricity prices due to factors such as the increasing cost of emission and carbon control.*
  - *Inflation – Inflation is adjusted for through an agreed to index such as US CPI or a natural gas price index. MH uses various indices to avoid the risk of over reliance on a single index.*
  - *Term – MH structures its portfolio of export contracts to have varied start dates and durations. This policy avoids the risk of having to renew them all at the same unfavorable time.*
  - *Foreign exchange rates – Contract prices are usually denominated in $US. The resulting contract revenue results in a hedge against the cost of the majority of MH's debt which is also in $US. MH manages an ongoing hedging program to manage the risk of unfavorable movements in foreign exchange.*
  - *Drought – Delivery obligations may be reduced during drought conditions and/or contracts may include return energy provisions to ensure there is always sufficient supply available to meet demand. In the Minnesota Power and Wisconsin Public Service sales currently being negotiated, MH will have sufficient surplus dependable hydro energy available from the construction of Keeyask and Conawapa to fulfill the contractual requirements, and is therefore not exposed to the cost of purchased energy or the cost of its own gas fired generation in order to serve the sales under historic low water conditions.*
  - *Curtailment and force majeure – During periods when delivery is not possible, due to severe drought (worse than historic), generation and transmission outages, etc., MH has the right to curtail in order to protect delivery to Manitoba customers and is not exposed to the cost of providing replacement energy.*
  - *Credit and Legal – MH is implementing industry best practices in determining appropriate contract provisions through the use of internal and external subject matter experts.*

- *Final contract terms and prices for long-term sales are subject to Corporate economic and financial analysis and review comparing the sale to a no-sale base case. The analyses include a simulation of all revenues and costs associated with and without the sale utilizing a repeat of historic river flows in each year over the term of the sale. This analysis and evaluation is done independently from the marketing and sales group responsible for the sale negotiation.*

- *All export sale contracts are approved in accordance with Corporate policy on the import and export of power. This policy specifies the necessary approvals; long-term sales require Board of Directors approval. In considering final approval, the Board is provided with the economic and financial analysis as well as all other relevant factors including a drought risk assessment."*

4.6.2 Long-Term Electricity Price Forecast

As evidenced in the above pricing regime, the long tem price forecast used by MH is an important input. The following is a summary of MH's Long-Term Pricing Forecasts Methodology (*Source: Summary of Long-Term Pricing Forecasts Methodology provided by Manitoba Hydro*):

- *"Long-term electricity price forecasts and market analyses are purchased from five industry experts. The industry forecasts have been used for 2007 and some consultants' forecasts have been consistently used since 2002, prior to the opening of MISO Day 2 in April 2005.*

- *The forecasts are assigned a weighting based on a detailed analysis and consideration of the fundamental assumptions that influence each of the electricity price forecasts. In 2008 it was an equal weighting.*

- *A [redacted] is [redacted] to the on peak forecast to reflect the expectation that a [redacted] would be willing to [redacted] over the long-term and reflect our experience to attain a higher value for a long-term dependable product sourced from dependable resources.*

- *The Electricity Export Price Forecast is used for the purposes of long-term studies and market activities related to:*
  - *the 2008/2009 Power Resource Plan which will result in generation cost and export;*
  - *revenue estimates for the 2008 Integrated Financial Forecast;*

- *the determination of marginal costs;*
- *the evaluation of export/merchant plant opportunities;*
- *the evaluation of resource options such as supply-side improvements and demand-side management; and*
- *establishing pricing targets for long-term dependable export sales.*

- *The consultants price forecast reference is MINN Hub. The Corporation delivers its power to the Canada - US border the MHEB node. The Consultants price forecasts are deemed to reflect our experience for opportunity sales and purchases, adjusted to the Manitoba border. The adjustment to the Manitoba border is determined by considering the price difference or basis differential between the MINN Hub and MHEB node pricing points caused by transmission congestion and marginal transmission line losses, which is approximately 10% lower on-peak and 5.5% off-peak".*

The electricity price forecasts provided by the consultants provides both on-peak and off-peak market clearing prices. The on-peak market clearing price includes the value that reflects the short-run operating costs of the marginal unit to supply the next increment of energy to the grid during the on-peak period (energy value); and a value for short-term capacity adequacy that is driven by the need for reliable energy supply, which is intended to secure adequate reserve margins in the short-term (short-term capacity value). Therefore, the consultants' price forecasts are an all-in energy and capacity price.

4.6.3 Avoided Cost Analysis

In addition to examining forecasts of future market prices, we understand that MH also completes an avoided cost analysis to benchmark the long-term price against the long-run marginal cost of generation of the counterparties. This analysis is done using cost data on generation capacity, financing, variable O&M, emissions, and fuel from publically available sources.

Pricing a contract using counterparty's avoided cost is a well established pricing methodology. For example, in the US the 1978 Public Utilities Regulatory Policies Act (PURPA) required a utility to purchase power output from a qualifying facility (QF). Section 210 of the PURPA requires that the rates paid to QFs be *"just and reasonable"* and *"shall not discriminate against qualifying cogenerators."* However, the rates should not *"exceed the incremental cost to the electric utility of the alternative electric energy"* (*Source: The Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95-617, sec. 210*). (i.e., the costs the utility avoided by purchasing from the QF).

A QF contract may have a fixed price term that lasts for many years or even decades. When a long-term QF contract's price is capped at a utility's unbiased projection of avoided cost, the QF purchase should *ex ante* not increase the utility's expected rates. As FERC observed in the preamble to its rules implementing PURPA (*Source: 45 Fed.Reg. 12224, February 25, 1980*), the QF price may turn out to be higher or lower than the utility's actual avoided cost. Nonetheless, an unbiased avoided cost projection is the commonly used benchmark by state regulators for capping the price of a long-term QF contract. Thus, QF pricing illustrates the important and relevant role of price benchmarking in ensuring that a utility's rates are *"just and reasonable"*, as required by Section 210 of PURPA.

While pricing a contract based on the counterparty's avoided cost is an accepted pricing methodology, the inputs to derive the avoided cost are equally important. MH's avoided cost analysis is generally in line with those of other jurisdictions. In general, PURPA delegates the responsibility for determining the utility's avoided cost and enforcement of the utility's purchase obligations to state regulators. Based on this authority, state regulators develop approaches to price benchmarking that while different across states in the details; nevertheless follow the same general principles.

For example the California Public Utilities Commission (CPUC) approach to price benchmarking uses publicly available cost data on generation capacity, financing, variable O&M, emissions, and fuel to calculate the long-run marginal cost (LRMC) of generation, the all-in per kWh cost of owning and operating new generation. In California, the California Energy Commission (CEC) publishes such cost data in its long-run market price projection. Such cost data and their implications are well-understood by the regulator and the regulated utilities because of their experience with avoided cost pricing and cost-effectiveness analyses in integrated resource planning. The resulting benchmark, being cost-based, is less vulnerable to the potential price distortions caused by electricity market imperfections. The CPUC has used this approach to determine the cap for the formerly integrated utilities' long-run avoided cost for QF pricing under Section 210 of PURPA and to perform cost-effectiveness evaluations of resources (*Source: California Public Utilities Commission and California Energy Commission, standard practice manual, 1987*). The CEC has also used it to project the long-run price in California for guiding the state's resource planning (*Source: California Energy Commission, Docket # 01-EOR-1, 2002-2012 Electricity Outlook Report, 2002*).

In summary, an avoided cost analysis is a useful addition to market price forecasts in the contract pricing process.

4.6.4 Escalation Factors in Long-Term Contracts

Another aspect of setting a long-term contract price is the price escalation factor, if any, used over the term of the contract. If the contract is appropriately priced at the expected long-term nominal price of power, there is no obvious need for any escalators, but to price a contract at the long-term nominal price of power requires an estimate of expected inflation which is essentially extraneous to the process. The more common procedure, therefore, is to strike a bargain at the expected real long-run price of power and use an escalation clause to account for inflation. Some of MH's contracts are structured in this way, using the GDP implicit price deflator as a measure of inflation.

It would be inappropriate to use market prices for power as the escalator. First, doing so would simply transform a fixed price contract to a variable price contract and reintroduce all the problems that led one to reject a short-run contracting framework in the first place. Second, the starting market price would then have to be unrelated to long-run avoided costs, since those already include expected market price increases. We note that some of the contracts do have alternative indices which might bear some relationship to market prices in MISO, e.g., those contracts which are partially indexed to gas and electricity prices. Such an index might be necessary where the buyer needs some such protection. Where this is the case MH should adjust their offer to reflect this adjustment to the avoided cost risk.

Based on the foregoing analysis, we feel that MH has developed an appropriate methodology for arriving at the sales price in its long-term contracts.

4.6.4.1 Comments on the Application of MH's Methodology

We note the following observations with respect to MH's application of its long-term contracts pricing methodology:

- MH [redacted] to the consultants' electricity price forecasts to set a reference price for the negotiation of long-term export contracts. MH's management control plan calls for this [redacted] to be applied. MH indicated to us that this [redacted] reflects its experience on previous negotiations as to what is achievable in the market place. MH further indicated that conceptually the [redacted] represents the value associated with MH being viewed as both a reliable supplier and a supplier of green energy as well as the value associated with providing price certainty to the counterparty. KPMG was not provided supporting documentation on the value of this [redacted] KPMG recommends that MH should clarify the role of this [redacted] confirm the appropriate magnitude and document this analysis.

- KPMG was provided with an avoided cost analysis for the WPS and MP term sheets. When KPMG asked for additional details on the process and documentation supporting this analysis, we were provided with a spreadsheet containing a cost build-up. On further inquiry regarding the inputs and assumptions used in the calculations, we were informed that the source of the data was information received in the past when MH was considering a potential asset acquisition and we were given a copy of the costing information provided to MH by the asset owner. KPMG recommends that MH document the process and methodology to be followed for future avoided cost analyses.

- In addition to the spreadsheet underlying the avoided cost analysis, MH also provided KPMG with two spreadsheet models that were used to set the price for the WPS and MP term sheets, i.e., in the form of a "levelized"[11] price. The models are based on the forecast prices and do not appear to take into account the

[11] *To calculate the respective capacity and energy revenues to MH over the contract term, the model respectively applies the contract volumes against a fixed capacity charge and forecasted future electricity prices. The anticipated revenues are then levelized by calculating the present value of contract revenues divided by the present value of cumulative contract volumes, all discounted at MH's cost of borrowing.*

avoided cost analysis. Since avoided cost analysis is an industry standard practice in establishing pricing for negotiating term sheets, KPMG recommends that MH consider avoided cost analysis in such negotiations. However, MH personnel indicated to us that they view the forecast price [redacted] as a proxy of their counterparty's avoided cost. Further, MH has indicated to us that in the context of the WPS and MP term sheets, its personnel were confident that they understood where market prices were and specifically what prices would be acceptable to the counterparty. Accordingly MH is relying on the considerable industry experience of the key individuals involved. Again, as mentioned elsewhere, a reliance on a small number of highly skilled individuals is evident, together with the need to consider the risk associated with the potential loss of key personnel.

- Through our interviews with MH personnel, we understand that MH does not view the term sheets executed with WPS and MP as fully binding contractual commitments between the parties given the extent of the conditions precedent contained therein. Instead, MH views them as a step along the way to reaching such firm contracts.

  KPMG notes that contract term sheets were signed with counterparties with the caveat of *pending MH Board approval*. KPMG further notes that MH management presented the term sheets to the MH Board for information. In the context of WPS and MP term sheets, the minutes of relevant MH Board meeting indicate that the Board requested the following information to be provided before seeking approval to enter into binding commitments:

  - an updated financial analysis of the proposed long-term sales and associated generating and transmission facilities, comparing proceeding with and without the sales;
  - information on the magnitude of the developments, opportunities and risks of the proposed sales; and
  - other relevant information.

  MH management has indicated to KPMG that it intends to provide this information to the Board when the project has advanced sufficiently prior to seeking final Board approval.

  It is common practice for management to sign term sheets pending their Board approval for the sake of commercial expediency. However, in such circumstances, during the period prior to obtaining Board approval, any expenditure in developing a project is exposed to the risk that the Board may not approve the term sheet.

Perhaps more importantly for MH, it faces the same risk with the counterparty. To the extent this is not already occurring, KPMG recommends that MH regularly follow up with the counterpart to its signed term sheet to ensure that the counterparty is seeking the required governance approvals and consider the status of this in expending efforts to develop the project.

4.7 Sales Volume Commitments

In resource planning studies, MH examines how it might expand its system for the benefit of the ratepayers of the Province. MH has asserted that export sales have covered a significant portion of the carrying cost of the new facilities that were built to support them. The next question is how does MH decide how much power it can sell outside the Province on a firm[12] basis and is this decision sound?

MH has asserted that the firm volumes committed under its long-term export contracts (current and planned) are such that MH can meet current and projected Manitoba load and the Capacity and Energy Resource Planning Criteria described earlier from its current and projected dependable energy supply.

A key issue in evaluating the prudency of the export volumes committed under long-term contracts is therefore the calculation and definition of the amount of dependable energy supply. Concerns have been raised that MH's models used to calculate dependable energy/drought risk are flawed. Concerns[13] that have been raised with respect to the definition of dependable energy supply and its link to long-term contracting include the following:

[12] *Firm power sales are "guaranteed" and create some an obligation on the part of the seller. If the seller can't deliver the power, then the buyer may be entitled to damages in lieu of the power that the seller was obligated to deliver.*

[13] *For example, PUB order 32/09 states on page 27 (of 48) that "Dependable hydraulic generation for the year 2003/04 was 18,500 GWh, that being a level significantly below the 21,000 GWh on which MH bases its potential for firm export contracts (after fulfilling the domestic requirement). Yet, MH has not lowered the dependable resource level to 18,500 GWh; rather MH now defines the dependable resource as a multi-year historical event (not a one-year event). This effectively means that once every fifteen years (the deemed frequency of the 2003/04 drought event), MH will be faced with dependable energy shortfalls comparable to 2003/04; though perhaps in an environment of much higher import prices. MH has not adequately demonstrated that the Corporation's mean energy forecast adequately reflects this self-imposed additional risk."*

- Dependable energy supply includes the amount of energy that can be supplied under firm import contracts. These contracts, which provide import energy at market prices, leave MH exposed to high prices in MISO during drought years.

- Dependable energy supply includes energy supplied from MH's thermal facilities. These facilities are relatively inefficient and will thus only operate for any significant amount of time under drought conditions. Under such a scenario, MH will be exposed to the risk of high prices for input fuels.

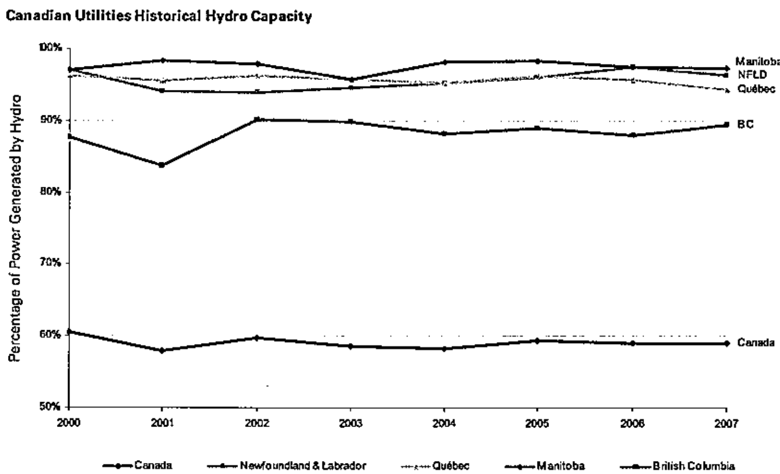
- Dependable energy supply is based on MH's historical flow record. Flows worse than the historical record could occur and these could jeopardize MH's ability to serve its full commitments.

4.7.1 Assessment of MH's Dependable Energy methodology

We have a number of observations with respect to these concerns that must be put in context of MH's unique circumstances, namely a very high proportion of electric production from hydroelectric sources and highly variable hydro capacity factor.

Among Canadian utilities, MH has the highest proportion of electric production from hydroelectric sources as shown in Exhibit 4-13.

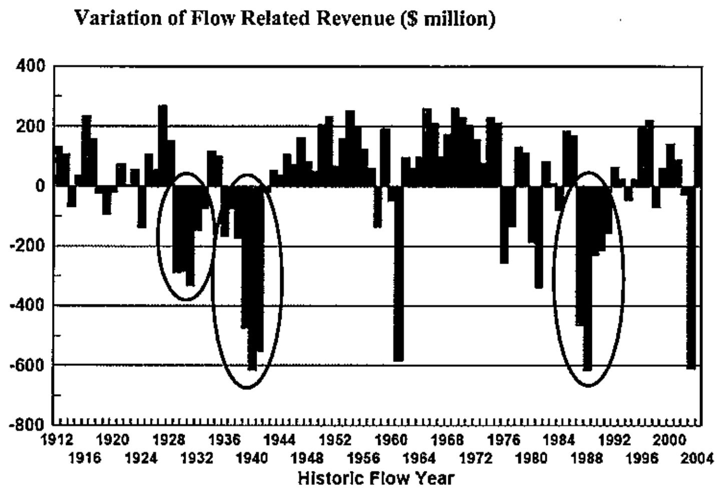
Exhibit 4-13: Hydro Capacity of Select Canadian Electric Utilities



Source: Statistics Canada, Electric Power Generation, Transmission and Distribution Reports

More so than other Canadian utilities, MH must therefore pay special attention to ensuring that it does not over commit firm energy; the production of which is highly dependent on uncertain water flows as illustrated in Exhibit 4-14.

Exhibit 4-14: Manitoba Hydro Variation of Flow Related Revenue



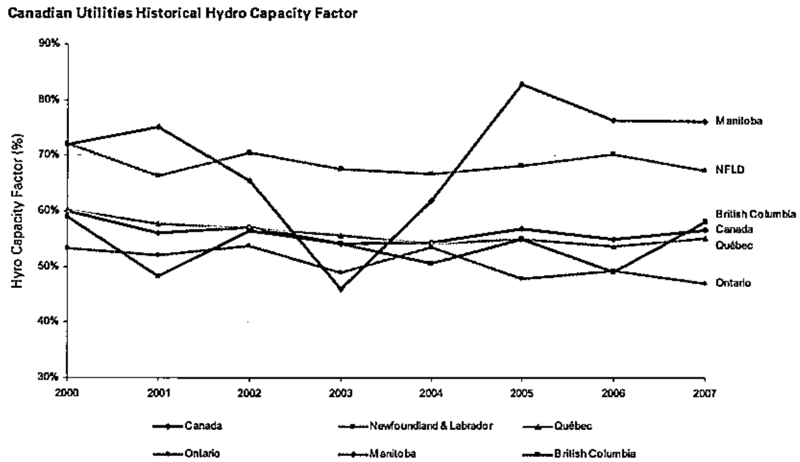
Notes:

1. The calculations for the graph above assume current generation capability and a single base case for other parameters.
2. The circled time periods indicate extended drought years.
3. The years 1937 to 1941 are the worst five years of drought in MH's historical water record.

Source: Manitoba Hydro response to PUB Order 117/06, p.1.

Another way of looking at this variability is an examination of MH's historical capacity factor compared to other major Canadian utilities. As indicated in Exhibit 4-15, MH hydrology is much more variable than its Canadian peers and is further an indication of the limited storage capacity in MH's hydro system.

Exhibit 4-15: Hydro Capacity Factor of Select Canadian Electric Utilities



Source: Statistics Canada, Electric Power Generation, Transmission and Distribution Reports

If MH was to exclude firm import contracts as a source of its dependable energy, then it would either:

- have to build additional domestic thermal generation; or
- reduce the amount of power that is sold on a firm basis. The amount of power thus freed up from long-term contract commitments would instead need to be sold on a short-term, or spot basis, leading MH to be exposed to spot market price fluctuations in years when such surplus energy is available.

By purchasing firm import contracts, MH effectively "outsources" some of its back-up requirements to external parties. A key advantage of this approach is that the thermal generation thus obtained has more opportunity to be used for purposes other than providing back-up to MH. This reflects a location that is nearer to major US markets, and less subject to import transmission constraints, and which can better take advantage of diversity in demand profiles. (US utilities tend to be summer peaking while MH is a winter peaking utility.). As a consequence, MH is likely to pay lower costs for such back-up generation by outsourcing it than by building thermal generation locally.

To help quantify potential financial risks to MH of the proposed new export contracts, we asked MH for an analysis of the additional costs to MH of a drought scenario as a result of entering into the long-term contracts in parallel with building associated new generation facilities. This analysis is summarized later in this chapter.

Adopting a stricter definition of dependable energy would undoubtedly reduce the risks that MH faces under scenarios of very low flow. In this context, risks could be in the form of financial losses that result under such a low flow scenario. Such a reduction in the risk of loss, however, has to be balanced against decreases in expected returns under the full range of flow conditions.

For Keeyask, which is the proposed new generating plant that is associated with the WPS and MP contracts, average annual energy is 4,430 GWH and dependable energy is 2,900 GWh. Thus, on average, the difference of 1,530 GWh, or roughly one-third of the total average expected energy from this facility, will be delivered to spot markets or otherwise sold on a short-term basis (*Source: Manitoba Hydro Report, "Major Facilities Strategy, A Power Supply Perspective", Table 3, October 2009, p.18*). A stricter definition of dependable energy would inevitably result in more of this energy being delivered to the spot markets and hence subject to significant price uncertainty and revenue volatility. As has been explained previously, low revenue volatility is a benefit to MH and Manitoba ratepayers.

With regards to the calculation of dependable energy, MH performs this analysis using SPLASH. The SPLASH model is discussed in more detail in Chapter 3.

With regards to the concern that the calibration of dependable production to the drought year of 1940-1941 is inadequate, we note that this concern can be interpreted in different ways:

- An interpretation is that a drought of 1940-1941 intensity would in fact lead to shortages. This assumes that SPLASH does not do what it purports to do. As noted previously, we find that as used, SPLASH is an appropriate decision support tool.
- Another interpretation is that droughts at a 1940-1941 level do not in fact represent a once-in-94 year possibility but in fact are more likely than that. This is of course possible, and as we understand it, MH has embarked on a series of studies to help better understand the probabilities of drought of a given level.

Based on the information presented above, we see no evidence that MH is over committing its firm dependable energy production through the proposed export contracts is and thereby unnecessarily exposing MH to volume risk.

4.8 Contract Structure

While long-term contracts for firm energy sales are a sound method for mitigating risks associated with the construction of new facilities, the form that the contract takes matters. The original long-term contracts which had been employed by MH had limited curtailment rights, while the new form of contracts have more curtailment provisions. While such provisions clearly reduce risk for MH, they do so by either making the contract riskier for the counterparty or changing the nature of the product (i.e., purchasing energy without firm capacity). Without knowing how counterparties value MH's curtailment rights, it is difficult to know whether such provisions are cost-effective or not.

This proposition is generally applicable to almost all novel terms. The aggregate risk of long-term contracts must be allocated between the parties. The general theory of risk bearing makes the commonplace observation that those best able to bear the risk – either because they have a relatively higher tolerance for risk, a better ability to manage risk, or because they have better ways to assess the risk – ought to bear the risk.

MH's counterparties are at a significant disadvantage in assessing hydrologic risk. MH knows a great deal more about the hydrologic conditions in its system than other market participants do. It is possible that MH and the Province might wish to limit their risk in the firm power sales contracts. The implication, however, is that the prices MH will receive are less than they would be if MH self-insured against such risks. Curtailment rights diminish the value of power to MH's counterparties, and can significantly weaken the counterparty's interest in closing a deal. Finally, curtailment rights can lead to significant litigation – was the contract curtailed because of the actual rights in the contract, or because the market worth of power was greater than the contract price?

The form of the contract must also be consistent with the needs of the counterparties. We are not in a position to state the intent of the counterparties. However, if the buyer is seeking a long-term resource to serve anticipated load obligations and the seller is seeking to sell surplus sales and finance a new generation project, then the contract form needs to match these objectives.

We note that in the electric utility industry, fixed price contracts of the form entered into by MH are a relatively common structure. MH is entering into standard arrangements seeking mutually acceptable terms trending to greater curtailment provisions to mitigate volume risk and should continue to assess what the most appropriate form of contract should be for each arrangement.

4.9 Manitoba Hydro's Risk Mitigation Strategies for Power Sales

While we have discussed some ways in which MH mitigates the risks associated with its long-term firm export commitments in the previous sections, it is worthwhile to examine these in some further detail, especially the much greater mitigation of risks in the three proposed long-term contracts[14] relative to MH's existing long-term contracts.

With the envisioned risk mitigation terms in the proposed long-term contracts, the risks assumed by MH in selling long-term firm power appear reasonable in consideration of the firm sales commitments during droughts. This is based on the following contractual provisions in the term sheets for the proposed contracts:

- Curtailment rights in the [redacted] should a drought of severity within the historical record occur: In such a drought event, MH can decrease firm energy volumes in these contracts by [redacted] if necessary, to meet domestic load. This decrease results from the ability of MH to reduce sales volume [redacted]
- Curtailment rights should a drought of severity outside of the historical record occur. MH has negotiated into its proposed contracts the right to curtail energy supply in the event of an extreme drought to the extent needed to serve high priority domestic load or in the event of catastrophic failure of its DC transmission system. Thus under these adverse conditions, MH can provide all its available supply to its high priority domestic load.
- Firm delivery volume reduction rights exist in the [redacted] if and when MH declares Adverse Water Conditions, i.e., drought: In this contract, MH can [redacted] that it will not be obligated to deliver to [redacted] Thus MH can preserve the associated water in its reservoirs to produce electricity for Manitoba consumption. While [redacted]

[14] *Please refer to Appendix H for a summary of the term sheets for the proposed long-term contracts.*

[redacted] The terms of this call option are discussed in more detailed in the section 4.9.1.

