

**REPORT OF THE ROSENBERG INTERNATIONAL
FORUM ON WATER POLICY TO THE MINISTRY
OF ENVIRONMENT, PROVINCE OF ALBERTA**

February 2007

**Rosenberg International Forum on Water Policy
University of California, Division of Agriculture and Natural Resources
324 Giannini Hall
University of California, Berkeley**

FOREWARD

The Rosenberg International Forum on Water Policy is an activity of the University of California created through an endowment gift from the Bank of America in honor of Richard Rosenberg on the occasion of his retirement as Chairman of the Bank. The overarching theme of the Forum is: To reduce conflict in the management of water resources. The Forum pursues two objectives in an effort to address this theme. The first is to emphasize the role of science in water management and in the making of water policy. The second is to promote interaction between scientists and policy makers for the purpose of facilitating the use of science in the making and executing of water policy. These objectives are accomplished through the biennial meetings of the Rosenberg Forum where approximately 50 water scholars and senior water managers from around the globe have an opportunity for discourse on a variety of topics which are pertinent to contemporary global water problems.

The Advisory Committee of the Rosenberg International Forum has recently launched a second activity subsumed under the general title of “Regional Rosenberg Workshops.” The concept of the Workshop entails the convening of a small, international expert panel to consider a regional water problem or problems and offer scientific advice about the nature of the problem and the ways in which it might be addressed. This document is the report of the first of these Regional Rosenberg Workshops. This Workshop was convened at the request of the Minister of the Environment, Province of Alberta, Canada. The Minister and the Ministry sought advice on two questions. The panel was asked first to review the Alberta water strategy, *Water for Life*, and make recommendations as to how it could be strengthened both as a strategic document and in the implementation of various measures that make up that strategy. Second, in recognition of the increasing importance of groundwater in Alberta’s water budget, the panel was asked to review the existing arrangements for governing and managing groundwater in the Province and make recommendations about how those arrangements could be further strengthened and improved.

The Rosenberg International Forum on Water Policy convened a distinguished international panel of experts with appropriate disciplinary backgrounds and experience. The names, institutional affiliations and areas of expertise of the panel members are listed below.

WORKSHOP PANEL

Professor Helen Ingram, University of California, Irvine (water institutions & governance)

Professor William Jury, University of California, Riverside (soil & water science)

Professor Ramon Llamas, The Polytechnic University of Madrid (groundwater hydrology)

Professor Paul Perkins, Australian National University (water management and the use of technical information)

Dr. Alphonso Rivera, Natural Resources Canada (hydrology and water management)

Professor Ben Rolston, University of Alberta (hydrology and water resources)

Mr. Robert Sandford, Chair, United Nations *Water for Life* Decade, Canada (water resources of Canada and their history)

Professor Uri Shamir, Israel Institute of Technology, The Technion (hydrology and water management)

Professor Henry Vaux, Jr. University of California, Berkeley (economics of water resources)

The panel, which was chaired by Professor Vaux, met in Calgary, Alberta on June 7–9, 2006. The session began with a series of briefings by the Deputy Minister of the Environment and senior staff from the Ministry and the Provincial geologist. The deliberations began with a thorough review of the *Water for Life* Strategy and led to an explicit enumeration of the strengths and weaknesses of the strategy. Subsequently, a brief review and a series of recommendations for strengthening the strategy emerged. The remainder of the deliberations focused on the emerging importance of Alberta's groundwater resources and on developing recommendations related to the management and governance of this important resource.

The Deputy Minister, Assistant Deputy Minister and members of the senior staff of Alberta Environment and the Provincial Geologist participated in the deliberations and contributed to them in a highly positive way. The panel wishes to acknowledge and thank the water and geology professionals from the Province, who took time from busy schedules to provide us with knowledge gleaned from their experience, insights and wisdom. While acknowledging this assistance we wish to note that the findings and recommendations are those of the panel alone and representatives of the Provincial government are not responsible for any errors of fact or interpretation. The Provincial staff members who assisted us are listed below.

PARTICIPANTS FROM THE ALBERTA GOVERNMENT

Mr. Peter Watson, Deputy Minister, Alberta Environment
Ms. Bev Yee, Assistant Deputy Minister, Alberta Environment
Ms. Nga de la Cruz, Senior Hydrologist, Alberta Environment
Mr. Colin Fraser, Hydrologist, Alberta Environment
Mr. Rob George, Groundwater Quality Specialist, Alberta Environment
Dr. Kevin Parks, Provincial Geologist, Alberta Geological Survey
Ms. Kate Rich, Manager, Water Strategy Office, Alberta Environment
Ms. Heather von Hauff, Groundwater Quality Specialist, Alberta Environment

The report of the panel and its recommendations are found in the remainder of this document. A first draft of the report was written at the workshop session itself and subsequently expanded upon and sharpened by the Panel Chair and Panel members. The staff of the Alberta Environment reviewed the final document and made a number of helpful suggestions. Subsequently, the final report was evaluated by three anonymous peer reviewers to ensure scientific accuracy. The panelists thank the reviewers and note that they bear no responsibility for any errors that may remain.

The report is organized in two sections. Section I contains a review of the Alberta *Water for Life Strategy* and sets forth a number of recommendations about how the strategy can be adapted to emerging circumstances and improved as it is revised and implemented. The recommendations and review are based on an assessment which the panel made of the strengths and weakness of the strategy. That assessment has been included as Appendix A. Section II of the report contains the review and recommendations of the management and governance of groundwater resources in Alberta.

The final report was reviewed by three anonymous peers. The Workshop Panel wishes to thank and acknowledge the peers for helpful comments which materially improved the substance of the report. The peers are, of course, absolved of any responsibility for the contents of the report. .

