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"€lean Environment Commission Presentation by
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We are opposed to the findings of the study material supporting the request for a water supply system. We believe this project will harm the aquifer that lies beneath the Sandilands provincial forest and the ecological life led above it. While the proponents believe the area to be unsuitable for development other than logging, they believe the groundwater will accommodate additional growth for the region's population. The basis for their application is that enough water may not be available to them during drought times. The forecasts for what may be available to the aquifer in times of drought isn't readily apparent in the study material. I had a hard time understanding the graphs, charts, diagrams, maps and conclusions the proponents have come to. They seem to arrive at the same one each time "there's enough water under the Sandi lands forest to fill the pumps and pipes so developments can survive, but who sustains the aquifer?

What does this aquifer complex need to survive? Who will replenish the recharge areas in times of drought? Who has established the response times and systems for this aquifer?

If our provincial departments, charged with the responsibility of unraveling the mysteries of this complex hydrology system, couldn't come to conclusions about it, how then can the proponent's consultants be so sure? If I was to expand at the rate of the Pembina Valley Co-op, I wouldn't be able to fit into my skirt. I'd have to begin using elastic waistbands to accommodate the growth, and if I grew too much, the elastic would stretch to the point of no return. That's what I'm worried about with this aquifer. How much and for how long can it give until the systertl collapses?

Response monitoring (uh oh, the waistband is tightening) may be too late. It is lacking in common sense to measure the long term response of the aquifer to a project if it means the aquifer's demise. As to the proponent's claim that the environment will not be affected, the U.S. geological surveys contradict this.

Groundwater and Surface Water Interaction

Ground-water pumping can affect not only water supply for human consumption but also the maintenance of instream-flow requirements for fish habitat and other environmental needs. Longterm reductions in streamflow can affect vegetation along streams (riparian zones) that serve critical roles in maintaining wildlife habitat and in enhancing the quality of surface water. Pumpinginduced changes in the flow direction to and from streams may affect temperature, oxygen levels, and nutrient concentrations in the stream, which may in turn affect aquatic life in the stream.

Perennial streams, springs, and wetlands in the United States are highly valued as a source of water for humans and for the plant and animal species they support. Development of ground-water resources since the late 1800's has resulted in the elimination or alteration of many perennial stream reaches, wetlands, and associated riparian ecosystems.

The chemistry of ground water and the direction and magnitude of exchange with surface water significantly affect the input of dissolved chemicals to lakes. Infact, ground water can be the principal source of dissolved chemicals to a lake, even in cases where ground-water discharge is a small component of a lake's water budget. Changes in flow patterns to lakes as a result of pumping may alter the natural fluxes to lakes of key constituents such as nutrients and dissolved oxygen, in turn altering lake biota, their environment, and the interaction of both.

I Wetlands can be quite sensitive to the effects of ground-water pumping. Ground-water pumping can affect wetlands not only as a result of progressive lowering of the water table, but also by increased seasonal changes in the altitude of the water table. The amplitude and frequency of water-level fluctuations through changing seasons, commonly termed the hydroperiod, affect wetland characteristics such as the type of vegetation, nutrient cycling, and the type of invertebrates, fish, and bird species present. The effects of pumping on seasonal fluctuations in ground-water levels near wetlands add a new dimension to the usual concerns about sustainable development that typically focus on annual withdrawals (Bacchus, 1998).

Ground-water development can lead to reductions in springflow, changes of springs from perennial to ephemeral, or elimination of *springs altogether. Springs typically represent points on the landscape where ground-water-flow paths from different sources converge. Ground-water development may affect the amount offlow from these different sources to varying extents, thus affecting the resultant chemical composition of the spring water.*

In summary, we have seen that changes to surface-water bodies in response to ground-water pumping commonly are subtle and may occur over long periods 0/ time. The cumulative effects of pumping can cause significant and unanticipated consequences when not properly considered in water-management plans. The types of water bodies that can be affected are highly varied, as are the potential effects.

A common response to droughts is to drill more wells. Increased use of ground water may continue after a drought because installation of wells and the infrastructure for delivery of ground water can be a considerable investment. Thus, a drought may lead to a permanent, unanticipated change in the level of ground-water development.

The effect of potential long-term changes in climate, including changes in average conditions and in climate variability, also merits consideration. Climate change could affect ground-water sustainability in several ways, including (/) *changes in ground-water recharge resulting from changes in average precipitation and temperature or in the seasonal distribution of precipitation.* (2) *more severe and longer lasting droughts.* (3) *changes in evapotranspiration resulting/rom changes in vegetation, and* (4) *possible increased demands for ground water as a backup source of water supply. Surficial aquifers, which supply much of the flow to streams, lakes, wetlands, and springs, are likely to be the part of the ground-water system most sensitive to climate change; yet, limited attention has been directed at determining the possible effects of climate change on*

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ow aquifers and their interaction with swface water.