4.9.1 Comments on the Embedded Call Option

The embedded call option associated with the [redacted] has the specific provisions noted below:

[redacted]

[redacted]

MH's rationale for this option is that since the MISO price would be expected to be set by a marginal unit with a heat rate[15] in the range of [redacted] consuming [redacted] priced off the chosen [redacted] the call option [redacted] serves as a price cap. In the above example, the MISO price is expected to be [redacted] if the marginal unit has a [redacted] Thus if [redacted] had to replace the curtailed power by buying from the MISO market, it would do so at an effective cost of [redacted] (i.e. less the [redacted] The [redacted] can be seen as compensation to [redacted] for the [redacted] This is the attraction of the option to [redacted] As long as the MISO price is set by the chosen [redacted] and the MISO market average heat rate is [redacted] or less, [redacted] can be reasonably sure of never having to pay more than the contract price for replacement power.

The benefit of this call option is that it provides MH a LD benefit to the extent that MH can avoid using its thermal units with a greater than [redacted] to generate the curtailed amount of power. This analysis assumes that the [redacted] cost to MH under a "self produce" scenario would be at the same or lower basis as the [redacted] index chosen to settle the call option. As an additional benefit, MH would not have to incur the [redacted] that it would have physically burned in its thermal units in the absence of this call option.

4.9.2 Comments on Volume Curtailment Provisions

Taking into account the various contract provisions noted above, [redacted] Volume curtailment is especially important if in the context of a drought, domestic demand growth turns out to be

[15] *Heat rate is usually expressed as the ratio of the amount of natural gas burned as typically measured in MMBtu's to produce a MWh of electricity. Thus an* [redacted] *MWh heat rate generation unit signifies that* [redacted] *of natural gas will be burnt in the generator to produce 1MWh of electricity.*

greater than forecast, or future drought plans are similar to the 2003 drought plan, which required MH to assume higher than forecast domestic demand. Though MH has curtailment rights, in our interviews with MH management, it was repeatedly stressed that MH has a history of very reliable supply and is viewed as a reliable source of power by counterparties. Thus, it has a business interest in avoiding use of this and the other mitigating options to its firm obligations. Even so, MH has [redacted]

4.9.3 Impact of Diversity Agreements

MH's "Diversity Agreements" are another aspect of its power sales risk mitigation strategy. As discussed earlier in this report, MH has significant surplus capacity in the summer season, when its energy requirements are low, but lower capacity in the winter season, when its energy requirements are high. To balance the seasonal capacity and energy requirements, MH has entered into a number of agreements to exchange capacity and associated energy between the counterparties that have power systems whose peak loads occur at different times in a year, i.e., Diversity Agreements.

Specifically, the Diversity Agreements provide for an exchange of capacity and energy between the Summer Season (May 1 to October 31) and the Winter Season (November 1 to April 30) at the option of the holder. The Diversity Agreements require the supplying system to reserve firm capacity to ensure the capacity and energy is available at the request of the counterparty. During each Summer Season or Winter Season, the supplying counterparty may, at its option, limit the energy associated with the Diversity Agreements to an amount which will result in an average capacity factor of 20% over that season.

MH has a total of 500 MW of Winter/Summer Season capacity exchange available under Diversity Agreements, a 150 MW and 200 MW Diversity Agreement with Northern States Power ("NSP"), and a 150 MW Diversity Agreement with Great River Energy ("GRE"). The Diversity Agreements provide that each party has the right to limit the amount of energy delivered over that season to an average capacity factor of 20%. The Diversity Agreements also provide for certain energy guarantees which enable access to additional capacity in the event that MH is experiencing adverse water conditions. The maximum energy provided by the energy guarantees contained in the Diversity Agreements is 2,120 GWh over a twelve month period. The total energy available under the Diversity Agreements, including the energy guarantees, are considered firm energy, and as such are included in the determination of MH's dependable energy.

The Summer Season energy price received by MH under the 150MW and 200MW Diversity Agreements with NSP are [redacted] for the Summer Season [redacted] thereafter by the [redacted] The Winter Season energy price paid by MH to NSP is based on the [redacted] The Summer/Winter Season [redacted] in the NSP Diversity Agreements are [redacted] however, it should be noted that the two NSP Diversity Agreements were amended in 2002 to [redacted] the Winnipeg-Twin Cities 500kV Interconnection Coordinating Agreement with NSP for the purpose of allowing MH to conduct power and energy transactions. For the 2009 Summer Season, the [redacted] under the 150 MW GRE Diversity Agreement has been [redacted] For the Winter Season, MH has the [redacted] and [redacted] any [redacted] available at the [redacted] There is no capacity price under the Diversity Agreements.

In addition to the Diversity Agreements outlined above, MH has also entered into a long-term Energy Service Agreement with NSP to provide firm import capabilities for up to 500 MW during the period [redacted] and preserves MH's right to utilize the firm northbound Winnipeg-Twin Cities 500kV Interconnection transmission service. This Energy Service Agreement will [redacted] the existing 150 MW NSP Diversity Agreement beyond [redacted] The [redacted] during any time of the year and MH is obligated to [redacted] provided the transmission capability is 500 MW.

The capacity/energy obligations associated with the four contracts are summarized in Exhibit 4-16.

Exhibit 4-16: Diversity Agreement Capacity/Energy Obligations

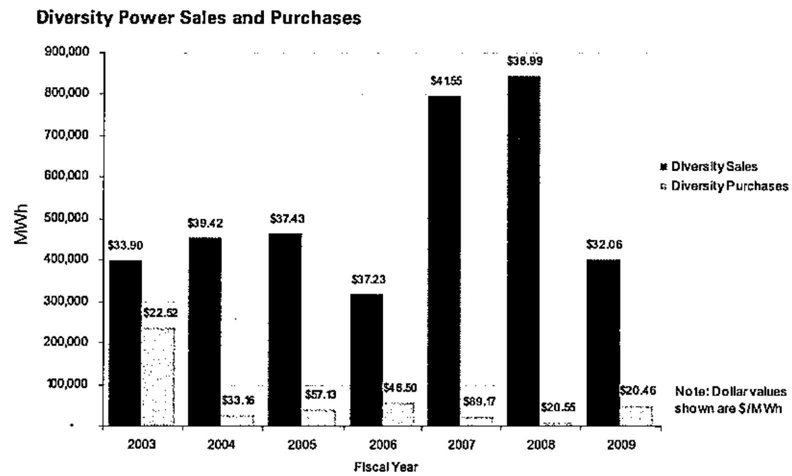
Customer	MW	Annual Dependable Energy, GWh	Type	Term
NSP	200	[redacted]	Diversity Exchange 20% capacity factor	Nov 1996 - Oct 2016
		[redacted]	Diversity Exchange Energy Guarantee	
NSP	150	[redacted]	Diversity Exchange 20% capacity factor	May 1995 – Apr 2015
		[redacted]	Diversity Exchange Energy Guarantee	
GRE	150	[redacted]	Diversity Exchange 20% capacity factor	May 1995 – Apr 2015
		[redacted]	Diversity Exchange Energy Guarantee	
NSP	500	[redacted]	Energy Service Agreement - minimum energy	May 2009 – Apr 2019

Source: Manitoba Hydro 2009/10 Power Resource Plan, Table 3

As indicated above, the Diversity and Energy Service Agreements provide MH with up to 2,656 GWh's of annual dependable energy import capabilities and preserves the firm northbound Winnipeg-Twin Cities 500kV Interconnection transmission service for MH to conduct power and energy transactions.

Based on the our review of the period May 1, 2003 to December 31, 2009, in Exhibit 4-17 we have summarized MH's utilization of the Diversity Agreements for Diversity Sales of Summer Season capacity at average energy prices received, and Diversity Purchases of Winter Season capacity at average energy prices paid.

Exhibit 4-17: Diversity Agreement Power Sales and Purchases (US$)



Source: KPMG analysis of historical purchases and sales

As indicated in Exhibit 4-17, the Diversity Agreements provide MH with firm energy sales in the Summer Season when MH has surplus capacity. MH only relies on the Diversity Agreements for firm import capacity in the Winter Season when MH capacity is constrained due to low water flows, or if the seasonal on-peak/off-peak price differential is favourable to MH. In this context, it is worth noting that historically, MISO summer season on-peak energy prices have been greater than the winter season on-peak energy prices. Thus MH has sold more power in the summer and at a higher price than it has bought back in the winter.

4.10 Drought Risk Analysis of MH's Preferred Development Sequence

MH has to meet Manitoba load demands and its contractual firm obligations under the long-term contracts from a hydrological system that has variable water flows. Even with the various aspects of MH's practices that mitigate this risk, there is still some risk due to that the water flow volumes will not be sufficient to meet MH's obligations in periods of adverse water conditions, i.e., a drought.

As noted earlier, MH is subject to unusually wide variation in water flows relative to other major hydroelectric utilities. From a financial planning perspective, MH's ability to withstand a drought is thus a major concern. As a result, the potential financial impact of drought events has been the focus of a variety of MH reports and submissions to the PUB.

In examining drought risk, MH has typically focused on the financial impact of a drought beginning in the next fiscal period and extending over a five or seven year period. Financial impacts are measured relative to the base financial forecast contained in the IFF. Droughts impacts are measured at expected prices and, in some cases, have also been examined under a scenario with high external electricity prices and high natural gas prices. MH's reports to the PUB have typically focused on the following metrics:

- changes in Revenue relative to the IFF by year;
- changes in Net Income by year;
- changes in Debt Ratio;
- changes in Interest Coverage Ratio; and
- the cumulative change in Retained Earnings over the drought period.

The cumulative change in Retained Earnings over the period of the drought is, in all cases, higher than the total change in Net Income. This reflects additional financing costs that are incurred over the period of analysis a result of reductions in cash flow.

The analyses assume that MH domestic rates remain unchanged, relative to the forecast in the IFF.

Exhibit 4-18 summarizes, at a high level, some key aspects of these analyses.

Exhibit 4-18: Financial Impact of Drought Events

($ billions)

Metric	5-Year Drought (2009 – 2013)	7-Year Drought (2009 – 2015)	
	Expected Prices	Expected Prices	High Prices
Total Reduction in Net Income	1.693	2.149	2.460
Cumulative Impact on Retained Earnings	2.764	Not Presented	3.515

Source: Manitoba Hydro response to PUB Order 117/06

As indicated in Exhibit 4-18, a five-year drought at expected prices results in a $2.764 billion reduction in Retained Earnings.

These analyses are not new, and have been the subject of significant deliberation at the PUB. Analyses of drought costs, in particular, have influenced the development of MH's financial targets for the ratio of debt to equity and for required Retained Earnings as a buffer or risk capital reserve for drought risk.

4.10.1 Assessment of Drought Risk on MH's Preferred Development Sequence

To assess MH's drought risk analysis on MH's preferred development sequence, KPMG asked MH to run various drought scenarios on their development plans in the 2009/10 Power Resource Plan (PRP). The 2009/10 PRP establishes that the preferred option (development sequence) to meet projected Manitoba load is to build both Keeyask (in 2018) and Conawapa (in 2022/23), and enter into new export contracts with Wisconsin Public Service ("WPS") and Minnesota Power ("MP") that bring with them additional US transmission interconnection capabilities (herein defined as the "Sale Scenario").

To determine the preferred development sequence, we understand that MH compares the economics of various development sequences. Analysis is done by examining differences in the net present value (NPV) to MH ratepayers under the different sequences.

An example of an alternative development sequence in MH's 2009/10 PRP is one that excludes the export sales related to the WPS and MP contracts, and thus the planned new US transmission interconnections. This alternative development sequence requires Conawapa to be advanced by a year to 2021/22 and includes a combined cycle combustion turbine in 2033/34. The construction of Keeyask is no longer required in this sequence. We herein define this alternative development sequence as the "No Sale Scenario".

MH determined that the NPV of a Sale Scenario development plan was $5.018 billion (2009 $). The NPV of the Sale Scenario is [redacted] (2009 $) greater than the NPV of the No Sale Scenario (*Source: Manitoba Hydro 2009/10 Power Resource Plan, September 16, 2009, p.29*). Accordingly, the Sale Scenario development plan represented the most economic alternative development sequence and provided an expected internal rate of return of [redacted] (*Source: Manitoba Hydro 2009/10 Power Resource Plan, September 16, 2009, p.29*). In this section, we analyze the results of the various drought scenarios we had requested to address the question:

- Does the Sale Scenario (which includes the new export contracts and additional generation and transmission investments) still provide a positive value over the No Sale Scenario to MH, even in the event that a drought event occurs sometime during the period of the sale?

This analysis thus addresses the concern that long-term contracts could be uneconomic under certain scenarios, even if they do not result in undue risk of financial stress.

The quantification of drought risk is represented by the change in the financial position of MH in comparison to a "Base Forecast". The appropriate Base Forecast is the 20-Year Financial Outlook that is an extension to the Integrated Financial Forecast IFF09-01. The 20-Year Financial Outlook was approved by the Manitoba Hydro Board in January 2010. The 20-Year Financial Outlook reflects the Sale Scenario assumptions and takes into account 94 years of historic flow conditions in identifying expected financial results. The Financial Outlook also takes into account expected export and natural gas prices determined by Manitoba Hydro's 2008 Electricity Export Price Forecast for the 2009 to 2040 period ("2008 Price Forecast").

The drought risk analysis is conducted using the SPLASH computer model for low, expected and high export and natural gas prices (as determined by Manitoba Hydro's 2008 Price Forecast), based on the following assumed water flows for the various years of the development sequence as follows.

4.10.2 Low Flow Scenarios

To test the sensitivities of the NPV economic evaluation under varying water flow conditions, we asked MH to replace the assumed 94 year average historic flow conditions with low water flow conditions commencing at various times as follows:

- 5 year drought flow conditions of 1937 to 1941, commencing in 2011, 2013, 2019 and 2025, and returning to average 94 flow conditions in the periods preceding and following the low flow period assuming low, expected and high prices.

- 10 year low flow conditions of 1932 to 1941, commencing in 2011, 2013, 2019 and 2025, returning to average 94 flow conditions in the periods preceding and following the low flow period assuming low, expected, and high prices.

- 15 year low flow conditions of 1927 to 1941, commencing in 2011, 2013, 2019 and 2025, and returning to average 94 flow conditions in the periods preceding and following the low flow period assuming low, expected, and high prices.

The low water flow conditions were imposed on the Sale Scenario and No Sale Scenario to determine the impact on the NPV economic evaluation, assuming the cost of the development plans remained constant, but the water flow related benefits were impacted by flow conditions. The flow related benefits include opportunity export sales, cost of energy imports, cost of fuel and operations for thermal generation, and savings related to water rentals.

Exhibit 4-19 summarizes the findings of the low flow water scenarios compared to the NPV of [redacted] (2009 $) determined by MH in the Sale Scenario and No Sale Scenario provided in the 2009/10 PRP assuming low, expected and high export and natural gas prices.

Exhibit 4-19: Low Flow Scenario Analysis - Incremental NPV of Sale Scenario vs. No Sale Scenario

NPV of Low Flow Conditions Commencing at Various Periods ($ millions)			
	5-Year Period Water Flow Years 1937-1941		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013			
Commencing in 2019			
Commencing in 2025			
	10-Year Period Water Flow Years 1932-1941		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013			
Commencing in 2019			
Commencing in 2025			
	15-Year Period Water Flow Years 1927-1941		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013			
Commencing in 2019			
Commencing in 2025			

Source: derived from Manitoba Hydro data and model runs

As indicated, the expected NPV's range from a low of [redacted] (2009$ million) in the fifteen year high price scenario beginning in 2013, to high of [redacted] (2009$ million) in the ten year high price scenario beginning in 2011.

Under all of the scenarios analyzed, the NPV of the Sale Scenario remains strongly positive relative to the No Sale Scenario. This means that drought events do not impair the economics of MH's preferred development sequence and associated proposed long-term contracts.

The above result is not unexpected. The new generating facilities and transmission assets associated with the contracts are long-lived assets that will generate positive returns for many years into the future. A drought, even one starting at the beginning of a hydroelectric plant's life, will likely not offset the long-run benefits of the additional generating capacity.

The MH analyses were pessimistic in one key aspect. For a particular drought run, financial results were calculated using low flows in the period of the drought. For all other years, financial results were calculated as the average of those obtained from each of the water flow sequences used within SPLASH. The water flows used to calculate results in other years thus contain the low-flow sequence used in the drought period. This results in slight negative bias in water flow assumptions because the low-flow sequence is over-represented. (It is used alone for the drought period, and then contributes to the results in all remaining years.)

4.10.3 High Flow Scenarios

We also asked MH to replace the assumed 94 year average historic flow conditions with high water flow conditions commencing at various times as follows:

- 5 year high flow conditions of 1966 to 1970, commencing in 2011, 2013, 2019 and 2025, and returning to average 94 flow conditions in the periods preceding and following the high flow period assuming low, expected, and high prices;
- 10 year low flow conditions of 1965 to 1974, commencing in 2011, 2013, 2019 and 2025, and returning to average 94 flow conditions in the periods preceding and following the high flow period assuming low, expected, and high prices; and
- 15 year low flow conditions of 1961 to 1975, commencing in 2011, 2013, 2019 and 2025, and returning to average 94 flow conditions in the periods preceding and following the high flow period assuming low, expected, and high prices.

Exhibit 4-20 below summarizes the findings of the high flow conditions compared to the NPV of [redacted] (2009 $) determined by MH in the Sale Scenario and No Sale Scenario plan provided in the 2009/10 PRP assuming low, expected and high export and natural gas prices.

As indicated, the expected NPV's range from a low of [redacted] 2009$ million) in the fifteen year low price scenario beginning in 2025, to a high of [redacted] (2009$ million) in the fifteen year high price scenario beginning in 2025.

Exhibit 4-20: High Flow Scenario Analysis - Incremental NPV of Sale Scenario vs. No Sale Scenario

NPV of High Flow Conditions Commencing at Various Periods ($ millions)			
	5-Year Period Water Flow Years 1966-1970		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013	[redacted]	[redacted]	[redacted]
Commencing in 2019	[redacted]	[redacted]	[redacted]
Commencing in 2025	[redacted]	[redacted]	[redacted]
	10-Year Period Water Flow Years 1965-1974		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013	[redacted]	[redacted]	[redacted]
Commencing in 2019	[redacted]	[redacted]	[redacted]
Commencing in 2025	[redacted]	[redacted]	[redacted]
	15-Year Period Water Flow Years 1961-1975		
	Low	Expected	High
Commencing in 2011	[redacted]	[redacted]	[redacted]
Commencing in 2013	[redacted]	[redacted]	[redacted]
Commencing in 2019	[redacted]	[redacted]	[redacted]
Commencing in 2025	[redacted]	[redacted]	[redacted]

Source: derived from Manitoba Hydro data and model runs

Under all of the scenarios analyzed, the NPV of the Sale Scenario remains strongly positive relative to the No Sale Scenario. This result is not unexpected and illustrates the financial upside to MH from high water flows in its preferred development sequence.

In conclusion, based on the above analysis, the Sale Scenario, which includes Keeyask, Conawapa, new US transmission interconnection capabilities and the WPS and MP export contracts, provides the most economic benefit compared to the No Sale Scenario plan, both in low flow and high flow years.

4.10.4 Impact of Curtailment Rights

As more fully described in section 4.9, the term sheets for the proposed long-term contracts provide that Manitoba Hydro can rely on certain curtailment provisions to lessen the amount of energy that Manitoba Hydro is contractually obligated to deliver during droughts of severity outside of the historical record. The potential impact of these curtailment provisions have not been included in the above analysis since these curtailment provisions apply in situations where MH is experiencing water flows worse than the 1937 to 1941 drought on historical record. The drought and low flow analysis included above does not assume flows lower than the 1937 to 1941 flows, therefore the curtailment provisions have not been factored into the analysis.

4.11 Quantification of Drought Risk and Associated Risk Capital Reserves

The prior section examined the potential impact that drought events could have on the economic evaluation of the proposed long-term contracts and on the associated development sequence.

In this section, we examine the potential impact of the proposed long-term export sales on the drought risk of MH, examined from the perspective of impacts on Net Income and Retained Earnings (and hence the associated risk capital reserves held by MH in the form of equity).

In order to isolate the impact of the long-term contracts on MH's drought risk, we requested MH to run drought risk analyses, similar to those described for the Sale Scenario in section 4.10, for the No Sale Scenario. This drought risk analysis is also conducted using the SPLASH computer model for low, expected and high export and natural gas prices (as determined by Manitoba Hydro's 2008 Price Forecast), based on the following assumed water flows for the various years of the development sequence as follows:

- Drought years – a reoccurrence of the worst five years of drought on record, commencing in:
  - **Year 2013** – corresponding to the start of the major construction expenditures for Keeyask.
  - **Year 2019** – corresponding to the in-service date for Keeyask and the start of the construction stage for Conawapa.

- **Year 2025** – corresponding to the in-service date of Conawapa.

  The start dates listed above were selected for the analysis because they represent potential points of financial stress when significant capital expenditures have been incurred by MH without the benefit of the corresponding revenues.

- Other years – for years not specifically identified with a drought under a particular scenario, the financial results reflect average or expected results taking into account the full 94 year historical flow record. We noted that this calculation of average results incorporates the impact of the five worst flow years on record. The result is thus more conservative than if the worst five flow years were excluded from the average.

A comparison of the financial impacts of drought conditions under a Sale Scenario and a No Sale Scenario allows us to isolate the financial risks associated with the associated development investments of additional generation (Keeyask and Conawapa), new US transmission interconnection, and the related long-term export contracts with WPS and MP.

These analyses thus identify the magnitude of drought impacts, taking into account the additional size and scope of MH as a result of new generation facilities and the related long-term contracts.

4.11.1 Summary Results

As described above, KPMG asked MH to conduct drought risk analysis on the Sale Scenario and No Sale Scenarios. Exhibit 4-21 provides a high level summary of our results. Results are presented in terms of:

- the cumulative reduction in Net Income[16] relative to plan as a result of five year droughts starting at various points in time; and

- the amount of MH Retained Earnings under the two scenarios at the end of each of the five year droughts.

Exhibit 4-21 focuses, for any particular combination of drought event and Sale or No Sale Scenario, on the cumulative reduction in Net Income and impact on Retained Earnings. It thus focuses on drought risk, as measured by a shortfall in cumulative

- [16] *The cumulative reduction in Net Income excludes financing costs associated with increased borrowing that may result from the Net Income reduction.*

Net Income relative to plan and the amount of Retained Earnings available to MH at the end of the drought. It is important to note, however, that the Net Income in the absence of a drought, which is the basis for calculating the differences shown in the Exhibit, is not the same under the Sale and No Sale Scenarios. In general, Net Income and Retained Earnings will be higher under a Sale Scenario. In other words, the drought risk (in terms of reduction in Net Income) will be calculated for a higher base under the Sale Scenario. This has implications for MH's ability to withstand a drought. MH's Retained Earnings (i.e., equity) will be generally higher under a Sale Scenario than under a No Sale Scenario, improving its ability to use its equity as a buffer to cover a given shortfall in Net Income as a result of a drought.

Note that in this analysis, Retained Earnings are allowed to accumulate over time with no dividends paid out. Thus, Retained Earnings for the Base Case may be overstated in the event that dividends are required to be paid by MH.

Exhibit 4-21: Impact on Net Income and Retained Earnings over a 5-Year Drought

($ millions)

	Cumulative Reduction In Net Income			Retained Earnings (Deficit) End of Drought		
	Sale Scenario	No Sale Scenario	Sale Scenario Greater Than (Less Than) No Sale Scenario	Sale Scenario	No Sale Scenario	Sale Scenario Greater Than No Sale Scenario
Drought Starting 2013						
- Low Price	2,089	[redacted]	[redacted]	1,031	[redacted]	[redacted]
- Expected Price	2,836	[redacted]	[redacted]	190	[redacted]	[redacted]
- High Prices	3,956	[redacted]	[redacted]	(1,079)	[redacted]	[redacted]
Drought Starting 2019						
- Low Price	2,626	[redacted]	[redacted]	2,973	[redacted]	[redacted]
- Expected Price	3,752	[redacted]	[redacted]	1,708	[redacted]	[redacted]
- High Prices	5,316	[redacted]	[redacted]	(53)	[redacted]	[redacted]
Drought Starting 2025						
- Low Price	3,502	[redacted]	[redacted]	8,494	[redacted]	[redacted]
- Expected Price	5,155	[redacted]	[redacted]	6,711	[redacted]	[redacted]
- High Prices	7,239	[redacted]	[redacted]	4,420	[redacted]	[redacted]

Source: derived from Manitoba Hydro data and model runs

As shown in Exhibit 4-21 above, for a drought commencing in 2013, the differences between the Sale Scenario and a No Sale Scenario, in terms of the impact on Net Income, are relatively small. It is reasonable that there is only a relatively nominal

Net Income difference between the Sale Scenario and a No Sale Scenario for five year droughts commencing 2013. This reflects the fact that the planned capital expenditures for the additional generation assets in the Sale Scenario only result in additional revenues after 2018, the in-service date of Keeyask. Hence, base or expected revenues under both the Sale Scenario and No Sale Scenario are relatively similar during the five year period beginning in 2013. As expected, the Net Income differential between the scenarios increases as the new generation assets are completed.

For droughts starting 2019 or later, Net Income is reduced to a greater extent in the Sale Scenario (but from a higher baseline) than in the No Sale Scenario for all price cases. However, an important finding illustrated in Exhibit 4-21 is that Retained Earnings fall to a lower amount in the No Sale Scenario as compared to the Sale Scenario for the drought scenarios analyzed. Stated differently, MH's Retained Earnings at the end of a drought are projected to be higher in the Sale Scenario than in the No Sale Scenario (hence the positive numbers in the last column of Exhibit 4-21).