SECTION I

The Alberta *Water for Life* Strategy: Review and Recommendations

Introduction

In an absolute sense, water scarcity in Alberta is not as immediately serious as it is in many places elsewhere in the world. Nevertheless, failure to manage water effectively may limit social and economic development in the future and make water scarcity problems in Alberta worse than they need to be. The implementation of the *Water for Life* strategic plan should continue and consideration should be given to the variety of improvements summarized in the recommendations below.

1. Development and Evolution of the Strategy.

The citizens of Alberta and the Ministry of Environment are to be complimented on the development of the *Water for Life* strategy. The mere existence of such a strategy attests to the importance which Albertans place on managing their water and managing it well.

The development of the water strategy has entailed a relatively open, collaborative process involving significant input from stakeholders. Moreover, the vision which is articulated in the water strategy is a collaborative vision in which the planning and management of water resources will continue to be strongly influenced by stakeholder input in the future. The strategic plan also envisions a program of education in which all Albertans will have access to detailed information about the water resources of the Province and can thereby become more effective participants in processes of water planning and management.

Development and evolution of this important strategy should continue. The efforts to involve stakeholders, both in the devising of the strategy and in the water management and operations processes themselves, should continue.

Recommendation: We recommend that the Ministry and the Government of Alberta continue to pursue and support the development of an evolving Provincial water strategy based on the *Water for Life* model and that considerable emphasis continue to be placed on collaborative approaches involving an ever widening circle of interested stakeholders and public participants.

2. Need for Inclusive Portfolio of Management Measures

The water strategy relies predominantly on water conservation as the means of managing water scarcity. The strategy is largely silent on other means such as storage, conjunctive

use of ground and surface water and water re-use. As the population and economy of Alberta grow, water scarcity can be expected to intensify. It is unlikely that a single management strategy or a single cluster of management strategies will be sufficient to manage intensifying water scarcity in a satisfactory way. What will be needed is a balanced portfolio of management measures that should include water conservation measures, storage – both surface and managed underground storage-, conjunctive use and water re-use.

Recommendation: We recommend that the *Water for Life* strategy be modified to include a balanced portfolio of measures for managing water scarcity. The portfolio should include water conservation, storage – both surface and ground, conjunctive use of ground and surface water, water re-use and other appropriate measures.

3. Resource Inadequacies and Funding Changes

Achieving the potential of the *Water for Life* strategy will require an investment in Alberta's future water resource security. The ambitious scope, inter-relatedness, complexity and necessarily long time scale of the strategy demand a continuity of both political and professional leadership. To be successful the strategy also requires a coordinated investment in skills. Research and public policy must be developed on the one hand while engagement, communications, education and integrated implementation of actions is happening on the other.

A review of world water initiatives confirms the quality and competitive advantages accruing from Alberta's *Water for Life* strategy but reinforces the need for robust and sufficient fiscal investment support to match the timescale of the strategy. There are numerous examples in the world of well-designed strategic plans that have failed because of inadequate organizational and fiscal support. Most similar state level strategies fail to deliver on all but short-term objectives due mainly to conflicts in priorities of participating agencies. Those few strategies that have succeeded have all gone beyond standard budgeting and appropriation approaches to make long cycle fiscal commitments, supported by legislative instruments to secure the funding.

Leveraging of government investment from private sector, industry and community partners is best achieved where such arrangements provide reasonable certainty of continuing commitment. Cost, resource and skills efficiencies are also better achieved where these instruments are in place.

Recommendation: The Government of Alberta should take appropriate steps to require the alignment of Ministries and programs with responsibilities for water resources. Legislation authorizing budgetary and fiscal support sufficient to realize the *Water for Life* strategy's immediate and medium term objectives should be an urgent priority. Such legislation should also include time-limited provisions for review and commitment to emerging long-term objectives.

4. Integrating Research and Science with Policy-Making

Achievement of the goals and objectives contained in the strategic plan will not be possible without both employing existing science and undertaking needed scientific research to fill knowledge gaps in support of the strategy. A thorough new review of the most urgent research needed to support the strategy should be undertaken.

In the future water policies should be based on the best available scientific and professional knowledge gleaned from all available sources. Explicit and well organized efforts will have to be made to convert such knowledge into information that will allow legislators to put appropriate public policy options into relief. Knowledge will forever be incomplete and therefore broad water resources management programs (at the Ministerial level) must support a significant research effort. The resulting research portfolio should have a component of mission-oriented research to address specific issues and needs as well as a basic component in which new ideas and work in anticipation of future problems will be supported. Research will continue to be the platform for developing high level professional capacity.

Recommendation: The *Water for Life* strategy should contain a substantial and continuing commitment to the support of applied and basic research and on-going programs of monitoring that will address specified problems, develop new knowledge to fill gaps and be the platform for developing high-level professional capacity.

5. Need for Specific Implementation Targets

Policies will need to be translated into specific implementation outcomes linked directly to targets. Targets must be expressed in terms that can be monitored, measured and compared. Some targets will be numeric values (such as "percent reduction in water used to produce one unit of output"), while others may only be expressed in verbal terms (such as "the decision/action is acceptable to the relevant stakeholders"). Outcomes/targets that are mutually dependent should be expressed jointly.

Implementation targets are best developed gradually, through a learning process, often referred to as "Adaptive Management.". They should be formulated according to the best scientific information available at the time and should evolve as scientific knowledge and social preferences change. This means that the statement of implementation targets should be flexible and the process for defining targets evolutionary.

Recommendation: Policy objectives should be translated into implementation targets that can be monitored, measured and compared. Targets should be modified over time as part of a learning process that specifically incorporates new scientific knowledge and changing social preferences.

6. Issues of Governance

The new arrangements for water governance envisioned in the *Water for Life* strategy represent a considerable advance over traditional governance arrangements for water resources. Accordingly, it will be crucial to recognize that the new arrangements will require significant resources and efforts if they are to be successfully implemented.

