Review of Hydrogeology Aspects
Of Red River Floodway Expansion EIS
Oakbank, Manitoba

Rural Municipality of Springfield

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1.0 Introduction

This report presents the results of a review of the hydrogeology aspects of the Environmental Impact Statement for the Proposed Red River Floodway Project in the vicinity of Winnipeg, Manitoba as published by the Manitoba Floodway Expansion Authority (MFEA) in August 2004. The scope of the review, as described in a proposal to the RM of Springfield was, on behalf of the Municipalities of Springfield, East St. Paul and St. Clements, to:

- Review the Guidelines for the Preparation of an EIS for the Red River Floodway Expansion Project;
- Review the hydrogeology aspects of the EIS as published by the Manitoba Floodway Expansion Authority;
- Provide an opinion as to the adequacy of the analysis of impacts and proposed mitigation; and,
- Meet with representatives of Council to discuss my report.

We received authorization to proceed with this work on 22 September 2004. A preliminary report based on review of the EIS and Appendices 1 to 9 inclusive was submitted on 04 October and discussed with representatives of the RM's of Springfield, East St. Paul and St. Clements on 06 October 2004. Later that day, an informal meeting was held with Paul McNeil, P.Eng. of MFEA and Bert Smith P.Eng of KGS, consultant to MFEA. During the course of that meeting, the existence of additional technical appendices (not listed in the Table of Contents or the Letter of Transmittal of the EIS) was revealed by MFEA and CD's of the technical documents were provided for my review. This report incorporates a review of the technical appendices related to hydrogeology, but time did not allow for a comprehensive review of all of the documentation received at that meeting.

2.0 Background

Groundwater is an important resource to the economy of the RM of Springfield and its neighboring municipalities. Woodbury (1995) describes the hydrogeology of the region, pointing out that the carbonate aquifers confined by clay and till underlie most of the region. While the carbonate aquifers are ubiquitous, the water quality deteriorates with depth and a salinity front is well developed to the south of Winnipeg; fresh, potable groundwater is an important regional resource.

The highest quality groundwater is found in the unconfined aquifers that are comprised of sand and gravel deposited by retreating glaciers. The Birds Hill aquifer is one such aquifer. Covering about 155 sq kms and made up of high transmissivity sand and gravel, it is one of the more important regional aquifers. It is an important source of recharge to the carbonate aquifers, creating a recharge "mound" that causes strong flow gradients radially outward from the topographic high that demarcates the aquifer. As a recharge area, it is also an important "reservoir" that stores groundwater to dampen the variable infiltration that comes from natural climatic variations.

The Birds Hill aquifer has a strong hydraulic connection to, and is an important recharge area for, the bedrock aquifer. From a groundwater management perspective, the two aquifers must be considered together (App N p. 2-7 sec 2.5.1):

> *"Recharge through the Birds Hill sand and gravel deposits were estimated by Manitoba Water Resources as approximately 9 000 cu m/day (1400 Igpm), including about 3000 cu m/day (460 Igpm) moving toward Selkirk and 1600 cu m/day (250 Igpm) moving towards the Floodway (Woodbury 1995a)."*

It is further stated that (App N, p. 2-6):

> " *Groundwater in the carbonate aquifer flows from east to west, from the till outcrop recharge areas of Anola towards the Red River and north toward Lake Winnipeg. Most of the flow is in the upper 25 m of the carbonate aquifer.* ------ "

Overburden sediments that have been partially removed by Floodway construction, protect the bedrock aquifer. The current conditions along the channel are described in the EIS (App N p. 1-6) as follows:

> *"The overburden along the Floodway Channel ----- consists primarily of high plasticity lacustrine clay overlying an uncemented to cemented silt till and Paleozoic limestone bedrock. The bedrock forms the regional Upper Carbonate Aquifer. The existing Main Channel Invert cuts primarily into the lacustrine clay and into glacial till for approximately 28% or 13 km (8 miles) of the 47 km (29 miles) Floodway length. The Low Flow Channel bottom cuts into till for approximately 38% or 18 km (11.4 miles). The Channel also cuts through 1.5 km (1 mile) of sand and gravel outwash complex at Birds Hill.*
>
> *The thickness of lacustrine clay below the Channel Invert is up to 10 m (33 ft) near the Floodway Inlet, decreasing to 1 or 2 m thick locally between Highway 59 south and Trans-Canada Highway crossings. The till unit is exposed in the Floodway Channel bottom for a 2 km section from south of Highway 15 (Station 25+000) to Cook's Creek, a 2 km section north of the Keewatin rail bridge and extensively downstream (north) of the Dunning Road crossing.* ***In these areas, blowouts and groundwater discharge were observed during the original construction****."* [Bold added for emphasis]