Thus, the Sale Scenario provides MH with improved Retained Earnings compared to the No Sale Scenario. The improved Retained Earnings are due primarily to the increased surplus export sales associated with the new generation and increased US transmission interconnection capabilities. Moreover, the availability of increased US transmission interconnection capacity (planned in service date of 2018) under a Sale Scenario has an ameliorating effect on Net Income reduction due to droughts. This is due to the increased US transmission interconnection in the Sale Scenario allowing MH to import more power than in the No Sale Scenario with such imports being typically less expensive than MH's domestic thermal production.

Accordingly, the analysis of the Sale Scenario shows reduction of the overall risk of a five year drought compared to a No Sale Scenario, since it provides greater Retained Earnings to withstand the financial impact of a five year drought.

Summary

In summary, the Sale Scenario results in a relatively modest increase in the financial impact for drought events starting in 2013 and 2019. (The potential additional reduction in Net Income over a 5-year period, under expected prices, ranges from negative $10 million (i.e., a decrease in losses) to $95.8 million, as a result of moving to the Sale Scenario.) The additional cost of a drought under the Sale Scenario is greater for droughts beginning in 2025. Under the expected price case, a five year drought results in a cumulative reduction of Net Income of $617.3 million. Although drought impacts are larger in later periods in nominal dollars, they are relatively more manageable for MH because of its greater level of Retained Earnings by that period.

The results demonstrate that the Sale Scenario and the related long-term export contracts do not lead to a significant increase in financial risk for MH from a drought risk perspective. On the contrary, the Sale Scenario appears to reduce the overall risk of a five year drought compared to a No Sale Scenario, since it provides greater Retained Earnings to withstand the financial impact of a five year drought.

Further detailed runs on the above analysis appear in **Appendix J**.

4.12 Conclusion

With respect to long-term contracting for export power sales, based on our analysis combined with our knowledge and expertise in the energy sector, it is our opinion that:

- Manitoba Hydro has made appropriate strategic choices in entering into long-term fixed price contracts for export power sales;
- Manitoba Hydro has appropriately established the firm export volumes in these contracts; and
- Manitoba Hydro has an appropriate methodology for arriving at the sales price in such contracts.

Also, we find that Manitoba Hydro continues to improve its contractual documentation to more effectively mitigate the risk exposure from entering into long-term fixed price contracts for the sale of firm energy. On the basis of the policy decisions in place with respect to risk tolerance, Manitoba Hydro'sHydro quantifies its drought risk appropriately and currently provides for appropriate levels of reserves of risk capital against its projected drought risk.

Formatted: Indent: Left: 0"

5. Risk Governance

Risk governance addresses the roles, responsibilities, reporting relationships, and policies designed to support decisions about risk that may threaten an organization's achievement of objectives and the successful execution of its strategies. Risk governance has become increasingly important to power utilities for reasons such as the introduction of competitive markets, the recent turmoil experienced in financial markets and complex capital projects.

This chapter is organized under the following headings:

- 5.1 Scope of our Review
- 5.2 Key Findings
- 5.3 Approach and Methodology
- 5.4 Manitoba Hydro's Risk Governance Practices
- 5.5 Risk Governance Leading Practices
- 5.6 Case Studies
- 5.7 Risk Management Roles, Responsibilities and Reporting Relationships
- 5.8 Risk Management Policies
- 5.9 Conclusions.

5.1 Scope of Our Review

In Phase 1 of the Review, KPMG identified two issues within the Risk Governance Theme. The two Issues and along with a summary of the Consultant assertions of each Issue are outlined below.

- Issue 1 - Independence of the middle office function

The Consultant asserts that, as MH integrates risk management into its corporate framework, it is imperative to segregate the duties involved in calculating and reporting the risk and financial exposure of MH from the business units responsible for operating level decisions, trading and opportunistic deals. The Consultant asserts that segregation of these duties is an important internal control element of compliance programs because it mitigates errors and opportunities for corporate fraud and misstatement of financial earnings. The Consultant's assertion is that it is important for the middle office function to have an independent reporting relationship.

- Issue 2 - Resourcing and authorities relating to energy risk management

The Consultant asserts that the energy risk management function of MH does not meet best practices. Specifically, the Consultant notes that there are limited risk management policies with inadequate ability for the Middle Office to perform an oversight role over PS&O and trading transactions. The Consultant infers that relevant risk management reports are not being utilized in the management of risk at MH. The Consultant argues that it is common industry practice for risk management to monitor on a regular basis market price and hedging valuations in order to manage corporate performance in line with the achievement of the IFF.

Specifically, our assessment of risk governance considers the following elements:

- **Risk Management Roles, Responsibilities and Reporting Relationships** — focusing on risk management structure, committees, functional risk management duties, reporting relationships, resourcing, and delegated authorities with a primary focus on the Middle Office.

- **Risk Management Policies** – focusing on the risk management policy environment for power sales.

Our assessment relates to the MH power sales risk management function which may be divided into long-term sales (addressed to the extent of Issues raised in the previous and following chapters), and opportunity sales, which is the topic of this chapter.

For background purposes, we describe in this chapter the key elements of risk governance at MH. This establishes the broader context for our assessment of MH's risk management roles, responsibilities and reporting relationships, and its risk management polices with respect to opportunity sales.

The scope of our assessment does not include MH's corporate risk management function, operational risk management function (e.g., dam safety risk management procedures), its environmental risk management function, its major capital project risk management function, and its legal and regulatory risk management function.

MH's business model is built on a combination of domestic Manitoba sales, long-term contracts to export customers, and opportunity sales to extraprovincial / export customers. Opportunity sales are the responsibility of the Power Sales & Operations Division, with day-to-day oversight from the Middle Office.

In earlier chapters, we described MH's approach to power sales, insofar as it is asset backed. That is, the water resources needed to generate the power are known to exist with a high level of confidence prior to the actual sale of the energy. Opportunity sales do not characteristically present high levels of risk for MH, as they are made on a real-time basis, or day-ahead basis. Some volatility may exist on price, but the supply of, and demand for, the energy is known by MH staff with a high degree of certainty.

This contrasts with a speculative trading business model that trades energy and holds open positions, based on a market view. MH is not a trader of energy that takes speculative positions into the future. MH's primary business objective is to provide low cost and reliable energy services to its domestic customers and to optimize its assets and excess energy supply.

- We note that there are separate risk management functions to deal with long-term contracts which are largely outside the scope of this chapter. Long-term contracts are typically backed by new generation (e.g., Long Spruce, Limestone) and have characteristically been executed once every 10 to 20 years. There are significant risk management resources and processes dedicated to assessing these opportunities over a multi-year time frame. The large risks associated with these opportunities, including the economic models and load forecasts developed, are assessed, optimized and approved over a number of years by multiple layers of management at MH.

Decisions to proceed with new generation and long-term contracts are ultimately reviewed and approved by the Export Power Marketing Committee (EPRMC), the Executive Committee, the Audit Committee and Board of Directors. The risk management activities related to opportunity export power sales are transactional in nature – and within the purview of the Power Sales and Operations Division (PS&O). It is these transactions that the Middle Office is focused on monitoring to ensure that they are made in compliance with MH policies and procedures.

5.2 Key Findings

This section outlines our key findings with respect to risk governance.

With respect to the independence of MH's middle office functions, we find the following:

- The Export Power Middle Office (EPMO) is a single, independent, risk management function. It reports to the manager of Corporate Risk Management, who in turn reports to the Chief Financial Officer. It is independent from the business unit of Power Sales and Operations (PS&O) Division. It is steadily progressing in terms of its responsibilities for measuring, monitoring, controlling, and reporting the risks associated with PS&O's transacting activity. The progress made by the EPMO is consistent with the pace of change identified at other electric utilities in our case study research and continued progress is suggested.

- MH's risk power sales governance practices compare favourably for the most part to leading practices. Based on the nature of its asset backed power sales business model, the risk governance practices at MH are, for the most part, appropriate. The comparative analysis conducted by KPMG to other electric utilities demonstrates that MH's risk management practices are consistent with other utilities of similar size.

- Based on the size and nature of the asset backed power sales strategy adopted by MH, the independent reporting relationship of the Export Power Middle Office to Corporate Risk Management and the Chief Financial Officer is in keeping with leading practice.

- The power sales risk management policy framework substantially meets the leading practice.

- MH should continue to institutionalize the policy setting roles of the Export Power Middle Office and fully align its power sales risk management policies with leading practices for market, credit and contractual risk management. The current middle office structure partially meets the leading practices.

  In order to fully meet the leading practice, credit risk analysis should report directly to the Middle Office. The market risk quantification capabilities of the Middle Office should be enhanced. The HR and technology resources of the

Export Power Middle Office to conduct independent risk assessments of power sales partially meets the leading practice.

MH should also continue its efforts to enhance the resources of the Middle Office through the addition of a market risk analyst. The credit risk analyst positions which currently report to the Contracts Administrator within the Export Power Marketing Group should report directly to the Middle Office. For operational efficiencies continued effective working relationships within the Export Power Marketing Group, these positions could continue to physically reside within PS&O.

MH should also continue to actively define its functional requirements (including risk metrics) and continue its efforts to acquire a risk analysis software tool to enhance the analytic capability of the Middle Office.

5.3 Approach and Methodology

Our approach to assessing risk governance related to opportunity sales at MH is based primarily on three lines of evidence:

- a review of MH risk governance practices to provide context for how opportunity sales risk management fits into the overall corporate risk management framework at MH, as described in section 5.4;
- a review of related risk management leading practices as expressed by a number of recognized authorities; and
- consideration of case studies of other electric power utilities in which we examined their risk governance roles, responsibilities and reporting relationships and their risk governance policies.

Our description of MH risk governance practices is based on data gathered from the following sources:

- documentation review; and
- interviews of MH personnel.

The documentation reviewed included organization charts, committee charters, terms of reference, committee meeting minutes, internal audit reports, and policies related to risk management. These documents were provided by MH and describe many aspects of its corporate approach to risk management for the period 2002 through to February 2010. Additionally, we reviewed third party reports that have been prepared for various purposes which document certain aspects of risk governance at MH.

We also conducted a series of interviews with MH personnel to validate our understanding of the documentation and to obtain an appreciation of how risk governance at MH functions in practice. Our interviews were conducted with personnel from the following areas: Corporate Risk Management, Power Sales and Operations Division, Finance, Corporate Controller, Legal, Export Power Middle Office, Power Planning and Development Division, Information Technology, and Internal Audit.

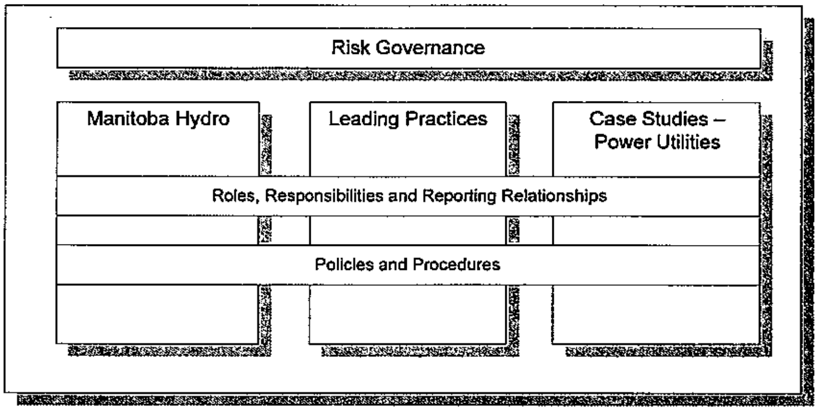
Our analysis compared MH's practices for opportunity sales to relevant leading practices in order to identify gaps and opportunities for improvement. Peer practices (i.e., case studies) provided additional insight on prevailing practices and underscored the aspirational rather than authoritative nature of leading practice literature. Utilizing both comparisons provides us with a principles-based perspective to the assessment.

Risk governance in practice is a balance between professional judgment exercised by experienced management and steady progress in adopting relevant aspects of risk management leading practice. We believe that this is particularly the case in the context of a power utility like MH because:

- there is no industry standard set of risk governance practices that apply universally to all power utilities; and
- each comparator utility considered in our case studies faces unique business circumstances and therefore is not directly comparable to MH.

Exhibit 5-1 provides a high-level summary of the approach and methodology described above by portraying the framework used for our review of MH's risk governance practices.

Exhibit 5-1: Approach



5.4 Manitoba Hydro's Risk Governance Practices

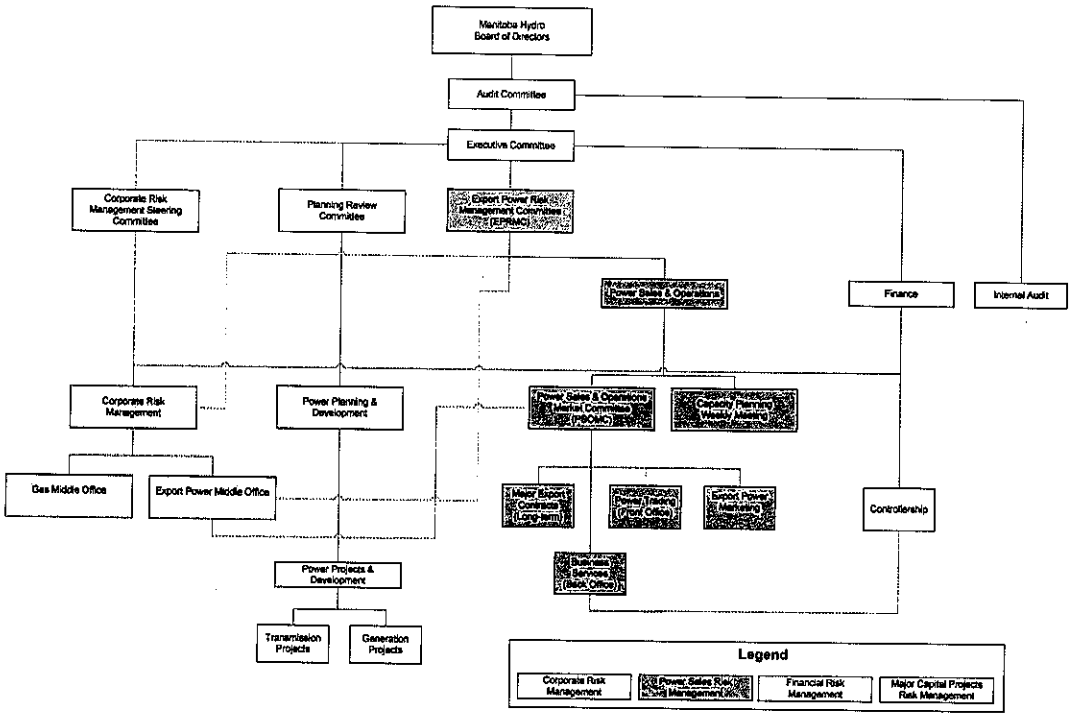
This section describes the risk governance practices at MH today. Its purpose is to illustrate the risk governance landscape at MH as context for our assessment of risk management over opportunity power sales, and the related role of the Middle Office.

MH has the following four key functional areas of risk management:

- Corporate risk management, which addresses strategic risk and coordinates the corporate risk profile.
- Power sales risk management, which addresses related market, credit and operational risk.
- Financial risk management, which addresses financial statement reporting and controllership risk; and
- Major capital projects risk management, which addresses planning, scheduling budgeting and quality risks associated with major generation and transmission construction projects.

Exhibit 5-2 presents an overview of this risk governance structure at MH focused on power sales.

Exhibit 5-2: Manitoba Hydro – Power Sales Risk Governance Structure



MH governs and manages risk through the following key risk management governing bodies and executive/management committees:

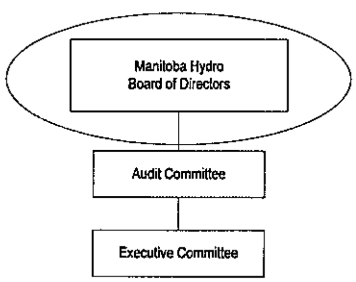
- Manitoba Hydro-Electric Board;
- Audit Committee;
- Executive Committee;
- Corporate Risk Management Steering Committee;
- Planning Review Committee;
- Export Power Risk Management Committee; and
- Power Sales and Operations Market Committee.

In Section 5.4.1, we describe each of these as well as MH's Export Power Middle Office.

5.4.1 Roles, Responsibilities and Reporting Relationships

This overview describes the roles and responsibilities of these risk management committees and their membership.

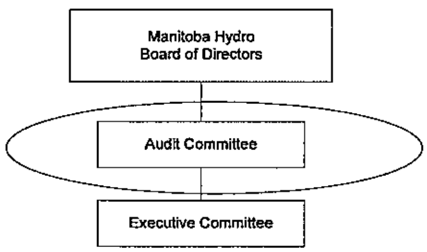
5.4.1.1 Manitoba Hydro-Electric Board



Oversight responsibility for corporate risk management rests with the Board of Directors. Primary responsibility for financial reporting, accounting systems and internal controls at MH is vested in senior management and is overseen by the Board of Directors.

The Board of Directors is ultimately accountable for ensuring, through management, that appropriate risk management policies, systems, governance, leadership and stewardship are in place. For example, regarding export and import of power, the Board of Directors oversees approval of any sales requiring new generation, in conjunction with approving new generation and long-term sales exceeding five years or 100 MW. The Board is comprised of not more than 11 members who are appointed by order of the Lieutenant Governor-in-Council. The Board meets eight times per year.

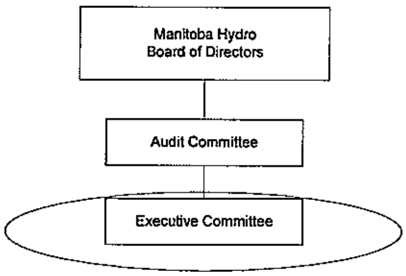
5.4.1.2 Audit Committee



The Audit Committee has been established by the Board of Directors to assist the Board in fulfilling its risk management responsibilities. The Audit Committee confirms that:

- MH complies with applicable laws, regulations, rules, policies and other requirements of governments and regulatory agencies related to financial reporting and disclosure;
- management has assessed areas of potential significant financial and operational risk to MH and has taken appropriate measures;
- MH's financial forecasts fairly represent the future financial direction of the Corporation and adequately support rate applications to the Public Utilities Board.
- MH's auditors have performed their duties satisfactorily and with sufficient independence from management;
- the accounting principles, significant judgments and disclosures that underlie or are incorporated in MH's financial statements are the most appropriate in the prevailing circumstances;
- MH's quarterly and annual financial statements present fairly Hydro's financial position and performance in accordance with generally accepted accounting principles;
- appropriate information concerning the financial position and performance of MH is disseminated to the public in a timely manner.

5.4.1.3 Executive Committee

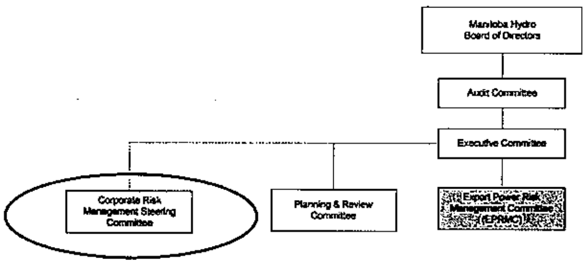


The Executive Committee acts in an advisory capacity to the President and Chief Executive Officer in addressing issues, initiatives or concerns of corporate significance. It determines or authorizes appropriate subsequent action to be taken to mitigate such issues and risks. Responsibilities of the Executive Committee include:

- assisting in the review and resolution of matters of corporate-wide concern;
- resolving matters of corporate policy;
- assisting in establishing a corporate position on external issues;
- reviewing items to be advanced to the Manitoba Hydro-Electric Board;
- acting as the Strategic Planning Committee;
- acting as the Review Committee for the Integrated Financial Forecast and the Corporate Risk Management Report; and
- approving all contracts for consulting services greater than $5,000 in value.

This Executive Committee is made up of the senior management team of MH and generally meets on a weekly basis.

5.4.1.4 Corporate Risk Management Steering Committee



The Corporate Risk Management Steering Committee was formed in September 2002. The Corporate Risk Management Steering Committee is to provide a cross-functional forum to guide and monitor the processes that ensure MH's principal risks are appropriately identified, assessed, managed and communicated. Its responsibilities include:

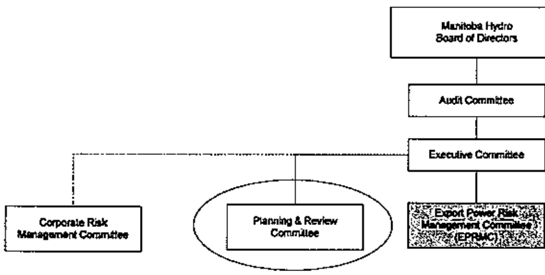
- introducing an organization-wide enterprise risk management framework and process to ensure that risks are identified, assessed, monitored, measured and communicated;
- recommending appropriate corporate risk policies and measures of risk tolerance;
- ensuring that there is an appropriate alignment between identified risks and corporate goals and strategies;
- creating a risk map or profile that identifies and assesses MH's key risks in terms of probability and magnitude of impact, and actions to be taken by the area responsible; and
- providing guidance for the development and maintenance of a risk monitoring and reporting system including the review and consolidation of periodic reports on specific risk areas from the business units and corporate functions.

All business units, at the division manager level, are represented on the Corporate Risk Management Steering Committee and it is chaired by the Senior Vice-President, Finance and Administration and Chief Financial Officer. The committee mandate is to meet six times per year. This is a comprehensive cross organizational committee and includes the following members:

- Senior Vice-President, Finance and Administration and CFO (Chair);
- Vice-President, Corporate Relations;
- General Counsel;

- Division Manager, Corporate Planning and Development;
- Manager, Insurance Services;
- Manager, Internal Audit;
- Division Manager, Business Analysis and Corporate Risk Management;
- Division Manager, Gas Supply;
- Division Manager, IT Services;
- Division Manager, Rates and Regulatory Affairs;
- Treasurer;
- Corporate Controller;
- Division Manager, Power Sales and Operations;
- Division Manager, Business Support Services;
- Division Manager, Consumer Marketing and Sales;
- Division Manager, Transmission System Operations;
- Division Manager, Apparatus Maintenance;
- Division Manager, Transmission Planning and Design;
- Manager, Corporate Planning;
- Manager, Corporate Risk Management; and
- Senior Risk Officer, Corporate Risk Management (Secretary of Committee).

5.4.1.5 Planning Review Committee

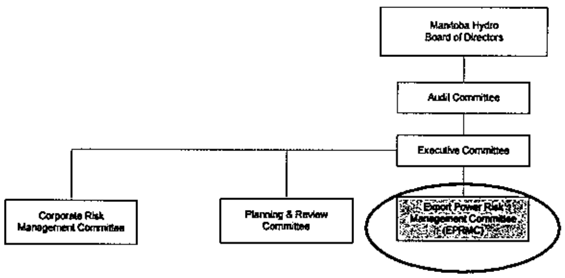


The Planning Review Committee reviews long-term planning issues with corporation-wide implications that are brought to it by the executive responsible for the issue. Some of the matters reviewed by the Planning and Review Committee include forecasts (e.g., economic outlook, interruptible import/export market, energy price outlook, system load forecast and avoided cost) and integrated resource plans (e.g., demand side management plans, supply side management plans, generation development plans, transmission development plans and import/export plans and contracts).

Members of the Planning and Review Committee are appointed by the President and Chief Executive Officer and are drawn from MH's senior management group. Current membership of the committee includes:

- Vice-President, Corporate Planning & Strategic Development;
- Division Manager, Transmission Systems Operation;
- Assistant Corporate Secretary;
- Division Manager, Consumer Marketing and Sales;
- Division Manager, Aboriginal Relations;
- Division Manager, Transmission Planning and Design;
- Manager, Government Relations and Current Issues;
- Division Manager, Power Projects Development;
- Manager, Internal Audit; and
- Division Manager, Power Planning.

5.1.4.6 Export Power Risk Management Committee



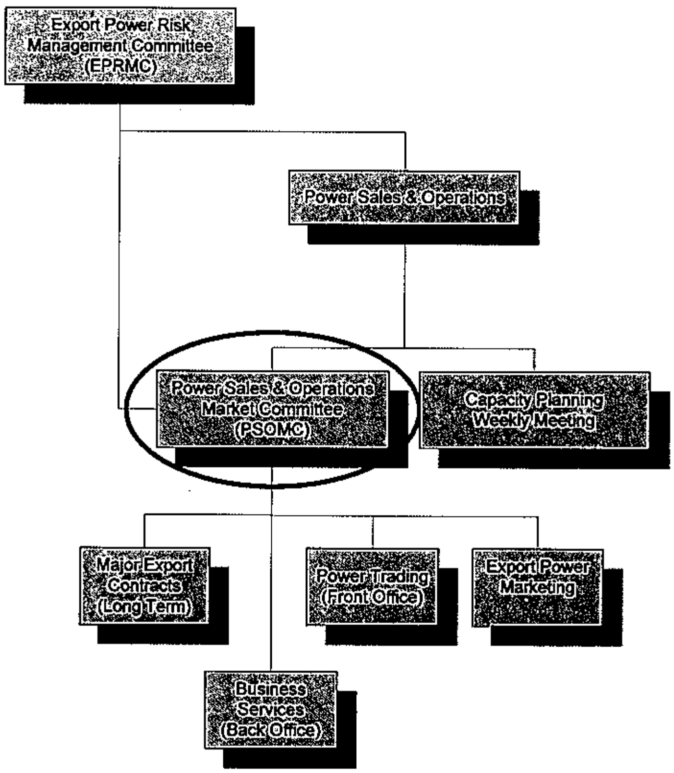
The Export Power Risk Management Committee ("EPRMC") was established in November 2006. According to its terms of reference, the role of the EPRMC is to provide oversight of the management of the energy supply and financial risks resulting from Manitoba Hydro's participation in the export power market. EPRMC is responsible for authorizing and ensuring that the strategies, measurement methodologies and controls for the management of these risks are effective in protecting MH's interests consistent with the corporation's tolerance for risk.