The partnership framework, involving multiple levels of government and private entities, will require the expenditure of effort, not just of those involved in water, but also other sectors (community development, energy, transportation, agriculture, forestry, etc) and Ministries whose activities impact water. For many partners, water related goals are not central concerns, yet the productive participation of these partners in the strategy is crucial.

The extent of public participation in the development of *Water for Life* is highly commendable but public interest and patience may be difficult to sustain over the longer term. The willingness of stakeholders to participate in collaborative arrangements will endure only if participants believe they are being listened to and that their recommendations are being acted upon. Unless broad engagement and participation occurs, inclusive governance may devolve into rule by narrow, private interests. It may be necessary to provide support to some non-government organizations that otherwise lack the necessary resources to participate.

It is not yet entirely clear what the relationship of the Alberta Water Council is to the Watershed Councils and to the Stewardship Groups and questions of recruitment and selection are not yet entirely settled. Clearly, governance arrangements will involve continual building and rebuilding of relationships and ongoing government commitment and resources.

Recommendation: In order to ensure that water governance is open, transparent, accountable and effective, a self-study followed by outside review should be undertaken periodically to assess the extent to which: 1) partnerships remain effective; 2) participatory processes remain open; and, 3) all processes of governance remain accountable.

7. Jurisdictional and Transboundary Issues

The Province of Alberta has large upland watersheds from which water flows to Saskatchewan and Manitoba to the east, to the Northwest Territories to the north, and to the state of Montana to the south. The *Water for Life* strategy should fully acknowledge Alberta's shared responsibilities with those jurisdictions and should indicate how those shared responsibilities will affect the achievement of the three long-term objectives of the strategy.

Current agreements (with organizations and institutions such as the Prairie Provinces Water Board, Mackenzie River Basin Board, and the International Joint Commission)

should be used as frameworks for collaboration among the jurisdictions in question. Task groups should be designed specifically to track use and proper management of inter-jurisdictional rivers and aquifers. These groups should generate comprehensive data on water resources within their jurisdictions and cooperate with each other by exchanging data and information.

The equitable and “reasonable” use of shared waters should be the essential principle governing groundwater. Competition for groundwater between Provinces would be inherently destructive and should be avoided at all costs. Other principles that should be developed and employed in inter-jurisdictional groundwater management schemes include:

- 1) development of a prioritized list of uses;
- 2) practices that ensure that aquifers remain sustainable over the long-run;
- 3) the joint apportionment of surface water and groundwater,
- 4) the specification of pumping locations and amounts, and
- 5) the development and publication of Provincial allocation methods.

It will also be essential to develop arrangements which will ensure that watershed management plans and aquifer management plans are consistent with each other, can be reconciled and are compatible.

Recommendation: The *Water for Life* strategy should acknowledge that current agreements with Provinces and nations may need to be modified and updated in response to changing circumstances. Inter-jurisdictional collaborations with shared responsibilities for the management of water resources should be created to oversee the development of databases on transboundary watersheds and aquifers and to facilitate the collection and exchange of data and information. Institutional arrangements should be developed to ensure that watershed and aquifer management plans are reconciled and are compatible with each other.

8. Policy Implementation Instruments

Policy is usually implemented through the use of instruments such as laws, institutions, financial and economic incentives and via the employment of specific technologies. The *Water for Life* strategy should identify the mix of instruments to be used to achieve each objective. Thus, for example, improvements in the efficiency of household water use might be achieved through water pricing, laws and regulations, education, or the development and licensing of water-saving devices. Some of these same instruments as well as a wide array of technologies and techniques can also be employed in the agricultural and energy sectors. Care should be taken not to restrict the implementation of policy to prevailing instruments. Innovation and development of additional instruments, which could permit targets to be reached more effectively and efficiently, should be encouraged.

Recommendation: The *Water for Life* strategy should include a list of implementation instruments that could be used to achieve each policy objective. The strategy should also encourage the development of new and innovative instruments.

9. Data Acquisition and Monitoring

The existing network of groundwater monitoring is insufficient to provide reliable information on water quality and water levels and their variability. Without a more comprehensive monitoring network, it will be very difficult to achieve the goal of ensuring safe drinking water, healthy ecosystems, and reliable water supplies. Monitoring networks need to be installed – and sustained over time - at a density sufficient to ensure proper tracking of level changes and a high probability of detecting contamination before it has spread over a large area. A proactive approach to monitoring should include on-going measurement of contamination indices in the vicinity of agricultural, industrial, and municipal operations that have the potential to pollute ground or surface waters. Such an approach will almost always be cost effective because it will greatly decrease cleanup expenses. In addition, ecological indicators need to be identified and monitored to ensure that adverse ecological changes are detected early in their evolution.

Recommendation: The monitoring networks for assessing the quantity and quality of both surface and groundwater need to be expanded and strengthened. Monitoring networks and indices for assessing ecosystem health also need to be developed and implemented. Monitoring networks need to be maintained over time and be sufficiently dense to allow trends to be measured and analyzed and to permit early detection of contamination episodes.

10. Water-Related Activities and Policies

Water policies should be developed in consonance with other water-related and water using activities. All too often policies for related activities are made without adequately accounting for the impact of those policies on water. Policies governing urban and suburban development are but one example. Such policies and activities should include consideration of the implications for water resources from the beginning.

In the management of Alberta's economy, water should be viewed as being every bit as important as oil. Evolving water policy should be proactive in anticipating the needs and demands of a growing economy rather than simply providing reactive response to resource development and population growth and pressures. Only by being proactive and anticipatory can water managers and policy makers ensure that the availability of water and water quality do not limit economic and social development in the future. The exploitation of Alberta's energy resources is proceeding at a pace much faster than had been anticipated. There has been no parallel acceleration in the research upon which protection of the associated water resources could be based.