In summary, consideration of climate can be a key, but underemphasized, factor in ensuring the sustainability and proper management ofgrowzd-water resources. As increasing attention is placed on the interactions of ground water with land and surfacewater resources, concerns about the effects ~(droughts, other aspects *of climate variability, and the potential effects qf climate change are likely to increase.*

The one common factor for all ground-water systems, however, is that the total amount of water entering, leaving, and being stored in the system must be conserved. An accounting of all the inflows, outjlpws. and changes in storage is called a water budget.

Human activities, such as ground-water withdrawals and irrigation, change the natural flow patterns, and these changes must be accounted for in the calculation of the water budget. Because any water that is used must come from somewhere, human activities qffect the amount and rate of movement of water in the system, entering the system, and leaving the system.

Some hydrologists believe that a pre-development water budget for a ground-water system (that is, a water budget for the natural conditions before humans used the water) can be used to calculate the amount of water available for consumption (or the safe yield). In this case, the development of a ground-water system is considered to be "safe" if the rate of ground-water withdrawal does not exceed the rate of natural recharge. This concept has been referred to as the "Water-Budget Myth" (Bredehoeft and others, 1982). It is a myth because it is an oversimplification of the information that is needed to understand the effects of developing a ground-water system. As human activities change the system, the components of the water budget (inflows, outflows, and changes in storage) also will change and must be accounted for in any management decision. Understanding water budgets and how they change in response to human activities is an important aspect of ground-water hydrology; however, as we shall see, a predevelopment water budget by itself is of limited value in determining the amount of ground water that caK! be withdrawn on a sustained basis.

First, the use of ground water and surface water must be evaluated together on a systemwide basis. This evaluation includes the amount of water available from changes in ground-water recharge, from changes in ground-water discharge, and from changes in storage for different levels of water consumption. Second, because *any use of ground water changes the subsurface and surface environment {that is, the water must come from somewhere}, the public should determine the tradeoff between ground-water use and changes to the environment and set a threshold at which the level of change becomes undesirable. This threshold can then be used in conjunction with a systemwide analysis of the ground-water am:!. surface-water resources to determine appropriate limits for consumptive use.*

Systemwide hydrologic analyses typically use simulations {that is. computer models} to aid in estimating water availability and the effects of extracting water on the ground-water and surface-water system. Computer models attempt to reproduce the most important features of an actual system with a mathematical representation. {f constructed correctly, the model represents the complex relations among the inflows, outflows, changes in storage, movement o.lwater in the system, and possibly other important features. As a mathematical representation of the system, the model can be used to estimate the response of the system to various development options and provide insight into appropriate management strategies. However, a computer model is a simplified representation of the actual system, and the judgment of water-management pro.lessionals is required to evaluate model simulation results and plan appropriate actions.

I could not, in the bewildering amount of graphs, charts and reports prepared by the consultant engineers on this project, locate a systemwide computer model, or a model of any kind. .

- *The effects of ground-water development may require many years to become evident. Thus, there is an unfortunate tendency to forego the data collection and analysis that is needed to support informed decision making until well6:/ter problems materialize.*
- *Evaluation of possible ground-water management approaches (a) depends on the continuing collection, archiving, and analysis of a broad range of different types of information. and {b} can be assisted by well-designed computer simulation models.*

Solutions

. Computer simulation models offlow and transport are a principal means for evaluating the response of aquifer systems to ground-water withdrawals and other human activities. There is a tendency to view development of such models as a one-time activity. However, if a model is used to address questions about thefuture responses ofa ground-water system that are of continuing significance to society, then field monitoring of the ground-water system should continue and the model should be reevaluated periodically to incorporate new information or new insights (Konikow and Reilly, 1999). *For example, it might be desirable to add new capabilities to an existing model, such as interactions between ground water and surface-water bodies.*

Ground-water models commonly are used to makeforecastsfor a decade or more in the future. Confidence in the reliability of a ground-water model is dependent in large part upon the quality and extent of historical data used to calibrate and test the model. In recent years, studies have been made of the accuracy of selected model forecasts several years after the date for which the forecasts had been made. Such studies, commonly referred to as post audits, qlfer a means to evaluate overall performance of a model and the nature and magnitude of model forecasting errors. Post audits also provide insights into possible future model enhancements.