Responsibilities include:

- reviewing and approving criteria for managing risks associated with MH's electrical energy planning and operations; long-term export marketing initiatives; and opportunity export marketing and trading initiatives;
- reviewing and approving MH's export risk management program, including risk tolerance, risk measurement methodologies, risk management strategies and instruments;
- reviewing and approving general drought management strategies, including securing energy supplies, hedging objectives and tools;
- reviewing and approving trading and export market policies and procedures; and
- receiving and reviewing reports and audits of market activities and transactions.

Membership of the committee includes the President and CEO (Committee Chair); the Senior Vice-President, Finance and Administration and CFO; the Senior Vice-President, Power Supply; and the Corporate Secretary and Legal Counsel (Committee Secretary). The Committee receives regular or *ad hoc* reports from division and department managers, including but not limited to: ~~power sales and operations, power planning and development, corporate controller~~Power Sales and Operations, Power Planning and Development, Corporate Controller and Export Power Middle Office.

5.4.1.7 Power Sales and Operations Market Committee



The Power Sales and Operations Market Committee ("PSOMC") is a management committee within the PS&O division that was established in November 2005 to oversee power transactions. According to the committee's terms of reference, its primary responsibility is to provide coordinated business direction, communication and control regarding energy transactions strategy, practices and procedures, product sales and purchases, and customer relations for Manitoba Hydro's participation in the export power market. Its terms of reference were updated in February 2009. The PSOMC reviews and approves operational activities within the parameters of the Board approved Management Control Plan and the EPRMC endorsed Approval Authority Table for Power Related Transactions, including but not limited to:

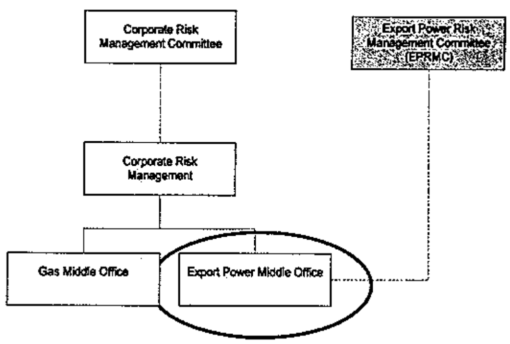
- reviewing, implementing and modifying business procedures;
- reviewing opportunity sales and purchase strategies and forward quantities;

- reviewing merchant sales and purchase strategies;
- reviewing transmission acquisition and maintenance strategies including the nomination, purchase and sale of auction revenue rights and financial transmission rights or equivalent;
- reviewing system financial products strategies;
- reviewing and monitoring export transactions and risk reports;
- reviewing and providing recommendations for approval to the EPRMC regarding:
  - export power sales, marketing and associated business policies;
  - export power marketing strategies and trading initiatives;
  - risk management strategies and hedging activities including drought; and
  - new markets, products and transaction types.

The members of the PSOMC are:

- PS&O Division Manager (Chair);
- Export Power Marketing Manager;
- Power Trading Manager.
- Export Power Middle Office Senior Risk Officer

5.4.1.8 The Export Power Middle Office



The Export Power Middle Office ("Middle Office") was established on February 6, 2007. According to its terms of reference, the Middle Office was initially created to be a review and advisory function reporting to the EPRMC under the direction of the Senior Vice-President of Finance and Administration and Chief Financial Officer.

The Middle Office is responsible for:

- Assessing whether potential risk exposures for export power strategies are identified;
- Evaluating risk treatment mitigation activities;
  - reviewing all formal policy and procedure documents to identify gaps or weaknesses in risk treatment and provide recommendations to improve risk mitigation;
  - reviewing established risk tolerances to determine whether they provide direction in electric export power activities and operations are within the established limits;
- Evaluating the accuracy of risk exposure / measurement information;
  - assessing the quantitative methodologies and systems in place to measure risk exposures;
  - testing methodologies and systems to ensure accuracy and adherence to stated objectives and logic;
  - determining that measurement information is accurately calculated, prepared in a timely manner and clearly communicated;
  - performing stress and backtesting and when appropriate scenario analysis on risk exposures;

- Monitoring export power activities for adherence to established policy, procedures and guidelines and assessing the effectiveness of controls;
  - reviewing export power activities on an ongoing basis and where possible incorporating exception reporting into those systems used for tracking and reporting of trading activities;
  - reporting on weaknesses and all non compliance issues; and
- Reviewing all new products to confirm that the risks around these new products have been identified and report the results of the review.

The Middle Office reports to the EPRMC on a quarterly basis.

5.4.2 Policies

The following key policies establish MH risk management standards and practices:

- Corporate Risk Management Policy
- Management Control Plan ("MCP")
- Power Sales Approval Authority Table
- Export Power Contractual and Legal Policy
- The Power Sales and Operations Credit Management Policy and Procedures
- Manitoba Hydro Wholesale Power Risk Policy (Draft)

To provide further context for our subsequent assessment of the management of opportunity sales risks, the following is a description of these policies:

5.4.2.1 Corporate Risk Management Policy

The corporate risk management policy establishes the corporate-wide risk management program. According to the policy, MH will manage its business and operational risks through a systematic, proactive and integrated process that is designed to balance the objectives of:

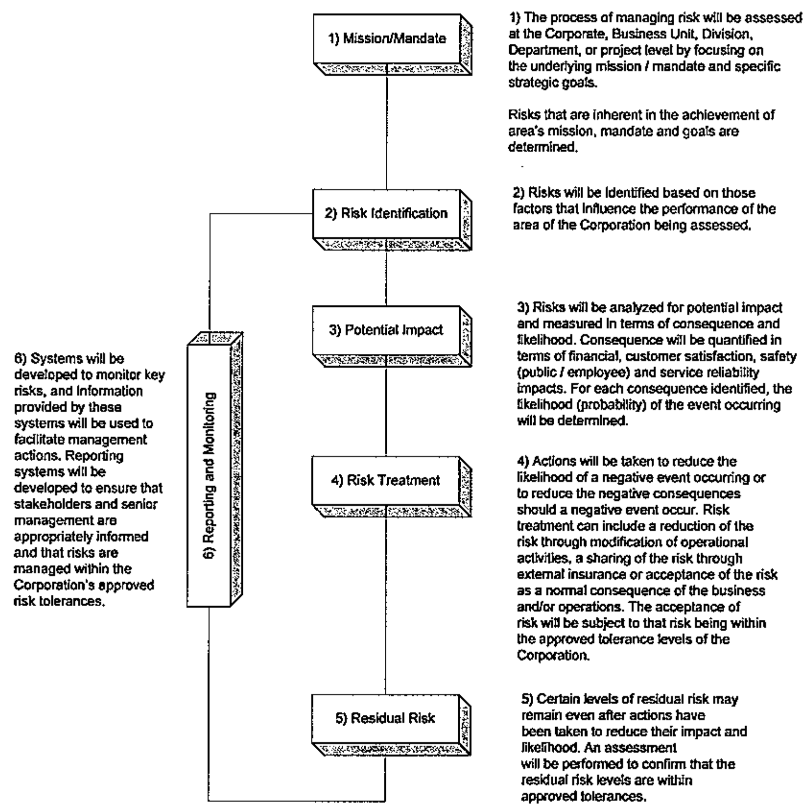
- identifying threats that affect the achievement of MH's mission and mandate;
- mitigating the consequences of negative occurrences; and
- taking advantage of opportunities to provide benefits to all stakeholders.

The policy is supported by the corporate risk management operating procedures that establishes risk management roles and responsibilities, the risk identification process and outputs such as the corporate and business unit risk profiles. These profiles are to be updated on a regular basis to ensure that risks are prudently managed and documentation is kept current.

The procedures require that a risk map will be produced at the corporate level to provide a graphical representation of risks facing the corporation. The risk map will depict risks in terms of consequence and likelihood of occurrence, and will be used to facilitate analysis, prioritization, risk tolerance, assessment, decision making and communication.

A clearly defined process for the identification, assessment and treatment of risk is articulated in the operating procedures document. A six step risk assessment and management process is described. Exhibit 5-3 provides an overview of the process:

Exhibit 5-3: Manitoba Hydro - Risk Management Process



Source: Manitoba Hydro

5.4.2.2 Management Control Plan

On April 25, 2002, the Board of Directors authorized the President & Chief Executive Officer or his/her delegate to execute contracts for the export and import of power and for associated purchases of transmission, fuel and ancillary services. At that time, the Board requested that management develop a risk management plan for the import and export of power. In response to this Board request, management developed the original MCP. It was approved by the Board on June 13, 2002. The MCP has been subsequently updated and approved by the Board in 2005 and again in 2007.

The scope of the MCP covers all power related transactions in both the United States and Canada, including energy and financial products as well as associated transactions for related products, including transmission, fuel, ancillary services and environmental attributes such as emission credits or allowances, and renewable energy credits. It consists of a portfolio of risk management mechanisms to protect the corporation from unnecessary risk or harm as a result of improper business practices. These mechanisms include application of both corporate-wide and divisional policies and procedures, control mechanisms such as signing authority requirements and segregation of duties, sophisticated computerized systems, use of budgets and reporting and review.

The MCP establishes the control framework for the following areas:

- long-term generation adequacy (resource availability);
- short-term resource management;
- system transactions, for energy products and financial products;
- merchant transactions (related or pure merchant), for energy products and financial products; and
- customer credit.

5.4.2.3 Power Sales Approval Authority Table

In January 2006, delegations of authority were approved for power sales. The following are examples of the approval authorities established by Manitoba Hydro at that time:

- any system energy products transaction requiring new generation capacity requires approval by the Executive Committee and the Manitoba Hydro-Electric Board;
- any system energy products transaction from existing generation or any purchase exceeding five years in duration and greater than 100 MW requires approval by the Executive Committee and the Manitoba Hydro-Electric Board; and
- any system energy products transaction from existing generation or purchase exceeding five years in duration and less than 100 MW requires approval by PSOMC.

On October 1, 2007, the power sale approval authority table was modified. The modified table provides an expanded universe of approval authorities required by Manitoba Hydro for the execution of wholesale power transactions and related agreements once the necessary license and regulatory approvals have been obtained. The expanded approval authorities cover the following areas:

- system energy product transactions, for both new and existing generation in terms of megawatt size and contract duration;
- system financial product transactions; that is financial transmission rights, virtual supply or demand bids or offers, and for the use of call and put options and swaps;
- merchant transactions, covering both merchant energy transactions and financial transactions; and
- related agreements (for all transactions), including the master (interchange) agreement, remarketing agreements, market participation agreements, clearing firm and broker agreements, transmission or transportation service agreements, credit and netting agreements, customer creditworthiness requirements and changes and exceptions to these export power sales creditworthiness requirements.

5.4.2.4 Export Power Contractual and Legal Policy

This policy came into effect in September 2007 and is designed to minimize the contractual and legal risk that may arise from a party's misinterpretation of their respective rights and obligations under a contract. Contractual and legal risk may result in costly dispute resolution or unenforceability of the contract. Key controls outlined in the supporting contract documentation and review procedure include:

- terms and conditions for entering into transactions;
- parameters for determining pricing and availability of supply;
- required provisions for contracts ensuring adherence to regulatory, legal and taxation requirements;
- internal review and signoff, including legal review of all written contracts; and
- contract retention and storage requirements.

The policy is supported by detailed procedures which were recently updated (in February 2010). The procedures cover standard contractual requirements, contract review and documentation requirements for energy capacity agreements, transmission access agreements, market plus premium agreements dependable sales agreements, request for proposals and terms sheets and environmental attribute agreements. The procedure also defines the process for amending contracts and contract administration requirements and provides guidance for contract documentation.

5.4.2.5 Power Sales and Operations Credit Management Draft Policy and Procedures

This draft policy and supporting procedures were developed in October 2009 and build upon credit management provisions that are contained in the MCP. These are now the governing documents to manage credit for all wholesale electricity related transactions. Credit management must adhere to the following principles:

- principle 1: establishing an appropriate credit risk environment;
- principle 2: operating under sound credit granting processes;
- principle 3: maintaining appropriate credit contracts, administration, measurement and monitoring processes; and
- principle 4: ensuring adequate controls over credit risk.

The documents provide credit management procedures to grant appropriate counterparty credit limits while mitigating the risk of credit losses. They also identify the tools used to monitor and evaluate the ongoing creditworthiness of MH's export power sales counterparties, and set out procedures to follow if counterparties request financial security from MH. Roles and responsibilities required to support the credit management function are provided.

5.4.2.6 Manitoba Hydro Wholesale Power Risk Draft Policy

In February 2010, the Middle Office at Manitoba Hydro drafted a new wholesale power risk policy that, if adopted by the Executive Committee and the Board of Directors, will become the successor policy to the MCP. The intent of the draft policy is to continue MH's management of risks and related exposures according to the following principles:

- ensuring that Provincial supply needs are met and not put at unjustified risk due to wholesale power activities. All activities should be supported by prudent risk management, power, water and credit management practices;

- risks are managed in a manner that will mitigate or reduce risk and related exposure while balancing opportunities to maximize net export revenue and expected financial outcomes;

- all wholesale power transactions will only be undertaken when there is an expected net benefit to MH as a result of the transactions and transactions will have adequate pricing margins;

- volumes associated with all wholesale power sales should not exceed at the time of commitment, energy availability projections or forecasts related to the duration of the sale;

- wholesale power transactions should be undertaken only with creditworthy counterparties based on maximum pre-defined credit limits, the use of collateral or guarantees when warranted and when appropriate, the use of industry standard agreements;

- activities undertaken must comply with all applicable laws, regulations, tariffs, rules and applicable corporate policies; and

- risk governance infrastructure will maintain adequate oversight, controls, measurement and reporting.

The draft policy provides direction on general transacting policy, anti-speculation in terms of energy and financial products trading, and the risk governance structure at MH including roles and responsibilities for the front, middle and back office functions of the corporation. It identifies other relevant risk management support functions (e.g., Hydraulic Operations, Resource Planning and Market Analysis, Legal, Corporate Accounting, Treasury, Technology and Audit).

The draft policy also provides risk reporting requirements including the Credit Report, Transaction Performance and Position Reports, Policy and Procedure Compliance, Generation System Status, and other information and reports on specific risks when applicable.

5.5 Risk Governance Leading Practices

Leading practice organizations such as the Committee of Chief Risk Officers (CCRO), the International Organization for Standardization (ISO) and the Canadian Standards Association (CSA) have made significant contributions to articulating and maturing the role of risk management from both a strategic enterprise-wide perspective and for specialized risk management functions (e.g., market risk, credit risk, operational risk and strategic business risk). The following table provides a summary comparison of MH's risk management practices for power sales against the leading practices.

The comparison of MH's power sales risk governance practices to the leading practices is positive. Based on the nature of its asset backed power sales business model, the MH risk governance practices are for the most part appropriate. The comparative analysis demonstrates that MH is making progress on maturing its power sales risk management policy framework and its Middle Office in accordance with leading practices.

Exhibit 5-4

Comparison of MH's risk management practices against the leading practices

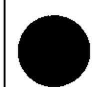
Legend

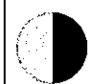
No evidence of leading practice

Partially meets the leading practice

Substantially meets the leading practice

Fully meets leading practice

Leading Practice	Manitoba Hydro Practice	Findings	Conclusions	Overall Assessment
1. An independent senior executive (e.g., Chief Financial Officer (CFO) or Chief Risk Officer (CRO) is responsible for overseeing an independent Middle Office function.	The Senior Vice President of Finance and Administration, Chief Financial Officer is ultimately responsibly for overseeing the independent Export Power Middle Office.	This oversight role has been in place since 2006. The Export Power Middle Office reports to the Corporate Risk Manager who in turn reports directly to the Senior Vice President of Finance and Administration, Chief Financial Officer.	Based on the size and nature of the asset backed power sales strategy adopted by Manitoba Hydro, the independent leadership of the Export Power Middle Office is in keeping with leading practice.	
2. The CFO or CRO chairs a risk oversight committee which is responsible for ensuring that power sale risks are identified, assessed and managed according to the corporation's risk tolerances and supporting policies.	The Export Power Risk Management Committee was established in November 2006. The EPRMC provides oversight of the management of the energy supply and financial risks resulting from Manitoba Hydro's participation in the export power market.	The committee is chaired by the CEO. Membership also includes the Senior Vice-President, Finance and Administration, CFO; the Vice-President, Power Supply; and the Corporate Secretary and Legal Counsel (Committee Secretary). It plays a significant role in terms of risk-based decisions for power sales. The Committee receives periodic updates from the Export Power Middle Office on risks and compliance issues.	The EPRMC's oversight and pre-Executive Committee review and approval role fully meets the leading practice.	
3. Risk management policies and procedures are established for power sales and independently monitored for power sales.	Manitoba Hydro has established a series of risk management policies covering power sales including: • The Management Control Plan (2002, 2005, 2007) • The Power Sales Approval Authority Table (2006) • Export Power Contractual and Legal Policy (2007) • Power Sales and Operations Credit Management Policy and Procedures (Draft) (2009) • Manitoba Hydro Wholesale Power Risk Policy (Draft 2010)	Manitoba Hydro has a detailed opportunity sales policy framework that is regularly assessed for compliance by the Middle Office. Ownership of power sales risk management policies has been historically within the domain of PS&O. We understand that MH is considering transfer of the responsibility for power sales risk management policy stewardship to the Export Power Middle Office.	The power sales risk management policy framework substantially meets the leading practices Manitoba Hydro should continue to institutionalize the policy setting roles of the Export Power Middle Office.	

Leading Practice	Manitoba Hydro Practice	Findings	Conclusions	Overall Assessment
4. An independent Middle Office has been established which reports directly to the CFO or CRO. It conducts independent risk analysis of power sales from both market and credit risk perspectives.	The Export Power Middle Office was established in 2007 and is staffed by a senior risk officer.	The Middle Office function is currently responsible for: • Power sales risk policy and procedures • Policy/procedure compliance • Risk monitoring and measurement • Risk and compliance reporting • Transaction evaluation. Under leading practice, the Middle Office would also be responsible for counterparty credit risk analysis. This function currently resides with the Export Power Marketing group within PS&O.	The current Middle Office structure partially meets the leading practices. In order to fully meet the leading practice, credit risk analysis should report directly to the Middle Office. The market risk quantification capabilities of the Middle Office should also be enhanced.	
5. The Middle Office function is adequately resourced (HR and technology) to carry out independent risk assessments of power sales.	The Export Power Middle Office is currently staffed by one senior risk officer.	Currently the Export Power Middle Office has limited risk analysis resources for both market and credit risk. The current energy trading system, WebTrader, does not have an integrated risk analysis module which provides the Middle Office with the capability to conduct risk analysis against a series of risk metrics. Manitoba Hydro currently has an initiative under way to select a risk analysis software tool that will integrate with its energy trading system.	The current HR and technology resources of the Export Power Middle Office to conduct independent risk assessments of power sales only partially meet the leading practice.	

5.6 Case Studies

Formatted: Indent: Left: 0", Hanging: 0.5", Right: 0.75", Space Before: 6 pt, No bullets or numbering

This section of the report presents a summary of our findings related to risk governance approaches of other electric power utilities. It demonstrates that as electric utilities across North America are adapting to their changing environments, a variety of approaches are in place, largely driven by their unique operating characteristics, regulatory regime and the pace at which they are implementing relevant leading practices.

KPMG reviewed 14 other electric utilities as part of its case study review. For the purposes of our analysis on risk governance we have considered 13 of the 14 utilities. The utility excluded from our analysis does not engage in any power sales; thus it is not a relevant comparator. The following table provides a summary of the findings in terms of stated risk governance roles, responsibilities and reporting relationships, and policies in place at the utilities we researched.

Exhibit 5-5

Comparison of Case Study Findings to MH Practices

Legend

No evidence of comparative case study findings

Partially aligns with the case study findings

Substantially aligns with the case study findings

Fully aligns with the case study findings

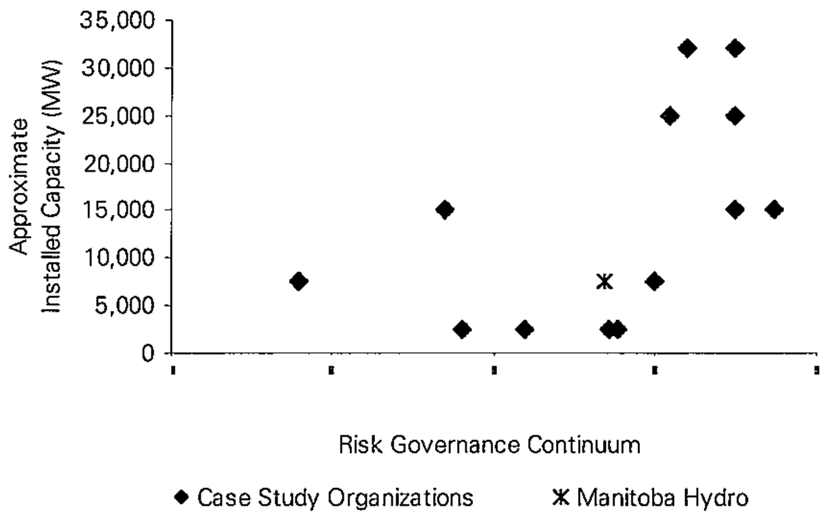
Case Study Element	Case Study Finding	Hydro Assessment
Roles, Responsibilities and Reporting Relationships		
Independent Middle Office	Twelve of the 13 organizations studied have defined front, middle and back office roles and responsibilities. The make-up of the Middle Office is unique across organizations and is dependent on the mandate, trading activity, and policies and procedures of the organization. The number of personnel in our sample of Middle Offices range from one to thirteen dedicated professionals. Typically these professionals are segregated within the Middle Office either by type of risk (i.e., credit, market or operational risk) or by function (i.e., risk planning, risk reporting or risk control).	
Policies		
Risk Management Policy	KPMG's case study review revealed that every organization has a documented risk management policy. Each of the organizations also have more specific risk policies and procedures that outline risk limits, hedging strategies, approval structures, etc. Due to the proprietary nature of such policies KPMG was unable to conduct a detailed comparison to Manitoba Hydro's risk management policy framework.	

5.6.1 Overall Risk Governance Structure

To provide additional context on MH's risk governance practices, we prepared the following scatter plot comparing MH to the results of the case study research. Note that the scatter plot compares the organizations on the basis of their overall risk governance practices pertaining to power sales, and not just to opportunity sales. Exhibit 5-6 below illustrates each organization's risk governance structure along a "risk governance continuum" as contrasted with the approximate size of their generation capacity.

Formatted: Font: 11 pt

Exhibit 5-6: Risk Governance Continuum



In creating the scatter plot, KPMG considered the five leading practices outlined in Exhibit 5-4, the context of the organization and other pertinent factors as a basis upon which to apply professional judgment to determine each organization's location on the scatter plot.

As seen in Exhibit 5-6, there are three clusters of organizations present in our sample. Four of the organizations are closer to the "basic" end of the spectrum; six of the organizations are closer to the "advanced" end and four of the organizations fall in a middle cluster between the "basic" and "advanced" ends. Note that the organizations that are close to the "advanced" end of the spectrum tend to have significantly larger installed capacity than the other organizations in our sample. MH lands in the middle cluster of organizations, and its risk governance structure is similar to the organizations with installed capacity under 10,000 MW.

Formatted: Indent: Left: 0", Hanging: 0.5"

5.7 Risk Management Roles, Responsibilities and Reporting Relationships

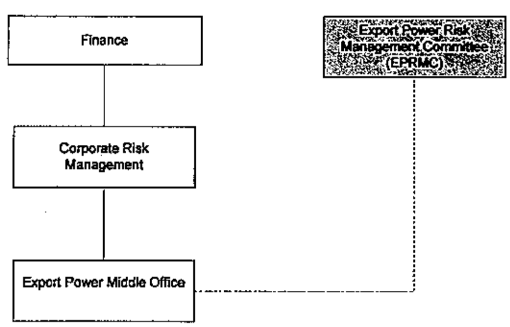
In this section we present our key findings and conclusion with respect to risk management roles, responsibilities and reporting relationships. We have based our findings and conclusions on our understanding of MH's business and risk management practices, the applicability of leading practices to this business, our case study analysis and KPMG's professional risk management experience in the power sector.

The following are our findings on the middle office function at Manitoba Hydro.

The Export Power Middle Office is a single, independent, risk management office and is progressing appropriately toward its responsibilities for assessing the risks of transactions in opportunity sales in the export market.

- The Export Power Middle Office has been established as an independent entity that reports to the Manager, Corporate Risk Management, who in turn reports directly to the Senior Vice-President, Finance and Administration and CFO. MH has effectively segregated the middle office function from the PS&O division, which is responsible for power sales. The Export Power Middle Office has a dotted line reporting relationship to the EPRMC and reports on risk and compliance matters to the committee on a quarterly basis. The following exhibit demonstrates the independence of the Middle Office:

Exhibit 5-7: Reporting Relationship of the Export Power Middle Office



- The Export Power Middle Office provides advice and assistance to PS&O on risk assessment methods and calculations for energy transactions. It also fulfills an important risk policy compliance role for MH.

- There has been steady progress at MH towards a fully functioning Middle Office, as evidenced by changes in reporting relationships and policies described in section 5.4 (e.g., creation of EPRMC and independent Middle Office reporting to the CFO). The evolution of the middle office function at MH is not dissimilar from what we observed from the case study participants. The case studies demonstrated that the core requirements and time frame for maturing the middle office function are by-products of the power utility's complexity from a business model, asset base and power trading perspective. The nature and volumes of transactions are factors in determining how extensive the Middle Office's role has become.

MH should consider empowering the Export Power Middle Office to provide both independent credit and market risk analysis

- Leading practice suggests progressively moving to a fully independent Middle Office function with strong risk management capabilities for both market and credit risk. These functions are currently found in PS&O, which does not allow fully independent oversight.

- Credit risk management for counterparty transactions is most effective when it is performed at an independent Middle Office level rather than within the power trading and marketing area.

- MH (and other utilities) have certain market risk assessment functions housed in the power trading business unit to support the assessment of market risk exposure. While not ideal from an independence perspective, there are operational efficiencies associated with this approach.