Many activities have impacts on water resources. Industrial processes use water and discharge effluents. Urban development affects runoff quantity and quality and aquifer

recharge. Hydropower operations affect stream flows. Some important domains have already developed their own policies, laws, regulations and plans without due regard for their influence on water. Water resources and water policies must be treated explicitly and integrated into all water-related development plans and activities.

Recommendation: All Ministries should be mindful of policies and activities within their respective domains that involve or have impacts on water resources. These policies should acknowledge interrelationships with water and include appropriate provisions for the protection of water quality and availability. This recommendation will require commitment and support from the highest levels of the Provincial government.

Recommendation: In the face of accelerated energy production and population growth all efforts should be made to advance the research and regulatory activities needed to protect water resources that could be threatened.

SECTION II

Managing and Governing Groundwater In Alberta: A Review

I. Preamble

Groundwater uses in Alberta are currently small when compared with current surface water use. Yet, groundwater will become an increasingly important component of the province's water supply in the future. As surface water becomes more fully allocated, groundwater use will continue to grow.

In southern Alberta where much of the population and industry (including irrigated agriculture) are located and where much of the population and economic growth is projected to occur, many of the surface water sources are now fully allocated or even over-allocated. It is a given that the explosive urban and suburban growth in the Calgary-Edmonton corridor will have to be supported with groundwater. Climatic variability and the prospect that variability may increase means that surface water supplies may become less reliable. Groundwater, which does not respond directly to variations and extremes of precipitation and run-off, will become increasingly prized as a particularly reliable component of the total water supply.

As groundwater becomes increasingly important in the water budget of Alberta, new attention will have to be focused on its management. Existing management and governance arrangements are not adequate to respond to contemporary pressures. Groundwater is not adequately monitored; its availability and the quantities of water extracted are not carefully measured or recorded; and, the regulation and control of groundwater exploitation could be improved. In short, existing governance and management institutions must be strengthened to prevent the "Tragedy of the Commons" which may result when the use of common pool resources is governed by the law of capture and characterized by competitive exploitation. In addition, it will be important to recognize that maintenance and protection of groundwater quality will be a critical element in any effective management strategy.

The development and projected exploitation of oil sands and coal bed methane are likely to pose special threats to both groundwater quantity and quality. These threats will be exacerbated unless both public and private stakeholders remain fully accountable for any adverse environmental consequences that result from their activities. It will be essential to integrate water protection policies into broad resource development strategies and decisions. There is a compelling need for plans to manage unforeseen as well as foreseeable environmental impacts stemming from the development and expansion of the energy industry. The livestock industry and irrigated agriculture will also continue to pose threats to groundwater quality.

If Albertans are to protect and enhance their groundwater resources so that they will be available in the future as a reliable source of fresh water, they will have to develop and

implement a strong groundwater management and protection program. Pumping quotas, taxes and extraction fees are examples of the kinds of economic incentives that can be used to regulate and protect groundwater resources. All policies and implementation actions should be fully consistent with the “polluter pay principle” which is implied in most efforts to regulate pollution worldwide. Such policies should be realistically scaled and realistically implemented.

The three major objectives in the *Water for Life* strategy are likely to drive concerns about groundwater:

- securing high quality drinking water supplies for populations mainly located in southern Alberta, which only has 17% of the province’s surface water,
- maintaining healthy aquatic ecosystems,
- securing reliable water supplies of appropriate quality for resource development.

Groundwater will play different roles in addressing each of these objectives. According to Alberta Environment calculations, groundwater allocation and use today accounts for 3% to 4 % of total annual recharge. This helps to explain why groundwater problems have not received much attention. However, future population and industrial growth will put increasing pressures on limited surface supplies that are already allocated. Furthermore, local groundwater management issues may be critical, even if on the average they are less evident. Worldwide, groundwater has been important source of water in supporting economic development and in coping with problems of surface water scarcity. Thus, it is critically important to protect this source of water in Alberta as it may play a critical role in supporting future economic growth. Given that most aquifers are not yet fully developed and used, groundwater will undoubtedly become the least cost alternative source of supply for many urban and industrial uses.

As groundwater supplies are developed and used, care should be taken to address environmental problems that will inevitably result. Thus, for example reduction of surface ponding and maintenance of stream flows are common consequences of groundwater drawdown. Damage to aquatic ecosystems is almost always cheaper to avoid from the outset than it is to mitigate later. Thus, much better knowledge of the relationship between groundwater and aquatic ecosystems is necessary. It should also be acknowledged that groundwater may become an important source for irrigated agriculture, particularly if more frequent and prolonged droughts occur.

Again, contamination of aquifers from the residues of agricultural chemicals is likely to be less expensive to avoid than to remediate. Although oil sands, coal and coal bed methane developments are very important to the future of Alberta and Canada, their very size and complexity pose potential threats to the groundwater resource. Some environmental impact analyses of these activities have been completed but they do not always address the entire range of impacts and especially cumulative effects. Moreover better information about the threats to groundwater quality and quantity is needed as there is significant risk and uncertainty which is incompletely understood by the public.

These risks and uncertainties cannot be comprehensively addressed in a groundwater management plan alone because they transcend traditional parameters of groundwater management. Surface water/groundwater interactions must be accounted for as to the important interrelationships between groundwater, land use and other natural resources.

Alberta's groundwater resources may play a critical role in defining future economic development. Decisions on problems must be made irrespective of whether the underlying science and data are available. The Ministry must be vigilant so as to be prepared to respond to emerging problems even while making efforts to improve the available science and data on groundwater.