One of the limitations of a model can be the underestimating of surface water depletion and ground-water development. What was relatively limited at the time of original model calibration can be expanded over time, and create additional stresses GIn the aquifer's ability to stabilize. A common finding of post audits of ground-water model forecasts is that the time period for matching historical conditions in the original model was too short to capture important elements of the ground-water system in the model. Processes or boundary conditions that are insignificant under the initial, lower stress regime may become important under a dflferent and generally larger set of imposed stresses. Thus, a conceptual modelfounded on *observed behavior of a ground-water system may provide inaccurate forecasts if existing stresses are increased or new stresses are added. In addition,jillure projections of water withdrawals typically are highly uncertain and need to be refined with time. The possibility of periodic refinement and reuse of ground-water models highlights the importance of thorough documentation and careful archiving of these models and continued monitoring of the ground-water system.'*

Since we haven't monitored this groundwater system, I suggest we begin, see how it reacts to drought or climatic conditions, understand how it works, and have Pembina Valley Water Co-op limit its growth, in particular in areas of high consumption and pollution potential, like intensive livestock operations.

If the proponents had been serious about safeguarding the health of the aquifer they intend to source, they would have planned for recharge of the system. Making efforts to allow water to get back into the ground is vital. When the proponents assert that withdrawals are approximately an order of magnitude less than the existing groundwater flow rate, they ignore the dynamics of change. How, then, will the aquifer make up for the withdrawals except by lowering itself? The Commission should recommend to the province that efforts to recharge the aquifer take place whenever there' is a withdrawal, or a water license issued. This would constitute a balance. The most efficient way to do this is to maintain areas that aJIow water to percolate or penetrate into the ground, usuaJIy through the ground between the stems of plants, or beneath the sediment of streams and lakes and ponds. We must preserve and protect wetlands, keep or plant shelterbelts, forests and riparian zones, install water gardens and native prairie gardens to compensate for concrete and sod, and compost or rebuild our depleted soils in agriculture. There are so many techniques for reducing wind and water erosion, preventing si It from contaminating surface water etc. - much mor<t than the adherence to guidelines in stream crossings as the proponent has stated. Where are the erosion control plans for the pipeline work? Where is the basic analysis of slopes, predictions of slumping, emergency plans to deal with human error, the consultation with the Certified Professionals in Erosion and Sediment Control?

The simple fact that this Commision had to (again) ask for additional material for a meaningful discussion of this project is telling. The fact that the Pembina Valley Co-op has come to the province for additional water supply and sources over and over again is telling.

It's not time for a generous new wardrobe in a larger size for the Pembina Valley Co-op, it's time for them to control their appetite.

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Project Highlights

Location
Minnehaha Creek Watershed District

Date
2001-2003

Client
Minnehaha Watershed District

Hydrologic, Hydraulic and Pollutant Loading Study

Background

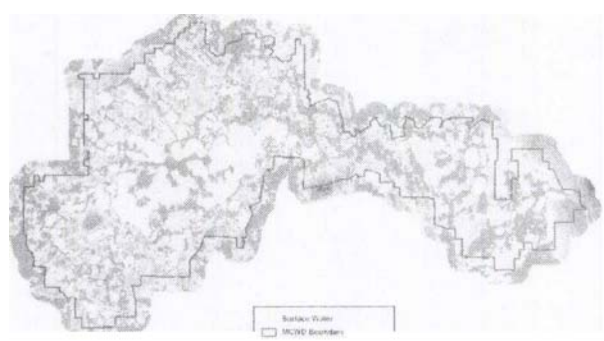
EOR completed a water resources modeling study or the Minnehaha Creek Watershed District. A hydrologic and hydraulic model or the entire watershed was developed using XP SWMM soliware. including modeling of nalllral streams and tributaries. Watershed and in-lake water quality models were devek)ped with PLOAD and WiLMS. Groundwater now patterns in each aquircr were anal~ded. and the contribution and significance or groundwatcr was cvaluated for difh:rcnt parts of Minnehaha Creek. Infiltration potcntial maps wen: crcated to assist thc watershed district with future stormwater management and pennJttll1g issuc~.

72 meetings with regional teams and source groups were held as part or thc public involvement process, during which issues were identilied and management strategies to address the issues were proposed.

The prioritized issues that were identified through this projcet arc bemg uscd by the watershed district in their planning process to prioritizc watershed improvcmcnt projects. The watershed models arc being uscd as a technical tool, forming the basis of more in-depth studies. Additional projects that used the watershed models are the Highway 26 Wetland Restoration Projcct. the FEMA Mapping Project. the Painter Creek Feasibility Study. and the Nine Lake~ lMDL Study.

Key Outcomes of Study

- Hydrologic and hydraulic model, predicting peak discharges and flood elevations Ii.H water bodies in thc entire watersIH.:d. It))" both exi~ting and 2020 developed conditions.
- Pollutant-loading model. predicting phosphorus and seJimentloaJs for both existing and 2020 developed conditions.
- Models of major lakes prediding current and 2020 in-lake phosphorus concentrations, as well as lake rcsponses to changes in phosphorus loads.
- Custom GIS system for displaying and qucrying model results.



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