The Export Power Middle Office should continue its efforts to improve its risk analytics capabilities.

- Currently, the Export Power Middle Office is staffed by a senior risk officer with a strong background in financial and risk analysis. The Export Power Middle Office risk quantification capabilities would be enhanced through the addition of a market risk analyst position to support the risk officer. This would also complement MH's current initiative to invest in risk analysis software that can be integrated with its energy trading software –WebTrader.

- The Middle Office should have the necessary core risk assessment and quantification methods and systems to independently assess the risk profile of all opportunity ~~energy~~sales transactions. This is consistent with leading practice and a number of our case studies. It would provide more timely and insightful management information.

- MH has acknowledged that its current power transaction system WebTrader does not have an integrated risk analysis module. It has also recognized that spreadsheet-based risk analysis tools may not be the most efficient or integrated way to assess the risk associated with opportunity sales. As a result, MH is currently developing detailed functional requirements for its Middle Office risk analysis system. It is assessing core risk measurement requirements with leading energy risk analysis software offerings in the market. As part of this undertaking it has issued an Expression of Interest (EOI), and has invited vendors to provide on-site demonstrations of their solutions. This market scan and demonstration phase will lead to a comprehensive Request for Proposals (RFP) phase to acquire a solution that integrates with the current transaction management system. These initiatives by MH will further enhance the capacity and efficiency of the risk analytics capabilities of the Export Power Middle Office.

5.8 Risk Management Policies

In this section we present our key findings and conclusion with respect to risk management policies. We have based our findings and conclusions on our understanding of MH's business and risk management practices, the applicability of leading practices to this business, our case study analysis and KPMG's professional risk management experience in the power sector.

MH's policies concerning opportunity power trading are progressing appropriately for the nature of its business.

- MH has established both the Board of Directors' and the senior management's commitment to establishing policies at the corporate and business unit level to manage the corporation's risks with a strong focus on power sales. For example, this is demonstrated in the Audit Committee Charter and in the delegated authority to the Executive Committee and the EPRMC.

- Since 2002, MH has had the Management Control Plan and the Table of Authorities for a range of power transactions in order to control the risk of unauthorized sales or financial transactions. The Table of Authorities was updated in 2007 to reflect the changing nature of MH's transactions.

- Since 2007, the Export Power Contractual and Legal Policy has been in place and is designed to minimize the contractual and legal risk that may arise from a party's misinterpretation of their respective rights and obligations under a contract. The policy is designed to mitigate contractual and legal risk that may result in costly dispute resolution or unenforceability of an export power contract.

- The Power Sales and Operations Credit Management Policy and Procedures were developed in October 2009. They build upon credit management provisions that are contained in the Management Control Plan. These are now the governing documents to manage credit for all opportunity wholesale electricity related transactions.
- According to our case study review it was found that every organization has a documented risk management policy. Each of the organizations also has specific risk policies and procedures that outline risk limits, hedging strategies, approval structures, etc. MH's risk policy framework is in keeping with these findings.

MH should continue its effort to institutionalize the policy setting role regarding risk management of the Middle Office in accordance with leading practices.

- The recent drafting of the revised export power wholesale marketing (February 2010) and credit policies and procedures (October 2009) indicates that MH is maturing and aligning the opportunity export power marketing risk management governance and policy framework with leading practices.
- We understand that recently (March 2010) a plan has been developed to consolidate contract and credit procedures into one set of risk management guidelines and procedures document. It would include a new section for risk management procedures on all types of transactions and would flow from a final approved new risk policy.
- We understand that a plan has been developed to consolidate the stewardship for opportunity power sales risk management policy development and renewal under the Export Power Middle Office. This is an appropriate and consistent approach to developing, integrating and maintaining its opportunity sales risk management framework going forward.

The leading practice suggests a comprehensive and integrated approach to developing and managing risk management policies. Manitoba Hydro's current risk management policy consolidation initiative is in keeping with such practice.

5.9 Conclusion

In terms of risk governance, based on our analysis, we conclude the following:

- MH's power sales are asset backed. These sales are generally low risk and the MH risk governance policies and reporting relationships, including the role of the Middle Office, are evolving appropriately.
- The Export Power Middle Office is a single, independent, risk management function. It is steadily progressing in terms of its responsibilities for measuring, monitoring, controlling, and reporting the risks associated with PS&O's opportunity power sales activity.
- The Export Power Middle Office is undertaking an initiative to improve its risk analytics capabilities. It requires further resource(s), supported by risk analytics software that is integrated with Manitoba Hydro's energy transaction management system (WebTrader). The timeliness of this risk monitoring will continue to improve with added analytical resources and related technology.

6. Power Risk Management

Power risk management is the process by which a utility identifies, measures, controls, and reports risk associated with its energy transacting activities.

This chapter is organized as follows:

6.1 Scope of Our Review

In Phase 1 of the Review and as shown in Exhibit 1-1, KPMG identified one Issue within the Theme of Power Risk Management:

- Issue – Treatment of risk (identification, measurement, treatment)

To summarize the Consultant's assertions on this Issue, the Consultant asserts that MH is not adequately analyzing its risks associated with export power sales by breaking the risks into its component sub-risks and using a structured framework for assessment. The assertions relate to risk identification, risk measurement, risk control and risk reporting.

In addition, as noted in Section 1.2.1 of this report, another Theme (Portfolio Monitoring and Reporting) and the related issue (methodology for valuation and hedging (mark-to-market)) identified during the conduct of our Phase 1 work were merged into the Theme of Power Risk Management, and the related Issue consolidated with the treatment of risk issue, because of the high level of overlap in content.

In accordance with the general approach outlined in Chapter 1, our assessment of these issues has been extended beyond the specific subject matters addressed by the issues as defined in the Phase I report. Specifically, our assessment of power risk management considers the issues in the context of a typical risk management framework containing the following elements:

- Risk identification;
- Risk measurement;
- Risk control; and
- Risk reporting.

For each of these risk management framework elements, one or a number of topics were identified of relevance to power risk management and the issues raised. These are identified in Exhibit 6-1.

Exhibit 6-1: Power Risk Management Framework

Risk Identification	Risk Measurement	Risk Control	Risk Reporting
Major Export Contracts	Mark-to-Market Risk Analytics Credit Risk Management	Risk Limits Transaction Processing Controls	Adequacy of Existing Reports

In relation to each topic included above, one or a number of questions were identified as a means of addressing the subject matter of the chapter and framing the analysis covered in this chapter. These include:

Major Export Contracts

- *Are inherent risks associated with prospective major export contracts identified in a systematic and disciplined manner?*
- *Are prospective major export contracts reviewed by relevant internal stakeholders (i.e., legal, regulatory affairs, environmental, etc.)?*

Mark-to-Market

- *Should MTM be applied to measure market, credit and volumetric risks?*

- *Should physical gas assets (e.g., gas storage) and its embedded optionality characteristics be marked to market?*
- *Does MH apply proper accounting treatment to its long-term sales contracts consistent with Generally Accepted Accounting Principles (GAAP)?*

Risk Analytics

- *Should a VAR-based method be considered to measure drought risk?*
- *Is the current stress testing methodology reasonable?*
- *Should backtesting be performed to calibrate and validate model assumptions?*

Credit Risk Management

- *Does MH measure credit exposure in a manner consistent with leading practices?*

Risk Limits

- *Does MH have appropriate risk limits commensurate with PS&O power transacting activities?*

Transaction Processing Controls

- *Are MH's transaction processing controls consistent with leading practices?*

Adequacy of Existing Reports

- *Are MH risk reports comprehensive?*
- *Are reports accurate and complete?*
- *Are variance reports produced to compare actual versus forecasted data?*

6.2 Key Findings

This section outlines our key findings with respect to power risk management. Aspects associated with drought-related risks have been addressed in Chapters 3 and 4.

In the context of risk identification:

- While MH has documented contract review procedures, they do not explicitly include risk identification, assessment and risk mitigation strategies. MH should consider expanding these procedures to include these items.

- Major export contracts undergo extensive review by internal stakeholders prior to executing binding term sheets. We suggest that the Middle Office also be involved in the review of export contracts.

In the context of risk measurement:

- MH should consider extending its current practices of using Mark-to-Market (MTM) methodologies to measure and monitor its short-term physical transactions and its credit risk exposures (i.e., replacement cost);

- MH quantifies drought risk using a non-probabilistic stress test, an appropriate measure. MH should also consider developing a probabilistic stress test to further assist management decision-making.

In the context of risk control:

- MH has specified risk limits limited to "Power Related Transactions" in the area of Merchant Transactions (Related or Pure Merchant) and Customer Credit. MH continues to enhance its limit structure, for example, by recently establishing Stop Loss Limits. We recommend that MH continue developing further limits such as Value-at-Risk (VAR) limits for ~~related~~Related Merchant Transactions.

- MH employs a wide range of control mechanisms to mitigate operational risk throughout the transaction process in a reasonable manner. Based on our experience with peer utilities, MH transaction controls are consistent with prevalent practices.

In the context of risk reporting:

- MH risk reporting is generally consistent with leading practice except in the area of "Exposure vs. Limits" reports. We recommend MH expand its report suite to include this key report.
- Variance reports are produced at MH to compare actual against forecasted data for all of its forecasted data and in adequate detail and structure.

6.3 Approach and Methodologies

We analyzed both MH-provided data and external sources to formulate our conclusions and recommendations. Our analysis approach included the following activities:

- a review of how MH manages the inherent risks associated with export power transacting (short- and long-term);
- a review of risk management leading practices in the energy industry; and
- a review of applicable risk management practices from other electric utilities described in **Appendix E.**

Obtaining information on power risk management practices at MH provides the basis for the analysis described in this chapter. In essence, the analysis consist of comparing MH's practices with leading practices (and case study information where applicable) in order to identify gaps and opportunities for improvement.

6.3.1 A Note on Leading Practices

Leading industry risk management practices were gathered from a diverse set of authoritative sources, listed in **Appendix M.**

It is important to note that leading practices are aspirational, continue to evolve and are subject to limitations:

- Leading practices offer insight into an organization's risk management capabilities, and a directional compass for an organization's risk management development. However, the development and implementation of such practices does not assure that control objectives will always be achieved.

- Many leading practices reflect the capabilities of organizations that primarily transact and manage risk in the more traditional financial markets. Requirements of organizations transacting in the energy markets can be different, and in this context, leading priorities should be modified accordingly. In addition, the adoption of leading practices should be considered in the context of costs versus benefits.

6.4 Risk Identification

Risk identification is a requisite component of an effective risk management framework. Before a company can begin managing its inherent risks, the risks must be identified and defined. Management consensus on key risk categories (e.g., market, credit, operational, regulatory, legal, environmental, reputational, etc.) and corresponding definitions establishes the company's risk taxonomy.

MH is a unique utility holding a natural long position in energy supply. MH's experience transacting in the extraprovincial wholesale electricity business initiated with the first transmission interconnection in 1958. Short-term trading began in 2001. ~~MH's core business objective is to provide its domestic customers low cost and reliable energy services. Consistent with this objective,~~

MH participates in the wholesale energy markets by exporting surplus power only to capture market opportunities, generate incremental income, and to ensure market access for current and future domestic needs.

The overall breadth of MH transacting activities are low risk in nature due to the short duration of the majority of their power trading activities. Coupling the low risk with the conservative risk management practices in place, MH manages its market, credit and volume risks in a prudent manner.

The area of MH's power risk management where risk identification is critical relates to its export power sales. This is because non-export sales are made in the context of a regulated utility environment. Within export power sales, it is primarily long-term contracts that raise issues related to risk identification (and measurement and mitigation) because short-term contracts are low risk. This is where we focused our analysis.

A critical success factor to effective risk identification is establishing an agreed upon risk taxonomy. For the purposes of this report, we have identified and defined applicable risk categories in **Appendix L** – Risk Definitions to facilitate a consistent

KPMG

understanding of our observations and recommendations. In this regard, it is noted that there is little industry consensus on definitions for each risk category mentioned.

Risk definitions reflect the organization's unique business model and core activities. For purposes of this report, it is necessary to define PS&O risks upfront to facilitate a consistent understanding of our observations and recommendations, and we have done so in **Appendix L** – Risk Definitions.

PS&O's inherent risks are related to its current scope of authorized transacting activities summarized in Exhibit 6-2.

Exhibit 6-2: Power Sales & Operations – Scope of Authorized Transacting Activities

Product	Commodity	Counterparty	Purchase	Sale
Real time	Electricity	Bilateral, Market	☒	☒
Day ahead	Electricity	Bilateral, Market	☒	☒
Short-term ($x \leq 1$ yr)	Electricity	Bilateral	☐	☒
Long-term ($x > 10$ yrs)[17]	Electricity	Bilateral	☐	☒
Short-term	Natural gas	Bilateral	☒	☒
Exchange-traded products (futures, options)	Electricity and Natural Gas	Market	☒	☒
Over-the-counter products (forwards, options, swaps)	Electricity and Natural Gas	Bilateral	☒	☒
Financial Transmission Rights	Transmission	Market	☒	☒
Ancillary Services	Electricity and Transmission	Market	☒	☒

6.4.1 Long-Term Export Contracts – Risk Identification

Specifically within PS&O, the Major Export Contracts function (i.e., "MEC") within PS&O is responsible for managing and negotiating major export contracts.[18] The MEC came into existence in 2008. Prior to that time, the Export Power Marketing ("EPM") department was responsible for managing and negotiating major export

[17] *Long-term sales contracts are offered in two standard products – 1) System Participation Sales and 2) Diversity Exchange Agreements. (See Appendix G for a detailed description of each contract).*

[18] *Major export contracts are a subset of long-term contracts.*

contracts. We understand that the purpose of this organizational change was to allocate a dedicated resource to better manage the term sheet due diligence process. MEC currently comprises one full-time equivalent position, the MEC Manager.

MEC is currently negotiating term sheets with three U.S. utilities Northern States Power (NSP)[19], Wisconsin Public Service (WPS) and Minnesota Power (MP). MEC provides formal progress updates on the negotiations to the Senior Vice-President Power Supply and MH President through the "PS&O Monthly Report".

As previously described in Chapter 4 – Power Sales Management, major export contracts include two types of long-term surplus sales contracts:

- System participation power agreements; and
- Diversity exchange agreements

This section addresses the following long-term contract risk identification issues:

- *Are inherent risks associated with prospective major export contracts identified in a systematic and disciplined manner?*
- *Are prospective major export contracts reviewed by relevant internal stakeholders (i.e., legal, regulatory affairs, environmental, etc.)?*

6.4.1.1 Leading Practices

KPMG considered the following leading practices in assessing MH's risk identification process for major export contracts:

- *"The front office should develop new business after extensive research; it should document the information in a market business plan or risk analysis report. This documentation includes, but is not limited to, industry background, entry and exit plans, risk analysis, return on investment, and proposed limits. Before its plan is approved, the middle office should validate the appropriateness of the market research, models, curves, and assumptions used to value the new business. Additionally, the middle office should independently identify and quantify the various risks involved in accepting the new business activity." (Source: "CCRO Governance and Controls Whitepaper," November 2002, Vol. 2, pg. 18.).*

[19] *The NSP term sheets have now entered the contracting phase, undergoing negotiations and pending counterparty approval.*

- *"Potential events that might have an impact on the entity must be identified. Event identification involves identifying potential events from internal or external sources affecting achievement of objectives. It includes distinguishing between events that represent risks, those representing opportunities, and those that may be both. Opportunities are channelled back to management's strategy or objective-setting processes." (Source: "COSO Enterprise Risk Management – Integrated Framework," September 2004, pg. 22.).*

- *"Depth, breadth, timing, and discipline in event identification vary among entities. Management selects techniques that fit its risk management philosophy and ensures that the entity develops needed event identification capabilities and that supporting tools are in place. Overall, event identification needs to be robust, as it forms the basis for the risk assessment and risk response components." (Source: COSO Enterprise Risk Management – Integrated Framework," September 2004, pg. 45.)*

6.4.1.2 Analysis

Issue #1: Are inherent risks associated with prospective major export contracts identified in a systematic and disciplined manner?

MH's current contract review procedures, documented in November 2007, prescribe detailed documentation guidelines related to long-term commercial terms and operational parameters (e.g., delivery point, curtailment provisions). However, these guidelines do not include procedures addressing contract risk identification, assessment and risk mitigation strategies.

Issue #2: Are prospective major export contracts reviewed by relevant internal stakeholders (i.e., legal, regulatory affairs, environmental, etc.)?

MH develops forecasts of Dependable Energy and a forward-looking Power Resource Plan. This identifies the amount of firm surplus energy available for sale under long-term contracts. (See Chapter 4 – Power Sales Management for further details)

Volumes available for export sale must conform to the Dependable Energy Criteria Policy. The long-term dependable supply is based on the Power Resource Plan prepared by Resource Planning and Market Analysis (RPMA) who are independent of PS&O and report to the Senior VP Power Supply. Once volumes are deemed available for export sale by RPMA, MEC creates draft term sheets for internal review. The MEC internal review process is required to comply with provisions stipulated in the following policy and procedures documents:

- Management Control Plan;
- Contract Documentation and Review Procedures; and
- Generation Planning G195[20].

Term sheets undergo a lengthy negotiation process (e.g., averaging two to four years) and MEC provides formal progress updates on the negotiations to the Senior VP Power Supply and MH President. During the internal review process, draft terms and conditions are reviewed by the following MH departments / personnel / oversight committee:

- Executive Committee
- EPM Contract Administration;
- Law Department;
- Power Planning Division;
- EPM Transmission Access;
- Manager, Business Services, PS&O; and
- Manager, Power Trading.

MEC may seek additional review and feedback, as determined by the MEC Manager, from the following business areas:

- Transmission;
- Public Affairs;
- Rates and Regulatory Affairs;
- Power Projects Development Division;
- New Generation Construction; and
- Aboriginal Relations.

[20] *The Generation Planning G195 is a corporate policy statement included in the Management Control Plan providing guidance on resource reserve requirements and the minimum resources needed to provide firm dependable energy under the lowest recorded river flow conditions.*

KPMG

Major export contracts undergo extensive review by internal stakeholders, except by the Middle Office. We note that long-term contract policies do not stipulate that Middle Office review and feedback is required.

The MEC internal review process also requires Power Supply to review draft term sheet provisions and acknowledge their review on a "sign-off sheet". However, the "sign-off sheet" does not appear to be utilized in practice. MH management has indicated that internal stakeholder feedback on preliminary term sheet provisions is collected on a real time basis.

MH management indicate that the internal review process has remained consistent when MEC was part of EPM and thereafter.

6.4.1.3 Recommendations

- MH should consider enhancing its major export contracts internal review procedures by documenting its internal review process.

  KPMG recognizes that System Participation Power and Diversity Exchange Agreements are relatively standard MH contracts. However, when a new export contract is executed, it adds incremental risk and opportunity to MH's power portfolio. In its contracting process to date, MH has mitigated its incremental risk by securing firm transmission capacity and expanding import capability. To ensure that similar mitigation strategies are adopted in the future, MH should consider ~~developing and~~ documenting its risk identification and assessment procedures to institutionalize MH's existing informal internal review process.

  The industry-accepted process used to identify risks associated with new and existing products is referred to as the new product process (NPP). The NPP guides management in analyzing all commodity products, instruments and markets related to trading and marketing activities. New and existing products, if not properly reviewed and implemented, can adversely impact MH's risk profile. These products may result in modified risk profiles due to, for example, differing pricing mechanisms, complex embedded options, or incomplete risk decomposition.

  The NPP's primary objective is to validate that all significant risks associated with commodity products have been identified and integrated into the existing risk measurement process and control structure. Second, the NPP helps educate and focuses senior management and relevant functional personnel (e.g., Treasury, Trading, Legal, Tax, Accounting, Risk Management, Regulatory Affairs, Public

Affairs, Resource Planning, etc.) attention to the product's inherent risks. Finally, it provides management with a structured framework allowing relevant functional areas to provide input into new product research and development.

An example of an NPP process can be found at Salt River Project, one of the utilities in KPMG's case study review. Salt River Project has established a Complex Deal Committee comprised of managers from the front, middle and back offices. The committee reviews potential new counterparties and agreements to ensure they provide input in their area of expertise. In addition, every contract is reviewed by several groups in the organization including legal, accounting resource planning, energy risk management and regulatory affairs. Any contract with a tenor greater than five years requires approval from the Board and the risk oversight committee.

- MH should consider amending long-term contract policies to require Middle Office participation in the major export contracts internal review process.[21]

  As specifically previously mentioned in CCRO Governance and Controls White Paper, November 2002, Volume 2, page 18 leading industry practices calls for the middle office to validate the appropriateness of the front office's market research, models, curves and assumptions used to value new business (i.e., new long-term contracts).

  Current MH policy does not require Middle Office input in the internal review process. Middle Office input would provide a compliance perspective and a risk mitigation perspective. Specifically, Middle Office participation would enable discussions on whether appropriate strategies are in place to remediate any incremental exposures that materially change MH's risk profile.

- MH should comply with the MEC sign off requirement in accordance with existing policies.

  As mentioned previously, the MEC internal review process requires Power Supply to review draft term sheet provisions and acknowledge their review on a "sign-off sheet". Sign off requirements serve as a key evidentiary control indicating appropriate functional personnel have assessed the inherent risks associated with every major export contract. Signatures also foster individual accountability whereby any delegated proxies who participate in the review process possess the requisite background and professional experience.

[21] *Major export contracts represent significant endeavours and are not a frequent transaction type. Given the low transaction volume and the time it takes to finalize term sheets, Middle Office participation does not have significant resource requirements.*

6.5 Risk Measurement

Risk measurement refers to a company's quantification of its risk exposures. Risk measurement is a prerequisite step to risk mitigation and hedging, and should be comprehensively applied to firm-wide risks. However, not all risks are readily quantifiable. In circumstances where quantification is not a feasible option, qualitative measures are a suitable alternative. In power sales, risk measurement is primarily tied to the assessment and reporting of fair value (mark-to-market) and risk exposure (at-risk measures, stress testing) amounts associated with an organization's open commodity positions. Risk measurement leads to financial performance measures to mitigate earnings volatility, evaluate profit drivers, manage credit risk, assess hedge effectiveness and efficiently allocate risk capital.

The most prominent risk in trading is price risk, i.e., the risk of an economic loss caused by the decrease in the market value of a portfolio of contracts. Three key types of analytical price risk measures are:

- non-statistical or scenario-based measures;
- statistical measures; and
- stress tests.

A non-statistical measure of price risk is the calculation of the contract's or portfolio of contracts change in market value that would occur for a particular scenario (i.e., for a particular change in each market factor affecting the portfolio) independently of the likelihood of that scenario occurring.

A statistical measurement of price risk, in contrast to non-statistical analysis, is the potential loss of a portfolio's market value at a specified confidence level rather than for a specific scenario. In effect, one measures the probability distribution of the potential changes in the portfolio's value corresponding to thousands of scenarios of potential changes in market factors, with each scenario having a particular probability of occurrence. Value at Risk (VAR) is an example of statistical measurement of price risk.

Stress testing is another form of measuring price risk. Stress testing can be either non-statistical or statistical in nature. A non-statistical stress test, tests the potential economic loss of value of a contract (or a portfolio of contracts) for a specified scenario of very large changes in market factors (e.g., water flows in a hydro system). A stress test would calculate VAR under non-standard conditions (e.g., at a confidence level that is much higher than usual or with non-standard volatility or correlation assumptions).

This section addresses issues associated with the following risk measurement topics:

- mark-to-market;
- risk analytics; and
- credit risk management.

6.5.1 Mark-to-Market

Mark-to-Market (MTM) is a methodology used to value open, fixed-priced positions using forward market prices as a proxy. MTM reflects how much the open, fixed price position is worth if it were sold today at the current and projected forward prices prevailing over the term of the position. MTM represents the transaction's fair market value, over its remaining life, if it was liquidated in today's market. MTM measures *unrealized* gains and losses prior to contract settlement by calculating the difference between the transaction price and the forward dated market price.

The prevalent practice in the energy industry is to MTM transactions and portfolios, as a method of monitoring changes in value due to forward market price changes. For a trading portfolio, where the transacting objective is to capture changes in value over time, transactions are MTM in order to measure unrealized profits and losses as they occur. These profits and losses are typically monitored against pre-determined limits specifying the maximum acceptable loss for that transaction (i.e., stop loss limit). As such, this represents a key risk control mechanism.

MTM is also used to measure hedge effectiveness from an economic perspective (i.e., non-accounting perspective). A hedge is a transaction put into place to reduce the effect of adverse price movements on an asset. The hedge transaction consists of taking an offsetting position to the asset being hedged such that the effect of the adverse price movement on the hedge is opposite to the effect of the adverse price movement on the asset. A hedge is said to be effective when the magnitude of the price movement on the hedge and the asset are almost equal (albeit of opposite signs). As such, the MTM value of the asset and the MTM value of the hedge should be almost equal, but of opposite signs. Hence, for a hedged portfolio, measuring the MTM change is a convenient method of measuring hedge effectiveness through a single number, especially for a portfolio with many contracts (and hedges).

MTM is also relevant for calculating credit exposures. Credit exposure arises from a counterparty potentially defaulting on an existing contract. The potential default would result in the non-defaulting party having to either liquidate or replace the contract at current and projected forward prices. Since MTM reflects how much the open, fixed price position is worth if it were sold today, it is a useful tool to quantify credit risk exposure. (See Section 6.5.3 for further detail.)