II. Governance of Groundwater

Governance of groundwater resources in Alberta has not received much attention in the past since surface water supplies have been adequate to satisfy demands. Groundwater is now emerging as an important resource both in terms of its capacity to provide additional water supplies but for other reasons as well. Groundwater is a covenant with future generations. It is a necessary backup supply for emerging needs and to provide flexibility in responding to hydrological variability and to climate change. This generation could provide an important legacy to descendants by attending to emerging groundwater governance issues now.

Historically, the Province of Alberta has approached groundwater in much the same fashion as it has approached surface water. So long as groundwater was a relatively small component of the water budget and the groundwater resource was not threatened through inadequate management, this strategy was probably adequate. Today, groundwater is under intensifying pressure and will become an increasingly important component of the water budget for the foreseeable future. Therefore, it is essential that groundwater be treated not as a mere extension of surface water and that new forms of governance which require strategies adapted to the fundamental physical, biological and hydrologic properties of groundwater and its interconnections with surface water.

Previous practices of groundwater monitoring and management were appropriate to an era in which groundwater was a relatively minor source of supply in most areas. These practices will not be adequate in an era of intensifying pressure to develop groundwater resources. For example, the number of groundwater wells in use in the Province is not accurately known. There are a large number of individual households and small agricultural users who rely on groundwater but are not registered or required to report on groundwater use. Not all groundwater uses are known and licensed. There are reporting and monitoring requirements but these are inconsistently applied across sectors and/or activities and are not adequately recorded. There are now no requirements for metering small users. The result is that there is little information on the quantity of groundwater extractions and virtually no information on groundwater quality. This merely draws attention to the urgent need to monitor and manage the Province's ground water resource.

Governance of groundwater in Alberta is hampered by a number of factors. The absence of long-term monitoring and the data that it yields hampers scientific decision-making. Management cannot be effective without knowledge of such key characteristics as recharge rates, draw-downs, and actual and potential sources of contamination. This type of information is often not available when decisions must be made to proceed with projects that will have to be supported with groundwater. Further, information that is available is generally collected on a site-specific, project by project basis. Moreover, governing agencies lack both the financial resources and sufficient qualified staff to compile and analyze the limited data that is presently reported, thereby hampering the development of effective management options. In devising new procedures and processes through which licenses and permits are granted, it will be important to ensure that all applicants are treated equitably. Moreover, all permittees and licensees must be held accountable for the conditions of their licenses and permits and for achievement of agreed to environmental outcomes. Care should be taken not to create perceptions that these processes favor one group or another as such perceptions generally weaken regulatory efforts. Existing water governance structures neglect the important interactions between groundwater and surface water. If groundwater is to be effectively governed and managed, institutions will need to be developed that account adequately for the interactions between groundwater and surface water.

Currently in Alberta the base of groundwater protection is defined as the point below which the water contains a concentration of total dissolved solids (TDS) of 4,000 mg/L or higher. Such a regulation was appropriate for a different era in which it was infeasible technologically and financially to reclaim brackish waters with this level of TDS. Today, such waters are routinely desalted and have become important sources of supply in many regions of the world. Indeed, groundwaters between 4000 and 10,000 mg/L have become an important global resource because they can be economically treated for domestic and other uses. Given the potential for heavy demands on water in the future it would be advisable to expand the definition of regulated groundwater in Alberta so as to ensure that all waters with economic value are regulated.

The Watershed Planning and Advisory Councils (WPACs), which are the existing and emerging watershed governance entities, encompass the boundaries of surface watersheds. However, these surface water boundaries are not coincident with subsurface groundwater boundaries. For this reason, different governance arrangements are clearly needed for groundwater. It is unrealistic to expect fledgling watershed governance groups to reconcile surface water and groundwater boundaries. Further, the challenges faced by the WPACs are formidable even without the additional mandate over groundwater. It seems clear that a different set of arrangements will be necessary for the governance of groundwater.

A process through which groundwater management districts come into existence in areas where there is a critical need for more intensive government regulation should be considered. In other words, governance institutions should be developed first where the need is greatest. Identifying these districts of concern can be done in a relatively straightforward way by identifying aquifers or districts that are subject to:

- intense development pressures;
- groundwater quality degradation;
- persistent groundwater overdraft;
- threats to ecosystem integrity; or some combination of the above.

Once identified, such aquifers will need more intensive management than is currently envisioned. Intensive management could include: total registration of all wells, quantitative metering, identification and protection of recharge areas, identification of overdraft areas, and/or the regulation of activities in those areas via the modification of existing licenses. The assessment of cumulative impacts on groundwater will be especially important. Just as importantly, such assessments need to be open and transparent. In addition - and of equal importance - there should be efforts to acquire the appropriate hydrological, geological, biological and other appropriate information needed by managers in districts of concern. The effectiveness of governance will depend crucially on the availability of this information.

In setting up the first governance arrangements, an explicit learning process should be established which will lead to improved future governance structures based on experience gained. This flexibility should be maintained in the initial arrangements so that improvements can be introduced without undue difficulties.

Though such a proposal will generate controversy in some sectors, it could well be necessary to revisit the “first in time, first in right” (FITFIR) principle but only as it applies to groundwater. There is no reason why this particular principle should be applied to groundwater. The evidence suggests that when rights are vested according to this principle a system emerges that is hard to manage, encourages waste, is inflexible, and robs future generations of users of their options. Thus, for example, consideration might be given to a system in which rights are vested for a specific term and are not automatically renewed when that term is up. The opportunity to explore alternative systems is ripe. This important opportunity will disappear as groundwater development and use increase.

It should be recognized that the husbanding and management of groundwater resources is an emerging responsibility that will require additional resources and personnel whose skills are appropriate to the task. It would be a mistake to try to address the many facets of the groundwater management challenge with existing resources which are clearly inadequate. It will also be important to acknowledge that groundwater, like surface water, is linked across many sectors of the Province and therefore across different Ministries. Housing, transportation, agriculture, forestry and energy development are only a subset of the various activities that will, in the future, have important impacts on groundwater. The Provincial government will need to take an inclusive approach to managing groundwater and ensure that there is high level leadership and that all pertinent Ministries understand the importance of their own stake in good groundwater management.