These blowouts created a series of springs that perennially discharge groundwater into the channel both upstream and downstream of Dunning Crossing. As a result, the aquifer system in the vicinity was heavily impacted by construction of the Existing Floodway in 1962-1968. Modelling, calibrated to match the observed drawdown in the late 1960's after Floodway construction (App N p. 4-2, sec 4.2), estimated that the drawdown cone reached to Anola with 4 to 6 m of drawdown at the Floodway between the Trans-Canada Highway and Spring Hill. A drawdown of 4 to 5 m was estimated from the Trans-Canada Highway to Spring Hill, with isolated areas of higher drawdown up to 6 m estimated at the Trans-Canada Highway and Highway 15. This simulation correlates with local views, expressed in our meetings, that groundwater impacts from initial construction were severe and will persist into the future.

The groundwater regime in the vicinity of the channel was permanently altered (see Figure 5.4.1) by the uncontrolled discharge of groundwater into the channel. Woodbury (1995) estimates groundwater flow in the area south of Birds Hill to be 1000 USGPM. This correlates with a published 2003 winter measurement of 1000 Igpm (although the verbal estimate provided at the MFEA meeting was 2000 Igpm; the value should be confirmed).

This volume of flow represents a 15% increase from post-initial-construction conditions (App N) and is very significant by comparison with the reported extraction of 700 Igpm in the St. Boniface area and 270 Igpm (on an annual basis) in the Ft. Garry area.

The increased seepage flow is attributed largely to the lower invert of the 2003 surveyed Low Flow Channel as a result of scour in the channel. This perennial flow represents an uncontrolled loss of a scarce and valuable resource; a number of riparian users were impacted, necessitating wells to be modified or replaced. Without mitigation, this loss will continue unabated and will probably increase with time.

3.0 Approach to the EIS

Even though the Existing Floodway has never been subjected to an EIA, the methodology employed for this EIS was to consider the impacts of expansion only. "*Existing or past projects*---*were considered as part of the evolving 'baseline'*"; hence, no consideration was given to pre-existing effects. This is an important consideration since it minimizes the scope of consideration of the cumulative effects in that the expansion is considered as an isolated, stand-alone project, not incorporating any of the pre-existing or ongoing impacts of the original project. This approach appears to be counter to the intent of CEAA and the EIS Guidelines, which state that the EIS should examine (p. 1A-7):

> "*Cumulative effects of the Project that are likely to result from the Project when its effects are considered in combination with the effects of other projects or activities that* ***have been*** [italics added for emphasis] *or will be carried out*".

The CEAA Practitioners Guide, as quoted on p. 2-7, outlines that:

> "*Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions –*".

By ignoring the contribution of past actions in constructing the Existing Floodway, the EIS presents a very narrow and simplistic overview of project impacts, particularly with respect to the groundwater system. In my view, the interpretation of cumulative effects adopted for this EIS is unusually narrow and does not allow full interpretation of the project impacts. This is of critical importance to the consideration of groundwater issues.

4.0 Hydrogeological Analysis

4.1 Physical Hydrogeology

The Guidelines for preparation of the EIS stated that it should describe the*" local and regional hydrogeology"*. Such a description would normally include:

- Regional and local hydro-stratigraphy;
- Regional and local potentiometric (i.e. groundwater surface) maps;
- Regional and local groundwater quality; and,
- An evaluation of current water demand.

The regional and local hydro-stratigraphy are well presented. The groundwater surface maps are apparently "derivative" maps that use data from various dates (e.g. " early 2000's") and are adequate for conceptual delineation of regional flow systems, but not adequate for baseline definition. Groundwater quality data are rudimentary, and no comprehensive evaluation of water demand, current or future, is presented. Insufficient quality and demand data are presented to adjudicate impacts on existing systems, although it is recognized that detailed design work is needed to design groundwater mitigation and protection measures. The lack of engineering detail in this key area is a prime deficiency.