This section addresses the following MTM issues:

- *Should MH use MTM to measure market, credit and volume risks?*
- *Should physical gas assets (e.g., gas storage) and its embedded optionality characteristics be marked to market?*
- *Does MH apply proper accounting treatment to its long-term sales contracts consistent with Generally Accepted Accounting Principles (GAAP)?*

6.5.1.1 Leading Practices

KPMG considered the following leading practices in assessing MH's MTM practices:

- *"Marking to market is the only valuation technique that correctly reflects the current value of derivatives cash flows to be managed and provides information about market risk and appropriate hedging actions." (Source: "Derivatives: Practices and Principles", G30 Global Derivatives Study Group, July 1993, pg. 9.)*
- *"Organizations should have "market risk measurement systems commensurate with the size and nature of their holdings. Institutions with significant holdings of highly complex instruments should ensure that they have independent means to value their positions. "...Institutions relying on third parties for market-risk measurement systems and analyses should fully understand the assumptions and techniques used by the third party." (Source: Federal Reserve Board of Governors "Trading and Capital Markets Activities Manual", February 1998 edition, Overview of Risk Management in Trading Activities Section 3000.1 pg. 14.)*
- *"All major risks should be measured explicitly and consistently and integrated into the firm-wide risk management system. Systems and procedures should recognize that measurement of some types of risk is an approximation and that some risks, can be very difficult to quantify and can vary with economic and*

market conditions. Nevertheless, at a minimum, the vulnerabilities of the firm to these risks should be explicitly assessed on an ongoing basis in response to changing circumstances." (Source: "Trading and Capital Markets Activities Manual", Federal Reserve Board of Governors, February 1998 edition, Overview of Risk Management in Trading Activities Section 2000.1 pg. 4.)

- *"...where a firm is using its own internal estimate to produce a valuation, it should document in detail the process followed in order to produce the valuation." (Source: "Senior Management Arrangements, Systems and Controls", FSA Handbook, Release 065, May 2007, Section 16.1.12, pg. 6.)*

6.5.1.2 Analysis

Issue #1: Should MH use MTM to measure market, credit and volume risk?

MH's MTM practices have remained consistent from 2006 through to February 2010.

The majority of MH MTM practices are limited to measuring market risk associated with financial transactions, including options and swaps (i.e., contract for differences). Market risk associated with physical transactions, both short and long-term (i.e., export contracts) are not MTM.

Regarding credit risk measurement, MH does not measure the replacement cost of power (in the event of counterparty default) using MTM methodologies as described previously.

Volume risk refers to unexpected electricity supply variances as a result of uncertain water flows. The random nature of these water flows is a result of natural phenomena. For example, precipitation is concentrated in particular seasons depending on weather patterns. Price movements may follow changing water flows (e.g., drought causing price spikes), however, the reverse relationship is not true. Therefore, the range of volume uncertainty can vary more erratically than its price counterpart. Hence, combining volume and price uncertainty has a multiplicative effect generating a large potential range of outcomes.

An additional complicating factor in volume risk measurement is the inherent operational flexibility of MH's hydro system (i.e., MH's ability to store limited amounts of water in plant forebays to use during on-peak periods). Thus, by shifting some incremental production to typically higher priced on-peak periods, MH can offset, on a percentage basis, some of the revenue loss from lower water volumes. Moreover, MH can take comparatively more advantage of forebay storage capacity in moderate water years as compared to extremely high water years (when there may be no forebay storage available), and low water years (when there may not be enough water to store).

Measuring volume risk using traditional MTM practices pose practical challenges for MH due to the above complications and the lack of published long-term forward electricity prices.

In lieu of MTM, MH practices an industry-accepted proxy referred to as mark-to-model by using third-party[22] long-term energy price forecasts and modeling low, expected and high flow scenarios. The long-term price forecast represents the MINN hub ~~however, and~~, which is adjusted by MH to reflect the contract delivery location (i.e., MHEB hub).

Issue #2: Should physical gas assets (e.g., gas storage) and its embedded optionality characteristics be marked to market?

MH does not currently have equity ownership in any natural gas storage facilities. During drought years, PS&O may procure adequate gas storage facilities from Tenaska Marketing Ventures / Tenaska Marketing Canada (collectively TMV) or other supplier with the intent to inject gas and withdraw to fuel MH's thermal plants, as necessary. These gas purchases are viewed as necessary to firm up fuel supply and as "insurance" against spot electricity price volatility in the event MH is short supply to serve provincial load. MH does not hold gas storage capacity during normal water years and has leased gas storage facilities only once during the 2003/04 drought.

Since MH uses gas storage only as an integral part of its drought management strategy and does not hold storage during normal water conditions, it is not necessary to measure the storage value and its embedded optionality characteristics.

Issue #3: Does MH apply proper accounting treatment to its long-term sales contracts consistent with Generally Accepted Accounting Principles (GAAP)?

MTM is applied to measure both economic value of long-term sales contracts and comply with GAAP addressing derivative accounting.

In general, contracts for future purchase or delivery of an energy commodity will be considered a derivative unless the contracts qualify for the "normal purchase and

[22] *MH develops its long-term price forecasts based on market forecasts purchased from the following five consultants: Global Energy Decisions, PIRA Energy Group, ICF Consulting, PA Consulting and ZE PowerGroup.*

sale" exemption. If a contract is considered an energy derivative contract, then MTM of the contract should be used and the change in fair value should be recognized for financial reporting purposes. If the contract is a purchase and sale in the normal course of business, the contract would qualify for the "normal purchase and sale exemption" and would not be valued at fair value for external financial reporting purposes.

Based on our review of MH's audited Consolidated Financial Statements for the Year Ended March 31, 2009, the sale of energy under long-term contracts are in accordance with MH's expected normal purchases and sales, and are therefore not required to be carried at fair value for financial reporting purposes. This is disclosed in note 1(n) of MH's Consolidated Financial Statements for the Year Ended March 31, 2009 as follows:

Note 1(n) – Derivatives

> *The Corporation does not engage in derivative trading or speculative activities. All derivative instruments are carried at fair value on the consolidated balance sheet with the exception of those that were entered into for the purpose of physical receipt or delivery in accordance with the Corporation's expected normal purchases and sales. Changes in the fair value of derivatives that are not designated in a hedging relationship and do not qualify for the normal purchase and sale exemption are recorded in net income.*

Accordingly, all derivatives which are not in the expected normal purchase and sale of MH would be carried at fair value, and the changes in fair value which are not designated in a hedging relationship would be measured and recorded in net income.

MH's sale of energy under long-term contracts for the future delivery of energy are considered derivative contracts which qualifies for "normal purchase and sale" exemption. Accordingly, the long-term contracts are not required to be measured and carried at fair value for financial reporting purposes.

Based on the audit opinion provided by the external auditors, Ernst & Young LLP, the financial reporting requirements of MH as reflected in the Consolidated Financial Statements for the Fiscal Years Ended March 31, 2007, March 31, 2008, and March 31, 2009 are in accordance with Canadian generally accepted accounting principles and MH has complied with its obligations with respect to the measurement and financial reporting of its long-term contracts and derivatives.

6.5.1.3 Conclusions and Recommendations

- MH should consider applying MTM initially to its open short-term commodity positions and thereafter to its long-term contracts.

  There are challenges to marking to market a portfolio of assets and long-term contracts, where there is no intention to liquidate in the short-term, no intention to transact to capture changes in value, or where market illiquidity would make it difficult to value a position. It is primarily for this reason that while MTM represents leading practice for energy market participants, some entities do not MTM the value of their physical assets (e.g., power plants) or the value of their long-term contracts.

  If MH were to MTM its long-term export contracts, it would require forward price curves for the pricing nodes in these contracts. Developing such forward price curves will require resources for proprietary ~~modelling~~modeling and analysis. MH could rely on a third-party forward price curves but would need to validate third-party curves in same manner as it would validate internally developed forward price curves.

  Long-term contracts should be viewed as asset positions in MH's overall portfolio. If MH elected to MTM its long-term contracts, hedging opportunities could be identified and portfolio optimization could be facilitated.

6.5.2 Risk Analytics

Risk analytics represent a suite of quantitative tools used to measure various market risk exposures related to commodity trading activities. The purpose of risk analytics are twofold: 1) quantify uncertainty as an attempt to identify probable future mark-to-market movements on the current portfolio, and 2) test model accuracy by ensuring assumptions and inputs (e.g., volatility and liquidity parameters, and MTM) to provide reasonable assurance that model outputs are reliable.

Risk analytics generally used in the energy industry include the following:

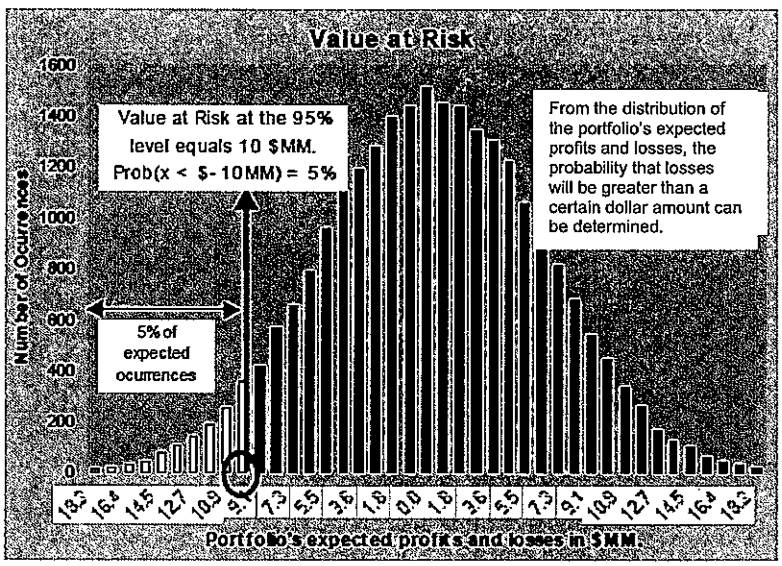
- Value at Risk
- stress tests
- backtests

Value at Risk

Value at Risk (VAR) is a method of measuring risk that captures in a single number, how much money an organization can lose under **normal** market conditions for a particular **horizon** (i.e., time period) and for a given confidence level (i.e., probability). VAR has increasingly become a standard risk management tool, providing quantification of the primary risk exposures an organization faces. VAR can provide critical insight to senior management, traders, shareholders, auditors, rating agencies, and regulators regarding a company's overall portfolio risk.

Exhibit 6-3 below graphically depicts the VAR concept:

Exhibit 6-3: Illustrative VAR distribution curve



In Exhibit 6-3, the probabilistic changes in a organization's hypothetical portfolio value due to a change in various market factors affecting the portfolio value over a one day period are graphed on the x-axis. At the 95% confidence level, the expected change in portfolio value over the next day is estimated at $10 MM. VAR for the portfolio, at a 95% confidence level over the one day time period is therefore $10MM. Stated differently, this means that there is only a 5% chance that the organization's portfolio could lose more than $10MM over the next one day period. (Note: the above example is for illustrative purposes only).

There are three main VAR methodologies simulating changes in the market factors affecting the portfolio being analyzed and in terms of their method of transposing a simulated change in market factors into a simulated change in portfolio value:

- variance-covariance (also known as analytic VAR)
- historical simulation and
- Monte Carlo simulation.

There is no one "right" methodology and each methodology has its own advantages and disadvantages.

Analytic VAR is based on analyzing volatilities and correlations between the different risk exposures of the portfolio. Every instrument in the portfolio being analyzed needs to be expressed as a collection of cash flows in order to derive a "synthetic" portfolio or a cash flow map to study the organization's risk exposures. For a specified time horizon, changes in each cash flow stream individually, and correlated to the other cash flow streams in the portfolio are simulated as a result of simulated changes in the various market risk factors that can affect the portfolio cash flows. These cash flow changes are aggregated into a total portfolio cash flow change probability distribution from which VAR at the desired confidence level can be estimated.

Historical simulation re-values the portfolio being analyzed based on several hundred historical scenarios of past market factors that affect portfolio value to build a "hypothetical" distribution of changes in portfolio value. This hypothetical distribution of portfolio values can then be used to calculate VAR at the desired confidence level. Historical simulation assumes that past portfolio behavior is a reasonable proxy for future portfolio behavior. This assumption can be hard to justify in the fairly nascent energy markets because of the limited availability of historical data and the evolving energy markets (e.g., planned expansion in capacity).

Monte Carlo simulation uses statistical parameters such as volatility and correlation derived from past time series of past changes in market factors to simulate future changes in these market factors. These simulated future market factors are used to generate random scenarios of portfolio value under each scenario. With enough scenarios, a full distribution of simulated portfolio values can be generated from which to estimate VAR. Monte Carlo simulation has an advantage over analytic VAR in that portfolio returns are not assumed to be normally distributed allowing for portfolio characteristics to include non linearity and optionality. On the other hand, Monte Carlo VAR is more computationally intensive due to the number of simulations and statistical parameters required.

Stress tests

Stress testing is another form of measuring price risk. Stress tests are scenario exercises to determine financial losses that might occur under **unlikely but plausible** circumstances. Traditional stress testing is conducted on a stand-alone basis and the stress test results are highly subjective because they depend on scenarios chosen by the stress tester. As a result, the value of stress testing depends on scenario choice and skill of the modeler. A related problem is that stress tests results are difficult to interpret because the scenarios are not probabilistic. Another challenge with stress tests is that stress test procedures are difficult to backtest (See Backtest below for further details). Hypothetical stress scenarios cannot be "validated" based on actual market events. In other words, even when the events specified in a hypothetical scenario actually occurs, there is usually no way to apply what was "right" and "wrong" in the scenario to other hypothetical scenarios to improve them.

Stress tests provide information about an organization's risk exposure that VAR methods can miss. VAR measures risks in the normal course of business and measures the maximum loss expected at a given confidence level over a given holding period but not the expected loss under extreme (i.e., fat tail) market conditions. Thus VAR and stress testing are complementary methods; taken together, VAR and stress tests can provide insight over the full probability distribution of portfolio value changes.

In order to achieve an integrated stress-VAR calculation, hypothetical high loss scenarios with assigned probabilities are added to the appropriate VAR number. Integrating probabilistic stress scenarios into the VAR model helps fill in "risk holes" and adds rigor to the risk measurement process.

Backtests

Backtesting is the comparison of actual transaction risk measure with model-predicted risk measure. If the comparison is close enough, the backtest raises no ~~modelling~~modeling issues. However, in some cases, the comparison uncovers sufficient variances that raise questions on ~~modelling~~modeling assumptions.

There is no industry standard on a single backtesting methodology. However, the Basel Committee on Banking Supervision has outlined a framework that attempts to strike a balance between recognized limitations of backtesting and the need for a mechanism to calibrate risk measurement models.

This section addresses the following risk analytic issues:

- *Should a VAR-based method be considered to measure drought risk?*
- *Is the current stress testing methodology reasonable?*
- *Should backtesting be performed to calibrate and validate model assumption?*

6.5.2.1 Leading Practices

KPMG considered the following leading practices in assessing MH's risk analytics:

VAR Models

- VAR *"provides a measurement technique to estimate risk of positions, financial assets, and transactions and intended to predict the potential future range in the MTM value of the forward portfolio, not future realized losses". (Source: "CCRO Valuations Whitepaper," November 2002, Vol. 3, pg. 10.)*
- *"The 'basic' level of exposure measurement is the ability to calculate a value-at-risk (VAR) type measure on a portfolio of transactions. This allows companies to at least obtain a basic quantification of market risk." (Source: "How to be top of the class", Energy Risk Magazine, August 2003, Vol. 8, No. 5, Brett Humphreys, pg. 1.)*

Stress Tests

A firm should be able to:

- *"regularly stress test all or parts of the firm's portfolio to estimate potential economic losses in a range of market conditions including abnormal markets. Corporate level stress test results should be discussed regularly by risk monitors, senior management and risk takers, and should guide the firm's risk appetite (for example, stress tests may lead to discussions on how best to unwind or hedge a position), and influence the internal capital allocation process and...*
- *regularly back test realized results against internal model generated market risk measures in order to evaluate and assess its accuracy. For example, a firm should keep a database of daily risk measures such as VAR...and use these to back test predicted profit and loss against actual profit and loss for all trading desks and business units, and monitor the number of exceptions from agreed confidence bands." (Source: "Senior Management Arrangements, Systems and Controls", FSA Handbook, Release 065, May 2007, Section 16.1.10, pp. 4 -5.)*

Backtests

- *"...when a model has been in use for a reasonable period of time, its results are tested against actual outcomes." (Source: "OCC Bulletin 2000-16, Risk Modeling and Model Validation", Office of the Comptroller of the Currency Bulletin, May 2000, pg. 6.)*

- The Basel Committee on Banking Supervision has issued the following suggested guidelines regarding a backtesting framework:

  - *"...develop the capability to perform backtests using hypothetical and actual trading outcomes."*

  - *perform "formal testing and accounting of exceptions on a quarterly basis using the most recent twelve months of data."*

  - *develop a three zone approach to classify backtest results, "distinguished by colours into a hierarchy of responses." The green zone corresponds to backtesting results that do not themselves suggest a model problem. The yellow zone raises model questions but are not conclusive. The red zone indicates a fundamental problem with the organization's model. (Source: "Supervisory Framework for the Use of 'Backtesting' in Conjunction with the Internal Models Approach to Market Risk Capital Requirements", Basel Committee on Banking Supervision, January 1996, pp. 6-7.)*

6.5.2.2 Analysis

Issue #1: Should a VAR-based method be considered to measure drought risk?

KPMG recognizes that VAR is a not a widely adopted measure by many utilities which is supported by the case studies of other electric utilities. Three of the utilities in KPMG's case studies explicitly stated that they did not use VAR as they do not view it is a relevant metric for their business. One utility cited that it does not use VAR as it is unable to liquidate an unknown commodity, and thus does not view it as a relevant metric. Another stated that it is a net short utility, and thus it is not a useful metric in its analysis.

However, there are relevant variations to VAR such as Earnings at Risk, Budget at Risk, Profit at Risk and Revenue at Risk that can have meaningful application to a utility model. For example, Bonneville Power Administration (BPA) calculates a Budget at Risk in order to monitor any impairment to its ability to pay the US Treasury on its outstanding debt in a given fiscal year. Many utilities acknowledge these VAR-based measures have potential application and are exploring these options to measure their market exposures associated with their energy positions.

A VAR-based measure is an alternative approach to measuring revenue exposure in the event of a drought but as with any modeling exercise, the outputs are a function of the underlying assumptions. KPMG recognizes that a VAR-based measure is a complex endeavor for a hydroelectric utility such as MH due to the operational complexities associated with managing water volumes. If MH was to consider implementing a VAR-based drought risk measure, key input data issues include:

- limited historical MISO pricing data (i.e., MISO launched DA and RT energy markets in March 2005);
- the historical worst case drought periods occurred prior to any extensive pricing data for MISO or MAPP; and
- the assumption that MH's asset portfolio remains constant over a five year holding period (a five year holding period is assumed based on the duration of the worst drought on record) arising from any VAR-based model's requirement for a static portfolio over the holding period.[23]

Issue #2: Is the current stress testing methodology reasonable?

In its 2007 Corporate Risk Management Report, MH defined its drought exposure equivalent to the cost of a repeat of the worst drought on historical record in the range of $2.2 to $2.5 billion. MH also quantified the financial impact of a one-year drought, similar to the worst year on record, occurring during the fiscal year ending 2008/09 as being in the order of $600 million.

MH has not assigned a probability to a drought period equivalent to 1937 – 1941, but views a drought event as high likelihood. As a result, MH may have adopted a conservative view in defining an extreme drought by selecting the period from 1937 – 1941 (the worst drought in historical record) as its scenario criteria for an extreme drought period. A detailed description of MH's stress testing calculation is presented in Chapter 4 Power Sales Management.

[23] *A five year holding period is assumed based on MH's current drought exposure analysis is based on a five year drought event. Utilities who have adopted a VAR-based measure assume a one year holding period so they can analyze financial exposures associated with the prevailing fiscal year.*

Because drought frequency and flow volumes can be observed in the historical record, probabilities can be developed in an objective manner. In a document filed during the course of MH's 2008 General Rate Application, MH estimated that a five-year drought might occur once every 50 years, based on the historical record.[24] Current assumptions on pricing, however, are subjective and not statistically derived. Thus, the stress test uses three discrete price forecasts (i.e., "high", "expected", "low") for both power and natural gas to develop three drought risk scenarios. To the extent that MH adopts a probabilistic approach (i.e., VAR-based measure) to measuring its drought risk, a single, integrated VAR-stress test can provides MH with an alternative estimate of its drought exposure.

As discussed in Chapter 2, equity is being set aside by MH to act as a buffer against an extreme drought event. MH's methodology is conservative and is consistent with how stress tests are performed by other utilities. Due to the conservative nature of MH's stress test scenario, the methodology appears reasonable.

While there is no industry consensus regarding stress test methodology, prevalent practices suggest stress tests represent "extreme" scenarios rather than catastrophic events. In fact, most banks with strict capital requirements calculate value-at-risk and economic capital thresholds using a two (95% confidence) or three (99%) standard deviation test rather than a doomsday scenario.

Organizations typically address catastrophic events through periodic and highly targeted brainstorming sessions where these events are inventoried and reviewed to determine what management action will be required.

Issue #3: Should backtesting be performed to calibrate and validate model assumptions?

As described in Chapter 3, MH personnel who operate the decision support models (i.e., HERMES, SPLASH, PRISM) are continually validating the models to reflect MH's system performance. The models are not independently validated using backtesting or alternative methodology to document validation results. Currently, only the select MH personnel who have a proficient understanding of the model logic and assumptions are conducting model verifications. As such MH is relying on the expertise and continued availability of these MH personnel in ensuring that MH models are kept up to date and appropriately calibrated, etc. (Please refer to Chapter 3 for a detailed discussion on MH models).

[24] *Source: Interrogatory Response: Coalition/MH 1-43, 2007 12 07.*

6.5.2.3 Recommendations

- MH should consider assigning probabilities to its drought stress scenarios in order to have an improved understanding of the financial losses associated with a likely extreme event. Should MH management act on its traditional stress test results? The answer is not definitive.

  MH calculates stressed loss numbers using stress tests and exercises professional judgment to develop associated risk management targets (e.g., a $2.5 billion retained earnings). However, this approach raises the potential risk that the corporation will develop remediation plans based on very unlikely scenarios. Assigning probabilities to the scenarios used in stress tests and incorporating these tests into a VAR-framework would provide MH with a better understanding of potential events' relative probabilities. In particular, a VAR framework allows consideration of impact and probability of other event combinations. As a result, MH should gain a better understanding of the full distribution of potential earnings outcomes. For example, MH would then be able to quantify a risk that, under a scenario of high electricity and/or natural gas prices, a drought of lesser magnitude would result in similar earnings variability.

- MH should consider developing a VAR-based method (e.g., Profit at Risk, Earnings at Risk, Revenue at Risk) to measure its drought exposure.

  Adopting a probabilistic approach to calculating drought exposure can provide MH additional information on retained earnings volatility and provide additional input for arriving at an optimal capital structure. In considering this recommendation, MH should consider the input data issues discussed in Section 6.5.2.2.

- MH should consider incorporating independent backtesting practices to validate internal market risk models.

  Backtesting should be applied to all models, current and prospective (e.g., VAR and long-term contract pricing models) and performed by a function independent of the front office (e.g., Middle Office).

6.5.3 Credit Risk Management

Credit risk management is the process of assessing, measuring, controlling and reporting credit exposures associated with a company's commodity transactions. Credit risk management combines professional judgment and mechanistic techniques to analyze, monitor, and report the credit exposures at both the counterparty and portfolio level.

Credit risk management attempts to mitigate total credit exposure and its components in the event of counterparty default.

Default covers a variety of scenarios (i.e., credit events)[25] including, but not limited to, the following:

- bankruptcy;
- insolvency;
- credit downgrade;
- contractual disputes;
- inadequate quality and untimely commodity deliveries;
- grace period defaults; and
- omitted, partial or delinquent payments.

Total credit exposure is comprised of the following two exposure types:

- Current Exposure
  - Replacement Cost (i.e., MTM)
  - Settlement Exposure
  - Pre-settlement
  - Settlement
- Potential Exposure.

A brief description of each credit exposure type is provided below.

Current exposure is the estimated financial loss that a company would incur if a given counterparty failed to perform its obligation under a given contract(s) today.

[25] *A credit event is material, objectively measurable and publicly disclosed.*

The current exposure amount is the sum of replacement cost and settlement exposure (net of any collateral held (in present value dollars).

Replacement cost or MTM is the unrealized **gain**[26] associated with an open contract's fair value. If a counterparty fails to perform, the company is required to purchase energy at current market prices greater than the contract price incurring credit losses. Alternatively, if the purchaser of an in-the-money power sale contract defaults, the seller must find a replacement purchaser at current market prices that are lower than the contract price.

Settlement exposure is the risk that a counterparty defaults subsequent to the company performing its obligation. Settlement exposure is comprised of two sub-components – pre-settlement risk (i.e., unbilled receivables); and settlement risk (billed receivables).

Potential exposure represents the measure of the potential change in credit exposure based on expected fluctuations in market prices (i.e., price volatility of the underlying commodity) over a given time horizon. Potential Exposure is equal to the Current Exposure plus a statistical estimate of expected changes in underlying commodity prices affecting the contract's fair value.

Varying methodologies are currently used to calculate potential exposure, most notably:

- Value-at-Risk (i.e., Credit Value-at-Risk)
- Stress Testing
- Scenario Analysis

Credit Value-at-Risk ("CVAR") and its various models are complex analytic tools to determine the portfolio's or counterparty's maximum credit exposure in "normal" market conditions over a given time period within a specified probability (i.e., confidence interval).

In general, Potential Exposure involves using historical data on market prices, volatility, correlation and interest rates, the current portfolio positions, and pricing models (e.g., option models) to determine fair market values for those positions. These inputs are then combined in different ways, depending on the method, to derive an estimate of a particular percentile of the distribution, typically between the

[26] *MH's current exposure related to future commodity deliveries is limited to contracts where the contracted price of commodity is favourable to the market price (i.e., in-the-money). Current exposure is zero when mark-to-market values are negative.*

95th and 99th percentile and an assumed holding period (i.e., the time it takes to liquidate the positions in the portfolio).