Finally, it is important to realize that the engagement of stakeholders may be more difficult to sustain for groundwater governance than for the governance of surface waters. Groundwater is out of sight and the nature of the resource is not always clearly understood by users or by members of the public. Despite this fact it will be critically important to sustain the interest and engagement of stakeholders and the public in groundwater management. Programs of public education about groundwater and other types of special support may be necessary.

III. Scope and Scale: Capacity, Funding and Resource

The current status of Alberta's Groundwater Action Plan (GAP) is captured in the 2002 "Water Strategy – Groundwater Action Plan" with its five Key Actions and 14 recommendations, and in the 2005 Draft Discussion Paper "A Management System for Groundwater in Alberta", with its elaborate system-oriented terminology and flow diagrams. These documents constitute an attempt to describe an "ideal" groundwater management system. Other sections of this report review specific components of the GAP, suggest certain improvements, and address integration of the Groundwater Action Plan within the Water Strategy. This section of the report examines the scope and scale of the GAP, as described in the above documents and presented at our meeting, with the view of considering its overall scope, scale and phasing.

The proposed Groundwater Action Plan, in its present, ambitious form, may not be readily implemented within a reasonable time-frame given the human and financial resources that are expected to be available. This observation in no way detracts from the Workshop Panel's recommendation that very substantial resources of budget, person-time and administrative attention must be allocated to the plan. It merely reflects the view that the plan should be structured in a phased manner, with priorities of timing, budget and human resources allocated to specific components of the plan, so that implementation can proceed in a logical and manageable manner which will have a better chance of succeeding. It would be a mistake to set out an overly ambitious plan, which has little chance of being implemented within a prescribed time frame. Such a strategy would create false and unrealistic expectations and lead to public frustration. It could also erode the morale of the professionals who are engaged in and are responsible for implementation. And, it would almost surely entail inefficient use of budgets.

Even if substantial resources should be available, the Groundwater Action Plan must be phased-in in accordance with the professional capacity available in the Government agencies and in the academic and consulting organizations that can and should participate in the plan's evolution and implementation. Implementation should also proceed with due consideration to mobilizing groundwater developers and users to participate in the process of monitoring and reporting. As the plan is further developed, it should be closely coordinated with the groundwater programs and plans of Natural Resources Canada.

IV. Monitoring, Data Management and Tools for Interpretation

Alberta is developing rapidly, and groundwater use is expected to increase markedly in the future. It is vitally important that the spatial distribution, volume, present quality, and hydrologic connectivity of the groundwater resource be characterized and subsequently monitored to determine changes in storage and quality while changes are occurring. Only when the entire groundwater resource has been analyzed will it be possible to manage Alberta's water resources effectively and optimally in the presence of substantial development and increased use.

To reach this goal, the groundwater management plan of Alberta's *Water for Life* strategy needs to include practical, yet modern and scientifically-based tools to survey, monitor, access, integrate and use ground and surface water data as well as land use, climate variability and water quality.

Monitoring

Although capital expenditures to create a comprehensive network to monitor groundwater levels and quality may seem high, they are invariably a bargain compared to costs for remediation of contamination if not detected early. Similarly, because response times are often quite slow in groundwater systems, it is important and highly cost-effective to develop the capability to detect changes in water levels on a continuous basis, so that rates of water use may be adjusted, if necessary, to ensure that the supply is not depleted considerably before action is taken.

Beyond its role in assessing the reliability of groundwater supply, the monitoring network is the last line of defense against contamination by industries that are essential to the economic future of the Province. Alberta is embarking on an ambitious plan of oil and gas extraction that will require substantial water withdrawals and quality deterioration that has the potential to seriously contaminate ground and surface waters if protective measures should fail. For this reason it is important to have a comprehensive early warning system for detection of contamination from each operation before it has had a chance to migrate and disperse over a substantial volume of groundwater. Similarly, ground and surface waters receiving agricultural return flow need to be monitored regularly for pesticides and fertilizer chemicals to ensure that buildup to levels adverse to human or ecosystem health is not occurring.

The Role of Models

In conjunction with observation, a comprehensive system is needed for managing and interpreting data. Over the last two decades, computer models for simulating groundwater and surface-water systems have played an increasingly important role in the evaluation of groundwater development and management alternatives. While these models, tailored as practical tools, cannot replace measurements, they are very valuable for interpreting data, designing monitoring networks, performing mass balances, and predicting responses to changes in management, climate, or surface conditions. Models are also an essential tool to better organize the full baseline assessment of aquifers and aquifer systems.

In general, computer models and monitoring systems are treated as separate activities, but to be most effective, the two should be linked. The process of building, calibrating and using a model provides a good framework for evaluating which components of the simulated system are best known, which are poorly known and which are the most important or sensitive to disturbance. Thus, the experience gained from the modeling exercise should provide a basis for a periodic evaluation of the monitoring network.

There are many types of hydrologic models, ranging from simple water accounting systems to complex three dimensional models that describe movement of water at a fine scale of resolution. No model is universally applicable to all problems, and selection of models from a progression beginning with the simple and aggregate to the more detailed and complex is recommended. Models are also helpful in pointing to missing critical information.

Data Management

The third component of groundwater monitoring and assessment is data management. The groundwater management plan includes provisions to build a groundwater information centre as a water data warehouse. However, this should be more than a storage facility. The 'centre' should be designed as a full inter-operable facility where data is not only stored but can be shared with multiple users. This can only be accomplished if the database is designed to be compatible with international standards for data recognition and transfer. Such a database would not need to be centralised, and could be maintained by many agencies. By placing data in a GIS format, vital information on land use and other related phenomena can be readily obtained.