4.2 Modelling

The technical appendices to the EIS outline the groundwater studies and modelling results. Both regional and site-specific models are presented. By nature of their formulation, the models enable a mechanistic understanding of the groundwater flow regime, but the lack of site specific data limits the conclusions that can be drawn for design and assessment purposes. Specifically:

- The models do not discretize the channel in sufficient detail to make judgments about important local effects. For example, seepage into the channel is treated as a uniform seepage phenomenon (occurring through uniform clay and till sediments), whereas historical records have identified local areas of blowouts and fractures where preferential seepage occurs. Accurate simulation of these phenomena is needed to more clearly assess impacts.

- Detailed local models focused on head delineation with no evaluation of flow. Given the locally high transmissivity, small changes in head can mean large changes in flow.

- Local pumping effects are ignored in evaluation of infiltration impacts although it is recognized that (App P, p.4-2, sec 4.1):

  " Pumping from the four municipal wells in the Bird Hill sand and gravel aquifer along Oasis Road will form local drawdown cones, with the overall averaging influence monitored in the vicinity observation wells. There is some interconnection to the underlying aquifer, with a minor overall imposed hydraulic gradient that is not anticipated to impact on the rate of intrusion of the surface water".

Given the importance of the Oasis Road well installation to the residents of East St. Paul and the sensitivity of that location to contamination by infiltration, further evaluation is required before potential impacts can be dismissed.

- The detailed analyses presented have largely focused on the engineering aspects of the project; results are generally presented in terms of changes in head but, in the high transmissivity sediments of the aquifer systems, small changes in head can mean significant groundwater flows that would add to the groundwater losses already being experienced.

- The technical appendices acknowledge the uncertainty that exists within the models and recommend detailed design studies, while at the same time predicting only local impacts. Given this uncertainty, commitment to mitigation measures that will provide the required level of protection for the groundwater resource and users should be anticipated. No such commitment is provided in the EIS.

- The EIS predicts only local effects and proposes to mitigate affected groundwater users on a "case by case" basis. This is not an acceptable approach given the inherent level of uncertainty in the analysis and modelling. A regional approach is recommended, based on:

  - Detailed investigations to gather site specific data;

  - Site specific analysis (modelling), particularly in the channel spring areas;

  - A comprehensive monitoring system;

    - A regional action plan, with uniform mitigative measures for all affected parties; and,

    - A transparent, stakeholder-based review committee supported by qualified technical and engineering resources.

- Time effects are not considered. Uncontrolled discharge of groundwater is seldom an acceptable engineering solution since flow conditions will change with time as seepage erodes the spring areas and forms channels in the subsurface materials. It is recognized that groundwater flow has increased 15% since initial construction; this is attributed to channel deepening by scour. It may also have a component of increased permeability due to erosion (piping) in the subsurface. Analysis should consider these and other potential time effects (such as local springs reducing the aquifer head to the elevation of the channel invert) and assessing the potential effects on the water table. It is almost a certainty that the conditions modelled will not be sustainable over the next centuries.

- Future development scenarios, leading to increased municipal demand, also need to be considered as impacts on aquifers and future water supplies are assessed. This is an important part of cumulative effects assessment.

Considerable effort has been invested in developing models that could be a useful aquifer management tool for the regional users. Consideration should be given to long term use of the model to support development decisions.

4.3 Unresolved Issues

Despite extensive analyses, the engineering assessment in the technical appendices (not fully reflected in the EIS or Executive Summary) is that a number of issues remain unresolved and need further work. These include:

- Groundwater monitoring is required throughout the construction of the Floodway Expansion Project and thereafter, as necessary, to identify possible impacts on groundwater levels and groundwater quality.
- For the Oasis Road area, the requirements for protecting the Birds Hill sand and gravel aquifer have to be finalized in conjunction with additional site investigations of soils and groundwater conditions that are planned for the final design phase.
- The overall mitigation strategy for potential groundwater impacts has to be developed in the final design for the Floodway Expansion Project construction and post construction periods.
- Substantial design effort is anticipated during final design stages to minimize groundwater effects in areas such as bridge pier footing excavations and other locations where there may be short-term effects on groundwater.