Total Exposure represents the maximum financial loss a company stands to lose assuming no recovery is collected when a counterparty defaults on its obligations (i.e., **worst case scenario**). Total exposure is calculated as the sum of two components – current; and potential exposure less any collateral held as represented in the Equation 1.0 below.

Equation 1.0: Total Credit Exposure

Total Exposure = [(MTM+A/R+CVAR) – (Net Collateral Held)]

This section addresses the following credit risk management issue:

- *Does MH measure credit exposure in a manner consistent with leading practices?*

6.5.3.1 Leading Practices

KPMG applied the following leading practices in assessing MH's credit risk measurement practices:

- *"Position replacement cost and collateral values should be measured both at market and estimated liquidation value." (Source: "Toward Greater Financial Stability: A Private Sector Perspective", The Report of the Counterparty Risk Management Policy Group II, July 2005, p.58.)*

- *"Exposure reporting and monitoring should cover all activities with a counterparty. At a minimum, accounts receivable, MTM, and accounts payable should be monitored on a daily basis." (Source: "CCRO Credit Risk Management Whitepaper," November 2002, Vol. 4, pg. 18.)*

6.5.3.2 Analysis

Issue #1: Does MH measure credit exposure in a manner consistent with leading practices?

Based on a review of a MH credit exposure report dated December 31, 2006, it appears that MH measures counterparty credit exposure on an accounts receivable basis only. MH adjusts its receivables exposure by the long-term average default probabilities as provided by Moody's and S&P. The resulting adjusted exposure is a close proxy to calculating expected losses.

Moody's and S&P default probabilities however vary based on time to default. In other words, using long-term default probabilities to adjust 30 day receivables may not always be a reasonable assumption. This practice overestimates MH's expected losses since long-term default probabilities are higher than short-term default probabilities. If MH wishes to adjust its receivables exposure by default probabilities, the time associated with outstanding receivables must closely match the time to default probabilities (i.e., essentially zero for 30 day receivables) corresponding to the respective credit rating.

Currently, measuring replacement cost using MTM valuation principles is limited to transactions under an ISDA agreement (i.e., financial transactions only). Replacement cost for physical transactions is not measured, and doing so would provide a more complete picture of potential future revenue losses in the event of counterparty default.

Based on a June 30, 2009 MH credit exposure report, the peak exposure during the quarter was $53.3 million CAD relative to $146.6 million CAD in total export sales (or 36% of total export sales). This percentage represents a third of total export sales and MH should note that it represents their **minimum** exposure since replacement costs are likely to increase total credit exposure.

Although replacement cost is not measured, MH monitors and measures counterparty exposure in a manner consistent with its transaction volume, complexity and sophistication. In addition, the majority of MH's credit risk management practices are consistent with other utilities who do not engage in speculative trading activities.

6.5.3.3 Recommendations

- MH's practice of adjusting its A/R exposure by long-term default probabilities is a conservative practice in estimating expected losses. Further, MH should consider augmenting its credit exposure calculations by incorporating MTM and Potential Exposure.
- Long-term export contracts expose MH to the greatest amount of potential credit risk rather than short-term opportunity, merchant and financial transactions. MH should consider investing more effort in measuring this exposure in order to develop appropriate risk mitigation strategies in a proactive manner.

6.6 Risk Control

Risk control is a set of tools to manage risks associated with energy transacting activities in a prudent manner. It is an important distinction to understand that risk controls do not reduce risk. Instead, controls represent how much risk an organization is willing to accept. Controls are a direct reflection of a company's risk tolerance defined as the "acceptable level of variation relative to achievement of a specific objective." *(As defined by COSO's Enterprise Risk Management – Integrated Framework, September 2004).*

This section assesses two common risk controls:

- risk limits; and
- transaction processing controls.

Risk limits are designed to manage the magnitude of variance in market and credit exposure. Transaction processing controls are designed to manage the magnitude of variance in operational costs associated with human error.

6.6.1 Risk Limits

The limits placed over market and credit risk are one of the most fundamental controls over an organization's trading and marketing activities. Organizations should establish limits for risks that relate to their risk measures (e.g., mark-to-market, value-at-risk, etc.) which are consistent with maximum exposures authorized by senior management and the board of directors. The established limit structure should apply to all risks arising from an organization's commodity trading and marketing activities.

Risk limits serve as the internal control mechanism over the market and credit risks associated with an organization's trading and marketing activities. Risk limits are dollar denominated or volume based values that: define boundaries of permissible trading activities; and, restrict unauthorized trading activities based on senior management's risk tolerances.

The purpose of a risk limit structure is to:

- mitigate large losses associated with adverse market movements;
- limit exposure to unrealized market and credit losses;

- ensure consistency between trading activity and strategic business objectives;
- promote the development of a diversified and controlled portfolio;
- allocate risk capital on a risk-adjusted basis;
- facilitate the evaluation of financial exposures against corporate risk tolerances; and
- empower an organization to engage in commodity trading and marketing activities within a pre-defined set of guidelines.

A conventional risk limit structure consists of: (1) market limits and, 2) credit limits. Market limits mitigate exposure to downside risk resulting from adverse market volatility and adverse price movements. Market limits typically include dollar stop-loss limits, VAR limits, position limits, trader limits, tenor limits and option limits. Credit limits mitigate potential losses from counterparty default. Credit limits are trade limits placed on counterparty activity. Credit limits are measured against current exposure, potential exposure and settlement risk exposure (see Section 6.5.3 for further detail).

This section addresses the following risk limit issue:

- *Does MH have appropriate market risk limits commensurate with PS&O "Power Related Transactions"?*

6.6.1.1 Leading Practices

KPMG applied the following standards in assessing MH's market and credit risk limit structure:

The limit structure represents maximum exposures authorized by senior management and the board of directors. Limit types should include:

- *volume limits, trader limits, stop-loss limits, VAR limits, and authority limits, position limits, tenor limits;*
- *liquidity limits (i.e., bid-ask spreads) to prohibit trading in illiquid instruments or geographies;*
- *limits reflecting stress testing and scenario analysis results; and*

- *the limit structure should include a reference to an "Authorization to Transact" appendix that specifically defines the authorized instruments, commodities, geographic regions, types and markets and tenors.*

(Source: "CCRO - Guidelines on Establishing a Risk Management Framework and Policy", February 2005, pp. 13-14.)

6.6.1.2 Analysis

Issue #1: Does MH have appropriate market risk limits commensurate with PS&O "Power Related Transactions"?

MH has specified risk limits in the MCP that are limited to the following "Power Related Transactions" activities:

- merchant transactions (Related or Pure Merchant)[27];and
- customer credit.

Merchant Transaction Limits
A summary of the Merchant Transactions limits (Quantitative and Qualitative) are highlighted in Exhibit 6-4. MH has also authorized "System Transactions" which are defined as *"system resources either owned by MH or those procured to meet its load obligations. When economic, System Transactions also include power purchase transactions to serve MH's export obligations, intended to be supplied by MH system resources. System Transactions include both energy and financial products. System Energy Products provide a physical supply while System Financial Products must be associated with an underlying physical position. System Financial Products are used to financially settle price for power related transactions or to manage risk on physical supply." (Source: MCP Schedule "A" dated Oct. 5, 2007).*

We note that risk limits have not been specified for System Transactions.

[27] *Related Merchant Transactions involve the resale of power purchased from third parties, and which either flows over transmission owned or reserved by/for Manitoba Hydro, or was purchased for Manitoba Hydro system requirements and has subsequently been deemed surplus.*

Pure Merchant Transactions involve the purchase of power by Manitoba Hydro from one or more parties for resale to one or more parties.

Exhibit 6-4: Summary of Merchant Transaction Risk Limits

Quantitative Limits

Summary of Merchant Transaction Limits			
Limit Type	**Related Merchant**	**Pure Merchant (3)**	**Leading Practice**
Stop Loss	$250,000 (1)	$500,000	Yes
Option Greeks (2)	NA	NA	Yes
VaR	NA	NA	Yes

(1) This stop loss limit has been proposed by PS&O to the PSOMC in a memo dated Jan. 30, 2009. Currently, a stop loss limit has not been specified for Related Merchant transactions.

(2) Greek limits mitigate exposures to adverse movements in options value given a movement in the price of the underlying asset (Delta); rate of change in price of the underlying asset (Gamma); price volatility of the underlying asset (Vega); and time to expiry (Theta).

(3) No Pure Merchant transactions have occurred from 2005 through Jan. 2010. Per the PS&O Division Manager, there are no intentions to engage in Merchant Transactions in the immediate future.

Qualitative Limits

Summary of Merchant Transaction Limits			
Limit Type	**Related Merchant**	**Pure Merchant**	**Leading Practice**
Volume	800 MWh (1)	NA	Yes
Net Position	0 GWh (1)	NA	Yes
Tenor	3 days	3 days	Yes

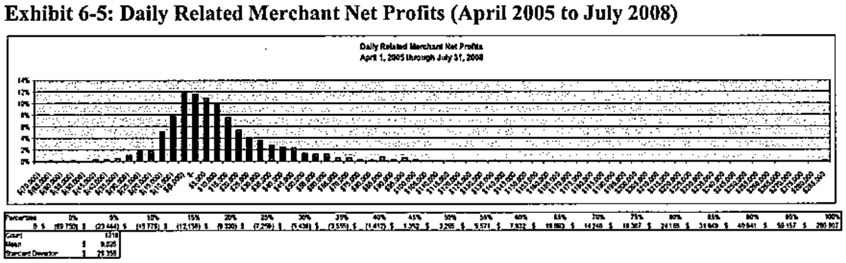
(1) The MCP does not specify a volume limit and specifies a net position limit of 1,000 GWh. In a memo dated Jan. 30, 2009, PS&O has proposed to the PSOMC new volume and net position limits.

In addition to the market risk limits summarized above, MH has established the following trading parameters:

- Fixed price to fixed price transactions may be entered into only if there is a positive profit margin.
- All merchant transactions shall have a maximum duration of six months.[28]
- All transactions must have a positive expected value.
- Long-term wholesale power transactions shall not result in MH's forecast peak or firm energy demand contravening the documented capacity criteria during the contract term.

MH's market risk limits apply to its relatively low risk merchant activities. Based on a historical analysis (performed by PS&O) of the risk exposure for Related Merchant ~~transactions~~Transactions, net profits totalled $10.6 million since April 1, 2005. The profits represent a return of 58% on total transmission investment over the period. In Exhibit 6-5, the distribution of daily returns is characterized by many small positive returns and infrequent, yet extremely large returns. The maximum daily loss has been $70,000 and the maximum daily profit has been $285,000. The average trading volume has been approximately 2,400 MWh / day or 100 ~~Mwh~~MW / day.

Exhibit 6-5: Daily Related Merchant Net Profits (April 2005 to July 2008)



Source: PS&O Memo to PSOMC dated Jan. 30, 2009 titled "Related Merchant Transactions – Trading Volume Limits and Associated Amendments."

Despite the relative low risk of Related Merchant Transactions, MH recognizes that it is still exposed to significant losses under certain circumstances. A worst case scenario was performed using 800 MWh / day (maximum volume limit) under unfavourable Ontario – MISO price spreads for a three hour period. VAR under 95% and 99% confidence intervals were calculated at $92,579 and $159,122, respectively.

---

[28] *Under normal water flow conditions, the tenor limit is three days. Under drought conditions, the tenor limit is six months.*

Based on PS&O's historical performance analysis of its Related Merchant trading, the proposed Stop Loss limit of $250,000 appears reasonable. MH's limit structure does not appear to have a VAR limit defined. Additionally, somewhat less importantly, Options limits are also not defined. MH's option transaction volumes are limited to hedging physical natural gas purchases, which are executed in drought periods only. However, to the extent that Options are an authorized product and occasionally executed, MH should consider developing commensurate limits.

Customer Credit Limits

MH's customer credit limit structure is documented in the "Manitoba Hydro Credit Worthiness" dated May 31, 2001. A summary of MH credit limits are highlighted in Exhibit 6-6.

Exhibit 6-6 Summary of MH Credit Limits

Credit Limits

Summary of Credit Limits			
Limit Type	**Merchant**	**System**	**Leading Practice**
Counterparty	Yes	Yes	Yes
Receivables	Yes	Yes	Yes
MTM	No	No	Yes
Current Exposure	No	No	Yes (1)
Potential Exposure	No	No	Yes (2)
Concentration	No	No	Yes (2)

(1) Some companies have established separate A/R and MTM limits to control each exposure type. Separate A/R limits control slow pay or delinquent payment behavior. MTM limits control the replacement cost of in-the-money contracts held by the company.

(2) More sophisticated and larger energy companies have a more comprehensive credit limit structure that include Potential Exposure and Concentration Limits.

As mentioned in Section 6.5.1 Mark-to-Market, MH does not mark its short-term and long-term physical positions. However, as of July 2007, MTM is calculated for three counterparties under ISDA agreements. Based on a MH credit exposure report dated June 30, 2009 there were no transactions outstanding or executed under current ISDA agreements. Aside from the three ISDA agreements, replacement cost is not measured.

In order to provide an understanding of the credit exposure calculation, an example of measuring settlement and MTM exposure against the total counterparty limit is provided in example below.

Example: Counterparty exposures against limits

On March 7, 2010, Utility ABC sells 100 MW, 7 X 24 electricity at $35/MW to Counterparty XYZ for five years with delivery beginning April 1, 2010. An enforceable netting agreement between Utility ABC and Counterparty XYZ exists and Counterparty XYZ has posted a $3,500,000 Letter of Credit ("L/C") issued by a Canadian bank rated "A" by S&P. Counterparty XYZ is rated BBB without the credit enhancement. Based on Counterparty XYZ's net worth and the L/C, it has received an unsecured credit line of $10,000,000 from Utility ABC.

Counterparty XYZ currently has $500,000 in outstanding accounts receivable and net unbilled payables of $365,000 with Utility ABC. On March 8, 2010, the forward curve for 7X24 baseload power is a flat $36/MW for the same five year period. The credit exposure is calculated in the following manner:

Counterparty XYZ Rating	A/R		Prompt Month Sales		Prompt Month Purchases		MTM		Potential Exposure		Collateral Held		Total Exposure	Credit Limit	Available Credit Limit
BBB	(a)	+	[(b)	-	(c)]	+	(b)	+	(c)	-	(d)	=	(e)	(f)	(e) - (g)
	$500,000		$165,000		$515,000		$4,380,000		$3,285,000		$3,500,000		$4,315,000	$10,000,000	$5,685,000

MTM = 100 MW *24 hrs*5yrs*365*(36-35)=$4,380,000
Potential Exposure = $3,285,000*
* Assumes 99% confidence interval, one day holding period, and historical volatility of 80%.
An 80% volatility results in an additional $.75/MW price increase to $36.75/MW and resulting MTM of
An 80% volatility is the worst case scenario within the 99% confidence interval.

This example is for illustrative purposes only

As the example illustrates, MTM exposure and Potential Exposure can be significant and typically greater than outstanding A/R. In the event a counterparty defaults and MH holds an "in-the-money" short or long-term sales contract (i.e., market prices are lower than sales price), future revenue is adversely impacted. If a counterparty defaults on a long-term export contract, future revenue can be impacted for the period of time it would take to find another creditworthy purchaser.

Another gap in MH's limit structure is the absence of a concentration limit. From December 2006 through June 30, 2009, MH's greatest exposure lies within the BBB credit rating as highlighted in Exhibit 6-7.

Exhibit 6-7: Export Sales by Credit Rating for Quarter ending December 31, 2006 and June 30, 2009

Source: derived from Manitoba Hydro data

6.6.1.3 Recommendations

- MH should consider developing a VAR limit for its Related Merchant Transactions.

  It is apparent that MH has the foundational understanding and analytical capability to implement a VAR limit. Calculating VAR based on actual market prices and comparing it against actual Related Merchant profit and losses may provide meaningful insight into the relative low risk of ~~related merchant transactions.~~Related Merchant Transactions. However, MH management should not interpret the VAR calculation as a comparison of potential exposures against a defined limit.

  For a meaningful VAR application, a VAR limit should be developed and compared against MTM gains and losses, not a stop loss limit.

- MH should consider developing Options limits for its options transactions.

  Options limits are not an urgent issue given the transaction activity is limited to drought periods and transaction volumes are minimal. However, options are complex instruments and under volatile market conditions, can add incremental risk rather than hedge it. Since options are an authorized product under the MCP, commensurate limits should exist consistent with MH management risk tolerance.

- MH should consider establishing counterparty concentration limits.

Historically, the probability of counterparty default is very low. However, management should consider establishing concentration limits in order to manage and monitor portfolio concentrations in certain credit ratings (e.g., BBB).

6.6.2 Transaction Processing Controls

Transaction processing controls refer to the operational controls that preserve data integrity throughout the transaction lifecycle. The lifecycle begins with the origination of a physical or financial energy transaction and ends with transaction recording into the accountings system. This lifecycle does not apply to long-term energy sales contracts as they follow a unique set of operational steps and processes (See Chapter 4 Power Sales Management for further detail). The analysis in this section focuses on three predominant transaction types executed by Power Trading:

- Real Time;
- Day Ahead; and
- System Merchant.

PS&O departments are responsible for performing various transactional processes:

- Power Trading is responsible for initiating and executing short-term power trades; and
- Business Services is responsible for confirmations, settlements and accounting.

Each department reports to the PS&O Division Manager. Business Services reports to the PS&O Division Manager in order to provide efficient operational support. In order to preserve segregation of duties, Business Services reports administratively to the Controller.

This section describes MH's transaction lifecycle, together with the transaction processing controls currently in place. Our understanding of controls is based on the controls documented in the WebTrader Summary of Trading Process documents, internal audit reports, and the MCP. A summary of the transaction processing controls at each stage of the lifecycle is included in Exhibit 6-8.

Exhibit 6-8: Summary of Transaction Processing Controls

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

▪ Determination of energy position:
  ▪ Internal analysis
  ▪ Strategy meetings
  ▪ External inputs
▪ Determination of 'value of energy curve':
  ▪ Historical prices
  ▪ Gas prices
  ▪ Internal analysis
▪ Management approvals of:
  ▪ Value of energy curve
  ▪ Trading strategy
  ▪ Bid submissions
	▪ Through pre-negotiated agreements only
	▪ Execution telephone calls recorded for verification
	▪ Each trader has transaction limits and authorities
		▪ Deal entered into webTrader
		  ▪ Verification checks and system limits control inputs
		▪ webTrader tracks any changes made to deals and deal deletions
		▪ Electronic tag is created, includes:
		  ▪ Transmission path
		  ▪ MW volume
		  ▪ Duration
		  ▪ Marketers involved
			▪ Generator and transmission provider approves deal before energy flows
			▪ MH and counterparty monitor IESO dispatch reports for deal tag
			▪ Analysts and traders review all day-ahead deals for accuracy
			▪ Log of counterparty communication maintained
			▪ Conversations with counterparties recorded for verification
				▪ Confirmations sent to non-market counterparties weekly
				▪ Confirmation of deal terms executed on a recorded phone cal prior to execution of written agreement
					▪ Billing Support Officer responsible for daily trading settlements
					▪ Billing Officer responsible for adjustment recording and invoice preparation
					▪ Formal actualization performed by System Control Centre
					  ▪ Ensures energy flowed matches energy scheduled
						▪ Day-ahead decision analyzer balanced to webTrader to ensure all purchases, obligations, etc are captured
						▪ Shadow invoice created to compare to IESO/MISO invoices
						▪ Manual checks of invoices to internal spreadsheets
						▪ Paper contract details matched to webTrader contract details

Pre-Deal Analysis
Pre-deal analysis begins with determining energy positions and prices by Power Trading.

The analytical tools and transaction controls used in this process differ for day-ahead, real-time and merchant trades. There are several aspects of the pre-deal process where risks are mitigated through transactional controls.

Day Ahead Traders monitor energy positions and prices through weekly management meetings, as well as daily trader strategy meetings. Energy positions are determined by analyzing various parameters, including:

- weather forecasts;
- MISO, IESO & Alberta Electric System Operator (AESO) load forecasts;
- MH load forecasts;
- genscape-generation status across Canada and U.S.;
- available transmission;
- water sheets;
- Day Ahead Traders' water optimization spreadsheet;
- the water graph maintained on WebTrader and the EXCEL spreadsheet which projects out one month; and
- the MISO Day II Locational Marginal Pricing (LMP) Tool.

In order to determine the range of prices that are allowable to buy/sell energy in the Day Ahead market, a "value of energy" price curve (i.e., forward curve) indicating the maximum buy price and minimum sell price for each hour is calculated by Power Trading. The curve is developed based on inputs from the following sources:

- MISO market clearing prices from the previous day;
- WebRTO;
- Intercontinental Exchange (ICE);
- Pattern Recognition Technology;

- PROMOD; and
- natural gas prices.

Real Time Traders use a tool known as the Supply and Demand Planner (within WebTrader) to help them balance MH's power supply and demand. This tool calculates the physical capacity position by hour, for up to seven days into the future. The Supply and Demand Planner provides the following information:

- hourly MHEB generation capacity;
- load forecast and load forecast adjustments;
- operating reserves;
- regulating margin;
- actual load, purchases, sales, net transactions, net available resources;
- System Control Centre net MW surplus;
- temperature; and
- existing power deals.

Real Time Traders also review the available transmission and the daily water pricing spreadsheet from the Day Ahead Traders. This analysis allows the Real Time Traders to identify the optimal market (MISO, AESO or IESO) or counterparty.

In order to assess the strategy performance, the Power Trading Supervisor (Real Time Sales) reviews reports from the Real Time desk and the Supply and Demand Planner throughout the day to ensure staff are optimizing the system. In addition, the P&L is monitored daily to determine whether the current strategy is appropriate.

System Merchant Traders use IMO trends, IESO similar day, the bidding strategy spreadsheet, the price pivot spreadsheet and Price Band when making their trading decisions.

For each transaction type, the inputs used in determining the optimization strategies are developed by parties independent from Traders.

Review and approval of key trading reports is the second step. The Power Trading Supervisor (Term Power Sales) reviews various reports for Day Ahead performance, including: P&L Statement, Daily Credit Report, Trade Violations screen, and the Day Ahead Trading Report. Additionally, the value of energy curve is reviewed daily by the PS&O Division Manager.

Deal Execution

MH executes standard Master Agreements and Market Participation Agreements to minimize deal execution risk. Master Agreements govern bilateral power transactions and Market Participation Agreements govern ISO transactions such as MISO and IESO. MH does not undertake transactions with customers who do not have an executed Master Agreement in place.

In order to monitor the trader's activities, deal input is restricted to traders and each trader transacts within their respective individual transaction limits and delegated authorities outlined in the MCP (Approval Authority for System Energy Products). These limits are configured into WebTrader to control unpermitted activities.

As an additional control, all transactions are executed on a recorded telephone line to allow investigations of any transaction discrepancies or counterparty disputes.

Deal Capture and Amendments

During the deal capture and amendment process, WebTrader serves as MH's official system of record. Entering a transaction into WebTrader requires supervisory authorization in addition to checking counterparty credit limits, and the transaction's delivery dates, quantity and term details. An audit trail of any deal changes is captured in WebTrader. Deal modifications in WebTrader [prior to confirmations] can only occur when a reason is entered into the system by authorized front office personnel. Any cancelled / deleted deals appear on the deal summary and violation screen which is reviewed by the Trading Supervisor daily.

Regarding System Merchant Transactions, deals are initially recorded into a spreadsheet (i.e., the profit allocation calculation) and subsequently re-entered into WebTrader. The reason for the dual entry process is that WebTrader does not currently have the system functionality to calculate the profit allocation between Tenaska and MH.[29] Both Internal Audit and PS&O recognize the potential for human error and an initiative to enhance WebTrader is under development by PS&O's Market Process and Technology Department.

[29] *MH has four unique profit sharing agreements with Tenaska. Three are firm transmission positions and the fourth is not. For the three firm contracts, MH will buy power from MISO in the DA (or RT) market via Tenaska and sell power to the IESO in the RT market. The profit on the sale to IESO will be shared in accordance with Tenaska's participation rate. The fourth contract involves RT Trading to try and earn a spread between MISO and IESO markets.*

All physical deals require an electronic "tag" (e-tag) for scheduling purposes. As part of the deal capture process, MH traders monitor the IESO dispatch report every hour to identify deals requiring e-tags. Traders create e-tags in WebTrader's tagging system. E-tags include information on the transmission path, MW volume, duration, marketers involved and any line losses. Power schedules cannot be accepted by the IESO without proper e-tags.

Deal Validation

In order to ensure deals are recorded accurately power trading analysts and day ahead power traders review all DA deals. They also review any deals rejected by MISO to check for the reasonableness of rejection and to ensure that tags are cleared to ensure that power is not released for cancelled deals.

For verification purposes, MH maintains a log of counterparty communication and maintains a record of all phone and chat room conversations with counterparties.

Confirmation

Energy contracts with terms less than two weeks with delivery within the next two weeks do not require a written confirmation. These transactions are executed using either MH's recorded telephone lines or approved on-line electronic trading platforms (e.g., ICE, MISO) using MH equipment.

Transaction confirmations are sent to counterparties who MH has executed physical bilateral and financial transactions (under an ISDA agreement). Transaction provisions to be confirmed by the parties include: transaction term, product, point of delivery, price and quantity.

Settlement and Accounting

Several controls are in place at MH to ensure trades are recorded accurately, including the following:

- The month-end journal entry is reviewed by the Billing Coordinator or Business Services Department Manager prior to being uploaded to SAP (i.e., the General Ledger).
- The Billing Officer runs the WebTrader MISO Settlement Discrepancy Manager to reconcile/isolate any discrepancies between WebTrader and the MISO settlement statement. Any discrepancies are tracked on a dispute tracking spreadsheet.