Development of a comprehensive monitoring and data management plan for Alberta's groundwater is best achieved in stages. We offer the following priorities as a tentative plan:

- a. Monitoring, data capture, screening and improvement and archiving, while maximizing the capture in digital electronic formats. Consideration must be given to inclusion of all groundwater users and uses into the system of licensing and reporting.
- b. Continued development of the data archiving system.
- c. Creation of information products, such as water budgets, time series and maps – dictated by the requirements of analysis tools and management needs.
- d. Creation of open and user-friendly access to the basic data and to information products.

SUMMARY AND RECOMMENDATIONS

Alberta Environment and the citizens of the Province are to be complimented for their foresight and pro-activity in developing an impressive, if idealized, groundwater management strategy. Few if any countries, provinces or regions in the world have been willing to take this important step, and we urge that all efforts to strengthen and refine and ultimately implement the groundwater plan proceed apace. The Committee makes the following recommendations in the hopes that Albertans can use them to achieve early success in managing their groundwater resources.

- a. This Committee's review and recommendations on the *Water for Life* Strategy apply in some respects to the Groundwater Action Plan and should be considered a part of this report. It is essential that the Government of Alberta provide increased financial support to undertake the effort needed to develop and implement a phased and appropriately sized Groundwater Action Plan. This increased support will need to be sustained for the foreseeable future. In integrating the Groundwater Action Plan with the *Water for Life* Strategy priority should be given to ensuring that the profile of groundwater is equivalent to the high profile already given to surface water. In particular, the resulting integrated *Water for Life* Strategy should acknowledge and emphasize the essential hydrologic interactions between ground- and surface water.
- b. The groundwater management scheme to be developed and adopted by the Government of Alberta, with input from interested citizens, should be of realistic size and scope. More specifically, it should be carefully phased. The first phase should focus on realistic time, personnel and budget constraints and concentrate on the most crucial problems of groundwater management confronting the Province.
- c. The Committee notes that strong leadership at all levels of government, by NGOs and by interested citizens will be essential if the considerable opportunities to develop effective schemes for groundwater management are to be realized. The Committee recommends that no effort be spared to take advantage of the opportunity to develop effective governance mechanisms for groundwater in Alberta. If such mechanisms are to be developed in a broadly informed way, information about the groundwater resource will need to be readily accessible to all interested parties.

Consideration needs to be given to the following specific points:

- Water of quality in the 4,000 to 10,000 mg/L total dissolved solids range has considerable value as a resource after treatment. Therefore, the definition of groundwater resource should be extended to include this quality range.
- It is important to identify immediately the critical groundwater basins to be subjected to more intense regulation and management.
- All groundwater uses should be licensed, and consideration should be given to limiting the duration of licenses and renewal only upon favourable review.
- The Water Planning and Advisory Councils, as currently structured, align with surface water watersheds, which are not always coincident with aquifers. Groundwater management institutions need to be spatially aligned with the realities of aquifer dynamics.
- It would be timely to revisit the “first in time, first in right” for groundwater to ensure that it is the most appropriate way to realize the beneficial use of groundwater.
 - a. Priority should be given to groundwater monitoring, data archiving, dissemination and use with tools of analysis (including models) to produce products such as water level and water quality maps and time series graphs which are useful for understanding and for management of the groundwater resource. Initial efforts should be appropriately scaled and phased within time and budget constraints and focused on the groundwater basins identified as having the most urgent problems.
 - b. Special attention should be devoted to the need for constant monitoring and vigilance over the water use and waste generating and disposal activities of the energy industry as well as other industries to ensure that there is timely and early indication of any adverse depletion of the water resource or releases that could lead to groundwater contamination. This is especially true of large industries and those that employ new technologies.

The Government of Alberta should take appropriate steps to require the alignment of Ministries and programs with responsibilities for and impacts on groundwater resources. The agricultural, forestry, energy, environment and other departments and sectors will all have to work in common if the ambitious groundwater objectives are to be achieved.

APPENDIX A

The Alberta *Water for Life* Strategy: Strengths and Weaknesses

STRENGTHS

General

- The existence of a water strategy of this caliber and scope at the Provincial level is highly praiseworthy.
- The strategy is not just a plan for allocation. It is proactive, and because it embraces proposals for new mechanisms of governance at all levels represents a potentially significant opportunity to create a new planning culture.
- It is appropriately ambitious, given the urgent need to manage water more effectively in Alberta. Its high objectives are commensurate with the government's desire to proactively ensure that issues related to water availability and quality do not limit economic growth or social development, and do not damage ecosystems in the province now or in the future.
- It includes knowledge and research as important elements of a developing new foundation for managing water in the province.
- The strategy is a holistic framework for learning not just about managing water, but for developing effective collaborative mechanisms that could assist the province in linking water stewardship to land-use and other larger issues in the future.

Priorities

- An important strength of the strategy is its focus on the development of information systems or centres of information that are easily accessible and that share data in commonly usable formats with all partners and with the public.
- The importance of considering not just efficiency and productivity but also conservation within the goals of the strategy has been established.
- The crucial importance of developing integrated versus atomized planning and management of water resources in the province is clearly identified.
- Different priorities are assigned appropriate weight (e.g., the protection of the environment and aquatic ecosystems is as important as protection of drinking water).

Implementation

- The strategy is highly supportive of stakeholder input and public education programming, which both promise engagement of an even broader range of stakeholders. There is a recognized need for additional support for stewardship groups.
- The desire to understand the role of economics and the potential use of economic instruments within the *Water for Life* strategy is a major strength..
- The desire to understand ecosystem function and the role water plays in ecosystem health is a major strength.