4.4 Monitoring

The EIS main report does not contain a commitment to comprehensive groundwater monitoring, except for limited site-specific plans related to engineering needs. Given the importance of the resource to the region, a long-term, science-based monitoring plan for both levels and quality is strongly recommended. The plan should be tempered by local knowledge of the areas that were impacted by earlier construction. A modern system would incorporate automated level logging supported by communications and automated data acquisition.

Given the sensitive nature of this issue, it would be a benefit to both the community to form a joint project-community environmental monitoring committee that would bring transparency to the monitoring and mitigation process and establish management oversight on a resource that is strategic to development of the region.

The need for monitoring is recognized in the technical appendices (Preliminary Engineering Report, p.12.5, sec 12.10):

> *"Groundwater monitoring is required throughout the construction of the Floodway Expansion Project and thereafter, as necessary, to identify possible impacts on groundwater levels and groundwater quality."*

It is recommended that a firm commitment be sought for long-term monitoring and management of the aquifers.

5.0 Summary

The information presented in the EIS does not allow an informed judgment to be made with respect to the ongoing impacts of the Red River Floodway in the vicinity of the Rural Municipalities of Springfield, East St. Paul and St. Clements. Concerns include:

- The aquifer system, comprised of the Birds Hill sand and gravel and the upper carbonate aquifer, is a valuable regional resource of great socio-economic importance to the municipalities.
- The aquifers were heavily impacted by initial construction of the Floodway with up to 6 m estimated permanent drawdown of the water table within the municipalities.
- The consideration of groundwater is incomplete in that it did not describe quality and demand as required by the Guidelines.
- Detailed mapping of the areas of groundwater discharge in the channel is recommended to evaluate the degree to which the existing aquitards have been damaged by water pressure and seepage. This is essential information in the analysis of impacts of the Floodway.
- The estimated average recharge through the Birds Hill sand and gravel is 1400 Igpm. The existing groundwater flow into the channel is 1000 Igpm. This value has increased 15% since construction and will probably continue to increase with time. It is anticipated that flow will increase about 5% immediately after expansion and will probably continue to increase gradually until outflow is approximately equal to average recharge at Birds Hill.
- Long-term uncontrolled discharge of groundwater through sediments is not a sustainable engineering approach. Ongoing scour and piping can be expected, resulting in increasing flows and further dewatering of the aquifers with time. Examination of the long-term impacts of this approach is absent from the documents.

- Continued uncontrolled discharge is depriving the municipalities of a valuable water resource and thereby limiting their opportunities for growth. Compensation may be in order.

- MFEA is among the largest consumers of groundwater in the region (1000 Igpm vs 700 Igpm in St. Boniface and 270 Igpm in Ft. Garry). The extraction is unlicensed and uncontrolled. It is recommended the municipalities seek to have the extraction licensed and controlled under the appropriate regulations and that MFEA be required to minimize groundwater extraction and optimize aquifer protection.

- The consideration of cumulative effects on the groundwater regime is incomplete in that future development plans of the Municipalities were not considered and the time effects of the proposed long-term uncontrolled discharge were not examined. The long-term impacts are potentially significant at both the local and regional level (see Figure 2.3-1 of the EIS).

- A mitigation plan and a fully funded "adaptive management strategy" is recommended to address long-term impacts.

- The EIS contains no commitment to ongoing monitoring;

- The EIS contains no commitment to ongoing public involvement beyond the EIS. Discussions on groundwater should entail full transparency with community involvement. Consideration should be given to a multi-stakeholder-proponent committee to monitor design, construction, mitigation and long-term management of the groundwater resource. In addition, a technical review committee specific to the groundwater issue should be considered.

6.0 Closure

This report prepared for the exclusive use of the Rural Municipalities of Springfield, St. Clements and East St. Paul to assist them in addressing hydrogeology issues arising in the MFEA Manitoba Floodway Expansion Project EIS. The author must authorize any use beyond, or by any other parties, that in advance.

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