- During the settlement process, a trader is unable to change any terms or provisions without Billing and Settlement's approval in the system.
- The accounting system places a lock on WebTrader at month-end to ensure no further changes take place during the reconciliation between the data uploaded to the G/L and WebTrader.
- A spreadsheet of PSOMC FTR bid approvals is maintained by Billing and bids are compared to invoices to address any discrepancies.
- The Business Services Manager periodically reviews the FTR bid approval spreadsheet.
- For MISO FTR activities, Billing receives weekly invoices and reconciles these with shadow settlements. The Billing Coordinator compares shadow settlements with invoice before approving the invoice.

MH segregates the daily trading settlement function (Billing Support Officer) and the adjustment recording and invoice preparation functions (Billing Officer). This provides an additional control as the Billing Officer provides an additional check on the work conducted by the Billing Support Officer.

Reconciliations

There are several controls in place to ensure that information has been documented correctly at MH.

- To ensure that all generation resources, power purchases, obligations, etc., have been entered into WebTrader, MH balances the DA Decision Analyzer to WebTrader on a daily basis. This reconciliation is signed off by the Power Trading Supervisor or Department Manager.
- To ensure that accurate billings have been generated, a shadow invoice is created in WebTrader and compared to the final invoice from IESO and MISO.
- The Billing Officer manually compares the Extra-provincial Sales/Purchases Report (from WebTrader) to the balances in SAP.
- MISO invoices are also reconciled to the settlement worksheet and the market net invoice and the administration fee invoice is reconciled to the settlement worksheet.

- Billing manually compares the Excel spreadsheet of PSOMC FTR approvals to actual FTR positions.
- To ensure that correct contract terms are documented, one of the Billing Officers compares the paper contract details to the contract details within WebTrader during its month-end procedures.

The process for reconciliations has been continually advanced since the 2006 review and recommendations for further enhancements are in the recommendations in Section 6.6.3.2.

6.6.3.1 Leading Practices

KPMG considered the following leading practices in assessing transaction controls:

"*Before a deal is executed, senior management works with the front office to establish strategies that develop the business in alignment with the risk/reward profile of the company. The front office then executes deals that satisfy that strategy. More complex or long-term deals may require additional structuring or pricing to assess their true value. If a deal is within defined limits and the terms are approved, a contract is put in place. The deal is then executed with the counterparty and the terms are captured in a system. The deal is then assigned to a portfolio for ongoing management over the term of the deal as market conditions change. If a deal requires the movement of a physical commodity, the front office schedules product flow with a transportation provider.*

After a deal has been executed and captured, the middle office must independently verify the accuracy of the terms through system reconciliations, third-party confirmations, and risk analytics. These processes serve as key control functions over the deal execution process. The credit and contract administration groups will also monitor the deal over its life, ensuring that contract provisions are maintained and credit risk managed. Once the deal has reached its term and the contract provisions have been satisfied, the back office will settle the deal (i.e., resolve discrepancies and invoice the counterparty) and book the appropriate entry in the financial records." *(Source: CCRO Organizational Independence and Governance Working Group, November 19, 2002 pg 16.)*

6.6.3.2 Recommendations

MH employs a wide range of control mechanisms throughout the power sales transaction process that provide reasonable assurance that operational risk is

managed. Based on KPMG's experience with peer utilities, MH transaction controls are consistent with prevalent practices. In comparison to leading practices, MH would benefit from the following:

- Update documentation regarding FTR settlement and the reconciliation processes to reflect practices currently in place. In reviewing procedural documentation on the FTR process, KPMG observed that the current reconciliation process for FTR has not been updated in the procedural documentation.
- Continue efforts to eliminate the redundant deal entry process related to System Merchant transactions.
- The profit allocation calculation related to System Merchant transactions (i.e., Related Merchant) is performed by the front office. KPMG recommends that the back office verify the profit allocation calculation to ensure P&L performance monitoring is independent.

6.7 Risk Reporting

Risk reports are regularly disseminated throughout an organization to convey exposures and business unit performance to executive management, the risk management committee and the Board of Directors. A meaningful package of risk reports summarizes portfolio positions, market and credit exposures against limits, financial performance and probabilistic risk measurement. Risk reports are typically generated and prepared by an independent function (e.g., middle office) in order to ensure objectivity and accuracy.

Effective risk reports are in a format that can be easily read and understood by executive management and the Board. Leading companies have developed user-friendly reports that present information in a consistent manner.

This section describes our assessment of risk reporting for power sales. A timely, comprehensive suite of risk reports are designed to help management monitor and make informed decisions regarding market, credit, drought and operational exposures.

6.7.1 Adequacy of Risk Reporting

This section addresses both adequacy of existing reports and the productions standards in place at MH as compared to leading practices. In this section we address the following risk reporting issues:

- *Are MH risk reports comprehensive?*
- *Are reports accurate and complete?*
- *Do current variance reports adequately present actual versus forecasted data?*

6.7.1.1 Leading Practices

KPMG considered the following leading practices in assessing MH's risk reporting:

- *"The role of management information should be to help govern a firm's governing body and senior managers to understand risk at a firm-wide level. Doing so should help them determine if the firm is prudently managed with adequate financial resources; make decisions that fall within their ambit (for example, the high level business plans, strategy and risk tolerances of the firm); and oversee the execution of tasks for which they are responsible." (Source: FSA-Senior Management, Arrangements, Systems and Controls-SYSC 14-Prudential risk management and associated systems and controls Section 14.1.47).*

- *"The management information that is provided to a firm's governing body and senior management has the following characteristics:*

  It should be timely, its frequency determined by factors such as: the volatility of the business in which the firm is engaged (that is, the speed at which its risk can change); any time constraints on when action needs to be taken; and the level of risk that the firm is exposed to, compared to its available financial resources and tolerance of risk;

  It should be reliable, having regard to the fact that it may be necessary to sacrifice a degree of accuracy and timeliness; and it should be presented in a manner that highlights any relevant issues on which those undertaking governing functions should focus particular attention." (Source: FSA-Senior Management, Arrangements, Systems and Controls-SYSC 14-Prudential risk management and associated systems and controls Section 14.1.49).

Exhibit 6-9 describes the leading practice regarding power risk reports generated and the frequency of reporting. Leading practices indicate that these reports are originated by the risk management group on a daily and monthly basis. Reports are typically circulated to the Board of Directors, CEO, CFO, CRO (or equivalent), the Risk Management Committee, and Business Unit Leaders, and front line management.

Exhibit 6-9: Leading Practices in Risk Reporting

Leading Practice Reports	Contents
Position Reports	Net position by: - Commodity - Region - Counterparty - Tenor
Financial Performance Reports	Realized and unrealized gains and losses by: - Risk book - Commodity - Trader
VAR Report	Probabilistic market exposures by: - Risk book - Commodity - Trader - Transaction
Exposure vs. Limits Report	Market exposures vs. limits
Limit Violation Report	Limit exceptions with rationale and corrective action
Stress Testing Report	Potential market exposures under extreme market conditions
Credit Exposure Report	Counterparty exposures vs. limits

Source: CCRO, CCRO0-Volume 2 of 6 Governance and Controls November 19, 200 pp. 41-43.

6.7.1.2 Analysis

Issue #1: Are MH's risk reports comprehensive?

Exhibit 6-10 lists the reports currently used at Manitoba Hydro to communicate short and long-term power trading activities. Exhibit 6-10 provides a summary listing of MH's current management reports highlighting each report's:

- summary of contents;
- report origination;
- report recipients; and
- frequency of reporting.

Exhibit 6-10: Summary of Manitoba Hydro Management Reports (sorted by Report Origination)

Summary of Manitoba Hydro Risk and Management Reports				
Report Name	**Summary of Contents**	**Report Origination**	**Report Recipient**	**Frequency**
Day Ahead Trading Report	Financial and physical positions for day ahead trades	Power Trading	Power Trading Supervisor	Daily
FTR Position Report	FTR cost vs.revenue	Power Trading	PSO PSOMC	Monthly Monthly
Credit Exposure and Exception Report	Credit exposures and exceptions by counterparty	Export Power Marketing	PSO Management EPRMC (exceptions)	Monthly Monthly
Wholesale Power Transactions Credit Report	Credit exposure Export sales by credit rating	Export Power Marketing	EPRMC	Quarterly
Monthly Middle Office Report (first report issued June 2008)	MISO market conditions Executed ST transactions Surplus energy/forward position Related merchant transactions	Middle Office	EPRMC	Quarterly
Transaction Compliance Report	Policy exceptions	Middle Office	EPRMC	Quarterly
Activities Report	YTD power sales and expenses Portfolio summary	Business Services	PSO Management	Monthly
Export Power Sales and Expenses Report	Export power sales Power purchases Net export revenue	Business Services	PSO Management PSOMC EPRMC	Monthly Quarterly Quarterly
Export Power Sales and Expenses Summary	Summary of export power sales and expenses	Business Services	Corporate Accounting	Monthly
Transaction Performance Report	Opportunity and merchant transactions versus market prices	Business Services	PSO Division Manager EPRMC	Monthly Quarterly
Management Report	Financial data for power purchases and sales	Corporate Accounting	PSO Management Sr. VP Power Supply Executive Committee	Monthly Monthly Monthly
Supply Value at Risk Variance Analysis	IFF variance analysis	Hydraulic Operations	EPRMC	Quarterly
Energy Resource Review and Outlook Report	IFF variance analysis	Hydraulic Operations (input from Bus Svcs)	Executive Committee MH Senior Management	Monthly Monthly
Forecast Generation Costs and Interchange Revenue Report	Year one and two forecast of generation costs, export and import revenue	Hydraulic Operations	PSO Management Planning Review Committee Executive Committee	Annual Annual Annual
Forecast Generation Costs and Interchange Revenue Report	Years three to eleven forecast of generation costs, export and import revenue	Resource Planning and Market Analysis	PS Management Planning Review Committee Executive Committee	Annual Annual Annual

Source: KPMG compiled from Manitoba Hydro data.

The following Exhibit 6-11 compares MH's risk reports to leading practice reports.

Exhibit 6-11: MH's Risk Reports by Leading Practices

Leading Practice Reports	MH Reports
Position Reports	Monthly Middle Office Report Activities Report Day Ahead Trading Report FTR Position Report Energy Resource Review and Outlook
Financial Performance Reports	Export Power Sales and Expenses Transaction Performance Report Management Report Forecast Generation Costs & Interchange Revenue
VAR Report	Not Applicable
Exposure vs. Limits	Does not exist
Limit Violation Report	Credit Exposure and Exception Report
Stress Testing Report	IFF
Credit Exposure Report	Credit Exposure and Exception Report Wholesale Power Transactions Credit Report

Source: KPMG analysis

As seen in Exhibit 6-11, MH reporting is generally consistent with leading practice except in the area of "Exposure vs. Limits" reports. An Exposure vs. Limits report is a key risk report that MH should consider developing to monitor the market exposures related to System Merchant transactions. Since a Stop Loss limit has been proposed for this transaction type, a report to present exposures (i.e., realized gains and losses) vis-à-vis the limit would be helpful for performance and compliance monitoring purposes.

Issue #2: Are risk reports accurate and complete?

Overall, MH quality assurance and controls appear to be sufficient to ensure accurate and complete reports. The reconciliations performed to ensure accurate and complete reports are documented in Section 6.6.2.

Issue #3: Do current variance reports adequately present actual versus forecasted data?

Variance reports are produced to compare actual against forecasted data. Overall, we find that MH prepares variance reports for all of its forecasted data in adequate detail and structure. Our finding is based on an analysis of the following variance reports produced by MH.

- The Preliminary Variance Report - prepared by Hydraulic Operations with input from Business Services. This report compares the annual IFF versus actual revenues. Variances are included for dependable trades, opportunity trades, other revenues, purchase costs, thermal costs, water rental costs and other transmission costs. Business Services is responsible for validating the accuracy of the "actual" numbers through the reconciliation process outlined above. Hydraulics and Business Services coordinate to provide explanations for the variances. This analysis is reviewed by the Division Manager of PS&O and distributed to the Senior Executives, Division Managers and a number of other Managers.

- The Preliminary Variance Report is created annually and describes variances between the annual IFF and actual results. Additionally, it provides the details that were in the preliminary analysis and related to energy in reservoir storage, water supply conditions and energy supply outlook.

- The Monthly Management Report - includes an operating forecast variance analysis, capital forecast variance analysis, revenue and consumption variance analysis and explanation for MH's 25 largest customers.

- A Supply Variance Analysis Report - is created~~,~~ quarterly, or more frequently on an as needed basis (e.g., if there are material changes to the IFF which cause MH to re-forecast its revenue). This report is provided to the EPRMC.

6.7.1.3 Recommendations

MH produces a wide range of risk reports that provide useful information to line managers and the EPRMC. Based on KPMG's experience with power utility reporting processes, this is consistent with prevalent practices. When compared to leading practices, MH provides most of the recommended reports. However, MH would benefit from the following additional risk reports to make its suite of risk reports more comprehensive.

- A report detailing market risk exposures versus limits. Exposure reporting on a daily and monthly basis will allow ~~traders and~~ management to monitor ~~trading~~that transaction exposures are within management risk tolerances. Any limit exceptions would be identified and reported to MH senior management and the EPRMC.

- Stress testing reports analyzing MH's portfolio risk exposure under a variety of scenarios. These reports would help with strategic planning, risk capital allocation and portfolio management.

- Additionally, with the exception of the Day Ahead Trading Report, MH does not produce any daily risk reports. MH may benefit from increasing the frequency of risk reporting to help ensure early identification of risk management issues and to keep traders apprised of their individuals positions and limits.

6.8 Conclusion

With respect to power risk management, based on our analysis, we conclude that MH demonstrates prudent risk management with the following risk management practices:

Formatted: Space After: 6 pt

- Extensive corporate oversight and a deliberate internal review process related to major export contract term sheets;
- Conservative stress testing assumptions and methodology;
- Transaction processing controls consistent with prevailing practices to mitigate human error and operational risk;
- Compliance and risk monitoring performed by an independent middle office; and
- Comprehensive suite of management and performance reports.

In light of these prudent practices, MH will continue to strive to keep pace with the dynamic energy markets and will identify opportunities to improve theirits risk management capabilities. MH may consider the following recommendations:

- Revise long-term contract policies stipulating Middle Office participation in the internal review process of major export contract term sheets;
- Develop formal identification of all significant risks in policies and procedures;
- Measure market risk exposure for short-term physical positions in its trading portfolio and evaluate the benefits associated with valuing its long-term contracts;
- Consider a probabilistic measure (e.g., Revenue-at-Risk) as an alternative tool to further understand potential drought exposure;
- Develop risk limits commensurate with authorized trading activities and products; and
- Develop risk exposure monitoring reports for compliance purposes.

7. Conclusion

7. Conclusions and Recommendations

This Chapter summarizes our conclusions and our key recommendations from the previous chapters, followed by key highlights.

7.1 Conclusions

The utility industry has undergone significant change in the last decade, including deregulation in some jurisdictions, the introduction of competitive energy markets across Canada and the United States, heightened environmental attention, fluctuating economic conditions and a continued focus on security of supply at reasonable prices for ratepayers.

Taken together, these factors have significantly added to the complexity of managing risk. Most utilities are continually adapting their risk management practices to these changing circumstances.

Like its peers, Manitoba Hydro is subject to the impacts of these changes. Accordingly, Manitoba Hydro's operations have become, and will continue to be, more complex than ever before. This will continue to require further advancements in its modeling capabilities, export power sales practices, corporate risk governance, and power risk management practices.

Manitoba Hydro has well established practices in place and a number of initiatives underway to improve its risk management practices. Many of our key findings reflect recommendations Manitoba Hydro should consider in further improving these practices.

- With respect to the modeling approach at Manitoba Hydro, we conclude:
  - Manitoba Hydro has developed a suite of models that capture the key characteristics of the Manitoba Hydro system. These models are used to help optimize system operations and to support long-term capacity planning.
  - We are satisfied that Manitoba Hydro has taken appropriate care and due diligence in developing and maintaining these models and in using them in its operations planning process.

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

- Manitoba Hydro's current approach to forecasting and to calculating dependable energy appears reasonable and is consistent with practices at other North American hydroelectric utilities. It is reasonable to rely on historical flow data for estimating dependable energy.

- With respect to long-term contracting for export power sales, it is our opinion that:
  - Manitoba Hydro has made appropriate strategic choices in entering into long-term fixed price contracts for export power sales;
  - Manitoba Hydro has appropriately established the firm export volumes in these contracts; and
  - Manitoba Hydro has an appropriate methodology for arriving at the sales price in such contracts.

  Also, we find that Manitoba Hydro continues to improve its contractual documentation to more effectively mitigate the risk exposure from entering into long-term fixed price contracts for the sale of firm energy.

  On the basis of the policy decisions in place with respect to risk tolerance, Manitoba Hydro's Hydro quantifies its drought risk appropriately and currently provides for appropriate levels of reserves of risk capital against its projected drought risk.

- In terms of risk governance, we conclude the following:
  - Manitoba Hydro's power sales are asset backed. These sales are generally low risk and the Manitoba Hydro risk governance policies and reporting relationships, including the role of the Middle Office, are evolving appropriately.
  - The Export Power Middle Office is a single, independent, risk management function. It is steadily progressing in terms of its responsibilities for measuring, monitoring, controlling, and reporting the risks associated with PS&O's Power Sales and Operation's opportunity power sales activity.
  - The Export Power Middle Office is undertaking an initiative to improve its risk analytics capabilities. It requires further resource(s), supported by risk analytics software that is integrated with Manitoba Hydro's energy

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

Formatted: English (Canada)

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

Formatted: English (Canada)

transaction management system (WebTrader). The timeliness of this risk monitoring will continue to improve with added analytical resources and related technology.

- With respect to power risk management, we conclude that Manitoba Hydro demonstrates prudent risk management with the following risk management practices:

  – Extensive corporate oversight and a deliberate internal review process related to major export contract term sheets;

  – Conservative stress testing assumptions and methodology;

  – Transaction processing controls consistent with prevailing practices to mitigate human error and operational risk;

  – Compliance and risk monitoring performed by an independent middle office; and

  – Comprehensive suite of management and performance reports.

  In light of these prudent practices, Manitoba Hydro willshould continue to strive to keep pace with the dynamic energy markets and will identify opportunitiesin doing so should consider our recommendations to improve theirits power risk management capabilities. Manitoba Hydro may consider practices.

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

7.2 Recommendations

While we conclude that Manitoba Hydro has well established risk management practices in place and a number of initiatives underway, the following recommendations:summarizes our key recommendations to further advance and Manitoba Hydro's management of risk. Most of the recommendations relate to generating improved operations management and better documentation. Specifically, Manitoba Hydro should consider the following.

Formatted: Body Text, Indent: Left: 0"

- Revise long-term contractEnhance the functionality and resourcing of the Export Power Middle Office.

  – Manitoba Hydro should transfer the credit risk function in Power Sales & Operations to the Middle Office. This would further enhance independence and oversight of decisions made in Power Sales and Operations.

- Manitoba Hydro should also consider the transfer of the market risk function in Power Sales & Operations to the Middle Office. This would further enhance independence and oversight of decisions made in Power Sales and Operations.

- Manitoba Hydro's process of reviewing export contracts and term sheets should include the Middle Office to perform a challenge function.

- Responsibility for power risk management policy for opportunity sales should be consolidated in the Middle Office.

- Manitoba Hydro should consider adding resource(s) including risk analytic tools (i.e., software) to increase the risk analysis capabilities of the Middle Office. The Middle Office should have the necessary core risk assessment and quantification methods and systems to independently assess the risk profile of all opportunity sales transactions.

■ Develop formal identification of all significant risks in policies stipulating Middle Office participation in the and procedures.

  - In its export contracting process to date, Manitoba Hydro has mitigated its incremental risk by securing firm transmission capacity and expanding import capability. To ensure that similar mitigation strategies are adopted in the future, Manitoba Hydro should consider documenting its risk identification and assessment procedures to institutionalize its existing informal internal review process of major export contract term sheets;. This could help validate that all significant risks have been identified and integrated into the risk measurement process and control structure.

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

■ Enhance the number of risk tolerance limits.

  - While Manitoba Hydro has specified risk limits in "Power Related Transactions" and Customer Credit, and has expanded its limit structure by recently establishing Stop Loss Limits, it should consider developing a Value at Risk (VAR)-based limit for Related Merchant Transactions. This may provide a meaningful insight into the relative low risk of Related Merchant Transactions.

  - Manitoba Hydro may also consider developing other risk tolerance limits such as options limits and counterparty concentration limits, recognizing that these types of transactions are also relatively low risk.

- Measure market risk exposure forof short-term physical positions in its trading portfolio and and credit risk exposures.

  - Manitoba Hydro should consider applying mark-to-market initially to its open short-term commodity positions.

  - Manitoba Hydro should also evaluate the benefits associatedfor measuring market risk in long-term export contracts which would require resources to develop forward price curves.

  - Manitoba Hydro should add an "exposure versus limits" report to its existing suite of risk reports. Exposure reporting on a daily and monthly basis allows monitoring of transaction exposures with valuing its risk tolerance levels.

- Further document how the pricing was arrived at for export contracts and term sheets, as well as document the approvals of term sheets.

  - While the pricing methodology and process is appropriate, Manitoba Hydro would benefit from improving its documentation of pricing as well as term sheet approvals. Manitoba Hydro should clarify the role of the premium applied to long-term contracts;, confirm the appropriate magnitude, and document its pricing analysis and its future avoided cost analysis.

Formatted: Indent: Left: 0.25", Tab stops: 0.5", List tab + Not at 0.25"

– Consider a probabilistic measure (e.g., Revenue at Risk) as an alternative tool to further understand potential drought exposure;

– Develop risk limits commensurate with authorized trading activities and products; and

– Develop risk exposure monitoring reports for compliance purposes.

A key benefit of adopting of the above recommendations would be better information to decision makers on the optimal capital structure of Manitoba Hydro. To be clear, on the basis of reviewing PUB Board Orders and from Manitoba Hydro personnel, there has been considerable attention paid to the company's capital structure. This has led to a policy of Manitoba Hydro maintaining sufficient equity to act as a buffer against the inherent volatility of its business. As of fiscal 2008/09, Manitoba Hydro has built its retained earnings to $2.1 billion, providing an equity buffer against risk.

  - Accordingly,Manitoba Hydro has a relatively small group of highly skilled analysts and negotiators in power sales with deep experience in long-term export sales contracts, and more formal documentation of the pricing analysis will help preserve that experience.

- Continue to further improve the HERMES and SPLASH models.
  - Manitoba Hydro should continue with its current initiatives and plans to enhance its models.
  - Manitoba Hydro should better quantify and communicate to stakeholders the impacts of the "perfect foresight" assumption on the calculation of drought costs.
  - Manitoba Hydro should explicitly consider uncertainty in future water flows in the modeling process used to identify optimal production decisions.
- Conduct more scenario analyses, stress testing and backtesting.
  - Given uncertainty over climate change, Manitoba Hydro may wish to examine the potential impact of changes in water flows from the historical patterns. In particular, Manitoba Hydro may wish to assess the financial impacts of drought events worse than those found in the historical record.
  - In its analysis of expansion plans and development sequencing, Manitoba Hydro should consider conducting additional scenario analyses as detailed in Chapter 4 to examine the potential financial impact of drought events on the economics of expansion plans.
  - Manitoba Hydro should consider undertaking more stress testing to evaluate risk exposure. Stress testing can help management discussions on risk tolerance levels, risk capital allocation and portfolio management.
  - Manitoba Hydro should consider using backtesting to assist in further validating model outputs. Backtesting compares actual risk with model-predicted risks, and helps evaluate model accuracy.
- Formally document the HERMES and SPLASH models.
  - As HERMES and SPLASH are in-house models and operated by a small group of highly skilled modelers, Manitoba Hydro should provide more formal documentation of the models to preserve their proprietary information and assist new modelers. This will require dedicated additional resources to develop the documentation, but doing so will help mitigate risk in the event of staff turnover.

- Given ongoing evolution in modeling, Manitoba Hydro should consider formal peer review or benchmarking of the models to benefit from modeling developments elsewhere in the energy sector.

- Review its capital structure and its risk management practices are linked. To the extent that on a regular basis.

  - Manitoba Hydro is ableplanning a major capital expansion to improveits generation and transmission system. Manitoba Hydro is also in the process of improving its risk management practices in the future, doing so. Both of these may affect its optimal capital structure. Accordingly, the appropriateManitoba Hydro's capital structure for Manitoba Hydro will continue to be an ongoing issue for the company, its regulator, its shareholder, ratepayers and lenders. should continue to be formally reviewed on a regular basis.

Formatted: Bullet 2,b2

Formatted: Font: Not Bold, Not All caps

7.3 Key Highlights

The Consultant has raised serious concerns as to the financial viability of Manitoba Hydro and the risk of major power outages related to its long-term export contracts. Further, the Consultant asserted in 2008 that Manitoba Hydro actions in the previous five years have cost the corporation in the range of $1 billion. Our approach has been to identify and analyze all of the alleged deficiencies in Manitoba Hydro's operations and have done so pursuant to our scope of work as detailed in the main report.

We are of the view that:

- there is no material risk that Manitoba Hydro is facing bankruptcy as a direct consequence of Manitoba Hydro's export sales practices;
- there is no material risk that Manitoba is facing power outages as a direct consequence of Manitoba Hydro's export sales practices;
- Manitoba Hydro's drought management strategies are prudent in the context of a hydro-based generation system;
- there is no evidence to support an assertion of losses approaching $1 billion in the five years cited, based on our analysis of Manitoba Hydro's modeling, export sales contracts and risk management practices;
- Manitoba Hydro has prudently utilized a strategy based on entering into long-term contracts and the securing of transmission rights in the development of its system; and
- Manitoba Hydro has operated in accordance with its legislative mandate.

Overall, in the context of the nature, size and business model of its hydroelectric power operations, we are satisfied that Manitoba Hydro is following sound practices in its use of forecasting models, long-term power sales contracting, risk governance, and power risk management. ~~Our report provides recommendations to Manitoba Hydro in order to continue to advance in these areas.~~