Cooperation and Collaboration

- The *Water for Life* strategy includes consultation and ongoing engagement of the public.
- The strategy embodies a willingness to share responsibility.
- The strategy already has substantial visibility, and the public already has high expectations on what it should and could deliver.
- There is clear emphasis on participation of the public and coordination across government departments and with stakeholders.
- The highly transparent manner in which the strategy has evolved is very important in involving stakeholders and the public.

WEAKNESSES

Strategic Considerations

- Though holistic in design, the *Water for Life* strategy's approach is incomplete. For example, the plan does not account sufficiently for groundwater or the relationships between water-air-land.
- The importance of equity or fairness is not explicitly acknowledged or specifically addressed in the strategy. Equity will be increasingly important in gaining public compliance should the province be faced with the introduction of rationing programs and other water economizing measures.
- The lack of timely public funding and other public resources to support the evolution and implementation of the strategy is a major weakness. (Collaboration takes organizational attention and the time of people who are in government, not just volunteers. Without proper and timely funding for the initiative both inside and outside government, all gains made to date could be negated.)
- More attention should be paid to the impact of surface water irrigation on groundwater pollution and the potential future use of groundwater for irrigation.
- Transboundary issues - both intra-and inter-Provincial and international - are not well defined.
- Many important definitions (such as those for healthy ecosystems, conservation etc.) are missing.

- The linkages to water law and regulation in the strategic plan are weak or non-existent.
- Conjunctive use of ground and surface water should be an integral part of the strategy
- The strategy needs to contain specific targets (in a quantitative sense), and those targets should evolve as learning occurs. Adaptive management suggests that targets could change as improved knowledge and experiences becomes available. The sectoral goals for water conservation need to be set specifically based on what is being achieved now.
- The strategy should articulate a balanced portfolio of management strategies including water conservation, conjunctive management, storage and other means for managing water in general and scarcity in particular.
- The Strategy ought to include measures that will allow the Government of Alberta to respond flexibly to the likelihood that the Provincial water supply will not stay constant over time due to climatic variability and climate change.
- Similarly, the strategy should acknowledge the role and uncertainty of variables that drive demand for water such as population growth, changes in technology, and changing patterns of industry.

Allocations and Allocative Mechanisms

- The interim 30 percent improvement goal is a reasonable first step. Nevertheless, it should be recognized that it is not economically optimal to treat all sectors the same. (The sectors that use water to relatively low-value ends should be cut more, and high value water users should be cut less.) Conservation has been characterized in terms of both water use efficiency and economic productivity. These are very different concepts and should be recognized as such.
- The Ministry should consider charging fees to cover all the costs of activities for which individual beneficiaries can be identified.
- The strategy should call for the development of a conceptual framework which permits the assessment of trade-offs as part of the balancing of water resource management objectives. Where helpful, a hierarchy of models should be used. Such a framework is useful for analysis as well as communication and elucidation of values. Such a framework should be developed explicitly for use in real world decision-making.

Scope

- Economic and resource development policies in areas linked in important ways to water have been developed without adequate consideration of their overall short and long-term impacts on the Province's water resources. The result is that water policy lags and may be constrained by policy developments and precedents already established in related sectors. The strategy should acknowledge this fact and propose remedies.
- Irrigated agriculture, which accounts for the lions' share of consumptive use, is virtually unmentioned in the strategy. It should be recognized that the demands

for Alberta-produced food and fiber will be determined in part by an increasingly global agricultural economy. The importance of water for agriculture and a vision for the future of agriculture in Alberta should be recognized in The Strategy. Additionally, it will be essential to have a better inventory of uses and users for agriculture.

- The strategy should acknowledge that agriculture produces public goods such as green space and should also acknowledge the beneficial social dimensions of rural life and the contributions of agriculture not just to the economy but to the character of the province.
- Water quality issues are not adequately addressed in the strategy. Thus, for example, the strategy should adopt the “polluter pays” principle, and in addition look for opportunities to apply the precautionary principle in partnerships in which there is apparent risk to water quality.
- It is essential that the *Water for Life* strategy consider watersheds and aquifer systems together as the focus of management. Integration of these is essential if conjunctive use opportunities are to be addressed effectively.
- Reference to water sensitive urban planning is missing in the strategy. This is necessary to minimize the negative effects of urbanization on watersheds and their related water resources..
- The implications for water of transportation projects and systems should be accounted for in the strategy. Such implications bear importantly on design choices that need to be taken into account in building codes and standards.

Cooperation and Collaboration and Governance

- The cycle time for the strategy is too long to maintain community interest. (Because it is not funded and is reliant on volunteer effort, public engagement will erode and thus collaborative opportunities will be lost.)
- The words “accountability” and “consistency” are missing from the discussion of governance.
- The structure and role of the Alberta Water Council is still evolving. The structure, membership and operations are unclear and need to be refined over time.
- There should be more representation on the Council for the public.
- The evolution of the strategy and its implementation through the action plan needs to be publicly open and transparent.

Monitoring, Data and Measurement

- The strategy should acknowledge that the lack of comprehensive monitoring systems is a critical weakness. Existing monitoring systems, especially those for groundwater, are inadequate and without effective monitoring the goals of the Strategy (safe drinking water, healthy ecosystems and reliable supplies) cannot be achieved.

- Timely interpretation of monitoring data is essential but unmentioned in the strategy.
- It will be critically important to develop an inventory of water users, water uses and water rights.

Science and Research

- The linkages between science and policy in the Strategy are weak.
- The strategy ought to include measures that will allow the province to respond flexibly to the likelihood that the water supply in the province will not stay constant over time due to climate variability and change.
- The strategy should acknowledge the role and uncertainty of variables that determine the supply of water such as hydrological variability and climate change and drive the demand for water such as population growth, changes in technology, and changing patterns of industry.
- The impact of potential changes in international trade flows as a consequence of future WTO requirements should be acknowledged and assessed.